COPING WITH SO MANY CRISES, IS HUMANKID DOOMED TO FAILURE ?

Albert SASSON

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“ Climate collapse has started,’’ deplored the U.N. Secretary-General Antonio Guterres, before the end of 2023 – a record year hit by all kinds of extreme weather events.

According to the French climatologist, Christophe Cassou (French National Centre for Scientific Research – CNRS), “ the year 2023 has demonstrated that climate change is not a crisis, but a trend, along which every half °C of global warming increases the impacts of extreme weather events and their likelihood to occur simultaneously in several regions of the globe. The surface of the regions struck by these events is growing annually and increases the risks that we are undoubtedly getting farther from a world which is a living place for all.’’

“Hunger is knocking at the door, it is a final warning”, U.N. Office for the Coordination of Humanitarian Affairs.

“The climate crisis has to deal primarily with human beings, but also with economic security, national security and the whole life on the Planet,” US president’s statement at the COP27, 11 November 2022, Sharm El-Sheikh, Egypt.

“The clouds of recession are extending across the world,” has warned Seth Carpenter, chief economist at the American bank Morgan Stanley.

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FOREWORD

Paris, France, August 2022. I am at home and protecting myself against the heat wave, which has struck the French capital for the third time since the beginning of the summer season. Outside, temperatures in the shade approached the 30°C and sometimes were above such threshold, while in the south of the country they were close to 40°C right in the middle of the warm season. In addition almost everywhere in the country, megafires were burning forests, woodlands and several kinds of shrubby areas, thus reducing into ashes hundreds of thousands hectares and causing the evacuation of thousands of inhabitants. The warming of the planet and its outcome for human life cannot have to do with climate change and weather disturbances with extreme weather events, such as the present severe drought. This is happening across the world, e.g. in the south of Europe and throughout the Mediterranean Basin, and even the Nordic European countries (including Siberia) are not unscathed.

On the other hand, we are everyday smothered by the news conveyed by the usual media – radio, television, written press – and the numerical media – Internet and social networks – about the above-mentioned climatic world crisis and its overall consequences: lack of rainfall, dam lakes and waterways at very low levels, conflicts about the use of scarce water (agriculture, industry and particularly the cooling of thermic and nuclear plants, domestic uses). We are also facing a severe food crisis, which has some similarities with the 2008 crisis, but is now also caused by the war in Ukraine. Many countries depend on the imports of wheat, maize and sunflower oil, supplied by Ukraine and Russia and blocked for several months because of the conflict and the lack of security for navigation in the Black Sea. Fortunately, a recent agreement between Ukraine and Russia, negotiated with Turkey's assistance, has allowed the transport of thousands of tons of agricultural raw materials towards the Mediterranean.

Extreme poverty has increased among the poors worldwide (with a few exceptions), particularly in Africa, Asia and the Pacific, while the lower middle classes are strained by the inflation of food-items prices and have to ration themselves to limit their purchases. In the industrialized countries, e.g. in the United States or in Europe, and of course in many developing

countries, the number of people who cannot make ends meet with their weekly or monthly wages, has considerably increased. And all these people, whatever their level of poverty, have to rely on food distribution, be it by the state, the charity associations and the civic society as a whole. Everybody could see on the television screens during the Covid-19 pandemic, persons of all age (particularly students and seniors) making long queues to collect food baskets containing the most basic ingredients. The scarce supply of agrifood products was not only due to drought and warmer temperatures, but it was also worsened by the war in Ukraine (embargo on imports of cereals and cooking oil) and the high increase in inflation rate. Thus there is a correlation between the environmental crisis and the food and economic crises.

And as these crises were not sufficient to cope with, the Covid-19 pandemic has been and still is another challenge. It seems that with effective vaccination schemes, the pandemic is tapering in those countries (Europe), which applied these schemes. But China is still striving to eliminate the SARS-CoV-2 through the implementation of the Covid-0 policy. This is a very costly process, because it locks down parts or whole cities during several days (e.g. Shanghai and Beijing), thus strongly hampering economic life. The whole economic growth of China has greatly suffered from the pandemic and its slowdown explains the impact on the world economy. The Covid-19 pandemic was also part of the increasing number of emergent and re-emergent diseases and their pathogens; and by the middle of 2022 monkey pox added to the list, at least in Europe and the United States. There has been a tentative research that concluded that the prevalence of many of the communicable diseases – particularly between animals and humans – is increased by climate change and weather disturbances.

There is also an energy crisis. The prices of natural gas and oil have risen to unbelievable levels since the former crisis in 2008. Both the households and the motorcar users are heavily affected. Air transportation is also suffering and the low-cost airlines are progressively abandoning their low-rate-ticket policies. From the environmental and ecological viewpoints, there is a gradual behaviour of not flying over short distances and of travelling by train. But this behaviour, which should prevail in the short term, is not easy to adopt. The war in Ukraine and the sanctions imposed by the West

on Russia have drastically reduced the natural-gas flow from this country. The European countries that depend very much on this gas (for industry and heating) had to swiftly adopt policies aimed at ensuring the supply of gas during the forthcoming 2023 winter: finding other suppliers – e.g. Algeria, the Gulf countries and liquefied natural gas (LNG), mainly a shale gas from the United States; filling promptly their reserves and reducing some industrial uses with their economic implications. The European Union and Commission have adopted a series of measures aimed at helping countries which mostly depend on the Russian gas as well as on the embargo on Russian oil (already in place in August 2022), e.g. through relying on other pipelines inside and outside Europe (e.g. Algeria, Turkey). But the unanimous decision (except Hungary or Bulgaria) was to get rid of the supply of Russian natural gas in the very short term, adapt the industrial infrastructure and change the consumers' behaviour; and this after 70 years of peace and liberalization of economic exchanges across the European continent.

Furthermore, the energetic crisis has pushed all governments to speedily develop all the means to exploit the sources of renewable energies – mainly solar and eolian energies, and hydroelectricity when there is enough water behind the dams. But all these means, including nuclear energy, aim at producing electricity. Some countries already have a large share of these renewable energies in their energy mix. Morocco, for instance, now produces 42% of the electricity it uses from solar and wind energy. But how about the transportation, which relies on motorcars and the thermic engine, and therefore on petrol and diesel. The European Union has decided to forbid the use of this kind of engine by 2030; henceforth, the rapid marketing of electric or hybrid (petrol or ethanol, and electricity) cars and trucks, with the consequent fast designing, manufacture and distribution of electric cars – that are heavily connected and full of microelectronic devices. There is in fact, according to experts, a real motorcar revolution. However, the electric cars are very expensive and the state has to promote an assistance policy to help the buyers. But it is hoped that with the progress in technologies prices will decrease significantly. Hydrogen is another source of energy that can be used in trucks, heavy equipment and public transport (buses and aircrafts). Several countries, e.g. Iceland, Nordic European Countries, are already using hydrogen as a fuel; other countries are at the experimental stage. Hydrogen,

despite its drawbacks – it is very inflammable and a network of adequate supply stations must be built – is in all likelihood the energy of the future.

Furthermore and on the top of these crises, the whole world faces the political and economic implications of the war in Ukraine provoked by the Russian invasion of the eastern part of the Ukrainian territory. There is also a new "cold war" between China and the United States of America. They compete everywhere in terms of influence, particularly in the Pacific islands, the Indo-Pacific region, the Middle East, of technology supply (China has become a superpower in terms of scientific research, technology innovation and manufacture of all kinds of good-quality items). China's new "silk roads" project – One Road, One Belt – aims to build railways and harbours in many developing countries, which are subsequently indebted for long periods. Countries are divided: some (the Western world) support entirely or with nuances, the United States approach, others try to remain neutral because of the economic ties and weapons' supply with one or the other super-powers; finally a small group of countries are old allies of China, because of their political regimes. The war in Ukraine, initiated by Russia's invasion at the end of February 2022, has already caused tens of thousands of dead soldiers and civilians on both sides, and ten times more of crippled and wounded persons. It has, as mentioned earlier, economic implications, e.g. inflation of food prices and a likely situation of famine in some North African and sub-Saharan countries. It also triggered a vast increase in weapons manufacture. Some of these efforts aiming to help Ukraine have access to accurate and sophisticated weapons in order to resist Russian troops. But, more generally, countries try to strengthen their resilience to possible threats. On the other hand, although it is very difficult not to depend on China, in terms of a wide range of technical products and of engineering, China is a very important market for the whole world. The "cold war" and the hard competition it entails, play also a significant cultural role: each partner tries to play on its "soft power" through its language, culture and political regime, e.g. the recent extension of the Confucius Institutes network across the world.

Talking of political regimes, China may look attractive for some countries because of its huge development, poverty alleviation and increase in the individual gross domestic product. Others are strict opponents to such an

approach. But in these democratic countries, which have several political parties, regular elections, participation of the people in decision-making, trade unions and, above all, the rule of law, the democratic process seems very exhausted and it needs not only mending but a real rethinking, new ways of involving people in decision-making, the freedom of speech, reinforced role of the civic society and the full respect of human rights. There is no doubt that the solutions to the above-mentioned crisis will need the renovation of the democratic process in order to involve everyone in the crisis mitigation. The autocratic regimes or countries have no other choice than imposing their solutions, either nationally or through negotiations at international level.

At the end of this Foreword, it should be underlined that this book aims to be a summarized state-of-knowledge of the subjects presented. To a large extent, the latter have been and are treated in scientific journals, reports and press articles, on an almost daily basis. The objective of this book is to present them together and show their interactions. In order to alleviate the texts, I have decided not to add, as usual, a long list of literature references at the end. Based on facts drawn from the most reliable sources, the book purpose is to enlighten the readers and to popularize the knowledge of events of our time.

PART ONE
THE ENVIRONMENT CRISIS

The environment crisis includes climate change (disturbance) and global warming (increase in the average yearly temperatures, both on land and in the oceans), the melting of the Arctic ice shelf and the elevation of the sea level. It also includes all extreme weather events, such as recurrent droughts and their impact on river flow and on the water stress in many regions and countries, heat waves and mega forest fires, downpours, hurricanes and floods of an extreme violence, inflicting billions of dollars of colossal damage. The overall loss of biodiversity – animal and plant – in the sea and across vast terrestrial regions has been related to climate change and warming, as well as to human activities.

The unfulfilled commitments regarding climate change and global warming

In 2015, at the end of the 21st Conference of Parties (COP21) adhering to the International Convention on Climate Change, the 195 countries participating in the conference have agreed to limit earth warming under 2°C and, if possible under 1.5°C – the reference temperature being the average one of the pre-industrial era. To that end, all the States have, for the first time, made commitments to reduce their emissions of greenhouse-effect gases (GEGs) during the period 2015-2030. These gases include mainly CO_2, methane (produced by livestock) and a few other nitrogen compounds. The voluntary plans proposed by the countries were not sufficient to reach the target; consequently, the States decided to review them every five years in order to increase their effectiveness and thus reach carbon neutrality by 2050.

The COP26, held in Glasgow, Scotland, organized six years (and not five because of the Covid-19 pandemic), was therefore the moment to see if the commitments made have been implemented. The progress has not been significant: in 2015, the States' commitments were leading to an increase of 3.2°C by the end of the century. Therefore, at the COP26, it could not be hidden that the planet was still on the pathway of a "climate catastrophy", according to the Organization of the United Nations: 2.7°C, or even more because the States' objectives were not fulfilled. More than 140 States submitted to the UN new plans of action, but only half of them were more ambitious than the former ones. Some sixty States have issued programmes aimed at achieving carbon neutrality by the middle of the 21st century, but without detailing the

measures to achieve this objective and without getting rid of fossil sources of energy – the primary cause of climate change and global warming. We were therefore far from an energy transition, which was not yet on the political agenda.

China has become the world's first emitting country of GEGs, but it was also the world's leader in producing windmills, photovoltaic panels and electric cars; China is still "addicted" to using increasing volumes of coal and the country is building new coal-powered plants. India, the fourth GEG emitting country in the world – behind the European Union and the United States – follows a similar pathway as China because of its development needs and its reluctance to achieve carbon neutrality. India's Prime Minister has consistently repeated that the rich countries, which are the main polluters of the planet since the industrial era, should make more efforts. I have witnessed the beginning of this acrimonious debate between the rich and developing countries, at the first conference on Environment and Development, held in Stockholm in 1972. The debate may remain with us and will influence the outcome of the world negotiations on climate change. A more serene debate would come from the effective commitment of the rich countries to allow a fund of US$100 billion a year to assist developing countries to achieve their energy transition. Such aid is crucial if we want to reach the objectives set for mitigating climate change. While the United States, the European Union, United Kingdom, Canada (and not Australia) were accelerating their plans of reducing CO_2 emissions, they are not yet aligned to achieve the objective of +1.5°C global warming.

In this unsatisfactory context, the COP26 was held in Glasgow, from 31 October to 12 November 2021, with 30,000 persons attending and coming from 196 countries. Some 120 Heads of State were present in Glasgow. President Xi Jinping, who has not left his country since the beginning of the pandemic, was not attending the COP26, as well as the Russian, Brazilian and Mexican leaders. For about 30 years, all the countries of the world meet every year during a summit under the aegis of the UN, in order to accelerate the struggle against climate change. The UN Convention on Climate Change (UNCCC) has been adopted in 1992 during the Earth Summit in Rio de Janeiro. This text recognizes that climate change is induced by human activities (anthropic

nature) and it confers to industrialized countries the primary responsibility to struggle against this phenomenon. The convention has been ratified by 197 "parties" – 126 States and the European Union. The first COP was held in 1995 in Berlin. The following COPs are held annually in different cities across the world, under a rotation rule among the continents, or if necessary in Bonn, Germany, the headquarters of the UNCCC secretariat. Every COP is prepared over the year, through intermediary negotiations, which take place is Bonn, and it is preceded by a pre-COP. It should be reminded that in addition to the UNCCC, two other conventions have been adopted during the Earth Summit in 1992: the Convention on Biological Diversity (CBD) and the Convention on the Struggle Against Desertification.

At the COP26 in Glasgow the participants included the government delegations of the 196 States, the civic society (businesses companies, non-governmental organizations – NGOs, scientists, territorial communities, trade-unions) and the media from all over the world. As was the case with other COPs, two zones have been set up in Glasgow: the blue zone, managed by the UN and where took place the negotiations; the green zone, organized by the United Kingdom and conceived as a platform for the participation of the wider public – workshops, debates and exhibitions. Among the most important COPs, the COP3, held in Japan in 1997, adopted the Kyoto Protocol – the first treaty legally constraining, which aimed to reduce by at least 5% the emissions of GEGs – from the figures recorded in 1990 – of 55 industrialized countries between 2008 and 2012. The COP15, held in Copenhagen, Denmark, in 2009, had on its agenda the ambition to renegotiate an agreement on climate change among both the industrialized and the developing countries. It failed to achieve this goal. The COP21, held at Le Bourget, north of Paris, has led, on 12 December 2015, to the Paris Agreement, the first international treaty on the reduction of GEG emissions that aims to limit global warming under 2°C, and if possible at 1.5°C. The Paris Agreement was signed by 195 parties and ratified by 192 of them. The COP24 in Katowice, Poland, in 2018, adopted most of the application regulations of Paris Agreement. The COPs maintain the political discussions at a higher level, they keep alive multilateralism and give a voice to all countries, particularly the vulnerable ones (e.g. Small Island States). Although they cannot prevent the increase in GEG emissions, the COPs have the key advantage to draw public attention and to fully involve the civic society.

The COP26 in Glasgow was qualified by its British chairperson, Alok Sharma, as an "extraordinary COP in extraordinary times". Extraordinary, because this COP has been the most important one since the Paris Agreement in 2015. Its real purpose is to assess if the countries have fulfilled their commitments in order to reach carbon neutrality in 2050. Such assessment was expected to be made in 2020, but the Covid-19 pandemic did not allow it to take place. Extraordinary, because it was the first COP to be delayed by one year, and held in drastic conditions, i.e. the vaccination of all participants, their daily testing for the presence of the SARS-CoV-2, the full respect of barrier gestures, so as to prevent a huge contamination cluster. These measures as well as the very high costs of accommodation did not facilitate the participation of civic society and poor countries that are often the victims of global warming. And, finally, the period was extraordinary, because the urgency has never been so obvious. It has been reiterated in various scientific reports, in particular those of the Intergovernmental Group of Experts on Climate Change (IGECC), year after year, month after month; and it has never been so global, severe and visible. Across the world, there is a multiplication of floods, hurricanes, forest fires or recurrent droughts, which can be correlated with extreme weather disturbances, climate change and global warming. And, nevertheless, the countries' commitments to reduce their GEG emissions were not fulfilled sufficiently. We can therefore estimate now that the average increase of temperature on Earth might be 2.7°C at the end of the 21st century. The UN Secretary General, Antonio Guterres, has warned that this could be "a one-way ticket to disaster". The countries, therefore, ought to do more and faster!

The COP26 (Glasgow) outcome

The United Kingdom's hosts of the COP26 have done their outmost to make it a successful meeting. The former State Secretary in charge of energy has visited 45 countries with this purpose in mind. Nevertheless, the leaders of China, Russia or Brazil – major polluters – were not present at the opening of the conference. The British chairperson of the latter, Alok Sharma, has hammered the most important mission of the COP26: "To keep 1.5°C alive", as has been the objective of the Paris Agreement. This objective seems difficult to achieve, because global warming in 2022 was already at the level of 1.1°C; this may be likely if drastic reductions of GEG emissions are carried

out, rapidly and continuously, as mentioned in the IGECC report published in August 2021. Some countries, including reluctant ones, have committed themselves to achieve carbon neutrality by the middle of this century: Australia, Saudi Arabia, United Arab Emirates or Turkey. Other major polluters have heightened their objectives for 2030, such as Japan or South Africa. More than 140 countries have informed the UN about their new climate commitments for 2030 or the so-called National Determined Contributions (NDC), as requested by the Paris Agreement. But in general the countries remain rather far from the initial commitments: while adding all the respective NDCs, the GEG emissions would be increased by 16% in 2030 compared with 2010, whereas they must be reduced by 45% with a view to remaining under 1.5°C of global warming. The explanation of such a situation is that around half of the new plans were less ambitious than the earlier ones, and some 40 countries have not reviewed them at all. The most vulnerable countries, acting as a Climate Vulnerable Forum, call for heightening the countries' commitments every year, and not every five years. According to Laurence Tubiana, architect of the Paris Agreement and director of the European Foundation for Climate, "the countries at the COP26 need to be honest, serious and cristal clear. They have one more year in order to increase their endeavours and therefore they have no more excuses."

If we are dealing with a collective endeavour, it is expected much more from the G20 countries, which produce 80% of the global GEG emissions. Only eleven of the G20 countries have strengthened their objectives, without nevertheless putting them on the track of a 1.5°C global warming: South Africa, Argentina, Canada, United States, Japan, the European Union, United Kingdom and China (just before the beginning of COP26). China, the world's leading producer of GEG emissions intends to reach an emission peak before 2030, and to achieve carbon neutrality by 2060; non-fossil sources of energy would make up 25% of the energy mix by 2030. Four heavyweight countries have not officially posted new climate objectives: India, Saudi Arabia, Turkey and South Korea. The other big G20 countries have either adopted new objectives which in fact do not indicate any real progress (Australia, Indonesia), or would trigger an increase in their emissions compared with their earlier plans (Brazil, Mexico, Russia).

The COP26 should be followed by concrete actions and not just promises. It is true that during the Covid-19 pandemic, CO_2 emissions decreased in 2020, but they peaked again in 2021 – the second highest in history – due to a strong consumption of fossil sources of energy. In fact, the countries have missed the opportunity to add a green tinge to their economies, and therefore they remain far from the 1.5°C increase in global warming. On the other hand, commitments should be made at the sectorial level, i.e. regarding, as often reiterated by the COP26 chairperson, "coal, motor-cars, funding and trees." For instance, A. Sharma called for abandoning coal use as a historical deadlock. In this regard, the UN Secretary General mentioned 2030 for the OECD countries to abandon coal use, and 2040 for the other countries. However, many countries continue to rely on this source of energy. Also several coalitions, including countries and non-governmental bodies, have launched appeals in order to progressively put an end to the use of coal, gas and oil; to move from the thermic engine to electric motor-cars; to stop international funding or subsidies to fossil sources of energy; or to forbid deforestation. The United States and the European Union were involved in an initiative aiming at decreasing by at least 30% the emissions of methane by 2030, compared with the 2020 rates. About sixty countries, including France, have announced their participation in that initiative.

It was very good news that the United States have decided to join the Paris Agreement at the beginning of 2021. Nevertheless, the COP26 occurs at a time of very harsh trade war between the United States and China; also when there were many attacks against multilateralism and when the prices of energy were skyrocketing. The divorce between industrialized and developing countries that occurred in 2009 at the Copenhagen-COP15, was still looming on the COP26. The developing countries were complaining about the lack of solidarity shown by the industrialized partners, not only with regard to the negotiations on climate change, but also in struggle against the Covid-19 pandemic and the huge inequality of access to the available vaccines. Trust-rebuilding was necessary in terms of supporting the developing countries' efforts in their energy transition as well as in keeping afloat the 1.5°C threshold for global warming. A pledge of US$100 billion per year has been made 12 years ago by the industrialized countries in order to assist developing ones, and this assistance to mitigate climate change was supposed to start in 2020. This did

not happen and the COP26 has postponed this help to 2023. The developing countries' disappointment has been strongly expressed as an anger because of the pressing issue to face the huge damage of extreme weather events that these countries were enduring. However, the United States, in September 2021, announced in New York their commitment to double their financial contribution up to US$11.4 billion per year as of 2024. France's contribution was to reach €6 billion per year in 2025, one-third of the contribution being allocated to the adaptation to climate change – while the French NGOs demanded US$8 billion for this purpose. In 2019, only 25% of the climate funds aimed at helping the countries to adapt to the impacts of the climate crisis, whereas 64% of these funds were allocated to the reduction of their GEG emissions, that is to say mitigation. The Paris Agreement has foreseen a balance between adaptation and mitigation.

The COP26 has to handle both technical and political subjects, i.e. the rule book of the Paris Agreement that includes the final formulation of transparency rules – regarding the provision of precise informations on the reduction of GEG emissions or the funding support; and to agree on a common agenda of climate objectives so as to start working in 2023 on a first "world balance-sheet" assessing the progress made in the individual countries. Finally, after having left aside the issue of international carbon markets at the COP24 and COP25 due to disagreements, the COP26 has to come back on this issue in order to regulate the exchange of CO_2 emissions between countries and to create a new international carbon market. By contrast with the Paris COP21, the COP26 was not supposed to lead to a common agreement, but to ensure that a number of decisions are made. The international negotiations will continue at the COP27, to be held in November 2022 at Sharm El-Sheik, Egypt. And it was hoped almost unanimously that governments, under the tireless pressure of NGOs and civic society, move from the "thirty years of bla-bla" on the climate issue – denounced by the young Swedish environmental activist Greta Thunberg – to concrete, fast and durable actions.

The general figures and the world's biggest CO_2 producers

Nowadays, China is the world's leading CO_2 producer, while earlier the United States occupied this rank, since the beginning of the industrial revolution. The Carbon Brief site has evaluated the contribution of every country to CO_2

production, and therefore climate change since 1850, and the results show the "historic responsibility" of the United States. This exercise is nevertheless complex, because the changes in the country borders do not facilitate the estimated share in CO_2 production. Since 1850, 2,500 billion tons of CO_2 have been produced and the CO_2 concentration in the atmosphere (parties per million) has increased from 278 before the industrial revolution to 300 ppm in 1960, 400 in 2015 and 417 in 2020. One hundred years is the life duration of CO_2 in the atmosphere. By 2019, the CO_2 emissions per inhabitant reached 16 tons for the United States, 7.1 tons for the European Union, 6.6 tons for China and 1.9 tons for India. The world's average has been estimated at 5 tons. In billion tons per country the cumulative CO_2 emissions since 1850 have been estimated in 2021 at 509.1 for the United States (20.3% of the total), 363,7 for the European Union (14.5%), 284.5 for China (11.4%), 172.4 for Russia (6.9%), 112.9 for Brazil (4.5%), 102.6 for Indonesia (4.1%), 85.7 for India (3.4%) and 873 for the rest of the world (34.9%). It should be underlined that between 2010 and 2021-2022 China has emitted two times more CO_2 than the United States. China's production has increased from 0.2 billion tons of CO_2 in 1850 up to 12 billion tons in 2021, while that of the United States has increased from 0.8 billion tons of CO_2 in 1850 up to 4.9 billion tons in 2021. The reason behind such an increase has been and still is economic growth and the reliance on fossil-fuel energy (coal, oil and gas). Other factors could be mentioned: China's membership of the World Trade Organization (WTO) in 2001, the liberalization of the economy in India by the beginning of the 21st century, the resumption of economic growth in 1946 (after the Second World War) in the European Union, mining activities in Russia, forest megafires in Indonesia in 1997 and the heavy toll of deforestation in Brazil – 80% of CO_2 emissions is produced by deforestation.

India's CO_2 emissions reached 2.6 billion tons, derived from coal production (+121% from 2000 to 2018), i.e. 130.6 million tons of oil equivalent up to 288.8 million tons of oil equivalent in 2018. Regarding the production of electricity, the energy mix was, in 2019, 73% for coal, 0.5% for oil, 4.5% for natural gas, 17.5% for sources of renewable energy, 2.9% for nuclear energy and 1.6% for other sources. This highly carbon-based energy production was due to the fast economic growth of the country. The latter who was home of 17.7% of the world population, produced 6.8% of the world's CO_2 production

by 2019. The growth rate of gross domestic product has been estimated at +6.5%. Afterwards it fell down in 2020 and, according to the International Monetary Fund (IMF), it grew again. According to an NGO, Climate Action Tracker, the objectives and policies of India in terms of mitigation of climate change and global warming were lagging behind. The efforts made by the country in 2021-2022 were indicating a scenario of +4°C in global warming. The NGO strongly recommended that India should progressively eliminate the use of coal in electricity production by 2040, in order to respect the 1.5°C increase in global warming of the Paris Agreement. But India is among the leading developing countries who keeps insisting that the industrialized countries should make the biggest efforts in decreasing CO_2 emissions.

China's Head of State, Xi Jinping, announced in September 2020, at the podium of the United Nations, that he would make sure that "the CO_2 emissions of his country reach their maximum before 2030, so that China becomes carbon-neutral by 2060." China was emitting in 2021, 27% of the GEGs of the world; it may have failed to make its climate commitments when the United States withdrew from The Paris Agreement. It did not, and it even considered that the scepticism of the White House was an opportunity to take some kind of leadership and to appear as environment conscious to the rest of the world. In September 2021, still at the United Nations, the Chinese leader announced that his country would not fund new coal-fuelled plants outside China, within its colossal investment programme, the "New Silk Roads". In addition, at the COP15 on biodiversity, the country wanted to play a key role in the negotiations on climate and environment. And this, not only to improve its image at the international level, but also to impose its values and vocabulary. Thus, the concept of "ecological civilization", introduced in the Chinese Constitution in 2012, has been accepted, instead of the concept of "sustainable development", considered too much "western".

Some hoped that China will commit itself to become carbon neutral by 2050, such as South Korea and Japan. But the Chinese experts considered that such a target could not be reached. Even the commitments made by Xi Jinping will need colossal efforts, while China continues to consume fossil sources of energy for its industrial growth. Even though the share of coal in the energy mix decreases, it still represented 65% in 2021. Much more than

wind and solar (photovoltaic) energies (about 30%) and nuclear energy (5%). This situation must be correlated with the fact that China had in 2021 the world's largest number of motor-cars (thermic to a large extent): 281 million units compared with 279 million in the United States. Still, the number of cars per 1,000 inhabitants was only 204 against 649 in Japan and 816 in the United States. But as the main objective of China was to become the world's leading superpower in 2049, that is one hundred years after the Communist Party took the power. And this entails considerable industrial growth and the postponement of carbon neutrality to 2060. Nevertheless, despite these contingencies, China stated that it will fulfil its commitments, made as soon as 2015: in 2030, its carbon intensity would decrease by 65%, compared with 2005 and the non-fossil sources of energy would represent 25% of the energy mix. China committed itself to progressively increase the share of non-fossil sources of energy in its total consumption, "more than 80% in 2060." But are such commitments realistic? A French expert stated that China has done a lot: "In 40 years, its GDP has been multiplied by 26 and its energy consumption has been multiplied by five only. In twenty years, China has become the world's leading producer of LEDs (light emitting diode), wind mills, solar panels, batteries for electric cars and electric motor-cars." In terms of reforestation, China announced that it already reached, in 2019, the objective of increasing the volume of its forests by 4.5 billion cubic metres in 2030, compared with 2005. In addition, China announced it would increase this figure by 6 billion cubic metres. But despite all these commendable efforts, the consumption of coal is growing. Although China's objective was to produce only 1,100 gigaWatts (GW) of electricity from coal-fuelled plants during its 13th five-year plan (2016-2020), the *Global Energy Monitor* showed in mid-2018 that China was building 250 GW of production capacity, while 993 GW were already installed. It should be noted that "between 2018 and June 2019, China had increased its capacity of electricity production from coal plants by 42.9 GW, while the rest of the world had reduced it by 8.1," according to a French expert.

However, many experts are concerned about the likelihood for China to miss its objectives of reduction of GEG emissions by 2030, and reach carbon neutrality before 2060. For instance, Frans Timmermans, vice-president of the European Commission in charge of the energy transition, stated, during

a visit to Beijing on the 3rd and 4th of July 2023, "I am convinced that China wants to move in the right direction, but it is true that more coal-fuelled plants are opened." This statement was part of a speech he delivered at Tsinghua University. China, indeed, has been for the last two years (2021-2022) the world's leader in the building and managing offshore eolian farms or parks. According to the research centre Global Energy Monitor (GEM), the projects launched by China, including the most recent ones being carried out, represent *ca*. 379 gigaWatts in solar energy, and *ca*. 371 gigaWatts in eolian energy. This capacity is twice the present capacity of the country. If China completely carries out its projects, its power capacity in solar and eolian energy would amount to 1,200 gigaWatts in 2025, five years before the foreseen target, according to GEM. Right now, the power capacity based on solar energy reaches 228 gigaWatts, more than the rest of the world, according to the estimates made by GEM in its report. Bloomberg, the economic firm, has estimated that China has invested US$495 billion in renewable sources of energy in 2022, or 55% of the global investments made in this sector. *At the same time*, China carries out a policy aimed at opening new coal-fuelled plants. In April 2023, Greenpeace has revealed that during the first term of 2023 China has already approved a number of new coal-fuelled plants (20.45 gigaWatts of total power capacity) equivalent to that of the whole year 2021. Following this pace, the 2022 record power capacity (90.72 gigaWatts) could be overtaken. It is true that several Chinese provinces, which in 2021 and 2022 have suffered many electric breakdowns, are now relying again on coal to produce energy and thus avoid the ups and downs of the renewable sources of energy. Even Sichuan, which relies very much on hydroelectricity, is concerned about the drought and the fall of the water level of its dams; and it has therefore opened new coal mines. In June 2023, China has been struck by a severe drought – June has been the hottest month ever recorded in the north of the country – and a series of electric breakdowns may be expected in the forthcoming weeks. As mentioned earlier, this controversial situation has led many experts to express their doubts about the capacity of China to reach its objectives of reduction of GEG emissions and of reaching a decarbonated economy.

In April 2021, at the Climate Summit, organized by Joe Biden, the US President, Xi Jinping had recognized that the agenda on the struggle against

climate change and global warming "required very difficult efforts to be made." In this context, China and the United States have established a dialogue aimed at examining all modalities of reducing the GEG emissions as well as cooperation in this respect. Unfortunately, China withdrew from this dialogue in August 2022, after the crisis following the visit to Taiwan of Nancy Pelosi, President of the US Congress House of Representatives.

Regarding the position of **Russia**, Vladimir Poutine, the President of the Russian Federation, unexpectedly declared by mid-October 2021 (just before the COP26 in Glasgow) that his country will reach carbon neutrality in 2060. But this announcement was not accompanied by an action plan, nor by intermediary objectives. The Russian vision about climate change remains under the influence of possible advantages Russia could draw from global warming. These advantages are present in the public speeches as much as in the routine listing of extreme weather events (EWE), like floods, extreme drought and above all forest climatic fires or megafires – for instance, during the summer of 2021, a forest area bigger than the whole of Portugal was burnt in Iakoutia (now named Sakha) – a region where during the winter such temperatures as -50°C could be recorded. It is true that small volumes of wheat, barley and oats have been produced in this very cold region, but these crops required heavy investments. However, Greenpeace does not share this kind of optimism, as far as, for the time being, warming was not followed by energy saving nor by any change in the heating infrastructures. A similar paradox exists for the forest fires: considerable funds are invested in reforestation, but each year much more extensive areas are destroyed by forest fires, with little or no action from the public authorities.

The overall result is the following: if the reality of global warming is recognized (the phenomenon is 2-5 times faster in Russia than in the rest of the planet), the human responsibility in this process is often questioned. Since V. Poutine has become the president of Russia, in 2000, the CO_2 emissions of the country have increased by at least 15%. However, among the very rare measures taken, one should mention the legal obligation for the companies and businesses to declare their CO_2 emissions. But in general the regulations as specified in the government's statements, remain very weak. According to a Russian economic expert, the country's strategy can be summarized

in a simple way: “While there is enough coal and oil, the country should produce and sell them. Taking into consideration this approach, a ten-year scenario seems very far ...” Regarding international agreements, 1990 has been the reference year for the comparisons of CO_2 emissions and that year marked the replacement of the USSR by the Federation of Russia, these emissions could continue to grow by 40% without penalizing Russia. Such situation is not so prone to the industry modernization. In fact, just before V. Poutine’s statements, it was foreseen to increase CO_2 emissions until 2050. Public opinion, excluding some rare actions by environmental activists, is not ready to act in favour of the struggle against global warming. However, the issue of permafrost melting has been raised, not because of the global risks it may entail such as the emissions of methane, but because of the possible damage it may cause to rather obsolete oil and gas infrastructures. Every year, thousands of accidents are recorded on Russian oil and gas pipelines. Another more decisive factor is the project of setting up a carbon border adjustment mechanism by the European Union. This project, presented in 2021, would make more expensive Russian exports of oil and gas, as well as of aluminium, steel and chemical fertilizers. The Russian reaction to this initiative has been to present it as part of the commercial war between Russia and European countries; the obvious retaliation was to increase taxes on several European products. Russian businesses may be more reactive and become the actors of change.

For the time being, Vladimir Poutine’s statements on Russia’s carbon neutrality in 2060 are not very convincing. However, these statements have induced some kind of debate on the cost of energy transition. Russia’s vice-prime minister has estimated this cost at €1,000 billion over 30 years, and he assessed the likely benefits drawn from this transition. It is true that Russia has an enormous potential in terms of renewable sources of energy and of technologies aimed at modernizing its polluting industrial processes, including coal mining and extractive industries in the Kouzbass region (south-west of Russia).

On 7 August 2022, the **United States Congress** (**Senate**) has approved the project of law, called *Inflation Reduction Act* that was a light version of the US President Joe Biden’s vast plan, *Build Back Better*. The latter has been

blocked during the spring session of the Senate by a few Democrat senators who disagreed. But in August 2022, the party was reunited and all the Senate's Democrats voted for the plan. The latter was passed without a single Republican in favour. This success was supposed to raise the president's rate of public opinion approving his action. This would have a positive effect on the mid-term elections to be held in November 2022 through the adoption of the *Inflation Reduction Act*; the Democrats could claim they are making a "historical progress", according to the leader of the Democrat Senate's members, Chuck Schumer. The Act indeed included the lowering of medicine prices for senior people – a request made by almost all Americans, who were very unhappy to have to pay up to ten times more than in Canada, for similar prescriptions. As of 2026, the health minister will be able to negotiate directly with the pharmaceutical companies to make them lower the price of their medicines; the estimated savings were *ca*. US$300 billion in ten years. The Act included a more equitable distribution of the tax fees. Companies that make a profit of more than US$1 billion will pay a 15% tax fee, while a 1% tax applied to all share purchases; that enables the companies to maintain the share values and to deliver profits to the shareholders. The expected resources from these decisions, estimated at US$300 billion, will help funding the social and environmental measures listed in the plan, and at the same time, reducing the debt.

Besides the opposition of the Senate's Republican members, the left side of the Democrat party (Bernie Sanders) recalled the very high expectations of the initial project had been forgotten, e.g. nursery schools and public universities free of charge, parents' leave, and even the full payment of dental and audition devices for senior people, while the three main pharmaceutical laboratories have announced a 90% increase in their profits in 2022. It was nevertheless expected that the Act will be promulgated by the US president, whose rate of favourable opinions among the large public will gain a few points – even it is still below 50%. However, the image of the Democrat party was better than that of the US president. According to a poll carried out by *USA Today* – Suffolk University, between the 22nd and the 25th of July 2022, 44% of the voters stated that they would vote for a Democrat candidate, if the mid-term elections would be held now; 40% would support a Republican and 16% have not yet decided.

The *Inflation Reduction Act* included the most ambitious programme on climate ever adopted in the USA. *Ca*. US$369 billion will be invested in this area, i.e. energy transition, development of sources of renewable energy, manufacture in North America of electric motorcars and vehicles, of solar panels and batteries. All these investments will allow the **United States** to be close to the target objective indicated by US President Joe Biden during the COP26 in Glasgow in November 2021: a reduction of more than 50% of GEG emissions before 2030, compared with the rate of emissions in 2005. *Ca*. US$60 billion will be allocated to programmes aiming at environmental justice. *Ca*. US$20 billion will help develop less polluting practices in agriculture and US$1.5 billion will be allocated to the US Environment Protection Agency (in particular for initiatives aimed at reducing the emissions of methane). The *Inflation Reduction Act* forecasts tax exemptions for carbon sequestration technologies, which some Democrats consider they would allow coal or cement industries to collect billions of dollars in the form of subsidies, while they continue to produce toxic dust and GEGs as well. But, besides these critical observations and advice for more progress in the struggle against social inequities and for an energy transition that does not inflict a heavier burden on the poor social categories, the US president's plan for climate-change and global-warming mitigation was generally considered as a good step in the right direction. For instance, Laurence Tubiana, director of the European Foundation for Climate, considers the US president's climate plan as encouraging. In addition, she made important observations a few months before the organization of the COP27 in Egypt (Sharm El-Sheikh). She feels that, despite the promises made by President Joe Biden, when he was elected, to reduce by 50% the emissions of GEGs of his country in 2030, no important act on climate has been promulgated till 2022. It would be difficult to understand that the world's second-biggest producer of GEGs would keep off the track regarding climate change and global warming. The decisions made by the US Congress Senate and the US President reflect a greater ambition than US President Barack Obama's proposals during his second mandate (2013-2017). Nevertheless, the philosophy guiding the actions of both presidents was the same: promote and support the relevant activities rather than impose new taxes. President B. Obama's action for the promotion of sources of renewable energy had a considerable impact, e.g. Texas who is

the above all an oil State, has become the first renewable energy exporter in the United States. There will be a continuous growth of renewable sources of energy in President Joe Biden's programme. One should remind that by the end of 2021 the United States prohibited the imports of Chinese solar panels. This will be followed by the relocation of this kind of industry in the United States, and by technological innovations as well as by finding solutions to recycling rare metals – strategic materials used in the manufacture of batteries and windmills. To sum up, three referees have estimated that, within the new context, the United States will reduce by 35% to 45% the emissions of GEGs in 2030, compared with the volumes recorded in 2005. This will mean two-thirds of the country's commitments in the Paris Agreement. This is very encouraging, although the authorizations given to the exploration of fossil-energy deposits, as well as the investments made in fracking – water fracturation of shales to extract oil and gas – remain a controversial issue. Also the war in Ukraine and the associated energy crisis tend to trigger fossil-fuel production. There is also the issue of funding the climate-change transition, i.e. the assistance to developing countries to carry out this transition. The US president had pledged US$11 billion during the first conference on climate change and global warming he had organized, but this commitment was not mentioned in the *Inflation Reduction Act*. The issue will be on the agenda of COP27 (November 2022, Egypt).

Regarding the bilateral cooperation on climate change between China and the United States, an agreement was signed between both countries. But following the visit to Taiwan by Nancy Pelosi, chairwoman of the US Congress House of Representatives, the agreement has been suspended. But Laurence Tubiana is of the opinion that, taking account of the evolving situation in the United States and the final edition of the 15th Five-Year Plan in China, both countries seem to follow clear-cut approaches. In China, despite all the current debates on the need to trigger again economic growth and to use domestic coal to ensure energy security, the investments made by China into the sources of renewable energy remain considerable. China remains the world's leading investor in this sector, as well as in electric mobility. It seems that the general policy of the Chinese government in promoting the sources of renewable energy is not questioned. However, the overall situation may seem paradoxical to some extent: while it is obvious that the use of coal is

expanding in order to respond to the energy crisis, there is at the same time a harsh competition in the means aimed to use sources of renewable energy, as well as in electric mobility. Excluding Brazil, there seems to be a positive move among the large emerging countries: India has made declarations that are more ambitions than expected, while South Africa has maintained its electric sector restructuration with a view to relying no more on coal use. Laurence Tubiana has reacted to the recurrent impacts of extreme weather events such as drought, forest climatic fires and heat waves, by stating there is a risk to evaluate these events through making short-term decisions that may worsen the situation on the long term. For instance, the extreme droughts that hit southern Europe, China, India and elsewhere, demand not only immediate remedies, but also the need for a long-term policy. The latter includes the decisions to be made by the various users of water: industry, agriculture and domestic uses. The same applies to decisions on energy use in the long term in order to avoid or mitigate the crises. L. Tubiana also underlined that the greater awareness of societies over the last ten years has led the citizens to better understand the correlation between the damage they could see and the climatic change and global warming. They realize that we are dealing with it not only as an issue for the future, but for today. They will be able therefore to encourage governments to make urgent radical decisions.

Extreme weather events

Heat waves and forest climatic fires

The year 2022 has been the year of all the records: very high temperatures, heat waves (the most intense since 1947 or even since the beginning of temperature recording), recurrent extreme droughts, forest megafires, unexpected downpours and floods causing severe damage, melting of mountain glaciers. These extreme weather events occurred all across Europe, especially throughout the centre and south of the old continent. They also occurred in China, the Indian subcontinent, Latin America, and even in Siberia and Amazonia.

For instance, in **France**, after an extremely hot and dry month of July 2022, August had the same features. A third heat wave started on 31 July and lasted during the second week of August. Less intense, but longer than the earlier

heat wave, a peak of temperatures has been reached across the country as of the 10th August. Daily temperatures were higher than 30°C in all regions, except in the far north bordering the Channel. These temperatures were even higher than 35°C in large sections of the country, exceeding 40°C in some areas. These heat waves have been explained by the extension of an anticyclone over the northwest of Europe, i.e. above the British islands. This anticyclone results in a dry and hot weather, because it plays the role of a trap for the air coming from North Africa. These heat waves will worsen the drought that already hits the whole territory and leads to water restrictions applied in 93 French departments, including 68 in a state of crisis. 2022 has been the hottest year ever recorded (on the basis of temperatures recorded between January and July). Since the 17th of July, soil humidity has been much below the index recorded during former historical droughts (1976 and 2003). Some French climatologists thought that we have been dealing with an exceptional drought, the worst since the beginning of modern temperature recording (1959). Since January, meteorologists observe a rainfall deficit compared with the average seasonal rainfall. In addition, a relatively dry winter caused the insufficient replenishment of the underground water tables. It should be underlined that when heavy rains occur, they have almost no effect on soil humidity. Soils are so dry that they cannot absorb the water, which slips on them and increases the runoff. Nevertheless these rains can contribute, to some extent, to refill lakes, rivers and dams. But in 2022, many lakes, rivers or dams have reached their lowest level of water. Even some portions of river transportation of goods have been closed down because of the very low water level (in France, almost 579 km of such kind of transportation have been made inaccessible to barges and ships). Behind some dams, the lakes have reached a very low level; for instance, in the Hautes-Alpes department, the level of Serre-Ponçon-dam Lake fell down 14 meters beneath the normal average. Rivers and their smaller tributaries, as well as the lakes supply 82% of the water used in France (i.e. 26 billion cubic meters) for different purposes; henceforth their importance in the water cycle. On the 5th of August 2022, the minister in charge of the ecological transition stated that more than one hundred small human settlements have been deprived of drinking water. At this time of the year, this situation did occur very rarely. Many villages have shared their resources, thus pumping water from neighbouring lakes or treating seawater in some areas close to the coast. Water has also been supplied by truck tankers.

It is forecast that the increase in daily temperatures and the heat waves they imply, will lengthen the droughts, which may occur earlier during the year and become more intense. Since 1947, the meteorological service, Météo-France, has recorded more than 47 heat waves, the 46th one in 2022. In 75 years, the number of days with high or very high temperatures (compared with the normal ones), has been multiplied by nine. In the southwest of France, in the Gironde departments, after heat waves and megafires have destroyed 28,000 hectares of forests in July and August, new fires started on Monday the 12th of September 2022 afternoon not very far from the previous locations. Wednesday morning, the fires have already burnt 3,500 hectares of forests. *Ca*. 540 persons have been evacuated by the firemen, while four houses and a few buildings have been destroyed. The fires were boosted by the winds blowing in their direction. Firemen have been requested to come from several neighbouring regions in order to help the struggle against the fires; there were a total 1,000 firemen supported five Canadair aircrafts, three helicopters that can pour their stored water on the fires, two Dash aircrafts, and up to 300 trucks. In addition to the unfavourable winds, the very dry vegetation beneath the trees fuelled the fires, thus complicating the firemen's task. An "explosive cocktail" made of higher temperatures, drought and heat was prevailing in these areas. Nevertheless, there was some hope that the temperatures will fall down and the winds will blow less strongly. To sum up, this region of the southwest of France was still threatened by the fires even by mid-September. In the southeast, along the Mediterranean, the situation has been watched carefully by the firemen ready to squash any fire departure.

In July 2022, **China** was hit by an exceptional heat wave. Across the country, 84 towns have alerted their dwellers about temperatures reaching 40°C. In Shanghai, on 13 July 2022, daily temperature rose up to 40.9°C in the shade, a record since 2017. On the same day, in Chongqing, in the centre of the country, a temperature of 41.3°C has been recorded. Such heat waves have an impact on electricity consumption, due to air conditioning, and the authorities of several provinces have taken restriction measures in order to protect the electric network. These conditions also jeopardize the harvests and the prices of some agri-food items are increasing. It should be reminded that the 2022 heat wave is not an isolated phenomenon June was already the hottest month China had ever withstood since 1961. In July, Chinese media

reported several deaths due to the very hot weather, e.g. in Xi'an, Sechuan and Zhejiang provinces. Temperatures were to be very high by the end of the month, between 39°C and 42°C, according to the Chinese meteorological administration. Generally, China is accustomed to a hot summer (high temperatures and humidity rate). But in 2022 heat waves last longer, at least until the 24th of August. Generally rains interrupt these hot periods, and they could be very heavy across the whole country. China's antiCovid-19 policy (Covid-19 Zero) was being implemented across the country. In Shanghai and the river Yangzi basin, the inhabitants waiting to be tested, complained about the long periods they had to stay in a muggy environment before reaching the vaccination centres. These conditions were also very unconformable for the medical staff, in charge of testing the people, under their mandatory and integral uniform. In Nanchang, a medium-sized city north of Shanghai, the authorities have decided to enable the medical staff to wear a lighter dress. At the same time, some companies have designed uniforms equipped with refrigeration system for their staff exposed to high temperatures and humidity rate.

In addition to the discomfort of people, this heat wave could have an economic impact. For instance, in the Zhejiang province, southwest of Shanghai, the 65 million inhabitants have been requested to lower their energy consumption. Hotels have blocked their air conditioning at 28°C, without any possibility to lower the air temperature. Some industries, such as the textile industry, which consume too much electricity, have been requested to adopt restriction measures; that has been the case in Hangzhou, Shaoxing and Haining. Finally, the heat waves and drought in some northern provinces of China could have a negative impact on the harvests in arid regions, such as in Interior Mongolia, Ningxia and Hebei: wheat, soybean, maize and pastures are under threat. Ice cream and watermelon consumption rose in order to lessen the discomfort of the people, while some towns have reopened antimissile shelters built in the 1930s, and where the population could find a cooler environment. On the order hand, on the 17th of July 2022, the city of Hangzhou, capital of the Zhejiang province, has tried to provoke artificial rainfall trough «seeding» clouds with particles.

The lack of water, associated with a very low air-humidity and drought conditions, inevitably lead to **forest fires**. In 2022, these fires were so numerous and extended that firemen and their equipment were often insufficient to extinguish these megafires, obviously correlated with global warming. For instance, California's megafires began early, before the summer, and they were present late in the autumn. In 2022, thousands of hectares have been burnt; thousands of people have been evacuated from their households threatened by the fires. The latter extended up to the borders of Yosemite National Park. The images shown on the TV-networks were impressive and frightening; huge surfaces have been reduced into ashes in a context of recurrent droughts of which the severity has not been recorded for decades. But then, all of a sudden, downpours fell for a few hours in the desert areas of the Death Valley, which strengthens the hypothesis of associating extreme weather events with climate change and global warming. The issue of abandoning entire regions and for the people to build a new life elsewhere has been raised.

In France, in the forested areas of the southern Atlantic coast megafires occurred during the summer – July and August 2022. *Ca.* 19,000 hectares of woodlands and pine forests have been burnt since July 12th 2022. The smoke as well as a kind of mist reached the city of Bordeaux. *Ca.* 37,000 people have been evacuated – inhabitants and/or tourists living there in numerous camping sites. Some of them have returned, they saw the damage caused by the fires and decided to relocate their homes elsewhere. Others have returned to the reopened sites of camping. But the overall disaster has been considerable: from the human and environment perspective. Across the country, 60,000 hectares of forest and woodlands have been burnt, as well as many vacation sites. Throughout Europe (excluding most of the northern Scandinavian countries), almost 760,000 hectares of forests have been turned into ashes. Both the inhabitants and firemen have never seen so many megafires, to the point that the firemen were overwhelmed during several days before circling and extinguishing the fires. For a long time, the region affected will be bearing the enormous scars in their landscape, before very young planted trees and shrubs could be seen. But new solutions should be found to better protect the natural heritage and biodiversity, the populations and their habitat as well as their goods. Some experts have qualified these major fires and their impacts as

an "ecological drama", to which we must respond in the phase of emergency, to which we must be prepared, by increasing all the means of struggling against the fires; but also to foresee new methods of replanting the destroyed vegetation, of selecting fire-resistant species, of increasing all the systems of forest vigilance in both the public estate and private properties. In other words, we cannot just act in the short-term and, for instance, order more Canadair aircrafts or helicopters to help the firemen on the ground, but we must have a long-term approach; because these forest climatic fires are associated with climate change and global warming. They are part of the scenarios strongly suggested by the International Group of Experts on Climate Change (IGECC). Since the 1st of February 2023, amidst the South-Hemisphere summer, **megafires**, fuelled by an extreme drought and heat waves, have destroyed 373,000 hectares in the **central and southern region of Chile** including the Maule, Nuble, Biobío and Araucanía provinces – 280 km from Santiago, the country's capital. On the 10th of February 2023, these megafires have caused 24 deaths, completely destroyed 1,250 households and more than 2,000 persons have been sheltered by the sanitary services. These were considered as the worst fires after those of 2017, that destroyed 467,000 hectares. The newly elected president of Chile, Gabriel Boric, has stressed "the very difficult days" Chile was going through and he called on the participation and cooperation of all citizens, including the private sector. In five days, the area burnt by these megafires was close to that destroyed by the fires during two (normal) years. During the second week of February 2023, more than 5,600 Chilean firemen have been struggling to fight the fires and to reduce their extension, with the support of international cooperation. The latter has been coming from Argentina, Mexico, Spain on the United States, in the form of human and material resources. France has sent dozens of firemen, when at the same time the president of the Republic granted the help of his country in the struggle against this rife. The European Union has also promised its assistance. The Chilean meteorologists have recognized that these megafires were, to a large extent, difficult or even impossible to control. The experts have also been adamant: the origins of the fires were human ones, criminal or incidental. A police enquiry is being carried out in order to arrest arsonists (at least 28 persons have been arrested by Friday the 10th of February 2023, when 321 sources of fire have remained active).

However, a series of factors explain the speed and intensity of these megafires: climate change that is at the origin of a historical megadrought which has been lasting for *ca*. 13 years in the country; a historical scarcity of rainfall – -30% between 2010 and 2019, according to a report of the Chilean Research Centre on Climate and Resilience (CR2). During the last 50 years, maximum temperatures during the summer have increased +0.43°C per decade – the CR2 has indicated in a note of the 8th of February 2023. Daily temperatures above 40°C have been recorded during the last decade, according to the CR2 experts. By mid-February 2023, an alert for a heat wave was still maintained for a region including more than 900 km from north to south (i.e. from the region of Coquimbo to that of Nuble). It should also be mentioned that these regions contain a lot of combustible material: pines and eucalyptus planted on a large scale by the wood industry. The latter is the driving force of the regional economy and it has received the support of the military dictatorship (1973-1990). Moreover, this wood industry is at the core of territorial conflicts with part of the indigenous populations – *Mapuches* – that reinvindicate the areas occupied by the industry, because they are part of their ancestral lands. In 2022, the wood-sector exports have been estimated at €6.5 billion, according to the Chilean Forestry Institute – depending from the agriculture ministry – and this industry provides more than 11,000 jobs. Pine and eucalyptus trees consume much more water than native species and they dry out the rivers that can be a natural barrier against the spreading of fires. They also burn more rapidly than native species and the density of the plantations fuels the fires as well as their extension. Furthermore, the winds that blow over the whole region accelerate the overall damage of the megafires. There is therefore a need to rethink the wood-production system, and, for instance, planting endemic tree species that are generally more fire-resistant. Another worsening factor in the struggle against megafires is the increasing proximity between the households and the tree plantations; this makes more difficult the struggle against fires, when all efforts are made to save the households. In 2014, a modification of the "wood law" has been proposed by a senator from the Biobío region, with a view to setting up a distance of a least 500 metres between the tree plantations and the housing settlements, or the roads. In 2015, another initiative of the Chilean parliament included the former proposal and aimed to forbid the plantation of tree species that burn rapidly. The texts have not been passed, despite

the relevance of the proposals. Indeed, there is a major concern among the social actors that these megafires might become recurrent in the future and consequently be an important source of greenhouse-effect gases. For instance, in 2017, fires alone made up 90% of total emissions of GEGs recorded in the reference year 2016. They are also a major threat for the loss of biodiversity, stated the Chilean environment minister.

In almost one hundred countries – 98 million people more than in 2020, compared with the period 1981-2010 – food security is threatened by extreme heat waves. The harvest cycle is reduced, with growth shortened by 9.3 days for maize, 1.7 days for rice and six days for winter and spring wheat. An average of an additional 30% of land has been struck by annual extreme drought between 2012 and 2021, compared with the period 1951-1960. In France, the harvests of cereals, fruits as well as from vineyards have been modified by an early plant growth, due to the weather changes. A sunny month of October 2022 offered some advantages to the farmers, because the fall-sowing conditions were excellent. The first sowings of winter barley and wheat have been made at the beginning of October and till the 20th of October approximately. But due to the heat and scarce rainfall, the earliest seeds have already germinated and reached the four-leaflet stage. This is considered quite fast, and there is a risk that the crop will be too advanced and become more vulnerable to frost if the temperatures fall down quickly. An earlier growth was also noted for rapeseed, sown during the month of August. Sunshine and heat boosted plant growth. For instance, in the gardens strawberry plants still give fruit, but, although the harvest is over by the month of November, the volume of production is low during this period of the year. Regarding the growth of fruit trees, the farmers are waiting for the following spring is order to know if a hot or warm month of October has an impact on fruit production. Finally, with respect to the livestock raisers, they were happy to see their animals grazing and browsing on lands covered with green and flourishing grass.

It is good to have a few warmer days in October, but not during such a long period. All has been surprising in 2022: after such a mild winter, spring was very dry, and heat waves and water stress have worsened during the summer. Due to this unexpected weather calendar, wheat, barley and rapeseed have not been so much affected, vineyards have benefited from scattered rains in some

regions in August; the yields of maize, sugar-beet and potatoes have been affected. Grazing lands were also burnt during that period and the livestock had to feed on haystacks, before the rains occurring at the end of August or in September restore the greenery of the pastures. The combination of sunshine and dry weather had nevertheless the advantage of preventing the multiplication of fungi and other plant diseases. That was particularly true of vineyards. Similarly, it has facilitated the harvests and allowed, for instance, to store maize without its usual drying out. And consumers could taste fruit with a rather high content of sugar.

More than ever, the farmers are wondering how to adapt themselves to this climate change and global warming, in terms of cultivation calendar, more water stress-resistant crop varieties, new crop rotations, appropriate lopping practical, tree plantations and obviously access to water. Fruit and vegetable producers also raise the issue of consumers' behaviour. When the fall is slow to occur, the consumers scorn pumpkins, carrots and leeks, and they tend to extend their summer eating habits, with the likelihood not to be tuned with vegetable producers. By the end of 2022, the farmers were hoping that a cold winter will put nature in dormancy and that a more normal seasonal rhythm will follow suit.

Heat waves across Europe have been prevailing during the month of October 2022; this has been the hottest month recorded since 2001. Daily temperatures were almost equal to those of August. For instance, in France, the peak of this heat wave is expected between the 27th and 29th of October. This recurrent episode follows a very dry year, which started early and now includes the autumn in the Northern Hemisphere. During this heat wave, temperatures reached figures that were above the climatic averages for the season: until 8°C. The French meteorologists consider that across the country October was absolutely far from being typical, because during that month temperatures drop by 3°C every six days. What was even more surprising is that this heat wave lasted between 15 and 17 days. The cause was a vast low-pressure system in the Atlantic, which allows the penetration of a very hot air from the north of Africa; these air masses were blocked by a high-pressure system (anticyclonic) located in Eastern Europe. This

meteorological situation is rather classical, but with climate change it is associated with higher temperatures. Also, the winds blowing from the south become warmer when they reach the Mediterranean Sea. Consequently, across Western Europe temperature anomalies are observed: +2°C and +4°C, in particular in Spain, northern Italy and Germany. This extended "Indian summer" would, on the one hand, alleviate the heating of households, but, on the other, worsens the drought. In France, the overall rainfall deficit has been estimated at 35%, with great disparities. Thus, the southern half of the country had an extreme rainfall deficit: 80% to 90%. The heat wave, if it goes further, would entail disturbances at the beginning of spring 2023, in terms of supply of drinking water, crop yields and electricity production, as well as in terms of forest efficiency to sequester carbon. By the end of October 2022, there is a displacement of the low-pressure system northwards, permitting the penetration of a cooler oceanic air; but the weather will remain rather lukewarm, and temperatures would remain above the average seasonal ones till the 20th of November 2022. The conclusion drawn by the meteorologists is that, with the exception of a small period in September, we have recorded continuous higher temperatures since May 2022. The threshold of very hot heat waves (30°C) has been reached since mid-May. Then, France was struck by three heat waves in three months, which most likely caused an additional 11,000 deaths across the country. Finally, the 2022 summer has been the second warmest at least since 1901, just behind that of 2003. The year 2022 was also in all likelihood the warmest one to be recorded in France, behind the year 2020.

Climate disturbance, caused by the emissions of greenhouse-effect gases due to human activities – mainly combustion of coal, petrol and gas – provokes more frequent heat waves and drought periods, as well as megafires and floods. The world is already 1.2°C warmer than the pre-industrial era, and 1.7°C in the case of France. This situation is likely to worsen if the efforts of the whole international community are not sufficient to stop the climate crisis. According to two reports published by the United Nations by the end of October 2022, the world is heading towards a global warming estimated at +2.5°C by the end of the last century – a catastrophic level far from the objective of +1.5°C (maximum +2°C) agreed at the COP21 in Paris. For

France, the forecasts are worse: the warming would reach +3.8°C in 2100, within a scenario where the emissions of GEGs remain the same as nowadays. This would practically mean longer summers and extreme weather events.

Ten days before the COP27 in Sharm El-Sheikh (Egypt), one has to admit that the international community is far from the commitments agreed on at the COP21 in Paris. It is not yet clear that a "reliable" pathway has been found to limit global warming at +1.5°C. By contrast, the commitments made by most countries lead the planet to a warming of +2.5°C at the end of the 21st century. If numerous countries pursue their present policies, the rise of global temperature could even reach +2.8°C in 2100. These alarming conclusions were drawn from the report of the United Nations Environment Programme (UNEP) on its annual action on climate, published on the 27th of October 2022, and the United Nations climate synthesis of the commitments of the countries that signed the Paris treaty, published on the 26th of October 2022. The UN Secretary General spoke about "a global catastrophe" we are heading for. The planet which, since the pre-industrial era, has seen a global warming of +1.2°C, is now confronted with a series of dreadful extreme weather events – floods, recurrent droughts, heat waves, megafires – in 2022. Their relationship with climate change and global warming, caused by human activities, is unequivocal. The window of opportunity to reach a global warming of 1.5°C, as agreed in Paris, would progressively disappear, unless all the countries across the world strengthen their programmes of diminution of emissions of GEGs and implement them during the forthcoming eight years. The UNEP report even concluded that 2022 was a lost year, because the progress announced in the new plans was largely insufficient. It is hoped nevertheless that the new commitments made by Australia, South Korea, Brazil or Indonesia, would at least avoid 1% of the forecast world emissions of GEGs in 2030. It is assumed that a drop of 45% of GEGs from now to 2030 is absolutely a must in order to limit global warming +1.5°C; this drop would be 30% of GEGs if you keep global warming under +2°C – another objective of the Paris treaty. Consequently, the efforts made by member States should be trebled or even multiplied by nine.

Overall, the lack of firm commitments by the States seems to lead to a global warming that is high and dangerous. While according to UN Climate, the rise

in global temperature would be +2.5 by the end of the 21st century, UNEP estimates that this rise would be between +2.4°C and +2.6°C in 2100, if all the objectives set up in 2030 were achieved. Hopefully, 88 countries have committed themselves to reach net emissions that are nil by 2050. They include 19 members of the G20 countries that contribute 75% of global emissions and seem to head for this objective (with the exception of Mexico). All these efforts may lead to a global warming of +1.8°C. But, according to UNEP, this scenario does not seem trustworthy, because climate-change issues are postponed. Many countries have not yet adopted ambitious plans from now to 2030, so as to reach carbon neutrality in 2050. Firm action is still lacking, and GEG emissions have been increasing: 52.8 billion tons of CO_2-equivalent in 2021, not taking into account deforestation or changes in land use; this was a slight increase (+0.4%) compared with 2019. The historical drop in GEG emissions in 2020, because of the Covid-19 pandemic, appears like a parenthesis. In 2022, the CO_2 global emissions would increase again, but less than foreseen because of the remarkable growth of sources of renewable energy, according to the data published by the International Energy Agency (IEA). In 2021, the content of CO_2 in the atmosphere reached 416 ppm (parts per million), while that of methane was 1,908 ppb (parts per billion) and that of nitrous oxide was estimated at 335 ppb, i.e. a rise of 149%, 262% and 124% respectively and compared with the concentrations of the pre-industrial era. The content of CO_2 in the atmosphere reaches nowadays a value that was never recorded. The contents of methane have been the highest since the beginning of measurements, forty years ago. Due to a much higher potential in fostering global warming, despite a shorter life duration than CO_2 – approximately nine years, compared with *ca*. one hundred years for CO_2 – the reduction of the content of methane, produced by agriculture, fossil-energy exploitation, waste decomposition or in humid zones, is very urgent.

The executive director of UNEP, Inger Andersen, has drawn the following conclusion, on the basis of the analysis and assumptions made by her organization: “Times for progressive change are bygone. From now on, only a drastic change of our economies and our societies could save us from the climatic catastrophe.” She added: “it is a great challenge for humankind to reform the global economy and to halve the GEG emissions in a lapse of eight years, but we must try to respond … We must try to be closer to a

global warming of +1.5°C." The UNEP report observes that a transformation towards carbon neutrality is being carried out in four economic sectors: electricity production, industry, transports and building construction. But this transformation should be faster. UNEP also recommends that the food systems should be reformed – they contribute to about one-third of GEG emissions – through a diminution of meat consumption or the protection of natural ecosystems. The UNEP report also recommends the transformation of the financial system, because most of its actors "have not shown a real commitment to respond to climate change, despite announcements to do so." The UN Secretary General, Antonio Guterres, concluded that: "our world cannot just do green washing, or pretend to act or to come too late." He calls on the developed countries to lead the way forward through strengthening their national plans, and on the emerging economies to do more, thanks to the financial and technological assistance of the wealthy countries. Once again, the UN Secretary General makes an appeal to stop our dependence on fossil fuels and to accelerate the development of renewable energies.

Recurrent extreme droughts

Extreme weather events include recurrent severe droughts across the globe during the year 2022. They are to a large extent responsible for the megafires, which spread out rapidly across a very dry vegetation that offers a perfect fuel. Drought, heat waves and megafires all reflect the impact of climate change and global warming. These are not episodic events, but all climatologists warn about their recurrence, their frequency and their strength. Recurrent extreme droughts have a direct impact on the availability of water for domestic uses, agriculture, energy-production industry, and of course on biological diversity. Water becomes scarcer and scarcer, its various uses need to be regulated and an equitable balance should be sought between these uses. It is up to the state and to collectivities to play this role of regulation and balance.

For instance, in 2022 and everywhere in **France**, the lack of water leads to conditions that were thought to be confined to arid regions. The 2022 historic drought, that has been worsened by a series of heat waves during the summer, has created a number of societal divisions regarding the acceptable uses of a scarce resource. Tensions exist between some uses – tourism, agriculture, energy, etc. – and between the state and some collectivities. On Friday the

12th of August 2022, almost the whole of French territory was under water stress and 73 departments have been classified in crisis conditions and water restrictions were applied. Such a level meant that, according to the rules, "water will be allocated to priority uses (such as drinking water, civic security, health and sanitation)". According to the ministry in charge of ecological transition, more than one hundred communities received bottled water as their minimum supply.

During the 2022 fall, the drought persisted across the country: if the heat waves were less frequent, the lack of water is almost everywhere. By the 1st of September 2022, one-fifth of the rivers and canals were under water restriction and 1,000 km of the water network were closed to transport or tourism (14.8 % of the network). Moreover, 90% of the rivers and waterways had a very low level of flow rate or were dried up. This low water level generally occurs in October-November, so that managing the scarce water resources becomes very complicated. It was likely that some rivers will run dry in south-eastern regions of the country. This is another signal of the extreme drought France has been going through: it was present before the summer, rainfall has been scarce during the previous winter and the underground water tables have been deprived of their resources. Since the 1st of September 2022, total rainfall has been decreased by 25% to 75% across almost the country, according to the data provided by Météo-France. Some rainfall was nevertheless recorded in September, but as the soils remain compact and dry, the rains run off on them instead of filtering down to feed the underground water tables. Soil humidity indexes were lower than during the extreme drought of 1976 and 2003. Some, therefore, ask the question: Whether there will be enough water at Christmas period? Rains and snow will fall, but probably not enough to feed the underground water tables; and the supply of water will not feed enough rivers and water streams. The specialists fear that, at the beginning of 2022-2023 winter, the levels of these water tables will be lower than those of the previous year. Without persistent and abundant rains until the spring of 2023, the drought is likely to persist, particularly in the southeast of the country.

The authorities therefore recommended that water restrictions be maintained, because these measures have slowed down the drain of the underground water tables. Thus, by the 1st of September 2022, 93 French departments have been

going through water restrictions – this number has not change since 28 July 2022 –, including those considered in crisis. By mid-September 2022, 96 departments, i.e. the total metropolitan area, including Paris, have been put under strict monitoring, or under red alert, or even worse: 77 of them were in crisis. Some hydrologists have stated that two rainy winters would be necessary to refill the underground water tables. According to the NGO France Nature Environment, the objectives of a balanced and prospective water policy were set up during the National Conventions on Water: reduce the drain of water by 10% over five years and by 25% over 15 years – but that was decided in 2019. And in the meantime, agricultural irrigation has increased by 70% in the north of France. Therefore, these objectives should be revised and stricter measures must be taken, particularly regarding agricultural irrigation.

Drought is also rather frequent in the **Netherlands** – a country which generally receives abundant rainfall, and even known for the ways the Dutch master water flow, protect themselves against floods and for maintaining one-third of the country's area under sea level (polders). «Nevertheless, the drought periods, generally rare, become recurrent. Thus, the year 2018 has been an extremely dry year and it was followed by another two very dry years. While at the beginning the issue of recurrent drought was not taken seriously, now the authorities have been scrutinizing their water management policy when water become scarce», stated the coordinator of the European Centre for Drought at Wageningen University. On the 2nd of August 2022, the Dutch government has officially declared that there was a lack of water across the country. At that time, however, there were no restrictions to water access, because the drinking-water reserves were not threatened. But the authorities rely on the awareness of the inhabitants in order to avoid the wastage of water. However, at the local level, the prohibitions to use surface waters for agriculture are not numerous.

In the **Netherlands**, sweet water is provided by annual rainfall, but also and to a large extent, from the Rhine River, the Meuse and their tributaries. The river flow plays a crucial role in the country's organization. But this is being jeopardized by the drought. For instance at Lobith, at the German border, the Rhine water flow in a normal year reaches 1,750 cubic metres per second. But on Friday the 12th of August 2022, this water flow drastically fell down

to 749 m^3. River traffic from Rotterdam to the Ruhr river (a Rhine tributary) has been badly affected. The ships which navigate upstream and carry coal, metals, sand or oil, to Germany, or those who navigate downstream towards Rotterdam and carry manufactured goods, must reduce their total load because of the low water level. Therefore, the traffic is slower and the cost of the goods transported trough the Rhine River has been steadily increasing. According to the same Wageningen University's expert, when the water flow of both the Rhine and the Meuse is below the usual average, seawater enter more deeply into the rivers, and the salinization impact can be seen in agriculture, horticulture and in some peat lands that need freshwater. In order to avoid this disbalance in the ecosystems, the Water Management Centre uses the very dense network of canals, weirs and locks extending throughout half of the western part of the country, generally under the sea level, so as to allow the circulation of water and its distribution according to the needs and priorities. This kind of technologies cannot be applied in the eastern and northern parts of the country, generally above sea level and having a smaller number of canals. In the absence of this network, rivers and lakes existing in these regions or provinces, dry up, fish and amphibians die massively, insect populations decrease, while farmers start drawing water from underground water tables, angering the associations for environment protection.

Sine the 1976 drought, the Dutch government has adopted a series of rules for the priority distribution of water. In a country that will be confronted with the risks of submersion due to the rise of ocean level, the priority in to the allocation of sweet water reserves, even before the supply of drinking water to the citizen, is the protection of the dikes against the encroachment by the sea. Among the 17,500 km of dikes that protect the country, many of them are several-hundred-years old and were built with peat. The latter becomes fractured when the dikes dry up, and these can collapse, e.g. two structures during the 2003 extreme drought. By the end of August 2022, the partial restrictions on water distribution concerned agriculture and river transportation at local level, with a view to conserving sweet-water stocks. But the situation may worsen during the end of 2022 summer, because of the lack or very scarce rainfall.

In **Spain**, a crucial problem, especially in conditions of long-lasting drought, is the digging of illegal wells to pump water. In 2014, their number reached almost 510,000; but some experts estimated them at more than one million. It should be underlined that there is a lack of reliable data, not only on the wells, but on the whole hydrographic system in Spain. And this situation impedes decision-making on equitable water distribution. These wells which are located near the zones of intensive agriculture, e.g. in Andalucía (Murcia), and also close to touristic areas, can contaminate water tables. To steal water is an environmental crime and it is frequent in Spain, despite the existing heavy fines and even jail sentences (six months to five years); but these measures are not fully applied, and the lack of means to pursue the guilty farmers in court contributes to the impunity of stealers. These conditions are worsened by the fact that Spain has been officially declared in a state of exceptional drought. According to the most recent data provided by the ministry in charge of the ecological transition, the level of water reserves has fallen down to 39,2%, a record since 1995. The paucity of rainfall – 26% less than during an average normal year, since October 2021 – as well as the successive heat waves worsen water scarcity and the prospects are not encouraging. Restrictions of water distribution are already in place in certain municipalities of Galicia, Cataluña, Andalucía, Extremadura, Castilla and León, Navarra and even in the Basque Country.

In Spain, drought is not an unusual phenomenon, but it is more severe each year. In a report published in 2021, the government made a pessimistic evaluation of the hydrological situation in Spain. It underlined that *ca*. 22 million Spaniards – half the total population – are living in regions where water consumption outpaces the available water resources. This population include 3.3 million inhabitants living in very high water-stress regions. This very preoccupying situation is not often perceived by most of the citizens. A similar government report stressed that 40% of surface water and 45% of underground water were contaminated to some extent, and that Spanish rivers have now less water than forty years ago. The lack of drastic measures, some experts think, is due to the fact that Spain's economy depends heavily on tourism and intensive agriculture, and most governments were reluctant to take environmental measures, because this implied the limitation of some

agricultural activities that create many jobs. However, a report by the World Wildlife Fund for Nature (WWF) mentioned the case of the national park of Doñana, in Andalucía – on the UNESCO List of World Heritage – where thrive several thousands plant and animal species on 100,000 hectares of lagunas, marshes and forests. The overexploitation of the underground water tables of this unique park, in the estuary of the Guadalquivir River, results from hundreds of illegal wells; this situation led the European Commission to bring Spain at the European Court of Justice in 2019. Nevertheless, the situation did not change over three years and the EC, on the 15th of July 2022, has renewed a procedure of infraction and warned Spain of a severe fine if no action were taken before mid-September 2022.

A few kilometres north of Doñana, an initiative of the Andalucian regional government (*junta de Andalucía*) aimed to develop *ca*. 1,900 hectares of cultures of red fruits, which are irrigated using illegal wells, according to the estimates of WWF. The Spanish central government has been opposed to this project that has been suspended. But what is at stake is the following: being the leading exporter of red fruits to Europe, the Andalucian province of Huelva, where the park of Doñana is located, produces *ca*. 300,000 tons of strawberries – 99% of the total Spanish production. This horticultural activity provides jobs to *ca*. 100,000 persons and contributes to *ca*. 8% of the regional GDP, according to the association of producers Freshuelva. Being the orchard or the vegetable garden of Europe, Spain is becoming a more arid area and is even threatened with desertification in the southern half of the country. It will not be possible to irrigate 4 million hectares of agricultural land – this figure includes only legal cultures. We should adapt our agriculture and avoid to plant, for instance, tropical species like mangoes or avocadoes. Water becoming scarcer and scarcer, such adaptation is compulsory, stated an expert of Greenpeace in charge of water management.

In **Italy**, the 2022 drought has been qualified as historical. Heat waves and the paucity of rainfall have worsened a situation of water-stress. Nevertheless, it is estimated that 40% of the water circulating in the distribution pipe networks is wasted. In some communities, this figure can reach 70%. This serious defect is not new, but has become even more obvious with the 2022 drought. Time is short to win this battle against water leakage and wastage. Some experts

underline that it is a pity in a country where, 20 centuries ago, the engineers and architects of the Roman Empire invented the aqueducts to convey the water with an outstanding efficiency. Following the recurrent warnings of the World Wildlife Fund for Nature (WWF) about water wastage, the NGO concluded that the Italians consume more water than the other Europeans because of this wastage. The main reason is a very old and degraded network of distribution: 60% of the latter is more than 30 years old, and 25% of the existing pipes have been laid more than 50 years ago. The reclamation and rehabilitation of the network are a Herculean piece of work, because there are more than 500,000 km of water pipes; and the government aims to reduce the water wastage by 15% in 2026. To that end, the national plan for boosting economic growth and resilience (PNRR) includes a budget of *ca*. €4 billion, aiming at protecting water resources, with €900 million for the maintenance of water infrastructures.

The Italian startup Sensoworks, founded at the beginning of 2020 and specialized in artificial intelligence, has developed a system of sound sensors that allow the localization of the leakages or the likely break down of the pipes, without having to dig down ditches. This will save a lot of time in the maintenance of the water-pipe network, a priority being given to the oldest infrastructures. Sensoworks is already using its expertise in the Latium (centre) and Campania (southwest) regions. In the Brescia province (Lombardy, north), another company, PipeCare, is working in the same area: in addition to the "numerical monitoring" of the leakage points and to the remote tracking of corrosion signs on the water pipes, the company is providing a system of repairing the leakage points through the injection of at organic resin. The latter is considered "revolutionary" by the company and its role consists of taking the shape of pipes, thus avoiding digging ditches in the ground. PipeCare delivers the repairs in two weeks, compared with several months for a traditional piece of work. During the fall of 2021, PipeCare operations in Brescia, in conjunction with the local energy supplier A2A, have resulted in a reduction of almost 10% of the water wastage, according to the municipality.

Regarding the **United States**, and particularly the South West of the country, on the 16th of August 2022, the director of the Bureau of Reclamation – the Federal agency in charge of the management of water and dams – has stated

that the drought, which has been hitting the region for the 23rd time, has reached "a no-return point." The two most important water reservoirs of the country, Lake Powell and Lake Mead, have reached very low levels, probably the lowest in recent history. She mentioned that exceptional measures had to be taken in order to guarantee the supply of hydroelectricity to the population. The Bureau has qualified the situation as "lack of water of category 2", which means that Arizona and Nevada should have to reduce their consumption of hydroelectricity as of January 2023. Mexico was also concerned. One should recall that the Colorado River – having a total length of 2,320 km – supplies water and hydroelectricity to 40 million people in seven States, as well as to 29 Amerindian tribes. Between Arizona and Nevada, on its course, near Las Vegas, Lake Mead – the biggest dam lake of the country – has become the symbol of aridity of California. Its water level has become the nightmare of millions of Californians. The River Bill regulates the sharing and distribution of water of the river since the agreement, the *Colorado River Compact*, in 1922. If the water level of Lake Mead falls below 328 meters above sea level, the Bureau of Reclamation, in charge of the river management, make a statement of lack of water category 1. It has done so in August 2021, for the first time since the inauguration in 1935 of the Hoover Dam, behind which lies Lake Mead, 50 km from Las Vegas – Arizona, has lost 18% of its water allocation for 2022, Nevada 3%. In August 2022, the water level of Lake Mead fell down to 320 meters and a second series of restrictions have been imposed. The critical threshold of the lake water level has been estimated at 273 m : at this stage, the water turbines of the Hoover Dam enormous hydroelectric plant, which meets the needs of Las Vegas (Nevada) and its 42 million visitors a year, would stop running. The specialists call this stage the dead pool. On the 15th of May 2023, the level of the lake was 320 m: a miraculous rise (+1.82 m) due to the exceptional rainfall during the winter. Millions of persons had a sigh of relief, but those in charge of the river management were still anxious: Lake Mead was still lacking 72% of its capacity. Even heavy rains could not compensate the water deficit resulting from 20 years of drought. In 2022, the *Colorado River Compact* was a century old, and climate change makes it difficult to implement: the river has lost 20% of its water flow since the agreement between the seven American States (Colorado, Wyoming, Utah, New Mexico, Arizona, Nevada and California). But nobody would dare to

change its basic principle: anteriority. First come, first served: this is the law in the West of the country. The farms of the Imperial Valley, established in the 19th century, receive more water than the whole of Arizona State. In 1968, when Arizona wanted to build a network of 500 km of canals, the Central Arizona Project, with a view to deriving the water of the Colorado towards the centre of the State and growing alfalfa and cotton in the middle of the desert with a federal funding, California objected. It has lifted its veto on the condition that its neighbouring State be the first to be hurt if the distribution of water is restricted. This was the case in 2023, and some farmers from Arizona have received only 13% of their usual allocation. By contrast, in California, no restriction has been imposed on the farmers, who nevertheless made some concessions in terms of water pumping. The competition between California and Arizona is a long-term one. Arizona has initially refused to sign the *Compact* during 22 years. In November 1934, war has been declared to California in order to stop the construction of Parker dam, 300 km south of Las Vegas. The water district of Los Angeles has unilaterally decided to build this dam in order to bring water to the south of California. In 1952, both States have taken their case to the Supreme Court of the United States. The court took 11 years to deliver its decision, that confirms the water quota to each State: out of the 9.3 billion m^3 of the Colorado River allocated to the south basin, 4.4 million m^3 should go to California, 2.8 million m^3 to Arizona and 300,000 m^3 to Nevada (Las Vegas was at that time a small town in the desert). Nowadays, the rivalry between the States is exacerbated by the aridification of the whole region. Arizona as well as five other States demanded that the sacrifice to be made in terms of water withdrawal be shared equitably among all the States. But California – 39 million inhabitants and the world's fifth-biggest economy – refuses to make a backstep regarding the River Law and its privilege to have been first. On the 22nd of May 2023, a truce has been agreed between both neighbours. The latter and Nevada find a compromise in deciding to save 13% of the water pumped in the river. This was possible thanks to the federal government which has made a pledge of US$1.2 billion to help farmers leave in fallow some of their lands cultivated with alfalfa and cotton. This truce is just temporary and a revision of the *Colorado River Compact* should be made before the end of 2026. Some hydrologists consider that savings of water can be made in terms of agricultural irrigation: a total of

20% seems feasible. Because the same experts make an outcry such as : “We cannot let the Colorado River dry out and we cannot reach the point when the Hoover Dam turbines would stop providing enough electrical power.”

The federal authorities hoped to reduce the tension between the States, thanks to the assistance provided by the federal government in order to mitigate the impacts of drought. This assistance included the funds for infrastructures approved in November 2021, i.e. U$8.3 billion of investments, and in the *Inflation Reduction Act* notified by the US president on Tuesday the 16th of August 2022. This act earmarked US$4 billion in order to increase the resilience of the Colorado Basin. The Bureau of Reclamation would allocate indemnities to those who will give up their water share.

In Utah, at the beginning of June 2022, the level of the Great Salt Lake reached the level of 1,276 m above Sea level, while the scientists consider that the critical threshold is 1,280 m; at this level the lake will start to perish. Eighteen months later, thanks to winter rains, the level of the lake has risen 1.20 meter. The prospect to see its lake disappear causes a real upheaval in Salt Lake City. Until then the lake environment did not really attract the attention of the inhabitants (3.3 million people live in Utah and most of them are Mormon). They were more interested in the mountainous areas, but now everybody is united behind the slogan: Save the Lake! Presently, 2,070 km^2 of bottom of the Lake are exposed (i.e. 20 times the surface of Paris). Dust tempests are increasingly frequent and, in the medium-term, Salt Lake City is threatened. Since the *New York Times* has quoted the research and conclusions of Kevin Perry, professor of atmospheric sciences at the University of Utah, who contributed to the engagement of people, and the newspaper recalled the statement of a deputy that qualified the drying up of the lake “an environment nuclear bomb”, the issue has become a major concern. In Utah, 82% of the water is used in agriculture; hay and alfalfa consume two-thirds of this water, but they did contribute to only 0.2% of the State’s gross domestic product. It has been suggested by a professor at the University of Utah that thanks to an US$80 tax per inhabitant, it would be possible to financially help the farmers abandon the cultivation of hay. And the volume of water saved would be more than enough to fill the lake. But it remains to evaluate the impact of the almost disappearance of agriculture on the rural economy. In a State where

agriculture is so embedded in the identity of the people, it is out of question to limit the role of farmers – the Mormons persecuted in the east of the country find a refuge in this unhospitable basin, which they progressively developed. The Mormon Church – one of the biggest landlords of the American West – had to step in the debate: on the 17th of March 2023, Bishop Christopher Waddell has announced a perpetual donation of 25 million m^3 in order to contribute to refilling the lake. In other words, the water of River Jordan will not be derived to irrigate the Church's farms, but will be proved towards the lake. This gesture represented only 2% of the water volume needed, but it stimulated other efforts to save the lake.

In September 2022, **megafires** continued to destroy considerable areas of woodlands in **California**. Thus, since the sixth of September, on the foothills of Sierra Nevada, in northern California, the "Mosquito Fire" caused a disaster that lead to the evacuation of 11,000 people. Having burnt 17,000 hectares of woodlands and underwood, it is considered as at the second most important fire in 2022. The plume of smoke could be seen until San Francisco Bay, i.e. 200 km west of the fire area. The formidable images of the pyrocumulus, created by the megafires and seen on the social networks, were accompanied by an atmospheric "mushroom" that reached up to 12,000 metres in the sky on the 8th of September when the fire crossed the American River. Once again, the electricity company PG&E has reckoned that its activities may have a relation with the initiation of the Mosquito Fire. The latter continued to defuse toxic smoke on Lake Tahoe – a natural jewel of Sierra Nevada at an altitude of 1,850 metres. In southern California, firemen who were struggling against the Fairview Fire, that destroyed 11,300 hectares of woodlands and caused the death of two persons, 120 km southeast of Los Angeles (not very far from San Diego), could have some rest because of a relative drop in temperature. Earlier on, the region suffered from heat waves during 10 days. According to Gavin Newson, governor of the State of California, September has been the hottest month and the longest in this regard, in the history of the Sate. Since early September and the holiday week-end of Labor Day, many heat records were registered because of the presence of a stationary heat dome over the Golden State: at Los Angeles airport, on the 9th of September 2022, the daily temperature (in the shade) reached 38.8°C – the highest figure since 1984 – and in Sacramento, the State's capital, the 1925 record of temperature has

been beaten on the 5th of September, reaching 46.7°C. All the towns located in the Central Valley have recorded, between the 4th and the 9th of September, temperatures that have never occurred in September. In a period of ten days, dozens of people had to be admitted in hospital in the region of San Francisco.

Furthermore, the Golden State could fortunately escape from a very rare extreme weather event on its west coast: a hurricane. At the beginning of September hurricanes generally hit the region of the Gulf of Mexico and the Atlantic; hurricane Kay passed over the Mexican coast in Baja California and headed for the United States. Since 1858 in San Diego a hurricane has never landed in California. In September 2022, fortunately, hurricane Kay was finally a tropical storm that poured heavy rains on the south of the State, but the floods with their numerous casualties and mud slides that generally scare the local authorities, did not occur. The worst situation has also been avoided with regard to electricity production. Blacks-outs have not been necessary; Californian people have shown a commendable behaviour, praised by the State's authorities. For about ten days, they received flex alerts, launched by the supervisor of electrical networks of California, the Independent System Operator, with a view to requesting them to save energy between 4 pm and 9 pm and to switch on their air conditioner only when room temperature rose above 25.5°C, and to switch off all the non-essential electric equipment. On the 6th of September 2022, when energy consumption reached a peak (52,061 megawatts), 27 million telephones received a special flex alert at 5.45 pm. The reaction of the consumers was very positive, because the overall energy consumption has been decreased by 2,600 megawatts in 45 minutes. On the 9th of September 2022, the State's governor took a series of measures aimed at protecting the population against heat waves that become more frequent and more severe, due to climate change and global warming. These measures included the setting up of an early alert system and implementation of environmental-impact studies on the effects of heat waves on companies, their employees, fragile people and perinatal health. These measures took account of the observations made over the years: in the 1990s, temperatures in Los Angeles were higher than 32°C during 56 days (average); the models produced forecast that in 2072 such temperatures would last 87 days.

Another example of recurrent and extreme drought concerns the **south of Irak**, where Lake Sawa dried up completely. This lake has been formed more than 5,000 years ago, near the Euphrates River, in the farthest western part of the Mesopotamia fertile valley. The latter extends up to the Tigris River and it is the cradle of the Sumerian civilization that brought to the world the art of writing as well as agriculture. According to an Iraki environment expert, the surface of the lake represented, in 2022, 5%-10% of its initial area. It will never come back to this area and play the role of a water reservoir. If the remaining surface of the lake could be saved, that would be a valuable accomplishment. This situation is compounded by the harsh competition between the main users of water: industrialists, farmers and livestock herders. Thus the extreme drought has pushed many farmers to dig wells illegally in this desertic area, with a view to supplying water to agricultural projects and to industries such as cement factories and salt works. These wells withdraw a lot of water from the underground water table, which feeds the lake. The drying up of Lake Sawa in April 2022 has once again underlined the urgency of mitigating climate change and global warming in a country suffering from water stress and confronted with recurrent droughts and desertification. The year 2022 has been very critical: the lack of seasonal rainfall and the drop in the water level of the rivers have reduced by 60% the sources of water, compared with 2021, according to the ministry in charge of water resources.

For a long time, Iraki authorities have ignored the whole problem of water scarcity and stress, despite the alarming reports of United Nations agencies and environment experts. The United Nations Environment Programme (UNEP) has listed Irak as one of the world's five countries that are very vulnerable to climate change and desertification. For instance, the cumulative water flow of both the Euphrates and Tigris has been halved over two decades. These rivers supply 98% of surface waters of the country; while desertification has been extended to 39% of the national territory and 54% of agricultural soils have a high content of salt precisely because of the reduction of surface water. *Ca*. 7 million Iraki people are suffering from these conditions and are prone to become climatic migrants. According to the World Bank, the employment in agriculture has fallen from 43% of the total national figure to 26% since 1991. The Iraki government has launched, at the end of 2020, a national plan for the adaptation to climate change with the UNEP's assistance. *Ca*. US$2.5 million

have been allocated to the plan, but in May 2022 another US$3 million were added, after the drying up of Lake Sawa and a series of sand storms, in order to set up projects against desertification. Many environment experts think that it is too late and not enough, when they refer to a more proactive and efficient policy of the decision-makers. It should be mentioned that since 2014 a global plan of action against the water crisis that foresaw a US$180 billion investment over 20 years, is at standstill. However, every year, water needs increase due to population growth: Irak's population would rise to 70 million people in 2050, from 40 million in 2020. At that time, there may be no water at all ! The ministry in charge of water resources has estimated that there will be no water in both the Euphrates and Tigris by 2040, and experts belonging to that ministry consider that life would become almost impossible across the country. For an ex-minister of water resources, the main issue has to do with the construction of a hundred dams and reservoirs on the Euphrates and Tigris. In other words, every drop of water is under the control of these works. And as Irak lies downstream, it suffers to a large extent from the hydraulic projects carried out by the countries stretching upstream the rivers. Turkey, which stretches north of Irak, and where both rivers originate and then flow throughout Syria and Iran, has been suspected to derive water in order to develop an intensive agriculture. In fact, Turkey has been building since the 1970s a dozen of dams out to the 22 works planned in the framework of the Project of South-East Anatolia (GAP), including that of Ilisu, finished in 2018 and which reduced by 34% the Tigris water flow. Syria has built two dams on the Euphrates, while Iran has diverted the course of 34 rivers, which were feeding the Tigris in Irak. The negotiations among the neighbours of Irak are at standstill: water is a red line for the three countries; while the persistent drought is worse than terrorism, stated that ex-minister of water resources. Every country claims that a war about water should be avoided, but some appeal to the United Nations with a view to finding an equitable solution in water-resource sharing. But it should not be hidden that Irak has also a responsibility: it built a dozen of dams on the two rivers, and, despite the increasing scarcity of water, the Iraki authorities are planning to build a new dam in Makhoul, at the confluence of the Small Zab and Tigris. There are many leakages from these works as well as from the networks of water pipes, which are old and deteriorated after four decades of war, including the last

one fought against the Organization of the Islamic State, from 2014 to 2017. Water is also wasted as the result of flood irrigation, a technique inherited from the Sumerian period and that many farmers continue to use, while drip irrigation should prevail.

The Al-Mouthanna province, where Lake Sawa is situated, is mainly a desertic area with soils containing high concentrations of salt. It was among the first Iraki provinces to suffer from the drought and water crisis. The latter is threatening the employment of 70% of the 900,000 people who live from agriculture and livestock breeding. On the other hand, big farmers have left the river in order to develop agricultural projects in the desert: *ca*. 25,000 hectares of land have been sown with barley and wheat during the winter and they are irrigated with water pumped from wells that are deeper and deeper in these arid regions. The farmer association of Al-Mouthanna has estimated the number of these wells at *ca*. 5,000, most of them dug illegally and sometimes down to a depth of 400 metres. On the other hand, a very small number of farmers have adopted modern irrigation techniques, such as drip irrigation or automatic sprayers, in order to limit their water consumption. The ministry in charge of water resources wanted to close down illegal wells and to forbid digging new ones; but it would face the farmers' anger. In the meantime, the harvest of wheat and barley has been very poor in 2022; and the government has instructed the farmers to halve the surface devoted to these crops. If the conditions of water stress and extreme drought are repeated the following year, the big farmers could not maintain their activity. The livestock breeders are already in great difficulty; the flocks and herds have been decimated due to the lack of vegetation to graze or to browse. The public authorities have realized the magnitude of the crisis when the populations of the Rhim gazelles collapsed in the governmental reserve close to Lake Sawa.

Within the fertile valley, on the banks of Euphrates, the landscape becomes greener; flocks and herds are browsing at the shade of date-palm trees and water buffaloes refresh themselves in the remaining ponds. However, all the livestock is suffering from the water crisis and heat waves. In June 2022, the authorities have forbidden the sowing of rice across the whole valley. In addition, maize and alfalfa had to be authorized, because the three crops need more water than other drought-resistant crops. In these harsh environmental

conditions, the farmers have also to deal with the political crisis through which Irak is going. The government changes result in changes in the strategies aimed at struggling against the water crisis. One end result of the latter is that many small farmers try to keep their plot of land and at the same time find out a job in the neighbouring towns. But most of them are afraid of the collapse of their agricultural activity, if the river water flow continues to shrink. The number of climatic migrants or refugees will therefore be on the rise.

Water stress and its impacts

The persistent lack of water (recurrent drought), coupled with high temperatures, has affected almost the whole globe in 2022. Climate change and global warming are the causes of this rarely seen situation. Water stress is becoming a global issue and warns us, once more, that all countries should reduce their greenhouse-effect gases; obviously, some more than others, but it is an urgent humankind's task. Otherwise, for a growing number of human populations life would be unbearable or even impossible on Earth.

For instance, in **France**, during the summer of 2022, the combination of the heat waves, the very low humidity content of the air, the dryness of the woodlands and underwood, the non-maintenance of this underwood in order to eliminate inflammable weeds and shrubs, has resulted in forest fires the number and intensity of which have never been recorded. By mid-August 2022, according to the information system on forest fires, *ca*. 61,507 hectares have been burnt across the country. That was unseen until then: hundreds of firemen and aircrafts have been struggling to extinguish more than eight megafires throughout the country, as well as many less extensive fires in the areas prone to annual recurrent fires, but not exclusively. We have seen fires in the northeast, a humid region, but that suffered from heat waves. France had to call on European assistance – Italy, Germany, Greece, Poland, Romania and Austria – to help mastering the megafires. The latter are obviously related to climate change and global warming, and especially to severe water stress conditions. Two factors indeed should be borne in mind: the drought due to the rainfall deficit for more than a year, and the heat waves. The scarcity of water causes a drought that will make the trees more inflammable. In addition, drought causes a total lack of water in the soils; consequently, the trees drastically reduce their activity in order to become more resilient; but

the plant cover becomes more vulnerable, due to the reduction of transpiration and premature loss of foliage. All conditions are therefore met to allow fires to burst up and destroy large areas.

Since 1947, Météo-France (the national meteorological service) has underlined that the number of days with very high temperatures has been multiplied by nine, and climatologists' forecast is that droughts will occur sooner in the year, they will last longer and they will be more severe. That is why France's prime minister, also in charge of ecological transition, has recalled that a new plan of adaptation to climate change will be debated at the parliament. In fact, by mid-August 2022, almost the whole French metropolitan territory was under water-stress conditions: restrictions of water distribution have been imposed, with 73 departments considered in a crisis status – the highest level of crisis, when water is only used for priority needs, e.g. in health and sanitary conditions, drinking water and civic security. According to the ministry of ecological transition, there was no tap water in *ca*. one hundred communities that had to be supplied with bottled water.

In **China**, in the northwest of the country – an arid zone to a large extent – floods have caused heavy damage, while an extreme drought along the Yangtze River has occurred along with temperatures above 40°C, recorded in one-third of the meteorological stations across the country. From Shaanxi in the north to Guangdong in the south the temperatures have never been so high since 1961– the year they started to be recorded. In the provinces suffering from drought and through which the Yangtze flows, temperatures were 6°C higher than the usual seasonal figures. In the Sichuan province – 83 million inhabitants – the river water flow has fallen to 20%-50% of its usual volume. At Wuhan (Hubei province), the water level of the Yangtze has never been so low. In another province, the Jiangxi, Lake Poyang – the largest lake of sweet water in China – has lost three-quarters of its area due to the lack of rainfall: its surface has shrunk down to 737 km^2, compared with 2,203 km^2 in 2021 at the same period. The lake started its dry-season period on the 6th of August 2022, 69 days earlier than the average period recorded during the last 20 years. According to experts, the drought will last at least until September 2022.

As a result, hydroelectric production that supplies 80% of electricity in the Sichuan province and 17% of the total electricity in the country has dropped

by 26% in July 2022, compared with the 2021 figures. Furthermore, these heat waves trigger an increased consumption in air conditioning, which needs a big supply of energy, while the overall demand for energy reached record figures. On the 14th of August 2022, in the Sichuan province, out of 21 towns 19 have requested, many industries to stop their production for a week, in order to privilege the supply of energy to residential zones. Among the companies that have been affected, one can quote the motor-car manufacturers (Toyota and Volkswagen, for instance), FoxConn which assembles the Apple Ipads and the world's leading producer of batteries for electric cars, Contemporary Amperex Technology (CATL). On the 17th of August 2022, in the megacity of Chongqing (30 million inhabitants, including its suburban zones) the temperature recorded was 44.6°C. During the same day, the city authorities have requested industrial companies (several motor-car manufacturers) and commercial centres to reduce or even stop their activities until the 24th of August. The Chinese press also mentioned that two other provinces, Jiangsu and Zhejiang, took similar measures. It is nevertheless true that the blackouts cannot be compared with those occurred in August and September 2021 across the country; but they could slow down an economic growth, already quaked by the Zero Covid approach to struggle against the pandemic. Many western experts estimated that economic growth would be less than 3.5% in 2022, two points less than the evaluation made by the Chinese government. Furthermore, the drought will have a heavy impact on the harvests of several crops and a subsequent increase in the price of foodstuffs – a very delicate issue in China. With a view to responding to the lack of hydroelectricity, Chinese authorities have boosted coal production and its use in energy production: +15% during the two first weeks of August 2022, compared with 2021. For the authorities the obvious priority is to support economic growth and social stability.

The second impact of water stress, which is related to forest or woodland or plant cover fires, is precisely the extreme dryness of the vegetation and its vulnerability to be burnt into ashes, whatever the origin of the igniting sparkles. As soon as water becomes scarce and air humidity very low, the trees stop their transpiration and lose their wilted leaves. The most fragile among them die, but a large majority suffers from heat. However, there are some differences: whereas spruce and beech burn rapidly, holm oak – a Mediterranean species

– is more resistant; but this does not mean an entire resilience to the recurrent and extreme droughts. In France, for instance, out of the last five years, four have been very dry. Only the year 2021 was an exception. That was the case across Europe: according to a study published on the 15th of March 2022 in the review *Geophysical Research Letters*, the drought which hit the old continent from the beginning of 2018 to the end of 2020 has been the most severe since at least 1766. The summer of 2022 follows the same trend: for instance, the total rainfall over the French territory, between the 1st of January and the 7th of August, has been the second-lowest (just behind 1976), with an average of 332.5 millimetres of rain. Besides the fact that the northern part of France was more affected by the water stress, because plant species are less adapted to heat waves, the overall situation is particularly critical in the urban areas; there, buildings and human activities contribute to the formation of "heat islets", where water restrictions can worsen the risk of plant-cover desiccation. In rural areas, plants weakened by water stress are facing other threats such as fires induced by the lack of transpiration and therefore of humidity. By the 13th of August 2022, *ca*. 61,507 hectares of forest and woodland areas have been burnt in France, i.e. a destroyed surface eight times higher than the average for the period 2006-2021. The soil humidity index – that represents over a depth of 2 meters the soil-water reserve compared with the reserve available for hydrating the plants – fell down to a historical level on the 17th of July 2022 and it has reached since the 6th of August 2022 the national record figure of drought since 1958. Also in France, the recurrent or episodic heat waves are detrimental to the plant cover: since the beginning of 2022, 30 days of scorching heat have been recorded and the month of July has been one of the four hottest months since the beginning of the 20th century – with an average temperature of +2.1°C across the French territory.

In order to increase their resilience to heat, some plant species tend to migrate northwards. Winds, as well as some animal species which also seek cooler areas, can transport pollen grains and seeds far from the plant origins. Researchers of the University of Alaska have described this phenomenon in the case of the white spruce migrating northwards. In France, it has been noticed that several plant species tend to migrate towards higher-altitude areas: some underwood species, because of global warming, are displaced towards summits of French ridges. Finally, water stress makes the flora more

vulnerable to diseases and parasitic insects. For instance, the proliferation of bark beetles, which cause heavy damage in trees like spruce, is explained by the drought conditions. In 2020, another dry year, it has been estimated that 1.8 million cubic meters of spruce wood have been deteriorated by the bark beetles in the northeast of France.

Water stress has also a profound impact on the wild fauna. That was particularly the case in Western Europe. We have seen, for instance, the disastrous death of carps in the southwest of France. Near Granada, Spain, in the national park of Sierra de Baza, dozens of deers and does have died because of the lack of water and heat waves. The disappearance of lakes and ponds, due to the drought, has caused the asphyxia of hundreds of frogs in the French Mercantour, a mountainous area near the border with Italy. It has to be reiterated that the drought that struck Western Europe in 2022, the worst since temperatures have been recorded, had a disastrous impact on the wild fauna. Some experts consider that 2022 would most likely be a reference in terms of overmortality of aquatic and terrestrial species. Underground, many insects and invertebrates die due to the lack of water. In fact the soil humidity index is lower than those figures recorded during earlier droughts, in 1976 and 2003. In some soils, most of the microorganisms disappear and the functions they play in the food chain as well. That is why wild boars are found near water pipes or along some beaches, because they try to find something to eat instead of the insects, earthworms and caterpillars, or even slugs and snails, on which they feed when food becomes very scarce. Hedgehogs walk across long distances to find something to eat and many of them are crushed on the roads. Hedgehogs also are considered as “sentinel” animals, because their behaviour gives an indication on the degradation of the ecosystem where they live. It is also true of the green tree frog. According to the World Wildlife Fund for Nature (WWF), this amphibian, present in the ponds and lakes of the northern half of France, is among the first species to suffer from water stress, disappearance of humid zones and water pollution. It is on the list of threatened species of the International Union for the Conservation of Nature (IUCN).

In the aquatic environments, the impact of drought on the fauna is due to the high water temperatures. For instance in August 2022, in the city of Orléans (centrewest of France), the temperature of water in the Loire River – the

longest river in the country – has reached 31°C. On the 15th of July 2022, a peak of 32°C has been reached in the last wild river of the Old Continent, the Vjosa in Albania. Such high temperatures are lethal for many fishes; they provoke disasters among those species undertaking long migrations during summer time, such as the shad or the Loire salmon, the last wild strain in Western Europe. These species suffer from both the higher water temperature induced by the sunshine and the lower water flow, as well as the decrease in the water movement that slows down the mobility needed for the fishes' biological cycle. Ten years ago, the impacts of extreme drought on the rivers' low water level have not been numerous, but since 2015 they have been observed more frequently, at least two months in sequence. And since 2017, the low level of water in the rivers has lasted three months or more. The subsequent death of crayfish, aquatic insects such as dragonfly, molluscs such as the pearl oyster (a species on the European list of threatened species) and amphibians such as salamander and newt, is catastrophic.

Bird species also suffer from the implications of water stress: less food and drinking water. Near the aquatic environments, the populations of ducks and limicolous birds – long-billed and wide-pawed wading birds – are more numerous on the rare water bodies, where they are responsible for the degradation of general sanitary conditions and environment disruption – droppings accumulation and spreading of diseases. Thus, since the beginning of July 2022, the French Biodiversity Office (OFB) has recorded more avian-flu outbreaks among wild birds. Water stress has also an impact on migrating birds, e.g. towards Africa, as well as on birds living in agricultural lands, such as partridges. Egg hatching is delayed or fails, due to the dryness of the internal membrane of the egg. The mortality of young birds is increased, particularly for these species which nest in various kinds of cavities or live in the tree canopy, where the nest temperature can reach almost 50°C and becomes deadly. Swallows and swifts, which nest under the roofs, are also heavily struck due to the lack of food and water. It is true that the 2022 drought was much more extreme than those of 1976 and 2003, because it is part of a long trend related to the emissions of greenhouse-effect gases (GEGs). This feature is very important to underline, because animal species that can recover in the medium term from an annual drought, have much more difficulties to overcome recurrent extreme weather events. What happened in 2022 could

mean great disturbances in the ecosystems and their likely recomposition. Some animal species move to other biotopes, such as thermophilic insects that need higher temperatures for their development; they have now been found in Normandy and Brettany (northwest of France), whereas they used to live exclusively south of the Loire River. In 2002, a paper published in the journal *Nature* (*Ecological responses to recent climate change*) had also underlined a likely change in all the ecosystems, from the species level to that of communities. Twenty years later, the prospects are bleaker. Drought can become more recurrent and severe in the Mediterranean region, in Western Europe and the north of Scandinavia, according to a study carried out by the Royal Meteorological Society, and published in 2017. It may cause heavy damage from nowadays to the end of the 21st century.

Livestock, even more than the wild fauna and microflora, is suffering from heat waves and water stress. Lack of feed and water are profoundly disturbing the physiology of the domestic animals. And often deaths can be numerous, like in many developing countries, e.g. in sub-Saharan Africa. In France for instance, cattle breeders across the whole country have been complaining about the difficulties to raise their animals, either in stables or outside. Most of them are already using part of the hay stocked for the winter to feed their animals; because most of the green prairies have been burnt by heat waves and water stress and converted into non-digestible straw. For those animals raised in stables, cattle breeders have to use hay and feed supplements in order to maintain the yields of milk and to avoid bankruptcy. Fortunately in 2021, the year has been outstanding: maize harvest has been abundant and cattle breeders could make excellent harvests of grass through mowing the lawns four times. But all the hay stored has been almost exhausted in 2022. According to the observations carried out by Agreste – the statistical service of the agriculture ministry – by the 20th of July 2022 the cumulative production of the permanent prairies (since the beginning of the year) was 21% lower than during a normal year. Agreste also underlined that the situation has worsened in July and August across most of the national territory.

The maize harvest is also a subject of major concern. This grain crop is used, to a very large extent, for feeding the livestock. Agreste's estimates, published on the 5th of August 2022, forecast a production of 15.2 million tons of fodder

maize in 2022, i.e. 13% less than in 2021. Some farmers' harvests have been evaluated at 40 quintals per hectare, compared with 110 quintals per ha in 2021; other figures were even lower. Regarding the harvest of grain maize, the General Association of Maize Producers forecast a lower figure down to 11 million tons – a level that has been qualified as a historically low one. Therefore, the 2022 harvest would be 20% lower than the five-year average. Due to the poor conditions of the crops, many farmers had rather to harvest fodder than grain: on more than 80,000 hectares. In addition, by the 20th of August 2022, grass production was 31% lower than in a normal year.

Cattle breeders are therefore living through very difficult conditions. What is at stake is the price paid to the breeders. And this is a major issue. For instance, the ton of standard milk was higher than €400 in April 2022 and in May 2022 its value reached €419 (average), a 27% increase in a year, according to the data collected by France Agri-Mer – a statistical base. However, this increase in the cost of milk was not a windfall or a good bargain, because the costs of production of 1,000 litres of milk rose by €60 or €70. This was due to the higher costs of fertilizers, fuel and feed. The breeders have estimated that a fair price would be €450 per ton of milk. In Germany, the price paid to the cattle breeders was €500 per ton of milk. On the other hand, the lack of fresh grass lowers the volume of production. In the case of organic feeding, the problem is worsened because this kind of breeding needs good pastures; some of these organic cattle breeders have lost 30% of milk volume in July and August 2022.

In the feeding lots, the cost of raising the animals at their commercial size has increased for similar reasons as in milk production. And this has been reflected in the price of meat: the kilogram of meat of the Charolais breed rose from €3.8 to €5.20 in less than a year, while the production costs reached €6. In order to mitigate the rising costs of feeds, on the 30th of May 2022 the French government, in the framework of the Plan of resilience to climate change and global warming, has allocated €308 million to help cattle breeders. There was a great risk that these breeders may choose to eliminate part of their livestock if their feeding becomes too costly, or even try to find another job because the cost of living becomes unsustainable. That situation may happen in the fall of 2022 and worsen the drift of the French bovine livestock breeding.

Talking of the impact of water stress and recurrent drought on livestock, during the extraordinary year 2022, it should also be recalled that the food chain (farming, cattle breeding, transformation and transport of cattle and food) produces *ca*. one fourth of GEGs of human origin, half of it being emitted by cattle ranching and breeding. On the other hand, food nutritional recommendations aim to limit the consumption of red meat (beef, pork and game, etc.) to less than 500 g per week. This is a global trend: the scientists of the International Group of Experts on Climate Change (IGECC), in their report on the mitigation of global warming, have insisted on the reduction of meat consumption and on its replacement by vegetables in the daily food intake. In addition to the mitigation of the impact of climate change, there is a health issue: red meat and cooked meats may facilitate the occurrence of cancers, and this has been proved in 2015 by the International Centre for Cancer Research. It is true that the share of vegetables in the daily food intake tends to increase in industrialized countries, e.g. in institutional catering, but there is still too many advertisements on the consumption of red meat. It is ironic that the European Union, over the period 2016-2020, has devoted 33% of its budget for agriculture promotion (€777 million) for campaigns in favour of red meat and milk products consumption, compared with only 19% for fruits and vegetables. Recently, the EU has decided to balance these budgets: "a meal of lentils should become as attractive as a steak, and this for men and women alike."

Impact on river transport

In 2022, in France for instance, boat and ferrymen or women have never been confronted with the difficulty to navigate through many rivers and canals since the extreme drought of 1976. The river flow or volume has been reduced, as well as the water level, so that the transport of goods and tourism become difficult to manage. Nevertheless, by mid-August 2022, 591 km of canals had to be closed, i.e. 10% of the 6,700 km that are managed by the relevant agencies. But if the small canals having a double purpose, tourism and transport of goods, are taken into account, this percentage reaches 15%. The situation differs within the regions; in some of them the canals have been closed to give priority to the supply of drinking water. The main waterways and rivers in the northeast of France could not supply the canals that connect

them, due to their low water level and flow; also the capacity of the fifty dams/reservoirs that regulate the water level has been reduced. Therefore the boats carry only one-third of their capacity in order not to scratch the riverbed.

The Rhine, considered as the water highway in the heart of Europe, could receive twice the number of barges and smaller boats, in theory. But in 2018 the lack of water has hindered the navigation on the Rhine and led to an economic loss estimated at €5 billion. In 2022, the water flow fell down to 555 m^3 per second, seven times less than during the catastrophic floods that occurred by mid-July 2021 in Belgium and Germany. The economic cost would be worse in 2022 than in 2018. River transport has an advantage over other means of transport: it emits only 9-37 g CO_2 per ton-kilometre, according to the type of boat and its freight. A medium-sized barge could transport freight equivalent to 110 big trucks, and river traffic could avoid the circulation of 2.6 million heavy trucks.

In France, the use of waterways prone to navigation – 8,500 km, including 2,400 km for the transport of heavy freight – has been divided by two since 1974, from 100 million down to 52.5 million-ton-kilometre in 2021. The preference given to road transportation explained this decline, partly due to the lower industrialization rate of France and henceforth the lesser use of heavy materials. It seems that nowadays river transport is privileged whenever possible and economically sustainable. Although its annual growth rate has been *ca*. 3% over the last four years (excluding the year 2020), river transport should also adapt itself to climate change and global warming.

Floods and their considerable damage

Another evidence of climate change and global warming is the occurrence, across the whole world and amidst severe droughts, of sudden and extremely violent rains during a short lapse of time and with winds blowing gales, and floods across the regions struck by these extreme weather events. A few examples will illustrate this impact of climate change and its considerable damage.

In **Corsica**, for instance, on the 18th of August 2022, a violent storm killed five persons and injured *ca*. 20, according to the French home ministry. The

tempest was qualified as "herculean", with winds blowing sometimes at 200 km per hour, intense lightning and heavy rains. This storm has crossed the island from west to east; between 8h15 and 9h35 a.m. *Ca*. 12,400 people were transferred to a safe shelter, including 7,000 in southern Corsica and 5,400 people (on vacation) to several regions of northern Corsica. And almost 45,000 households were deprived of electricity. A comment by a member of the French parliament, representing southern Corsica, is worth mentioning: "If one should have doubts or questions about climate disturbance, the frequence and violence of these extreme weather events are the response; photographs are an obvious demonstration: a kind of cloud having the shape of a nuclear mushroom has fallen on us." And the same parliamentarian stated that he was ready to design public policies regarding environment protection, with special emphasis on ecosystem resilience. Some have criticized Météo-France for having alerting the populations too late regarding the storm. It is true that the alert system is not perfect. For instance, during the year 2021, out of 66 episodes of strict monitoring, the rate of false alerts was 14%, while the rate of non-detection (when a dangerous event is observed, but not anticipated) reached 1.7%. During the year 2020, the percentages were 6.7% of undetected events and only 10% of false alerts. The dilemma is therefore: if the alerts were more frequent, the occurrence of dangerous extreme weather events could be reduced, but the number of undetected false alerts increases mechanically, thus jeopardizing the credibility of Météo-France. The system will be improved, every year, on the basis of its performance. Meteorological experts have suggested that another item be added to the surveillance or monitoring weather bulletins: "predictability-uncertainty".

In **Italy**, on the 18th of August 2022, a series of violent storms have struck the north of the peninsula and caused the death of at least two persons and wounded 50. Tuscany has been the most affected region. In some areas, the winds blew at a speed of 150 km per hour, with heavy rainfall and sometimes, impressive hailstorms. In Venice, also, at about 1 am the tempest hit the whole laguna. Gales and heavy rainfall ran through the canals and the Piazza San Marco in the center of Venice. The violent winds have damaged the bell-tower, located at a height of 100 m above the well-known square. Italy has been struck by this series of storm, while the summer, like in many Mediterranean countries, has been very dry with numerous fires. For instance, on the 18th of

August 2022, an impressive fire has destroyed dozens of hectares of pines on Pantelleria Island, off the coast of Sicily, before being extinguished by the fire squads. In Palermo, a landfill was also being destroyed by the flames. According to some members of the ecologist party, Europa Verde, Italy had reached a no-return point and the only way to make any progress is to listen to science and to swiftly adopt an ambitious climatic law. It is true that the Italian scientific community has repeatedly warned the politicians about this emergency, particularly during the summer of 2022. In an open letter addressed to the Italian politicians, disseminated via the Internet on the 3rd of August 2022 by the EuroMediterranean Centre for Climate Change, more than 700 scientists have underlined the increasingly obvious Italy's vulnerability. They added that there is already an undisputable evidence of the increase of heat waves and drought, the retreat of the Alps glaciers, marine warming and, to some extent, the frequent occurrence of heavy rainfall. The report of the Centre stated that over the last 20 years, extreme weather events like very heavy-rainfall episodes have increased by 9%. This trend applies to both the north and south of Italy. In the coming years, the fire season will have a longer duration, and the number of violent-fire days will rise. The Italian branch of the movement of youth for the climate, Fridays for Future, stated that it is time to act rapidly, and that the Italian phrase "mal tempo" (bad weather) is an understatement of what is happening: in other words, it is now more appropriate than ever to speak about a climate crisis and not just about meteorological warnings.

By mid-September 2022, another extreme weather event has struck the region of Marchi, in eastern Italy, with violent storms causing heavy damage: in less than six hours, rainfall reached 400 mm, amounting to one-third of the annual volume of rainfall. The civic protection, in charge of helping the citizens overwhelmed by the floods, has mentioned the death of ten persons and three missing. About 50 persons were admitted in hospitals, while 150 others had to leave their household. Not only the fire squads of neighbouring regions were called on the sites in order to rescue and help the flood victims, but also helicopters of the army participated in the protection of the people and their households. A few hours after this dramatic event, the images delivered by the European satellite Copernicus have shown the violence of the storms as well as the destruction through gullying: it was possible to see from the space that

the subsequent mudslides had penetrated into the Adriatic Sea, 80 km off the coast. These extreme weather events were similar to those occurred in Corsica (18th of August 2022), as well as Liguria and Tuscany. More or less, the same scenario is repeated. Although the majority of Italians are not trained to face these events and do not know how to behave when these calamities happen – characterized by their violence and suddenness – their recurrence increases the populations' anxiety. Italy has been confronted with at least seven extreme weather events since July 2022, as mentioned by an Italian climatologist, such as ground slides in the Valley di Fassa in the Dolomites (5th of August 2022) that cut several roads and forced a hundred of citizens out of their households. The unlikelihood of violent storms in the Marchi has upheaved the meteorological service; the latter launched a "yellow" alert instead of "red" alert, which would have been more appropriate considering the damage caused by the storms. The region struck by these extreme weather events is located between the eastern slope of the Appennino ridge and the Adriatic Sea. This was not the first time: on the 3rd of May 2014, downpours resulted in flooding and a huge increase of the flow of the river Misa that devastated the coastal town of Senigallia; this town has been struck again in 2022.

At the beginning of this drama, the Italian government allocated €5 million for emergency assistance. The Council President (prime minister) Mario Draghi travelled to the sites of the disaster and seized this opportunity to insist on the hydraulic vulnerability of the country. Without paying careful attention to this vulnerability and proposing durable solutions, it would be difficult or even impossible to restore the trust of the inhabitants of this region and other Italian ones. In fact, the country seems to pay once again its neglect in terms of land management and the struggle against natural disasters. As an example of this neglect, a daily newspaper *Il Foglio* highlighted a resolution, adopted in March 2016 by the Marchi region, that listed a series of landscaping operations and constructions with a view to mitigating the river Misa floods. Nothing has been done, whereas there is a need for an interdisciplinary work involving climatologists, hydrologists and urban planners, as well as for a long-term policy. It is true that the first national plan for struggling against climatic disturbances in Italy has been issued in June 2018. Since then, three governments have followed suit and the population is still waiting for the implementation of this plan.

One may think that the multiplication of extreme weather events in Italy during the summer 2022 – violent storms that killed people in the Marchi, collapse of a glacier in July 2022, a historical drought along the Po valley, multiplication of fires – would have resulted in raising climate emergency amidst the political debates before the legislative elections scheduled for the 25th of September 2022. Unfortunately, this has not been the case. Thus, on the 15th of September 2022, a baffling study was published and showed that during the two first weeks of the campaign – 21th of August to the 4th of September 2022 – scientists have scrutinized the television news, the main talk-shows on the television network (RAI) as well as the two main private TV channels; and they found that less than 0.5% of the comments or presentations of the main candidates dealt with climate crisis. This study, prepared in partnership with Greenpeace, has analyzed the Facebook profiles of 14 political leaders and revealed that climate disturbances were mentioned in only 2% of these profiles. The €200 billion of the European Plan for Economic Renaissance is a historical opportunity for Italy to implement its ecological transition. For instance, Italy remains the second country of the European Union that is very inefficient in terms of building isolation. In the area of transport, emphasis is laid on the development of high-speed railways, but very little is made to boost the manufacture of electric cars, thus disregarding the European Union's objectives. All these stakes are of major importance and they would have deserved more attention during the election campaign. The ecologists' claims have difficulties to be listened to, for instance in the digging of oil and gas wells in the area between the Adriatic Sea and the Straight of Sicily – the volumes have been estimated at 112 million cubic meters. The lack of supply of Russian gas, because of the war in Ukraine, will most probably support this kind of fossil-energy exploitation. But the spokesperson of the youth movement, Fridays for Future, underlined that the forthcoming legislative actions must clearly show whether Italy is really serious about ecological issues. The movement announced strikes in high schools of 50 Italian towns in order to voice their concerns. The urgency to act was again recalled, when catastrophic floods occurred in May-June 2023 in northern Italy (Emilia-Romagna) and around Naples.

To sum up, on the 18th of August 2022, several **Mediterranean countries** have been struck by very high temperatures (48°C or even more) and megafires never seen before (for instance, in Algeria, 1,700 firemen had to struggle

against 84 forest fires that killed 38 people and wounded more than 200). At the same time, violent storms and floods washed away many households due to very strong winds, up to 224 km per hour on the west coast of Corsica. Both rims of the Mediterranean Sea have been hit by both kinds of extreme weather events. These are the two facets of climate change and global warming. The latter is faster in the Mediterranean Basin than in other parts of the world: average daily temperature has increased by 0.036°C per year between 1993 and 2000, almost a total of 1°C, according to Copernicus, the European Earth Observation Programme. This rising trend has shown its impacts during the summer of 2022. In the western part of the Basin, Spain and Portugal have been struck by megafires, while Morocco has been experiencing its worst drought for the last 40 years; three-quarters of its dams are almost empty, while the others have a replenishment rate below 27%. To the East, desertification is making progress in Irak, where the cumulative water flow of both the Euphrates and Tigris has been halved in two decades. It may be argued that climate change does not necessarily explain all these extreme weather events, but it is clearly responsible for the increased frequency of the heat waves, including in the coastal areas. Along the coasts of France, Spain and Italy, temperatures rose +6,5°C above the seasonal average and these important temperature disturbances lasted at least 70 days in sequence during the summer of 2022. The sea temperature reached 28°C in the first 28 metres under the sea level, off the Marseille harbour, 30°C off the city of Bastia (Corsica) and the Balearic Islands. These marine heat waves have disastrous impacts on the fauna and its habitats, on coral reefs and *Posidonia* grasslands.

In 2020, an important state-of-knowledge of climate change and environment modifications in the Mediterranean Sea has been published by an organization that includes 42 countries and the United Nations Environment Programme (UNEP). This study revealed that the "lake around which live 500 million people" has become one of the warmest points of the planet. Its warming rate is 20% faster than the world's average. If the policy and economic strategies are pursued according to the present models, heat waves will become more frequent and will last longer. The fresher summer months will be much warmer than the present hottest periods and it will be much more difficult to withstand the weather in most of the big cities. Furthermore, the rise of the sea level, which may be one meter from now to the year 2100, does not only threaten

some small flat islands of Tunisia, Greece or Italy, but will likely lash coastal towns, already exposed to violent storms. One-third of the populations living on these shorelines would be jeopardized: at least 37 million people would have to deal with the scarcity of their living resources. Agricultural lands would be eroded by the rising sea level and would be submerged in the long term. The crop yields would fall because of soil salinization; this is presently the case of the Camargue region, in the southeast of France. Regarding wheat yields, their decline would be estimated at 7.5% for each degree Celsius of global warming. Food security and, more generally, health will be threatened, with the multiplication of pathogens and waterborne diseases; the scarcer the water, the contaminants are more concentrated in its volume. As a result of downpours, floods and landslides are likely to occur. Salinization of drinking water is a major drawback, because the underground water tables become progressively brackish; heat waves boost soil evapotranspiration, as well as that of ponds and lakes. More than 250 million people will have access to scarce water in *ca*. 20 years, and this situation may generate conflicts among countries as well as massive migration (climate migrants).

The Mediterranean Basin is also a "hot spot" of global biodiversity, but beyond devastated forests and the disappearance of humid zones, climate change will upheave the various ecosystems, including marine wildlife and its behaviour. The arrival of 700 exogenous animals and plant species into the Mediterranean Sea is a good indication of environmental change. For instance, many species have migrated from the Red Sea through the Suez Canal; that is the case of the lionfish, which eats the larvae of many other species, has now spread across the whole sea. In addition, jellyfish proliferates and toxic microalgae as well. Furthermore, like the oceans across the world, the Mediterranean Sea becomes more acid. The above-mentioned report underlines the loss of 41% of the main marine predators, including mammals. The lack of plankton – a key food element for the shoals of pelagic fishes – reduces for instance the shoal of sardines. On the other hand, after having organized an exploration of submarine volcanoes, close to the Eolian islands, UNESCO launched, in June 2022, a warning regarding the underestimated risk of a tsunami in the Mediterranean. The latter would generate more than 1-metre high billows against very populated shore lines. The likely occurrence of this tsunami during the next 30 years would be 100%.

Far away from the Mediterranean Sea, the **Korean Peninsula**, in August 2022, has been struck by downpours for several days. By the 11th of August, the Korean Meteorological Administration has lifted the alert regarding these downpours in the region of Seoul, but it maintained it for the centre of South Korea, particularly in the Chungcheong province, for another two days. In Seoul, between the 8th and the 10th of August 2022, the rainfall reached 525 mm, something that never happened in 115 years. The army was called on to help the victims of the floods and to clean the regions struck by this national havoc. *Ca*. 80 roads have been closed, as well as some underground routes. In five national parks, including that of Mount Bukhan, northeast of Seoul, the access to 156 very popular hiking tracks has been forbidden. Furthermore, eight ferry lines have stopped their service. In the south of Seoul, the meteorological station of Dongjak, a record of 381.5 mm has been recorded on the 8th of August 2022; that is more than the previous daily record of 354.7 mm established in 1920, and the highest level since the setting up in 1907 of the first modern system of recording meteorological data. Floods are regularly occurring in the capital of South Korea, e.g. in 2011 (69 people died) and in 2020, but they have now become more frequent and violent. After the 2011 floods, the drainage systems have been reclaimed; they can withstand 85 mm of rainfall-per hour, compared with 45 mm earlier. The president of South Korea, Yoon Seok-youl, while presenting his apologies to the population, stated: "the government must review completely its present management of catastrophes, due to the fact that extreme weather events, associated with climate change and global warming, are becoming part of our daily life."

On the 9th of August 2022, North Korea, after the warning by the government of the risk of heavy rainfall (between 50 and 80 mm) in the southern regions of the country, has joined all its forces to protect the harvests against the coming floods. Downpours, qualified as "disastrous" by the daily newspaper *Rodong Sinmun*, have provoked the overflow of the river Taedong which crosses the capital, Pyongyang. Southward, near the port of Nampo, the Yellow Sea dam has been unballasted in order to protect agricultural lands. Rice and maize crops must be protected because they are vital for North Korea, where spring was dry in terms of rainfall, whereas floods have struck the north of the country in July. These disasters jeopardize an agrifood production that cannot

already meet the population's needs – between 2018 and 2020, 42.4% of the country's population have been suffering from undernutrition.

In **Pakistan**, the calamities due to an early monsoon (June 2022), preceded by heat waves from March to June 2022, have resulted in devastating floods, the violence of which was never seen before. Across the country, torrents of floodwater have ripped away mountain sides, swept buildings off their foundations and roared through the countryside, turning whole districts into inland seas. Rainfall reached 354 mm on the 26th of August 2022, compared with 125 mm on the 30th of September 2021. By the end of August 2022, 33 million Pakistanis have been affected, i.e. one out of seven; 1,191 people have died so far; 50 million people had to migrate and to try to find a shelter; 1.1 million damaged or destroyed homes; 730,000 heads of cattle have been lost and 1.8 million hectares of agricultural land have been flooded. The country is quite often hit by floods. In 2010, floods have caused the death of 2,000 people and left millions homeless; they inflicted damages estimated at US$40 billion. At the time, the United Nations Secretary-General, Ban Ki-moon, described the disaster as the worst he had ever seen. Since then, these extreme weather events have become more frequent.

In South Asia and elsewhere, global warming is increasing the likelihood of severe rain. When it falls in an area also grappling with drought, it can be particularly damaging, causing sharp swings between far too little water and far too much, too quickly. With 220 million inhabitants and an annual population growth of 2.4%, towns are built sometimes on zones that can be flooded; waterways are modified and their banks are covered with concrete. Soil artificialization makes run off more important. Furthermore, glaciers are melting due to the rise in temperature, and they feed rivers and other waterways. High-altitude glaciers break down and this results in a sudden and important supply of water that can cause floods. It has been estimated that *ca*. 30 high-altitude lakes threaten more than 7 million people. Strong cloudbursts are ruining crops and washing away infrastructures, with huge consequences for vulnerable societies. It is almost impossible to manage the implications of these extreme weather events or to mitigate them.

Pakistan's compounding economic and political crises – exacerbated by pandemic economic sluggishness and a weakening currency – will be further

entrenched by the floods of 2022. The country's planning minister stated that damages would exceed US$10 billion and that it would take the better part of a decade for the nation to rebuild. On the other hand, Pakistan was already beset by skyrocketing food prices as well as political instability, leaving the country's government shaky precisely when leadership is most critical. At the end of August 2022, prices for basic food items like tomatoes had quadrupled in a few days as the rains intensified again. Everything has already become expensive because of rising petrol prices, and the recent floods will further worsen the situation. Pakistan's finance minister was quoted by local news agencies as saying that the floods and accompanying increases in food prices could lead the government to reopen some trade routes to India to ease supply issues, despite persistent tensions between the two countries. India itself has been hit so hard by the drought in 2022 that it has dramatically decreased its food exports. That decision deepened fears of a prolonged global crisis, driven in part by huge deductions in wheat and fertilizer supply after Russia's invasion of Ukraine, a major wheat, maize and sunflower-oil producer.

Pakistan's climate-change minister called the flooding a "climate-induced humanitarian disaster" of "epic proportions" and appealed for international aid. Only *ca*. US$50 million has been allocated to Pakistan's climate-change ministry in the 2022 budget, reflecting a cut of almost one-third. Pakistan's National Disaster Management Authority stated that 162 bridges had so far been damaged by the floods and that more than 3,200 km of roads had been washed away. The Sukkur dam is 1.6-km long, between the two banks of the Indus River. It was built during the British Empire in 1932 and is a major keystone of one of the biggest irrigation systems in the world. It also aims at protecting the population against flooding. The canals originating from the water accumulated behind the dam run across the agricultural lands of the Sind region, south Pakistan, over almost 10,000 km. Although the size of the dam is impressive, the dilapidated state of the structure maybe, in the future, unable to regulate the floods of the Indus River. When downpours hit Pakistan at the end of August 2022, the rivers and torrents flowing from the mountains increased the water flow of the Indus and subsequently the pressure exerted on the dam. Fortunately, at the peak time of the floods, it did not rain in the Desa Ghazi Khan region, situated in the south of Pundjab, upstream of the Sukkur dam. Otherwise, another disaster would have occurred. The poor state of the

infrastructure – once the engineer's pride – is a major concern for all those who oversee the resistance of the dam to ever more violent floods. However, it can withstand high levels of water, but not the megafloods, and it must be reclaimed. If the dam were to collapse, the whole economy of the region would also collapse. Reclamation works, supported by the World Bank and to be undertaken by a Chinese company, have been foreseen a long time ago and they should start after the water recedes. Those difficulties are compounded by an obsolete meteorological system, which does not permit to rapidly predict the extreme weather events. For instance, it is almost impossible to estimate the volume of water coming from the neighbouring Baluchistan, west of the Sind region. This province, generally spared by the monsoon rains, has received since July 2022 downpours, five times heavier than the average. Furthermore, the climate models developed in the industrialized countries do not fit some meteorological features of Pakistan and South Asia. There should be more investment in designing climate models that are more specific to this region of the world. The 60 days with heavy rainfall on the entire Indus basin have been 50% more intense than if global warming (+1.2°C) did not occur. This means that torrential rains can become recurrent.

On the 15th of September 2022, Pakistani authorities announced that the floods were receding in the Sind province – the most affected one. Some experts of the Centre for Climate Change and Sustainable Development Islamabad suggested that in addition to the reclamation of infrastructures across the country, like bridges, dams and roads, as well as the development of more accurate warning systems regarding flooding, the local governments should be strengthened so as to rely on the knowledge and know-how of local communities. Pakistan has joined the international community, especially the vast group of developing countries, with a view to demanding the drastic reduction of greenhouse-effect gases and maintaining global warming at +1.2°C (compared with the average global temperature of the preindustrial era). In the opinion of the experts of the center, if this temperature threshold is not kept, "the result will be a death sentence for the Pakistani people." "Any flood relief should not be seen as an 'aid', but rather as a reparation for injustices accumulated over the past few centuries" stated Nida Kirmani, a professor of sociology at the Lahore School for Management Sciences. This reflects a long-running debate over the obligation of rich polluting nations to

help poor developing countries to cope with climate change – a sticking point in global climate negotiations.

Pakistani agriculture has been hit by the monsoon during the month of August 2022, especially in the plains of the Sind region. More than 600,000 hectares of cotton land have been completely destroyed on the left bank of the Indus. Pakistan is the world's fifth-biggest cotton producer. This enormous loss for the textile industry – equivalent to 10% of GDP – will not help the Pakistani industry and economy to recover. *Ca*. 40% of the population depends on agriculture, that makes up 5% of the whole country's economy. Pakistan which lacks a strong currency may have to import cotton as well as foodstuffs. On the right bank of the Indus, more than half of the paddy fields have been destroyed. Furthermore, the floods may jeopardize the sowing of wheat that generally starts in October. Due to the lack of drainage, the farmers have to wait for the evaporation of water before initiating their agricultural work. Authorities have estimated that three to six months will be necessary to drain the excess water from the towns and plantations. When visiting Pakistan, the United Nations Secretary-General, Antonio Guterres, stated on the 10th of September 2022 that "he had never seen a climatic slaughter of this magnitude," and he called on the big polluters of the planet to «stop this madness» that consists of investing more in fossil energy. "The rich countries have the moral responsibility to help developing countries like Pakistan to heel such catastrophes". Pakistan, which produces less than 1% of greenhouse-effect gases, is nevertheless one of the most vulnerable countries to climate change and global warming.

According to the Food and Agriculture Organization of the United Nations (FAO), 1.2 million hectares of agricultural land have been damaged, and more than 700,000 heads of cattle died across the country. And those who survived, browsing for instance in destroyed cotton plantations, are hit by epidemic outbreaks, which affect the cows' milk yield. To sum up, the food security of the country and its 220 million inhabitants is jeopardized. The prices of basic foods are skyrocketing, the inflation rate reaching 21.5% compared with the previous year. A food crisis in Pakistan would have international implications. "The country is the world's fourth-biggest exporter of rice to China as well as to sub-Saharan Africa; any drop of exports will worsen the

world's food insecurity, already fuelled by the downfall of wheat and maize exports from Ukraine," stated the deputy-director of the Wilson Centre's Asia Programme published in the *Foreign Policy* review. The overall damage, initially estimated at US$10 billion, will certainly be higher, according to the Pakistani government.

Even though floods are progressively receding, Pakistan was facing a sanitary crisis, in addition to the food insecurity situation. Since the beginning of August 2022, more than 90,000 people have been treated for infectious and water-borne diseases in one day in the south of the country following the floods, according to the government data. The Sind province's authorities have drawn the attention on malaria presence: 588 confirmed cases and 10,604 suspected cases, 17,977 diarrheal-disease cases and 20,064 skin-disease patients. A total of 2.3 million ill persons have been attended since the 1st of July 2022 in field hospitals set up in the flooded zones. The hospital of Karachi, capital of the Sind province, has been overwhelmed by a high number of dengue-affected patients. Cholera, respiratory acute diseases as well as typhoid have also been detected in the flooded regions, according to the World Health Organization (WHO) field offices. Infant and child mortality will likely increase. Across the whole country, more than 1,460 health infrastructures have been destroyed or heavily damaged. North of Karachi, in the district of Khaipur, along the Indus, 90% of the health centres delivering proximity services have been flooded. Many villages are completely isolated and have no access to health care. The United Nations for Childhood Protection (UNICEF) has estimated that 3.4 million children needed an immediate humanitarian assistance; their mental health and their education are jeopardized by the overall sanitary conditions – lack of drinking water, of latrines and undernutrition. Most of the schools and education settlements are closed, destroyed or damaged by the floods; or they are used to provide a shelter for the displaced families. On the other hand, on the campus of Larkana University, more than 400 children have been enrolled in temporary training centres that were set up by UNICEF. In the camps of displaced people, international and humanitarian organizations have started their activities. On a portion of the campus of Quaid-e-Awam University at Larkana, that was still being built, emergency infrastructures have been deployed. Confronted with so many needs, it is necessary to innovate: for instance, working spaces have been set up on small trailers, while buses have

been transformed in a very short time into clinics, ready to move along the roads and serve the victims of the floods.

In **Nigeria**, floods have been extremely devastating: waters coming from the northern part of the country have swollen the tributaries of the Niger River and devastated everything along their course. Out of the 36 States that constitute Nigeria, 34 have been affected by the floods that caused 600 deaths during the third quarter of 2022. According to the Federal Government, 1.5 million people have been displaced, including 800,000 children (according to UNICEF), in the most populated country of Africa – 220 million inhabitants. In the oil-producing regions of the Niger delta, rivers have gone out of their beds invading and devastating their banks and human settlements, before flowing down towards the Atlantic Ocean. In the State of Bayelsa, 25 km downstream from Yenagoa – the capital of the State –, in the town of Oporoma, muddy waters continued to flow through the streets, three weeks after the floods reached the peak of their intensity. In this town of *ca*. 20,000 inhabitants, in the most stricken boroughs circulation was only possible using small boats. Some city-dwellers have still their feet in the water and have tried to adapt to the situation. The population is plagued with cholera – associated with the scarcity of safe water –, the lack of hygiene and the proliferation of mosquitoes transmitting malaria.

The receding waters have nevertheless brought some hope in Oporoma, where many inhabitants think that such a catastrophe will not happen before another decade. They all refer to the catastrophic floods of 2012 – which caused the displacement of 2 million people and US$17 billion losses for the Nigerian economy. But they do recognize that the 2022 floods were even more damaging. In fact, most people ignore the global warming that may have similar consequences in 2023 or 2024. In this oil-producing country since the end of 1950s, very few works have been carried out in order to regulate the river flow and to protect the village or city-dwellers. Several years ago, however, the Committee for the Development of the Niger Delta had allocated a contract aimed at dredging and embanking the rivers around Oporoma. This piece of work has been rapidly abandoned, despite the disbursement of the funds that were probably swallowed by corrupted people.

It is true that for a long time the populations along the Niger River are accustomed to seasonal floods, the silt of which fertilizes the soils. The floods also fill the ponds and lakes where are grown fishes and giant snails – a highly appreciated meal in Nigeria. However, the 2022 floods did not bring any advantage and according to the director of the centre Environmental Rights Action – the Nigerian branch of the international network Friends of the Earth – no lesson has been drawn from the 2012 floods: despite many alerts that were subestimated by the authorities, no mitigation measures have been taken, no foods or medicines have been stored in order to reduce the impact of the floods. Another worsening cause of the flood damage was the opening of the Lagdo dam in the north of Cameroon by mid-September 2022, while the populations living in plains liable to flooding were already hit by heavy rains. When Cameroon built this dam, between 1977 and 1982, Nigeria has launched the building of its own dam in the bordering State of Adamawa. The work that started in 1981 has never been completed, and thus the regions near the Benoué and Niger Rivers could not be protected if water flows from the Cameroon dam. On 19 October 2022, the Nigerian water-resources ministry has stated that "80% of the floods" had been caused by excessive rainfall and not by opening of the dam sluice gates.

The increase in human activities, from the north to the south of Nigeria, is a worsening factor. There are more and more monocultures that need vast areas. The former vegetation that could retain part of the flooding waters has disappeared, because of deforestation and the diminution of native vegetation, according to the executive director of the NGO Corporate Accountability and Public Participation Africa. In addition, in the Niger delta another ecological disaster is looming on the horizon: floods have resulted in pouring oil out of the numerous pipelines that are corroded or vandalized. Food has become scarce and the prices of foodstuffs have soared because it was impossible to transport food via the flooded roads. When mitigating natural disasters and allocating funds to help the victims, many observers insist on the problem of corruption. Many voices expressed this concern within the National Assembly and denounced the inaction of the authorities, as well as the delay of approving a law on water resources and on the massive embezzelement of the budget allocated to the national ecological fund. The latter has been established since 1981 in order to mitigate the impacts of extreme weather events in the country.

The global concern about the regression of the Amazonian forest

Marcel Bursztyn, a professor at the University of Brasilia Centre for Sustainable Development and a knowledgeable expert in the environment and development issues, has mentioned that Brazil's economy has been based on the exploitation of natural resources for several centuries. But "what we are dealing with, today, has never been seen since the restoration of democracy in 1985: an ecocidian government, whose objective is the planned destruction of the environment", he stated. In the case of the Amazonian forest, by the end of the year 2022, almost 40,000 km^2 of tropical forest will be razed to the ground, i.e. a surface equal to that of Switzerland. The forests will be replaced (often forever) by grazing lands or soybean cropland. Every day, 1.5 million trees are felled in what has been called "the planet's lung". That has never been seen in two decades. Under the presidency of Jair Bolsonaro (2019-2022), the trend of deforestation was not only amplified, but new fronts of deforestation have been opened in the country. And the State of Amazonas, the largest in Brazil, has become a global concern regarding its protection, whereas during the 2010s the State was praised for its conservation policies. According to a researcher of the Environmental Research Institute (IPAM), thousands of kilometres of tracks have been opened by wood plunderers, and almost 300,000 km^2 of primary or rainforests – the equivalent of Italy's surface – are being threatened with complete destruction. Before J. Bolsonaro, trends of deforestation of the Amazonian forest have been the following :

- under the presidency of Itamar Franco (1992-1995), 29,059 km^2 have been deforested. In 1995, the international opinion, which denounced this immense destruction, forced the following president of Brazil, Fernando Henrique Cardoso to protect 80% of the forest and to forbid the transformation of the natural vegetation into agricultural land;

- under the presidency of Luiz Inácio Lula da Silva (2004-2010), in 2004 there has been a peak of deforestation amounting to 27,772 km^2, due to a severe drought and to numerous fires; a plan of action aimed to prevent and control deforestation; in 2006, a moratorium regarding soybean croplands – replacing forest land – has been signed by the edible oil industry and the exporters of grains, who made the commitment not to finance, nor to commercialize soybeans grown on deforested land; during the same year (2006), the area

of deforestation reached 14,286 km^2, and later on in 2009 this area fell down to 7,464 km^2; in 2009, a moratorium concerning meat was approved, and big slaughterhouses, supermarkets and consumers agreed not to buy meat produced from animals grazing on land illegally withdrawn from forest destruction;

- between 2004 and 2010, deforestation has been reduced by 80% thanks to the action of President Luiz Inácio Lula da Silva, and the above-mentioned commitments;

- conversely, between 2019 and 2022, deforestation rose by 50%; in 2016, under the presidency of Michel Temer (2016-2018), the deforested area has been estimated at 7,536 km^2;

- Jair Bolsonaro has been elected as President of Brazil with the support of the agri-food lobby, and since then the area of erased tropical forest reached 34,000 km^2 by the end of 2021 – an area equivalent to that of Belgium.

President Jair Bolsonaro has dismantled all the agencies working for environment protection of which Brazil has been very proud: Environment Police, Chico-Mendes Institute, Space Institute, etc. All these agencies have seen their budgets severely cut, from one-fourth to half of their respective allotment. The expenditures of the projects of mitigation or adaptation to climate change were cut by 93%. The environment minister, Ricardo Salles (2019-2021), has been obviously supporting the unlimited exploitation of the tropical forest. In 2020, he even seized the opportunity of the Covid-19 pandemic to call for the destruction of the forest: “Let the cattle herds go through.” That sentence meant that the ranchers could exploit the deforested areas without any kind of legal hindrances. J. Bolsonaro also stated: “The interest of Amazonas is not to care for the Indians or the trees, but to exploit the ores.” The president’s decrees and speeches have clearly encouraged the illegal gold extraction. The latter is very profitable and is the source of living of tens of thousands Amazonians, but it pollutes waterways and large rivers with mercury – used in the process of gold extraction. That is the case of the Rio Tapajós – the river in the State of Pará –, which has been polluted by mining activities across hundreds of kilometres. The ongoing disaster hurts primarily autochthonous (indigenous) populations living in the forests. Between 2019

and 2021, the invasions into indigenous territories have trebled. According to Jair Bolsonaro, we are dealing with "prehistoric human beings," and he slashed the already modest budget of the Indian Foundation; the latter is in charge of protecting and assisting the indigenous people of Brazil – the first occupants of the country, far ahead of the subsequent colonizers. Such policy has resulted in the rise of starvation and epidemic outbreaks in the villages.

It is clear that the government of J. Bolsonaro had an anti-environment policy: all the measures taken obey to a predation logics, where "the forest jungle was perceived as an obstacle to development", according to Greenpeace Brazil. "J. Bolsonaro has disseminated the illusion that the future of Amazonia implied the destruction of the tropical forest", and this kind of speech was well received by the poor populations living on the edges of the forest; these populations can be easily convinced that forest destruction and its conversion into agricultural or grazing lands could be beneficial, whereas it is in fact a source of large profits for the big agri-food companies, contrasting with the low wages of the workers and the farmers. It was thought that international action and warnings could slow down this nefarious policy. But in August 2019, the megafires, which struck the Amazonian forest, caused a global concern and provoked a diplomatic crisis between J. Bolsonaro and the President of France, Emmanuel Macron. One year later, Joe Biden, campaigning for the presidency of the United States, also voiced his concern and he mentioned that sanctions would be imposed on Brazil. But all these warnings did not last; the Covid-19 pandemic and the war in Ukraine made the crisis in Amazonia less relevant: global health and geopolitics were more urgent issues. At the same time, J. Bolsonaro made his speeches softer, he dismissed R. Salles – the environment minister – and he promised to end illegal deforestation in 2023. But on the ground, nothing has really changed, deforestation reached new records: 74,000 fires have been recorded since the beginning of the year 2022, i.e. 51% more than in 2021.

Marcel Bursztyn of the University of Brasilia Centre for Sustainable Development stated that besides the global concern regarding the gradual destruction of the Amazonian forest, the other biomes of Brazil – that included 15% of global biodiversity – have suffered equally or even more due to the operations of the agri-food industry. For instance, in the Brazilian savannah

called *cerrado* the deforestation rate has been increased by 34% in three years; or the vulnerable swamps of the Pantanal have been devastated by megafires in 2020, causing the death of 17 million Vertebrates; or the Atlantic Forest, *Mata Atlantica*, a coastal lush forest, where the equivalent of 30,000 football fields have been deforested between 2020 and 2021 in order to develop housing plots. The 7,500 km of the Brazilian coastline have not been spared either: in several occasions, the extreme-right government intended to cancel the restrictions limiting fishing activities and those concerning the protection of mangroves. Among the other environmental tragedies of the J. Bolsonaro presidency, it is worth mentioning that of Brumadinho: on the 25th of January 2019, the dam of the mining company Vale located in that small town of the State of Minas Gerais (southeast of Brazil) collapsed, causing the death of 270 people and the spillover of more than 13 million cubic metres of toxic wastes. In 2022, the trial of those responsible for this tragedy has not yet started.

Another disquieting aspect of the "ecological balance sheet" of Brazil's president is related to pesticides. Tereza Cristina, a leading figure of the agri-food sector and agriculture minister in the government of J. Bolsonaro, has authorized the marketing of almost 1,700 new products, e.g. one per day, many of them forbidden in the European market. The whole policy consisted of financially supporting agri-production, of stopping the implementation of the agrarian reform and of lifting the constraints regarding the spray of pesticides. The government has complied with the demands of the agri-business sector; in September 2020, J. Bolsonaro addressing the big farmers stated: "I am your employee and you are my bosses!" As a result, the environment activists have set their hopes in Luiz Inácio Lula da Silva, candidate to the October presidential election. He publicly stated that he will protect the natural environment as well as the autochthonous peoples. Nevertheless, the experts are cautious, because the impacts of the government's policy have been colossal and some of them are irreversible, according to Greenpeace Brazil: almost one-fifth of the Amazonian forest has already been destroyed and these complex ecosystems were approaching their "no-return" point, meaning that a decrease in rainfall and a more severe drought would transform large areas of rain forests into savannas. In addition, violence is encroaching throughout the whole of Amazonas, making it a zone of non-rule of law. The region

indeed includes 13 out of the 30 most dangerous towns of the country, where the number of firearms rose by 219% in three years. All kinds of trafficking are found in the region: wood, gold and animal dealers, and drug production and smuggling. If L.I. Lula da Silva were elected president of Brazil, many observers fear a firing of the Amazonas, and regional or local institutions have been so weakened that they would not be able to meet this formidable challenge.

In this respect, it is worth mentioning the opinion of Marina Silva. Born in Amazonas, trade-union leader and a forest advocate, M. Silva has been a world-known environment minister (2003-2008). A nature-conservation activist who has been for two decades combating for the protection of the Brazilian environment, Marina Silva has been three times an unfortunate candidate to the country's presidential election. But she was again ready for campaigning for the October 2022 election and she supported L.I. Lula da Silva, despite their previous disagreements about the protection of the environment. At the end of the 2000s, she wanted more radical solutions in order to embark Brazil in a successful ecological transition. She considers J. Bolsonaro as the "worst threat" for his country and she thinks that he has the behaviour of a criminal: he is the culprit of a vast programme aimed at destructing many environments, including above all the tropical forests; he also bears the responsibility for attacking the indigenous or autochthonous peoples is a way never seen until then. In due course, she feels that J. Bolsonaro will be trialed for all his crimes, especially those concerning the destruction – sometimes irreversible – of the Brazilian ecosystems. The trial can take place before a Brazilian or an international court, but above all J. Bolsonaro must be replaced soon as president of Brazil. Marina Silva who fully supported the candidacy of Lula da Silva, had presented to the latter 27 proposals aimed at setting up a new development model, both democratic and respectful of the environment, and bringing social justice. As an urgent proposal, she considers that all the national agencies dealing with the protection of the environment and indigenous peoples must be restored, with the appropriate budget and means of action. She suggested the creation of "a national authority on climate" that would be in charge of controlling the emissions of GEGs and of planning the transition to a low-carbon economy. In her opinion, there must be a zero tolerance of deforestation, particularly in the Amazonian forest. And these

proposals are not dreams, they could be applied swiftly and systematically if there is political will to restore order and end up with the chaos created by Jair Bolsonaro's government.

In August 2023, President I. Lula Da Silva convened in Belem (State of Pará), near the delta of the Amazonas River, the meeting of the eight member countries of the Organization of the Amazonian Cooperation Treaty (OTCA), with a view to strengthening the struggle against climate change and to conserving biodiversity in this key area of the world. On the 8th and 9th of August 2023, these eight countries have been confronted to the dire fact: 17% of the Amazonian forest have disappeared due to deforestation, including 60% in Brazil. Such a trend, if it is pursued, may transform this enormous carbon sink into an ecosystem which produces more CO_2 than the volume it absorbs (carbon "sponge"); and this will result into a cascade of catastrophic effects. After seven months of his presidency, Lula has strongly reduced the deforestation rate and reversed the disastrous trend caused by his predecessor Jair Bolsonaro. While making more responsible the member countries of the OTCA that share parts of the Amazonian forest and associating to the same endeavour other countries like France (French Guiana), the Republic of Congo and the Democratic Republic of Congo and Indonesia, as well as donor countries like Germany and Norway, the Brazilian president had the extraordinary merit to convene a number of States and non-governmental organizations that have never been seen in the region since the historical Rio Earth Summit in 1992.

The Belem Summit ended with a declaration without mandatory commitments, but made a list of good intentions. It is true that some Amazonian countries do not share the same approach to the management of the Amazonian forest, e.g. the divide between Lula and Gustavo Petro, the Colombian president, regarding the exploitation of oil deposits. While the latter has called for stopping any kind of this exploitation in the forest area, the former did not commit himself regarding this issue – Petrobras, the Brazilian national oil company, has an immense project in the Amazonas River estuary. The Belem declaration does not call for the not-agreed commitment to stop deforestation from nowadays to 2030. Through his action of promoting the preservation of the Amazonian ecosystem, in association with the relevant countries sharing

this ecosystem, Lula sent a clearcut message to the European Union who wanted to add a mandatory environmental clause to the Free Trade Agreement with the Mercosur which is still to be ratified. Lula who has shown in June 2023 and in Paris, in the presence of Emmanuel Macron, the French president, his strong will to denounce the environmental responsibility of the old industrial countries, indicates now that he does need their help to progress on the issue. And one cannot refrain from paying tribute to the will expressed by Lula, to engage in a green transition at the regional level, aimed at conserving the tropical forests. Such ambition, urgent but still uncertain, should become concrete, in facts and deeds, before the COP30, to be held in 2025 in the city of Belem.

Climate change and health

Hundreds of million people, across the world, die every year from the direct and indirect consequences of climate change and global warming. The increasing likelihood of extreme weather events is now well documented, but not enough regarding health. The British medical review *The Lancet*, in partnership with 51 institutions – including the World Health Organization, WHO – has published on the 26th of October 2022 its "Countdown on health and climate change", a few days before the COP27 began on the 6th of November 2022 in Sharm El-Sheikh, Egypt. The study was based on 43 indicators developed by about one hundred experts; the executive director of the project at London's University College, Marina Romanello, stated: "we are at a turning point". Due to the fast rise in global temperatures – already at +1.1°C compared with the preindustrial era – vulnerable populations such as the persons over 65 years and less than one-year old children, are exposed to high temperatures during long periods. For instance, in Europe, heat waves have increased by 57% (average) during the period 2010-2019, compared with the earlier decade, and by more than 250% in some regions like the south of Spain and the Czech Republic. The impact on cardiovascular or respiratory diseases, the deterioration of sleep and mental health, as well as the increased number of fatalities due to injuries, is well documented. Mortality due to heat has increased by 68% between 2017 and 2021 compared with the period 2000-2004. In Europe, if the present trends continue to prevail, deaths during the heat waves may double in 34 years, according to the first public report

published about this region. The impact of these high temperatures can be withdrawn from economic data: in 2021, 470 billion hours of work have been lost, a 37% increase compared with the annual average during the period 1990-1999. To sum up, this amounts to almost 140 hours per person in a year. This impact on the economy is seen above all in the agricultural sector (40%) and in the countries having a low human-development index. The losses in terms of potential income amount to 5.6% of GDP in these countries where the workers are more vulnerable to the effects of financial fluctuations.

Another major concern is the risk of infectious diseases. Thus the duration of malaria transmissibility has increased by 32.1% in the higher-altitude regions of North and South America and by 14.9% in Africa, between 2012 and 2021, compared with the period 1951-1960. Also in Europe the climate change and global warming are more favourable to the dissemination of diseases transmitted by mosquitoes (see below). The Covid-19 pandemic has worsened the situation: the impact of the pandemic on the health-care systems has weakened the States' capacity to deal with the disease associated with global warming. And, at the same time, the funds allocated to this world sanitary crisis have mechanically decreased the investments made by local communities in the struggle against climate change. Out of 798 towns interviewed in this regard, one-third has estimated that the Covid-19 pandemic had reduced the funds allocated for climate-change mitigation. *The Lancet* report has estimated that less than one-third of the €3,000 billion spent to confront the pandemic would have allowed a significant reduction in GEG emissions, as well as of air pollution. Also *The Lancet* report states that "the short-term responses to the energy crisis and inflation may likely worsen climate change, when many governments and companies reuse coal, thus threatening human health and survival. The fine particles associated with the use of fossil fuels kill an average of 1.2 million persons every year. A new analysis shows that in 62 countries the atmosphere within the households contains 30 times more fine particles than the thresholds recommended by the World Health Organization (WHO). This is a heavy tribute we pay for our dependence on fossil fuels. The UN Secretary-General, Antonio Guterres, has stated: "The climatic crisis kills us. Not only it does harm our planet's health, but also it hurts the health of all its inhabitants." According to the opinion of the co-president of *The Lancet*'s project, there is still time for action: "A

response to the present crises, focused on health, may offer the chance of a future with low carbon emissions, and people would not only survive but would also be healthier across the world."

On Wednesday the 21st of September 2022, the World Health Organization (WHO) has published a report on the real magnitude of the damage caused by non-communicable diseases and on what should be done to combat them. Cardiovascular diseases, cancers, chronic respiratory diseases, diabetes, maternal or perinatal mortality, nutritional illnesses, traumas, … are the causes of 74% of deaths across the world. Every two seconds, a less than 70-year-old person dies because of one of these diseases, i.e. a total of 17 million deaths per year in the world. The date of publication of the WHO report coincided with the first meeting of the Heads of States and Governments on the subject, at the United Nations General Assembly in New York. Since the end of the 1980s, non-communicable diseases have become the first cause of mortality at the global level. But this change was to a large extent overlooked, according to the head of the WHO department of non-communicable diseases. The same international civil servant stressed that the underlying causes of these diseases are social, environmental, commercial and genetic; that their presence at the global level is growing, and yet the funding allocated to their treatment, at the national or global level, is far from being significant. This is a tragedy, because these diseases can be prevented or manageable. For instance, a large part of the mortality could be avoided through acting on four risk factors: smoking, unhealthy eating, excessive consumption of alcohol and sedentary lifestyle, and also air pollution. If every country were to adopt measures of which the efficiency is proved, at least 39 million deaths could be avoided from now until 2030, and a considerable number of lives would be longer, healthier and happier. This diagnosis by WHO is unfortunately based on the lack of governments' action: in 2015, the United Nations had adopted a set of sustainable development objectives; one of them concerned the reduction by one-third of the mortality caused by non-communicable diseases, from now until 2030. Unfortunately, as shown in the WHO report of the 21st of September 2022, a small number of countries could reach this objective. Therefore the whole process should be accelerated in order to reach the foreseen objectives. But changing lifestyles takes time and issues of prevention are the most difficult to be implemented by the decision-makers. WHO has nevertheless

tried to soften such approach. Take the case of smoking: more than 8 million deaths per year are caused by smoking across the world, according to WHO; but the adoption in 2005 of a framework convention on the subject has shown that some measures could rapidly have good effects. Smoking has been forbidden in all public spaces and in the working environment, and this can lead to a drop in the admissions in hospitals of patients suffering from a heart attack or a stroke, as well as from lung diseases. "It has been demonstrated that the policies which target the underlying causes of chronic diseases within all social categories, also reduce social inequities," according to Antoine Flahault, director of the Global Health Institute in Geneva. This was true of smoking.

WHO, in addition to its report of the 21st of September 2022, has put online an interactive map that stores the data of 194 States. It is therefore possible to have access to the data concerning the extent and cost of these diseases, their risk factors, as well as the preventive policies carried out. This tool kit shows great disparities. The risk for a person to die from a non-communicable disease before 70 years is 7% in South Korea, 8% in Sweden and Japan, 9% in Italy, Norway, Iceland and Australia. This figure varies between 10% and 15% in most European and North American countries, as well as in Colombia, Peru, Ecuador, Chile, Algeria and Thailand. This risk is over 20% in Russia, India and most African countries. Finally, it exceeds 30% in Mozambique, Somalia, Afghanistan and Mongolia. Thus, 86% of these untimely deaths occur in low or intermediary income countries. The Covid-19 pandemic has to some extent hidden the impact of these diseases; but it also revealed the relations between non-communicable and communicable (infectious) diseases. The pandemic has worsened the exposure to the risk factors of non-communicable diseases: for instance, the lockdown of people for sanitary reasons has led to the decrease in exercise, while economic insecurity has interferred with the access to healthy food.

Climate change and global warming have a strong impact on the prevalence of communicable diseases. An American study, published on the 8th of August 2022 in *Nature Climate Change*, and coordinated by Erik Franklin, a geographer of the University of Hawaii, has reviewed the impact on diseases provoked by pathogens, of nine climatic disturbances or upheavals associated with the emissions of greenhouse-effect gases (GEGs): global warming,

drought, heat waves, forest climatic fires, abnormal rainfall and floods, ocean warming, rise in sea level and more frequent storms. The authors of the study have also analyzed another implication of the emissions of GEGs: the change in the plant cover. They have concluded that up to 58% of the infectious or allergic diseases have been exacerbated by climate change and global warming, due to the increase in the emissions of GEGs. These diseases amounted to 218, out of the 375 human diseases, known to be caused by pathogens. By contrast, 16% of these diseases have been sometimes less worsened. Firstly, the University of Hawaii team has searched the database Google Scholar in order to collect all the published studies that presented concrete examples of infectious diseases affected by one of the climatic risks. The authors have thus reviewed more than 77,000 papers, and they selected 830 out of them that showed a correlation between an extreme weather event (heat waves, floods, etc.) and the prevalence of a specific disease (malaria, dengue, etc.). This correlation referred to a region and/or over a particular period. The authors found that 58% of the human infectious diseases (i.e. 218 out of 375) have been related to one of the consequences of climate change, at a certain period. The pathogens involved were most often viruses (76 infectious diseases), bacteria (69), animals (45), fungi (24), parasites (23) and plants (12). This analytical review has underlined that climate change and global warming had a more pronounced impact on diseases transmitted by such vectors as mosquitoes, ticks or fleas.

Three-quarters of human emergent diseases are zoonoses, transmitted to human beings by other animal species. Climate change has a clearcut impact on the distribution area of the animals, which shelter microbial pathogens that can affect humans. When these animal populations become closer to humans, the transmission of the pathogens is facilitated. The distribution area of mosquitoes, ticks, fleas, birds and mammals involved in diseases caused by viruses (dengue, chikungunya, Zika, West Nile virus, etc.), bacteria (Lyme disease, plague), animals or parasites (malaria, trypanosomiasis, echinococcosis), has become wider. On the other hand, storms, downpours and floods left behind them stagnant waters and thereby increase the sites of reproduction and multiplication of mosquitoes and the assorted pathogens (malaria, leishmaniosis, Rift Valley fever, yellow fever, dengue, encephalitis, etc.). Heat waves have sometimes increased waterborne diseases, such as

gastroenteritis and meningo-encephalitis caused by amoeba. Storms, floods and the rise in sea level have often caused human migrations that increased the dissemination of leptospirosis, Lassa fever, gastroenteritis, legionellosis and cholera. Drought, due to inappropriate treatment of wastewaters, may subsequently cause outbreaks of cholera, dysentery, salmonellosis, *Escherichia coli* infections, conjunctivitis, scabies and typhoid fever.

While the majority of infectious diseases have been aggravated by the extreme weather events, 63 human pathologies seem to have been spared. For instance, warming seemed to have reduced the transmission of some viral diseases, either through the creation of an environment less prone to virus multiplication and transmission, or through the strengthening of our immune reaction. One should stress that climate change is not the only factor that influences the emergence and dissemination of an infectious disease. Other factors include the change in human behaviour, such as the urban sprawl that creates dense human concentrations where epidemic outbreaks can occur, or the boom in air transport and exchanges.

Impact of smoke derived from climatic fires

On the 27th of August 2022, a megafire was the latest in a string of extraordinary fire seasons in California. The air filled with particulate matter from the wildfires and the smoke carried over thousands of miles have been dense enough to produce air-quality warnings in New York City, Boston and Philadelphia. Ten years ago, Californians often feared fire, even as they lived in some uneasy accommodation to it. Nowadays, increasingly, they fear smoke – each an airborne toxic event expanding outward from the flames. Ten years ago, coastal residents might have taken comfort in the hundreds of miles between the inland fires and their homes; now they wonder about wind patterns that might bring the particle pollution to their doors. They may also know about the degradation of health that smoke brings. Now, they follow smoke-tracking apps, install air monitors and purifiers. Unlike flooding or drought or heat, the threat of smoke in the American West is not compartmentalized along class lines; smoke exposure is largely uncorrelated with income. When the Campfire torched Paradise in 2018, burning through the entire town in a few hours, it seemed hard to imagine fires producing more haunting imagery anytime soon. But just two years later, the dark orange

panoramas of the 2020 season displaced it to being. There are now 27 times as many such days as they were just a decade ago. The wildfire pollution is enough to threaten the gains of the *Clean Air Act*, which though it was passed five decades ago, is still saving an estimated 370,000 American lives each year. In 2020, such smoke accounted for roughly half of the air pollution in the Western United States, which means that, on that side of the Rocky Mountains, as much toxic smog was coming from wildfires as from all human activities combined.

That smoke is the focus of a growing subfield of research into the damage of air pollution, specially a level of particulate matter called PM2.5, which is the main component of wildfire smoke. Unlike other forms of air pollution, smoke can kill you immediately if you inhale it. While rare among average residents, death from smoke inhalation is common among wild land firefighters, who also suffer significantly higher rates of death from lung cancer and cardiovascular disease. For residents, even short-term exposure to wildfire smoke can worsen bronchitis, asthma, chronic obstruction pulmonary disease and other respiratory diseases, as well as trigger heart attacks, heart failure and strokes. In a very large longitudinal study published in May 2022 in *The Lancet*, those living within 30 miles or so of even a single wildfire were, over 20 years, nearly 5% more likely to develop lung cancer and 10% more likely to develop brain tumours. It would not be surprising that wildfire smoke is linked to nearly all the negative outcomes to which PM2.5 pollution has already been linked: cuts to cognitive performance and economic productivity; increases in rates of Alzheimer's, Parkinson's and dementia; worse memory, attention and vocabulary: episodes of mental illness, depression, suicide and self-harm; miscarriage, premature birth and low birth weight; pediatric leukemia, kidney cancer, eye tumours and even degenerating eyesight. When one is breathing air layered with wildfire smoke only several weeks each year, and perhaps the risks to one's health are only on the margins, when this is true for 78 million Americans living across the West of the country, the damage mounts – not to mention tens of millions more in Canada, Australia, Siberia and, increasingly, the Mediterranean. Closing doors and windows helps, of course, but even houses designed to be almost leakless for reason of energy efficiency, smoke can come in through dryer vents and oven hoods. The long run is also a harrowing timeline for fire the American West, which is projected, even by

conservative estimates, to grow substantially in the decades ahead. The 15 largest fires in modern California history have occurred since 2003, and six of the seven largest since 2020. In 2021, it was a relatively quiet season in the State, but the scariest period has been expected by mid-August 2022. Across the broader West, nearly six million acres (1 acre = 0.4 ha) have been burnt through July 2022 – the third megafire recorded.

In Canada and the United States, the smoke generated by 497 megafires across the Canadian territory – half of them being out of control particularly in the northeast of Ontario and Quebec – has spread over the whole of North America. By the end of June 2023, smog alerts have been issued in about a dozen of American States, including Iowa, Wisconsin, Michigan, Kansas and Pennsylvania. Thus *ca*. 80 million Americans have been affected by the air bad quality. From Quebec City to Pittsburg, from the northeast of Canada to Chicago, at a distance of thousands kilometers, the same yellowish smog is making the atmosphere thicker, the same acid air has been irritating the throats of people and making their eyes sting. Meteorologists are particularly following the content of fine particles in the air, because these particles are more volatile than pollutants like ozone or nitrogen dioxide and can invade the lungs. When their content is over 35 micrograms (μg) per cubic meter, air quality is considered "bad". On the 25th of June 2023, in the city of Montreal, this content reached a record of 500 μg/m^3. North winds across Canada are pushing the immense plumes of smoke towards the south of the continent. These PM2.5 fine particles can penetrate deeply in the lungs and the blood system, and they have an impact on the whole respiratory system and on the heart physiology, particularly among the vulnerable people like those suffering from asthma, the seniors and pregnant women. Thus, the most affected cities like Quebec, Montreal, Toronto and Ottawa, have been increasing their daily appeals to a great care. The government of Quebec province has started to organize a network for the distribution of N95 masks that can filtrate these fine particles, especially for people who are at risk. The alteration of air quality across such a big territory in North America – on the 26th of June 2023, the smoke generated by the megafires in Canada even crossed the Atlantic Ocean and reached French coasts – is due to the immensity of fires : 8 million hectares of forests and woodlands have already been destroyed by the end of June 2023, which is equivalent to the surface of a country like Austria. It is also

due to the unusual length of this fire season – the first megafires have been recorded since the beginning of May 2023 in the Alberta province, in Western Canada. It is also explained by the particular ecosystem of the boreal forest, which covers Canada across 500-550 million hectares. This forest is mainly composed of spruce – a highly inflammable coniferous species – that produces underneath a thick layer of dry needles that is broken down over the years into a dense humus. The wet climate, which normally prevails in this northern part of the globe, fills this humus with water. However, because of the occurrence of very high temperatures and the low rainfall, recorded since the beginning of 2023, almost half of the area of Canada has been struck by drought – from moderate to extreme, according to climatologists. Consequently, the resulting dried humus becomes a very inflammable fuel. About 50% to 75% of this humus is burnt, compared with 25% usually. And whenever a new zone starts burning, the production of smoke is 50% higher than during a normal year. Smoulders in the subsoil are rapidly burning the tree canopy – "crown fires" – with plumes higher than the trees themselves. These big plumes of smoke can reach Montreal or New York. Another characteristic of this boreal forest is that it releases 10 to 20 times more carbon per unit of burnt surface than other ecosystems. The 160 megatons of carbon emissions due to these megafires have already been higher than the Canadian annual record of 2014. Ironically, the boreal forest which is a natural carbon sink, becomes when it is burning an important source of GEG emissions, that contribute to global warming – of which the forest is the victim.

Proliferation of insect-borne virus diseases

As a consequence of a warm autumn in France in 2022, the tiger mosquito, *Aedes albopictus*, was still active – its females feed on human blood. Health authorities fear a second wave of autochtonous dengue transmitted by the tiger mosquito. The French Agence de Santé has published on the 25th of October 2022 its last statistics in this regard: with 217 dengue cases imported by travelers coming from infected countries the year may seem a "normal" one, but the authorities have recorded 65 cases, called "autochtonous," i.e. detected among persons who never left the country. These cases are mainly concentrated in the south of France, in the region Provence-Alpes-Côte d'Azur (52 cases), in Occitanie (12 cases) and Corsica (two cases). This incidence of

the insect species and the associated virus disease has been wider than usual. In a so-called normal year, 12 cases of dengue are generally detected, but in 2022, 34 cases have been detected in the Alpes Maritimes (southern and Mediterranean Alps), while in the whole country some experts consider that there is an epidemic outbreak of the disease. Many cases have been identified between the end of August and the beginning of October. After two years of the Covid-19 pandemic, French people have reinitiated their journey habits, while the exceptional warming has boosted the growth of the mosquitoes and their extension across the country. From now on, *Aedes albopictus* has found a new niche in all the 70 departments of France. The "Indian summer" has worsened the situation: while, in a normal year, there is a slow-down of the presence of the mosquito by mid-October, this was not the case in 2022. It was hoped that in November the situation might change: the role of winter in the development of insect-borne diseases should remain a crucial factor in the epidemiology of these diseases. The risk factor is the persistence of old mosquito females which bite infected tourists coming from countries where the disease is endemic not in the summer but in October; and thereafter transmit the disease to healthy people. On the basis of these observations, the health authorities are planning to extend the period of reinforced monitoring of the disease, from the beginning of May to the end of November. The post-Covid-19 new advisory health council (COVARS) will most likely draw the attention to the incidence of dengue, the viruses Zika and West Nile, as well as of chikungunya and other arthropod-borne viruses, that global warming is transforming into a new threat.

Conclusions

The year 2022 has been a record one in terms of extreme weather events whose magnitude has never been seen: heat waves in Europe and China, devastating floods in Pakistan, recurrent and extreme drought in the Horn of Africa, megafires in the United States (California) and southwest of France, to mention a few countries. The last seven years, 2015-2021, have been the hottest ever recorded. According to forecasts, it is most likely that the period 2022-2026 would be hotter and at least one of these years would overcome the 2016 record. There is now a chance out of two that the average annual temperature outpaces the 1.5°C threshold during at least one out of the next

five years. According to the Intergovernmental Group of Experts on Climate Change (IGECC), this threshold will be reached or outpaced before 2040. The extreme weather events, whose association is clearly established with climate change caused by anthropic activities, are to become more frequent, intense and longer. At the global level, from now to the years 2050, more than 1.6 billion city-dwellers will be regularly exposed to temperatures of at least 35°C during an average of a three-month-period. Cities and towns ubicated at low altitudes, such as Bangkok, Houston and Venice, will likely be confronted with multiple flooding because of the rise in sea level. Climate disturbances will also worsen the impacts on health and food security.

Regarding the severe drought that struck in 2022 a great part of the Northern Hemisphere, a study published on Wednesday the 5th of October has established the correlation of this historic drought with global warming. Human activity has made this drought likely to occur at least 20 times more than normal; with the obvious implications on the reduction of the harvests of various crops, and subsequently worsening the tensions on the agricultural markets, energy production and water supply. This study is drawn from the work of a network of international scientists, the World Weather Attribution. The study has been focused on the desiccation of soils, also called agricultural drought, that occurred during the summer of 2022. The 21 scientists involved in the study have analyzed the surface-soil humidity content, and down to 1-metre depth, in June, July and August across the whole Northern Hemisphere, excluding the Tropics. They also focused their work on Western and Central Europe – two-thirds of the continent that were hit by the severe drought by the 10th of August 2022. Using models associated with field observations, the climatologists have compared this situation, in a +1.2°C-warmed climate, with that of past climate. The team of researchers concluded that climate change in the Northern Hemisphere has made the agricultural drought at least 20 times more likely in the soils at 1-metre depth – this is where plants absorb the water available –, and at least five times more likely in the surface soils. The effects are also important in Western and Central Europe: global warming has trebled or even quadrupled the likelihood of drought in the soils at 1-metre depth; the figure was five to six times higher in the surface soils. Such kind of drought may therefore occur every 20 years across the Northern Hemisphere and Europe in the present climate. By contrast, without

global warming, such drought may occur once every 400 years in the same hemisphere, and in Europe once every 60 or 80 years. This drought at the soil level has been the worst in Europe since at least 1950 and the second worst one in the Northern Hemisphere (excluding the Tropics). These results are consistent with the last Intergovernmental Group of Experts on Climate Change (IGECC) report, which shows that the risks of drought increase with climate change in some regions.

The World Weather Attribution study underlines that, by contrast with heat waves or rainfall, the impact of climate change on droughts is difficult to forecast in a precise way, because we need more field observations and long series of soil-humidity measurements. Even though a strong diminution in rainfall has been recorded in many parts of the Northern Hemisphere, it is the rise in temperature that is mainly responsible for droughts. This rise induces plant evapotranspiration and subsequently decreases soil humidity. The authors of the study concluded that the high levels of temperature recorded during the summer of 2022 in the Northern Hemisphere would have not occurred without climate change. This new research work tends to indicate a bleak future with a global warming of +2°C, that could be reached by 2050; the likelihood of occurrence of a drought similar to that of 2022 may be 15 to 30 times higher in the Northern Hemisphere (excluding the Tropics); and the likelihood would be twice higher in Western and Central Europe. In September 2022, almost half of the European Union area was still under drought conditions, and a similar situation prevails in China and the United States. It should also be stressed that the implications of droughts include indirectly the fall in electricity production in Europe, due to the reduction in river flow, and the soaring price of energy – also linked to the war in Ukraine. The high cost of energy also increases the price of fertilizers. Droughts have also reduced the harvests of summer crops in France, Italy, Germany, Slovenia, Hungary and Romania. This reduction coincided with the stiff fall of cereal exports from Russia and Ukraine; it also fuelled the soaring of food costs across the world, as well as food insecurity.

The United Nations in its report United in Science, issued on Tuesday the 13th of September 2022, has warned that without drastic measures, the climate crisis will be even more devastating and hitting first the most

vulnerable populations. The report has been prepared by several international institutions, and coordinated by the World Meteorological Organization; it puts together the conclusions of a dozen recent publications on the climate. *The United Nations Secretary-General, Antonio Guterres, in a video message, "underlined that this report shows that climate change is reaching a level of destruction unseen up to now …*" "While symptoms are worsening rapidly, we every year sink into our addiction to fossil fuels." In fact, the emissions of greenhouse-effect gases have come back in 2021 to the levels reached before the Covid-19 pandemic – during the latter, there was a steep fall in GEG emissions (in 2020). Nowadays, the world emissions of CO_2, recorded between January and May 2022, are 1.2% higher than during the same period in 2019 – that was nevertheless a record year, according to the preliminary data of the Global Carbon Project, a scientific consortium. CO_2 emissions are boosted by the production of electricity and industry, with a marked increase in India (+7.5%), in the United States (+5.7%) and most European countries (for instance, +10% in Spain). Other countries' emissions remain under the levels of 2021, e.g. in Brazil, Russia (because of the war in Ukraine) and China (due to extended periods of lockdown of the populations in many important towns). The concentrations of greenhouse-effect gases have reached record values in 2022 and they continue to increase since then. In May 2022, the concentration of CO_2 reached 421 parts per million (ppm) – a level never recorded during at least 2 million years.

The new national commitments for 2030 "suppose a decrease of CO_2 emissions as well as of GEGs, but they are not still enough", recalls the UN report, *United in Science*. These commitments should be seven times more ambitious in order to be on track for limiting global warming to +1.5°C, or four more ambitious if global warming remains at an average of +2°C. By contrast, the present policies lead the planet towards a +2.8 °C warming before the end of the 21st century. Global warming may be decreased to a threshold of +1.9°C if all the promises of carbon neutrality were fully implemented – which seems too unlikely. The UN Secretary-General, once again, reiterated the need to stop the "unlimited race to exploit and use fossil sources of energy", "this is a recipe for a permanent climatic chaos and suffering", starting with the G20 countries which produce 80% of the world emissions. The UN Secretary-General reiterates a drastic measure: prohibit the construction of new coal

thermic plants, eliminate progressively this dirtiest source of energy and promote renewable sources of energy.

It is true that oil remains the main source of energy across the world, followed by coal, natural gas and hydroelectricity, and far ahead of all renewable sources of energy. Despite the 8.8% decrease in 2020 in oil demand, the latter has been growing since then: from 99.7 million barrels a day up to 104.1 million barrels a day in 2026. Oil is the second source of pollution (CO_2 production) after coal: 31.8% compared with 40.2%. In terms of CO_2 production, natural gas corresponds to 21.3%, cement 4.7%, industrial combustion 1.3% and other industries 0.9%. Extracted from wells drilled inland or offshore, oil is transported through pipelines or aboard ships to a refinery, where raw oil is transformed into several marketable products: fuel oil for maritime transport (9% of the European Union's energy consumption in 2019), electricity production (4.7%) and industry (4.5%); diesel, used in trucks and diesel cars (31.8%), fuel for heating households; kerosene for aircraft transport (9.1%), petrol for motor-cars (15.9%) and central heating, liquefied petroleum gas for petrochemical uses (13.9%). For the whole road transport, the percentage of total oil consumption in 2019 of the European Union reached 66%. *Ca*. 40% of the chemical products used in the manufacture of cosmetics, e.g. soaps or perfumes, end up in the atmosphere. Our civilization and its early stages of development are tied to oil exploitation and transformation. It is far from easy to make abstraction of this source of energy, especially in the road transport. Electric cars (private or for collective transport), electricity produced by solar panels and windmills as well as hydroelectric power are solutions to get rid of oil; even they are not a cheap source of energy. Even though technical improvements lower the cost of renewable sources of energy, it is the ransom of an ecological transformation and the mitigation of climate change and global warming. Oil, in small quantities, can still be used for unique production processes (petrochemistry), where it is indispensable and when its cheap cost is a comparative advantage.

Another bone of contention between industrialized countries and developing ones is the funding by the former of a large proportion of the ecological transformation of the latter (50% of the assistance or aid should be devoted to struggle against climate change). The promises made are not fulfilled and the

issue will again be discussed at the COP27 to be held in Egypt in November 2022. "For those who are already confronted with climatic emergency, the COP27 should find new funding in order to enable them to rebuild their life," recalled Tasneem Essop, executive director of the platform Climate Action Network which includes 1,500 NGOs. The General Assembly of the United Nations, held in New York from the 20th to the 27th of September 2022, draw once again the attention to the demand by the developing countries, which are being hit by the various impacts of climate change and which are less responsible for global warming; another system of annual funding is needed for the mitigation of these impacts. Denmark has agreed to allocate an amount of US$13 million to repair the losses and damage caused by climate change and global warming in developing countries. That was considered a politically symbolic act that broke the taboo among industrialized countries – United States and European Union – which were opposed to this kind of specific funding. Several proposals were made at the General Assembly in order to reform a financial system that does not seem appropriate to giving an adequate response to the catastrophic implications of climate change and global warming. One month and half before the COP27, the prime minister of Barbados, who wishes to reform the International Monetary Fund (IMF) and the World Bank, has called for a "new internationalism". She proposed that a part of the US$650 billion invested by the IMF in the global economy in 2021 and in overcoming the Covid-19 pandemic, be redistributed to the countries struck by climatic disasters. This political will of reforming the present system was supported by an increasing number of countries and by the U.S. Special Envoy for Climate, John Kerry. The United Nations Secretary-General, Antonio Guterres, has made an appeal to the wealthy countries to tax "the exceptional profits" made by the companies involved in the extraction and transformation of fossil sources of energy (coal, oil and gas), and to redistribute these profits to the victims of climate change. Some Western countries, including France, were willing to invest in partnerships "for a just energy transformation" in emerging countries, like the funds allocated to South Africa in 2021 with a view to abandoning the coal industry. Similar discussions are being held with Indonesia, Vietnam, India and Senegal. However, despite individual interesting proposals made at the General Assembly, "the countries did not seize this opportunity to show their will to respond together to the very many

crises and struggles against climate change and global warming; there was no real and strong concern about these issues." For the time being the overall situation is not changing significantly: at the General Assembly, not a single country of the G7 group attended a roundtable on climatic action organized by the UN Secretary-General.

The countries of the North did not make progress in their pledges for gathering, as of 2020, US$100 billion per year to be allocated to the countries of the South in order to mitigate the catastrophic implications of climate change and transform their economy. According to the data of the Organization for Economic Cooperation and Development (OECD), published at the end of July 2022, the pledges amounted to only US$83.3 billion in 2020. A plan of action was to be issued by mid-October 2022 by Germany and Canada in order to draft a road map. The host country of the COP27 – Egypt – relies on the pre-COP to be held from the 3rd to the 5th of November 2022 in the Democratic Republic of Congo, as well as on the ministerial meetings, to really make progress on this matter and other burning issues. The Mexican diplomat, Patricia Espinosa, who stepped down from her post of Executive Secretary of the United Nations Framework Convention on Climate Change by mid-2022, added her voice to the UN Secretary-General and to many others to state: we must consider that this transfer of funds from the North to the South is an investment for the survival of humankind.

The UN Secretary-General also wishes, when 3.3 billion to 3.6 billion people are extremely vulnerable to climate change, that in the lapse of five years all the world's inhabitants be protected by early warning systems against the climatic dangers. Less than half of the countries across the world have these systems, while their number is very low in Africa and Small Island States. On the other hand, the United Nations do not at all discard the possible disruption of climatic thresholds that may result in sudden and often irreversible extreme events. In a study published on the 8th of September 2022 in the journal *Science*, researchers showed that we might go beyond five of these thresholds even with the present levels of global warming – e.g. the extinction of coral reefs or the disappearance of the ice shelf of West Antarctic. The UN Secretary-General is therefore advocating that "we must unite behind scientific research and transform the promises into action".

Within these changes in our behaviour and dealings with the mitigation of climate change and global warming, the continent of **Africa** deserves a special mention. Let us summarize a few key facts. Africa is not a big producer of CO_2: CO_2 emissions since 1850, in billion tons, amount to 180 billion tons in 2021, compared with 2,324 billion tons for the rest of the world, i.e. 7% of this total. In 2019, Africa emitted 4.1% of the greenhouse-effect gases discharged by the whole world, while the African continent represents 17% of the global population. Finally, the 20 countries that produce the least volumes of GEGs per inhabitant all are located in Africa. The latter is particularly struck by climate change compared with other continents. In 20 years of climatic disasters (2000-2019), 1,143 extreme weather events happened in Africa (64% floods, 11% drought, 15% tempests, 10% other causes); 46,078 persons passed away (32% floods, 46% drought, 8% tempests, 14% other causes); 337 million people were affected (80% drought, 16% floods, 4% tempests and less than 1% by other causes). Food security in Africa is a major concern and it tends to worsen: 95% of agricultural production depends on annual rainfall; 53% of jobs are in the agricultural sector in sub-Saharan Africa and 14.7% of them in North Africa (2019). Various studies have forecast a decrease in agricultural yield of -20% to -30% in 2050 in sub-Saharan Africa. Displaced people ("climatic migrants") further to weather extreme events amounted to a total of 4.3 million people in 2020.

At the end of August 2022, in Niger, meteorological services tried to seed clouds with particles of several chemicals in order to provoke rains and thus to reduce the impact of drought. This method, which is not quite reliable regarding its results and can cause air pollution, is a desperate attempt to struggle against a recurrent and severe drought. The latter jeopardizes the crops and livestock, and subsequently increases food insecurity as well as poverty. By contrast and ironically some regions of this country have been receiving since the beginning of June 2022 downpours which have already caused the death of 100 people and almost 150,000 persons requiring all kinds of assistance (food, shelter, health, etc.). As in the rest of the world, sub-Saharan Africa suffers from extreme weather events that are harsher and more frequent. For instance, in the Horn of Africa and for several months, a historic drought causes starvation among the populations and livestock. In South Sudan, in Chad and all across West Africa unusual heavy rainfall

wreck havoc among human beings and animals. In sub-Saharan Africa, 55% of people live in both extreme poverty and high-risk-flood regions, according to a report of the World Bank published by the end of 2020. According to the ND-GAIN index that measures the resilience to climatic disturbances, nine out of the ten most vulnerable countries, are located in sub-Saharan Africa. This is a very sad and bitter statement for a continent that produces only *ca*. 4% of the world's greenhouse-effect gases, while sharing almost 17% of the globe's population. Furthermore, when *ca*. 40 industrialized countries, including the United States and Germany, have decided in 2021 that they will not anymore provide investments in sources of fossil energy abroad – and in the meantime because of the energy crisis they have increased their production of oil and coal – that was perceived as a hard blow for the African countries. The latter, indeed, want to develop their large gas and oil deposits in order to boost their economy and supply electricity to the 600 million people who are still deprived of it. Africa is therefore torn between its vulnerability to climate change and global warming, extreme weather events – and their dire implications – and the need for further development in order to struggle against poverty, while not being a major polluter. Henceforth, the need to provide a large-magnitude assistance, so as to enable Africa to carry out its ecological transformation and to drastically reduce social inequalities.

In this respect, it is worth mentioning the global decline of the Human Development Index (HDI), which the United Nations Development Programme (UNDP) has been using for 32 years to assess the health, education and standard of living of a nation. In 2021, the HDI has been declining for the second year in sequence, according to the UNDP Annual Report published on the Thursday the 8th of September 2022. The HDI is coming back to its level of 2016 – 0.732 over 1. This fall has been noticed in 90% of the countries across the world over two years, while only a few countries are concerned by this decrease. "This has never happened before, even during the 2008 financial crisis," underlined Achim Steiner, the UNDP Administrator. This decline is due to the economic recession of many countries associated with the important decrease in the life-expectancy at birth, that fell down at the global level, from 72.8 years in 2019 to 71.4 years in 2021 – because of the Covid-19 pandemic and according to the UNDP data. For instance, the United States lost 2.7 years of life-expectancy in only two years of the sanitary crisis.

It is true nevertheless that the governments, institutions and researchers have generally reacted quite swiftly to this pandemic, particularly through the discovery of efficient vaccines in a time lapse of one year. "But the discrepancies in the access to vaccination have shown how our world has become unequal and how the access to something that can save lives depends on the wealth of those who can buy it," added A. Steiner. If some countries could afterwards boost their economy, many have still difficulties to withstand the implications of the pandemic, thus deepening the social inequalities. Among those, which are significantly affected, one finds Latin America and the Caribbean, sub-Saharan Africa and South Asia. The UNDP Annual Report insists on the fact that the world is going through an era of uncertainty, where climate disturbances, energy and materials transformation may lead to societal upheavals that could be as important as the transition of agricultural societies into industrial ones. In addition, one may see the growth of political and social polarization among countries and within each country. A. Steiner suggests a series of recommendations that may improve the present situation and the future of humankind: firstly, invest private and public funds into renewable sources of energy, as well as into facing future pandemics; secondly, support innovation, be it technological, economic or cultural, in order to find the appropriate response to forthcoming difficulties. Coming back to the ranking of countries on the basis of their HDI, the gap has deepened between the poor countries like Niger, Chad and South Sudan, with an HDI under 0.4 and the wealthy ones. For instance, France has kept its ranking (28th with an HDI of 0.903), behind Switzerland, Norway and Iceland, which are the leaders. The UNDP Annual Report concludes: "The paradox of our present time may be our inability to act, despite the increasing evidence of the havoc human pressure inflicts to the ecological and social systems of the Planet."

Anticipating the COP27: the warnings of the World Meteorological Organization (WMO) and others

Published just before the opening of the COP27 in Sharm El-Sheikh, Egypt, the report of WMO on the climate situation in 2022 – based on the data of the first nine months of the year, to be completed in January 2023 – concludes that the last eight years are poised to be the hottest recorded up to now.

Everybody could have observed climatic catastrophes all the year long, such as heat waves, extreme drought, floods and megafires, that have relentlessly struck the planet; affecting millions of people and causing economic losses amounting to billions of dollars. The year 2022 will probably be the fifth- or the sixth-hottest year to be recorded. Global temperatures have remained relatively "low" for the last two years, according to WMO; because of a temporary "freezing" provoked by the *La Niña* phenomenon – a thermic anomaly of surface waters of the East Equatorial Pacific, which lowers global temperatures. This phenomenon lasted during three successive years, which is rare. "However, this situation does not mean that the long-term trend would be reversed. It is just a question of time, before another record year occurs," warns the WMO! The promises of the States regarding their GEG emissions are not sufficient and therefore global warming may be around +2.5°C by the end of the 21st century. The likelihood of even higher global warming may become a reality, because the States' commitments are not fulfilled for the time being.

The UN Secretary-General, Antonio Guterres, stated that: "Our planet sends a message of distress", and he commented that the WMO report is "the chronicle of a climatic chaos. It shows that the change occurs at a catastrophic speed, destroying lives and basic needs across all continents." Again, he called for the setting up of early warning systems across the world, in a lapse of five years. In 2022, the average temperature at the globe surface has exceeded by +1.15°C the average of the preindustrial period (1850-1900), due to human activities, During that year, the emissions of greenhouse-effect gases – mainly generated by the combustion of coal, oil and gas, and also by deforestation – have continued to grow. Consequently, the contents of these gases in the atmosphere – mainly CO_2 and methane – have reached record values. They "are so high that the threshold of +1.5°C in global warming, agreed in the Paris Treaty, is almost out of our reach," warned the Secretary-General of WMO, Petteri Taalas. This excessive content of GEGs causes a surplus of energy that heats the atmosphere and above all the oceans: half of the ocean surface has been affected by a heat wave in 2022.

According to the conclusions of the Global Carbon Project – a consortium of more than 100 scientists in 80 international laboratories working on the

carbon cycle – published in the periodical *Earth System Science Data* on Friday the 11th of November 2022, the global emissions of CO_2 have increased markedly in 2021 – after a historic fall in 2020 due to the Covid-19 pandemic. In 2022, they remain at record levels. Their drastic decrease is necessary and urgent, because their present level cannot lead to a global warming of +1.5°C. This ambitious objective of the Paris Agreement has a 50% chance to be reached in nine years (in 2030), if drastic measures of reduction are taken now. The study carried out under the Global Carbon Project forecasts that the global CO_2 emissions will amount to 40.6 billion tons in 2022, not very far of the 2019 record, and 1% higher than 2021. Most of the CO_2 is generated by the combustion of fossil energies and cement factories, of which their contribution would amount to 36.6 billion tons in 2022, 1% above the amount of 2021. The rest of the emissions are associated with the change of land use, especially deforestation; they seem to have remained stable in 2022. The increase in CO_2 global emissions in 2022 are mainly due to the consumption of coal and also of oil, due to the marked recovery of international air transport. China remains the world's first producer (31.6% of the total), far ahead of the United States (13.8%) and the European Union (7.7%) and India (7.5%). In France, the annual reduction rate of GEG emissions would double so as to reach -4.7% per year (average) over the period 2022-2030, according to the objectives set up by the government; these emissions will continue to increase in the United States (+1.5%), due to the increase in gas consumption – used to replace coal – and in oil because of the recovery of domestic air transport. In India, the emissions jumped to +6% because more coal was burnt.

To reach carbon neutrality (CO_2) in 2050 and have therefore a chance to limit global warming at +1.5°C by the end of the 21st century, we must now reduce the global emissions by 1.4 billion tons per year – a figure close to that observed in 2020 due to the Covid-19 pandemic. One of the authors of the study, while underlining the magnitude of the action to be required, mentions that "it is impossible to keep global warming at +1.5°C without using technologies capturing CO_2 in the atmosphere, which are not yet mature on a large scale. "The goal of carbon neutrality will not be easy to reach because oceans and forests, which play the role of carbon sinks, are less efficient. These ecosystems absorb about half of the global emissions. However, according to the study, climate change has reduced by 4% CO_2 absorption by oceanic sinks

and that of terrestrial sinks by 17% during the 2012-2021 decade. According to a report of the International Energy Agency (IEA, Vienna), published at the end of October 2022, CO_2 emissions associated with energy production and consumption may, for the first time, reach a "high level" in 2025, before starting to decrease. But this would mean that "governments react now through stimulating investments in clean sources of energy, through planting more trees, rather than felling them ... We are at a turning point and we should not let the world events detract us from the urgent necessity to reduce our GEG emissions in order to stabilize the global climate," commented an author of the study carried out under the Global Carbon Project.

In the meantime, the rise of sea level continues and jeopardizes the Small Island States as well as hundreds of millions of people living in the coastal areas across world. The rate of sea-level rise has doubled since 1993 and it reached a new record in 2022, due to the acceleration of ice melting. Alpine glaciers have lost 3 to 4 metres of thickness (an average). The situation is a real concern in Switzerland where the glaciers have lost 6% of their volume of ice in one year, and one-third for the last 20 years. Also the ice cap of Groenland is breaking up rapidly, and this for the 26th year in sequence. Global warming which is just one aspect of climate change is also translated into extreme weather events (EWE), such as the downpours in July and August 2022 in Pakistan (see p. **74**). India has been struck by storms, downpours, landslides, floods, cold spells or heat waves, cyclones, drought, sandstorms, hail or snowfalls – once per day during the nine months of 2022, according to the Science and Environment Centre based in New Delhi. Through the compilation of the data of the Indian Meteorological Department and the division of catastrophe management at the interior ministry, it has been shown that during the 273 days between the 1st of January and the 30th of September 2022, 241 days, i.e. 88% of this time lapse, have been characterized by an EWE. Due to the impact of climate change, extreme weather events, that used to be recorded once every 100 years, are now happening every five years. The State of Madhya Pradesh, in the centre of India, was often struck by an EWE every two days, but it is the State of Himachal Pradesh, in the Himalaya ridge, that the number of victims was highest (359 people killed), followed by the Assam State where the monsoon torrential rains have caused 301 deaths in June 2022. The earth science ministry came to the conclusion that across

its vast territory, India has been struck by 203 heat waves in 2022, a figure five times higher than in 2021 (36 episodes). The absolute figure has been recorded in the Himalayan State of Uttarakand: 28 days of heat waves.

The Indian sub-continent, with 1.3 billion inhabitants – most likely the world's leader in terms of demography – is one of the regions of the globe exposed to EWEs and to the catastrophes these events entail. About 85% of its surface is vulnerable to one or more risks: in the northern part of the country, the Himalayan ridge and its glaciers are melting at an accelerated speed, due to global warming. Westwards and Eastwards, 7,500 km of seashore are facing the rise of sea level, as well as violent hurricanes. India has also deserts on its territory, which are already inhospitable, particularly during the summer, but with global warming it may become quite impossible to live in. Finally, the Indian sub-continent is under the monsoon cycle, of which the rains become more and more erratic, causing all sorts of damage. The only good new in this catastrophic scenario is that the country has a good alert system and efficient evacuation means. The latter permit a considerable decrease in losses of people that are the victims of the more devastating cyclones. For instance, according the data of the Science and Environment Centre, between January and September 2022, only two persons died after the cyclones that nevertheless devastated 95,066 hectares. Storm frequency and intensity are increasing: 159 days of storms and lightnings between January and September 2022. Three years ago, the Indian Meteorological Bureau has launched a specific system of forecasts, following the massive number of people struck by lightnings. Mobile applications have been created with a view to monitoring weather conditions. Climatologists believe that global warming and the rise in temperatures as well as in the humid air masses explains the subsequent frequency of storms and lightnings. All these events, including the earthquakes in Nepal and their impact on the north of India, have been discussed at the COP27, with reference to the losses and damage caused by climate change that should be compensated by subsidies from the industrialized and developed countries. India and many countries, including Pakistan, Small Island States, etc., are very eager to find an appropriate solution to this issue.

In *East Africa*, it is drought which provokes several disasters. Rainfall has been there below the average during four humid seasons – an event unseen during 40 years. And 2022 will probably be a dry year. In 2022, according to the UN, *ca*. 50 million people are suffering from hunger in that region. At the beginning of 2022 and during two months, a series of cyclones have spread through southern Africa. Madagascar was very struck: torrential rains and floods have caused great damage. In September 2022, IAN hurricane has also caused human losses and important damage in Cuba and the southwest of Florida. In vast regions of the Northern Hemisphere, heat waves and drought had devastating implications on the water level of lakes and rivers, on forest and woodland fires, as well as on unexpected floods during the summer. Europe is the continent mostly affected by global warming across the world (the Arctic excepted), according to the WMO and Copernicus Service. Temperatures have risen markedly during the period 1991-2021, with a warming of +0.5°C per decade, twice higher than the global average. Such a difference is explained by the fact that global warming affects lands more than oceans; part of Europe lies in northern latitudes (arctic and subarctic regions); these regions warm more rapidly because of the disappearance of white surfaces (ice and snow) which reflect sunrays. Whatever its reasons, this very high warming has been generally subestimated in the climatic models.

The COP27 : between hope and despair

The COP27 has been held in the recreative station of Sharm El-Sheikh, in Egypt, and it ended on Sunday 20 November 2022, with a 37-hour delay for the closing ceremony, due to last-minute negotiations. The overall result has been disappointing, despite a few agreements for future action, such as the financial assistance to developing countries for repairing the losses and damage caused by extreme weather events and for the adaptation to and mitigation of climate change and global warming. If the conference has recognized the necessity to financially help the most vulnerable (and poor) countries, it failed in the acceleration of the struggle against climate change because no agreement was reached on the reduction of the use of fossil sources of energy. In other words, the COP27 has begun to find appropriate solutions to the symptoms of the crisis, but not to its causes. The 196 countries present in Egypt have made a historical progress on a crucial stake of the COP27: they have decided to

create a fund for the loss and damage, so as to help the developing countries that are "most vulnerable" and enable them to repair or mitigate the damage resulting from climate change and global warming. This achievement has been in fact a response to a demand of developing countries for the last 30 years. Several speakers have expressed their great satisfaction about this result and underlined the useful role of the United Nations conferences, even though concrete results of this nature take time. In the conference centre bordering the Red Sea, in the Egyptian Sinai, these vulnerable States have hammered the issue: they are the main victims of droughts, floods or hurricanes, while they contribute very little to the emissions of greenhouse-effect gases. The losses and damages they suffer hinder their development and worsen their debt. Such "vicious circle must be broken out," stated the Senegalese environment minister – Alioune Ndoye – speaking on behalf developing countries. This demand is more than a solidarity issue; it is a "moral obligation" and a "climate debt", recalled the Small Island States, whereas the developed and industrialized countries have built their development and wealth thanks to fossil sources of energy. It was very difficult for the latter not to respond to this demand, after the extreme weather events that occurred during the summer of 2022, e.g. floods in Pakistan which caused 1,700 deaths, displaced hundreds of thousands of people and devastated a large part of the south of the country. The European Union has made a spectacular change in his position, when it accepted the principle of this fund that was adopted thereafter; the United States have also been in favour of the establishment of this fund. A commission including 14 countries from the South and 10 countries from the North will be in charge of making this fund operational at the COP28. The wealthy countries are expected to make pledges for the fund, but "other sources of funding will be sought". This would mean that some emergent countries could also participate, probably China, whose name has not been mentioned in the agreement. China still remains in the category of developing countries, but it has become the second-biggest economy as well as the first producer of GEGs in the world. This new situation would mean that China is a potential donor. The fund should not remain an empty shell and it must be clearly decided which are the donors and the receivers of this aid. During the COP27, *ca*. 40 countries have made pledges in order to collect US$350 million. This is far from meeting the needs of the countries struck by extreme weather events, but let us hope that this is just a beginning.

Another mechanism has been presented as one of the solutions to both climatic crisis and inequalities between the North and the South. It consists of " partnerships aimed at reaching a fair energy transition". On Tuesday the 15th of November 2022, seizing the opportunity of the G20 Summit in the Indonesian island of Bali, a group of wealthy countries made the pledge to transfer US$20 billion to Indonesia, with a view to reducing its heavy reliance on coal and to achieve carbon neutrality of its electric sector in 2050 instead of 2060. This large amount has been a record, after the first partnership concluded in 2021 with South Africa. The first African economy, also heavily dependent on coal, was expected to receive US$8,5 billion from France, the United Kingdom, Germany, United States and the European Union, with a view to carrying out its energy transition. Another partnership has been announced at the COP27: US$500 million granted to Egypt by the United States, the European Union and Germany, in order to contribute to a national transition to clean sources of energy, including renewable sources of energy. Discussions are being held with Vietnam, Senegal and India. The agreement with Indonesia is considered a significant progress in the process of energy transition for a country that is the first exporter and third consumer of coal in the world; coal makes up 60% of the energy mix in Indonesia – the fourth-largest population in the world and the fifth-biggest producer of GEGs. The pledges have been made by the G7 member countries, as well as Norway, Denmark and the European Union; they come from the private and the public sectors, on an equal basis and in various forms: gifts and aids, private investments, guaranteed loans. The funds should be disbursed in a lapse of three to five years. During the six months following the agreement, the details concerning the distribution between the gifts and loans, as well as the amounts of interests will be negotiated. The Indonesian government's commitments were the following: the GEG emissions of the national electric sector should reach their highest level (before starting to decrease), 290 million tons by 2030, seven years earlier than the previous commitments; 34% of electric production will be derived from renewable sources of energy, also by 2030, that is the double of the present output. These commitments would avoid the production of 300 million tons of GEGs by 2030, and 2 billion tons by 2060. The partnership with Indonesia has been negotiated for several months. In September 2022, bearing this in mind, the president of Indonesia took a series of measures to promote the adoption of renewable sources of energy and the

phasing out before 2050 of all thermic plants using coal to produce electricity. In this regard, the Indonesian government has identified 32 of these coal-burning plants whose total power was equivalent to 16.8 gigawatts (GW), out of a total of 45 GW for the whole country.

The light of hope of the COP27 was therefore the " historical agreement" on the creation of a mechanism of funding for the mitigation of the loss and damage inflicted on poor countries by climate change and global warming. This was agreed in principle and it remains to be seen how this mechanism will be put in practice. This first evidence of a real international solidarity in the struggle against climate change and global warming creates a feeling of optimism and the need for the participation of everybody in order to find the appropriate solutions. However, the means needed cannot be underestimated: hundreds of US$ billions are necessary, but these can be found if there is a general political will and leadership. Beyond the several hundred million dollars already pledged, the World Bank and the International Monetary Fund must play a more proactive role so as to orient their funding and aid towards mitigating the climate crisis. It is also indispensable to set up a reliable mechanism of controlling the financial flows in order to avoid any misuse of funds and corruption.

By contrast, the conference, which has been held in the context of multiple geopolitical, energy and agri-food crises, did not face the real challenge of drastically reducing the GEGs. In fact, with the impacts of climate change and global warming, these drastic reductions are "the two faces of the same coin," warned Frans Timmermans, vice-president of the European Commission. The latter was ready to slam the door of negotiations, if the right decisions were not made in terms of the world's reduction of GEGs. The COP27, despite this warning (see below), has not been bold enough to really make tough decisions on fossil fuels that are mainly responsible for global warming. The text of the conference only mentions that the countries commit themselves to accelerate the reduction in the use of coal, as well as the elimination of "inefficient" subsidies to fossil fuels – that commitment was made one year earlier at the COP26 in Glasgow. Neither oil or gas were mentioned, whereas carbon neutrality implies that not a single additional fossil-energy plant be built. Many countries, including the European Union and even big oil producers such as the United States, Canada, Norway and

Colombia, nevertheless agreed to gradually eliminate their reliance on fossil fuels. But a majority, including the Gulf Countries and China, were opposed to this proposal. According to Laurence Tubiana, director of the European Foundation for the Climate, "Egypt which chaired the COP27 has proposed a text that protects the oil States as well as the fossil-fuel industries." There is therefore a procrastination on the gradual reduction in the emissions of GEGs. It should be mentioned in this respect the contrast between the leadership of the European Union and the behaviour of the Gulf Countries, China and India that are reluctant to get rid of fossil fuels. We run the risk to formulate ambitious objectives in terms of struggling against climate change and global warming, that will remain out of reach if there is not a real international commitment to gradually eliminate the use of fossil fuels. It is true that the lobbying of the oil-producing countries and the companies involved in the extraction and transformation of these sources of fossil energy, is very powerful and has certainly played a role in postponing a clearcut decision on this matter – there were 636 lobbyists present.

The COP27 has effectively seen the agreement of the majority of countries to "pursuing their efforts" in order to limit global warming at +1.5°C, above the global temperature during the preindustrial era. This proposal has been the most ambitions one in the Paris Agreement (COP21), but it meant "an immediate, profound and sustainable" reduction in GEG production during the present "critical decade." This ambition has been nevertheless thwarted by several countries, including Saudi Arabia and China, which prefer to stick to the other objective of the Paris Agreement, i.e. contain the increase in global temperature under +2°C. The European Union, which has shown a leadership in this matter, has succeeded in setting up a request aimed to reach a peak in GEG emissions by 2025, in order to follow the conclusions of the last report by the International Group of Experts on Climate Change (IGECC). While the conclusions of the COP27 requested the countries, which have not done so, to strengthen their climate objectives before the next COP28, as a matter of fact, the countries' promises are obviously unsatisfactory and consequently the trend of global warming is expected to reach +2.5°C by the end of the century. It is true that recently India, Indonesia or Mexico have raised their ambitions, but they represent less than half to the G20 countries – the latter produce 80% of the global emissions of GEGs. The United Nations Secretary-

General, Antonio Guterres, has reiterated at the end of the conference: "we must now drastically reduce these emissions and this COP did not answer the issue properly." Frans Timmermans stated publicly his disappointment on the same topic, and in a very eloquent speech said bluntly: "What we have there is a too short step forward concerning the inhabitants of the Planet" – see below.

Another major omission in the COP27 conclusions is that there was no reference at all to the COP15 on biodiversity. The latter was to be held in Montreal, Canada, three weeks or less after the COP27. The decisions to be made are crucial for the Planet: another global framework will be adopted with a view to trying to stop the destruction of ecosystems by the year 2030. Such a decision is also mandatory for the struggle against climate change and global warming. Besides this omission, the ups and downs of the conference as well as of a number of critical positions of some countries or groups of Member States could have been lessened if the Egyptian presidency would have played an efficient role of a consensual facilitator. To sum up, the 33,000 participants in the COP27 will meet again in November 2023 in Dubai, and during this COP28 – or even during the whole year of 2023 – we may probably deplore new extreme weather events, more victims and alarming prospects. What will be at stake is to translate the global solidarity that emerged in Sharm El-Sheikh, into concrete actions and commitments, both in terms of funding, assistance and effective cooperation. There is a crucial need to pursue the efforts made at the COP27 to consolidate the trust between the North and the South, but also to stand firmly to confront the climate-change challenge.

As mentioned above, Frans Timmermans, the Dutch vice-president of the European Commission, has expressed his "great disappointment" after the closure of the COP27. In an interview with the French daily newspaper *Le Monde*, on the 26th of November 2022, he gave details about the results of the conference that were very far from the expectations: no firm mention of the end of using fossil fuels; nor of a date for the peak of GEG emissions; no update of the countries' commitments regarding their national efforts of reduction of GEG emissions. According to him, one year has been lost, despite the efforts made to save what has been agreed in Glasgow (COP26). It becomes very difficult to achieve the goals of the Paris Agreement, politically and technically, because time is running short. F. Timmermans stated that the

objective of keeping global warming at +1.5°C is almost dead. That is why, he added, we must work every year, every month, week and day to drastically reduce the GEG emissions. Achieving this objective does not only depend on Europe, but also on the other G20 countries, that produce 80% of these emissions. For instance, the role of India and China is crucial; F. Timmermans hopes that China will be able to reach its peak of emissions *before* 2030. If this is the case, then the objective of +1.5°C might be reached. The vice-president of the European Commission underlined that the real success of the COP27 has been to reach an agreement on the assistance and funding aimed to help developing countries mitigate the losses and damage caused by extreme weather events; and therefore to start rebuilding the trust between the North and the South. F. Timmermans recalls that we should take into account the fact that the difference between developing and developed countries has been established in 1992 (Earth Summit, in Rio de Janeiro, which was the starting point of the COPs). But nowadays, some developing countries qualified as such in 1992 have a gross domestic product that is equivalent or even higher than the so-called developed countries. They should therefore fairly contribute to the international cooperation aimed at mitigating climate change and global warming. China has a great responsibility in this regard. It is the world's second-largest producer of GEGs behind the United States. And F. Timmermans has mentioned that the Europeans contribute to 8% of GEG emissions, whereas the United States, China and other countries contribute to 30%. Therefore, even it may reach carbon neutrality in 2050, China has to drastically reduce its emissions if we want to be on the winning side. Otherwise, the struggle against climate change will be lost. The Europeans are aware of their responsibility and they implement their commitments through the Fit for 55 – a series of legal proposals aimed to accelerate the struggle against global warming. They even go beyond the 55% reduction in GEG emissions in 2030: a 57% reduction is now proposed, but the European Union may even go further. F. Timmermans thinks that this is feasible, e.g. new thermodynamic engine-driven motor-cars will not be commercialized beyond 2035, the reforestation programmes aimed to reinforce carbon sinks, and the fair distribution of efforts among the EU Member States. The latter know that from now on they could be condemned if they do not respect the objectives set up for 2030. This means that energy investments should be

cautious and rational. For instance, France cannot rely heavily on nuclear energy to produce electricity, but it must also invest in the development of renewable sources of energy.

F. Timmermans elaborated on the European Green Deal the objective of which is carbon neutrality by 2030. That is why he is supporting an ecological transition with a social component. That is the purpose of the social fund for the climate that should be adopted: we must protect those who have not the means to implement this transition. Regarding the possible divisions about the Green Deal within the European Commission, F. Timmermans had talks with the manufacturers of motor-car engines and he is convinced that Europeans should not drag behind China which is manufacturing 80 electric-cars models and commercializing them on the international markets. The United States are also working full speed in the same direction, as well as South Korea. The Europeans have no other choice than follow the same trend, and that is feasible.

Another opinion regarding the results of the COP27 is that of Aurore Mathieu, in charge of international policies within the Réseau Action Climat France (Network Climate Action / France), an active NGO in the struggle against climate change and global warming. The final text of the conference does not make a significant progress compared with the previous COP in Glasgow. No strong commitments have been made for accelerating the reduction of GEG emissions. The European Union made an attempt to defend ambitious prospects – regarding in particular the objective to reach a peak of these emissions in 2025, at the latest – but there is still a gap with the objectives of the Paris Agreement. The same is true of the United States. In addition, the countries of the North have dissociated the imperative need to contain global warming at +1.5°C from the issue of equity, whereas the countries of the South have emphasized their need to obtain financial and technological resources in order to contain global warming. However, the decision regarding the creation of a fund aimed at repairing the loss and damage caused by extreme weather events is a victory of the civic society. The developed countries have finally replied to an appeal launched almost 30 years ago. But there are still several issues: Which countries will benefit? Where will be the funding sources and who will contribute? The UN Secretary-General has suggested taxing the fossil-

fuel companies, which made and are making extraordinary profits during the energy crisis. By accepting this historical initiative, developed countries should not procrastinate before allocating the funds. The promise to make this fund operational before the COP28, in November 2023, will be a real test to restore the trust between the North and the South. One should nevertheless consider the issue of vulnerability: the countries particularly vulnerable to extreme weather events and climate-change impacts were mentioned as the countries primarily eligible to the fund. It seems that, on the basis of the equity principle, all countries that are not responsible for global warming should receive allocations from this fund. Regarding the contribution to the fund, that of China remains a disturbing issue: should the world's second-largest economy and second-biggest polluter contribute more to the fund and according to its means? It also remains to estimate these losses and damages, which are both economic, human and cultural. An evaluation report can be prepared, like it was the case for the cost of adaptation process, with a view to better assessing the losses and damages and to formulate the appropriate remedies. According to Aurore Mathieu, the most obvious conclusion of COP27 was that there was a strong resistance to eliminate fossil fuels; it is still a taboo in climate negotiations. The strong influence of oil- and coal-producers and industrial transforming companies, that was obvious during the conference, has been compounded by the Egyptian presidency's bias in favour of fossil sources of energy.

Finally, although absent from the conclusions of the conference, the assessment of the losses and damages caused by climate disturbances and extreme weather events, has been made by scientists: between US$290 billion and US$580 billion per year till 2030, and up to US$1,700 billion in 2050; all these figures only concern developing countries. This is obviously related to the importance of agricultural and food issues, which the Egyptian presidency of the conference wanted to highlight. This sector, which produces one-third of the global GEG emissions and is particularly struck by global warming, has been generally neglected in official climate negotiations. By the end of October 2022, a few days before the opening of the COP27, an evaluation carried out by several foundations has shown that food systems received a very small share of the public funding allocated to climate change (3%). In Sharm El-Sheikh, the food issues have been

debated extensively: *ca*. 200 parallel events and four pavilions – out of a hundred devoted to climate change – have been devoted to this topic; and even one day – 12 November 2022 – concerned this topic on the official agenda of the Conference. That was the first time in the history of COPs. Moreover, the negotiations on the losses and damages caused by climate disturbances have drawn the attention on agricultural issues and food security, which are in fact closely associated with the debates on climate justice. Unfortunately, according to several NGOs, the relevant discussions have been oriented towards technological solutions. Many consider that food systems are above all an issue of efficiency. But what is at stake is more than that: the issue is economic, social and related to human rights – right to food, right to land, etc. Among the announcements made at the COP27, the initiative AIM for Climate (AIM4) by the United States and the United Arab Emirates is the best illustration of the promotion of technological solutions. This initiative that would be funded by *ca*. US$8 billion over five years, supports the inclusion of additives in livestock feed in order to reduce belching and methane emissions by the livestock sector, but it does not deal with the reduction in livestock size. Another initiative presented at the COP27, called FAST, Food and Agriculture for a Sustainable Transformation, and fostered by Egypt and the FAO, aimed at funding agricultural transition in the developing countries. It has been criticized because of its lack of precision with regard to the different approaches to funding, as well as of the poor definition of the kind of sustainable transformation required. Moreover, the discussions have been tense in the framework of the *Koronivia dialogue*; this was set up in 2017, during the COP chaired by Fidji and its name is that of a tropical Graminaceae. The final text adopted by the working group facilitating this dialogue suggested to carry on the discussions for another four years; but it did not mention neither the stake of an approach involving the food systems – that include the distribution of foodstuffs, their wastage and food diets – nor that of agro-ecology. According to the attending NGOs, it was a real disappointment; because it has been proved that agro-ecology strengthens the ecosystem resilience, because it is based on food diversity, soil fertility and on farmers' knowledge. We are still in the middle of very lengthy discussions, very institutional and far from field action and the allocation of resources. On the other hand, the NGOs are watching very carefully the risks of carbon-marketing mechanisms for

the agricultural sector. Up to now, reforestation projects have benefited from carbon-market funds. Big agroindustrial companies were interested in carbon marketing, whereas the small farmers run the risk of being penalized. The United Arab Emirates (UAE) that will welcome the COP28 in Dubai, intend to reinforce the agricultural issue in the climate negotiations and put it at the same level as energy. Yet, NGO experts are not very confident that the COP28 would address the issues of agriculture and food properly.

In the meantime, on Monday the 20th of March 2023, the Intergovernmental Group of Experts on Climate Change (IGECC) has published an eight-year synthesis of its research work and analysis on climate change. The main conclusion is that there is a very slight chance to limit global warming at +1.5°C by the end of the 21st century. Although the text has been approved by a scientific and political consensus, its negotiation process had to overcome many blocking stages and tensions. The IGECC considers that the efforts made to reduce the GEG emissions are not sufficient and it expects an international burst of commitments by all the parties to the Convention on Climate Change. If this happens, the objective of +1.5°C could be reached. The United Nations Secretary-General, Antonio Guterres, has reacted to the publication of the IGECC report by qualifying it as "a guide for survival of humankind," confronted with the climatic bomb.

2023 : another evidence of climate change

Premises

By mid-June 2023, in the Northern Hemisphere, before the dreadful fire season starts, extreme weather events have again and again struck the whole Planet. From Canada to Siberia, through Asia and the oceans of the globe, temperatures have risen and reached figures never recorded. Confronted with such dreadful situation, the same question is increasingly asked: Is there an acceleration of the climate crisis? Unfortunately, the facts that can be observed lead to a positive answer. The average temperatures across the world have been, in June 2023, the hottest ever recorded for this period of the year, announced the European service Copernicus. Canada is being devastated by megafires, many of these being out of control, with more than 400 departures of fires from West (British Columbia) to East (Ontario, Nova Scotia). While

the fire season is expected later, in June 2023, almost 5 million hectares have been burnt, i.e. the double of the annual average surface recorded during the last decade. In Siberia, the freezing cold weather has been followed by very high temperatures: +40°C in the Russian Siberia, where there has been the worst heat wave in history. South-Asia is also suffering from a series of historical heat waves since mid-April 2023: 45°C in Thailand, 44°C in India, Vietnam and Myanmar (Burma), 43°C in Laos. Shanghai has also experienced the hottest May 2023 (36.7°C) during more than a century, and in about one hundred meteorological stations in China temperatures of 43°C have been recorded in June 2023. Porto Rico has been stuck by an exceptional heat wave, while in Spain the hottest spring has been recorded, as well as the second driest ever recorded. Denmark has known, for the first time since 2006, several months without rain, and the area of the Antarctic shelf has never been so narrow in May and June 2023.

These high temperatures across the world have a serious impact on the oceans, which generally absorb *ca*. 90% of the energy accumulated across the Earth. The surface waters have reached the highest temperatures in June 2023. The North Atlantic is a subject of major concern for the climatologists: it has been recorded an increase of +1.1°C of global warming; compared with the average during the period 1982-2023, this was an absolute record. The situation is even worse in the Western Mediterranean Sea and Tropical Atlantic, with a warming of +3°C to +4°C. Marine ecosystems cannot cope with this kind of sudden changes and therefore heavy mortality of marine organisms could occur as in 2022. Moreover, as mentioned above, the *El Niño* phenomenon that warms part of the equatorial Pacific Ocean and that occurs every two or seven years, rises global temperatures by about 0.2°C and therefore increases the risk of extreme weather events in many regions. But the catastrophies observed in 2023 and during the earlier years are above all the implications of climate change, due to human activities. There is no doubt that we are seeing, year after year, an intensification of extreme weather events provoked by global warming. According to Michael Mann, director of the Earth System Science Center of the University of Pennsylvania, “these catastrophies will become more frequent and more detrimental if we continue to warm the Planet.” “The warming rhythm has been more pronounced during this decade than during the earlier ones”, had added Valérie Masson-Delmotte, co-chair of group 1 of

the Intergovernmental Group of Experts on Climate Change (IGECC). Global Warming rises +0.2°C per decade (and +0.5°C for the continents), according to a recent study. The same climatologist states that he does not yet know if global warming is going to continue with the same rhythm. The present warming follows the established climate models, but some of its effects cannot be predicted. For instance, the melting of the Arctic shelf – that may disappear during the summer around the 2030s – or the withdrawal of the ice caps in Groenland and the Antarctic. Similarly, in West Europe, the high rise of temperatures during the summer is beyond the figures predicted by the models. The 1.5°C threshold of global warming that is the ambitious goal of the Paris Treaty could be higher at least during one year, between 2023 and 2027. "We are very concerned about the effects of the El Niño because we are expecting catastrophic warming levels in the oceans," stated Sabrina Speich, an oceanographer at the Pierre-Simon-Laplace Institute in Paris. Part of this energy dives into the depth of the oceans and then comes back at the surface after dozens, or even hundreds, of years. This explains why it would not be possible to stop global warming immediately, even if we drastically reduce tomorrow the emissions of GEGs. But this reduction is nevertheless necessary in order to avoid the worst effects of the climate crisis. Confronted with this acceleration of global warming, both inland and in the oceans, some commentators talk of "a point of disbalance in human history", with some irreversible impacts already seen or perceived and more uncertainty due to a medium- or long-terms emissions of GEGs. We must therefore stop investing in the production of fossil energy and fully respect the goals of the Paris Treaty. The danger is in front of us and we must abandon the short-sighted approach and think more seriously about the long-term future. We must in the meantime adapt to the implications of climate change and try to mitigate the extreme weather events brought forth month after month and year after year.

An exceptional drought in Argentina

By mid-March 2023, where autumn in the Southern Hemisphere is beginning, temperatures are generally mild, but this year they are still high and contribute to the exceptional drought occurring across Argentina. This is particularly true of the region called the agricultural "nucleus", located near the town of Pergamino, 230 km northwest of Buenos Aires. This "nucleus" is the agricultural pride of Argentina, in the centremost of the country. In this

region, on millions of hectares are grown soybeans, maize and wheat. This region is the driving force of Argentina production and exports. In 2023, if has been strangled by an exceptional drought, with heavy implications for an economy already weakened. Argentina has been living through the hottest summer in its recent history. In particular the agricultural "nucleus" has been struck by temperatures rising above 40°C, under the impact of the *La Niña* natural phenomenon and climate disturbances. During the summer, the average temperature has been +1.3°C above the recorded normal temperature. The scarce and residual soil humidity has evaporated. It is true that since 2019 drought has become recurrent. According to the national meteorological service, the rainfall has been only 44% of the normal rains during the last four months of 2022. This volume has been the smallest over the last 35 years. Cereal crops are particularly hurt because their watering depends exclusively on the rains. Another extreme weather event has been a lightning frost that occurred between two heat waves during the month of February and had a devastating impact on the crops.

According to a report published on the 9th of March 2023 by the Trade Stock Exchange of Rosario – a regional capital and an important export harbour – the losses of the agricultural sector have been estimated at €13 billion, with a drop of 40% of the export value compared with 2022. If all the activities connected with the agricultural sector are taken into account, the total losses due to the extreme drought amounted to €17.6 billion, i.e. 3 points of the Argentine gross domestic product (GDP) in 2023. This meant a serious reduction in the export taxes on cereals – €5,6 billion are not recovered by the state's coffers. It is worth recalling that Argentine economy is, to a large extent, dependent on the country's agriculture – *ca*. 60% of its export value in 2022. In addition, the drop in agricultural exports will also induce a decrease in the central bank's reserves in strong currencies, when the overall economy is already weak. Thus, the objectives set by the International Monetary Fund (IMF), in the framework of the renegotiation of Argentine debt – US$45 billion or €41 billion – will not be easy to reach. For instance, according to an economist of the Research Institute for the Argentine and Latin American Reality, limiting the budget deficit at 1.9% of the GDP for 2023 is probably out of reach and will not meet the IMF recommendations. It is therefore a real challenge, with a reduced tax income, to fund and promote social policies in

a country where almost 40% of the total population is poor; and when the endemic inflation rate has been very high since 1991 – in February 2023, it reached an annual rate of +102,5%.

Confronted with a sharp drop in the rainfall volume, particularly in the most fertile agriculture area – the "nucleus" – the country should implement a wide variety of actions: develop new systems of water spray and irrigation, but the necessary investments are too costly for the farmers; build new dams and water reservoirs, but that represents a very important budget for the state. The National Institute for Agricultural Technology (INTA) that is part of the agriculture ministry, recommends a series of good practises, e.g. instead of growing soybeans after soybeans on the same soil, implement a crop rotation that improves soil quality; make efforts to recover part of the rainfall – from the runoff water. In the area of crop adaptation to climate change, Argentina has developed a transgenic wheat variety, called *HB4*, that is resistant to water stress. This is a pioneering technology in a country where almost 100% of maize, soybeans and cotton varieties are genetically engineered. This wheat variety has been developed by the researchers of the National Council for Scientific and Technological Research (CONICET) and the agricultural-biotechnology company Bioceres. Although some experts do reckon this achievement and the performance behind it, they think that this variety will have some difficulty to resist the exceptional drought Argentina is going through. During the 2021-2022 agricultural campaign, only 53,000 hectares have been planted with *HB4*; this is not very much compared with the 5.9 million hectares of wheat in the whole country.

The prospects made by the climatologists are that extreme weather events (EWE), such as drought and floods, will tend to become recurrent in Argentina, because of climate change and global warming. These prospects underline the great dependence of Argentina on its agriculture that is also a source of environmental problems. This model has never been questioned. Already in 2018, a severe drought has cost 2.5 points of GDP and has aggravated the economic recession of the country. Earlier on, climate disturbances have shattered Argentine economy. Therefore, many economists recommend developing other sectors of the economy that can buttress agricultural exports, such as natural gas and oil extraction and transformation, mining and

motor-car industry. One must be aware, nevertheless, of the fact that these industries produce vast volumes of greenhouse-effect gases (GEGs); they should therefore be developed with a view to limiting GEG production to the largest extent possible.

It should be reiterated that in 2022 heat waves and very high temperatures, extreme droughts, devastating floods and megafires have relentlessly struck our Planet, thus affecting millions of persons and causing economic losses estimated at billions of US dollars. This brought additional evidence that climate-change-and-global-warming impacts are increasing and require swift action. According to the World Meteorological Organization (WMO) press release on the 12th of January 2023, the last eight years of the second decade of the 21st century have been the hottest ever recorded. This announcement has confirmed the WMO prospects of November 2022. In 2022, the average temperature of the globe has been +1.15°C higher than the preindustrial levels (1850-1900). It has been the eighth year in sequence when the level of +1°C has been exceeded. Since the 1980s, every decade is warmer than the preceding one. The year 2022 has been ranked as the fifth or sixth warmest year. This rise in temperature has been slightly attenuated by an episode of *La Niña*. As it occurs rarely, this episode of *La Niña* has been observed for three years in sequence. But the WMO warns that this re-cooling will be of a short duration and will not reverse the general trend of global warming, caused by the high concentrations of greenhouse-effect gases that keep the heat in the atmosphere. These concentrations are the highest for more than 2 million years in the case of CO_2 and for more than 800,000 years for methane.

In **Europe**, where global warming is the fastest, the year 2022 has been recorded as the warmest one, after the year 2020. The summer has been particularly hot. In France, the year 2022 has been the warmest one ever recorded, as well as in Western European countries –United Kingdom, Spain, Portugal, Italy, among others. The excessive concentrations of the GEGs generate a surplus of energy that induces the warming of oceans – which store more than 90% of the global heat. In 2022, ocean warming has reduced the concentration of oxygen and subsequently has affected the marine ecosystems – e.g. coral reefs. On the other hand, the average rise of sea level has doubled between the two decades 2010-2020 and 1990-2000. That was the result of the

expansion of the water due to global warming as well as of the acceleration of ice melting in the Polar Regions and the glaciers. In both Polar Regions, temperatures reached record highs, e.g. +8°C above the average temperature in Groenland in September 2022. Atlantic ice shelf has shrunk more than usual. Not to speak about all extreme weather events (see above), like floods, extreme droughts, hurricanes, and their considerable damage, or the historical cold spell in the United States that caused more than 60 deaths and has been a nightmare for millions of Americans during the Christmas weekend. These natural disasters have caused the death of *ca*. 11,000 persons across the world in 2022, compared with 9,320 in 2021, as well as heavy damage estimated at US€270 billion. According to the UN Secretary-General, Antonio Guterres, this disastrous balance-sheet describes the "sad chronicle" of the climate chaos. It was just a brief outline of what humankind can expect if we do not urgently and drastically reduce our emissions of greenhouse-effect gases. Presently, we could predict an average global warming of about +2.5°C at the end of the 21st century, which is far from the objective of +1.5°C or +2°C set up in the Paris Treaty. Therefore, we may guess what we can expect in 2023.

In **California**, after a long and severe drought across the State, seven series of storms have hit a large part of the "Sunshine State" during the first two weeks of 2023. Pushed at a very high speed by an altitude Jetstream coming from the Pacific Ocean, air masses containing considerable volumes of humidity have been pouring heavy rains on California. The latter have caused the death of 19 persons across the State. While other heavy rains were expected on Saturday the 14th of January 2023, Los Angeles mayor declared a state of emergency that facilitated the assistance of the federal government. In several locations, land- and mudslides have cut off roads and streets. According to some inhabitants living in the Los Angeles suburbs, they felt an earthquake was happening; in fact, it was even worse than the 1994 earthquake, mudslides have resulted in the destruction of households that were tumbling down the hills or streets. The National Weather Service, within the division of extreme-weather-event warning, has been struggling to derive the floods towards the Los Angeles River. The latter normally resembles a small canal, but during that period the water level reached unexpected values. The LA River has been built mainly with a view to accelerating the flow of water into the Pacific Ocean, thus avoiding the risks of floods in the urban zone. In 1938, the LA River

has overflowed its banks, killing one hundred people and causing damages estimated at more than US$1.5 billion. The United States Army Engineering Corps has been requested to "tame" the LA River through building higher and concrete-consolidated banks. Thus, in 2023, the LA River did play its role and conveyed the excess of water into the ocean. Unfortunately, that was not true of other towns, located in the centre and north of the State, such as Sacramento – the State's capital –, the Monterey peninsula and the city of Salinas (160,000 inhabitants). These were expected to receive downpours by mid-January 2023, according to the National Weather Service forecasts. The Democrat governor of the State, Gavin Newson, stated that during the last two years the megafires that occurred in California have provoked less human casualties than the weather conditions that prevailed since the beginning of the New Year. This statement made during a press conference preceded the declaration of state of emergency that led to the allocation of exceptional funds, along with the assistance of the National Guard. It was again confirmed that these extreme weather events were closely linked to global warming. The exceptional rise in temperature give to these events more energy and make them more destructive. The heavy rains had nevertheless some advantages: snowfall has been very abundant on the mountains; in the large reservoirs of the State, after three years of lack or scarcity of water, the levels were more than satisfactory. For the first time, since April 2020, not a single zone of California has been declared in extreme drought.

On Monday the 13th and Tuesday the 14th of March 2023, the 11th "atmospheric river" has once again submerged part of the State, that has been struck by a succession of these very high humidity "rivers" since the beginning of January 2023. The heavy rains have deprived more than 200,000 inhabitants of electrical power, while 88,000 people had to leave their households or have been invited to do so if the floods were rising up. Since the end of December 2022, the 39-million Californians have been enduring a whiplash weather. After the first atmospheric rivers of January 2023 and the snow blizzard at the end of February 2023 from the Sierra Nevada to the region of Los Angeles, this series of storms have been striking California. Called pineapple express, this extreme weather event has caused many death casualties. For weeks the television news have been transformed into meteorological bulletins and warnings. The pineapple express that occurred on Tuesday the 14th of March

2023 has been followed by a very high rainfall in the region of Los Angeles and at Santa Barbara – 6.45 cm of rainfall per square meter have been recorded at LA airport. In Northern California, as soon as the rains stopped, very strong winds have followed the wake of the atmospheric river : the wind speed reached a maximum of 156 km per hour, as recorded in the meteorological station of Santa Cruz. At San Francisco airport, 500 flights have been delayed or cancelled. According to the data provided by the electrical company PG&E, 367,000 people have been deprived of electrical power on Tuesday the 14th of March 2023 – a record figure since 1995. Dozens of schools had to close down. The town of Pajaro, settled along the Pajaro River, 140 km south of San Francisco, had to be evacuated on the 10th of March 2023, after the bursting of a dyke. The 8,500 city-dwellers have been requested to leave their households. Some of them refused to do so and 250 persons had to be rescued by the firemen due to the rise of water – up to 1.80 meters. That dyke, which was built in the 1940s, broke down at the same place as in 1995, and it needs to be repaired. The governor of California, Gavin Newsom, has travelled to Pajaro and he warned the population that a 12th atmospheric river has been announced by the meteorological service for the third week of March 2023. The governor, who had to face several megafires in the most populated State of the country, has stressed the lightening speed of the change of weather conditions across California. He made the following statement: "When we look behind us, during the last years, we have moved from fire to ice, and without a warm bath between both. If anybody has the minimum doubt about the wrath of Mother Nature or about the meaning of these events in terms of climate and the changes we are going through, he or she should come to California and realize what is happening."

To sum up between the end of December 2022 and mid-March 2023, 13 atmospheric rivers have discharged heavy downpours from the north to the south of the State, followed by important floods. Even Lake Tulare, whose memory has been almost forgotten by California's inhabitants, has made its reappearance. This has been an unprecedented event since 1983. On the 20th of April 2023, its area was 250 km^2 and one month later it jumped to 466 km^2, a surface equal to that of Lake Tahoe – the great mountain lake of Northern California. This has become a touristic area and Gavin Newson, the State's governor, described the landscape as "surrealistic". The sequoias of the

National Park that had to be protected from the megafires in September 2021, have received more snow than in the last 70 years. And in the spring of 2023, the desert bloom – an almost forgotten event – could then be seen again. Climatologists have described as *whiplash weather* the extreme events that occur during several weeks or months : a long and severe drought followed by downpours and floods.

At the beginning of the 2023 summer, the American West had its eyes on the weather prospects. From Los Angeles to Phoenix, from Salt Lake City to Denver, climatologists have become stars of the society, or oracles Like Daniel Swain, of the University of California Los Angeles (UCLA), author of the blog Weather West. All of them talk about the *El Niño* phenomenon which may affect the Pacific countries in the form of extreme weather events. According to Daniel Swain, *El Niño*, with starts in the waters of the South Pacific, could cause this year even more detrimental catastrophies. Therefore, one should be prepared very soon.

In the Northern Hemisphere, many hoped that snowfall and rains could alleviate the burden of the year 2022. In France, for instance, according to Météo-France and the Bureau for Geological and Mining Research (BRGM, French acronym), the season during which underground water tables are replenished was one-and-half month (or even two months) late, at the beginning of 2023. The rainfall recorded during the fall of 2022 could not replenish the underground water tables across almost the whole country, but above all in the southern half of it. In addition, the level of many rivers and other water bodies like lakes was very low. Several sky stations had to close down because of the lack of snow, whereas glaciers were melting at an alarming rate. The 2022 autumn having been unusually warm, it hindered the scarce rains to filter through the soils and reach the underground geological layers, in order to be stored and used till the following summer season. This is particularly true of the underground water tables that take two to three months to be replenished by the rainfall. Therefore, unless the rains are very abundant during the winter season, these water tables will remain under their normal levels. In the southeast of France, such situation occurs every 10 or 12 years at this period of the year – at the beginning of the winter season. Still, according to the French BRGM, the deficit of rainfall in 2021-2022 as well as

the increasing rate of irrigation since the spring of 2022, are also the causes of this situation; this has justified the restrictions in water uses during the period July-August 2022.

To sum up, between 1990 and 2018, the renewable availability of sweet water fell down by 14% in **France**. This water includes 94% of rainfall, and 6% coming from rivers. Its average annual volume amounted to 229 billion cubic metres (m^3) during the first 10 years, and to 197 billion m^3 between 2002 and 2018. Since 1959, rainfall has decreased across half of the French territory (49%), while the evaporation of plant cover (including cropland) has increased markedly, especially during the spring period. The French people have become concerned about the possible scarcity of water and the local authorities are expressing as loudly as possible this concern. The government has included a chapter on water in its ecological planning: reduction of water consumption and optimization of water withdrawals, better utilization of treated waste waters and sewage, and acceleration of the elimination of leaks in the waterpipe network. The government also listened to the recommendations made by the National Water Committee (CNE, French acronym) – which includes government representatives, consumers such as the farmers, but also environment activists and local consultants – that has been associated with this food-for-thought exercise. Some of the results have been expected, like thorough studies on the assessment of available water resources, more awareness of a need to spare the resource by all water consumers; and also some suggestions, that would have been unimaginable before the 2022 summer. For instance, some CNE members have insisted on the necessity to be prepared since the month of March to summer droughts and to therefore assess water withdrawals on the basis of a reasonable consumption. Some other members have demanded a more equitable distribution of water, as well as a large sharing of the information, with a view to knowing what is exactly withdrawn. A remote assessment could be put at the disposal of all farmers. Whereas CNE members demanded that in 2023 the control by the municipal or national police be enforced, in order to make sure that water-restriction measures are fully respected; others made a plea that the water resource be reclaimed and naturally conserved, e.g. in the soils, prairies, forests and humid zones. Also a special attention should be given to the overall preservation of natural ecosystems and their biodiversity, because it warrants a long-term conservation and use of water.

Water stress and a high risk of drought in France

On the 13th of April 2023, the Bureau for Geological and Mining Research (BRGM), in charge of monitoring the water resources in the soils and underground, has underlined that the level of underground waters was globally lower than that of 2022. According to the data recorded in the BRGM network, 75% of the points of observation had a water level qualified as moderately low or very low, compared with 58% one year earlier. Among these points of observation, 19% had a very low level of water resources. In some sectors, like in the southeast of France, the situation is characterized by "historically low" water levels. By contrast, some underground tables could receive enough water thanks to March rainfall and were recharged, e.g. in Brettany. In autumn 2022, the underground water tables have been slow to be refilled or replenished, due to a "weak infiltration of rainfall into the underground, the soils being very dry and the vegetation becoming active lately. Then, in February 2023, the scarcity of rainfall has stopped the refilling of the underground water resources; and the March rains could not reverse this trend. According to the BRGM, as of April 2023 the refilling episodes would be weak, except if rainfall is abundant. At the beginning of spring, available water resources will be withdrawn to a large extent from superficial soils and by the growing vegetation. These conditions result in a low infiltration or poor refilling of the water tables.

Météo-France has also mentioned the low level of another water storage, the snow volume. Snow melting supplies water to lakes and water streams. The meteorological service of France has indicated that in the Pyrénées Mountains, "snowfall has been far from it was expected all through the winter season (2022-2023) and snow started to melt very early" – since the beginning of February 2023 instead of mid-March. The end-result is that water volume flowing from the snow mantle is very close to low records. The service added that in most of the Alps Mountains and in the whole of Jura, this volume was in deficit on the 1st of April 2023. Even if superficial soils have been replenished to normal levels thanks to March rainfall, this improvement cannot hide the fact that many French departments, particularly around the Mediterranean Basin, still lack water due to the scarcity of winter rainfall. For instance, in April 2023, in the south of France – the Provence-Alps-Côte d'Azur (or

French Riviera) – the content of water in the superficial soils is equivalent to the volume during the month of June, and we are, according to Météo-France, still in a situation of meteorological and agricultural drought. The winter temperatures have been +0.8°C higher than the usual seasonal records and they have worsened the present conditions, that followed a dry and hot year 2022. This trend of higher temperatures continues in March 2023, that is the 14th month in sequence – a record since 1947. The rise in temperature has a direct impact on the available volume of water for the whole territory, because it accelerates evapotranspiration and therefore the transfer of that water into the atmosphere.

For the second time in France, a deficit in rainfall and an incomplete refilling of the underground water tables have been recorded. On a monthly basis, the rainfall deficit is persistent: since August 2021, the meteorologists have noticed three times more months with less rainfall that the normal figure (15), while those having enough rainfall – and even an excess of water – reached only five. Spring rainfall may modify the situation, but a scarcity of rains during that period of the year will provoke a fast desiccation of the superficial soils due to higher temperatures, while plant growth will pump in higher volumes of water.

The overall conclusion is that a drought will prevail during the summer period in several regions of France. The BRGM has estimated that this risk is high or very high in the north, centre and southeast of the capital. Several measures have been taken or are examined in order to meet the needs of the populations and farming. Strict allocation of water resources to the users has been put in place in several zones, e.g. the southern department of Bouches-du-Rhône (Marseille region).

Downpours and catastrophic floods in Peru

Since the beginning of January 2023, downpours and catastrophic floods have been striking Peru, causing at least 85 deaths, and 14 people that have disappeared, as well as 51,000 people harmed in various ways, 300,000 people affected. Thousands of hectares of agricultural land have been flooded. According to the National Institute for Civil Defense (INDECI) this was not the complete picture of the disaster, which creates havoc in the northern

departments of the country – Tumbes, Lambayeque and Piura – this is the second-populated department just after the capital Lima. On the 20th of April 2023, another episode of violent rains has been announced by the INDECI, also on the northern coast and in the Central and Northern Andes as well. Since January 2023, floods and mudslides, and ground collapses have become daily disasters for the inhabitants and households in the affected regions. Peru has been going through a rainfall season with downpours, due to the climatic phenomenon called coastal *El Niño* – rise in water temperature close to the shore, whose effects can be perceived in Peru and Ecuador. The coastal *El Niño* is different from the global phenomenon *El Niño*, that occurs every six or seven years and disturbs the global climate. The latter could start in December 2023 or January 2024, according to the estimates of the climatologists. In the case of Peru, television channels have spread out the impressive images of washed away houses, destroyed infrastructures, roads, schools and health-care centres, as well as of people trying to swim through the rivers and risking their life in this attempt. Lima, where rainfall is generally scarce, was not left unscathed: 10 people died between January and March. Hurricane YAKU, blowing off the Peruvian coasts by mid-March 2023 – a tropical extreme weather event rather unusual in this part of the world – has provoked heavy rainfall, causing important damage in Lima which is not prepared to receive such downpours.

As a matter of fact, Peru has an extremely high level of vulnerability and exposition to risk. Buildings are constructed and reconstructed in high-risk zones, stated one Peruvian member of the Intergovernmental Group of Experts on Climate Change. Economic losses have been estimated at €3 billion, according to local media. The president of the Central Bank has evaluated these losses at the equivalent of 0.25% of GDP for the month of March. The president of Peru, Dina Boluarte – a controversial leader – visited the regions affected by these extreme weather events, and she had to admit that the state had not the means to cope with such disaster; the machines and equipment necessary to evacuate the millions of cubic metres of stagnant water were clearly insufficient. The Peruvians have been amazed by this statement, while the Defensor of the People requested the government to call on an international emergency humanitarian assistance. International organizations such as UNICEF are warning about the risk of propagation of communicable diseases

due to stagnant waters, as well as of the multiplication of mosquitoes, vectors of the dengue, of which the number of cases was rising in the north of Peru.

Sharing of water resources : *the need for an inclusive planning thought*

The example of France is not unique; many countries from the Northern and Southern hemispheres are becoming more aware of the vital need to preserve water and to use it with restraint, especially in the semi-arid and arid zones of the globe. Consequently, it is important to promote everywhere an inclusive reflexion on the sharing of water resources. It is true that innovation and its technological transfer must play an important role, e.g. the collection of rainfall that runs off without being conserved by the natural ecosystems or by traditional irrigation schemes; or the use of treated waste waters – in some countries, 80% of these waters are evacuated towards the sea or rivers, and this is a big loss. Irrigation processes must also be regulated, so as to spare the maximum of water: extension of drip irrigation, computerized irrigation, use of mixtures of sweet and brackish water, etc. It is known that everywhere across the world, agriculture consumes between 70% and 80% of the available water resources. But there are countries or regions that spare more water without losing much of the crop yield. The trend to apply agroecology techniques or to rely on less water-consuming crops, such as sorghum in temperate-climate areas, is also recommended. Concertation and cooperation among all water consumers are crucial in order to reach acceptable solutions, including the rate of water distribution and storage. It is also crucial to involve the citizens in order to understand the challenges brought up by the future of water resources and to develop a kind of trust in the public choices or decisions. Otherwise, the feeling that there is a form of injustice could be a factor of social tension.

The increasing scarcity of water resources in numerous countries have led the United Nations to organize in New York an extraordinary conference on the subject, from the 22nd to the 24th of March 2023. The United Nations stated, at the beginning of the conference – and also to justify it – that the Planet is facing an “imminent” risk of sweet-water crisis. Water is too much withdrawn – which partly explains it subsequent scarcity; it is often polluted, while climate change and global warming are responsible for more severe and long-lasting droughts – an important factor in the availability of water. One-fourth of the global population has not yet access to drinking water,

and half of it has no toilets or rest rooms, nor an adequate sewage system. The lack of water that affects between 2 billion and 3 billion people, at least during one month per year, will become critical at least in the towns, warns the United Nations. Water-resource management is hampered by a piece-meal governance, without proper coordination and cooperation. An international political agreement is not yet on the priority agenda, while we are dealing with a crucial issue.

How to save water?

According to the Research Community Centre of the European Commission, the 2022 drought that struck half of Europe "seems to be the worst in 500 years". France is among the countries that bore the brunt of megafires that started at the beginning of the summer; the total rainfall from January to July has been 33% less than the average and this applies to the whole territory. It has been repeatedly stressed that one way of saving water is to reduce or even eliminate the leaks in the waterpipe network. In France, this waste has been evaluated at 20% (average), which means that one litre of water out of five is lost, i.e. 937 million cubic metres per year. The leakage loss is bigger in some regions: 50% in the Antilles and even between 50% and 70% in the southeast of the country. But eradicating the leaks in the 895,000 km of drinking water pipes and in the 423,000 km of sewage systems, is not enough.

Drought occurs when there is an excessive heat and the lack of rainfall, but it is also the result of unsuitable uses of water resources. In France, industry consumes an average 34% of the total available water, agriculture 45% – but 80% during the summer –, households and individuals 21% – this proportion remains globally stable, while the overall population is growing. The emergency measures aimed at restraining the use of water are not sufficient. A new policy of saving water has to be designed and implemented, e.g. the reduction of the wastage, but also the struggle against water pollution that makes the water unsuitable for many uses. Pollution caused by nitrates and pesticides has, for instance, resulted in the closing down of 4,300 water catchments in France since 1980. Furthermore, each drop of water should be used **efficiently**. The French government has allocated another €100 million to the six Water Agencies, in charge of managing and preserving water resources and aquatic environments. This budget will allow the creation of rainfall-retention basins

or of storage reservoirs for agricultural needs – these artificially created reservoirs fed essentially by rainfall have raised controversies between ecologists and farmers. This budget included subsidies to the development of more water-saving toilets in the schools, closed circuits in the industry – in order to recycle a maximum of water – as well as to the repair of irrigation canals. Several Water Agencies have decided to increase their expenditure budget – while they were hoping to reduce it – in order to improve their water-distribution network, to change their irrigation system and systemically introduce drip irrigation. Locally it was possible to save more than 110,000 m^3 in various regions. The Water Agency, Rhône-Mediterranean-Corsica, has allocated €67 million to 353 projects since 2019; this has resulted in saving 62 million m^3 of water for different uses. A better management of the water resource that supplies drinking water has saved 10.2 million m^3, while 5.7 million m^3 have been saved thanks to an improvement of some industrial processes and 46 million m^3 thanks to a more efficient agricultural irrigation. Furthermore, the Water Agencies are increasingly active in addressing the farmers in order to build up water-saving schemes, e.g. replace spraying-irrigation by drip irrigation. On the other hand, the partnership established by the National Research Institute for Agriculture, Food and Environment (INRAE, French acronym) with several public and private actors, via a chair on Water, Agriculture and Climate Change, is focused on the use of treated wastewaters for the irrigation of green spaces, gardens and golf courses. Some experts underlined that this is a limited source, because the plants that treat the wastewater and sewage also aim to refill the rivers that have a low or very low water level. They suggest that treated wastewaters should be used in peri-urban agriculture, because it would be too expensive to convey them to remote rural plots. According to a number of researchers, it should be possible to reduce by 20% to 30% the water consumption in agriculture, thanks to more efficient irrigation systems, designing sensors measuring soil humidity and other technologies. With respect to crops, it is repeatedly suggested to replace maize by sorghum, which is more drought resistant and gives a good fodder. Finally, the role of agroforestry is important because it covers the soils instead of leaving them barren; it provides shade and windbreaks that protect herbaceous crops.

Impact of water stress on industry

For the industrial companies, the scarcity of water is not a remote problem. It is true that these corporations are facing in Europe, but elsewhere, several difficulties, like the skyrocketing price of energy (electricity and natural gas), the scarcity in the supply of semi-conductors and the tensions on several raw materials. *The 2022 extreme drought has recalled the industrial managers that they should preserve the water resource and use it the most efficiently possible*. In **France**, the national industry consumes 2.5 billion m^3 per year, i.e. 8% of the total withdrawals from the underground water tables and rivers. According to the prospects of the ecological transition ministry, several industrial sectors run the risk of being deprived of part of their water supply: chemical industry (petrochemistry, pharmaceutical industry and production of phytosanitary products), which represents 25% to 30% of the withdrawals of water; paper industry (10%) and agri-food industry (8%) – especially the production of dairy products and beer.

The French electricity corporation EDF (Electricité de France) has from time to time difficulties to cool its nuclear plants located along the main rivers of the country – Rhône, Loire, Garonne and Moselle. River-fleet owners have to find appropriate solutions to the low water level of the Rhine and great canals. A prospective study of the French Bureau for Geological and Mining Research (BRGM), published in 2012, has forecast that the replenishment of the underground water tables would be decreased by 10% to 25%, compared with the period 1961-1990, whereas the average annual river water flow would be decreased by 10% to 40%. The French industrial corporations discover that France may become a semi-arid region and that in 20 years there will be 10% to 20% less water at the surface level or in the underground water tables. As we aim to reduce the carbon imprint, we must also reduce the water imprint. It is true that for the last ten to twenty years, large industrial groups have been setting up water policies and have improved their industrial processes. For instance, 15 m^3 of water were used for building a motor-car in 1995 (by the French group Peugeot-PSA, now called Stellantis), and only 3.5 m^3 twenty years later. The production of a ton of paper needed 40 m^3 of water in 1990 and only 23 m^3 in 2017. Even though they return more than 90% of the water resource to the environment, industrial corporations have to make

more efforts in order to withdraw less water. *The British association CDP* (*ex - Carbon Disclosure Project*) *which measures the environmental impact of companies at the global level, has mentioned that only one-third of the European corporations clearly indicate their purpose to reduce their water consumption*. In 2019, the association estimated that the large distribution, considered as the least performing sector in water management, had a primary role to play: "composed of corporations at the top of the agriculture value chain and having big incomes, it should promote significant improvements in water use and management among the producers of meat, farmers and dyeing corporations across the whole world." The same platform, in partnership with the NGO Planet Tracker, has revealed that one-third of the banks listed on the stock index do not evaluate "the water risk" in their portfolios, generally behind the issue of CO_2 emissions. By contrast, according to CDP, three-quarters of the companies mentioned they were exposed to important risks linked to water (security, poor quality, etc.), and even pointed out a degradation of their image regarding an excessive use of water and its pollution.

In **France**, in 2019, the government has organized a national meeting that agreed on the objective to reduce by 10% the water withdrawal in five years and by 25% in 15 years, and to better share the available water volumes. Regarding the use of treated wastewaters, it has been restrained by the health authorities. The objective is to move from an estimated use of 0.1% to 0.3%, compared with 10% in Italy, 15% in Spain, 30% in Singapore and 87% in Israel. In France, out of 8.4 billion m^3 of wastewaters produced annually, 1.6 billion m^3 could be used in a closed circuit. This use has started in agricultural irrigation and the watering of green spaces, in addition to cleaning the streets and vehicles, as well as the cleaning out of sewage and sanitary networks. The National Union of Water Industries and Corporations, including the big Veolia and Suez groups, has considered that the national objective of using 0.3% of treated wastewaters was not satisfactory, and there has been an endeavour aimed at improving or developing wastewater-treatment technologies. These companies suggest that France should have a greater ambition in this sector and thus respond to the new demands of the European Union in terms of water quality. And this approach is even more important when new activities are added to traditional industries, such as innovative technologies that need more pure water: e.g. manufacture of semi-conductors or the management

of more data centres. A very large market of "grey waters" will become available for big French groups such as Veolia and Suez, with a view to better managing the water resource.

Wood industry and sylviculture in France

Replaced by steel, thereafter by concrete, during the 19th and 20th centuries, wood – an excellent ecological material – becomes fashionable during the 21st century. Such come back could become very beneficial for France which has the fourth-forested area in Europe, as well as a wide variety of species – 136 compared with 20 in Germany. Unfortunately, these potential benefits are not translated into reality. For instance, the balance-trade deficit is enormous: *ca*. €7 billion. Many reports have stressed this disbalance, due to a weak integration between the upstream and downstream components of the industry, or between the offer and demand for wood. Upstream, three-quarters of French forests belong to very numerous private owners. Most of them are the heirs of landlords that quite often live far away of their forests and are not interested in their exploitation. Not to speak about those who are involved in this industry, but have often difficulties to sell their cherry ash or beech woods, due to the lack of adapted sawmills. While their number reached 15,000 units in 1964 across the whole countryside, they could not resist the competition of furniture made of Formica, as well as of the use of concrete. They had to merge and nowadays they are only 1,250. The most resilient ones have decided to work on coniferous species, which is more economic.

On the other hand, in January 2022 a regulation called RE2020 has been put in place in order to reduce the carbon impact of new buildings and to better adapt them to withstand heat waves. In this context, wood used in the construction works in an average proportion of 6%, could jump to 20%-30% in 2030. And construction is not the only demand for wood; many industrialists are rushing to using wood as a source of energy. Indeed, the production of a renewable source of heat from biomass in the industry and local communities should double from now to 2028. But forests are not the unique suppliers; wood wastes, sawdust and agricultural subproducts will be used more frequently. Scientists are criticizing the felling of trees for heat production, as well the subsequent pollution. We should not forget the role of forests in being a natural carbon sink, in the water cycle or in the struggle against soil erosion.

But these ecosystemic roles suppose that the forests are healthy. That is not really the case. In the report published on the 30th of June 2022, the French High Council on Climate has shown that, despite the increase in forest and woodland area, the latter have a lesser capacity of CO_2 storage. Moreover, global warming increases the recurrence of droughts, the rise in temperature, the occurrence of megafires and finally the attacks by rodents that ruin the trees. It is also important to mention the damage caused by bark beetles: after having proliferated in the East of France, these xylophagous insects can now be found in almost all spruce forests. The end result of these attacks was that in 2020, 3.3 million cubic metres (m^3) of wood have been "declassified" in the East of France.

Beyond the issue of exploiting the forests, which leads to many debates, there is a challenge of how to do it. If more trees are felled down and replaced by more diversified plantations, bearing in mind their multifunctionality, it is quite a different approach if the intensity of exploitation is increased and more coniferous species are used to meet a high demand for wood. Such exploitation scheme could lead to soil acidification, to a weaker resilience to climate change and to a loss of biodiversity. Obviously France needs large sawmills, but they should be able to handle various species of trees. The director of Fransylva – the French Federation of Private Foresters – mentions that during the 2000s he could not find outlets for its birches, acacias and hornbeams; therefore, he decided to create a sawmill fit for all woods. In the northern French departments, sawmills have merged in order to specialize on poplar woods. In Normandy, the group Manubois, a subsidiary of the group Lefebvre, has been recently involved in the manufacture of construction products made of beech trees. On their side, the furniture manufacturers insist on using the locally available forest wood, as well as the output of the recycling processes. In the Basque country, Alki, a manufacturer of high-quality furniture, makes a point to carefully monitor the supply of wood: square wooden pieces made of local oaks. As the buyers are more and more Asian and very active on the market of wooden floor-pieces, there are campaigns promoting the limitation or even the prohibition of French-oak exports to China. French manufacturers are afraid of not having enough of this wood for their own uses, particularly when economic growth rises again. There is certainly a need for concertation among all the players of the wood industry, in order to identify the urgent issues and to better orient the relevant public policies.

The following figures illustrate the state of the forest sector in France:

1. The construction sector absorbs 44% of energy consumption and produces 25% of CO_2 emissions. In 2020, 6% of the new homes have been built with wood. Forests are the first reservoir of carbon; they occupy 31% of the total area of the country, i.e. 17 million hectares. In terms of surface, French forests are ranked at the fourth place in Europe, behind Sweden, Finland and Spain.

2. 74% of forests and woodlands are owned by private landlords, 16% by local communities and 10% by the state. Public services sell 40% of the available wood with the assistance of the National Forest Office. The number of French sawmills has been divided by 12 in *ca*. 60 years: 15,000 units in 1964 compared with 1,250 units in 2021. The subsequent result is a trade deficit that tends to increase: *ca*. €7.0 billion in 2020 compared with €6.7 billion in 2011.

3. The French forests are mainly composed of deciduous species (oaks, poplars, beeches, etc.) with a proportion of 67% of the total, of coniferous species (fir, pine, and spruce) – 21% of the total – and of 12% of mixed forests. The exports of wood consist of raw materials (logs, raw wood), while the imports of wood include transformed products (furnitures, wood paste, paper and cartons). The three main suppliers were in 2020: Germany (673,210 m^3), Benelux (438,208 m^3) and Finland (387,906 m^3). Regarding the categories of wood commercialized in 2019: wood for central heating (8,061 thousands m^3), industrial wood (paper paste and manufacture of panels) – 10,533 thousands m^3 – and sawed and construction wood – 19,588 thousands m^3. Forty-one percent of the wood used in French construction works has been harvested and manufactured abroad.

Need for a forest-management reform

Due to the extreme stresses affecting forests – megafires and water stress among others – many experts consider that by giving more means to the firefighters is not the only response to the forest crisis. Mainly due to climate change the present challenges are considerable. In France, for instance, during the first half of August 2022, 53 departments have been struck by fires that devastated at least 10 hectares of forests and woodlands per day

– this figure has never been recorded earlier. Moreover, since 2017, the volume of wood harvested in unhealthy conditions in public forests has been multiplied by four. And from nowadays to 2050, one-third of the 17 million hectares of forests across the French territory (excluding the tropical areas of Guyana and the Antilles) is threatened by withering. In addition to some forest species that may disappear, the carbon-storing capacity of the forests would be decreased, and the tree-growth rate would become slower. On the economic side, the whole wood industry is being shattered. In general, funds and human resources devoted to forest management have not been at the level of the challenges and stakes over the last decades. For instance, the National Forest Office (ONF, French acronym) in charge of the management of public forests – i.e. 25% of forests and woodlands across metropolitan France – has lost 5,000 jobs in 20 years. The National Centre for the Forest Property (CNPF, French acronym) relies on *ca*. 310 employees, a figure that has been falling over the last five years. Moreover, the centre lacks the digital tools that allow the remote establishment and transmission of management documents. The last important forest law has been promulgated in 2001. Some experts and politicians have requested the creation of a forest ministry in order to highlight the ambition of the state and government and give priority to forest management. Such ministry would include persons from the forest world, but also from the research, industry and environment sectors. The agriculture ministry, where forestry is under the purview of a sub-directorate, has reacted to the demands regarding the means available to repair the damage inflicted to forests and woodlands and to implement a new management policy. Since 2020, the ministry has allocated €150 million per year, within the frameworks of the national programmes "France Relance", and thereafter "France 2030", and for the most urgent reforestation projects, following the 1999 storm event. The sylviculturists hope that this subsidy will be renewed at least until 2030. This sustainable funding is needed for investing in forest areas, collecting the seeds of Mediterranean tree species, that would be more adapted to climate change, growing them in nurseries and then planting them. In forestry, work is carried out over a long time and therefore long-term and sustainable funding is necessary. Associations for the protection of nature also request the allocation of funds in order to support sylvicultural practices in natural regeneration of forests and tree-species diversification.

The agriculture ministry wanted to give priority to sylvicultural management in small plots that were not attended properly. Private forests are very fragmented: *ca*. 1 million landowners possess 1-ha to 20-ha plots, and they are not obliged to have a management scheme – an analytical tool for the ecologic, economic and social functions of a forest-or-woodland plot. Out of the 62,000 hectares that have been destroyed by fire since the beginning of 2022, only 4,000 hectares belong to the public sector. Because of this fragmentation between the public and private sectors, some parliamentarians have strongly suggested the creation of a large national agency that would include the National Centre for the Forest Property (CNPF) and the National Forest Office (ONF). They underlined the need to put in common the means of observation and monitoring (through satellite imagery), to define the tools needed at the level of the territories, and to set up a stronger link between research and experimentations. The supporters of this new agency do not think that it could replace the CNPF or the ONF, but that it could coordinate their respective activities, improve the general efficiency of the work carried out through the merging of technical services and have a long-term approach. If one thinks that private and public forests have almost the same functions in terms of carbon sequestration, natural-risk prevention or water storage, a single agency could be useful in overseeing the activities carried out in both kinds of forests, for instance the law-enforced clearing of the herbaceous plants and small shrubs growing under the trees. This undergrowth is a very inflammable material that ignites and fuels forest fires. Both CNPF and ONF are reluctant regarding the creation of this agency and they prefer to strengthen their partnerships – already very close. On the other hand, some associations (ONG) are making a strong plea for a new programmation law that would outline a clear policy, before creating the above-mentioned agency. Others think that a forest policy has already been defined during the national Meetings on Forests and Wood, that came to an end in March 2022 after several months of negotiations. If all the recommendations of these meetings were implemented, that would be a great achievement. The agriculture ministry should meet during the fall of 2022 with the Higher Council on Forests and Wood with a view to monitoring the implementation of the conclusions of the National Meetings. In addition, the French prime minister, Elisabeth Borne, wanted to meet with the representatives of the forest sector within the framework of the ecological transition that should be carried out across the whole country.

Stop and reverse the global loss of biological diversity

Climate change and loss of biodiversity : two interconnected crises

The United Nations 15th Conference of the Parties to the Convention on Biological Diversity (CBD) or COP15, has been convened in Montreal from the 7th of December 2022 to the 19th of December 2022. Scientists, civic society and part of the negotiators of the attending 196 States were expecting strong recommendations aimed at stopping the destruction of life across the Planet. While the latter is expected to be close to the sixth mass extinction of living beings, this COP15, called "COP of the decade", has issued a new global framework aiming to "stop and reverse" the loss of biological diversity from now to 2030; and this, before "living in harmony with nature" as of 2050, according to Elizabeth Maruma Mrema, executive secretary of the UN Convention on Biological Diversity. While for decades the struggle against climate change and the loss of biodiversity was carried out separately by each category of researchers and scientists under each relevant convention, many are those who claim that both crises are interconnected and that bridges and partnerships should be created, especially between the Intergovernmental Group of Experts on Climate Change (IGECC) and the Intergovernmental Scientific and Policy Platform on Biodiversity and Ecosystemic Services (IPBES). Climate change and global warming indeed are increasingly threatening biodiversity, whereas conserving and protecting healthy ecosystems are indispensable to contain the global warming at +1.5°C.

From the historical viewpoint, Laurence Tubiana, director of the European Foundation for Climate, who has been one of the architects of the Paris Treaty, signed in 2015 and who has been following up the international negotiations on biodiversity, has recalled that the concern about climate change was born from the involvement of many scientists, in particular American ones, that led to the creation of the IGECC in 1988. At the Rio Summit in 1992, where the major international agreements have been concluded, scientists and NGOs were relatively organized. There was a strong political dimension; even Georges Bush participated in the summit and signed the convention on climate change, ratified thereafter by the United States. Regarding the Convention on Biological Diversity (CBD), it has been promoted by scientists, but also by nature-conservation NGOs, in particular the International Union for the

Conservation of Nature (IUCN). The latter had a conservationist approach, especially the natural scientists in charge of identifying the living species (taxonomists) and of protecting the natural environment. There have been discrepancies between NGOs and governments: some stating that natural resources should be utilized, while others calling for the preservation of natural ecosystems in their wild or native state. While the IGECC has established global scenarios that are theoretical on the common global risk, biodiversity represents a challenge at the territorial level. And the clash between different visions is a limiting factor of real action. At the beginning, biodiversity was understood as the protection of big species, considered as totemic like tigers or apes. But beyond this emotional dimension biodiversity has a scientific basis when it involves the study of genes, genomes and ecosystem functioning. However there was no real support from the political side, nor a real economic stake.

With the success of the IGECC in the multinational negotiations about climate change and global warming, there has been an impact on the IPBES, added Laurence Tubiana. Beyond the efforts aimed at protecting big species, it has been gradually realized that biodiversity was indeed the conservation of natural environments and their ecosystems, as well as the research on the impact of human activities on these ecosystems. The IPBES that includes scientists from a wide range of disciplines has begun to change things. But it took time and the Platform has been created in 2012. And there has been an attempt to become closer to the climate negotiations, which were politically more attractive. The oceanographers were among the first to try and to succeed to make this connection. And it was during the two COP21 and COP22 that the voices of biodiversity were clearly heard. The option was made to connect the two crises and not to treat them separately; and that the solutions of the relevant problems must be convergent. For instance, the adaptation to climate change is largely linked to the resilience of ecosystems. As shown by the studies and reports of the IGECC, human activities have a direct impact on climate change and there is, one year after the other, an evidence for this relation. Likewise, the loss of biodiversity is also provoked by human activities, such as: change in soil uses and fragmentation of the habitats (associated with agriculture); overexploitation of species (overfishing, poaching); climate disturbances and invasive species. The combination of these causes has led to a species

extension rate, never noticed before, as well as to a modification or alteration of terrestrial and marine ecosystems. The ultimate cause of both crises – climate change and biodiversity – is likely to have to do with the global society model, where the evaluation of social progress is based on economic growth, correlated with technological advances. That was mentioned in the first joint report of IGECC and IPBES, published in June 2021.

Climate change and loss of biodiversity jeopardize humankind; while both are causing wide-ranging damages, some of the changes they already provoked have become irreversible. The loss of species, as well as the destruction of ecosystems have similar effects; human populations depend on some 50,000 wild species, used for food, health-care, heating, shelter and leisure. Until then scientists have provided detailed information on three cases of species extinction caused by global warming. For instance, in 2016, a tiny rodent, *Melomys* of Bramble Cay, living in a small island between Australia and Papuasia-New Guinea, has been declared extinct. The rise of ocean level and heavy storms have flooded its habitat. Climate disturbances, combined with various threats, have many other implications. For instance, in its February 2022 report, the IGECC has concluded that half of the species have already migrated towards the poles or the higher altitudes so as to find the same life conditions, and that hundreds of populations have disappeared. Forest ecosystems are severely affected: when winters are less cold and shorter, the risk of proliferation of insect pests is exacerbated; that is the cause of the gradual disappearance of spruce in the East of France. Recurrent fires and climatic megafires destroy not only the vegetation but also the habitats of many species. In the future, the risk of extinction of endemic species in the so-called "hotspots" of biodiversity will be tenfold higher in a Planet where the average temperature would reach more than +3°C, compared with the foreseen +1.5°C. Many specialists and experts consider that the impact of climate change would topple the main other factors that threaten biodiversity during the 21st century. But this opinion should not detract our attention from the present threats, such as the destruction of habitats and the overexploitation of natural resources. Moreover, the loss of biodiversity and the destruction of ecosystems have a major impact on climate change and global warming, and particularly in preventing the rise of the global average temperature beyond +1.5°C. Natural ecosystems (oceans, forests or soils) are enormous carbon

sinks. They absorb *ca*. half of greenhouse-effect-gas emissions produced by human activities. This very important role is jeopardized when these ecosystems are destroyed or overexploited. They can, sometimes, produce more CO_2 in the atmosphere than the proportion of CO_2 they absorb. Climate change, be it global warming, droughts, megafires or ocean acidification, have reduced by 17% the efficiency of terrestrial sinks and by 4% that of oceanic sinks during the 2012-2021 decade. All this makes the objective of carbon neutrality difficult to achieve. The issue, raised by some climatologists, is to know if this loss of carbon is temporary or if it would last over the years. In Australia, for instance, forests had reabsorbed in one year all the carbon released after the megafires that occurred in 2019 and 2020, following the 2018 drought. In general, the resilience of tropical forests decreases over time, after they suffered from repeated shocks, especially if their biodiversity is poorer. In the Amazonian forest, several studies have shown that it begins to produce a little more CO_2 than it absorbs, because of the deforestation and the degradation of the forest cover. Unfortunately, in some areas of the Amazonian forest, we have reached this trade-off.

Among the solutions that might help fighting against both processes, climate change and loss of biodiversity, the first priority is to protect areas that are less altered by humans, as well as the reclamation of the degraded ecosystems. The project negotiated at the COP15 foresees the protection of 30% of land and sea, as well as the reclamation of thousands of hectares. In other words, it is urgent to protect and widely reclame the ecosystems that store a maximum quantity of carbon and have a large biodiversity, such as the forests, humid zones, savannas or submarine prairies, according to the statement made by Valérie Masson-Delmotte, co-chair of the IGECC. About forty scientists have also made an appeal regarding the peat soils and lands that represent 3% of the terrestrial area, but store twice more carbon than all the trees of the globe. Both the IGECC and IPBES have estimated that the reduction of deforestation and forest degradation might contribute to lower the annual emissions of greenhouse-effect gases, from 0.4 billion tons to 5.8 billion tons of CO_2 equivalent, i.e. up to one-tenth of total emissions. Beyond the ecosystem-conservation activities, a drastic change in the agrifood system is needed. Intensive agriculture implies land conversion and the massive use of chemical inputs that are harmful to biodiversity, while at the same

time it contributes to one-fourth of GEG emissions in the world. According to experts, the development of agroecology and agroforestry, as well as the diversification of plant and forest species would result in a reduction of 3 billion to 6 billion tons of emissions. Moreover, both the IGECC and IPBES have strongly recommended the reduction of all kinds of wastage and the modification of food habits, particularly in the wealthy countries with less consumption of meat and a vegetable-based daily diet.

It should be stressed that some activities with the purpose of struggling against climate change, could have deleterious effects on biodiversity: that is the case of some examples of reforestation, i.e. planting trees on areas that have been deforested for a long time (savannas, formerly cultivated land, etc.): pines planted in New Zealand or eucalyptus in the South American cerrado – a savannah type. These extensive monocultures reduce biodiversity and they are not appropriate for mitigating climate change: fast-growing species are selected, but they could be vulnerable to drought or to attacks by parasitic insects or they need a lot of chemical fertilizers. In addition, the large plantations aimed at producing electricity, heat or biofuels, associated with the sequestration and storage of the emitted CO_2, can facilitate the energy transition, while withdrawing CO_2 from the atmosphere. This technological solution is a necessary one in all scenarios of carbon neutrality. However, it competes with other land uses such as the cultivation of food crops, it causes the erosion of biodiversity and its needs important water, nitrogen and phosphorus inputs, with finally a limited potential.

The COP15: stopping the loss of species

It is urgent to act. The populations of Vertebrates have collapsed: -69% in less than 50 years, 1 million of animal and plant species are threatened with extinction in the next decades, and 75% of the terrestrial area of the globe has been modified by human activities. At least 150 million tons of plastic material have been discharged in the seas, while 437 million hectares of forest cover have been lost since 2000. This tragedy has very concrete implications for human populations, particularly the most vulnerable ones: out of five people one depends on wild plants, algae and mushrooms for food and income, and 75% of crops depend on more than 20,000 species of pollinators, of which a large proportion is threatened with extinction. To sum up, more than half

of the global gross domestic product (GDP) relies on the good health of the ecosystems. The COP15 has been postponed several times because of the Covid-19 pandemic and the Chinese policy against the latter – China chairing this conference. It was finally displaced from Kunming to Montreal (6-19 December 2022). The document discussed at the COP15 aims to reach 22 targets by 2030, that include all the challenges of sustainable conservation and use of natural resources and of sharing the benefits of this sustainable utilization. These are the three pillars of the Convention on Biological Diversity (CBD) – one of the three Rio Conventions adopted in 1992 – and of its implementation.

A striking example of the loss of biodiversity is that of Vertebrates. Every two years, the World Wildlife Fund (WWF) evaluates the abundance of wild Vertebrates through the "Living Planet Index" (LPI). And every two years, this indicator underlines the gradual collapse of these populations. According to the report published on the 13th of October 2022, the populations of binds, fishes, mammals, amphibians and reptiles have shown a loss of 69% between 1970 and 2018. In 2020, the same indicator pointed to a loss of 68%. The fact that this index is not improving is a disaster. The Vertebrates represent less than 5% of known animal species and they are best monitored. In less than 50 years, the populations of lowland gorillas have been slashed by 80%, those of African forest elephants – in critical danger of extinction – by 86%. Also the populations of sharks and rays have collapsed (-71%). Other populations – about half of these monitored – are nevertheless stable or are even growing. The Living Planet Index, developed by the London Zoological Society, evaluates the average trend of evolution of tens of thousands of terrestrial, marine and sweet-water Vertebrate populations. In 2022, 31,825 populations representing 5,230 species were taken into account, i.e. 838 new species and 11,011 populations more than those of 2020 – a considerable increase. The numbers of fish (29%) and birds (+95%) species were particularly impressive, as well as the data gathered from until-now underrepresented regions, like Latin America and the Caribbean.

At the end of 2020, scientists have claimed in an article published in *Science* that the LPI leads to a catastrophic biodiversity loss, while estimating that the extreme decrease in some populations affected in a "disproportionate" way the

global average. Thus, the LPI has been recalculated for the 2022 edition, while excluding some species or populations. The loss of biodiversity is not easy to summarize through a number or a measurement that would be consensual, because the phenomenon itself has several dimensions. However, this index is of paramount importance for the communication on the biodiversity crisis and it clearly points to a rather catastrophic situation. But we must thereafter look at the populations running the risk of extinction and see why they are declining. The LPI being a global indicator, it does not necessarily help to target the measures to be implemented. For instance, the figure of 69% for Vertebrate loss shows great disparities among geographical regions: in Europe and Central Asia and North America, the loss since 1970 has been estimated at 18% and 20% respectively, while it reaches 55% in Asia and the Pacific and 66% in Africa. The Latin America and Caribbean region is by far the most affected, with an average loss of 94%. Sweet-water environments are mostly affected with an average loss of 83% of the populations. Migrating-fish populations are also hindered by dams on the rivers or by various obstacles set up along their migratory routes; their loss has been estimated at 76%.

The main factors of the loss of biodiversity across the globe have been classified by the IPBES. The first one is the change in land use and the fragmentation of space, mainly associated with intensive agriculture. Thereafter, comes the overexploitation of several species (intensive fisheries, hunting and poaching); various sources of pollution and the climate disturbances, and then the invasive species. If nothing is done to drastically reduce the emissions of GEGs, global warming would become the main threat to biodiversity. The intensity of these factors differs in the geographical regions. For instance, soil, water and air pollution have a strong impact in Europe, according to the WWF. The overuse of pesticides in intensive agriculture has deleterious effects on species and ecosystems. Regarding amphibians, birds and terrestrial mammals, the threats due to agriculture, hunting and forest exploitation are mainly acute in the tropics, while in Polar regions, the eastern coast of Australia and South Africa, climate change and global warming are the main factor of biodiversity loss. Quite often several factors add to each other: that is the case of the dugong, a marine herbivorous mammal, a cousin of the manatee, formerly present around the Indo-Pacific regions, is nowadays disappearing in many countries; it has been declared extinct in China at the end of August 2022.

In New Caledonia, there is still a viable population of dugongs, estimated at several hundreds animals. This species has a slow reproduction cycle, and even if it has been protected for a while, poaching still persists because its meat is highly valued by the local human populations. Moreover, animals can be caught in fishing nets or collide against boats. And the submarine prairies on which they feed are threatened by global warming, states the WWF.

Collapse of insect populations

In Europe, the collapse of insect populations is one of the most disquieting parts of the loss of biodiversity. Numerous scientific studies describe this collapse, underlining the speed and magnitude of the loss, as well as the urgency to respond to its challenges. The large public does not seem aware of the stakes as well as of the implications of this phenomenon. Research work carried out mainly in Germany and often quoted by the specialists of the subject, indicate that the loss of biomass of flying insects has been estimated at 80% since the beginning of the 1990s. Moreover, the studies published in December 2022 in the United Kingdom show that this loss is not decreasing, far from that. Insects are a crucial component of the natural terrestrial ecosystems; in addition this entomofauna brings to agriculture crucial services, such as the recycling of soil nutrients, the control of the proliferation of several pests and the pollination of crops. Across Europe, the political response to this alarming loss of biodiversity is not at the height of the magnitude of the problem. By contrast, a large scientific consensus highlights the need to deeply transform our agriculture and food systems. The European Commission's strategy "From Farm to Fork" – one of the pillars of its Green Pact – aims to be a minimum response to the collapse of insect biodiversity. Its main objectives are the drastic reduction in pesticide, phytosanitary product and chemical fertilizer use, as well as the conversion of more farms to organic agriculture. But in the case of the sustainable use of pesticides, the EC directive draft has been at the core of several chaotic discussions; it had been edulcorated, because of the strong lobbying of food industrialists, and had been delayed. One would expect a swifter action because of the alarming decline of the insect populations.

In France, the situation is almost the same, although the prohibition of the use of nicotinoids has been the end result of intense fighting and of the EU Court

of Justice's decision to completely exclude these nicotinoids. The use of latter during three decades has been a major cause of insect populations collapse. On the other hand, in May 2022, the French Cour des Comptes – Audit and Accounting Court – adopted a judgement concerning the support of organic agriculture: this support is not yet sufficient, and the court recalls nevertheless that it is the better means to ensure a successful agri-environmental transition. The struggle against the loss of insect populations is part of this transition that needs to be accelerated.

Coming back to the scientific studies and research on the loss of biodiversity among insect population, Dave Goulson, professor at the University of Sussex, United Kingdom, and a world expert in the biology and ecology of pollinating insects, described both the magnitude of this disaster and the variety of its causes, and he suggested measures or policies aimed at stopping it. By qualifying the insects as the "fuel of life", Dave Goulson underlines that many organisms cannot survive in the absence of insects, e.g. birds, bats, sweet-water fishes, amphibians, reptiles, etc. which feed on them, or the majority of flower plants that are pollinized by them. Agriculture would be in great difficulty if insect populations decrease or even disappear: pollination would be strongly hindered, while control of crop pests and soil quality would be hampered. It seems, nevertheless, that our societies are unable to stop or reverse this collapse because the latter is gradual and invisible. In this regard, it shares this common point with climate change, but the latter reminds us of its acceleration through extreme weather events, most often devastating. By contrast, the collapse of insects could go on without being really perceived and taken care of, and therefore without drawing the attention of the large public, like, for instance, do droughts, heat waves or megafires. However, with the collapse of insect populations, the cost of vegetables and fruit will likely increase after a drastic fall of pollination; similarly, water restrictions drew primarily the attention of human settlements rather than soil deterioration that has a marked impact on the refilling of undergrounded water tables. Likewise, at the international level, the Intergovernmental Group of Experts on Climate Change (IGECC) has been able to be put on the global political agenda in order to guide the international agreements and action strategies. It is, however, more difficult to see the impact on the policies of States of the Intergovernmental Scientific and Political Platform on Biodiversity and

Ecosystem Services (IPBES). It deals with too many objectives relating to the biodiversity loss and the collapse of insect populations does not seem to be a primary focus. Whereas the major environmental problems of the Planet have been, to a large extent, anticipated by the scientists – such as the shrinking of the ozone layer, global warming or acid rains – and could be managed in order not to have irreversible effects everywhere, the collapse of insect populations has not always been anticipated and most of the scientists are amazed by its already irreversible effects. For instance, the information given in 2017 by the Krefeld Entomological Society (Germany) concerning the collapse of *ca*. 80% of the biomass of flying insects across sixty German protected areas since the beginning of the 1990s has reinforced the feeling of scare and amazement of the scientific community. Our agricultural and food systems, which can bring the feeling of wise or comfortable regulation, should in fact be changed, for instance regarding the use of pesticides. Hundreds of authorized pesticides – a major cause of the decline of insect fauna at temperate latitudes – are strictly regulated so as to produce, theoretically, health and environmental damage that could be acceptable and mastered. However, the alarming collapse of insect populations proves that we are in fact far from controlling the whole process. Henceforth, urgent actions are needed to stop this detrimental decline and grant it a higher political priority.

Massive decline of birds in Europe

On the 15th of May 2023 the *Proceedings of the National Academy of Sciences* (*PNAS*) have published the research work of European scientists who have, for the first time, established the causes of the massive decline of bird populations across the Old Continent. A major cause of this decline is the excessive use of pesticides and synthetic fertilizers, ahead of global warming. The authors of the publication recall that the negative impact of intensive agriculture on the populations of birds has been mentioned a long time ago, regarding particularly the birds living in agricultural lands and also those feeding on insects; but their study provides a solid evidence of a direct and predominant effect of agricultural practices across the continent. The Netherlands, The Czech Republic, Ireland and France are the European countries where intensive agriculture has been making a fast progress over the last years, on the basis of an index conceived by the researchers. The

decline of the bird populations has reached 25% of the species monitored during the 37 years of the study, and taking account of the increase in the number of bird species that thrive next to human activities. *Ca*. 800 million birds have disappeared over the last 40 years. Regarding the bird species living in agricultural lands, the considerable decrease in populations has been 60%, while in the urban settlements the average figure was 28% and the latter reaches 18% in the areas of forests and woodlands. In order to carry out their analysis, the researchers have used the most comprehensive available data, drawn from the European follow-up programme concerning common birds: more than 200,000 locations across 28 European countries have been monitored according to a standardized protocol, and the presence of 170 distinct species has been steadily assessed.

About 50 European researchers, led by Vincent Devictor, Stanislas Rigal and Vasilis Dakos have tried to determine the major causes of this rapid decline, through the collection of the available data and their comparison with the trend of change of the four major anthropic pressures on the ecosystems: climate change, urban sprawl, forest cover and the use of pesticides and fertilizers. As mentioned by Vincent Devictor, a researcher at the Institute of Evolution Sciences of the National Scientific Research Centre, in Montpellier (southeast of France), and co-author of the study, the scientists have been able to determine the links of causality, using recent mathematical analytical techniques that are not often used in the study of biodiversity. Thus, the scientists could finely analyze the variations of the effects of different pressures, in terms of time and space, on bird populations. The results of the study highlight the linkage, already explored in many research works, between the collapse of insect populations and the massive decline of birds that feed on them. For instance, the populations of a strictly insectivorous bird species, *Muscicapa striata* (spotted flycatcher) have decreased by 63% over the period of the study. Other species that feed only or partially on insects have been also collapsing at an amazing speed. That is the case of formerly very common species such as the skylark (*Alauda arvensis*) or the ortolan bunting (*Emberiza hortulana*) – which has lost 93% of its populations since the 1980s.

Up to now, many people used to minimize the impact of pesticides on the loss of biodiversity, while the results of the European research consortium clearly

indicate that we must deeply transform the way we produce our food and manage the Planet. During the COP15 on biodiversity (December 2022), 195 States, including the European Union, have committed themselves to halve the risks associated with pesticides by 2030. This objective is also part of the European strategy *from farm to fork* and it is acknowledged that the quantity of pesticides applied to agricultural lands has increased across the European Union. Climate change and global warming has also an impact on the collapse of bird populations: birds that prefer higher temperatures lose only 18% of their populations, while those who are adapted to lower temperatures lose their populations twice more rapidly (the loss has been estimated at 40% during the period of study). According to several experts working on the impacts of agriculture on biological diversity, the comprehensive European study is the first to underline a hierarchy among the causes of the massive decline of bird populations.

A historical agreement to protect 30% of the Planet

After four years of negotiations, 195 states have adopted on the 19th of December 2022, a historical agreement in Montreal, Canada. The objectives of this agreement were to protect 30% of the Planet, reclaim 30% of the degraded ecosystems, halve the risks associated with the use of pesticides and double the global funding for the protection of nature. The governments have agreed to take "urgent measures aimed at stopping or reverse the loss of biodiversity", from now to the end of the present decade. The COP15 aimed to set up another global framework that was to replace the former "Aichi agreements", a series of objectives adopted in Japan in 2020 and were absolutely ineffective. On Sunday the 18th of December 2022, China, which has been chairing the conference, proposed a new version of the draft agreement, based on a series of previous consensual discussions. The negotiations have been accelerated and in less than 24 hours the blocking points or issues have been resolved. The Kunming-Montreal agreement includes 23 objectives, of which the most salient one is to protect at least 30% of the Planet before the end of the decade, whereas, presently, only 17% of the land area and 8% of the seas are under the protection status. "This is the greatest commitment to protect the lands and oceans in history", gladly stated Brian O'Donnell, director of the coalition of NGOs "Campaign for Nature".

The proposal of "30% in 2030" has been sponsored for a long time by the Coalition of High Ambition for Nature and Peoples, launched in January 2021 and co-chaired by France, Costa Rica and the United Kingdom. More than 110 States have joined the coalition, including the last reluctant ones – China, for instance, refusing to put under protection one-third of its marine space. Finally, all these States have adopted a global target of protection. According to the scientists, this figure of 30% should be considered as a first step in the good direction; because, in the medium or long-term, 50% of the Planet should be protected in order to safeguard the largest proportion of biodiversity. In addition, at least 30% of the degraded terrestrial and marine ecosystems should be reclaimed, while the rate of invasive-species introduction should be decreased by 50%. While one million plants may become extinct, the agreement foresees the prohibition of human activities that provoke this extinction. However, some scientists regret that no accurate figure has been given for 2030. On the other hand, the 196 States that are Parties to the Convention on Biological Diversity (CBD) have acknowledged the major role of autochtonous peoples and local communities in the custody of biodiversity. Autochtonous peoples, who represent 6% of the world population, manage at least 25% of terrestrial land where almost 80% of the global diversity is concentrated. The text states that their "free consent beforehand and enlightened" should be respected.

Agriculture, forestry and fisheries should be managed in a sustainable way, especially through the development of agroecology – the mention of this word in the agreement was considered a victory by France. Companies and funding institutions are requested to assess and make public their impact on natural resources. However, these reports are not mandatory, whereas the European Union and hundreds of companies wished they should be. The issue of financial resources needed to implement these measures has been at the core of lengthy negotiations at the conference and have raised adamant oppositions. In fact, the States should deal with the deficit of funding biodiversity protection, estimated at US$700 million per year. In order to achieve this objective, one should start by eliminating, doing away or reforming the subsidies that harm nature, estimated at US$500 million per year. It is far from easy, as some subsidies are, in many cases, needed to support agriculture. In addition, all national and international actors, public and private, should find out before

2030 at least US$200 billion per year, i.e. to double the present amount. It is true that before the COP15, France, Germany and the European Union have pledged to double their funding for biodiversity, while other States have announced the rise of their subsidies towards the same end. Another issue has been scrutinized by the negotiators: the amount of funds allocated to developing countries should double from now to 2025 and treble in 2030, so as to reach at least to US$20 billion, and thereafter to US$30 billion per year, respectively. A coalition of developing countries, including Brazil, Argentina, Indonesia and a number of African countries, was demanding much more, *ca*. US$100 billion per year. The industrialized countries are reluctant and explain their national budgets could not cope with this kind of public subsidies. They expected that some other countries, like China, should be involved in this financial assistance. Further to a compromise suggested by Colombia, it has been agreed that a new fund should be set up in 2023 and beyond, but within an existing structure like the World Environment Fund (WEF). Moreover, the most vulnerable States should have a faster access to this fund and take the urgent necessary measures. In order not to repeat the failure of the Aichi agreements, the States have agreed to set up a follow-up framework to evaluate the progress achieved and to eventually revise their commitments before the end of the decade. Common indicators are being developed and a global balance sheet should be established halfway. The COP16 to be held in Turkey at the end of 2024 should be an opportunity to assess the progress made.

The COP15 has heard the appeal made by the UN Secretary-General, Antonio Guterres, who called for the signature of a "Peace pact with nature". There has been a pessimistic view that the funds needed for reversing the loss of biodiversity were largely insufficient. The agreement reached at the COP15 has the merit to exist. However, without adopting a mandatory framework, many commitments run the risk of being disregarded. The European regulation adopted on the 6th of December 2022 and forbidding the imports of products derived from deforestation, is a good example that can complement the agreement of Montreal. Unfortunately, this type of initiative is an isolated one. Some countries like China have succeeded in obtaining at the COP15 that the objectives of preservation are global, and not at the level of every nation. This approach may be a sign of acting much less than expected at

the national level. "Not in my backyard (*nimby*)" continues to prevail in many cases. Henceforth, the need to transform the Montreal agreement into a sustainable struggle towards achieving the ambitious objectives set up by the international community.

Role of China in the successful end of COP15

For China, which was chairing its first global environment event, even if the latter has been relocated in Montreal instead of Kunming, the stake was to make this event a success; otherwise, it would have stained China's reputation. Initially, while China was still struggling against the Covid-19 pandemic, it agreed that the meeting be relocated in Montreal – headquarters of the Convention on Biological Diversity (CBD). This was not an easy decision because China had to chair an international meeting outside the country and in Canada with which the diplomatic relations were tense. At the opening of COP15, on the 7th of December 2022, the negotiations were considered rather complicated, but gradually the joint action of the Chinese environment minister and his Canadian colleague have led to agreements on various important subjects. In fact, the Chinese chair of the conference was very active, listening carefully to all parties and testing feasible objectives. After the attendance of the environment ministers of the COP15, the Chinese minister set up three teams from the South and the North with a view to working on the thorny subjects. On the 17th of December 2022, the teams delivered their results, and during the following day the Chinese chairperson submitted a new version of the future agreement. This version is rather balanced and satisfactory for all parties (see the above-mentioned objectives, including the financial aspects). When the Chinese environment minister received the heads of delegations after the publication of the new version, several countries like Mexico were ready to accept it without further debate. At the same time, the chairperson of the COP15 was carrying out negotiations with the reluctant countries, such as India, Indonesia and Brazil, in order to find out partial agreements and to slightly modify the new text. The last session of the conference took place during the night of Saturday the 17th and Sunday the 18th of December 2022, when the representative of the Democratic Republic of Congo (DRC) took the floor to declare its opposition to the new version of the text, because it was still very weak in terms of financial commitments

Brief discussions took place, before the Chinese chairperson of the conference hammered out the final approval of the new global framework concerning the protection of biodiversity. The Canadian environment minister stated that he has never seen that a text proposed by the chair of the conference, and largely supported, was approved in less than 24 hours. According to a Greenpeace expert, China has made an excellent endeavour towards joining the North and the South. Moreover, the approval of the COP15 historical agreement would entice China to play a more important role in the conservation of nature at the international level.

Role of the United States

Although the United States created the first national parks and includes a very high and diverse biodiversity, they are today the only country – member of the United Nations – that has not ratified the Convention on Biological Diversity (CBD). However, American diplomats have participated in the COP15 as "super-observers"; they have participated in the negotiations that led to the positive results of the conference, but they are not committed to fully implement its conclusions. The US Special Envoy for Biodiversity, Monica Medina, stated in this respect: "We hope that we shall be one day a full member of the CBD, but in the meantime we are entirely engaged in the struggle against the loss of biodiversity. We try to be as useful and constructive as possible." Initially, since the 1980s, the United States have been the "champion" of biodiversity protection and they actively participated in the elaboration of an international treaty on this matter. But when the CBD was adopted by dozens of States, in 1992 in Rio de Janeiro, the US national presidential elections have interfered with this process, and finally President George H. W. Bush decided not to sign the CBD. However, his successor in 1993, Bill Clinton did sign the convention, but the latter was never ratified by the Senate of the U.S. Congress. The Republicans claimed that this convention, when ratified, would threaten the country's sovereignty and become a too heavy burden – such fears were not really justified by the experts. It is true nevertheless that the United States have ratified the Paris Agreement on climate change, but they have not ratified the United Nations Convention on the Law of the Sea, nor the Stockholm Convention on the Remanent Organic Pollutants, nor the Bonn Convention on the Conservation of Migrant Species.

In fact, the United States apply at home what has been decided in the convention. President Joe Biden's administration, after appointing a Special Envoy for Biodiversity – Monica Medina, intended to protect 30% of land and sea from now to 2030 and it became a member of the Coalition of High Ambition for Nature and Peoples. The United States have participated in all the negotiations of the COP15 and they have been very constructive since the beginning of the process, stated Maruma Mrema, executive secretary of the CBD. But the "legal" absence of the United States deprives the negotiations of political strength and also of the economic support for the funding of the whole process. The absence of the United States may also complicate the issue of the digital sequencing of genetic resources – another thorny issue of the discussions held in Montreal. Developing countries demand a fair share of the benefits drawn from the use of these genetic resources in the production of drugs or cosmetics. An agreement may be reached about allocating part of these benefits to a fund aimed to protect biodiversity.

Protection of marine biodiversity : an international treaty on the high sea

On Saturday the 4th of March 2023, at the United Nations headquarters in New York, the international treaty on the high sea has been adopted after 40 hours of negotiations. In fact, the cycle of negotiations on this treaty have formally started in 2018, while the first work has started since 2004, with a view to granting a legal framework to the "conservation and sustainable use of marine biological diversity beyond the national jurisdictions," i.e. beyond the 200 marine miles (370 km). The text adopted at the beginning of March 2023, once translated in the U.N. six official languages, should be ratified by at least 60 States before being applied 120 days later. Some experts believe that the whole process would take two years approximately. The new treaty is linked to the Convention on the Law of the Sea.

In its preamble, the treaty highlights its full environmental ambition. It recognizes "the necessity to struggle, in a consistent and cooperative manner, against the loss of marine biodiversity and the degradation of oceanic ecosystems, caused by the impact of climate change on these ecosystems such as global warming and the diminution of oxygen content, as well as the acidification of oceans, the pollution, including the plastic-matter invasion, and the unsustainable use of resources." The treaty underlines the will to fairly share the potential revenues withdrawn from this very vast area with

the least developed countries. The treaty also underlines that the principle of transparency be applied to all activities, thanks to an open digital platform. The treaty *does no*t apply to the military sector, nor to large-scale fishing, as well as to the extraction of mineral resources laying on the bottom of oceans. Beyond these general principles, the treaty details precise regulations on activities carried out in international waters in 70 articles distributed in four major sections: environmental assessments; transfer of knowledge and marine technologies to the least developed countries (LDC); share of revenues drawn from the use of genetic resources – sponges living at high depths, algae, corals, bacteria and viruses; creation of protected marine areas. The latter is considered by the NGOs as a key issue and the ecologists among them welcome this commitment with great enthusiasm. Because the high sea – representing almost two-thirds of the global ocean, called by experts "the zone" – was the missing link aiming to put 30% of the global ocean under protection from now to 2030, in accordance with the international agreement on biodiversity adopted in December 2022 in Montreal.

In order to implement the principles of the treaty, a conference of the Parties will be created, a new COP that would be convened at least one year after the treaty has started to be applied. The member States will have the responsibility to create the marine protected areas, through the search of a consensus, but not running the risk of a deadlock due to one single opponent. As a matter of fact, even when unanimity is not reached for the creation of a marine protected area, the relevant decision can be achieved after two successive ballots within the COP – one of them being reached thanks to two-thirds of the voting members. Before any decision there should be a wide consultation among the States involved in the creation of a protected zone and those close to it, among the civic society, the scientific community, the private sector, indigenous people and local communities whose activities may be affected by the establishment of a marine protected zone. A scientific council, which is to be created as soon as possible, will also give its advice on the matter. The treaty reviews the ways and procedures to be used by the Member States Parties when sharing the profits derived from the "zone". The treaty has focused on any "genetic material" extracted from plants, animals, microorganisms or any organism, that may be of interest in medicine, pharmacy, cosmetics or chemistry. These profits should be fairly shared with the LDCs, Island States and African coastal countries.

In order to promote the enforcement of the treaty and support its implementation, the European Union has pledged €40 million to a fund mentioned in the treaty but still without precise assignments. This was meant to entice other States to do the same and give the fund a real existence and assignments. Regarding the environmental assessments, they remain under the purview of each Member State whose ships navigating in "the zone" carry its pavilion. But the States must be transparent in their reports, as well as regarding the COP Secretariat and the countries geographically concerned. They should transmit the details about the "intensity of the foreseen activity", its precise location and duration. The general issue behind all this transparent information is to anticipate the impacts of any activity and to examine other possibilities aimed at protecting and preserving the marine environment. The scientific council is expected to set up, in the short term, a list of activities that will deserve detailed environmental assessments, or not, and to draft guides for good practices. On the other hand, the States that ratify the treaty are committed to develop marine sciences and technologies, and to share the results with developing countries. The latter will thus benefit from all advances in research, especially regarding the conservation and sustainable use of the genetic resources of the high sea. In this respect, the treaty reiterates that 'indigenous peoples' and 'local communities' traditional knowledge should be respected and taken into account. Finally, the treaty invites all the Parties to resolve any discrepancy or disagreement through negotiations, arbitration or "any other pacific means of their choice."

PART TWO
THE AGRIFOOD CRISIS

Warnings on the exhaustion of natural resources

On Thursday the 9th of December 2021, the United Nations Food and Agriculture Organization (FAO) published a report on the status of soil and water resources. The subtitle of the report, "Systems at the brink of breakdown" meant that there was an emergency to act, because, according to FAO, these resources are submitted to an unprecedented pressure; these resources are close to the limits of their production capacity. The FAO diagnosis is the following: one-third of the soils across the world are degraded, moderately or heavily. In 2019, the report by the Intergovernmental Group of Experts on Climate Change (IGECC) had alerted on the intensive exploitation of these natural resources, which hinders our capacity to struggle against climate change and global warming, as well as our life conditions on Earth. The FAO report underlines that South Asia is the most affected region by soil degradation: 41% of the total soil surface (excluding desertic zones) is degraded. But looking at the geographical distribution, in absolute terms, sub-Saharan Africa has one-fifth of degraded land, followed by South America (17% of degraded land). Water resources are not in a better condition than soils: 10% of the capacity is withdrawn from waterways and aquifers, two-thirds being used for irrigation. According to FAO, the present schemes of agricultural practices do not seem sustainable. Some agricultural practices, such as irrigation, can provoke the erosion of soils and facilitate their salinization. Nowadays, 10% of agricultural land is under the threat of salt accumulation in the soils.

In order to illustrate the threats on water and soil resources, FAO quotes the drying up of the Aral Sea: formerly, one of the largest lakes in the world, situated between six countries of Central Asia, including Uzbekistan and Kazakhstan, it has been affected by massive plans of water withdrawal during the 1960s in order to irrigate cotton fields. Salinization and pesticide-pollution have decimated the populations of fishes present in the waterways upstream, thus ending up the fisheries that fed part of the human populations. The Aral Sea, at one stage, became almost a desert. FAO also underlined the global inequities in the access to natural resources: in the low- or medium-income countries, 77% of agricultural plots are located in regions where water is scarce, and less than one-third of water capacity is supplied for irrigation. Water stress is rather low in Europe – 8.3% – but it rises up to 45% and 70%

in East and West Asia. In sub-Saharan Africa, the availability of water per inhabitant has decreased by 40% during the past decade, and the agricultural area has dropped down to 0.64 hectare per inhabitant, from 0.8 ha, between 2000 and 2017. This situation does not lead to optimize, especially when FAO estimates that food production should be increased by 50% in 2050 in order to provide enough food supply to a world population estimated at 9.7 billions. These FAO estimates mean that South Asia and sub-Saharan Africa must at least double their agricultural production to meet the needs in calories of their populations. The rest of the world should increase its production by at least 30%. The likelihood to add more cultivated lands is very low, while urban sprawl is rapid – 55% of the world's population was living in an urban environment in 2018 and this figure would rise to two-thirds of the global population in 2050 – and it encroaches on the most fertile soils. Since 2010, agricultural land has lost almost 128 million hectares, mainly grazing lands. On the other hand, according to an expert of the French International Cooperation Centre in Agricultural Research for Development (CIRAD), over the past 20 years, the demand for water has increased twice more rapidly than the global population. Such discrepancy can be explained by the rise of urbanization and the changes in the food diet across part of the world, especially regarding meat consumption.

FAO stresses the need to distribute agricultural land in a more equitable way, in order to lessen the "extreme disbalances" existing in this area. The large commercial farms, indeed, have the lion's share: more than half of the agricultural land belongs to large farms exceeding 500 hectares each, while the small farms (less than 2-ha each) include 84% of the farmland, and only 12% of the world's total agricultural land. In addition, among women who represent 37% of agricultural humanpower at the global level, and even up to 48% in the low-income countries, only 12% of them possess their agricultural plots. However, despite this bleak situation, FAO estimates that soil degradation can be reversible, if we rely more on sustainable agricultural practices. The United Nations agency suggests, for instance, the creation of "green infrastructures", e.g. flooding plains instead of building dykes or embankments, in order to allow the flow of water during the floods, to improve water quality and increase biological diversity. Coming back to the Areal Sea, which in the 1990s seemed to become a desert, it has benefited from reclamation efforts

for the last years; these efforts have facilitated the creation of green areas and the return of some aquatic plants. It is still a vulnerable ecosystem, that may lead to a revival of the Aral Sea. To sum up, the main figures summarizing FAO warnings on the exhaustion of natural resources (soils and water) are the following: human activities are globally carried out on 72% of land (free from ice). Since 2010, *ca*. 128 million hectares of agricultural land have been lost. At the global level, 18% of available sweet water are withdrawn from the existing reserves, whereas soil erosion is the main cause of the annual loss of 7.6 million tons of cereals.

Are we under the threat of an agrifood crisis?

In addition to the starvation of millions of people across the world and to all those who cannot "meet the ends" and suffer from undernutrition and malnutrition, we are acknowledging by the end of the first quarter of the 21st century soaring food prices across the world; these prices have never been recorded for the last ten years. In November 2021, FAO announced that its monthly index measuring food prices had reached its highest level since July 2011. In 12 months this index, which aggregates the prices on the international markets of several basic foodstuffs (cereals, sugar, meat, milk products, etc.), rose by more than 30%. This increase in food prices occurs in a situation where one person out of ten suffers from hunger, and one-third of the world population is food insecure, i.e. it has not a regular access to an adequate food intake. In addition to the loss of jobs and income associated with the Covid-19 pandemic, the inflation of food prices is a major concern when we deal with the struggle against hunger. Several factors explain these soaring food prices. The latter reflect the steady progression of the cost of energy since 2020; FAO has shown that this increase in food prices follows the same curve concerning the cost of fertilizers, pesticides and energy. This increase also concurs with two main heavy trends : the higher frequency of climate-change-and-global-warming consequences – such as floods, droughts – and the rising rate of agrofuel production – which competes with the production of foodstuffs on agricultural lands.

By mid-November 2021, the cost of a ton of wheat reached a record: almost €300. In 2021, wheat harvests were poor in North America; palm-oil production fell down due to a lack of humanpower in Malaysia – a large producer at the

global level; the cost of vegetable oils rose 9.6% between September and October 2021. Sugar-cane production has suffered from severe frosts in July in Brazil – the world-leading exporter. All these factors combined make the present situation very critical, especially after a very severe drought in 2022. In **France**, for instance, and in particular in Brettany – a region which has never known such extreme weather events – heat waves with temperatures up to 39°C and sometimes 41°C had a very negative impact on the harvests of artichokes and onions, generally irrigated. The same heat waves and high temperatures had a negative impact on the yields of potatoes : according to the Union of Potato Producers, a 20% yield reduction has been estimated compared with a ten-year average. This yield decrease could amount to 10% only for fresh potatoes sold directly to the consumers because they are irrigated – that is not the case of potatoes grown for industrial purposes. The General Association of Maize Producers forecasts a harvest of less than 11 million tons – a level qualified as historically low. There would be a 20% decrease compared with a five-year average. However, the harvests of pears, apples and grapes have not suffered too much from heat waves and water stress. Thus, the harvests of apples have been estimated, at the beginning of August 2022, at 1.468 million tons; their size was bigger than those harvested in 2021 – a year of heavy frost –, but less than the average. Due to the drought, the content of sugar increased in all fruits such as pears, peaches and apricots. On the other hand, the drought has hindered the multiplication of molds and fungi on the grapes, and on the 7th of September 2022, the agriculture ministry has referred to a rise in wine production, estimated at 44 million hectolitres, compared with 37.5 million hectolitres in 2021 – a very bad year according to wine producers. Such disastrous situation has led to the government's decision to help the farmers suffering from extreme weather events: on the 1st of February 2023, a reform of the insurance against these climatic events has been issued, including an aid amounting to $600 million.

Another example of the skyrocketing prices of foodstuffs and their implications on the cost of living of the population is that of **Côte d'Ivoire**. According to the data of the National Institute of Statistics, the price index at the consumers level rose 4.7% between July 2020 and July 2021. The prices of meat and fish have risen much more : 10% at least. The government considered this situation an emergency one and the prime minister announced

a price control for some basic foodstuffs such as rice, refined palm oil, flour and beef. That was a short-term measure aimed to stop the price increase as well as to respond to social unrest. The results have not completely met the population's expectations, when a speculation approach was still thriving among some merchants. According to the local representation of FAO, the situation in Côte d'Ivoire is far from being satisfactory. When the economic growth rate was between 6% and 10%, between 2012 and 2019, the country could import almost three-quarters of the rice and fish consumed every day; this was impossible when the GDP (gross domestic product) growth rate was only 2% in 2020. A larger part of the population – among the poorest – was eating only once a day. The FAO representative recalled that the indicators of food security in Côte d'Ivoire fell down during the last decade and the control of food prices has prevented some regions of the country to become food dependent. The government's intervention and urgent aid have avoided the disastrous scenario of a food crisis, following the sanitary crisis and its associated economic and social burden. It has been strongly suggested that the national food system should be restructured in order to reach food self-sufficiency as soon as possible. In fact, strategic programmes have been designed to reach self-sufficiency in terms of sugar in 2023 and of fish in 2025.

In **China**, the summer of 2022 has been very harsh for farmers and those responsible for the strategic sector of agriculture. As occurred in several regions of the world, China has been confronted with climate change and global warming : drought, dozens millions of households with cut off electric-power supply, thousands of manufactures closed down (lack of energy), farmers who, across the whole country, were very worried about poor harvests. Temperatures have never been so high : 45°C recorded in Chongqing on the 18th of August 2022 – a record for a Chinese town; 40°C and even more in several provinces. And never before, drought has lasted so long. The Jiangxi River has the peculiarity to accommodate Lake Poyang – the largest sweet-water reserve of the country (25 km^3) – whose water level has fallen down from 19 meters to 7 metres since June 2022. A scientist from the Chinese Academy of Agricultural Sciences, who participated in the COP21, was of the opinion that Lake Poyang water level has never been so low for the last eight centuries. In 2021, the average ground temperature was 0.971°C higher than

the normal figure; it has never reached that level since the beginning of the 20th century. Out of the hottest ten years since 1901, nine of them occurred during the 21st century, according to the 2022 edition of the Blue Book on Climate Change in China, published at the beginning of August 2022 by the National Meteorological Administration. Subtropical climate, which only prevails in southwest China, is now extending to the northern and western areas of the country. Rice can now be grown up to the border with Russia, while cotton can be cultivated in Xinjiang, northwest of the country. But the negative impacts of this climate change are more numerous and much more important. Drought is now present in the whole Jiangxi basin and extreme weather events are happening across the whole country. In September 2020, a typhoon has wrecked havoc on 30% of the crops in the province of Jilin. During the 2021 winter, one million heads of livestock died and buried under snowfalls, while in July 2021 floods in the Henan province have devastated more than 1.5 million hectares of agricultural land.

With the second-largest population in the world, the obsession of the political power is to avoid a food crisis. The biggest worry concerns the supply of rice – the basic food, especially in the southern part of the country. That is why the President of China, Xi Jinping, always mentions the "rice bowl" in his speeches, with a view to underlining the importance of food security. According to the finance notation agency, Fitch, rice harvests would be reduced by 10% to 20% in 2022 due to persistent drought. Since 2020, China has been exporting rice, but if the production mainly consists of the *japonica* rice variety in the north and centre of the country, the production of the *indica* variety has been falling down progressively. The *indica* rice variety is mainly grown in the south and is preferred in the Chinese diet. As a result, China imports millions of tons of *indica* rice. The 2022 drought in the Jiangxi basin, where two-thirds of Chinese rice are produced, will likely worsen the structural disbalances in rice supply. But rice is not the only worry. Wheat does not seem to be a major concern, because 85% of the harvests come from winter wheat, while two other cereals are affected by the present drought: rice for human food and maize for animal feed. In the short term there is no risk of breakdown of the food chain, because the Chinese have stored enough food for a year supply, but we may see an increase in imports of food as well as in agricultural intensification – produce more food! In the medium

term, global warming as well as the geopolitical situation may reorient the Chinese agricultural policy. Since 2013, China, which up to then has been relying on food self-sufficiency, has decided to rely more on food imports in order to preserve its soils. In 2014, the government estimated, on the basis of field data, that 16% of soils were contaminated with heavy metals or organic pollutants. China, that possesses 8% of the world agricultural land, is using 33% of the globally applied pesticides. Aware of this dangerous situation, the government launched at the beginning of 2022 a new comprehensive enquiry on the status of Chinese soils – a colossal work that has not been undertaken for the last 40 years. The first results are expected in 2025. In the meantime, China has become dependent on cereal imports: since 2019, the latter have soared from 17 million tons before the Covid-19 pandemic to 65 million tons in 2021. The country is now the world's leading buyer of cereals, with a share of 25% of global markets. This situation is explained by the storage policy decided in Beijing and forced on the farmers, who grow more vegetable crops, that are more profitable and fit new food habits of Chinese people. The latter choose cereals for the morning meal and consume more meaty plates during the day. There is therefore a need for cereals to feed the livestock. In 2021, these cereals have been mainly imported from the United States, ahead of Ukraine and Canada. The new geopolitical situation created by the war in Ukraine as well as by the tensions with the United States will entice China to increase its stocks and to promote again the need for self-sufficiency. In other words, as stated by Xi Jinping, the "rice bowl" must be filled with cereals produced in China. The latter may focus less on sustainable development, but will emphasize a more productivist approach to agriculture, e.g. using genetically modified crops, despite consumers' reluctance. It is worth mentioning in this regard that one of the global leading companies in crop genetic engineering, the Swiss Syngenta, is now owned by China. In three or four years from now, it is expected that 80% of Chinese maize will be genetically modified, according to a Western diplomat.

Out of the four modernizations set up by China at the end of the 1970s – defence, industry, agriculture, science and technology – agriculture has not made the expected progress. Often, the farming plots remain small, and youth in rural areas prefer to seize any work opportunity in the cities. Consequently, some agricultural experts suggest the likelihood of creating bigger farms and

increasing their productivity. But the implementation of this task is extremely complex. It is a very great challenge for China to reach carbon neutrality in 2060. As an illustration of this daunting task, let us take the water policy and its relation with food security. Genevieve Donnellon-May of the University of Oxford, United Kingdom, has made many relevant comments on the subject. The north of China, that is very populated and whose economy is based on agriculture, is home of 25% of the country population and produces 27% of the national gross domestic product (GDP), has access to only 4% of national water resources. The north of China is also dependent on underground water tables, which supply water to industry (50%), to irrigation (33%) and to domestic uses (65%). The overexploitation of these water tables has an important negative impact on all the aquifer reserves across the country. The north of China aquifer is the world's most exploited one. Intensive agriculture and irrigation development have provoked a drop of 20 metres during the last decades, and even 40 metres in some places, in this shallow aquifer. In addition, water resources are often very polluted. A study carried out by the Chinese government in 2016 indicates that 80% of underground water is contaminated with various pollutants, including heavy metals or arsenic. It is worth mentioning the statement of Mao Zedong, first president of the People's Republic of China, regarding the transfer of part of the water resources of the south to the north of the country. China has therefore built a megaproject of water diversion from the south to the north. Three routes carry the water: eastbound for the water of Jiangsu towards Shandong and the town of Tianjin, through the Great Canal that has linked Hangzhou to Beijing for at least a period of 2,500 years; centerbound, from Hubei to Beijing and Tianjin, starting since 2014; westbound, a route which remains to be built. There is an official plan that aims to connect the Yellow River to the Yangzi through the Qinghai-Tibet plateau and to convey 17 million cubic metres of water per year.

According to William Masters, professor of food economy at Tufts University (Boston, United States), we are facing "the first world food crisis which is not due to agricultural production itself, but is a crisis of agrifood chains". On the other hand, the FAO index reflects, to some extent, the cost of food really disbursed by the consumer, but it does not hide the reality of soaring prices in many countries, especially those which depend on food imports. For instance,

in Uzbekistan, the government, which scrutinizes the price of the *plov* – the national meal containing rice, beef, carrots, onions and peas – has recorded a 30% increase in the price of this meal between January and September 2021. According to the International Food Policy Research Institute, these food soaring prices are a major concern, because the populations tend to buy less costly foodstuffs that are less healthy. In order to design a refined pattern of the cost of a balanced diet, William Masters and his colleagues have developed another tool of measurement. This has allowed the United Nations to estimate that 3 billion people – almost 40% of the global population – have not the purchasing power to feed themselves in a healthy way. "Our indicators have shown that, since April 2020, the variations of prices paid by the consumers to buy food have been higher and globally their average has been more expensive than that of other goods and services," stated W. Masters. The annual report of the United Nations, published in July 2021, has estimated that food insecurity has spread in 2020 during the Covid-19 pandemic, more than the earlier five years combined. Regarding the most critical situations, the World Food Programme (WFP) has underlined that the number of persons threatened with starvation rose from 42 million at the beginning of 2021 to 45 million in October 2021, particularly in Afghanistan, Syria and Yemen. These critical situations could worsen because of the soaring inflation.

An economist of the World Food Programme recalled there are three main causes of hunger or starvation across the world – conflicts, global warming and economic crises, that have been aggravated by the Covid-19 pandemic. During 2020 and 2021, part of the population has already made some painful choices regarding its food intake, because of the loss of income and jobs. Not only these people have less money in their pockets, but it is also more expensive to buy food. On their side, the NGOs are worried by the lack of international action, despite the organization in September 2021 of a United Nations Summit on Food Systems. The NGO CCFD-Terre solidaire has warned that we should not behave in a sluggish way to respond to this new food crisis, as we did in 2011-2012 – the international community took a year before waking up and react to that crisis.

The figures of hunger across the world

After having jumped from 8% to 9.3% of the global population between 2019 and 2020, undernutrition rose in 2021. Since then, 9.8% of the global population has fallen in this category; one person out of ten – i.e. between 702 million and 828 million people – are suffering from undernutrition. That is the conclusion of the last report on global food security, published on the 6th of July 2022 by six agencies of the United Nations: FAO, WFP, International Fund for Agricultural Development (IFAD), WHO and UNICEF. The indicators of food insecurity have been in the red since 2015, the prospects have been worsened by the Covid-19 pandemic, which paralyzed part of the global economies, in particular the informal sector on which depend the populations most in need. The restrictions that were set up to struggle against the pandemic have resulted in the increase in the number of underfed people: 150 million in two years, i.e. 103 million more in 2020 and 47 million in 2021. This state of knowledge by the United Nations based on the 2021 data is even worse because it did not take into consideration the implications of the invasion of Ukraine by Russia. This conflict that opposes two leading exporters of cereals, vegetable oils and their meals, and fertilizers, has resulted in the international difficult supply of these items – in the rise of food prices and in a major concern for countries dependent on the imports of cereals and vegetable oils, particularly in Africa and the Middle East. The United Nations agencies have estimated that the war in Ukraine may result in the rise of the number of people suffering from hunger: from 8 million to 19 million people, according to the scenarios contemplated and to the international response to mitigating the situation. An international panel of experts on sustainable food systems (IEPS - food) – a think tank based in Brussels – stated that the countries, which are growing cash crops and not enough food crops – such as cocoa in West Africa – are more dependent on food imports.

Thus, conflicts, climate change and economic crisis make up the cocktail of causes that explain the spread of hunger over the last years. The African continent (see below) is by far the most vulnerable: 20% of its population suffers from undernutrition, compared with 9.1% in Asia and 8.6% in Latin America. In 2015 the international community committed itself to eradicate hunger in the world by 2030; this objective seems very difficult to reach.

According to the forecasts of international agencies, hunger will still affect 670 million people in 2030, i.e. 8% of the global population, the same proportion as in 2015, when the 2030 Agenda for Sustainable Development was issued. Beyond the stake of hunger, the United Nations report (SOFI report) underlines the spread of food insecurity – a wider concept that includes the inability to have access, on a regular basis, to a healthy food intake. This food insecurity affects 2.3 billion people – one third of the global population. Here again, the African continent is hardly struck : 58% of its population lives in food-insecurity conditions. The latter also prevail in Latin America : between 2019 and 2021, food insecurity rose 10 points, i.e. from 31% to 41% of the population. This was explained by the pandemic and the associated measures of lockdown that had worsen the poverty of a large portion of the inhabitants. Regarding women, often employed without a job security and in informal sectors, their situation has worsened: in 2021, 31.9% of women were suffering from food insecurity, compared with 27.6% for men.

The United Nations agencies have focused on the various indicators of malnutrition as well as on the lack of sufficient progress in this matter. Breastfeeding of infants during their first six months of life makes a slow progress : from 37% in 2012 to 41% in 2020; the delay in growth rate of children retreats slightly, from 26% to 22%, but it is far behind the objective of 12% in 2030, whereas anemia (hemoglobin content in the blood) affects one-third of women in their age of procreation. Regarding obesity, it was present among adults (13.1% in 2016), and the relevant data for 2020-2021 were to be published soon. In order to reverse these trends, it is imperative that the world must drastically and rapidly change its food systems. Beyond the pictures of hunger that are disseminated across the world, starvation has nowadays a new image, generally silent : it is not so much a matter of non-availability of food, but the economic impossibility for a large part of the population to purchase it. Thus, the United Nations agencies have estimated that 3.1 billion people had not the purchasing power to acquire healthy food in 2020, i.e. 42% of the global population – a figure that can reach 80% in sub-Saharan Africa. These agencies warn that it is timely that the governments review their policies aimed to support food and agriculture, and commit themselves to ensure the supply of more accessible food.

Since the beginning of the war in Ukraine, there have been many initiatives for food security, such as the French Food and Agricultural Resilience Mission (FARM project), the World Alliance for Food Security, launched by the World Bank and Germany in the framework of the G7 (seven wealthiest countries in the world), the Group for the Global Response to Food, Energy and Funding, initiated by the United Nations. These initiatives meant that food insecurity is back on the political agenda, but more coordination is needed between these initiatives as well as more concertation with national activities having the same purpose. Some experts consider that progress has been made in the design and implementation of sustainable production systems, but with the crisis in Ukraine some private investors have been reluctant to pursue in this direction; therefore, they recommend the intensive production of more cereal crops in order to reduce hunger, leaving aside environmental aspects that should be dealt with later on. According to other experts, the lessons from an earlier food crisis have not been completely drawn. At the CCFD-Terre Solidaire – an NGO for international solidarity and development – the following observation has been mentioned: we see that big merchants in agricultural raw materials have agreed to provide massive investments; that was done in 2008 – after the skyrocketing food prices –, but this has not improved the situation of small farmers, due to land grabbing. This observation alluded to the "Coalition of the private sector for food security", launched by France at the end of June 2022 and involving dozens of big agrifood multinationals – including the big trader in agricultural raw materials, Louis-Dreyfus, or the chemical fertilizer manufacturer Yara. An important step in the cooperation against hunger is expected at the meeting in October 2022 of the Committee on Food Security (CFS) – a multilateral institution, reformed in 2009 – in charge of coordinating the response to food crises. This committee not only includes the States and the international agencies [FAO, WFP, IMF (International Monetary Fund), WTO (World Trade Organization), etc.], but also representatives of scientific research, civic society and private sector. The CFS relies on an advisory scientific council – a high-level panel of experts who have carried out since 2010 many studies on the volatility of agrifood prices, on the causes of food crises and the relevant mitigation or prevention activities.

The Horn of Africa scorched by hunger

In April 2022, more than 67 million people were suffering from a severe food insecurity. In percentages of the country population, the proportions have been estimated at 63% in South Sudan, 54% in Yemen, 38% in Somalia, 22% in Sudan, 17% in Djibouti, 6% in Kenya and 6% in Uganda. Very high temperatures have weakened farming and livestock or cattle ranging. Moreover, the region has been affected by violence and conflicts, which has led sometimes to fail States. An illustrative example is that of **Somalia**. Since 1991, the country has been devastated by civil war. In addition, in 2022, Somalia has been struck by the worst drought in 40 years. In 2021, hunger has caused the death of 260,000 people, and in 2022 hunger continues to loom on the horizon. Rainfall forecasts are far from being optimistic and the global increase in basic-food prices may put 40% of the Somalis in severe food insecurity. In Yemen, the civil war that started in 2014 was followed by a coalition led by Saudi Arabia against part of the population in 2015, and this has put the country in profound misery. Many observers have underlined the impossibility for the Somalis to have access to basic needs, while the food prices continued to rise. Moreover, in some regions, humanitarian aid cannot reach the populations because of the raging war. In **Ethiopia**, since the end of 2020, due to the civil war opposing the Tigre region and the central power in Addis Ababa, agriculture has been threatened seriously in that northern part of the country. In addition to the war prevailing there, an extremely severe drought has caused the death of almost 1.5 million heads of livestock. Ethiopia has more than 1 million refugees. In October 2022, a cease-fire has been agreed by both sides, and hopefully this may lead to more accessible humanitarian aid and to alleviating the burden of hunger on a country that formerly was an example of successful agricultural production in Africa. In **Kenya**, a country of 54 million inhabitants, the unemployment rate has doubled since 2020, reaching 10.4%, while almost 2 million Kenyans have been added to the poor sector of the population, according to the World Bank. The seventh economy of the African continent has been undertaking mega-infrastructure projects and runs the risk of being too much indebted, according to the International Monetary Fund. Global warming jeopardizes agricultural production, particularly in the north of the country. Livestock breeders have greater difficulties in maintaining their activity, while a widespread drought

is responsible for the undernutrition of half a million children. The inflation rate has increased, as in many parts of the world; in July 2022, it rose 8.3% compared with the same period one year earlier; that was a record in five years. The prices of flour, petrol, cooking oil as well as of other basic products have almost doubled in one year, complicating even more the way of life of a population that was struck by the Covid-19 pandemic. In order to bring some relief to an angry population, Kenya's president had to take emergency measures, like a 12% increase in the minimum wages, or an exceptional subsidy to halve the price of a flour bag. This emergency subsidy was decided three weeks before the presidential election and its duration was supposed to last one month. Many observers feared nevertheless that the social distress of the population may seriously disturb the ballot; this has occurred in 2007 when the post-electoral crisis caused the death of 1,100 people and more than half a million refugees. Fortunately, the presidential elections took place peacefully and the Vice-President William Ruto has been elected. Although Kenya is obviously suffering from a long and severe drought, many observers recognize the progress made in the development of infrastructures (railways, smartphone networking, training of informatics specialists, etc.); henceforth, Kenya's leadership in this part of Africa.

Somalia has been for a long time a synonym of crisis and it reached a point where all the alerts launched by humanitarian agencies seemed to have been unheard. "Hunger is knocking at the door, it is a final warning," stated the chief of the Office for the Coordination of Humanitarian Affairs (OCHA) on the 5th of September 2022. According to his forecasts, almost 300,000 people would perish if food and humanitarian assistance were not supplied quickly. During the first quarter of 2022, 730 children died in the nutrition centres, according to the United Nations. The persistence of drought till the end of 2022 explains the very pessimistic forecasts of the United Nations. The Regional Meteorological Centre, based in Nairobi and dealing with the Horn of Africa, has anticipated, between October and December, a wet season with scarce rainfall that would not permit efficient farming and the reclamation of grazing lands. If such forecasts prevail, that would be the fifth bad rainy season since 2020. Such conditions have resulted in the migration of more than 1 million people – mostly women and children – out of their households and surviving in crammed camps located in the vicinity of urban settlements.

In a large part of the country, farmers could not sow, while herds and flocks have been decimated. The United Nations estimate that by the end of 2022, 6.7 million people would live in severe food insecurity compared with 4.3 million in September 2022, i.e. more than 40% of the whole population. The funds needed to cope with this new crisis have been estimated at €1.5 billion, 65% of which are provided by international donors led by the United States. Such support was not considered sufficient and above all too much delayed, according to the humanitarian organizations that have seen the rapid deterioration of the situation. It is true that "an early warning system had identified risks of hunger in Somalia at the end of 2021, due to the rainfall deficit, but also because of the still prevailing impact of the Covid-19 pandemic and of the largest locust invasion during the last decades," stated the chief of the Bureau of the Care NGO in Mogadiscio. He also added that "in April 2022, the programme of humanitarian assistance has only covered 4.4% of the country's needs." At the same time, in addition to the war in Ukraine that negatively impacted the priority granted to Somalia, the food prices – sorghum and maize produced locally, or imported wheat – have risen 200% to 300% in a year – in July 2022 in the case of sorghum and maize – and 50% for wheat, according to the data of FAO. The lack of reaction by the international community has been criticized by the International Rescue Committee, an American NGO. This well-founded accusation does shed light on only part of the reality. The persistent clashes between the government and the Chabab – an extremist group – are an important hindrance to food distribution. This Islamic movement still controls vast rural zones and remains hostile to Western interference, even in the case of humanitarian assistance. The lack of security that prevails across the country, especially north of Mogadiscio, limits the mobility of NGOs. Out of the 74 districts of the country, seven are considered inaccessible, while 16 were very difficult to reach. Nevertheless, the United Nations agencies claim that they are able to move and to supply their assistance in these difficult conditions. But the use of aircrafts, to avoid the attacks on the road, makes the operations rather complex and expensive. In the neighbourhood of Mogadiscio, at a distance of 250 km from Kenya, two corridors, under the control of the African Union (Amisom) facilitate the access to the refugee camps, which were urgently built in order to shelter people and protect them from hunger and civil war. The reliance on mobile

banking – banking services online, that can be available from a cell phone or a tablet – can provide money to the families targeted by the NGOs in charge of food distribution; thus, the difficulties of access to humanitarian assistance are alleviated. In response to a deadly attack on a hotel in Mogadiscio by the end of August 2022, Somalia's president, Hassan Cheikh Mohamoud, has announced a "total war" against the Chabab. He has also requested people to remain far from the regions controlled by the radical Islamists, in order to avoid the risk of being caught between the drought impacts and the violence of civil war.

Queuing up for food and the role of non-governmental organizations

Argentina

Argentina is a good illustration of the food crisis and its impacts. In this country, a big exporter of foodstuffs – soybean and meal, sunflower oil and meal, cereals – the year 2022 has been marked, as elsewhere but more than elsewhere, by an endemic increase in inflation: 64% in the month of June 2022, over a year, while the Bank of Argentina was predicting a 90.2% rise in prices in 2022. The working environment – a growth rate of 10.3% in 2021 – was characterized by a large share of informal jobs (50%). Poverty has been striking 37% of the country's population by the end of the second half of 2021. Behind the statistics, there is the strain of a population scrambling with the crises and stuck in a precarious situation for generations. However "there is no social conflict nowadays in Argentina, because, to a large extent, the government's assistance has been efficient", stated a political scientist of the United Nations Development Programme (UNDP) in Argentina. Since the beginning of the Covid-19 pandemic and after a five-month lockdown in 2020 in the city of Buenos Aires, the government of Alberto Fernández (centre-left) has reinforced food assistance: a "food card", given to more than 4 million people, has been reevaluated at the beginning of April 2022 (+50%); an urgent assistance has been provided to almost 9 million people in 2020. Another kind of emergency assistance addressing non-declared workers has been announced by early August 2022. Also the budget allocated to food aid in institutional catering, in the form of food bags, has been increased between 2020 and 2021 – in reality there has been a reduction of 10 points, when the rate of inflation was taken into account. This budget amounted to more

than €74 million (official change rate), according to the data of the social development ministry. Social organizations are in charge of public food aid across the whole country. They are a kind of intermediary bodies between the state and the population. "Without them, the state will not have the logistic capacity", stated the UNDP-Argentina.

"Argentina has a long tradition in this regard, starting with the organizations created by the immigrants in the 19th century. It is also a country where trade-unions have a historical heavy weight", recalled an Argentine anthropologist at the National Centre for Scientific Research and Technology (CONICET). These movements contribute to a surprising social quietness in a country where the economic indicators could predict an explosion at any moment. At the beginning of the 2000s, "the social organizations are beginning to play a central role; this is a time when poverty increases markedly, particularly in the suburbs of towns like the capital Buenos Aires". Barrios de Pie – a social organization the name of which means Standing Boroughs – was born during the 2001 crisis. It is present across the whole territory with 80,000 members, compared with 50,000 three years earlier. The organization sponsors 3.200 sites for food distribution, that supply food to 400,000 people in a country of 47 million inhabitants – according the census carried out on the 18th of May 2022. Although food distribution is the main task of Barrios de Pie, the organization has also a training role, e.g. training of carpenters or children leaders; it also provides health-care to people in poor towns and contributes to a low price index for foods and other basic needs within the boroughs. The model adopted by Barrios de Pie is not unique. Other social movements or social-territorial, as they are called, constitute a changing pattern or model that is very fragmented and more or less institutionalized, according to a sociologist of the CONICET. The food distributed by Barrios de Pie and others is insufficient and irregular. The main items are: maté – an energy-boosting beverage that is widely consumed in Argentina and has the advantage of cutting off appetite –, polenta and pasta. The lack of variety among the distributed foodstuffs contributes to overweight, particularly in the poor districts. Public aid, according to the national coordinator of Barrios de Pie, is less than 30% of what is distributed or cooked in institutional catering. The rest comes from donations and self-management. It is true that one major characteristic of the food-distribution system is that it is often carried out

by the families that are the beneficiaries. The latter receive a little amount of money, which is equivalent to half the minimum wage (€178 since June 2022). As a counterpart, those who receive this money should work four hours a day. This tool enables the social organizations to select their teams and to create a kind of additional job – it is sometimes nevertheless the only source of income of the persons involved. Nowadays, there are 1.2 million people involved in this kind of employment, more than twice the 2019 figure. The government seems to support the continuity of social assistance, despite the request of the International Monetary Fund (IMF) to reduce the nation's budget deficit – Argentina is negotiating with the IMF the restructuration of its US$45-billion debt.

A paradoxical factor of the social food crisis in Argentina concerns people who have a job and some money to spent rather than save it. Inflation and the devaluation of the Argentine currency, the *peso*, make people resilient and push some of them to "run towards consumption" – as the economists say. Thus, the restaurants of Buenos Aires have recorded a rise in consumption, which is above that of 2015, according to the figures provided by the city authorities. Domestic tourism also rose : part of the well-off population, afraid of the taxes imposed by the government on expenses made outside the country, does not travel abroad and increases its local consumption. The summer season – between December 2021 and February 2022 in the Southern Hemisphere – had reached a historical record, a 2.4% journeys more than the peak of 2020. Making savings through buying US dollars is rather restricted by the government, and therefore Argentines tend to buy the US currency in the parallel market, where 283 pesos are exchanged against US$1, compared with the official rate of 152 pesos for one dollar. As a consequence, the natural behaviour is to consume more. Moreover, as the staggered payments of goods are free of charge or at a kind of negative rate because of the inflation, the households tend to purchase for instance more domestic electrical equipment. The decrease in underemployment – the rate amounted to 6.9% during the second term of 2022, i.e. 3 points less than the previous year – also explains the relative rise in consumption. According to Ariel Wilkis, a sociologist at the San Martin National University, "that money "burns" the hands of people and one must spend it, and this is true of all social categories : even the less privileged households decide to spend their surplus in pesos – it

could be buying an ice-cream at a street corner". However, due to the delay in upgrading the wages and the need to adjust them to the inflation rate, the economists predict a "freezing" of this consumption "fever." In September 2022, one could observe such a trend. The government still facilitates the sales of television sets, among other domestic electric equipments, and relies on the forthcoming Global Football Cup to boost the purchases by Argentines who are very much addicted to this kind of game.

England and its food banks

The United Kingdom is going through a deep social crisis, in the context of the war in Ukraine and the skyrocketing prices of energy. The British society has been suffering from a decade of austerity; it has been shattered by the Covid-19 pandemic and now struck by an inflation rate of more than 12% a year. The costs of foodstuffs have jumped by 16% in 2022. At the same time, social allowances have been reduced : they could not reach more than £1,000 per month for a two-persons household and they were not increased beyond two children; ultra flexible jobs have proliferated – such as the zero-hour contract which does not grant any guarantee to the employed person regarding the duration of the job – and poverty has become endemic. Even those who are not jobless can have difficulties to make ends meet. According to the work ministry, more than one person out of five is considered poor in the United Kingdom, i.e. 22% of total population or 14.5 million people. In this very difficult context, the charity NGOs, their private donors and their numerous volunteers – e.g. retired workers, half-time employed people – have played an increasing role in the struggle against poverty, sometimes substituting the public authorities. There are more food banks in the country than McDonald's restaurants: at least 2,500. *Ca*. 2.5% of British households rely on them in 2020 and it seems that this rate is increasing. During the first six months of 2022, 320,000 additional persons have attended a food-distribution site of the Trussell Trust – a charity association with 28,000 volunteers that manages half of the food banks across the country. The majority of the beneficiaries are family mothers : they are not necessarily hungry, but they have small savings and by offering them food, they can put some money aside. These families may have budget difficulties for any reason, e.g. buying a new uniform for a child who changes school, or a washing machine that breaks down. The social

allowances for the children are the lowest in Europe, deplored Sam Crosby, one of the managers of Toynbee Hall – a charity organization of London East-End, founded in 1884.

In London, near Canary Wharf, is ubicated one of the warehouses of the Felix Project – that collects surplus from farms or supermarkets and sends them as bulk, or in the form of cooked meals, to more than 1,000 food banks, households or London schools. One of its managers stated that by the middle of 2022, 3,000 meals per day were supplied in the East of London, and the objective is to jump to 4,500 meals per day. The demand is considerable and the pressure on the food banks is intense; it is difficult to recruit volunteers and the running costs have increased by 25% in one year – fuel, electricity, transport, etc. In the northeast of England, the city of Hartlepool is also suffering from poverty and similar efforts are made to struggle against it, i.e. charity organizations and volunteers. In this vast harbour of 90,000 inhabitants, 33% of the children live in poor households. As elsewhere in the same area – a former power force during the industrial revolution – industries have left; the last ship built in the shipyards of Hartlepool has left the harbour in 1961. Since then private and public investors have neglected the town. Most of the hotels are occupied by asylum seekers, coming from Dover. The scarcity of well-paid jobs is the main cause of poverty and making ends meet at the end of the month. The local baby bank – that collects donations of baby supplies and distributes them to the parents in need – has been abandoned, whereas it helps 120 households and has a long waiting list. Refugee women from Syria, Irak, Ukraine, but also women suffering from domestic assaults, as well as jobless parents, attend the headquarters of the association where they can find baby or child supplies. The woman manager of this organization is aware of the ailments of our time, such as the leap of families into poverty, the scarcity of public transportation – that impedes people to travel to Newcastle, the regional capital, in order to find a job – and those families who panick because of their soaring energy bills. Fortunately, local generosity is active as well as the solidarity of the neighbouring supermarket, Morrisson, but the charity organizations complain that the state relies more and more on them. That is the opinion of the End Child Poverty Coalition that includes more than 80 associations. The food banks provide a relief to people in need, but to really end with poverty the wages and social allowances must be raised. But

the present austerity measures made by the tory government of Rishi Sunak do not support such measures. Therefore, the social actors have to adapt to this recession situation: they focus on the expansion of the distribution of free school meals to all the children whose parents receive the minimum social allowances, but not only to those earning less than £7,400 a year. The objective is to make sure that at least 800,000 additional children eat a hot meal per day.

France : food aid and institutional catering

In November 2022, the prices of foodstuffs have risen 12% per year, higher than the general inflation rate of 6.2%, according to the National Institute for Statistics and Economic Studies (INSEE). Food-aid associations and institutions in charge of institutional catering try to respond to an increasing demand, when they have at the same time to face food-price inflation. At the beginning of 2023, there are *ca*. 6,000 associations, communal centres for social action and solidarity groceries that are supplied by food banks. They distribute food, free or at a very low price. They have welcomed 2.4 million people in 2022, according to the study issued by the food banks in February 2023. This number has trebled in ten years and tends to increase: +10% in 2022, i.e. a figure that equals the Covid-19 pandemic two years. *Ca*. 94% of people that are attended by the food banks live under the threshold of poverty, i.e. €1,128 per month for isolated individuals. Forty-one per cent live alone and 42% are between 51-year and 62-year old. Retired people make up 17% of those attending food banks : less than the jobless people (27%) but as much as those who are employed.

The **Restos du Cœur** (Restaurants Appealing to People's Heart) – a well known and esteemed food association – has launched their 38th campaign on the 22nd of November 2022 by making a strong appeal to the people's generosity in order to buy and distribute food. Since April 2022, the number of persons attending their centres has risen 12% and those already known by the association were poorer than before. The president of the association stated that he never saw such a rapid and strong degradation. The needs are increasing during every crisis (such as the Covid-19 pandemic), but they never decrease afterwards. Therefore there is a double challenge: respond to the increase in the number of people to be attended and to their needs; reach

the poor inhabitants living in "white zones", i.e. without food-distribution centres – and bearing in mind that the cost of fuel prevents people to move to the centres. The associations have therefore intensified the whole range of their activities and also created moving distribution sites. On the other hand, the main actors of the sector have opened integration working sites that grow fruits and vegetables and increased their donations in kind from farmers and agrifood industries. Nevertheless, they buy an increasing part of their foodstuffs at higher prices. They also have to adjust to the higher cost of energy – not entirely covered by the government's assistance; food banks include warehouses with a surface of 123,000 square meters and equipped with cold chambers that consume a lot of energy, as well as *ca*. 500 trucks. They receive donations to partly cover their expenses. In November 2022, the government decided to allocate €60 million to boost the support for a durable food, in addition to its usual subsidies. But Yann Auger, director-general of Andes – a network of 520 solidarity groceries – warned that this amount will only cover the expanding needs. He added that they had to reduce the monthly purchase of people registered in the network (on the basis of their resources or income) and/or the quality of items proposed for sale. In the city of Grenoble (centre east of France), the charity association, Le secours populaire, that does not depend on food banks and is ubicated in ancient warehouses, has announced a reduction in food allocation and has given the following information : In the Isère department, where Grenoble is located, the number of people assisted by the association jumped from 18,000 people in 2019 to 28,000 in 2023, a 55% increase, while there is less financial aid, the donations from the stores are falling down and the purchase of food is more expensive – due to inflation. The association tries to collect money and food while relying on its volunteers, more than one-fourth of them welcomed by the association.

Regarding the students, the queues or lines for food distribution have been numerous on the university campuses. The same is true of a network of groceries managed by the Federation of the General Students' Associations (FAGE, French acronym). Five new sites were opened in 2022, thus bringing their total number to 16 since the Covid-19 pandemic. The individual amount of scholarships has been increased by 4%, but it does not compensate the inflation rate. On 22 November 2022, the minister in charge of solidarities

has announced the release of €10 million for the associations that distribute food aid to the students. The 750 sales points of the Network of school and university assistance have been overwhelmed: their attendance rose 20% – the average at the national level – or 40% at some points. In September 2022, 2.2 million meals have been sold at €1 each for students having a scholarship, compared with 1.9 million one year earlier. The same increase has been observed in the case of the €3.3-meals served to 2.4 million people. It should be stressed that the triple crisis caused by the soaring prices of foodstuffs, the skyrocketing costs of energy and the lack of staff in the agrifood sector has greatly hampered the task carried out by the food-aid associations.

This situation also heavily impacts the school institutional catering, that delivers meals to 8 million pupils every day. In 2021, for instance, in a secondary school of northern France, food-ingredients costs amounted to €1.96 per meal served at the school dining hall. At the beginning of November 2022, this cost rose to €2.16 and it was even expected to reach €2.20 or more. Some politicians talked about a "real food shock". However, four departments out of five have been able to mitigate this shock and to ensure the access of pupils and students to a balanced meal and thus maintain the purchasing power of the families. In general, the big towns could maintain their meal cost because they have important budgets, while this is not the case in smaller towns or communities. Many are afraid of the forthcoming situation if the costs continue to rise along with the energy bill. This anxiety has been rekindled by the appeal launched at the beginning of November 2022 by the trade unions of the institutional-catering companies, aimed at rising by at least 9% the price of the commercialized meals. Some municipalities have already renegotiated the contract with their food suppliers and decided in 2023 to increase by 5% the meal rate in the school-dining halls. However, there is a general endeavour aiming to protect the poor from this rise in meal rates. A member of the France's Mayors Association has concluded that "the crisis we are presently going through has nothing to do with what we expect for the future. If we do not profoundly change our behaviours and habits, we are moving towards a brick wall."

Meanwhile, the inflation rate was still soaring in November 2022 : the French daily newspaper, *Le Monde*, has designed a food trolley that contains

the necessary foodstuffs for the day and follows its monthly cost rate; in November 2021, its value was slightly higher than €100. A year later, its cost was €118.36; the trolley contains a mixture of national-branded products, distributors' brands and the so-called "first prices". For instance, sunflower oil is still costing €3.35 a litre, i.e. a 120% jump in a year; similarly, the minced-steak cost rose 26.5% in a year; basmati-rice price rose more than 30% in a year, like pasta. Milk products have also become expensive: 20% inflation for a national brand of the butter pack or Emmental cheese. There are few exceptions, like orange juice (distributors' brands) the inflation rate of which has been only 1.8% per year. Other estimates lead to the same conclusion: an inflation rate of about 12% per year. The 10% rate has been already reached in October 2022, and all the households fear that there is no sign of decrease or stabilization in the prices of basic foodstuffs. After negotiations held between industrial producers and distributors, there has been an agreement to rise the cost of some products. By the middle of 2022, the annual negotiations should start with a view to fixing the food prices in 2023. Soaring energy costs have led industrial producers to be more demanding, e.g. 10% increase for poultry, after the 35% increase agreed by the middle of 2021. On 28 October 2022, the last figures published by the French National Institute for Statistics and Economic Studies (INSEE) indicate an annual 6.2% rise in the prices of widely consumed products, compared with 5.6% one month earlier, due to the soaring prices of energy, food and manufactured products. Regarding foodstuffs, the inflation rate has been estimated at 11.8% a year and at 16.9% for fresh products. The overall result is that the French people limit their purchases: experts have stated that there has been a very significant decrease in the purchase of fresh products such as fish, meat or vegetables and fruits – 20% to 30% decrease in the purchase of fish, 12% in meat departments and 8% to 10% for vegetables and fruits. Moreover, the consumers storm the sales of products sold at real cost or on special offers. Some consumers, who are convinced that the inflation rate will continue to rise, buy and store some foodstuffs in their freezers. Another clear-cut conclusion is that the French people buy less and limit their purchases to what is really needed. Even chocolates and toys sold for Christmas 2022 did not attract more consumers than one year earlier.

In January 2023, the annual inflation rate will reach 7% according to the data provided by the National Institute for Statistics and Economic Studies (INSEE). The cost of a trolley containing 38 products, generally bought at the supermarkets and selected by the daily newspaper *Le Monde*, has risen from €104.2 in January 2022 up to €118.31 in November 2022, i.e. a +14% inflation rate. The latter amounted to +136% for a litre of sunflower oil (November 2021 to November 2022); to +26% for four mashed steaks and to +6% for 1-kg-loaf of bread. The average cost of 1 kg of poultry has reached €8.22 in 2022, compared with €7.22 in 2020.

The cost of electricity rose +4% between November 2021 and December 2022, when the prices of natural gas have been blocked by the French government. The price of fuel (1 litre) for motor-cars rose from €1.63 in October 2021 to €1.87 in October 2022, while that of lead-free petrol rose from €1.63 in October 2021 to €1.62 in October 2022. In this case, the inflation rate has been limited thanks to government subsidies as well as to the retails made by the oil companies. Regarding transportation, the average price of an air ticket (all destinations included) has risen +22.1% since the beginning of 2022; the monthly pass in the Tube (Metropolitan) increased +11.8% (the pass costing €84.10 in 2023). Buying a new car will amount to +6% inflation rate in 2022 compared with 2021 – an average €32,920 in 2022 compared with €30,987 in 2021 –, while purchasing a second-hand car will amount to an average of €22,356 in 2022, compared with €22,056 in 2018 and €18,146 in 2016.

In the third term of 2022, the reference index for renting an apartment (or a house) has increased by +3.5%, compared with the same period in 2021. Between January and November 2022, the cost of building materials rose +204% for a bag of pellets (from €4.9 to €14.9), +10% for plaster, +25% for tiles, +28% for a wheelbarrow and +25% for window frames. Insurance rates rose +3% to +5% (additional health insurance, housing insurance, car insurance) during the year 2022, while the average cost of a smart-phone subscription rose +25% between December 2021 and December 2022. Regarding entertainments, the movie-house-seat cost rose +6% between 2020 (€6.63) and 2021 (€7.04). In 2022, the average daily rate for renting an apartment rose +10%, while the average cost of a hotel room rose +20.9% during the early-November 2022 holidays, compared with the same period in

2021. In a French ski-station (Courchevel, Savoie), the location of skis rose +10% during an average holiday period.

By contrast, the wages did not follow the same trend: only +3.7% in 2022, compared with 2019 (+1.6%) for the monthly wages, while the costs of household expenses rose +6.2% during the same period and from +1% in 2019. These costs did not include tobacco purchases. The share of unconstrained expenses (housing, loans, telephone, etc.) has been estimated at 30% of the total household expenses. The minimum salary (SMIC) rose from €1,554.58 in January 2021 to €1,678.95 in August 2022, i.e. +7.76% in a year. Therefore this salary increase has been adjusted to the average annual inflation rate.

Aware of their vulnerability, the lower middle classes need more help, but in this regard they are not as successful as the poorer ones. Maybe because they are less informed or they are afraid of being stigmatized ... This overstretching of life standards and well-being heightens the feeling of "territorial relegation", i.e. the feeling of living in "a territory neglected by the public authorities". This has been voiced by 17% of less than 40-year old-people, 20% of people living in rural communities and 26% of "independents". And both crises – the Covid-19 pandemic and the inflation-rate growth – are having a heavy impact on the feeling of loneliness.

Egypt : *a deep social crisis looming on the horizon, because of soaring food prices*

The war in Ukraine has a serious impact on the supply of wheat imported from the same country and Russia, as well as on the revenues drawn from tourism. Another drawback of the conflict has been the massive outflow of foreign capital. All the expectations concerning an inflation decrease, formulated by the end of 2021, have been ruined. Inflation rate has been soaring, as underlined by the official agency for statistics, CAPMAS; in October 2022, this rate reached a record level in four years, due to the rise in foodstuff costs. Everything has become expensive, used to say the Cairo consumers. Moreover, the Egyptian pound has been devaluated twice in seven months. The second devaluation occurred in October 2022 in order to comply with the conditions of the International Monetary Fund (IMF) that the Egyptian authorities called for rescue. Egypt immediately needs US$40 billion in order

to pay back its debt and to have a balanced commercial trade with a view to pursuing its imports. On the 16th of December 2022, the IMF has approved a US$3 billion loan to Egypt. This assistance has been granted in order to carry out economic reforms. In particular, the IMF mentions "a permanent move to a regime of flexible exchange rate", as well as the setting up of a "monetary policy aimed to progressively reduce the inflation rate in the country." In addition to the IMF loan, Egypt may rely on the financial support of the Gulf countries as well as on the sales of goods in order to feed its dollar reserves. While the Egyptians had to tighten their belt because of the relentless rise of food prices, the authorities have launched for a period of eight years the implementation of megaprojects for the modernization of the country. Some opponents to the governance of the country claim that these projects are just swallowing up money – a financial disaster that hampers the general economy and the daily way of life of people. The real risk is a deep social crisis: rise in poverty and difficulties of the less-privileged people to adjust to the economic situation. These social categories already bear the brunt of the crisis. During the Covid-19 pandemic, poor households, making up 30% of the country's population – *ca*. 100 million – have been obliged to reduce the number of daily meals, according to CAPMAS; rice – a basic foodstuff – has become very expensive and often out of the reach of the poors. The risk of social unrest is therefore assessed by the authorities : the price of bread has been frozen in March 2022 and the government announced in November 2022 that there will be a ceiling for the price of rice. It seems obvious that, despite the strengthening of security measures, the more the sufferings of the population worsen, the higher the risk of a chaotic and uncontrolled social explosion may become a reality.

Produce more or better: the European debate

On the 19th of October 2021, the European strategy, Farm to Fork or F2F, has been adopted by the Eurodeputies (452 members of the European Parliament voting in favour, 170 members against and 76 members abstained). The framework document of this strategy has been presented in May 2020 by the European Commission, as the same time as its strategy on biological diversity. The main objective is to support a healthier and sustainable food diet, when the food chain contributes to one-third of greenhouse-effect

gases at the global level and is one of the main factors explaining the loss of biodiversity. More specifically, the F2F strategy aims to halve the use of pesticides by 2030 and to reduce by 20% the use of fertilizers. It is expected that one-fourth of agricultural land will be organic at that time, compared with 8.5% (based on the data available in 2019); and also to halve the sales of antibiotics used in livestock breeding. The strategy also opens the way for the revision of European directives concerning animal well-being. The Eurodeputies have thus reiterated the need for the gradual prohibition of the use of cages in livestock breeding, and they have also requested measures to drastically reduce the consumption of meat as well as of ultratransformed foodstuffs.

The debate about this strategy have been fiery regarding the eventual decrease in agricultural productivity that may occur as a follow-up to the implementation of the strategy principles. Several Eurodeputies, particularly from the European Popular Party (EPP), have denounced a "sacrifice of our food sovereignty," as well as a "lack of transparency of the European Commission". The basis of these protests is a study published on the 28th of July 2021 by one of the technical bodies of the European Commission – the Research Common Centre – that anticipated a decrease in agricultural production as a consequence of reaching the strategy four objectives. Moreover, on the 12th of October 2021, a study carried out by the Dutch Wageningen University and ordered by the company CropLife Europe – a representative of the pesticide industry – also forecasts a drop in agricultural yields as implied by the F2F-strategy implementation. The European Commission had to publish a technical note on its various modelizations in order to pacify the debate. The above-mentioned studies did not take into account the changes in food behaviours that could be fostered by the strategy policies; nor the impact of a greater crop biodiversity and the cost of inaction. However, the objectives of the F2F strategy are not included in the Common Agriculture Policy (CAP) for the period 2023-2027, submitted to the Eurodeputies' vote at the end of November 2021. The 27 Member States must nevertheless include them in the national decisions as a follow up to the CAP. These decisions will be validated by the European Commission at the beginning of 2022. On its side, the commission has presented its travel warrant (way bill) for 2022 and has granted one of its highest priorities to this strategy for 2023. The commission has already announced the revision of its directive on the use of pesticides during the first term of 2023 (see below).

Regarding the CAP, on the 31st of August 2022, the European Commission has already approved a first bunch of "strategic plans", that are, at national level, the implementation of this European programme of subsidies to agriculture. Thus, the plans of France, Denmark, Finland, Ireland, Poland, Portugal and Spain have been approved. These countries will receive €120 billion of aid during the period 2023-2027, including €45.2 billion for French agriculture. At the end of March 2022, the European Commission had nevertheless emphasized the lack of environmental measures in the initial version of the French plan, sent to the EC in December 2021. The 1,884-page document that was sent back on the 4th of August 2022 by the newly-appointed French agriculture minister included several adjustments. For instance, the emphasis on organic agriculture has been stressed in order to differentiate it from the certification "high environmental value" (HEV) which is less constraining. From now on, the "ecoregime", which is the new tool rewarding the agricultural practices in favour of climate and biodiversity, will amount to €30 per hectare for organic-agriculture farmers, more than the subsidy allocated to those involved in the HEV certification. The total subsidy allocated to organic-agriculture farmers will amount to €110 per hectare, while the French farmers expected a minimum of €120 per hectare. According to a Eurodeputy involved in the report on the subject, this subsidy will not be sufficient to achieve the objective of doubling the share of organic agriculture – 18% of the agricultural area – in 2027. Another disagreement with the EC refers to mandatory crop rotation: the French government will be in favour of crop diversification and not of mandatory crop rotation, but the EC has maintained its position. In 2023 and 2024, crop rotation will take place on 35% of the total agricultural area, i.e. 65% of this area will remain under monoculture during two years. Since 2025, two different crops will be grown for four years on all the agricultural plots or one secondary crop every year. There will be an exception for maize grown for seed. The French National Trade-Unions of Farmers (FNSEA) has been opposed to the EC's enforcement directive concerning the fallowing of 4% of total agricultural area or maintained in the so-called "non-productive zone" within the CAP. Due to the war in Ukraine, France has obtained an exception to the rule in 2023. There are other subjects where there is nevertheless a consensus between France and the EC; for instance, the maintenance of the subsidies to grazing lands, or the increase in the financial support granted to young farmers – a €5,000 amount, whatever the farm area.

Some experts think that the "new" CAP remains to a large extent the continuation of the previous one. The large proportion of subsidies still consists of direct payments per hectare, which is not in favour of the transformation of agriculture. For instance, how this CAP will be able to adapt to recurrent drought? In France, the 2022 drought will reduce by 0.2 or 0.3 the economic growth rate, i.e. between €5 billion and €7 billion loss, according to an evaluation made by an insurance firm and based on the impact of former droughts. The 1990-1995 drought has resulted in -14% of agricultural production, while agriculture represents 1.5% of the gross domestic product (GDP). How also to lower the emissions of greenhouse-effect gases associated with agriculture? Or to reduce the impact of nitrogen fertilizers? Hervé Guyomard, research director at the French National Research Institute for Agriculture, Food and Environment (INRAE), has underlined another weakness of the CAP: "Much time has been spent before laying out this strategic plan, but there is still a lack of an analysis of expected impacts on GEG emissions or on biodiversity. How do we follow these measures and correct them if they are not sufficient?" The French economist is of the opinion that several measures are relevant and can facilitate the ecological transition, but "for the moment, the compliance of the CAP with the objectives of the *Green Deal* (carbon neutrality in the European Union in 2050) is not achieved". In 2025, at the latest, a review of the strategic plans should be implemented, with a view to including the *Green Deal* objectives. The latter should be submitted to the vote of the Eurodeputies and will therefore become an unavoidable constraint.

Nutritional labelling of foodstuffs: the European divide

In May 2020, when the European Commission has presented its strategy Farm to Fork, with a view to reaching a healthy and sustainable diet, it has been suggested that a nutritional labelling of foodstuffs should apply to all Member States of the European Union. What was at stake is that 53% of the European population was overweight, 22% suffered from obesity, and that there was a multiplication of chronic diseases associated with the food intake. In all the countries that have decided to put nutritional logos on their foodstuffs – the three-colour system in the United Kingdom, warning black logos adopted in part of South America, Nutri-score in France, etc. – there has been a strong opposition from the food industry. Until the summer of 2020,

the Nutri-score seemed to have an edge on the other logos that were tried in Europe. The Nutri-score system which gives a grade from A to E, with a colour from green to red, has been adopted by seven European countries; it is well known among consumers, it has been validated by a hundred of studies published in peer-review journals and fully approved by the International Cancer Research Centre.

In France, the Nutri-score system has been adopted in 2017 as an official labelling (but not mandatory) and, despite some opposition, it has progressively been approved by the agrifood sector. More than 400 companies have committed themselves to apply this labelling to half of the volumes of foodstuffs being sold. The logo has been disseminated across Europe: it has been adopted in Belgium, the Netherlands and Luxembourg, Germany, Switzerland and Spain. A political governance committee and an independent scientific council have been set up with a view to following the promotion of the logo. However, several Member States of the European Union have voiced their opposition to this nutritional labelling. For instance, the new government of Giorgia Meloni has called the system "absurd", "discriminatory" and "detrimental", concerning the Italian products. This antilabelling speech was not new in Italy, but it is from now on supported by the government itself. Very often Italian representatives give the slanderous examples of the Nutri-score ranking D or E (in red colour) applied to several Italian gastronomic items, such as the Parma ham, the Gorgonzola or Parmesan cheeses. Whereas this low-rank labelling means that these foodstuffs, which are fatty and salty, should be consumed in small quantities, for Italian politicians these attacks on their gastronomic items are interpreted as a fight against the Mediterranean diet. The truth is that there is in Italy a powerful agroindustrial sector, which makes up 8% of the gross domestic product (GDP) and is included in the Federalimentare. There has always been a bone of contention between the major Italian food companies and the French ones, the best example being illustrated by the Ferrero Company. Since the first debates or discussions about nutritional labelling in France, the Italian conglomerate has been opposed to Nutri-score and refused to label its products accordingly, especially the world-known spread-paste Nutella. The rationale of Ferrero is that "a harmonized labelling to be put in front of the foodstuffs," should bear in mind "a key-principle: to correctly take account of the role of the portions (rations) in

a balanced food diet." That position or viewpoint aims to devaluate Nutri-score, because the latter evaluates the foodstuffs on the same basis of – 100 g or 100 ml, – the concept of portion (ration) is subject to interpretation and could vary among individuals. The battle against Nutri-score has strengthened the alliance between the interests of the Italian agroindustrial large groups and the defensors of emblematic products "made in Italy", represented in Coldiretti – the main Italian agricultural confederation. Such convergence is rather unexpected between the producers of junk food and cooperatives commercializing excellent products.

This viewpoint is partly shared by those who refer to Italian culinary art. It is the case of *Slow Food*, an international movement born in Italy that aims to defend a sustainable and socially equitable gastronomy. "The food sector, the exports of the "made in Italy" products and the gastronomic dimension of tourism are the ultimate economic stronghold that stands firmly in Italy. It is to a large extent represented by medium-sized family producers, that Nutri-score may considerably affect", commented the philosopher and gastronome Eugenio Mailler, one of *Slow Food* representatives. "Italy has considered all this matter as an issue of tradition, culture and defense of AOP ("appellation d'origine protégée" or appellation of protected origin), while the basic nutritional labelling has not the same objective", stressed a French Eurodeputy. The French nutritionist Serge Hercberg, former president of the National Nutrition Health Programme during 16 years and whose team designed the Nutri-score, recalled that "for many years Italy has been against any public-health measure, that it considers detrimental to its economic sectors. Industrialists are therefore efficient spokespersons that influence governmental policies". The end result is that the antiNutri-score movement is very strong in Italy and it is quite impossible to reverse this trend. Even many Italian scientists prefer to keep a low profile, whereas S. Hercberg has received a lot of hatred and antisemitic messages on the social networks, and even death threats. The French scientist added: "this violence is fuelled by the official propaganda of populist and extreme-right movements." In Brussels, several meetings were convened with a view to fighting the Nutri-score and to demeaning it. Also think tanks and lobbying cabinets are involved in the same battle. Time passing, the strategy of the antiNutri-score movement seemed to pay off: the doubts on the validity of Nutri-score have been installed in

many European capitals. Italy has been able to put several Member States on its side: Greece, Cyprus, Romania, Lettonia, Czech Republic, and even Hungary. Spain who uses Nutri-score has chosen an ambiguous position and Rome also thinks that it is on its side. Only Germany and France are fully committed to promote Nutri-score. The European Commission has not yet a clearcut position. At the end of November 2022, Frans Timmermans, first vice-president of the EU, seemed to move away from Nutri-score: "With Nutri-score, we have not yet reached our target. I have some difficulty to understand what it means. How a transformed foodstuff should have a better Nutri-score than a natural product?" Finally, there seems to be a European divide on this issue of nutritional labelling of foodstuffs. Serge Hercberg, "regrets that Italy is blocking any public-health decision, because it considers it is detrimental to its economic sectors" – food industry and food transformation. Within the scientific community, there is a concern about the timely adoption of a harmonized nutritional labelling of food. Mike Rayner, professor at Oxford University, that played an important role in the establishment of a British three-colour labelling, expresses its skepticism to see the adoption of a food-labelling proposal by the European Commission in 2023. He added: "Most studies show the colour codes are those which fare well. I do not see any alternative to Nutri-score, or a system that is quite similar." The consumers' associations fear that the proposal by the commission be buried, after being delayed for a long time. Camille Perrin, in charge of food policies at the European Bureau of Consumers' Unions (EBCU), has underlined that "labelling is a first step – a very important one – that shows public authorities give a higher priority to public health than to economic interests. It is indeed a rather simple measure to put in place, but if it is not adopted, one may put a cross on any public-health policy".

It should be mentioned that Nutri-score would have to evolve. Adopted by seven European countries – Germany, Belgium, Spain, France, Luxembourg, the Netherlands and Switzerland – this food labelling has a transnational political governance, as well as an independent scientific committee including experts from each country. In France, for instance, it is the Institute for Public Health France that is in charge of the appropriate application of Nutri-score rules and of its utilization by the companies committed to follow this approach – the latter should put the label on the whole range of their products, and not to just

emphasize the value of their healthiest foodstuffs. In 2023, several changes will occur in the ranking of foodstuffs, after the adoption at the end of July of an update of the Nutri-score algorithm. Among the foreseen changes, a new ranking of edible oils: olive oil, that was ranked at the C level, will move up to the B level, as well as rapeseed and walnut oils. The objective is to suit the consumers, because they are rich in omega-6 for the first one, and omega-3 for the last two. Breads made with complete flour will also be ranked better than those made with refined flours. The category of several cheeses will also change, depending on their contents of fats and salt. For instance, cheeses with a low content of salt, like emmental, will be close to the ricotta and mozzarella, ranked as C. Sugary products, particularly the breakfast cereals, will be ranked more severely, as well as the already cooked meals and ready-to-eat pizzas, so as to take into account the transformation of foodstuffs. Cooked meats will remain at their previous ranking, D or E, while red meat will still have a lower ranking in the new Nutri-score. The transformation of the latter does not aim to please some sectors of the food industry, but to comply with the nutritional recommendations, observed S. Hercberg. It is true that some producers are not happy, such as those manufacturing cooked meats and cheeses. The update of the Nutri-score algorithm will subsequently follow its extension to products sold in bulk, e.g. fruits and vegetables, and to food served in institutional catering. The governing board of Nutri-score is also planning to adapt the algorithm to beverages and to send its recommendation to the EU. A three-month consultation period will take place before the decrees are issued; thereafter, the companies will be able to sell their stored foodstuffs, before using the new labels.

Overuse of pesticides: an increasing threat

Frans Timmerman stated in an interview with the French daily newspaper *Le Monde* (Saturday the 26th of November 2022), that the overuse of pesticides destroys a large part of the biodiversity across the EU. In the long-term, it is a serious and direct threat to the farming world. For instance, how to carry out agriculture without pollinating insects? How to take into account the impact of pesticides on human health? The European Union has postponed to the end of 2023 the review of the *Reach* regulation of chemical products. F. Timmermans underlined that this review has been still on the agenda of

the EU and that it cannot be waived out. One should note that in 20 years the Chinese pesticide manufacturers have been able to play a key role in this market, estimated at US$66 billion in 2020; their share was *ca*. 40% of this total amount. According to Christophe Alliot, co-founder of Basic, a consulting bureau – Bureau for the Societal Analysis for a Civic Information – China produces about half of the 4 million tons manufactured annually across the world. While multiplying by 11 its sales value, China has become the world's leading exporter in 2018 – US$5.2 billion sales – ahead of Germany. China exports mainly to Brazil, Thailand and the United States; thereafter, come Australia, Nigeria, Indonesia and Vietnam.

India has also become a big exporter of pesticides, thus multiplying by 14 its exports of low-cost phytosanitary products between 2000 and 2020. This disbalance of pesticide production towards Asia is a concern in the European Union, because most of the active components of the pesticides commercialized in the EU are manufactured outside the Union. At the same time, there has been a major concentration in the global agrochemical industry. In 2020, four big companies or conglomerates were the world leaders: Bayer-Monsanto, Syngenta, Corteva and BASF. Among those companies considered as "integrated", i.e. mastering the whole value chain from research-and-development to product distribution and marketing, the German company Bayer has purchased the French Crop Science in 2008, then Monsanto in 2018. The American companies Dow Chemical and DuPont have been merged so as to create Corteva in 2019. The most remarkable event has been the acquisition of the Swiss company Syngenta by the state company ChemChina in 2017, for an amount of US$43 billion – the largest acquisition ever made abroad by China. Since then, Syngenta has continued to grow, as well as the company that controls it. In 2020, the merger – foreseen for a long time – between ChemChina and the other Chinese giant, Sinochema, has become a reality. This merger gave birth to a giant firm that is equivalent to all American and European companies combined. It is obvious that China wants to create the biggest combined chemical conglomerate worldwide. The historical firms, mainly American and German that made up 78% of the world annual turnover of pesticides in 2014, represented only 67% in 2017. On the other hand, the proportion of protected-patent pesticides has been halved: the generics share has risen to 70% of the market, compared with 30% in

2000. The price of a kilogram (US$23) of these generics is three-and-half times lower than the price of patent-protected products (US$81). The sector is economically profitable because the costs associated with pesticide negative impact (decontamination, investments into agroecology, health-care) are not taken into account, and also because they receive state subsidies. China has the lion-share of the generics market, while often European products cannot be competitive in the world regions still using molecules forbidden in Europe. Quite often in emerging countries, pesticides with a low research-and-development component are used. Just behind the three first leaders of generics production – the American Albaugh, the Australian Nufarm and the Dutch Nutrichem –, China keeps the following seventh position among the top 10. This country has purchased the biggest firm of the sector, the Israeli Adama, in 2011; Adama, merged with Syngenta, has reached an annual turnover of US$15 billion in 2020.

Nowadays one can notice new alliances between agrochemical groups, seed-producers, machine-manufacturers and specialists in digital technologies. China's dominant position in agrochemistry is related to the need to supply more and better-quality agrifoodstuffs to its 1.4-billion population. Thanks to the merger with Syngenta, China has become a big player in the European sector and has access to agriculture-precision technologies and to genetically engineered seeds. This approach is part of a long-term strategy of the Chinese government that invests, each year, twice as many public funds in agricultural research than in the United States.

Meanwhile, the European Commission aims to reduce by 50% the use of pesticides in 2030, Europe remaining the leader of pesticide exports (US$5.8 billion in 2019). Bayer stresses that since 2016 it has been commercializing only the phytosanitary products of which the active components are registered in at least one Member State of the Organization of Economic Cooperation and Development – OECD. BASF has underlined that it was less interested in mass production; its investments are focused on products combining seeds, crop protection and digital technology. Four sub-sectors are targeted and deal with crops representing 70% of the global market: soybeans, maize and cotton in North and South America; wheat, rapeseed and sunflower in North America and Europe; fruits and vegetables across the whole world; and rice

in Asia. China, despite its transition to an agriculture using less chemicals, keeps exporting enormous quantities of pesticides. In the forthcoming ten years, Africa may receive large volumes of Chinese pesticides, including those products that are prohibited in Europe. How China could cope with the contradiction of producing safer products at home and of exporting less-safe ones, abroad? Also in Europe, the issue of a new dependence is raised: it is still the leading consumer of synthetic chemicals (for an amount estimated at US$12 billion in 2019), and France remains the first market of agricultural pesticides.

The organic-food crisis

This crisis can be explained by the sudden and drastic reduction in organic foodstuffs by the consumers. In France, for instance, there were already indications regarding this consumption slowdown in 2021, but they became more obvious in 2022. Almost €600 million of the annual turnover of this business disappeared and the organic-foodstuff consumption fell down to €12.076 billion in France, according to the director of the Agence Bio – a public structure in charge of promoting the organic-food system. The proportion of organic food in the French diet decreased from 6.4% to 6%. In the large distribution network of foodstuffs (e.g. supermarkets) sales retreated by 4.6%. The big companies of this distribution remain however the primary commercialization network of organic food: 53% of the total. The following figures can illustrate this crisis:

- in 2022, 60,483 farmers have been certified for organic-foodstuff production;

- 10.7% of agricultural land is devoted to organic agriculture – this percentage is stagnating and is far from the 18% target decided by the government;

- €60 million have been budgeted to help organic farmers in May 2023.

In addition to the reduction in the consumption of organic-food (-8.6% in the purchases made in specialized shops), another bad new concerns the share of organic food in catering; the latter has been retreating from 2% to 1%. The only positive point highlighted by the Agence Bio in its annual balance-sheet report, concerned the good status of direct sales that rose 3.9% and the gains in the marketing and purchase of organic food through institutional

catering (+18%). But these figures could not mitigate to the organic-food market crisis. After several years with a double-digit growth, the violent deceleration in 2022 has creating an amazing effect among all the organic-food producers. A good example is that of milk production that grew up and thereafter fell down due to the reluctance of consumers; although the price of conventional milk has been increased and even surpassed that of organic milk during one month, the farmers were not able to obtain price increases further to their higher production costs. Regarding egg production, avian flu has contributed to a lack of eggs in France in 2022; the percentage of organic eggs has reached 22% in the large distribution network, but thereafter it fell down to 19%-20%. However, it seems that globally the diminution of organic eggs in the supermarkets has been limited. The situation has been more complicated for chicken meat: in 2022, according to certain estimates of organic-fowl raisers, there has been a decrease of sales estimated at 20%-25%. Even the cereal market has not been unscathed: " the organic-cereal market is saturated", stated the president of the National Organic Agriculture Federation. In this dark context, only vinewards and wine marketing have not suffered, whereas at the same time 21% of the French vinewards are organic. This sector is less dependent on the large distribution networks than other organic sectors; the strong emphasis on the sales in the vineyards themselves or in their cellars can explain the situation.

In this context, the farmers are less attracted by organic agriculture : the conversion rate to this kind of agriculture has reached 40% in 2022, with more than 60,000 organic farmers. The latter receive their organic certificate after three years of conversion. For the first time, the agricultural area devoted to organic farming is stagnating at 10.7% compared with 10,4% one year earlier. What is today at stake is to avoid a wave of discouragement among the farmers who have decided to get rid of chemical fertilizers and synthetic pesticides. The present slogan is to stop the wave which is expected to expand in 2023. Chicken and pig breeders have reduced their production, while cereal farmers bet on diversification – the diversity of crops could make them more resilient. For instance, some farmers have sown soybeans and buckwheat, and reduced their wheat crop. Others emphasize the direct sales to farmer associations or livestock breeders. Many count on the assistance provided by the government: the agriculture ministry has

pledged €60 million to help organic farming. The government also promised to enforce in public establishments the law called EGalim – until the end of 2023 – which makes mandatory the supply in institutional catering of 50% of quality products, including 20% of organic foodstuffs. The government also decided to allocate €500,000 to the communication budget of Agence Bio, that expects to launch a €3-million advertisement campaign.

The main issue is to increase the consumption of organic foodstuffs, despite the difficulties occurring in the supermarkets during the first term of 2023. According to a consulting company, Circara, the consumers, because of the inflation rate (around 15%), privilege in their purchases the distributors' brands or the lowest-cost items. The end result is that the purchases of organic foodstuffs represented only 4.5% in volume. There is however some hope due to a slight increase in the purchase of organic products and to the communication campaign #BioRéflexe carried out by the Agence Bio. The objective of the latter is to better demonstrate the difference between the "bio" labeled products and other labels, and to emphasize their environmental benefits. Officially, the French government continues to support organic farming and sticks to the objective of devoting, in 2027, 18% of agricultural land to it.

Regarding the specialized shops or networks selling organic food, they face a competition from the traditional large food-distribution networks and the increasing sales of local products or "labeled as high environmental quality" or "pesticide-free". Since the end of 2021, these businesses have acknowledged a drastic slowdown of their activities. The situation has been similar through 2022 due to the rise of inflation rate and the reduced purchases of the French consumers. Even the market leaders, that were recording a two-digit growth for several years, have been struck by the fall of their annual turnover in 2022: -5.6% and a loss of €1.5 billion for the Biocoop network (765 shops across the French territory), and -7.8% and a loss of €355 million for Naturalia (245 shops in France). Despite a slight positive change at the beginning of 2023, the companies did not come back to their initial prospects. For instance, after having opened 38 new shops in 2021, Naturalia was expected to open another 30 to 40 in 2022. In fact, 23 openings took place, including 12 existing businesses that joined Naturalia.

And 26 closed down. Naturalia has even adopted a new strategy : widening its market offer in order to include “good” or “healthy” products that do not need the organic label. Its competitor, Biocoop, has estimated that in 2023 *ca*. 40 shops will close down, while 17 new ones will open. To sump up, “for about 10 years, an average of 200 to 250 new organic shops, have been opened every year in France, while in 2022 – the first year of growth slowdown – more than 100 shops have been closed down”, stated the director of the proximity brands of the French group Carrefour and chairman of two specialized brands of the group, So-bio and Bio c’ Bon, acquired by the group by mid-2018 and in November 2020, respectively.

Carrefour who abandoned its brand Carrefour Bio in 2021, conducts another more industrial strategy: transform the non-profitable organic shops into traditional supermarkets. After transforming a dozen of Bio c’ Bon in 2022, less than ten shops have changed their brand name and have become supermarkets at the end of the second term of 2023. Out of the 103 Bio c’ Bon shops acquired by Carrefour in November 2020, only 80 remain as organic shops, and about the same figure for So-bio shops. However, Carrefour is convinced to carry out its strategy, because its two organic networks of shops (Bio c’ Bon and So-bio) have increased 15% of their turnover in 2022, when the market retreated by 12% to 14%. These results, according to Carrefour, can be explained by its almost industrial operational management. For instance, 80% of customers of both organic shops possess loyalty cards and they receive very targeted offers to lure them. But for the smaller networks who have been supported by a growing market, the situation is more complicated: several brands have closed down their shops, or have tried to reconvert them or to sell them to more robust networks.

In Germany, the year 2022 has drastically changed a situation that during the previous 20 years has been rising with sometimes a two-digit growth for the purchase of organic foodstuffs. In 2022 and for the first time, the annual turnover of the organic sector has decreased by 3.5% compared with 2021 and fell down to €15.3 billion. The inflation rate that has particularly affected the foodstuffs (e.g. vegetables and fruits), induced the German consumers to restrain their purchases of food and to make choices in terms of price and quality. Among the producers, the atmosphere is also bleak:

they could not yet integrate the total of increased production costs in their sale prices, and some have preferred to store their production. In the sector of distribution the shock has mostly affected sales: -18%, according to the report published in February 2023 by the association of producers of organic food BÖLW. Several regional shop networks have gone bankrupt, while the bigger brands like Bio Company have seen an important decrease in their annual turnover (-10% at least). In an interview with the daily newspaper *Süddeutsche Zeitung*, published in September 2022, Götz Rehn, the founder of the Alnatura shops, stated: "We are going through the worst collapse of the organic market during the last 35 years." However, the situation is not that gloomy: sales have retreated, but they are still at a high level, much higher than just before the Covid-19 pandemic. During 2020, the closure of restaurants and the restrictions imposed on the movements out of the households have provoked a historical jump in the consumption of organic food. The annual turnover of the sector climbed from €12.2 billion in 2019 up to almost €15 billion in 2020, thereafter €15.8 billion in 2021, or a rise of 29% in a couple of years. The decrease in the sales of organic foodstuffs in 2022 did not question or completely change the consumers' faith in organic products and their relevant habits. The customers have less attended the organic shops, but they made their purchases in the discounter shops. This may be a weird alliance, because the discounters sell great volumes of goods and they are well known in terms of their harsh negotiations with the producers. But in Germany there has been in fact a positive evolution of the organic sector. Thus, Lidl, Aldi and their competitors, but also the traditional supermarkets, are good selling points of organic products of which the growth is very high. During 2022 – the crisis year – with a 10% increase in the annual turnover in these salespots, the organic food sector cannot scorn the large foodstuff distribution. Even the brand Naturland – one of the German well known traditional organic labels, created in 1982 – has been present since March 2023 in Aldi shops. "The collaboration with the discounters is an important development pillar in a market that is presently very dynamic," explained Willi Heilmann, director at Naturland, at the beginning of February 2023. "Aldi would not act as it does presently if it did not believe in the future of organic food. People do continue to purchase organic foodstuffs, and all the actors of the foodstuff distribution network

are widening their range of products and make sure that their supply in raw materials is satisfactory," he added.

Despite these positive facts, Germany is not likely to reach its objectives regarding the development of the organic sector: the government has set up the objective of 30% of agriculture land devoted to organic farming in 2030. That means thrice the current area in seven years. Difficult to achieve!

Dire forecasts of the World Food Programme

For several years the World Food Programme (WFP) has been at the vanguard of the struggle against hunger across the world, particularly during the Covid-19 pandemic and the war in Ukraine. It is the largest UN agency in the area of humanitarian assistance that alleviates the burden of hunger, under- and malnutrition. Its director, David Beasley, gave an interview on Friday the 11th of November 2022 in Paris, to the French daily newspaper *Le Monde*, regarding the forecasts of WFP in this struggle against hunger. He has indicated that when he was elected as head of WFP in 2017, there were *ca*. 80 million hungry people across the world. Just before the Covid-19 pandemic struck the planet, this figure was higher by the end of 2019, and when the war started in Ukraine it reached 276 million people. In 2022, it jumped to 345 million people, and this situation could lead to massive destabilization in several countries. There are already, he stated, a number of incipient rebellions in Indonesia, Sri Lanka, Peru and Panama, etc. Somalia is the country that knocks at the door of hunger. Several years without any rainfall have decimated livestock, while food prices are soaring and armed conflicts have been present for many years. The WFP has deployed a very large food-aid programme and has requested the donor countries to increase their contribution. However, D. Beasley feels that starvation or hunger will occur in Somalia, but everything is made to reverse this trend. The security situation is fragile and D. Beasley has made an appeal to all those who block the access to food aid, to respect humanitarian law, while at the same time WFP tries to carry out negotiations with the rebellion movements.

An increase in the number of droughts across the world has been observed not only in the Horn of Africa or in the Sahelian region, but also in North and South America, the Middle East and Asia, with devastating impacts on

food production. In addition in Africa, the lack of fertilizers could lead to a fall in agrifood production, amounting to US$2 billion. Hopefully, the cereal initiative of the Black Sea – an agreement concluded in July 2022 and aimed at facilitating cereal exports from Ukrainian ports – has been extended for several months in November 2022. It concerns both cereals and fertilizers from Ukraine and Russia: it is of paramount importance to decrease the tensions on the international markets and to partially meet the demands of some African and Middle Eastern countries. Let us hope this initiative will be pursued despite the war in Ukraine; otherwise, the present food-price problem could be transformed into a serious drawback for agricultural production in 2023 and 2024. Effectively, D. Beasley underlined that the present food-price crisis which implies a difficult availability of food for the poor populations, may become in 2023 a problem of general availability. The wealthy States would continue to pay for their food imports, but this would hamper the poors to have access to food. In other words, there will be hunger or starvation in many countries, destabilized nations and massive migrations of people. Confronted with what D. Beasley considers as the worst food and humanitarian crisis since the Second World War, the global needs are considerable when the population is getting out of two years of the Covid-19 pandemic with colossal economic impact. With US$1 or 2 per week, it is possible to fund a resilience programme that allows the feeding of a child in Guatemala, Ecuador or Honduras. If this child were to be taken care of, at the border of the United States territory, the cost would amount to US$4,000 per week.

It is true that some countries like France, Germany, the United States and others are carrying out programmes in food security, but, according to D. Beasley, the scale of the latter needs to change and they should be better coordinated. The final goal is that in a few years the poors will not need external assistance. This is the challenge of agricultural adaptation and resilience programmes, as well as of sustainability approaches; they constitute more useful investments than just bringing food aid. In 2020, WFP has been awarded the Nobel Peace Prize and on this occasion, the Nobel Committee sent two messages: first, to convey all the gratitude and thanks to WFP women and men that put their lives in danger in the field and for peace – because food accessibility is the way to peace; secondly, to make a “bugle” appeal and draw the attention

of governments and decision-makers to the importance and relevance of the food crisis. Let us hope that WFP dire forecasts do not become a reality in the field, provided that quick and effective action is focused on increasing sustainable food production and on reducing social inequalities in terms of food availability and accessibility. Maybe it is a good new to recall the US president's statement at the COP27, on the 11th of November 2022, in Sharm El-Sheikh, Egypt: "The climate crisis has to deal primarily with human beings, but also with economic security, national security and the whole life on the Planet." President Joe Biden also mentions at the beginning of his speech the "vulnerability" of Africa and he concluded that the efforts aimed at mitigating the climate crisis are "more urgent than ever". To support his action, he gave details about the colossal plan that has been adopted during the summer of 2022 estimated at US$370 billion and funds will be available for the development of renewable sources of energy, environmental protection and reclamation. One of the main climatologists of Brazil, Carlos Nobre, made the following comments regarding the US president's speech: "There are many positive points in that speech, such as the emphasis on renewable sources of energy, the commitment to reduce methane emissions, the insistence on the attenuation of global warming. This reiterated commitment of a country that plays a crucial role in climate-change negotiations, but is also a historical polluter, is a good sign".

Biofuels: worsening the agri-food crisis?

When filling the tanks of motor-cars, agrofuels can be distinguished by the initial E, with a number (5, 10, 85) indicating the proportion of ethanol mixed with the fuel. This ethanol is produced through the extraction of sugar from sugar-beet or/ and sugar-cane, thereafter microbially fermented and transformed into alcohol. It can also be produced with wheat or maize starch that is first degraded into smaller sugar molecules. For the cars that use diesel fuel, the biodiesels – B7 or B10 – are derived from vegetable oils – palm oil, rapeseed, among others. Both agrofuels have been produced since the 2000s and they have been commercialized as an alternative renewable source of energy. Biofuels include all the substitutes of fossil fuels, derived from plants or wastes and organic matter. The first-generation of biofuels are directly produced from crops or agrofuels, vegetable oils for biodiesels (excluding

palm oil in France and a few other European countries); sugar crops (sugar-beet and sugar-cane) and cereals (wheat, maize) for the production of bioethanol. These agrofuels make up 90% of the market in France. The second-generation biofuels are derived from organic materials, called "residual" or "not for food": used oils, animal fats, livestock effluents, wood cellulose, straw and winemaking residues. There is also a third generation derived from microalgae or from sewage, residual muds from wastewater treatment plants. All these biofuels represent a minor part of the energy mix, but there are promising prospects for their development, especially in air transport.

The European Union has the objective of using 14% of renewable sources of energy in transport activities; since 2015, the reliance on biofuels cannot be above 7% of the energy mix. Nevertheless, a favourable fiscal policy tends to support them. In 2020, the French motor-cars and trucks have consumed 2.9 billion litres of biodiesel and 1.1 billion litres of bioethanol, out of a total 47 billion litres consumed globally. *Ca*. 800,000 hectares are cultivated with crops used to produce agrofuels in France, i.e. 3% of the useful agricultural area. At the global level, the production of agrofuels is growing rapidly: 14% of vegetable oils produced in the world are the source of agrofuels, with a high growth rate in the United States. In 2015, 20% of soybean oil produced in the United States was converted into biodiesel; in 2021, this proportion amounted to 46%. Indonesia has the objective of incorporating 30% of palm oil into agrofuels and, by the end of April 2022, it has put in place a system forbidding the exports of palm oil.

By mid-June 2022, 38 scientists have sent an open letter to the European Parliament requesting the review of the European objectives regarding bioenergy. The proposed legislation (in the package on climate "Fit for 55", aimed at reducing by 55% the GEG emissions in 2030) would entail the increase in deforestation provoked by the high demand for tropical agricultural lands in order to meet the food and wood needs. All the areas devoted to the production of ethanol or biodiesel are surfaces withdrawn from food-crop cultivation. They also have a negative impact on biodiversity or on carbon sinks. Biofuels are considered carbon neutral in official texts, while they are not, indicated Wolfgang Cramer, a research director at the Mediterranean Institute for Biodiversity and Marine and Continental Ecology, who co-

signed the open letter to the European Parliament. However, the production chain overstates the advantages in the carbon balance: the production of biodiesel from rapeseed oil would produce 60% less GEGs than fossil fuels, while bioethanol would reduce by 70% the CO_2 "bill" or emissions. These figures are incomplete, according to the scientists, because the changes in the use of lands are not taken into account. "When a plot of land, initially cultivated to produce food crops, is planted with fuel crops, food agriculture would probably be displaced to forests, woodlands, prairies and other natural ecosystems; and that would be a source of GEG emissions. When this is taken into account, the balance sheet of agrofuels in terms of environmental impact is less favourable," stated the NGO Réseau Action Climat (RAC). In 2015, a study by the European Commission has integrated this change in land use and concluded that the production of biodiesels, whatever their source (rapeseed, soybean or palm oil), leads to more GEG emissions than fossil fuels. Also in this regard, the associations Canopée and Friends of the Earth have calculated that the incorporation of 7% of biofuels into the energy mix would result in a 3.5% rise of CO_2 emissions in the transport sector.

Would biofuels compete with food production? While food prices are soaring, jeopardizing the food security of many developing countries that depend on foodstuff imports, agrofuels are often considered as competitors of food crops. A researcher at Princeton University and specialist of biofuels, Timothy Searchinger, has calculated that if in the United States and Europe the reliance on agrofuels were to be halved, this would result in avoiding the imports of cereals and vegetable oils from Ukraine. The American scientist was particularly concerned by the higher reliance on bioenergy as foreseen in the legislative package "Fit for 55". According to its own estimates, the European Commission would devote one-fifth of European agricultural land to bioenergy production. This possibility should be discussed in a social debate, because it may mean that Europe would have to decrease its food production and import more foodstuffs, added T. Searchinger. However, in international organizations, the relevance of agrofuels in the context of the present agrifood crisis is not debated at all. For instance, the issue was not raised in the declaration of the G7 group on food security (28th of June 2022), nor in the last communication releases of the World Trade Organization (WTO) regarding the present difficulties of food production and supply. Those who

support biofuel production claim that there is no competition between the two chains of production. For instance, the Avril group – the main producer of biodiesel in France – stated it has abandoned the incorporation of sunflower oil in biodiesel since the war in Ukraine, devoting the release of agricultural land to human food production. Its biodiesel is now manufactured with rapeseed oil. The industrial group underlines that both food and agrofuels can be produced at the same time. For instance, in the case of rapeseed, the extracted oil is used in agrofuel production, while the seeds are transformed into a feed for livestock. The industrial group imports large volumes of rapeseed mainly from Australia and Canada – 47% of its needs in 2021.

What is the impact of biofuel production on biodiversity?

Some experts think that biofuel production promotes a non-sustainable agriculture, at the expense of water resources and of a suitable ecological transition. The crops involved, namely sugar-beet, wheat and rapeseed, need large quantities of pesticides, including neonicotinoids with persistent neurotoxic effect, that are granted an exemption in the case of sugar-beet cultivation. Another comment is that if we use sunflower or rapeseed oils to produce agrofuels, the relevant volumes cannot be integrated into the agrifood industry, that will likely use palm oil, considered as the main deforestation factor in the tropics. Regarding other sources of biofuels, like used cooking oils, the idea may seem interesting but the collected volumes are not significant. China has seized an opportunity to export used oils to Europe at a good price; but this income had to be compensated by the import of more palm oil, the least expensive on the international market. This being said, can we do away with biofuels? At the beginning of June 2022, the former director-general of the United Nations Food and Agriculture Organization (FAO), José Graziano da Silva, recalled in an interview with the French daily newspaper *Le Monde*, that agrofuels have been initially promoted as a solution in periods of abundant cereal crops, but not as a permanent solution – especially when the markets are overstressed. Some countries seem willing to change their mind, but at international level the debate on agrofuels is difficult. After the war in Ukraine and the forced embargo on the exports of cereals and other food crops, some members of the European Parliament suggested the setting up of a temporary suspension (moratorium) of agrofuel production, when

foodstuff prices rise above a certain threshold. Many feel nevertheless that the first-generation agrofuels should be progressively eliminated, when the thermodynamic engine will be gradually replaced by the electric motor, as programmed by the European Commission around 2035. Using wood as a fuel is a way to respond to the present energy crisis, especially by the lower and middle-class social categories. However, if we harvest more wood, we decrease the carbon sinks. We must therefore anticipate and promote the various forms of sustainable sources of energy. To sum up this debate, there is a principle that must be recalled: "First, we feed humans, then livestock, and when there is a surplus of agricultural products we can fill the tanks of motor-cars."

In Germany, there is a dilemma on agricultural land use: to what extent agricultural land should be devoted to biofuel production? In 2021, a volume of 3.4 billion litres of biodiesel were used to fuel cars and trucks, in addition to the usual diesel produced from oil, as well as 1.5 billion tons of bioethanol, produced from cereals, sugar-beet or maize, 90% of which is imported. By mid-2022, this controversial issue has been raised again : should the regulation concerning biofuel production be changed, so as to dedicate more land to food production, when food prices are soaring? For the ecologists, the answer is obvious, because they consider that the production of biofuels from food and/or feed crops is an error in the allocation of resources. However, in the early 2000s, these biofuels have been considered a good prospect, even by the ecologists ("The Green"), in order to reduce the carbon imprint of road transport and decrease the dependence on oil-producing countries. But progressively the support for this type of fuels has been less relevant and the criticisms about their impact on biodiversity prevailed. In 2023, the use of palm oil as a biofuel should be forbidden. In May 2022, the German environment minister, an ecologist, made a very clear statement: "Food should be in a plate and not in a tank". Even when certified, she estimated that biofuels could contribute indirectly to land clearing or to the intensive use of soils. Also their ecological balance was questioned: officially 13 million tons of CO_2 are spared each year in Germany thanks to the use of biofuel. But this figure does not take into account their negative indirect impact on ecosystems, such as marshes and swamps, forests and woodlands. This position was supported by the agriculture minister, also an ecologist. In 2023, the goal is to reduce by

30% the proportion of agrofuels used for transport. In 2030, no agrofuel will be used for this purpose. This objective would entail the reallocation of 4.2 million tons of foodstuffs and feed – 1.1 millions hectares of agricultural land in 2023. This objective is rejected by the biofuel producers, who question the calculations on which it has been based. Furthermore, they warn that such an objective contradicts another one promoted by the government on the energy autonomy of the country. The implications of the foreseen reform are very important: if adopted, the project would mean the replacement of agrofuels by conventional hydrocarbons, when Germany wants to get rid of Russian oil and when inflation rate is at its top level in fifty years. According to the transport ministry, the project would have an impact on the reduction of GEG emissions in this sector. Another issue is at stake: the threatening of a whole complex industry developed during recent years. To sum up, the industrialists defend the present regulation, i.e. that biomass represents 4.4% of the whole energy mix in the transport sector. They underline that the crops used to produce agrofuels are not aimed to replace food production and that their retreatment allows the production of derived compounds, such as glycerol used in disinfectant or toothpaste manufacture, or rapeseed meal. Moreover, the present legislation imposes a fine of €600 per ton of CO_2 emitted, and this makes agrofuels more attractive. At the environment ministry, the reform would induce the development of more advanced technologies on synthetic biofuels (called e-fuels) or on biofuels derived from wastes, as long as thermodynamic engines exist.

In France, the motor-car drivers find very attractive the advantageous price of superethanol E85 – €0.90 the litre. This agrofuel contains between 65% and 85% of bioethanol, derived to a large extent (90%) from sugar-beet, maize and wheat. The proportion of superethanol E85 has risen from 3.5% of the petrol market before October 2021 to more than 6% since March 2022. Between January and May 2022, 48,000 conversion boxes have been put in place in the motor-cars – a record figure in four months – and the total figure of these conversion boxes rose to 183,000 units – a 35% rise. Similarly, the number of "flexfuel" cars, using E85 almost exclusively, has soared in 2022, and particularly since March. The American car manufacturer Ford has the lion share, because it is the only one to bet on superethanol in France, where it has marketed five flexfuel models. In the case of heavy vehicles, the equivalent

of E85 is the B100, a biodiesel derived from vegetable oils (rapeseed, soybean and palm oil). On the 21st of June 2022, Flixbus, the leader of long-distance transport, has inaugurated the first line with vehicles using B100, between Paris and Grand Champ (south Brettany). At the beginning of 2022, Colas – a large public-work company – has signed a partnership with Saipol – the main French producer of B100 – with a view to fuelling its truck fleet. The National Railway Company (SNCF) is beginning to use B100 in some of its locomotive engines.

Another option exists for diesel engines: the HVO fuels (hydrotreated vegetable oils). These are secondary products of oil refineries (Total and the Finnish refinery Neste), or they are transformed from used vegetable oils (for instance, fry cooking oil) or from animal fats. These refined oils are also a major source of renewable fuels for the aircraft industry. In 2021, Air France flew an aircraft (Airbus A350) supplied with a biofuel containing 16% of this biokerosene. But the European aircraft industry recognizes that these biofuels derived from biomass are not the perfect solution, because they could not meet the needs of air transport. Airbus seems to have more confidence in synthetic biofuels derived from hydrogen and CO_2 sequestration. This policy has been supported by the European Parliament that excluded most biofuels in air transport and decided to give priority to the use of sustainable synthetic fuels – an 8.5% proportion in 2050. Regarding river and maritime transport, there seems to be a priority for the use of biogas – i.e. methane derived from the anaerobic fermentation of agricultural wastes and other types of wastes, muds from waste-water treatment, etc. The ship owners have chosen biogas to drive their engines because it is less "dirty" than the old diesel engines. The transition from fossil methane to renewable methane is already on the track: the French and international leading maritime transport company, the Compagnie maritime d'affrètement-Compagnie générale maritime, already owns twenty ships named "e-methane ready" and its prospects for 2024 is to rise this number up to 44. It should be mentioned that the use of biogas might also be applicable to heavy trucks, the fleets of public transport or the trucks that collect wastes. This would be a transitional source of energy before moving to the use of electricity or "green" hydrogen.

The use of biofuels is soaring in France because they are attractive to most people, despite the criticisms of environmental associations. The government grants a tax advantage to biofuels: the domestic consumption tax on energy products is €0.12 per litre compared with €0.66 in the case of SP95 E10 and €0.59 for B7 diesel; henceforth, a significant decrease in the value added tax (VAT). Moreover, in April 2022, the public administration has granted a Crit'Air label to heavy trucks using exclusively biodiesel B100. Biogas and bioethanol are promoted in some regions of France because they are the outlets of local productions and industrial activities. For instance, since the 1st of July 2022, the Ile-de-France region – the largest French region that includes Paris – has granted a €500 subsidy to each car using a bioethanol engine instead of the conventional thermodynamic engine. In 2021, the Grand-Est region – a vast eastern region that produces sugar-beet – has carried out a promotion campaign concerning "1,000 ethanol-powered engines for €1 each" that has met with a very big success.

Changes required

In March 2023, a number of French local and regional authorities have stated that in France and Europe as well, the reports or reviews on agriculture changes were alarming. In the European Union, the number of farms has fallen down to 32% between 2003 and 2016. In 2040, this decrease would reach 62% compared with 2016, according to the Research Committee of the European Commission on the Future of European Agriculture. In France, for instance, 100,000 farms have disappeared between 2010 and 2020. At the same time, the prospective studies come to the same conclusion: for instance, the French General Council for Food, Agriculture and Rural Space, as well as the General Inspection for the Environment and Sustainable Development have stated that the capacity of agriculture adaptation to climate change should move beyond the production of goods and provide several environmental services. For instance, provide carbon sinks thanks to the increase in biological diversity; water reservoirs in order to mitigate droughts and floods; drastic reduction of external inputs (fertilizers, phytosanitary products, etc.) and better reaction to their risks of supply; development of good practices for animal health-care and mitigation of the risks of epizootic diseases.

European law was elaborated at a time when the challenge was to build a competitive interior market. Nowadays, it is important to add two other components: a true ecological transition and food sovereignty, which entails sustainable and local production systems. These French authorities insist on the need to have a legal framework consistent with the national and European strategies : “From farm to Fork” strategy, Common Agricultural Policy (CAP), directives on the public calls, pact of agriculture future, European act on sustainable food systems and directive on the future of soils. All these measures should support a local agricultural and food model – a more resilient national, European and global model.

These French authorities have launched an appeal to their country and European Union with a view to introducing specific clauses or stipulations regarding food purchases, using a “food and agriculture exception”, similar to the cultural exception, part of the UNESCO convention on the protection and promotion of the diversity of cultural expressions. Food and agriculture exception includes measures for environmental transition, the protection of farmers and meal quality. In a nutshell, this means a transition between an imposed interdependence to a chosen interdependence.

PART THREE
THE ENERGY CRISIS

In 2021-2022, Western Europe was progressively deprived of the supply of Russian gas, in retaliation to the sanctions imposed on Russia by the countries belonging to the North Atlantic Treaty Organization (NATO) and following the invasion of Ukraine by Russia. On the 5th of September 2022, the Kremlin explained that the supply of Russian gas through the pipeline Nord Stream 1 to Europe would not completely flow again unless the "collective West" will lift all the sanctions imposed on Russia. Nord stream 1 was the main supply route to Germany from Saint Petersburg through the Baltic Sea. Gas transport was initially suspended on the 31st of August 2022 due to a "programmed maintainance" that was expected to last three days. But on the 3rd of September 2022, the Russian public conglomerate Gazprom announced a complete suspension of gas deliveries, due to another serious maintainance problem. Germany, which has been heavily depending on the cheap Russian gas for many years, has been strongly hurt. The other European countries had to face this energy shock: the Russian decision has provoked a high rise in the gas cost. On the 5th of September 2022, the European reference price, called the Dutch TTF, was around €242 the megaWatthour (MWh), and thereafter it rose 13%, whereas, one year ago, this cost was around €28 the MWh. European stock-exchanges have been oriented towards the fall, because they feared that the soaring prices of gas and energy may worsen the risks of a major economic crisis in the Euro zone. According to experts of the gas supply, that was the "worst scenario", with a scarcity of deliveries and soaring prices of energy for the companies and households.

The Gas-supply crisis

In the medium term, the strategic objective of the Russian authorities has been to demonstrate that without the Russian gas Europe will not be able to guarantee its energy supplies, to protect the consumers from an unbearable rise in energy prices and to even miss the objectives regarding climate change and global warming. But the Kremlin was not mentioning what to do with the gas previously sold to Europe. In fact, part of it was burnt – an environmental and economic disaster. Russia has not enough storage capacity and cannot reorient its gas towards other destinations through the pipelines running exclusively to Europe. The very firm decision made by the Russian authorities versus the European Union occurred when they realized the magnitude of the

domestic economic crisis. On the other hand, the Organization of Petroleum Exporting Countries (OPEC) has decided, on Monday the 5th of September 2022, to slightly reduce its global oil production – the first decrease in a year. The representatives of the 13 OPEC countries, in concertation with ten other countries led by Russia, have announced that they will decrease their oil production – *ca*. 100,000 barrels a day. The cartel feared that the risks of a world economic recession would decrease the price of the oil barrel, which was at that time rather high – *ca*. US$95 the barrel. This announcement was not welcomed by the United States that was defending a reverse policy.

Despite the economic sanctions imposed by the European Union and the United States, the experts of the Center for Research on Energy and Clean Air have mentioned in their report published on Monday the 5th of September 2022 that Russia has pocketed €158 billion during the first half of the year since the invasion of Ukraine thanks to its hydrocarbon (oil and gas) exports, the European Union being the major client. At this stage, one of the main authors of the report indicated that at least €43 billion have been recovered in Russia's coffers – in 2021, Russia's federal budget has been estimated at €230 billion – thanks to taxes and custom duties, since the beginning of the war. These revenues were higher than Russian military expenses estimated at €100 billion, while the destruction of Ukrainian infrastructures has been evaluated at €110 billion. The reason of this extraordinary income was the soaring prices of gas, particularly on the European markets. The fear of a cut-off of gas supply has fuelled an enormous rise of prices, the wholesale cost having more than trebled compared with 2021. In July-August 2022, the exported volumes fell down 25% compared with the same period in 2021, while the revenues rose 30%. The revenues have not changed, despite the strong diminution in the exports. During the first half of 2022, the European Union was still the largest importer of Russian fossil fuels (estimated at €85 billion), ahead of China, Turkey and India. In the European Union, Germany was the largest importer of Russian gas, followed by the Netherlands, Italy, Poland and France – its imports value has been estimated at €5.5 billion. Thereafter, the imports by the European Union have decreased markedly. The revenues from Russian exported gas (through pipelines) have fallen down 56%, while those of coal and liquefied natural gas have plummeted by 29% and 15%, respectively. The only exception was oil: the European Union

embargo having been postponed to the 5th of December 2022, Russia has been able to increase its sales (+19%) thanks to new outlets, such as China and India, United Arab Emirates or even Egypt. To sum up, in July-August 2022, China has replaced Germany as the first importer of fossil fuels from Russia; during this period, German imports have plummeted by 17% while those of China rose at the same rate.

The European Union had to find other gas suppliers, such as Algeria, Qatar and even the United States, and to design mechanisms for the protection of consumers against an unbearable rise of energy cost. Qatar is one of the main global gas producers, with Australia and the United Sates. The three countries export 60% of the gas in the world. During the first 10 months of 2022, Qatar has supplied 16% of the European Union's liquefied natural gas (LNG); it has been its second supplier after the United States and ahead of Russia. Despite the uproar created by the corruption scandal involving Qatar and the European Parliament, several European countries have shown their deep interest in the gas supplies by the emirate. Several heads of State and governments, including the French president and the German Chancellor, and the president of the European Council as well, have visited Qatar, with a view to signing several contracts of LNG supply – LNG makes up almost 40% of European gas imports, compared with 22% one year earlier. While some countries have been reluctant to sign long-term agreements, in November 2022, the German Chancellor has concluded with Qatar Energy a 15-year agreement for the supply of gas, as well as with the American company ConocoPhillips. In October 2022, Qatar Energy confirmed it has been in formal discussion with the Lebanese government in order to take a 30% participation in an offshore gas area, while negotiating on the same subject with the French multinational TotalEnergies and the Italian company ENI. A few months earlier Qatar Energy has built a partnership with both multinationals in order to develop the largest natural gas deposit in the world, called North Field South. Qatar has also the ambition to increase its LNG production and reach 126 million tons a year in 2027. Regarding the United States, during the first 10 months of 2022, its exports to the European Union have jumped 43% compared with 29% in 2021. It is worth noting that Qatar cannot more extend its exports of gas to Europe, because it has signed long-term contracts with Asian countries, such as China, Japan and South Korea. For instance, Qatar has signed an

agreement with China – on the 21th of November 2022 – concerning the supply of 4 million tons of gas a year during 27 years. This was the longest contract ever signed in the history of gas exports.

Refill the gas stocks in 2023 : **a great challenge for the European Union**

Fatih Birol, director-general of the International Energy Agency (IEA), stated on the 6th of October 2022 in an interview with the French daily newspaper *Le Monde* that the world has never known an energy crisis of this magnitude and complexity. He calls on the strong cooperation among European countries and with the emerging economies. He is not of the opinion that the constant increase in oil-and-gas prices is the right way to follow. Oil and gas producers will have to think about the implications of steadily rising energy prices, that may lead to an economic recession affecting more the emerging countries than the developed economies. He recalled that for the first time, in 20 years, the number of people that have no access to electricity will increase again in 2022 : 20 more million people will be added. A few days after the invasion of Ukraine, the IEA has proposed a plan aimed at counteracting the reduction in the supply of Russian gas and being ready for the winter. For instance, the IEA suggested to lower the temperature of central heating by 2°C, to shorten the delays of authorizing the use of sources of renewable energy, and to postpone the exit from nuclear energy production in some countries. This advice has been followed by most countries. At the moment of the interview with F. Birol, almost 90% of European gas stocks have been refilled. Europe could therefore resist the 2023 wintertime, if the latter is not too cold and long or if unexpected events occurred like the sabotage of a gas pipeline. He explained that the gas stocks were replenished at almost 90%, because Europe still receives small volumes of Russian gas and China – the world leader of imported liquefied natural gas (LNG) – has imported 20% less than the usual volumes since the beginning of the war in Ukraine. However, in February 2023, the stock replenishment would reach *ca*. 25% only. In 2023, the supply of Russian gas will be cut off and China will import more volumes of LNG. It seems that there will not be many LNG inputs to the market, and it will be a great challenge to refill almost completely the stocks between February 2023 and the 2023-2024 wintertime. To meet such a great challenge, European countries must engage in a wide-ranging cooperation, e.g. close

a petrochemical factory and send the spared energy to heat a hospital. By contrast, another scenario would be that each country privileges its own interests, and a possible conflict may happen. Solidarity between its Member States is one of the main pillars of the European Union, and its absence or deficiency may become a high risk for the political existence of the Union.

Is there also a risk of global fracture? F. Birol recalled that in August 2022 with a temperature of 52°C and when Pakistan needed liquefied natural gas (LNG), to be used for electricity production and air conditioning, a methane-ship bound to this country was finally rerouted to Europe, because the European Union was paying much more for its shipment. The result was electricity breakdowns in Pakistan. According to F. Birol, there were many similar examples. Emerging countries have difficulty to understand who is responsible for the present energy crisis: Is it the West or Russia? This situation may lead to a geopolitical fracture – between the Western countries and emerging ones, and that may be a very dangerous situation. However, this energy crisis could be an accelerator of the transition to clean sources of energy – many governments have approved or pledged huge amounts of money for such a purpose. For instance, the United States, through the *Inflation Reduction Act*, will allow a budget of US$400 billion that include allotments for building electric motor-cars, producing hydrogen, installing new nuclear plants and facilitating carbon sequestration and storage. Europe has set up the programme called *RePower Europe*, presented in May 2022 and allocating large amounts of money. Such "green" transformation is also ongoing in Japan. LNG cannot replace all the gas consumed in Europe, and in parallel there is a record increase in fostering renewable sources of energy in 2022. It is true that China and India are building coal-powered-plants, but much less than before. Many of them may not be utilized, because solar energy is becoming the cheapest source of electricity production in 80% of the regions of the Planet. F. Birol considers that CO_2 emissions will increase, but that trend will not last too long. The trend of GEG emissions will be, in the long term, less than we have predicted. But to what extent the global warming will be equal to +1.5°C is another issue, stated F. Birol. Nowadays, governments are not just making long speeches or forecasting objectives, they approve more than significant budgets and put money on the table. F. Birol is therefore optimistic that the present energy crisis may be a turning point in

the history of energy, the impact of which will become obvious in a few years, probably as of 2025-2030. It is indeed a very optimistic view compared with many others, as mentioned in the first part of the book about the environment crisis. The opinions of many experts and UN agencies have been underlining that the objective of +1.5°C for global warming will be difficult to achieve, unless decisions are made *now* with a view to drastically and sustainably reducing GEG emissions across the world.

The global rush for liquefied natural gas (LNG)

Since the beginning of the war in Ukraine, the European Union – which had to cut the supply of natural gas from Russia – has increased by *ca*. 60% its imports of LNG from the United States. This is the beginning of a world battle for LNG. Historically speaking, Europe has supplied LNG to Japan after the Fukushima nuclear catastrophe and has used instead the Russian natural gas. In 2023, Europe has been able to refill its gas tanks, partly thanks to LNG rerouted from its Asian destination and paid at an expensive price; this rerouting caused some black-outs in several countries such as India and Pakistan. Anticipating the 2023 winter, Asian countries will have to reconstitute their stocks of gas and that would make international competition quite harsh. For instance, South Korea where the law demands that the gas storage capacity reaches at least 90% of the tank volumes, will certainly import more LNG. Japan has anticipated the change and has refilled its tanks above 50% of their capacity over the last five years. China's behaviour is considered a global challenge: would it import more LNG, depending on the winter temperature as well as on the impact of the Covid-19 pandemic on industrial activity; depending also on opening up new coal-fuelled plants. China may decide to use more coal and at the same time buy gas from Central Asia and Russia. When the United States increase their exports of LNG, China takes advantage of selling at very expensive prices back to Europe part of its LNG imports in the framework of long-term contracts. This source of supply enables Europe to respond to the lack of supply of Russian gas and to be relieved from the constraint regarding the use of gas pipelines. This new situation is leading to building infrastructures for the gas liquefaction, its transport and delivery. This LNG is often derived from shale gas, the production of which includes LNG emissions – the latter are 1.5 to 4 times more important than in natural gas

production. In Germany alone, which has bet on the imports of natural gas via pipelines, six projects of floating terminals are being built in order to receive, store and deliver LNG. In Spain, there are at least six LNG terminals and a seventh will be rehabilitated in the north of the country (Asturias). France has already four LNG terminals and a fifth one started to function in 2023 in the harbour of Le Havre (on The Channel, northwest of the country). Since mid-October 2022, France can supply LNG to Germany, which has no import terminals, up to 100 gigaWatthours per day – a power equivalent to that of four nuclear sections. One would wonder whether these new infrastructures would receive enough LNG to be fully effective. Up to now, LNG has been substituting, to a large extent, the supply of Russian gas. But to substitute the last 10% would not be easy because of Asian competitors and of the lack of additional production of LNG.

Some important projects, such as LNG Canada (Shell) or North Field East (Qatar), will become operational after 2024. A few new capacities will be provided by the floating factory Coral South of ENI (Italian conglomerate) in Mozambique, and also thanks to the British Petroleum (BP) Grand Tortue [Ahmeyim] in Mauritania and Senegal, as well as the ENI project in the Republic of Congo. But besides these small-sized projects, few additional production capacities will become available in 2023-2024. One also has to take account of potential hazards in the production chain, such as the fire that occurred in June 2022 in the Texas methane-terminal Freeport LNG – one of the most important LNG exporters to Europe. Other limiting factors are the lesser availability of "methane-ships", the increase in the costs of hiring these ships, while some ships that do not comply with environmental standards are withdrawn from the market.

LNG : from extraction to transport and delivery

The natural gas used to produce LNG is to a very large extent derived from the fracturation of shales, particularly in the United States, along with shale oil. This gas is transported via pipelines to the liquefaction unit where takes place the purification, the drying and isolation of heavy hydrocarbons, and then the refrigeration of the gas at -163°C. This liquefied gas is conveyed with a lot of care to storage tanks, inland or via a ship. The storage envelope is made of stainless steel and should be perfectly isolated from the outside environment.

The result is a neutral liquid, that does not smell and that occupies 600 times less volume than the same amount of gas. Therefore, after reaching its destination, the LNG is gradually regasified in a specialized unit, more simple and fitted with heat exchangers. A liquefaction unit costs several US$ billions, the process is complex and consumes almost 10% of the gas to be liquefied, CO_2 emissions being two or three times more important than using a normal gas pipeline. The LNG has become since 2022 the star of the new energy pattern. It has an advantage over the transport via a gas pipeline : its flexibility. In the middle of the Indian Ocean, a methane-ship can be rerouted from its destination, Tokyo, to Rotterdam in the Netherlands. This is what happens nowadays. Gas, like oil, becomes a world commodity whose transport can be adapted to the needs of the buyers and whose price depends on the demand. Oil companies have therefore massively invested in this sector. This is in fact the same rationale when one compares the transport of freight via the railway network, rather cheap and with less CO_2 emissions, but very rigid and massive, with the transport via trucks, more costly, but delivering the gas at a precise address. In our present world – risky and uncertain – flexibility has a price.

In 2021, there were 641 of these "methane-ships" across the world, including 216 being built between 2021 and 2022. It is worth mentioning that 76% of the methane-ships ordered in 2022 will be built in South-Korean shipyards. Once a methane-ship arrives at its destination, LNG is transformed in gas to be transported through pipelines. There are two kinds of terminals for the ships: the land ones and the floating units. A land-terminal construction costs *ca*. €1 billion in 2022 and the time of building amounts to three to five years. The floating unit, which is often a storage and gasification factory, is less expensive: €250 million, and 12 to 24 months for its construction in 2022. LNG can remain in liquid form and transported via truck-tanks, barges or railway. In 2021, the main exporters of LNG were, in billion m^3 : Australia (108.1), Qatar (106.8), United States (95), Russia (39.6) and Indonesia (33.5). The United States, since the exploitation of oil shales, has become the first hydrocarbon producer ahead of Saudi Arabia and Russia. In 2016, the first LNG factory started to export and terminals to that effect have since then been multiplied in the Gulf of Mexico. Second-biggest world exporter of LNG behind Australia, Qatar delivers LNG mainly to Asian countries in the

framework of long-term contracts – an approach which European countries have been for a long time reluctant to adopt. A good fortune for Algeria: first gas exporter (16.1 billion m^3) in Africa in 2021, the country supplies gas to Europe via pipelines. By the end of 2021, due to the diplomatic breakdown between Morocco and Algeria, the latter has cut the gas pipeline that crosses Morocco. The development of LNG would allow Algeria – fourth gas supplier to Europe – to depend much less on its neighbours. Africa's potential gas production draws the attention of the Europeans who have to overcome the obstacles of insecurity – piracy acts in the Niger Delta (Nigeria 23.3 billion m^3 in 2021) – OIS attacks in Mozambique and the Sahel, as well as competition – e.g. the new offshore gas deposits in Senegal (2.5 million tons of LNG expected at the end of 2023) and to a large extent sold to Asian customers. In 2022, Asia represented 75% of the world demand of LNG. China is the leading importer of LNG (109.5 billion m^3 in 2021). During the first term of 2022, China has resold to European States 4 million tons of LNG coming from the United States or Africa, but Beijing may decide to keep at home the quantities of imported LNG in order to respond to an increase in gas consumption during the winter. This would create more competition on the LNG market. India imports 33.6 billion m^3, Japan 101.3 billion m^3, South Korea 64.1 billion m^3 and Taiwan 26.8 billion m^3 of LNG. In Europe, the imports of LNG have increased by 60% during the first half of 2022, outpacing those of Russian gas. However, Eastern Europe having little or no access to the sea is still dependent on the Russian gas. By contrast Germany has access to the sea, but has no regasification factory. Spain has six LNG terminals but not enough pipelines to convey the gas to the rest of the European Union. In 2021, the imports of LNG were, in billion m^3, as follows : 30.8 from the United States, 22.5 from Qatar, 18.4 from Algeria, 17.4 from Russia and 13 from Nigeria.

LNG exports : *the leading role of the United States with some drawbacks*

In Texas, by the fall of 2022, the price of natural gas was *ca*. US$8.50, the million of British Thermal Units (BTU, the unit that measures the gas energy content). This price has doubled in a year, but it has nothing to do with the price on the European market, due to the cut off of Russian-gas supply : on the Amsterdam market, this cost was US$64 the million BTU, i.e. eight times higher than in the United States (and eight times more than during the

previous years). The American LNG producers have therefore realized their good fortune : buy gas at the American price and sell it in Europe at the European market price. Thus, since the beginning of the war in Ukraine, on the 24th of February 2022, the American LNG producers started to supply the old continent, exporting their gas from the ports of Texas and Louisiana. During the first half of 2022, 70% of American exports have gone to Europe, compared with one-third in 2021. This supply represented about half of the European imports (compared with 15% for the imports from Qatar and 14% from Russia). The US President, Joe Biden, has supported this drastic change during a meeting he had with Ursula von der Leyen, president of the European Commission. Although American exports of LNG have increased, they rose only 20% according to the American Energy Information Agency. The help provided to the Europeans was in fact a problem of communicating recipients, because the Asian customers have reduced their LNG imports – China consumes less gas due to the closing down of part of its industry following the Covid-19 pandemic – and because the BTU price was lower (it was *ca*. US$50 in Tokyo and Seoul). In the United States, the LNG market is dominated by the company Cheniere that owns terminals in the Gulf of Mexico. Its value at the Stock Exchange has doubled in a year, reaching US$43 billion – compared with US$130 billion for TotalEnergies and US$30 billion for Engie. A number of companies are striving to build new terminals that would not be operational before several years; this is the case of Tellurian, of which the value at the Stock Exchange has increased only by 15%, because there are uncertainties about how the gas market will look like in a few years from now. In the short term, American exports of LNG suffered from the fire that burst in June 2022 in the harbour of Freeport (Texas); this drawback will delay the resumption of production till November 2022. Another shortcoming is the lack of pipelines for the transport of natural gas produced in the east of the United States – Pennsylvania or West Virginia. A project of a gas pipeline to service Chesapeake Bay (Maryland) is still in the files. To sum up, the United States are the first leading exporter of LNG, but its exports make up only 11% of national gas production and they cannot be higher than 13% because of the present capacities.

The oil industrialists are reluctant to massively invest in LNG production, because they fear that their activity may be hindered by the regulations

regarding global warming and also because they had to face a decade of disastrous profitability. That was explained in July 2022 by Shawn Wenko, director of economic development at Williston, capital of North Dakota oil basin : "Investments only reach one-third of what is necessary to function at full speed. But you cannot invest in pipelines or refineries that may be closed down the day after." On 14 September 2022, Quantum Energy Partners – one of the major invertors in this sector – has confirmed this opinion in the *Financial Times* : "One should not believe that the United States can pump out much more. Our production is what it is. There will not be any bail out (refloating) neither in gas nor in oil." However, gas consumption would rise 3% in 2022, which worries political authorities, as shown in a letter addressed by the State of New England to the energy secretary, Jennifer Granholm, and revealed by *the Financial Times*: "We appreciate the efforts made by J. Biden' administration with a view to increasing oil exports to Europe. A similar effort should be done for New England." They in fact requested the security of LNG supply to their States. The latter generally receive this supply in wintertime via the port of Boston, but the European demand may reroute this flow. This possibility is compounded by a protectionist law which the States' governors want to be loosened up: the ships which navigate along the ports without making a stopover abroad should have an American pavilion and a crew of the same nationality; this is not the case of many methane-carrying ships. Fortunately, oil prices have fallen by the end of 2022, and the gallon (3.8 litres) of petrol has fallen from US$5 by mid-June 2022 down to US$3.70 by mid-September 2022. It seems that the beginning of 2023 will be a period of stabilization of gas prices and even a slight decrease in oil and gas costs.

Other unexpected actors in the gas market : *example of Senegal*

Senegal's gas offshore deposits are coveted: these deposits, shared with Mauritania along their coasts, are expected to produce 2.5 million tons of LNG per year as of 2023, thereafter 10 million tons in 2030. The Senegal's President Macky Sall has given this information during a summit on hydrocarbons, organized in Dakar on the 1st and 2nd of September 2022. A total of 500 billion m^3 of gas have been discovered in the deposit of the Grand Tortue Ahmeyim (TGA) near the border with Mauritania. Phase 1 of this project carried out by the two national hydrocarbon companies in partnership with the British

BP and the American Kosmos Energy, has been implemented at more than 82% at the end of July 2022. Out of four, three wells have been drilled; the submarine conduits aimed at connecting the various offshore platforms have been installed and the billowbreak protecting the gas-liquefaction unit has been constructed. In 2023, tests will be carried out with a view to making effective LNG production by the end of the year. Initially, the first deliveries have been oriented towards the Asian markets, because the European market was supplied by the Russian gas. But the war in Ukraine has changed the situation and new markets become accessible to the Senegalese LNG. For instance, Germany will be supplied as of July 2024. This country would be ready to pay the gas three times higher than the prices proposed by BP in 2018, but discussions are taking place in order to re-evaluate the purchasing contract. Italy, Portugal and the Czech Republic have shown their interest in phases 2 and 3 of the exploitation and wanted to be supplied in due course. Furthermore, Poland's president visited officially Senegal on the 8th of September 2022 and he stated the projects of cooperation with Senegal were very promising, like the LNG delivery to his country in a near future.

While Europe in negotiating with other LNG-producing countries, such as the United States, Australia, Canada and Qatar, Senegal highlights its advantages in terms of competition : its geographic position reduces the cost of transport via methane-carrier ships; the duration of navigation to reach the European coasts is between four and five days only, compared to more than 12 days from the United states. The Old Continent has therefore rather to diversity its own supply sources and to negotiate with friendly countries. In the meantime, Senegal must focus on its priority regarding the funding of the forthcoming phases of the project. According to President Macky Sall, US$5 billion of additional funds must be raised. Disregarding the decision made at the COP26 in Glasgow by the industrialized countries to stop any funding abroad of fossil sources of energy by the end of 2022, Senegal's head of State makes a strong and reiterated plea for African gas, as well as for a "just and fair energy transition" – when half of Africa's population has not yet access to electricity. In the meantime, the European Parliament has approved a text that classifies natural gas as a "green" energy and also as a "transition" energy. This decision gives some hope to Senegal, but President Macky Sall has called for more vigilance, because, he stated, when the situation becomes

normal with Russia, the debate on the gas will come back and it might not be financed because it will be considered as a factor of climate change and global warming. Some Senegalese economists think that the African market must be carefully monitored, when Egypt and South Africa may need LNG on the long term with a view to getting out of coal consumption.

The good fortune of South Korean shipyards

The shipyard, created in March 1972 by the founder of Hyundai, the second-biggest *chaebol* or industrial conglomerate of South Korea, Chung Ju-yung (1915-2001), is part of the Korea Shipbuilding & Offshore Engineering (KSOE). The latter builds all kinds of ships, from the big containers to oil tankers, and even warships. Due to the global LNG rush, the shipyard annually builds 13 to 14 methane-ships. Between 28 and 30 months are needed to build the models of ships weighing 174,000 tons, 180,000 or 216,000 tons. The 174,000-ton model is the most successful because it is easier to utilize. Those which are weighing more than 200,000 tons can have access to only some ports that have the technical facilities to accommodate them. Since 1994, the shipyard has built 87 methane-ships, and its order book is full till 2026. The success of HHI as well as of its local competitors – Daewoo Shipbuilding & Marine Engineering (DSME) and Samsung Heavy Industries (SHI) – is due to a know-how globally recognized. Between January and July 2022, the three industrial groups have received orders for 78 methane-ships – 76% of the new orders of this type of ship worldwide. And this in spite of their cost: in July 2022, the 174,000-ton model was worth €236 million. In the case of HHI, the revenue from the sales has been estimated at €4,3 billion in 2022, compared with €3.84 billion in 2021. The profits are not quite high, because of the rapid increase in the cost of steel.

Shipbuilding has been for a long time dominated by Japan, but South Korea has become the world leader at the beginning of the century. During the 2010s, China with its low-cost shipyards has climbed up the ladder like Japan and South Korea did before, and has become a world leader. South Korea's shipbuilding industry had to face a deep crisis, with the lay off of thousands of jobs. According to the Korea Offshore Shipbuilding Association, the number of workers has fallen down by 54% from 203,441 in 2014 to 92,687 in 2021. But the difficulties of supply following the Covid-19 pandemic have

triggered the need for more ships. At the same time, the demand for LNG has soared due to the war in Ukraine, and that was the good fortune of South Korean shipyards. They privileged the building of methane-ships, while Japan has been less involved in this sector and China suffered from its Zero-Covid policy imposed across the country. Furthermore, the South Koreans had a real technological advance and their competitivity has been growing. Their reputation was also based on the full compliance with the dates of ship deliveries. The new environmental demands or regulations have become a comparative advantage : the International Maritime Organization demands a 50% decrease in CO_2 emissions by the ships, compared with their volumes in 2008. With the support of the government, the shipyards are fitting out the ships under construction with units that use LNG as a heavy fuel; the latter is more polluting but cheaper, but it is the fuel burnt when the ships navigate in the high sea. South Korean researchers have been trying to use other fuels such as fuel cells, methanol or ammoniac – HIH is working on engines fuelled with ammoniac.

Success has also its drawbacks: the South Korean groups have some difficulty to rise their turnover, due to a lack of humanpower – the technicians laid off in the 1990s are not willing to come back to work. This situation even leads to conflicts between the industrial groups, some accusing others of attracting the available humanpower thanks to better wages.

Energy transition in the United States

While in 2022 at the Ceraweek, in Houston (Texas) – the Davos for oil and energy, organized by the financial group S&P Global, owner of the famous notation agency Standard & Poor's – the oil companies won the battle against the Democrat Administration fighting to decrease the cost of petrol (gasoline) and also to rescue the Europeans. Meanwhile, the US Congress adopted, during the summer of 2022, the *Inflation Reduction Act*, which allocates US$369 billion of all kinds of subsidies aimed at boosting the energy transition of the country (batteries, hydrogen, wind and solar energy, sequestration of carbon, thermic isolation of the buildings, electrical network, etc.). Both sides have been reconciliated. J. Biden's administration, however, requested the oil companies to produce enough oil so as to markedly decrease the price of petrol; otherwise this issue can become a presidential-election

issue. But America was again united to impose its energy transition, based on its enormous gas resources and its technological advance. The Europeans have been angry at the American subsidy-policies that attract their investors towards the United States and deprived them from economic competitivity. The Americans consider the Europeans as jealous and lacking consistency : after having denounced for many years the lack of action by the United States regarding the struggle against global warming, they now criticize the behaviour of the latter.

The United States – second-biggest producer of GEGs in the world – have reduced their emissions by more than 15% since 2005 and pretend to become the leader in energy transition, with an economy having the least carbon imprint across the whole Planet. That was the opinion of Chris Romer, co-founder of the Canary Project that measures CO_2 and methane emissions. In a year lapse, the balance has been tilted towards the American conditions, with an ideological readjustment. During ten years, we have accepted the storytelling of the ecologists and, now, we fight against them using their own terms, explained a specialist of LNG production. First change : energy security and cheap energy are considered as the *sine qua non* conditions for that transition. It is not anymore question to get out of hydrocarbons, but to reduce CO_2 emissions. The enemy of these big oil companies is coal, which in 2022 has been used at record levels across the world, particularly in China and India. The executive director and president of EXXON, Darren Woods – the world leading producer of oil – explained that every ton of LNG produced in the United States or elsewhere reduces the use of coal somewhere else across the globe. The Americans want to promote at the level of the Planet what they do at home, i.e. reducing in the lapse of 15 years the proportion of coal in electricity production, from 50% to 20%, closing down thanks to gas output the equivalent of the French nuclear park. Toby Rice, executive director and president of EQT – the first natural-gas producer in the Appalachian region – stated that the use of shale gas has contributed to the reduction in emissions two times more than the *Enerigiewende* – the German energy transition. He hopes to be able to export more LNG to get rid of coal across the world.

To this end, there is no question to disinvest in the hydrocarbon sector. Who could decarbonate the economy, if not the oil giant companies who recover

US$ billions of profits – in 2022, the world's first companies have earned US$200 billion. This is what stated John Kerry, President J. Biden's Special Envoy for Climate: according to the negotiator of the Paris Agreement, the main issue is "to find more and more money, and we cannot do it without the oil and gas industry", which produces 15% of GEG emissions. The United States policy aims to boost research and development, and the national companies are absolutely convinced that technology breakthroughs will allow to continue to use hydrocarbons. According to Katharina Beumelburg, in charge of strategy and sustainability at SLB, ex-Schlumberger, "the challenge of global warming can be met with the help of technologies"; and the latter are already there, but they should be made available. The three priorities are the elimination of methane leaks, the capture of CO_2 and the transformation of gas into hydrogen. Methane leaks – a very powerful greenhouse-effect gas – have been for a long time an American tradition, and in the majority of oil or gas wells methane is burnt in flare stacks. In 18 months, however, the valves of 9,000 wells have been replaced and methane emissions have been reduced by 70%. The Federal Agency for Environment Protection has proposed at the end of 2022 a series of regulations aimed at reducing by 87% these emissions in 2030, compared with the 2005 figures. The American companies do not talk anymore about "shale gas" or "hydraulic fracturation" – concepts very controversial in Europe – but talk of a technological change, developed 15 years ago and with a high performance. The second priority is the capture of CO_2, massively supported by the government. Sean Strawbride, in charge of the port of Corpus Christi (Texas), has launched experimental studies aimed at storing CO_2. The region around the port contains underground pockets that were drilled and are available to store CO_2 produced by the neighbouring refineries. This project is just experimental, some companies suggest pharaonic projects, such as Occidental Petroleum, which invests US$1 billion in a prototype factory located in the Permian Basin – the oil heart of Texas. It is a real challenge, stated Andy March, executive director of Plug Power – a hydrogen company – who quotes that in the past billions of dollars have been invested by BP without conclusive results. The third priority is the production of hydrogen, also massively subsidized. Its promoters quote the example of the cost of solar energy that has been divided by 100 in 20 years. The hydrogen company TES (Italian), which has opened a subsidiary in Houston,

aims to use solar energy in the production of hydrogen that will be mixed with CO_2 for its transport, thus limiting the leaks of hydrogen in the pipelines due to its very high volatility. However, the Americans are more concentrated on the production of hydrogen where electricity cannot be used: cement, steel, maritime and heavyweight transport. The port of Corpus Christi has launched a US$7-billion project in order to become a hydrogen "hub", with partnerships in the Permian Basin. The head of the project refuses to make a distinction between green hydrogen (from water electrolysis) and gray hydrogen (from natural gas) – a great divide among European producers.

Building energy infrastructures is a key factor in the production of clean and sustainable energy. The White House has admitted that the "red tape" about the authorizations for building these infrastructures is causing great delays and is a real bottleneck. For instance, the LNG exports from the port of Corpus Christi have risen only 4% in 2022, after a jump of 80% in 2021, due to the lengthy construction of the port terminals. Also there is a need for more pipelines; without them, it would be difficult to produce more gas (LNG). At the Ceraweek meeting, the emphasis has been laid on production, while the forecasts dealt with a consumption that would double in 30 years. Not a word on energy restraint that is nevertheless mentioned in the *Inflation Reduction Act*. However, according to an executive of Schneider Electric, in charge of sustainability and based in Boston, "it is expected to talk about it". The impact on climate change and the environment has been slightly mentioned. One environment activist could dare to shout : "We must make an end to the fossil-energy era"; she also added that we must put an end to the "greenwashing" of oil companies. But this protest was far from being heard by the participants, which pursued their debate on the United States energy transition as they see it.

Energy crisis : **Europeans try to find appropriate solutions**

Since the beginning of the war in Ukraine, the Europeans knew they will have no more access – and this before long – to the cheap energy supplied by Russia; they were even worried that they could run short of natural gas. Till the summer of 2022 the 27 member States of the European Union have been obsessed to fill gas stocks, even if they had to buy it at a very high price, in order to spend the winter without the supply of Russian gas (see above).

Consequently, in many European capitals, the inflation of the megaWatthour has become a major concern. In this respect, there is a big divide. On the one hand, those in favour of the "laisser-faire" (non-interventionism), led by Germany, were concerned that fixing a ceiling price might provoke the departure of the suppliers and/or a higher consumption. On the other, several countries like Italy, that do not have the financial means of Germany for supporting the households' purchase capacity, are afraid from the economic and social implications of galloping inflation. But they are also aware they cannot run the risk to see Germany without gas, because of the interrelationships of their economies in the European Union. The debate is not over, but let us see what has been achieved in ten months. Regarding the consumption, the objective of reducing by 15% gas consumption, compared with the period preceding the war, has been achieved. In October-November 2022, the Europeans even went farther, with almost a 25% reduction in gas consumption. In the meantime, the European Union has diversified its suppliers: before the war, 40% of gas imports used to come from Russia; but in October 2022, Russian gas has been representing only 15% of the European Union gas imports. Only a few countries, landlocked like Hungary, were still receiving this gas. The imports from several countries, e.g. Norway, Qatar, Algeria and United States, in the form of LNG transported via methane-ships in the majority of cases, have substituted the Russian gas. Moreover the infrastructures have been improved markedly or even built from scratch, e.g. multiplication of the interconnections, construction of methane terminals with a view to transforming LNG into gas. All these actions do not really have a positive impact on the climate-change crisis and some experts think that by so doing we shall be relying on fossil fuels for another 15 years.

The winter of the year 2023 has been mild and the gas supply has been adequate. But that winter was only a preparation for the following one. The withdrawal of Russia has changed the state of affairs. There is not enough LNG for everybody across the world and the LNG purchased by the Europeans at a very high price is lacking in many poor countries, e.g. Pakistan or Bangladesh, and is the source of social tensions. At the end of December 2022, the stocks of the Europeans were full to the brim – beyond the 90% objective set up by themselves – with gas coming from Russia before Gazprom cut its supply, or elsewhere. In 2023, the volumes imported from Russia are expected to be very

low. The International Energy Agency (IEA) has estimated that the European Union would need 30 billion m^3 of gas in order to refill its stocks (90%). In this context, European countries want to negotiate long-term contracts – ten to fifteen years – with Norway and the United States with a counterpart : more reasonable prices (compared with the prices billed to the industries of these countries). To respond to emergency situations, the European governments have put in place assistance programmes aimed to help households and companies mitigate the soaring energy prices. In 2022, €600 billion have been spent to that end. Part of these expenses, which are not sustainable, could be absorbed by a tax on the exceptional profits made by oil and gas companies. The decision made by the 27 Member States of the European Union to impose this tax since the 1st of December 2022 result in the recovery of €140 billion per year. On the other hand, Germany has insisted on the need to increasingly reduce gas consumption, as the only way to tackle the problem.

Regarding the renewable sources of energy, the European Parliament, the Council and the Commission have reached an agreement on the 30th of March 2023 concerning a decision that is one of the pillars of the *European Green Deal*. This agreement was a kind of miracle, because the positions on the subject differ among Member States. After the decision made to stop in 2035 the manufacture of thermic engines for the motor-cars which Germany was about to derail, the negotiations were again challenged by the requests of France about the role of nuclear energy and hydrogen production. Finally, the new directive sets the objective to reach, in 2030, 42.5% of renewable sources of energy in the energy mix. In 2009, when the first directive on these energies had been adopted at the European level, the objective was 20% in 2030. This ambitious decision has been made necessary as a follow-up to the adoption of the European plan called *Fit for 55*, which foresees a 55% decrease in the GEG emissions in 2030. In 2021, 21% of the energy consumed in Europe has been produced from renewable sources of energy. The directive adopted at the end of March 2023 and called RED, mentions several sources of renewable energy, such as biomass, biofuels, as well as the acceleration of the procedures regarding the authorization of new installations of solar and wind energy. With respect to industry and transportation, one of the major issues is the gradual replacement of natural gas and methane by hydrogen (no CO_2 emissions). The revised directive indicates for each sector the objectives

concerning "renewable" hydrogen. On this subject the political debate has been quite harsh. France, supported by a dozen of Member States (including the Czech Republic, Romania or Finland), wanted an equal treatment between renewable hydrogen and "low-carbon" hydrogen, produced by nuclear-energy-produced electricity. One should be very cautious not to create a competitivity advantage of the United States, that equally subsidize renewable sources of energy and nuclear energy in their "green" plan of subsidies. Such proposal was not shared by another group of Member States, including Germany, Austria and Spain that are opposed to nuclear energy. These countries were worried by the fact of taking too much account of low-carbon hydrogen; the investments in renewable sources of energy might be slowed down. Under the presidency of Sweden, the new balance achieved foresees that the countries producing hydrogen from nuclear energy would reduce their renewable-hydrogen production by 20%, instead of 30% as requested by France. The EU Member States were supposed to formally approve this agreement.

The French position can be understood because France has the world's second-biggest nuclear park that is the main source of electricity. In 2021-2023, the company EDF (Electricité de France), in charge of the management of nuclear plants, has tried to speed up the maintenance problems of 32 plants out of a total of 56. In January 2023, only 12 plants were still in maintenance. According to the minister in charge of energy transition, another two or three plants will function normally in March 2023. Therefore, the French nuclear park could produce a total of 45 gigaWatts (GW), out of a theoretical capacity of 61 GW. In 2022, EDF nuclear-energy production had reached a very low level : between 275 and 285 teraWatthours (TWh). The forecasts for 2023 are better (300-330 TWh), as well as those for 2024 (315-345 TWh). Just before the Covid-19 pandemic, the level of production was 380 TWh; it even reached 430 TWh in 2005. The French nuclear-energy park has been reduced further to the closure of Fessenheim plant in 2020 – a political decision – and the new plant, the EPR of Flamanville (Manche department, centre-north of France) – the first of the third-generation reactors – has been piling up various technical difficulties for several years; finally, it will start to function by the middle of 2024. But the main factor explaining the rather weak availability of nuclear energy is the existence of corrosion cracks that could cause serious problems in the rescue pipes aimed to cool the reactor. The multiplication of

these problems has resulted in the closure of a number of plants in order to make the repairs – *ca*. 600 welders have been working on these cracks and they included about 100 North American technicians. The EDF company has a plan to check all the plants from now to 2025. In an instruction to EDF new executive director, the French Prime Minister Elisabeth Borne requests the reestablishment of the full capacity of the nuclear park, with a view to mitigating the soaring prices of electricity, when the war in Ukraine is keeping a tension on the gas market. After importing some 15 TWh in 2022, EDF, at the beginning of 2023, is again exporting electricity to Italy, Switzerland and the United Kingdom.

Soberness and a new scenario for decarbonation in Europe

The present objective of climate policies is to reverse the trend, i.e. soberness should be the starting step and not an adjustment variable. That was precisely the objective of the French association negaWatt and its partners, which have presented in Brussels on the 5th of June 2023 a new scenario for the energy transition in Europe. This new trend, christened CLEVER (A collaborative Low Energy Vision for the European Region), aims to decarbonate the consumption of energy thanks to a culture of soberness, but also to the increase in efficiency and the reliance on renewable sources of energy; and this while responding to the demands of a secure supply and sustainability of the system (resource consumption, protection of biodiversity, etc.). To that end, negaWatt and its 26 partners (universities, think tanks, research centres, NGOs) representing 21 European countries, set up at the core of their modelization the demand issue. Historically, climate policies are focused on offer, but gradually pressure was exerted in order to take account of energy efficiency. And nowadays it is just time to add another leverage so that soberness is put at the first place. Up to now the progress made in terms of efficiency has been to a large extent abolished by the absence of soberness in consumption : for instance, motor-cars are consuming less fuel, but they are heavier and are travelling more kilometres. But during the next 20 years, the European Union has to double its efforts to reduce GEG emissions, i.e. much more than the results of the last 30 years. Therefore the energy crisis has put soberness at the centre of climate policies, and for instance, the consumption of natural gas has been reduced (-17.7%) between August 2022 and March 2023 (according to Eurostat), as

well as electricity in the European Union. After four years of work and on the basis of about 30 national scenarios, the authors of the study published on the 5th of June 2023 have estimated that it would be possible to halve Europe's total consumption (-50% to -55%) in 2050, compared with 2019. In France, for instance, the national low-carbon strategy expects to decrease by 40% the energy consumption in thirty years. Soberness would contribute to 20% to 30% of this reduction, while the rest was related to efficiency. Once the needs have been defined, the organizations of the CLEVER network have focused on the necessary kinds of production. They consider that an energetic mix of 100% renewable sources of energy can meet the demand in 2050, relying first on land and offshore eolian energy, then on photovoltaic energy and biomass. The prospects for 2030 in terms of renewable sources of energy are already ambitious targets and do not need to be risen, but they must be developed at the national level. Regarding bioenergies, the trend mainly foresees the increase in biogas production from wastes and agricultural residues, without any arable land devoted to this production. The biomass derived from the forests remains the same. In addition, when several European countries have announced their wish to turn to nuclear energy in order to decarbonate their economy, the CLEVER members consider that the projects of nuclear plants could contribute to the reduction of GEG emissions only after 2040. The new scenario proposed by CLEVER, if applied, would be compatible with the most ambitious objective of the Paris Treaty: the reduction of global warming to +1.5°C. When the plan *FIT for 55*, that aims to decrease by 55% the GEG emissions in 2030, is being finalized, the European Union must start to define new targets for 2040. The CLEVER scenario brings a clear vision about what should be done in 2040 and beyond.

Regarding soberness, California where heat waves occur frequently and cause an increase in electricity consumption because of air conditioning, the efforts made to save energy have not yet been sufficient. This diagnostic could seem paradoxical for a State (Golden State) that boasts to be the first economy of the United Sates, a jewel of technology and a pioneer in the struggle against climate change and global warming. It is nowadays a laboratory of the difficult times to come. The fact is that California imports about one-third of its energy consumption, hydroelectricity from the northern States and gas and coal from the southern States. Moreover, its important storage capacity, due

to its big dams, is nevertheless insufficient, especially during a long drought, to compensate the intermittence of solar-energy production. In San Francisco, as well as in Los Angeles or San Diego – among the most prosperous regions of the world – people suffer from breakdowns in electricity supply (in 2020, almost 200,000 households have been deprived of electricity supply). That is also a problem for energy transition, because, when the electricity regulation authorities are reducing the number of hours for refilling motor-car electric engines, the State decides to ban the sales of thermic-engine-driven motor-cars in 2035. It remains therefore to wait for the Silicon-Valley innovators to find the recipies for energy autonomy.

On the other hand, the French government announced, on the 6th of October 2022, its plan on energy soberness. The objective, explained in the presence of several ministers and experts, was to decrease in two years the total consumption of energy by 10%, compared to that of the year 2019. That has been considered a first step made to reach the objective of 40% of energy savings so as to be close to carbon neutrality in 2050. The French Prime Minister, Elisabeth Borne, in her conclusion at the end of this seminar states: "Soberness is a new way of thinking and acting and it will be one of the keys of our ecological transition and of energy sovereignty". For instance, public administrations will have to upgrade remote working (+15% of the remote-working indemnity), to cut hot water in the rest rooms, instruct the drivers of public vehicles to reduce the speed on highways from 130 km/hour to 110 km/hour. Local collectivities and companies will also contribute to this soberness: maintain room temperature at 19°C and at 17°C in the hotels. Decreasing room temperature by one or two degrees Celsius can save 8% to 16% of central-heating consumption. The local collectivities will be encouraged to reduce (-2°C) the temperature of gymnasiums as well as of swimming pools (-1°C). Some municipalities have already decided to close down these infrastructures, due to the high cost of energy. Also a decree dated 7th of October 2022 has been issued in order to facilitate the switch off of shop windows and luminous signs and advertisements between 1am and 6am. Regarding the companies, they should try to implement a series of 16 concrete actions, such as reducing central heating or air conditioning, switching off the lights of unoccupied buildings, training of employees to systematically adopt ecogestures. The government is willing to assist the enterprises, as well as the citizens, to adopt

such measures of soberness. For instance, the distributors of energy agreed to give a discount for those consumers who reduce their consumption or master it. A bonus up to €9,000 will be awarded to the households that change their gas-fired boiler and replace it by a heat pump.

This plan which, according to the French government, would allow the reduction of energy consumption by about 50 teraWatthours, out of a total consumption of 1,600 TWh approximately, is above all based on pedagogy and enticement. The government has tried to make people aware of the seriousness of the situation and requested more efforts of soberness. "Each gesture matters", citizens and all sectors are therefore requested to reduce energy consumption. The energy-transition specialists have approved the government plan. At the end of September 2022, the association negaWatt has quantified the impact of the 50 measures that would reduce the consumption by 13% in 2024: sanitary hot water, lighting or motor-car speed have been identified as the sectors where are the main potential savings. While acknowledging the good orientation of the measures already taken or indicated, the energy-transition organizations are worried by the lack of regulation devices and by the insufficient facilitating measures, with a view to ensuring the fulfillment of commitments. As a matter of fact, there has been a reduction of energy consumption during the winter of 2022 and the households as well as the industrial sectors have listened to the government's messages in terms of soberness.

Reduction of electric consumption and pollution of the digital-revolution tools

These tools were responsible for 4% of the global GEG emissions in 2020 (twice the proportion of the civil air transport), and they are expected to reach 7.6% in 2025 and 10% in 2040. These tools consume 10% of the world's electricity. In 2019, the carbon imprint has been, in proportion, 38% for digital equipments, 14% for data centres, 11% for data-transmission networks; regarding the production of these equipments, the proportion of carbon imprint has been estimated at 15% for television sets, 10% for computers, 8% for smartphones and 4% for other equipments.

There has been a multiplication of connected equipments; the number of these equipments per inhabitant in the world has risen from 2.4 in 2018 to 3.6 in 2023 (+8.5%). In 2019, in France, the four leading and more polluting equipments, expressed in percentage of the GEG emissions due to their numeric components, are: television sets and screens (34%), computers (24%), smartphones (13%) and Internet and TV (Box) [12%]. The production of a smartphone needs five-hundred times its weight in raw materials. Only 15% of the smartphones are collected and recycled in France in 2020; 88% of French people change their cell phone, while the former equipment continues to function. The more polluting numeric habits are: watching video, exchanges through the social networks, communication through mails and use of research motors. Regarding the first habit, 60.6% are streaming videos, and when watching a 4 G video preferably to a WIFI, the energy consumption is 23 times higher. The exchanges through social networks represent more than 5% of the global traffic on Internet; 4.33 billion people – 55% of the global population – are active on these social networks. Regarding the communication through mail, a mail has to travel 15,000 km to reach its destination, 60% of these e-mails are not opened; 10 billion mails are sent every hour in the world – in terms of electric production it is the equivalent of 15 nuclear plants each hour. Another example: one year of research on Internet is equivalent to 120 TWh, i.e. the annual electricity consumption of a country like Norway.

It is obvious that in terms of soberness, drastic efforts should be made to produce equipments that consume much less electricity, but at the same time the consumers should adopt thrifty habits, such as recycling more the smartphones, repairing them and involving them in a circular economy; the same is true of the other digital-revolution tools, like the computers, the social networks or the excessive use of e-mails. Once again, we are outpaced by technology whose speed is relentless. We must therefore anticipate and look to the other side of the coin, and find the right balance between the benefits and costs or drawbacks.

Solar energy : **a major sector in energy transition**

Everywhere in the world, in the middle of deserts as well as on the roofs of households and parking lots, above the warehouses and factories, on the sides of highways, on agricultural lands and deforested areas, amidst lakes, solar

panels are installed at a speed never seen until then. For instance, in the very large solar plant of Al Dhafra, south of **Abu Dhabi**, workers are putting in place a solar panel every two minutes. The building site has been started in 2020 and the work is carried out by a consortium including the French EDF Renouvelables (Renewable), the Chinese Jinko Power and public Emirati operators. The solar plant has been almost finished in 2022. Equipped with 4 million solar panels and producing 2 gigaWatts (GW), it is one of the largest in the world. The electricity produced there will be distributed to 160,000 households and it is already purchased for the next thirty years. Indeed, the photovoltaic solar panels are globally widespread and their production and distribution have been accelerated : according to the International Energy Agency (IEA), solar energy would amount to 2,350 GW of potential energy across the world in the next four years, thus outpassing hydraulic power in 2024, natural gas in 2026 and coal in 2027 in electricity produced by other means.

In 2021, the Sun – of which the power can be used only on daylight – has contributed to the production of 1,000 terraWatthours (TWh) of electricity across the world; and this out of total consumption of 27,000 TWh (and provided by other sources such as nuclear power, wind, hydroelectricity). In 2022 the trend of increase will be 25% for solar energy, boosted by the struggle against global warming and the soaring prices of energy. Later on, this trend would be higher. The IEA, in its annual report on renewable sources of energy, has stated: "Despite high investment costs, due to the soaring prices of raw materials, the large-scale photovoltaic installations is the least costly choice for electricity production in a great number of countries across the year." Most of the industrialized countries have reached record figures in 2022 and 2023 in terms of creating new solar plants. "The crisis we are going through has allowed the accelerated transition towards renewable sources of energy, that was difficult to implement on behalf of the climate issue," stated Richard Loyen, one of the most knowledgeable French experts and chairperson of Enerplan, an association of professionals of the sector.

In 2022, **China** has installed 874 GW of solar panels, far above the former record in 2021 (54.9 GW). Despite some difficulties in the supply of materials, Chinese industrialists foresee in 2023 and the seven following

years the annual installation of 95 to 120 GW plants on their territory. Chinese companies also invest abroad, as shown by an agreement with Uzbekistan (announced by mid-February 2023) with a view to installing in a few months 2 GW of solar panels. Such approach cannot hide the heavy reliance of Uzbekistan on gas and coal because of its colossal needs. In **India**, two of the wealthiest men in the country, Mukesh Ambani and Gautam Adami, are heavily investing in solar plants. On the 3rd of March 2023, M. Ambani wanted to develop capacities of 10 GW in the State of Andhra Pradesh (South of India). India, with more than a capacity of 60 GW installed, is at the fifth position of the world ranking regarding solar-energy production. During the last years, a series of megaprojects and small units have been developed: the huge solar park of Bhadla in the desert of Rajasthan is considered as the most important in the world : 10 million solar panels laid on 5,700 hectares have a total capacity of 2.25 GW. India has plans to build 50 solar farms across the country. In the state of Kerala, the airport of Cochin is the first since 2015 to function thanks to solar energy. India, being the third-biggest GEG-emission producer and also the most populated country of the Planet, has posted ambitious objectives in terms of renewable sources of energy. It hopes to reach carbon neutrality in 2070. To that end, India wants to install a capacity to 500 GW of renewable sources of energy from now until 2030. In 2023-2024, 70% of national electricity is produced by coal-fired plants. From a capacity of 2 GW of renewable sources of energy in 2014, India has nevertheless reached a capacity of 100 GW in less than 10 years, which is a considerable progress. Moreover, the Indian government wants to involve the private sector and, to that end, has set up financial incentives. More than a dozen companies, including the Mukesh Ambani industrial conglomerate, Reliance Industries and Tata Power, have responded to a call for subsidies amounting to €2.24 billion, on the 3rd of March 2023, in order to manufacture solar panels and thus reduce the dependence on China. The overall objective is to meet national needs and to even export these panels. Gautam Adami – an important actor of the photovoltaic sector in India – did not respond to the call for subsidies, and he seeks the ways to preserve cash, after the crash in the Stock Exchange caused by fraud accusations. But in 2020 the conglomerate stated that it would invest €10 billion with a view to reaching the objective of installing a capacity of 45 GW.

The same trend can be observed in the **United States**, particularly in some States like California or Texas. In 2023, the American Information on Energy Agency has mentioned projects amounting to 29 GW, a figure almost trebling the 2020 one. A study by Princeton University highlights a steady growth that reaches 75 GW and 105 GW of installed solar panels in 2026 and 2027, with funding from the *Inflation Reduction Act* and the creation of thousands of jobs. The trend is similar in **Europe** (+41 GW): Germany (+7.9 GW), Spain (+7.5 GW), Poland (+4.9 GW) and the Netherlands (+4 GW). In the Netherlands, solar energy has contributed to 14% of the annual electricity consumption, a record in Europe, although sunshine is there less favourable than in the south of the continent. By contrast, **France** is not following the same trend in the adoption of solar energy: in 2022, 2.6 GW of solar panels have been installed, less that in 2021 (2.8 GW). There are several reasons for this situation: nuclear energy, a decarbonated form of energy, has given reasons to the energy engineers not be as fast as elsewhere. Also, in the years 2000s, they had to face the very expensive costs of photovoltaic panels, whose development has been subsidized. The finance ministry was rather reluctant to allocate such high subsidies, and the nuclear lobby had another reason to give a lower priority to solar energy. As a result, the panels have only produced 4.2% of total electricity consumption in 2022, i.e. 4 TWh more than in 2021. But, at the same time, due to the difficulties encountered in the maintenance of nuclear plants, gas production has risen to 11 TWh and imports have been increased by 30 TWh. The law on renewable sources of energy, adopted in January 2023, is an important step in the good direction, but it is not enough. In order to fulfill France's commitments, the objective is to install a capacity of 4.4 GW of solar energy in 2023. Afterwards, 3 GW should be produced every year till 2028. According to the public institutions in charge of electricity distribution, 16 GW of solar-energy projects were to be developed, but this figure has never been reached, and a new scenario was to be designed so as to install a capacity of 7 GW per year. The government is willing to induce self-consumption by the individuals or by small and medium-sized companies. The Spaniards had adopted this policy : instead of having a tariff shield to face the crisis, they have developed self-consumption and facilitated the installation of solar panels on the roofs of households or companies.

Another challenge is the **manufacture of solar panels**. According to the International Energy Agency (IEA), more than 80% of the various components of photovoltaic cells and panels come from China. The latter has played a key role in the cost reduction of photovoltaic cells worldwide – an important component of energy transition. But, at the same time, the geographic concentration of the global supply chain is a great challenge for the governments. It is a global battle. The president of the United States, through the *Inflation Reduction Act* (*IRA*), tries to attract investors and relocate part of the industrial production of solar panel components. India wants to build megafactories, while the European Commission has launched an alliance with the solar energy industry with a view to increasing the production of solar panels from 4 GW to 30 GW in 2025. One of the main Chinese industrialists, Longi Green Energy Technology, announced at the beginning of February 2023 that it was willing to invest US$6.7 billion in order to double its manufacturing capacities. The new factory would produce 50 GW of additional solar cells per year. In Europe, Enel, the Italian leading company in the development of renewable sources of energy, has pledged €600 million to rise up to 15 times the production of its solar-panel factory in Sicily. The latter would be in 2025 the most important factory in Europe with 3 GW – these are the expectations. Another French company, Carbon, has announced on the 3rd of March 2023 that is was planning to set up a factory producing solar cells and panels amounting to several gigawatts in 2025 on the industrial site of Fos-sur-Mer, near Marseille (southeast of France).

To sum up, all the prospects indicate a massive increase in the electricity consumption across the world, due in particular to the development of vehicles equipped with batteries and to the gradual decarbonation of the industry. The present trend might increase the demand more rapidly during this decade than expected by the experts. This increase should be, to a large extent, absorbed by the renewable sources of energy, especially solar energy whose panels are easy to install. But this has a prerequisite : to connect successfully the millions of the new solar panels to the networks of electric transport. It seems that, presently, more than 1,000 GW of potential projects of clean energy are in stand by, the main reason being the scarcity of electricity-transport networks.

The following figures summarize the present situation of solar energy production and consumption across the world :

- the power capacity in gigaWatts of different sources of energy across the world: the prospects for 2027 amount to *ca*. 2,250 GW for solar energy, compared with *ca*. 1,500 GW for wind (eolian) energy, *ca*. 1,500 GW for hydroelectricity, *ca*. 2,000 GW for natural gas and *ca*. 2,300 GW for coal; in 2021, solar energy represented 11% of the total installed power capacity;

- the global electricity production in 2021 in percentage of each source : 36% from coal, 23% from gas, 15% from hydroelectricity, 10% from nuclear energy, 7% from wind or eolian energy, 4% from solar energy (solar-energy electricity production is lower than the installed capacity, because the photovoltaic devices function only during the day), 2% from bioenergy and 3% from other sources;

- the average cost of electricity production (in US$ per megaWatthour) from each source: US$167 from nuclear energy, US$108 from coal, US$60 from gas, US$38 from wind energy and US$36 from solar energy; these costs have been calculated for the whole world and exclude any kind of subsidy;

- the annual investments in the renewable sources of energy have been in 2022 : 60% for solar energy, 28% for wind energy, 7% for marine wind energy, 2% for hydroelectricity and 3% for others;

- China masters the whole chain of production of solar panels (in percentage, in 2021) : 79% of silicium – the main raw material – and 97% of small silicium plates, 85% of photovoltaic cells and 75% of solar panels;

- installed solar-energy power in selected countries in GW in 2021-2022: China 307 GW, European Union 200 GW, United States 100 GW, Germany 58.5 GW, India 49.7 GW, Italy 22.7 GW, Spain 16 GW and France 14.7 GW;

- part (%) of solar energy in the energy mix of some countries in 2022: the Netherlands 14%; Spain, 12%; Germany, 10% and France, 4%.

Research and innovation play a key role in the development of solar-energy panels as well as in the yield of photovoltaic cells (transformation of sunlight energy into electricity). In addition to the fact that solar energy is produced only during daylight, a main drawback is the above-mentioned yield, which is under 30%. But it may be possible to reach this yield and even

go beyond. Daniel Lincot who has been working on solar energy for more than 40 years reflected on the recent acceleration of solar-energy production. The first photovoltaic cells have been discovered in 1954, with silicium as the key material; in 1958, photovoltaic cells have been part of the first satellite components. Also in 1958, for the first satellite, the power generated is around a few Watts. Since this date, there has been an exponential growth of installed capacity across the world that reached 30% per year. It was still non-visible compared with the other sources of energy. Solar energy has been considered a whim, according to D. Lincot. In terms of ranking, France has remained for a long time at the top, along with the United States and Japan, and far ahead of Germany. During the 1960s and 1970s, several French companies have been pioneering the progress made. In 1970, the oil shock resulted in the choice of nuclear energy as the best response, and solar energy has been put aside in the government's priorities. And this situation did not change significantly until the years 2000. By contrast, in Germany public and private funds have been invested into research and innovation, aimed to increase the yield of photovoltaic cells and lower the costs of electricity production. The industrial photovoltaic sector takes off at that period. A similar trend occurred with the flat screens, cell phones or electric vehicles. The industrial costs have been lowered so that solar energy has become very competitive economically. Research and innovation concerning the photovoltaic cells are focused on their above-mentioned yield. When sunlight reaches the Earth, the power produced by the Sun is 1,000 Watts per square meter. One has to take account of the day and night alternation, the seasons and localization. In France, for instance, the Sun generates an annual energy of 1.3 MWh per square meter. If 20% of this energy could be converted into electricity through photovoltaic cells, the end result is a production of 260 kWh per square meter. With *ca*. 15,000 km^2, i.e. less than one-third of the areas already covered artificially, it would be theoretically possible to meet the energy needs of France. This is the potential of solar energy. Regarding the yield of photovoltaic cells, in the 1950s it was 6%, then 15% and remained at this level during ten years. At the end of the 1980s, the 20% level has been reached, but research is now focused on increasing more this yield. A record of 26.7% has been reached by a Japanese laboratory. The prospects derived from the present worldwide research are that the threshold of 30% could be reached and even beyond. The

technological and commercial competition between China and the United States will certainly have an impact on the research-and-innovation efforts regarding the yield of photovoltaic cells. There is also an effort made by some countries to achieve some autonomy in the manufacture of photovoltaic cells, and reduce their dependence on the Chinese chain supply. Semi-conductors, a basic element of the chips used in so many electric tools, are also part of the competition between countries; today the dependence of Europe on China and other Asian nations is rather huge.

Spain and the big jump of photovoltaic energy

In 2021, the new photovoltaic installations (self-consumption) have doubled in Spain, compared with 2020, with more than 1,200 MW of additional power, rising the total up to 2,800 MW. In 2022, the National Association of Photovoltaic-Energy Producers (ANPIER, Spanish acronym) has estimated that *ca*. 2,000 MW will be added. This trend could be pursued, but the market seems to be saturated. Although the exceptional solar irradiation in the Iberian Peninsula is estimated at 17,000 to 19,000 kWh per square metre and the duration of sunshine is almost 300 days during the year over a large part of the territory, the installed photovoltaic power – almost 14 gigaWatts – was in 2021 four times less in Germany (59 gigaWatts). However, between 2005 and 2010, Spain was along with Germany a European pioneer in the use of renewable sources of energy. The socialist government of José Luis Rodríguez Zapatero has allocated generous subsidies to electricity producers willing to invest in this technology, costly and wobbly, and has allowed a high warranted remuneration. This development was cut off by the 2008 financial crisis. In 2010, Spain had to decrease the assistance to the sector, struck by a speculative bubble, which resulted in the difference between the price of electricity paid by the consumers and the real production costs. In 2012, the new Prime Minister Mariano Rajoy of the Popular Party approved a moratorium on the development of renewable sources of energy. In 2015, the tax called the "solar tax" concerning the owners of solar panels has been the deathblow for the consumers of solar energy. The tax was cancelled in 2012 when the socialists returned to the government. The end result of this policy has been the paralysis of the installation of solar panels between 2012 and 2018.

The soaring prices of electricity entices the consumers to try to find out other options, while the government's decision to allocate part of the Next Generation funds to the installation of renewable sources of energy for self-consumption, has boosted these installations. Thus, Cataluña has allocated €112 million of subsidies, Andalucía €97 million and Madrid €87 million. And most of the regions of Spain have cancelled the obligation to have a construction permit in order to install solar panels on the roofs of homes or residences. Most probably, this new trend is going to be sustained for the next seven or ten years, whereas 9% of the potential number of solar installations has been set up in Spain. Henceforth, the objective of the Spanish government to move from the present 3 GW of self-consumption to 9 GW in 2030. Some experts are of the opinion that this figure would be 14 GW in 2030. Beyond the development of self-consumption, it has been the whole Spanish park that grew by almost 30% in 2021, with a capacity of 14 GW at the end of 2021. From now on, solar energy represents 14,6% of the national electricity production. By the end of 2022, solar energy will become, ahead of hydraulic plants, the third source of electricity, behind the thermic plants (26 GW) and windmills (28 GW).

The jump of photovoltaic energy has been so big that everywhere, in the countryside, cereal fields, olive groves and vineyards alternate with solar panels extending over dozens, or even hundreds, of hectares. But it had its backlash : for instance, in September 2022, more than 70 Andalucian municipalities have introduced to the regional parliament an initiative requesting a moratorium on "macroprojects" in solar and wind energy; this moratorium is needed for the design of a national plan aimed to minimize the environmental impacts and to avoid speculative movements. The reduced or the lack of capacity to export electricity could be a serious limiting factor for the development of renewable sources of energy (solar and wind). The latter depends on the construction of electric interconnections with France. This country has reached only 2.8 GW for self-consumption, including all sectors, in particular 994 MW for solar energy. The difference between the two countries is not only due to sunshine, but also to the legal framework. For instance, in the northwest of France, there are twice less self-consumers of solar energy than in Belgium that enjoys almost the same climate. Even in Poland, which uses a lot of coal, self-consumption of solar energy reached

3 GW in 2022. Some simplifications have been nevertheless carried out at the end of 2022, especially for small installations and for collective self-consumption so as to facilitate the sale of electricity among neighbours in the same borough or district.

Portugal and the energy crisis

According to Eurostat, 16.4% of Portuguese people cannot have access to an adequate heating, compared with an average 6.9% in the European Union. The situation is worse only in Greece (17.5%), Lithuania (22.5%) and Bulgaria (23.7%). In addition to isolation problems, 25.2% of households are suffering from serious humidity infiltration, compared with an average 16.7%in the European Union. Energy crisis and the soaring inflation have compounded the situation. At the end of 2022 inflation rate has jumped to almost 11%, including 31% for electricity and gas, according to Eurostat. The Portuguese company of electricity (EDP) has indicated that 75% of 1.5 million buildings for 10 million inhabitants do not comply with the minimal norms in terms of thermic isolation. In the two decades following the collapse in 1974 of the dictatorship (Salazar), a real estate boom has occurred with a view to accommodating people coming the countryside and Portuguese colonies, explains João Pedro Gouveia, a scientist at the Research Centre on Environment and Sustainability (CENSE) of Nova University, Lisbon. This building boom did not comply with the European standards, used low-quality materials and lacked technical rigor. Portuguese people accepted this situation, as they have been sober in terms of electricity consumption and heating for many years. In the countryside, people collect dead wood, which they burn in their fireplaces. In the cities, in addition to wearing warm clothes, city-dwellers use a small electric or gas-heater. These conditions that are rooted in the lack of purchasing power and low wages lead some experts to state that the energy crisis is becoming a social crisis. However, the macro-economic data are satisfactory: economic growth has risen 0.3% during the third term of 2022 and the unemployment rate was about 6% by the end of that year. After having been struck by the Covid-19 pandemic, the country was put on the rails of economic growth when the socialists returned to power (Antonio Costa) in 2015. But, due to the pandemic, this progress has been stopped and the poverty rate has risen 12.5% in 2020, for the first time since 2014. In

2021, the figure was 18.4%, meaning that 1.9 million people were living under the poverty threshold (€554 per month), compared with an average 16.7% in the European Union according to Eurostat. Those needing assistance of NGOs like Caritas have been growing markedly. Although the unemployment rate was low, the number of employed people having a temporary job was around 15%, compared with 11.1% in the European Union. Young people are concerned more than other social categories : 60.02% of them had a temporary contract (50.4% in the European Union in 2021) and many had the so-called "green receipts" – contracts initially conceived for independent workers and having limited social rights – such as vacations, unemployment subsidies and health-care. Moreover, the social protection nets are among the least efficient in Europe.

According to official statistics, the average price of housing has again jumped 78% during the second term of 2022. The explanation was the great development of tourism and locations Airbnb that have a heavy impact on the demand for apartments. In addition, the government has greatly facilitated the foreign investments since 2012 : the so-called "golden visas" have granted an authorization of residence to the non-Europeans who were willing to invest more than €500,000 in a real-estate purchase. This trend has allowed the rehabilitation of crumbling districts in Lisbon and Porto, but only tourists draw a benefit from this effort, while the Portuguese are increasingly pushed out to town periphery and with a poor thermic isolation of their homes. The government took the following energy measures: in order to counter the soaring inflation, the value-added tax (VAT) has been lowered to 6% from 13% for electricity; allocation of an exceptional assistance amounting to €125 per household. In addition, the government was planning to allocate to energy rehabilitation part of the money drawn from the *European Reflation Plan* (*Economic Revival*). In particular, an amount of €1,300 was allocated to each household that undertakes rehabilitation works such as the installation of double windowpanes or a heat pump, aimed to reduce the electricity bill. The shortcoming of this measure is that low-income people may be reluctant to request this assistance, because of the bureaucratic impediments. But at least, this issue was taken seriously by the authorities, stated Constança Días, of Just a Change, an NGO that helps poor families rehabilitate their home, thanks to volunteers. Another possible danger is that unscrupulous landlords

could seize the opportunity of the *European Reflation Plan* and cancel the leases, in order to rent their home more expensively to tourists. If this issue is not taken care of, the commendable initiative of the government might not lead to improving the housing conditions of Portuguese people, without significantly lessening the energy crisis.

Wind (eolian) energy, promising short-term developments

Over the last decades, windy countries or regions have built windmills of which the pales drive a power turbine that produce electricity. This renewable source of energy has been adopted rapidly, despite the protests of environment activists who underline their nuisances: excessive noise for the villages or households located nearby, ruining the landscapes and loss of biodiversity. To lessen those nuisances, the countries have increasingly built their windmills near the shores or in the sea, where wind often blows, far from human settlements. There is now a way to capture the wind energy in ocean deep waters, using a new type of windmill. It is estimated that 80% of offshore wind-energy potential lies in ocean waters under more than 60 m. The first European floating windmill has been built in Portugal in 2011. In France, in 2022, similar windmills have been built in Brest harbour (Finistère, Brittany) and off Le Croisic (Atlantic Loire department). The latter has a power of 2 megaWatts and can supply electricity to a town of 5,000 inhabitants. Worldwide, in 2022, there were 13 parks of floating windmills, including 11 forecast in 2023 – the largest eolian farm being located in Norway. Electricity production by this type of windmills has been estimated (in gigaWatts) at 35 in 2020, 270 in 2030 and 2,000 in 2050, worldwide; this production has been multiplied by 7 in 2030 (compared with 2020) and by 7.5 in 2050 (compared with 2030). In France, in 2022, 90% of investments in eolian-energy technologies concern land-fixed windmills and 6% of them for floating windmills.

There are four kinds of floating windmills. The so-called cylinder is adapted to very deep waters (more than 100 m) and is the model that is less anchored in the seabed. The semi-submersible model uses the technology that is applied to most existing projects. The third kind of model is anchored on a barge and is only built with concrete. A model used in the Mediterranean Sea, weighing 2,500 tons, consists of (above sea level) a 90-metre pole or mast, at the top of which is located a nacelle or pod containing a power turbine of 8.4 megaWatts.

The latter is driven by three 75-metre long blades that turn around when the wind blows. Under the sea level, at a depth of 45 metres, a tripod consists of six buoys (12-m long and 7.5-m wide) linked to each other and to the mast through steel tubes. The whole of the windmill is settled in the seabed by suction anchors. The electricity produced by the power turbine is transported to an electrical relay station through a cable; the relay station is also anchored to the seabed, *ca*. one-third of the height of the relay station being above sea-level. Then, electricity is transported to a land-fixed connecting station and thereafter to high-voltage lines. The engineering companies that wish to meet the challenges of wind-energy construction are still hesitating between the use of steel or concrete. If it is made of steel, the floating structure and the power turbine weigh between 2,500 tons and 4,000 tons. If it is made of concrete, the weight is *ca*. 10,000 tons. But the weight is not the only issue – also the design of the ports, the load-bearing capacity of the piers, and the equipments needed for lifting and tugging, as well as the storing warehouses. Draught is another decisive factor. A floating structure made of concrete will need a deeper port for its launching than a model made of steel. Concrete has nevertheless some advantages: "in Europe, it is rather complicated to find a supply of steel that is competitive, while concrete can be prepared with local cement, sand and aggregates. Its price is also less volatile, especially in the inflationist context of 2022-2023, stated Paul de la Guérivière, executive director of the company BW Ideol, which developed the floating structures of EolMed – a pilot wind farm off the coast of the French department Aude (west off the French Mediterranean coast). This floating structure is a barge with a width of 40 to 60 metres, and 10-m high, i.e. a four-storey building, settled in the seabed through steel chains and marine anchors. The power turbine is located on one of the four sides of the square, while the centre of the parallelepiped is empty and can absorb the energy of waves and currents. This solution has been applied to the construction of a windmill farm in Japan in 2018, as well as of another windmill farm developed at the beginning of 2022 in Scotland by the French startup Ideol. The power of the latter has been estimated at 1gigaWatt – twice the power generated by the windmill park built off the coast of the city of Saint-Nazaire (centrewest of the French Atlantic Ocean). There are several other designs that are competitive with the floating "ring" model.

Regarding the floating windmill anchored off the marine coast, France must catch up with the developments made by other countries, like for instance Norway. The latter has been able to build and run the first seven power turbines of the biggest floating windmill farm in the world (88 megaWatts). Scotland has launched the construction of a windmill farm producing 15 gigaWatts, and it has been running since 2017 the first European windmill park, built by the Norwegian company Equinor (30 megaWatts). According to an expert working at the French Environment and Energy Mastery Agency (ADEME, French acronym), "if we want to produce 40% of electricity from renewable sources of energy in 2030 and reach carbon neutrality in 2050 – the French government's objective – offshore windmill farms are a must, because windmills built inland will not be sufficient; floating windmill farms in the sea are the future." In 2050, windmill farms in the sea – floating and anchored – would be built and managed in 50 sites and would meet 25% of the electricity consumed in France, according to the ecological transition ministry. In 2035 and 2040, the capacity expected is 18 gigaWatts and 40 gigaWatts, respectively. Out of this capacity, the floating technology would contribute a proportion of 35% to 70%, according to the ADEME assessment.

In the Mediterranean Sea, where the seabed lies at a depth of 60 metres or beyond rather rapidly, it is impossible to anchor a windmill like we do off the coasts of The Channel, where the continental plateau does not lie at a depth higher than 30 or 40 meters. The advantage of the floating design is not to depend too much on the depth of the waters and to build the farms farther off the shores; this would avoid conflicts with other marine users like fishermen and tourists. The prospects offered by the floating windmill farms could attract the interest of oil-drilling companies; they have a long experience in building marine off-shore platforms, and, for instance, TotalEnergies has started to work on offshore windmill farms in 2019 and it is a shareholder of EolMed (see above). In addition, TotalEnergies plays a key role in Erebus – a floating project (100 megaWatts) in Wales, expected to start producing electricity in 2026. The megaoil company is exploring the feasibility of four projects in South Korea off the coast of Ulsan, where the sea is deeper than in the Mediterranean. In the meantime, in July 2023, BP and TotalEnergies have won the call for a project in Germany that consists of building an eolian park offshore estimated at €12.6 billion. Two sites will be located in the North

Sea and one in the Baltic Sea. Expected to start producing electricity in 2030, the total power capacity of the three parks will amount to 7 gigaWatts. The competition was tough among the companies interested, but finally the British and French giants, which have now an expertise in building offshore eolian farms or parks, have won a new bidding process in Germany. In Spain, the national oil company Repsol is also interested in developing similar windmill farms. In April 2022, it became a partner of the Danish company ORSTED – the world's leader in offshore windmill installation – in order to explore the opportunities of building those parks off the Iberian coasts. In Italy, the national energy company ENI is also on the starting blocks with its subsidiary in energy services Plenitude. The latter replied to a call by the Italian government in April 2022, for the installation of two windmill farms off the coasts of Sicily and Sardinia. In Portugal, the national energy corporation EDP and its subsidiary EDPR working on renewable sources of energy have been involved in the construction of the first European floating-windmill pilot farm, producing 25 megaWatts and consisting of three power turbines, anchored at 20 km off Viana do Castelo, north of Porto. Electricity production can meet the energy needs of 60,000 households. In 2019, EDPR has created, in partnership with the French energy company ENGIE, the company Ocean Winds headquartered in Madrid, Spain. Ocean Winds has great ambitions, like the installation of an eolian park anchored at a depth of 2,000 metres in California, as well as in South Korea – installation of a windmill farm in a zone where the sea is between 200 and 300-metres deep. The Portuguese EDPR has been selected in August 2022 to build and manage a 2.3-megaWatt eolian farm in Scotland, off the Shetland Islands coasts.

In 2022-2023, the cost of a floating windmill is twice to thrice that of an anchored windmill. But the promoters of the floating technique are expecting economies of scale that will decrease this cost difference. According to Ocean Winds, "the cost of electricity decreases by 10% to 15% when the capacity of a windmill park is doubled." "In fact, we are not very far from the cost of an anchored windmill, because the winds are blowing at a higher speed and are more regular when the park is far from the coasts; and the electric-production yield is much higher than that of an anchored windmill." The renewable-sources-of-energy branch of the Spanish shipyards is very much aware of the issue: out of the 13 floating eolian parks, nowadays in operation in the

world, it has built 11. The director of TotalEnergies offshore eolian branch has estimated that a decade will be necessary to decrease the costs, but "the most important thing is to prepare the network of electricity distribution; in the long term, an offshore eolian farm would be comparable to a nuclear plant." It is therefore necessary to make sure that the electricity network can absorb the gigaWatts produced. Another challenge concerns the link between the power turbines and the electricity network. Research-and-development programmes are still needed for the development of high-strength cables that should resist to deep-sea currents, as well as for the design of floating electric sub-stations that are sufficiently stable so as to avoid continuous vibrations on the electro-technical equipments. Regarding the ports, their piers and bollards should be strengthened in order to welcome enormous structures. The French government, in the frameworks of the *Plan France 2030*, has invested €300 million in innovative solutions for the redesign of harbours and for improving their capacity to welcome big structures. In 2023, there will be an estimate of the electricity produced by the offshore eolian parks: the French government has targeted a price of €110-120 the megaWatthour, compared with €45-60 in the case of anchored windmills. For EDF Renouvelables (EDF Renewables), 2023 will be the year of production of three floating power turbines that aim to supply electricity to 45,000 households. In the meantime, a new law on Energy-climate is to be prepared and voted by the French National Assembly. This law is expected to regulate the future projects of floating eolian farms. The companies will therefore have to organize a real engineering chain that would produce floating structures; this is an industrial challenge that will be met not only thanks to a lot of funding, but it also requires consistency and patience from all those interested in offshore eolian energy.

Electric motor-car: an efficient tool to reduce greenhouse-effect gas emissions

The roots of the motor-car revolution

In the summer of the year 2015 the Volkswagen scandal broke out, it was called "dieselgate": further to America's pressure the German firm recognized that it had installed an information system on its vehicles with a view to hiding the real pollution of its diesel engines. This was the starting point of the seven-year revolution, which has upheaved the automotive industry. The European

Parliament banned the building of thermic engines after the year 2035. There was therefore room for of a three-facet transformation: electrification, digitalization and inflation. The association of these three events, accelerated or highlighted by climate disturbances, the Covid-19 pandemic since 2020 and the war in Ukraine since the 24th of February 2022, will drastically change the economic model of motor-car manufacturers. The figures illustrating the magnitude of these mutations are those of the motor-car industry. In France, for instance, the sales of new cars decreased by 7.0% in July 2022 – the fourteenth monthly fall in sequence. This phenomenon is global: the drop in the registration numbers of new cars has been noted in the main car markets – -12% in the United States, -13% in Germany, -16% in the United Kingdom and -7% in Japan. The 2009-2019 brilliant decade of expansion of the motor-car industry came to an end. Some experts underline that the industry has lived through the illusion of an infinite market supported by China, the world leading market. The peak was reached in 2017 and 2018, with 94 millions new vehicles sold across the world. Thereafter the global sales collapsed in 2020 (-18%) and, according to the predictions, they will be for the third year in sequence below 80 millions; whereas in 2015 experts have predicted that the new vehicles will amount to more than 100 millions in 2020.

In France, the sales of diesel cars represented less than 17% in 2021, compared with almost 70% seven years earlier. The electrification of the motor-car park is on its track, with the support of the public authorities – local, national and European –, that had encouraged the production of diesel engines and cars in the early 2000s. In France, the sales of completely electric cars or hybrid ones that must be recharged, represent 20% of the market of new cars : that was the so-called “watture” (Wattcar) which tends to eliminate not only the diesel, but also the petrol-fuelled cars. The figures are similar in China. But this proportion is even higher in some European countries: more than 30% in Germany and more than 50% in Scandinavia. Even though many car-drivers remain skeptical regarding battery-fuelled cars, the industry has clearly made a turning point, while taking care of the reinforcement of environmental regulations. The global investments in electric vehicles, announced in 2022 and for the next four years, reached €520 billion, compared with €200 billion for the period 2018-2022.

The second stage of the motor-car revolution is an unexpected lack of semi-conductors that are compulsory components of the software, informatics and calculators on-board the modern vehicles. For some cars, software represents more than 50% of the car price. And electronics growth rate will not slow down this trend: the motor-cars with batteries contain more chips than thermic engine vehicles. The third stage of the motor-car revolution is the rise in the cost of cars. This trend has been already present for about a dozen of years and it has been associated with the reinforcement of security and anti-pollution standards. But since 2020, the cost of the raw materials needed to produce a vehicle jumped 45% between 2019 and 2022, i.e. about €1,200 per thermic vehicle and €4,000 per electric vehicle. It is therefore obvious that electrification largely contributes to the soaring cost of electric vehicles. According to a consulting firm, AlixPartners, in 2022 the average cost of the components needed for the manufacture of a thermic car was €15,000, while this cost reaches €24,000 for an electric vehicle. The car manufacturers have transformed these difficulties into a profitable strategy, moving from a race of producing a higher number of cars to the search of an exclusive profitability; they give priority to vehicles with a high profitability. The half-year turnover of the French manufacturers perfectly illustrate this trend: Stellantis' (Citroën, Chrysler, Fiat) turnover rose 17% to €88 billion, with an extraordinary operational profit of 14.1%; even Renault that suffered a heavy loss due to a hasty leave from Russia during the first half of the year, could improve the profitability of its sales of electric and hybrid vehicles.

An effective solution, but not always easy to reach

Many people think the manufacture of, or the access to, an electric vehicle is not the magic bullet, or at least not yet. The decision banning the thermic car after 2035, made by the European Union, generates a pressure on the whole industry that has to face a situation that makes sense from the environmental viewpoint, but has some uncertainties. Regarding the access, the manufacturers estimate that five to seven years will be needed for reducing the cost difference between the electric car and the thermic one. In the meantime, the number of buyers may fall markedly. Setting up a subsidy for a leasing system has not been feasible before 2024. In the meantime, the French Republic's President Emmanuel Macron announced an increase in the bonus allocated to buy an

electric car; that means for the purchase of an electric vehicle by lower-income households an amount of €6,000 to €7,000. In spite of this help, the electric motor-car will be out of the reach of many French people. Even though the sales are taking off, even though more than 1 million of these electric motor-cars are being driven on French roads, electric vehicles represent only 2% of the total automobile park.

Technology must also overcome a number of limiting factors. Only one French person out of four believes in the generalization of all-electric vehicles in 2035. The rhythm of installation of recharging posts is too slow: out of the 100,000 promised by the public authorities, only three-quarters have been installed and their maintenance is very poor. It is therefore necessary to increase the investments in this sector and also to raise the vehicle autonomy. Moreover, the adoption of the electric car implies a new relationship with the car: to be really ecological, the latter must be smaller and will not have the same uses as today. And many uncertainties loom on the industrial implications of this transition. Half of the value chain is still located in Asia. Furthermore, Europe must import the components needed for the manufacture of batteries, and their prices are soaring. It is true nevertheless that French manufacturers try to accelerate the pace aimed to localize the assembling of components of these batteries in their factories, but it is not sure that they will win the race against the clock with their Chinese competitors. The latter are ready to flood the Old Continent with 20% to 30% less costly electric cars. Also, the availability of sufficient decarbonated electricity should be taken into account. Finally, the social implications of this industrial revolution are expected to be painful. Assembling an electric vehicle needs much less working hours than a classic vehicle and this will result in tens of thousands job layoffs. It remains that, despite all these shortcomings, the road map is clear: we are moving towards an all-electric industry, even if it may be a crooked pathway.

The Chips Act

Europe tries to become less dependent on the imports of chips (semiconductors) from China and the United States through doubling the shares of the European Union on the global market of chips from now to 2030. That is the goal of the European Commission's *Chips Act*. France has decided to allocate €2.9 billion to enlarging the STMicroelectronics factory, located in the French

department of Isère, 15 km from Grenoble (centre-east of the country). The French-Italian company manufactures high-quality semiconductors, the basic materials of electronic chips and for various sectors – aerospace, automotive, telecommunication industries, etc. The whole project, estimated at €7.5 billion, has been launched in July 2022. It goes beyond the French frontiers, as the project is part of the *Chips Act*. In the region of Grenoble, this factory enlargement has immediately raised the issue of sharing the water resources after a very dry summer 2022 and decisions aimed to restrict the use of water. Grenoble, a city of 450,000 inhabitants and capital of the Alps Mountains, enjoys the supply of abundant and pure water coming from the glaciers and that should be treated nevertheless. STMicroelectronics benefits from this advantage and its water consumption is very high. The silicium wafers (semi-conductor discs), which the company produces, are treated with chemicals and then washed with ultrapure water – i.e. potable water free of its minerals and impurities. Water is also used for air conditioning of the buildings. Supplied by the city of Grenoble, the factory of STMicroelectronics had used 6.8 million cubic metres of potable water in 2022, i.e. 20% of the total water supplied by the city; almost all this volume is returned to the river (Isère) after having been treated. In October 2021, an agreement has been signed between Grenoble and Grésivaudan where the factory is ubicated, regarding the purchase of 29,000 m^3 of water per day by STMicroelectronics till the end of 2023, compared with 23,000 m^3 in 2021. The deputies of the ecologist movements and parties, as well as many experts, are very concerned about the impact of this industry – of which they do not deny the importance – on the environment. Even the associations of citizens, Stop micro!, is campaigning under the slogan "Water, no Chips". As number of studies have been carried out on the water resource and its availability in order to base the decisions of sharing the water on agreed scientific facts. The economy minister has stated that STMicroelectronics and its American partner Global Foundries (that belongs entirely to the United Arab Emirates) have been committed to respect a high level of environment protection. STMicroelectronics has made the announcement that the adaptation of the manufacture process has enabled the reduction (-41%) of the volume of the water used for each wafer produced between 2016 and 2022. The company also aims to become the first site of semiconductors in Europe to recycle its wastewaters for the production of

ultrapure water. On the other hand, STMicroelectronics tries to diversify its source of water. In March 2022, it has obtained the authorization to withdraw, through two underground wells on its site, up to an additional 2.6 million m^3 per year. In 2035, the company foresees a need of 33,600 m^3 of water per day – a 190% increase compared with the consumption in 2021. This example of STMicroelectronics shows on the one hand that it is possible to reduce the dependence on imports of chips from China or/and the United States, and on the other the importance of environmental problems, especially the need of ultrapure water. Several European countries are trying to explore on their own territory possible deposits of the metals needed for the production of chips, but also to master the technological process regarding their manufacture.

China's leadership

Since 2021 Chinese automotive industry has been dominating the national market (26 million new cars registered in 2021), the biggest in the world and the only one to have steadily grown in 2021. Foreign companies, which were thriving in this market via co-enterprises, are releasing parts of the market to national brands. The latter went to take advantage of their strength in order to challenge the European manufacturers on their own ground. South-East Asia, the exclusive hunting ground of the Japanese, is also on the line of sight, before moving to the United States. The conversion to electrical vehicles in Europe is a fortunate experience for China. The following figures highlight China's leadership.

- In China, the sales of electric cars are twice higher than in the rest of the world. By the middle of 2022, 2.4 million electric and hybrid cars have been sold in China (+113% compared with 2021). In Europe, the figures have been 1.2 million vehicles sold (+9% compared with 2021). In North America, 0.5 million cars (+49% compared with 2021). And 0.2 million cars for the rest of the world. During the first half of 2022, the sales of electric and hybrid vehicles have been increasing by 62% over a year.

- Chinese companies are those which grow more rapidly :
    - BYD (Build Your Dream), *ca*. 650,000 vehicles by mid 2022, +320%
    - Tesla (United States), *ca*. 570,000, +46%

- Volkswagen (Germany), *ca*. 350,000, 0%
- General Motors (United States), *ca*. 250,000, +15%
- Hyundai (South Korea), *ca*. 230,000, +86%
- Chery, SAIC, Geely and GAC (China), *ca*. 100,000 to 125,000 vehicles each, +220%, +24%, +334%, and +135% respectively.

- By mid-2022, 5.4% of 100%-electric new vehicles registered in West Europe have been manufactured in China.

- 88% of 100%-electric vehicles registered in West Europe have been made by Geely and SAIC.

- China's share in the world's production of batteries for electric vehicles amounts to 56%; the top ten manufacturers were in 2022: CATL (China), 34%; L.G. Energy Solution (South Korea), 14%; BYD (China), 12%; Panasonic (Japan), 10%; SK On (South Korea), 7%; Samsung SDI (South Korea), 5%; CALB, Guoxuan, Sunwoda and Svolt (China), 10% altogether.

- By mid-2022, the global production of 100%-electric vehicles was divided between: China, 44%; United States, 32%; Europe, 19%; South Korea, 4% and Japan, 1%.

For about ten years, China has supported the transition to the electric-car industry with a lot of subsidies, thus encouraging companies like Great Wall Motors, Geely, BYD, SAIC (owner of MG among others), Xpeng, FAW, Chang'an, Brilliance, Dongfeng or GAC, to consolidate their advantage. All these companies will not necessarily survive, but the end result is that in China are sold twice more 100%-electric models than in the United States, Japan and Europe altogether. And this successful result does include the infrastructures: there is a public rechargeable post for three vehicles – electric or hybrid –, whereas in Europe, in 2022, the ratio was one for eight vehicles. With the help of co-enterprises created with foreign brands, the Chinese groups have acquired a technology expertise that nobody could deny. Chinese brands are already within the world's landscape : according to Jato Dynamics 19% of the electric cars sold in Europe are made in China. The consulting firm Inovev has estimated that Chinese companies have commercialized 80,000 units in 2021, especially in Norway and the United Kingdom, and

they will reach the figure of 150,000 in 2022. We are far from the records made by the Japanese and the Koreans, but the growth rates are impressive. In France, the first Chinese company established in the country is MG, a brand of the group SAIC (Shanghai Automotive Industry Corporation), which has purchased in the mid-2000's the almost centenary British brand MG that BMW could not keep. In France, MG has doubled the number of its registered electric models each year and hopes to overcome the threshold of 10,000 units in 2022 and 20,000 in 2023 – 1% of the market. Established in France since 2020, MG industrial approach is a conventional one : no exclusive sale on the Internet, but a network of 142 approved dealers, and a continuous widening of the range of new models – five launchings in a little more than two years. The Chinese group expects to build a factory in Europe. The last model – by mid-2023 – has been the MG4 that is the rival of Renault Mégane E-Tech and of Volkswagen ID[3], with a cost of €34,990 – less than €5,000 than the French model. Regarding BYD, it is breaking the records of growth and, at the beginning of October 2022, the short-duration car renter SIXT announced that it made an order of 100,000 BYD units that runs until 2028. The Shenzhen Company, which started to work in the automotive industry in 2003, has become the world's second-biggest electric-car manufacturer, behind Tesla. The company has chosen to launch in Paris the small SUV Atto3, the seven-seat Tang and the luxurious sedan Han – with a price of €38,000 for the first model, and €72,000 for the two others, largely under the prices of the European competitive models. According to the consulting firm Roland Berger, Great Wall expects to increase its sales outside China to 1.2 million electric cars in 2025, compared with 143,000 units in 2022. The proportion of exports to the Old Continent would be 25% of the foreseen number. On the other hand, SAIC wants to double its exports, up to 1.5 million units in 2025, 20% being dispatched to Europe.

All Chinese car manufacturers have not adopted the same business strategy. Geely is the champion of participation in, and merging with external companies, after having acquired Volvo in 2010. This acquisition has not been hostile and it gives a new impetus to the Swedish brand. Geely is also a shareholder of Samsung Motors along with the French company Renault; it is also a shareholder of Daimler, Lotus and Aston Martin. The European manufacturers share a common concern regarding the business strategy of their Chinese competitors. While electrification provokes a galloping inflation

of car prices, the "made in China" could launch a takeover bid on the "popular electric motor-car" through offering car models more accessible to the middle classes who cannot afford buying new models. For instance, 400,000 units of Wuling Mini EV that cost *ca*. €4,000 have been produced and distributed. At the level of the company Great Wall, the executives think that the market of small and cheap electric-cars will rise when the cost of the batteries will fall down markedly.

How about the production of batteries? The number of projects is growing, especially in France and Germany – that may become the leading country in the Old Continent – and the hypothesis of overproduction may become a reality. According to the consulting firm Inovev, the demand for battery cells would amount to 350 gigaWatthours (GWh), whereas the announced capacities would reach a minimum of 665 GWh, which means an overcapacity of almost 50%. What therefore to do with them: export them, use them in other applications or reduce their manufacture? Several projects seem indeed to be threatened, e.g. a Tesla factory, not very far from the Gigafactory in Berlin, which may be replaced by a factory ubicated in the United States. That could be a consequence of the *Inflation Reduction Act* that will allocate fiscal subsidies only to the electric vehicles that are fuelled by batteries manufactured in North America. On the other hand, Chinese manufacturers are more and more reluctant to accept the rising costs of batteries that are imposed on them. For instance, the price of lithium has been multiplied by eight in China between September 2021 and July 2022. Moreover the world's leader of battery production, the CATL (Contemporary Amperex Technology), is confronted with a major problem that may disturb the opening of its first European unit in Erfurt, Germany. The president of CATL Europe stated the unit was suffering from a lack of gas supply, while the manufacture of batteries needs a lot of energy. Half of the energy consumption of the German Unit, expected to start production by the end of 2022, is supplied by natural gas. CATL is actively trying to find alternative solutions that may rely on renewable sources of energy and it has promised that the factory will start its production during the 2022 winter. The cut-off of the supply of Russian natural gas has not been expected by the Chinese company that announced in the summer of 2022 a €7.3 billion investment, in partnership with Mercedes, with a view to producing batteries in Hungary. It also expects to launch a third factory.

Indonesia and its electric-car strategy

Tesla, the American manufacturer of the electric cars and their batteries, has signed contracts for the supply of nickel-containing products, with two companies based in Indonesia – one of the contracts with a US$5 billion value for five years. The announcement was made by the ministry in charge of investments on the 8th of August 2022. Indonesia, the world's leading country for its nickel reserves, aims to take off in the electric-car industry and become a future regional leader in the area. On the other hand, Indonesia – the first economic power in South-East Asia with its 273 million inhabitants – has set up the ambitious goal of reducing its carbon emissions by 41% in 2030. At the G20 summit, held in Djakarta in November 2022, Indonesia wished to present itself as a country of "green" industries in the medium and long term. The contracts signed with Tesla aimed to develop the transformation of nickel ore into locally-made battery components and also for homemade electric-cars. This agreement has been opposed by the Indonesian Initiative for a Sustainable Mining; in their view, the Indonesian government has given to Elon Musk, the owner of Tesla, "the freedom (or laissez-passer) to buy Indonesian nickel without being environmentally and ecologically responsible", i.e. taking care of the impacts of mining on the environment and the ecosystems. On the 25th of July 2022, Walhi – one of the major NGOs in Indonesia – as well as a dozen of other organizations have already sent a joint letter to Elon Musk, with a view to requesting him to reconsider his investment, because of "the potential devastating impact of nickel mining", especially the important deforestation caused by the mines and the pollution due to residual wastes. Despite these reactions, the project seems to be carried out: the two smelting units that will supply Tesla in order to produce nickel-ore derived hydroxides that are the battery components. The smelting works are located in the industrial park of Morowali, in the central part of Sulawesi Islands – where the Indonesian biggest integrated site of nickel production is ubicated. It is there where has been working one of the first production units of nickel hydroxide since the winter of 2022; it is a co-enterprise of Chinese groups : Zhejiang Huayou Cobalt and Tsingshan Holding Group.

Moreover, Elon Musk has been approached by the Indonesian government with a view to investing in a factory of car-electric production whose capacity has

been estimated at 500,000 units, either in Batang (Java island) or in Borneo – in the future North Kalimantan Green Industrial Park. The Indonesian government has shown its openness regarding foreign investors – e.g. the Chinese who have invested billions of euros in the transformation of nickel ore into the production of stainless steel – but also regarding big Asian or Western car manufacturers. Nowadays, *ca*. 70% of the world demand for nickel concerns the production of stainless steel, compared with 6% for battery production. This proportion is, however, expected to increase markedly in the coming years. On the other hand, the war in Ukraine has an impact on the rise of the price of nickel ore and therefore several projects are being carried out along the whole value chain. For instance, on the 21st of July 2022, Ford has announced an investment along with the Chinese Zhejiang Huayou Cobalt and the giant Indonesian nickel group, PT Vale, in another unit of nickel hydroxide production in Sulawesi Islands. In June 2022, the Indonesian president has inaugurated the first battery factory in the country, at Batang; this is a US$9.8-billion co-enterprise between Indonesian groups and the South Korean LG Energy Solution. This factory is supposed to supply the electric cars Ioniq 5 made by Hyundai, also in Java at Cikarang since March 2022, with an annual output of 250,000 models. There is no doubt that Indonesia wants to become an important producer of electric-car batteries and also of the cars themselves. Next to the other Asian manufacturers, Indonesia can become a regional leader in this area.

How to get rid of the diesel truck?

Before 2020, the natural gas for vehicles (NGV) seemed to be the solution to get rid of the diesel engine and to seriously apply the energy transition to heavy trucks. This solution has been put aside due to the soaring cost of gas and the acceleration of the electric-motor-car industry. This acceleration could now be applied to the whole sector of transport, including the heavy trucks. To equip 44-ton trucks with batteries and to put them on the roads and highways becomes a feasible solution, whereas it was inappropriate a few years back. On the 14th of February 2023, the European Commission issued guidelines to be approved by the European Parliament concerning the measures to be applied to heavy and industrial vehicles. The goal of these measures was to reduce by 90% the exhaust of pollutants from nowadays

to 2040, compared with the 2019 levels. A first step is to reach a 45% diminution of this exhaust in 2030 and another 45% in 2035. The European Commission's aims cannot be reached without relying heavily on the electric-powered engines. As an alternative to one solution adopted for the motor-cars and consisting of on-board batteries, the use of hydrogen produced by a fuel-cell seems appropriate. Both solutions have the advantage of not producing greenhouse-effect gases and the power equipment can be carried on the truck steel frame. Electric-powered trucks are highly appreciated by the drivers, because of the silence of the engine and a smoother driving, which does not impede rapid accelerations that facilitate the traffick fluidity. Until recently there was a consensus about the following divide : on the one hand, the heavy truck equipped with batteries for urban deliveries or regional transport; and on the other, the truck powered by hydrogen for long-distance transport due to its better autonomy. But this divide does not seem too much relevant. Batteries, due to the construction of gigafactories by the automotive industry or following its initiative across Europe, offer prospects of cost reduction and make them therefore more attractive, including long-distance transport. In 2022, out of the 139 registered electric trucks in France, only three were equipped with a fuel cell. By contrast, the difficulty to produce hydrogen at a lower cost and the low energy yield are obstacles to its wide-ranging use. Regarding its ecological advantages, they depend on the process of its production. According to International Council for a Clean Transport – an environmental NGO – only a truck consuming green hydrogen – i.e. produced from water electrolysis and not yet in important volumes – could compete with a similar heavy vehicle powered by batteries over its lifetime. "In the case of less heavy vehicles, the competitivity of the batteries is rather close to the use of publicly subsidized diesel fuel; regarding long driving distances, it is possible to seize the opportunity of the mandatory resting breaks of the drivers – every four hours and half – to recharge the batteries," stated an expert in mobility of the Institute of Sustainable Development and International Relations. He also added that "due to the long distances covered by these heavy trucks, they may compensate the CO_2 volume emitted by the production of their batteries in eight or ten months."

It remains true that to make profitable an electric truck with three to six tons of batteries on board is not that easy. For instance, the cost of the model

e-TGM made by the German manufacturer MAN (Volkswagen group), which weighs 15 tons (empty) and has an autonomy of 270 km, varies between €300,000 and €350,000. This is three times more expensive than a diesel truck, but less costly than a hydrogen-powered model. The marketing director of MAN Truck & Bus France has estimated that this difference could be reduced in four or five years. MAN that is supplied by the battery factories of Volkswagen expects to build 3,000 units of its TGM in 2025-2026, including a long-distance model with an autonomy of 450 km. In 2030, the figure will be 30,000 units. A model using a fuel cell could be also developed in 2030, but this is considered as a "B Plan", for instance if there is a serious lack of supply of lithium or cobalt. At Volvo-Trucks, the position is less decisive. Even though the models with batteries evolve very rapidly, the market will be divided between the two kinds of models. A hydrogen heavy truck can travel beyond 1,000 km of autonomy, a key advantage. Volvo has signed an agreement with Daimler to develop a fuel cell for this model. Ovarith Troeung, director-general of the French building company Hyliko (Kouros group) recognizes that the hydrogen price will make the reliance on a fuel cell "a little more expensive" than a conventional battery. He prefers to insist on the "complementarity" of both technologies and he highlights the comparative advantages of his trucks whose construction was expected to start at the end of 2023 in the centre-east of France. These vehicles will be equipped with a fuel cell supplied by Toyota. Hyliko is supposed to commercialize 5,000 to 6,000 trucks by 2030. Due to their high cost (€500,000 to €700,000), long-term leasing will become a necessity. For all these actors, the challenge is to rely on a network of energy supply. The groups Daimler (Mercedes), Traton (Volkswagen) and Volvo have announced the creation of a European network which, in 2027, will have around 1,700 posts of very high power (up to 1 megaWatt), requiring an investment of €500 million. This network, according to these groups, will cover only 10% of their needs. For the future vehicles using a fuel cell, the prospects regarding the creation of a network of stations for refueling hydrogen are not yet clear. In France, for instance, CMA-CGM-Engie and the highway company Sanef have partnered up to build along a North-South axis a first network of stations that will allow the heavy trucks to be refueled with electricity and hydrogen. Whatever the technology chosen, the gradual commercialization of electric heavy trucks will most likely have a strong impact on the concentration of transport corporations.

Adaptation to global warming : design of an environment-friendly air conditioner

Bill Gates, besides the activities of the Foundation Bill and Melinda Gates in health, education and struggle against poverty, is fully involved in the mitigation of climate change and global warming. He invests in the search of innovative technological solutions : his fund Breakthrough Energy Ventures has allocated US$20 million in a start-up, Blue Frontier, focused on discovering more environment-friendly air conditioners. According to the International Energy Agency, *ca*. 2 billion air conditioners are in service in the world today, and this figure could jump to more than 50% in the next ten years, due to the increase in the number of heat waves across the globe. Such a scenario is disquieting, when, according to the National Renewable Energy Laboratory based in Golden (Colorado) and the Palo Alto Research Centre, in California, air conditioning is producing almost 4% of GEGs in the world.

In order to mitigate this impact, Blue Frontier's engineers are working an a new system of refrigeration through evaporation, that can withdraw air humidity in a more efficient way than the traditional cooling fluids that are detrimental to the ozone layer. Frontier's make use of these gases – except the chlorofluorocarbons which many countries have prohibited – but in reduced quantities. Moreover, the process proposed uses a different storage system, that would permit a lesser electricity consumption during the peak period. John Hingley, vice-president in charge of operations at Blue Frontier's, stated: "We expect a reduction of emissions equivalent to 3-5 tons of CO_2 per year and per unit of the new type of air conditioner. The latter could be commercialized in 2023 and 2024 among a few customers, before being launched at a wider scale in 2025. These air conditioners should not prevent the consumers to take the measures of soberness and reduce their consumption of electricity.

Shall we still depend on fossil sources of energy?

We are making a considerable effort in developing and installing even bigger projects of renewable sources of energy – solar, eolian and hydroelectricity – and the energy transition has started across the world. But Jean-Baptiste Fressoz, a French historian published a short article in the daily newspaper *Le Monde*, where he considers that "it is unreasonable to expect from the

renewable sources of energy – solar panels and windmills – more than they can offer." Fist, electricity production does represent only 40% of GEG emissions worldwide and 40% of this energy is already decarbonated. Withdrawing the fossil sources of energy from the global electric production before 2050 would be an extraordinary success, but still inadequate regarding the climate objectives. Secondly, the construction of an infrastructure of renewable energy production at the global scale would mean that *ca*. 50 gigatons of CO_2 would be necessary to manufacture the solar panels and windmills, as well as their components. Moreover, renewable sources of energy cannot yet be produced in a competitive way, at a sufficient scale and the appropriate time schedule, such materials like steel, cement and plastic on which depend the present infrastructures, machinery and logistics. For instance, the production of steel, using hydrogen as energy, would be according to the prospects of the International Energy Agency (IEA) of a few million tons per year after 2030 – an unsignificant quantity compared with the 1.7 billion tons annually consumed worldwide. Furthermore, since the 2000s steel carbon intensity has remained stable and it did not decrease. Regarding cement factories, their GEG emissions have trebled since 1990 and they represent nowadays 8% of global emissions. The example of plastic can be taken: it is responsible for 3% to 5% of global emissions and this situation does not seem to improve. Regarding nitrogen fertilizers, responsible for 1.5% of GEG emissions at their manufacture level, the latter could be reduced using "green hydrogen"; but in fact the emissions can rise up to 5% worldwide if one takes into account the transformation of nitrogen fertilizers into nitrous oxide by the soil bacteria.

In fact windmills and solar panels are remarkable and ever improving technologies aimed to produce electricity, but they do have little interest in the production of the above-mentioned materials. It is therefore difficult, according this French historian, to believe than in 30 years the use of renewable sources of energy could decarbonate steel metallurgy, cement factories, the plastic industry as well as the production and use of nitrogen fertilizers. Taken together, these four materials make up more than one-fourth of global GEG emissions, and they make the objective of the Paris Treaty (+1.5°C for global warming) out of reach. Jean-Baptiste Fressoz concludes: "If "green" electricity energizes the same grey world consisting of cars, cement, steel, plastic and agro-industrial products, global warming will be

slowed down". This opinion shows that fossil sources of energy will still be available in 2030 or 2050, with different degrees of use across the world. But it is just about time to stop or to drastically reduce their exploration, extraction and use, because they are cheaper than the sources of renewable energy. Notwithstanding, every country must initiate its energy transition and should have a goal: decarbonate its energy, industry and transport. It is unfortunate and even harmful to realize that most of the oil, coal and gas companies are not, for the time being, convinced to deal with the nefarious role of this fossil sources of energy in climate change and global warming. In 2023, extremes of heat waves – above 40°C around the Mediterranean, and almost 18°C for the average global temperature in July-September –, droughts, megafires almost everywhere, torrential rains and downpours, floods and their billions of dollars of damage, must induce urgent actions across the whole Planet. We have the appropriate technologies and they can help us avoid the worst scenarios. But we need political will everywhere as well as cooperation and solidarity !

PART FOUR
THE ECONOMY CRISIS

What has changed?

When the world's business and political leaders gathered in 2018 at the annual economic forum in Davos, Switzerland, the general mood was very good. Growth in every major country was on an upswing. The global economy, stated Christine Lagarde, then the managing director of the International Monetary Fund (IMF) "is in a very sweet pot." But five years later, the outlook has decidedly changed. "Nearly all the economic forces that powered progress and prosperity over the last three decades are fading," The World Bank warned in a recent analysis. "The result could be a lost decade in the making – not just for some countries or regions as has occurred in the past – but for the whole world." Indeed, many events have happened between then and now; a global pandemic hit that has put most economics on their knees; the war is Ukraine; tensions between the United States and China; and the rise of inflation, in particular the soaring cost of energy and food. It seems that everything we thought we knew about the world economy was wrong. The economic conventions that policy makers had relied on since the Berlin Wall fell, more than 30 years ago – the unfailing superiority of open markets, liberalized trade and maximum efficiency – look to be derailed. The idea that trade and shared economic interests would prevent military conflicts was shattered by the invasion of Ukraine by Russia in February 2022. The market's invisible hand that was supposed to protect the Planet has not prevented extreme weather events to destroy crops, force migrations and halt power plants. Therefore, questions about the emerging economic playing field have taken centre stage. Globalization, seen in recent decades as unstoppable force, is clearly evolving in unpredictable ways. The move away from an integrated world economy is accelerating. And the best way to respond is a subject of harsh debate, as the challenges of economic consensus have been growing for a while. The financial meltdown in 2018 came close to sinking the global financial system. The United Kingdom pulled out of the European Union in 2016. President Donald J. Trump slapped tariffs on China in 2017, setting off a kind of trade war and increasing the technological race and rivalry between the two countries.

Reason of optimism or not?

Today's sense of unease is in stark contrast with the real optimism that followed the collapse of the Soviet Union in December 1991. It was a period when

Francis Fukuyama, an American political scientist, could declare that the fall of communism marked "the end of history"" – that liberal democratic ideas not only represented "the end point of humankind's ideological evolution". Associated economic theories, like open markets, hands-off government and the relentless pursuit of efficiency would offer the best route to prosperity. There was reason for optimism. During the 1990s, inflation rate was low while employment, wages and productivity were up. Global trade nearly doubled. Investments in developing countries surged and the stock market rose.

The World Trade Organization (WTO) was established in 1995 to enforce the rules. China's entry six years later and linking a huge market with 142 countries would irresistibly draw the Asian giant towards democracy. China, along with South Korea, Malaysia and others, turned struggling farmers into urban factory workers. The furniture, toys and electronics they sold around the world generated tremendous growth. The favoured economic road map helped produce considerable wealth, lift hundreds of million of people out of poverty and stimulated technological advances and innovations. But there were failures as well. Globalization hastened climate change and deepened inequalities. In the United States and other advanced economies, many industrial jobs were exported to lower-wage countries. The market was left to decide how to deploy labour, technology and capital in the belief that efficiency and growth would automatically follow. Companies embarked on a worldwide hunt for low-wages workers, regardless of worker protection, environmental impact or democratic rights. TV sets, T-shirts and tacos were cheaper than ever, but many essentials, such as healthcare, housing and higher education were increasingly out of reach. The job exodus pushed down wages at home and undercut workers' bargaining power, igniting anti-immigrant sentiments and strengthening hard-right populist leaders, including Donald J. Trump in America, Viktor Orban in Hungary and Marine Le Pen in France. In advanced industrial economies, political leaders were not able to prevent damaging environmental fallout. Transporting goods around the globe increased greenhouse-effect gas emissions. Producing for a world consumers strained natural resources, encouraging overfishing in South-East Asia and illegal deforestation in Brazil. It turned out that markets on their own were not able to automatically distribute gains fairly or had developing countries to grow or to establish democratic institutions.

Jake Sullivan, the U.S. national security advisor, stated in a recent speech that a central fallacy in American economic policy has been to assume "that markets always capital productively and efficiently – no matter what our competitors did, no matter how big our shared challenges grew, and no matter how many guardrails we took down". The proliferation of economic exchanges between nations also failed to usher a promised democratic renaissance. Communist-led China turned out to be the global economy system's biggest beneficiary without embracing democratic values. "Capitalist tools in socialist hands," the China leader Deng Xiaoping said in 1922, when his country was developing into the world's factory floor. China's astonishing growth transformed it into the world second-largest economy and a major engine of global growth. All along, though, Beijing maintained a tight grip on its raw materials, land, capital, energy, credit and labour, as well as the movements and freedom of speech of its people.

Dire results for developing countries

The economic havoc wrecked by the pandemic (Covid-19), combined with soaring food and fuel prices caused by the war in Ukraine have created a spate of debt crises. Rising interest rates have made those crises worse. Expenses, such as for energy and food, are often priced in dollars on the world market, so when US interest rates go up, debt payments are more costly. Poorer nations were pressured to lift all restrictions on capital moving in and out of their countries. Allowing governments, businesses and individuals to borrow from foreign lenders would finance industrial development and key infrastructure. "Financial globalization was supposed to usher in an era of robust economic growth and fiscal stability in the developing world," stated Jawati Ghosh, an economist at the University of Massachusetts at Amherst. But "it ended up doing the opposite." Some loans – whether from private lenders or institutions such as the World Bank – did not produce enough returns to pay off the debt. Others were poured into speculative plans, half-baked proposals, vanity projects and corrupt officials' bank accounts. And the debtors remained at the mercy of rising interest rates. Over the years, reckless lending, asset bubbles, currency fluctuations and official mismanagement led to boom-and-bustle cycles in Asia, Russia, Latin America and elsewhere. In Sri Lanka, for instance, extravagant projects undertaken by the government, from ports to

cricket stadiums, helped drive the country into bankruptcy in 2022 as citizens scavenged for food. And the mandated austerity that accompanied bailouts from the International Monetary Fund (IMF), which compelled governments to slash spending, often brought misery by cutting public assistance, pensions, education and health-care. Even IMF economists acknowledged in 2016 that instead of delivering growth, such policies "increased inequality, in turn jeopardizing sustainable expansion."

Cheap imports loosing importance

Josep Borrell, the European Union's head of foreign affairs and security policy, put it bluntly in a speech ten months after the invasion of Ukraine. "We have decoupled the sources of prosperity from the sources of security." Europe received cheap energy from Russia and cheap goods from China. "This is a world that is no longer there," he added. Supply-chain chokeholds stemming from the pandemic and subsequent recovery that already underscored the fragility of a globally sourced economy. As political tensions over the war grew, policy-makers quickly added self-reliance and strength to the goals of growth and efficiency. "Our supply chains are not secure, and they are not resilient," the U.S. Treasury Secretary Janet L. Yellen, stated during the spring of 2023. Trade relationships should be built around "trusted partners", she added, even if it means "a somewhat higher levels of cost, a somewhat less efficient system." "It was naive to think that markets are just about efficiency and that they are not also about power," said Abraham Newman. Economic networks, by their very nature, create power imbalances and pressure points because countries have varying capabilities, resources and vulnerabilities. Russia, which had supplied 40% of the European Union's natural gas, tried to use that dependency to pressure the Western block to withdraw its support for Ukraine. America and its allies used their domination of the global financial system to remove major Russian banks from the international payments system.

China manufactures 80% of the world's solar panels. Taiwan produces 92% of advanced semiconductors. Much of the world's trade and transactions are figured in US dollars. The new reality is reflected in American policy. The United States – the central architect of the liberalized economic order and the World Trade Organization (WTO) – has turned away from more comprehensive free-

trade agreements and repeatedly refused to abide by WTO decisions. Security concerns have led the J. Biden administration to block Chinese investment in American businesses and limit China's access to private data on citizens and to new technologies. And it has embraced Chinese-style industrial policy, offering enormous subsidies for electric vehicles, batteries, wind farms, solar plants and more to secure supply chains and speed the transition to renewable sources of energy. "Ignoring the economic dependencies that had built over the decades of liberalization had become really perilous," stated J. Sullivan. Adherence to "oversimplified market efficiency", he added, proved to be a mistake.

Replacing the present economic orthodoxy

While the previous economic orthodoxy has been partly abandoned, it is not clear what will replace it. Perhaps the only assumption that can be confidently relied on is that the path to prosperity and policy trade-offs will become murkier.

"**Are we entering the big stagflation**"?

This question has been raised by Nouriel Roubini at the beginning of 2023. N. Roubini, professor of economy at the University of New York, has been among the very few who predicated the 2008 economy crisis. He has been called "Doctor Catastrophe" because of his dire predictions. On the 12th of January 2023, he has published a new book on the "*Megathreats*" where he recapitulates the risks to which our societies are confronted in 2023 and beyond, particularly and above all a financial (economy) crisis. In an interview with the French daily newspaper *Le Monde*, published on the 14th of January 2023, he highlighted the differences between 2008 and 2023. In the short term, the risks are associated with the implications of the war in Ukraine, with a galloping inflation (especially the cost of energy and foodstuffs that are soaring) and with a financial crisis that may occur in the forthcoming two or three years. Among the megathreats occurring in the short and long terms, which do not entirely rely on economy, one can quote the climate change and global warming – with catastrophic implications for the Planet –, the political tensions that may lead to a global war, as well as the social and political instability. We have to acknowledge a backlash against the liberal democracies

and we are therefore seeing a trend towards authoritarian regimes. In the field of inflation, by contrast with the opinion of political decision-makers and central banks, the phenomenon is not temporary but persistent. Even though some prices are starting a decrease in some countries by the end of 2023 or the beginning of 2024, inflation persists and reduces the consumers' purchasing power worldwide. N. Roubini quotes the example of the United Kingdom that is at the border of stagflation with a very high inflation rate. He also believes that the increase in the interest rates by the banks, while the economy is slowing down, with a level of debt very superior to that of the 1970s, could provoke a collapse of the stock markets – a factor that would worsen the recession. He said that he was more concerned about a prospect of a trade war between the western world and a group of powers such as Russia, China, Iran or North Korea. That would lead to a fragmentation of globalization and relocation of the production chains – a factor increasing global insecurity. The United States have started an economic and technological war against China, particularly through imposing sanctions in the semi-conductor industry. By contrast, Europe maintains sustained exchanges with China, exporting goods and/or sustaining a production for the local market. If the tensions would become stronger between Washington and Beijing, e.g. because of Taiwan, the Europeans would be caught in a vice.

Regarding the climate-change issue, the cost resulting from attacking the problem and its implications will be high in the short term, while the benefits could be recorded in the long term. Obstacles are numerous: even in the United States, part of the population is still skeptical about the reality of climate change and global warming. There is also an intergeneration conflict, because the senior people, who vote today, are not willing to make sacrifices that will benefit the future generations. On the other hand, the coordination of the response to this issue among the member States is very difficult. The developing or emerging countries are very reluctant to make the efforts demanded by the industrialized countries that are responsible, to a large extent, for the pollution of the Planet since the industrial era. Not to mention the greenwashing that will occult the absence of truly adequate decisions in this area. The green transition will be costly and will increase inflation. N. Roubini agreed that the measures aimed to increase future growth or to reduce the social inequities depend on structural policies that are not in the area of

action of central banks. It is also true that budget policy, when it is too laxist and distributes money that may be spent to perhaps rise inflation, impedes the monetary policy whose objective is to keep the prices under control. This happened in recent years in the United States. In Europe, by contrast, the budget policy rather contributes to contain inflation through the limitation of the rising energy costs.

Regarding the countries' public debt, N. Roubini recalls that these debts increase when the expenses are rising or when the revenues are insufficient. But we must expect to considerably spend money in the coming years: these expenses are associated with the increase in the number of old people, the assistance provided to the losers of globalization – this kind of assistance will be even more relevant when artificial intelligence will destroy thousands of jobs –; also with the marked increase in defence budgets, the struggle against climate change and the multiplication of pandemics. Part of the solution will be through inflation that reduces the burden of the debts. N. Roubini stated that he was not saying that inflation is something one could wish, but he does not see how to avoid it. And he concludes: "The era of the great moderation is over, we are now entering the great stagflation." He goes on to explain his viewpoint. In 1914, the Western world comprised great nations who benefited from the industrial revolution. However, the globalization of trade and exchanges did not prevent the First World War, the "Spanish" flu, the stock-market collapse in 1929, the Great Depression of the 1930s and massive unemployment, the power grip by the fascists and the Nazis in Europe, the Second World War and the Shoah. After all these disasters, the creation of large international institutions has been followed by a period of relative peace and prosperity. N. Roubini thinks that this period cannot last forever, because new threats have been developing since the 1940s – such as climate change and global warming, or the risk of a nuclear war. My book, he stated, is a call for action, while we seem to be still jammed somewhere between the anger and denial.

Galloping inflation and the threat of a global recession

"The clouds of recession are extending across the world," warned Seth Carpenter, chief economist at Morgan Stanley, an influential American bank. "For the consumers, a long and cold winter is on the horizon," added Tamara

Vasiljev from Oxford Economics. An awful consensus is emerging among the economists: the Eurozone will be in recession before the end of 2022, the United States could perhaps escape, but they will not avoid a serious brake to their economy; regarding China, the engine of the world economy for 25 years, its economic growth rate has never been so fragile. One should add the United Kingdom, already in recession, Central Europe, struck by the implications of the war in Ukraine, and a lot of developing countries going through a serious crisis – Lebanon, Sri Lanka, Pakistan (almost bankrupt), Turkey facing an inflation rate estimated at 80%. This is not nevertheless a catastrophic scenario: "We are not on the eve of a great crisis such as that of 2008, but we are likely heading for a world recession. It is true, however that the year 2022 began with full optimism: the Covid-19 pandemic seemed to come to an end, while the households did not suffer too much thanks to an unprecedented support of the governments. There was been a rise in inflation, but, according to the majority of experts, the phenomenon was above all the concern of the United States and was temporary. But this optimistic scenario has been derailed for two reasons. First, the Western world has been going through the worst inflation outbreak in 40 years, caused by the economic disturbances following the sanitary crisis – disorganized logistic chains, tense work market – and thereafter the war in Ukraine. China has been carrying out a very strict zeroCovid policy. The forecasts of the International Monetary Fund (IMF) that are constantly pessimistic, illustrate this slow change. In October 2021, the IMF has predicted a global economic growth of 4.9% for the year 2022; in April 2022, it lowered it down to 3.6% and in July 2022 it revised it again to 3.2%. And this level was considered overoptimistic by many economists, e.g. Morgan Stanley that predicted a growth rate of 2.5%.

The Old Continent has been struck by the big gas shock. At the beginning of 2021, across Europe the price of the gas was around €15 the megaWatthour (on the Netherland's market, considered as the reference). By mid-June 2021, it rose up to €100, and on the 1st of August 2022 the price of €200 has been reached. After having bounced briefly to €340, it fell down to €282 on the 29th of August 2022. This was unprecedented; even during the 1970s this has never occurred. As we did say for the oil shock, the gas shock will have two violent impacts. The first one concerns the consumers, which generally spent almost 10% of their income to buy energy (an average). The increase

in the cost of heating, electricity, petrol at the service stations, etc., provokes a high rise of inflation – around 9% in the Eurozone. The household income will drop by 4% in 2022, according to Andrew Kenningham, an economist, specialist of the Eurozone at Capital Economics, who added that this situation would lead to a recession by the end of the year. The second impact will concern industry. Some factories are closing down because they are not more profitable: for instance, the Belgian company Nyrstar has announced that it will suspend the operations of zinc foundry located in the Netherlands since the 1st of September 2022. Two countries with an important industrial base have been struck: Germany and Italy. In Germany, before the beginning of the war in Ukraine, on the 24th of February 2022, economists forecast an average economic growth rate of 3.5% in 2022, then they reduced it to 1.5%, and according to some economists this figure is still quite optimistic. It may be brought down by at least one point. In addition to these difficulties and to struggle against inflation, the European Central Bank (ECB) has increased its interest rate in July 2022, for the first time since 2011: On the 27th of August 2022, Isabel Schnabel, member of the ECB board, announced that this was just a beginning, and the economists' forecasts are that the ECB will again increase its interest rate by at least 0.5 point or even 0.75 point.

In Spain, the general annual inflation rate amounted to 1.9% in June 2023, under the objective of 2% fixed by the European Central Bank (ECB) and the gross domestic product (GDP) has jumped 5.5% in 2022 and will grow again in 2023 – 2.3%, twice the average predicted in the European Union. Despite these positive factors and others concerning the 47% increase in the minimum salary (since June 2018), the adjustment of pensions to the inflation rate (+8.8% adjustment of these pensions in 2023) and a decrease in the proportion of working contracts with fixed term, living conditions are not that good. According to Yolanda Diaz, the vice-president of the government led by the socialist Pedro Sánchez, "inflation is hitting the people with low-income; the cost of life has risen, and the health and education staff have been exhausted since the Covid-19 pandemic." Soaring prices of foodstuffs are a major concern for middle- and low-income social categories. Because, if the inflation rate amounted to less than 2% due to the cancellation of VAT on some foodstuffs, since 2018 prices have increased by almost 30% and the energy bill has risen 40%, despite the government's "shield" to put a ceiling price

for the gas. The loss of purchasing power has been estimated at 4.5% and henceforth 9% of Spanish households could not meet their basic expenses, according to a report of the Bank of Spain published at the beginning of July 2023. Social inequities have worsened and some categories of the population, that suffer from inflation and the rise of interest rates, are loosing a big chunk of their purchasing power. This situation is likely to have an impact on the results of the legislative elections that took place on Sunday 23rd of July 2023, five years under the leadership of P. Sánchez. These elections have resulted in no majority for the two main parties (PSOE, socialist, and PP, Partido Popular). The high interest rates are weakening thousands of households. The latter, who acquired their homes with an almost nil real-estate loan between 2016 and 2022, have now be confronted with a rate of 4%. In the case of an average loan, the monthly disbursements have increased by almost €300 since the beginning of 2022. Furthermore, Spain's public debt has grown by 16% since 2008 (113% of the GDP). In order to help households, the PSOE has proposed to freeze the loan interests during a year and to extend to seven years the loan duration for the poor families. On its side, the PP suggested to help the loan holders with €750, to diminish taxes for those who declare less than €40,000 of income per year as well as to cancel the VAT on meat, fish and preserves – which were not included in the approved VAT cancellation by the leftist government.

In the Eurozone, in July 2023, the stagnation of the economy is noteworthy for the fourth term. After a 0.1% decrease in the GDP during the last term of 2022 and also during the first term of 2023 – a technical definition of a recession –, the Eurozone has shown the same trend during the second term of 2023 and is likely to do so during the following term. The annual inflation rate has retreated to 5.3% in July 2023, compared with 5.5% in June 2023 and 6.1% in May 2023, due to another decrease in the energy price, according to Eurostat. However, food prices are quite high: inflation rate reached 10.8% in July 2023, compared with 11.6% in June 2023. On the other hand, the ECB still increased its interest rate, +0.25 point expected at the end of July 2023 and another increase in September. This situation does not lead to a strong or significant jump for the economy across the member States of the European Union. In China, President Xi Jinping has been betting on an economic growth rate of 5.5% in 2022, but according to the International Monetary

Fund (IMF) this rate would not be higher than 3.3%. On the 24th of August 2022, the president announced a new plan that aims to boost the economy: 2,600 billion Yuan (€377.3 billion), including all the incentives given since the beginning of the year, aimed to save economic growth. In 2023, the prediction of economic growth was 4.6%, compared with 8.1% in 2021. Regarding the United States, the big economic problem is the inflation rate; despite a slight decrease the annual rate remains at 8.5% in 2022. The Federal Reserve (FED) is doing everything to reduce it and to reach its long-term objective of 2%. As announced by its president, Jerome Powell, its endeavour could even harm the households and companies". Since March 2022, the FED has increased its interest rate: +1.25 points and this already had noteworthy implications: for instance, a real-estate loan with fixed rate for 30 years is costing in 2022 5.5% compared with 2.7% earlier on. One may therefore ask if this trend could provoke a recession. In other words, could the FED succeed in reducing the overall inflation rate without causing a significant increase in the number of those seeking a job? For the time being, unemployment rate is at its lowest level for the last 50 years and the last statistics on job creation (half a million in July 2022) are optimistic. But according to the economists of the bank UBS, "this trend is not sustainable". In their note, they underline that Americans rely more and more on their credit cards or to consumption loans in order to counter their decreasing purchasing power. On the other hand, the job market is so tense that "it will not be possible to find out people who look for a job". The balance, for the FED, will be precarious.

Another factor that is associated with the economic developments is the struggle against extreme social inequities across the world. That is why a number of economists, including Joseph Stiglitz (professor at Columbia University and former World Bank's chief economist), Helen Clark (former New Zealand prime minister, 1999-2008, and the United Nations Development Programme's administrator, 2009-2017), Thomas Piketty (director at the French School for Higher Studies in Social Sciences and a scholar at the Paris Economy School), Ban Ki-moon (former UN Secretary-General (2007-2016), etc. have requested the United Nations through their Objectives of Sustainable Development (OSD) and the World Bank to support new objectives and indicators aimed at deploying more efforts to struggle against the increasing extreme inequities. They stated that in our world extreme poverty

and extreme wealth have increased markedly and simultaneously for the first time in 25 years. In 2019-2020, the world inequities have been growing more rapidly than in any period since the Second World War. The wealthiest 10% of the global population are presently recovering 52% of the world revenue, whereas the poorest half of the global population does receive only 8.5%. Billions of people are facing the worst difficulties of their lives due to the soaring prices of food and to starvation, while the number of billionaires has doubled during the last decade. These high-level experts underlined that these extreme inequities counteract all our social and environmental objectives. They destroy political trust and hinder collective economic prosperity. They also weaken multilateralism. Without a strong reduction of these inequities, the double objective of eradicating extreme poverty and avoiding the collapse of climate is obviously difficult to reach. They therefore request the World Bank and the United Nations – objectives of sustainable development aimed at decreasing inequities – to make more efforts to reduce these extreme inequities. If this were done, that would send a clear signal regarding our collective ambition to build a more equitable world.

Finally, is recession still a possibility?

On Wednesday the 26th of July 2023, *The New York Times International Edition* published an article titled *A recession is still a real possibility* by Peter Coy who has written about economics for nearly 40 years. P. Coy quoted his colleague Paul Krugman who wrote on the 18th of July 2023 that "a happy outcome that, not long ago, seemed like wishful thinking, now looks more likely that not". *The Times* asked, also in July 2023, "Could the recession in the distance be just a mirage?" It is true that in the United States unemployment was still low. Inflation has come down, lessening the need for the FED to cool the economy off with higher interest rates. Consumer confidence had strengthened. And the stock market was up, which makes people feel wealthier and in the mood to spend. Consumers still had unspent savings from the pandemic stimulus; businesses were slow to lay off workers even if conditions worsened, because talent was hard to find; household and business debt loads were light; and oil prices have receded. Despite all these favourable conditions, P. Coy was sticking to his prediction of a recession in the United States. He has been hammering on recession for a long time.

Looking at every recession since December 1969, the economist David Rosenberg has calculated that, on average, the Leading Economic Index starts to decline 13 months before a recession begins and falls 4.6% at this stage. By that metric, P. Coy thinks that we are even deeper into the danger zone than we were ahead of past recessions: June 2023 marked 18 months since the index's peak, and the decline from the peak has been 9.9%. The leading index is called "leading" for a reason. "Fifteen strikes in a row on the LEI and the economy is out". In July 2023, in a Bloomberg survey of 73 forecasters, the median forecast for the likelihood of a recession in the next 12 months (2023-2024) was still 60%. There are, according to P. Coy, solid reasons for their pessimism. The FED's interest-rate increases need time to be effective; their full force will hit the economy over the coming months. Rising interest rates have already dug into home sales' volume and prices and put pressure on small banks. Retail sales adjusted for inflation have fallen. In addition, there are special factors that are dangerous for the economy. Russia's attempted embargo on Ukraine's Black Sea ports has caused wheat prices to spike. The resumption of student loan payments will force many consumers to cut back on spending. P. Coy is therefore sticking to his recession forecast.

EPILOGUE

When humankind is coping with so many crises across the whole world and when there are few examples or opportunities for rejoicing, are we doomed to failure, can we still manage the Planet in a balanced and equitable way? The year 2023 has been the year of records in climate disturbance, global warming and extreme weather events. Heat waves with daily temperatures above 50°C in many places, e.g. around the Mediterranean Basin, in China or United States – in Phoenix, the capital of the State of Arizona, the heat was suffocating as it was stiflingly hot. Megafires have been going on, even in unusual places, like Canada. In this country, from west to east, 13 million hectares (the total surface of Greece for example), compared with 7.3 million hectares in 1989, of forests and woodlands have been reduced to ashes by mid-2023 and thousands of households have been burnt to the ground. On the Island of Rhodes, Greece, 18.000 hectares (15% of the whole territory) have been destroyed by the fires and 20,000 of tourists have been evacuated. Catastrophic floods followed suit almost everywhere, the superficial water temperatures of the oceans have jumped, sometimes up to 30°C in some areas of the Mediterranean Sea, and the average global temperature has reached 17°C-18°C. Tornados, typhoons and hurricanes have inflicted more damage than usual, because they were stronger and more frequent. The subsequent loss of biodiversity has been observed everywhere, whereas Island States are threatened of being submerged by the rising sea level. And the scientific facts have shown once again the relationship between these events and global warming, considered as the main consequence of human activities: the emissions of greenhouse-effect gases (GEGs). It is out of question to listen to the noisy statements of some groups of climate-skeptic people, based on fake news and scaremongering. But rather to hear the anxiety of the youth all over the world requesting urgent action by the decision-makers, i.e. the politicians and governments, to repair what can still be repaired and adopt another type of environment management. We seem to be quite far from the target of +1.5°C for global warming as this has been agreed in Paris at the COP21 (2015). The International Group of Experts on Climate Change (IGECC), as well as the United Nations agencies, have warned that with the present annual rate of GEG emissions the temperature of the Planet would be above +3°C. And there is a long-standing and tedious negotiations about the need and amount

of the assistance wealthy countries should provide to developing countries, including poor Island States, with a view to helping them repair partly the devastating damage of extreme weather events and implement their ecologic transition. There are of course commendable endeavours by some countries, like those made to drastically reduce their annual emissions of GEGs. But they are far from reaching a minimum of US$100 billion per year of assistance, as well as they are far from carbon neutrality in 2050 !

And we have not yet been able to erase hunger, starvation and extreme poverty across the Planet. Efforts have been made nevertheless by a few countries to upgrade the conditions of people and to help them climb up the social ladder. China is the outstanding example as it has been drawing hundreds of million people out of extreme poverty. Brazil, during the first presidency of Luiz Inácio Lula da Silva and thanks to the national programme *Bolsa Família*, has made similar commendable efforts. Both countries attacked the roots of poverty and they have been stubborn in their strategies. But a lot remains to be done, when extreme poverty and hunger are worsened by droughts, water stress, the lack of drinking water and food supply; the enormous disasters of the extreme weather events strike more the poor people than other social categories. Through the struggle against poverty we are confronted with the need to drastically reduce social inequities across the world… And in the present agrifood crisis, we see middle-class people becoming new poors; they cannot make the ends meet, they rely on charity associations that distribute daily or weekly bags of basic foodstuffs. There are also government-subsidized institutions that try to do the same in order to limit the damage caused by the soaring prices of foodstuffs, housing and energy. In fact, a profound social reform, embracing employment, education, health-care and justice, is needed; because we are facing not only the difficulties – national or/and international – of food supply, but also the structural social inequities and the lack of economic justice. We need to review the distribution of national income, as well as our agriculture and food systems in order to use more effectively and ecologically our natural resources. We must head for a "rational" agriculture, more sustainable and consuming less inputs such as fertilizers; for a livestock breeding and industry that is in tune with the protection and reclamation of natural resources – such as forests and woodlands – as well as with the efforts made to reduce their environment carbon imprint. We also need to change

our food habits: consume less red meat for those who eat too much of it and, conversely, allow the poors to consume a little of it; the overall trend should be to have a food diet based on plant proteins and to reduce, sometimes drastically, the consumption of red meat.

Europe has seen its supply of cheap Russian natural gas suddenly cut off due to the war in Ukraine. The prices of gas and energy in general have soared. Europe has to find out new suppliers, but at higher costs. The energy crisis spread out across the globe and resulted in the increased production of liquefied natural gas (LNG), a profitable outlet for some countries like the United States that used shale gas and also a good fortune for the South Korean shipyards that built a record number of methane ships to transport LNG. Once again the poor- or middle-income social categories have to bear the brunt of the soaring prices of energy. The price of the oil barrel rose, then fell down, but rose again. The industrialized countries, followed by a few developing ones like India, Indonesia, and led by China, have reacted, like in 1973 in front of the oil shock, by accelerating the production of renewable sources of energy. Wind (eolian), solar energy and hydroelectricity are the future and they must be. It is true that we shall rely on fossil energy, but to the minimum extent possible and for those uses that are indispensable (petrochemistry). But we ought to stop all kinds of investments into exploring and exploiting new deposits. Rather, it is time to move swiftly and urgently to all uses of "clean" electricity, including in the motor-car industry. Competition is, and will be harsh, between nations in order to build the cheapest electric motor-cars and make them accessible to the largest number of people. Nuclear energy and the electricity derived from it can help decarbonate the industry and provide a lot of consumers with a CO_2-free energy, but more research is needed to treat the radioactive wastes and to strengthen all the safety measures of the nuclear plants. We must get rid of fossil energy sources and we have the technological means to do so; once again, we must help developing countries to follow the same trend and to undertake their ecological transition.

Since the end of the Second World War, humankind has known several global recessions, and since the last two years (2021-2022) we seem to be confronted with another recession across the world. In Europe, the annual inflation rate has been 4% to 5%, while this rate has been 14% to 15% for

foodstuffs. And we can easily imagine the increasing difficulty of low- and even middle- income social categories to feed themselves and their families, and to pay their electricity bills and rents or loans. This global recession seems to last, while economic growth rate is low: we are far from the 2% recession rate and from the economic growth rate of 5% to 6% in wealthy countries. While reflecting on the roots of galloping inflation, many economists, social scientists and philosophers are hammering that we may come to an end of the present global economic pattern. Should not we try to invent another model, more equitable and respectful of nature, carrying out a smooth and sustainable ecological transition, that could save the Planet. Many regions of the latter cannot sustain life in the coming years due to the frequency and increasingly devastating extreme weather events. The only way out is adaptation, equity, soberness and the respect of human rights. We can "*Make the Planet Great Again*", if swift and sustainable action follows the speeches and the diagnoses, i.e. proceed quickly to drastically reduce the emissions of greenhouse-effect gases and gradually stop the use of sources of fossil energy. This is the repeated claim of environment activists and also of the youth who will inherit this Planet in a rather devastated state. But there is hope, despite some irreversible damage, if we act urgently and if the wise custody of the Earth prevails over selfish and greedy interests. There is also hope when we listen and reflect on the conviction of Pope Francis, who stated at the World Youth Days (JMJ, Lisbon, Portugal, 1-6 August 2023): "Let us listen not to the agony moaning, but to the childbirth moans." This window of opportunity will not last forever, and we ought to act urgently in order to avoid the collapse. *We are not doomed to failure, if we decide to act at once* !

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About the book

When humankind is coping with so many crises and when there are few examples for rejoicing, are we doomed to failure, and can we still manage the Planet in a balanced and equitable way ? The year 2023 has been the year of records in climate disturbance, global warming and extreme weather events (EWE). The latter have inflicted much more damage than ever, because they were stronger and more frequent. Scientific facts have shown once again the relationship between these EWEs and global warming – a result of human activities and the related emissions of greenhouse-effect gases (GEGs). Now, we seem far from the target of +1.5°C for global warming, as agreed in Paris at the COP21 (2015).

And we have not yet been able to erase hunger, starvation and extreme poverty across the Planet, when these conditions are worsened by droughts and EWEs that strike more the poor than other social categories. We must head for a "rational" agriculture and livestock breeding, more sustainable and consuming less inputs, and review our food systems.

Following the war in Ukraine and the interrupted delivery of Russian cheap natural gas to Europe, the energy crisis spread out across the globe and resulted in the increased production of liquefied natural gas (LNG). We ought nevertheless to stop all investments into exploring and exploiting new fossil-energy deposits and to move urgently and swiftly to all uses of "clean" or green electricity, including in the motor-car industry.

Since the end of the Second World-War, humankind has known several global recessions and since 2021-2022 another recession has been looming on the horizon. While reflecting on the roots of galloping inflation, many economists, social scientists and philosophers are hammering that we may come to an end of the present global economic pattern. We can *"Make the Planet Great Again"*, if swift and sustainable action follows the speeches and diagnoses, e.g. drastically reduce the emissions of GEGs and gradually stop the reliance on sources of fossil energy. There is hope if we act urgently, but this window of opportunity will not last forever. *We are not doomed to failure, if we decide to act at once !*

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