Università
Ca'Foscari
Venezia

Master's Degree

in

Languages, Economics and Institutions of Asia and North Africa

Final Thesis

# China's Environmental Crisis

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**Academic Year**
2018 / 2019

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# 前言

科学家谈论气候变化和自然污染事件多年，但是它却在近年来才成为大众所关心的事件。现在人们认为不能忽视这个问题。历史上地球温度自然而然地改变，但是科学家认为现在的变化却是因为人类活动，这些活动是造成温室气体最主要的原因。18世纪，在欧洲发生了工业革命，那时煤炭成为主要燃料，被用于发电及产生热良。燃烧的时候，在空气中分散着二氧化碳(CO2)、一氧化碳(CO)、二氧化硫(SO2)和别的煤气。这些气体之中，有的具有污染性和危险性，其导致的最明显的后果就是雾霾。当年人们大量使用煤炭，天空变为黑色，空气也无法呼吸。那些年，很多人死去，有的人死于呼吸了污染气体，其他的人则因为在雾霾中能见度低死于交通事故。

煤气之间也有温室气体，[1]他们都形成温室效应。温室效应是一个包围地球的壁障。在自然界已经存在温室效应，它使得地球成为适和人类居住，它吸收太阳的红外线辐射，保持大气温度。如果没有温室效应，地面平均温度会是 -18°C。

虽然温室效应是自然的，但是现代烧煤和人类活动使它的密度增长了。因此被温室效应吸收的太阳的红外线辐射越来越多，而地面温度越来越高。这种不自然的温度增加影响全世界男女生活， 让他们经历灾难性的事件。

- 越来越高的温度及越来越长旱灾时间
- 更加疯狂的天气，每年的飓风越来越多
- 冰川融化、冰海缩小、海平面上升
- 海洋的温度和酸度增长

上面所举的例子都是人类活动变更自然的证据。地球是一个身体，所以它的反响不会只体现在一个地区，它的反响是所有人类要共同面对的问题。由于不少地区都出现了温室效应，因此世界上所很多国家的政府都决定介入气候问题。

1992 年多国政府在巴西里约热内卢会谈，他们想找到环境问题的答案。那时经过会谈撰写了《联合国气候变化框架公约》。[2]根据“共同但有区别的责任”原则，公约里面各当事人承担“将大气温室气体浓度维持在一个稳定的水平，在该水平上人类

[1] 温室气体，Greenhouse Gas (GHG)
[2] 联合国气候变化框架公约，United Nations Framework Convention on Climate Change (UNFCCC)

活动对气候系统的危险干扰不会发生”(Baidu Baike, 2019: online)。[3]联合国气候变化框架公约是第一个重要的气候变化的国际首脑会议。从那以后，全球的国家每年见面，这个会议被称为缔约方会议,[4]最有名的是京都的第三个缔约方会议和巴黎的第二十一个缔约方会议。

本文主要探讨了中国的情况，这是因为现在中国环境的情况跟 18 世纪的欧洲环境差不多。作为世界上人口最多的国家之一，还有作为最大的发展中国家，中国在反污染反气候变化中发挥着重要作用。因为“中国是拥有 13 多亿人口的发展中国家，是遭受气候变化不利影响最为严重的国家之一.”(SU Wei, 2015: p. 1)，中国一直就承担着自己的责任，也参加了环境保护的国际公约，并在中国国内发布施行新的环境国内法则。

本文由三部分组成， 分别是：中国历史上人类和自然的关系、中国的污染事件、气候变化的问题。

第一章介绍了中国人口和自然关系，先从古典哲学描写，然后是事实说明。一开始，文章用儒家和道家的观点解释了这种关系，因为他们是中国本土产生的最古老和重要的哲学。其他影响关系的因素是天命。封建社会时期，人们认为天命决定一切，也决定了君王有没有好好地治理。上天通过灾害表示它的主意，如果特大洪水或者旱灾接踵而来，它的意思是君王治理得不好。稍后本文使用更实际的观点，观察人们周围的环境。我们明白中国人环境行为的原因，然后描写那个行为的变化。20 世纪的时候，那个行为急速地改变，因为有很多管家的变化。1905 年封建统治衰亡，然后有国民党的盛衰。1949 年中华人民共和国成立。中华人民共和国成立以后，毛主席想改变国家的经济，想让中国成为发达国家，想提高它的国际重要性。 1958 年大跃进开始，那三年的时候毛主席相信人口提高中国工业的水平。毛主席非常重视重工业，人口就在到处建造冶炼炉。一次污染问题、温室气体排放和森林破坏飞涨。大跃进十年后，文化大革命是第二个发展的尝试。毛主席的死亡和文化大革命的结束同时发生了。

[3] “百度百科”(Baidu Baike)是一集中国网上协同的百科全书

[4] 缔约方会议，Conference of the Parties (COP)

最后部分的章节说明现代的情况。1978 邓小平颁布经济改革，然后 2001 年中国参加世贸组织。[5]那以后，中国温室气体排放量、环境污染问题加剧。今天在世界上，中国的二氧化碳排放量位居第一。

这是为了环境污染是第二个章节的内容。我特别描写土壤污染、大气污染、水污染的事件：

- **土壤污染**的主要原因是城市化和森林破坏，他们都减速了土地的降解过程。联合国粮食及农业组织[6]也说土壤污染危及粮食安全。
- 水系统不仅有水资源短缺，还有**水污染**加剧的问题。不全是饮用水，河流已被生活和工业废水排放的有毒废水污染，因为他们不过滤废水。加上河流和湖泊里的有机废物导致富营养化。
- 煤炭和其他的化石燃料是**大气污染**的主要原因。中国人把煤炭用作生产能源，它是大部分地区的主要能源，不仅在工业方面，在家庭生活方面也是。汽车的气体污染是别的大气污染的原因。中国私家车车主众多，跟美国人口差不多一样的。

此外，也有酸沉积的污染。酸沉积是大气污染的后果，气里的硫磺和氮气化学反应，他们成为硫酸和硝酸。硫酸和硝酸伤害土壤水流改变他们的自然酸性。

上面提到的污染不仅影响环境，它也影响人们健康和国内经济，因此中国政府开始反污染。为反污染，中国改善投资再生能源和天然气。现在中国是世界上第三个天然气用户的国家。它也建设新的核电站而让老煤电站提高效率。因此他们可能增长产生的电力从而减少煤炭的使用。

第三个章节的内容是国家的气候变化易损性、签署的国际公约、大气污染问题的减轻和调试计划。气候变化是地球的周期性变化。气候与大气密切相关,温室气体让大气温度变暖，气候也随之变化。气候变化能导致可怕后果，在《强化应对气候变化行动—中国国家自主贡献》[7]中国国家发展改革委应对气候变化司司长写到“气候变化对全球自然生态系统产生显著影响，温度升高、海平面上升、极端气候事件频发给人类生存和发展带来严峻挑战.” (SU Wei, 2015: p. 1)

[5] 世贸组织，World Trade Organization (WTO)
[6] 联合国粮食及农业组织，Food and Agriculture Organization of the United Nations (FAO)
[7] 2015 年巴黎协议的中国国家自主贡献

介绍中国易损性的程度以后，我列举了中国签署的环境国际协议。

1997 年，多国政府在日本京都见面。多国政府约定《京都议定书》。但是它不能履行，因为签署的国家不足。议定书将由 55 个国家都签署，还有那个国家应该涵盖55%数量的排放。那个时候中国说除非协议不会减缓中国的发展它才签署环境国际协议，发达国家发展的时候不考虑环境的安全，中国认为发展中国家与发达国家应该有相同的机会。

2015 年，在第二十一个缔约方会议国家都签署巴黎协议。大家希望这是京都议定书的后嗣。巴黎协议说所有的会员应该承诺使温度不会增加 1.5 度以上。发展中国家和发达国家的标准不能一样的，所以每个国家供给自己的国家自主贡献。[8]在它的国家自主贡献，中国说它采取缓解和适应的措施。缓解措施是减排的措施，而适应措施是减少对基础设施和人口破坏的措施。制定的目标是 2020 年之内减少排放量，增加可再生能源的用途，增加森林覆盖土地的面积。

最后第三个章节的部分的内容是缓解和适应的措施。这种措施都很重要，但是中国的优先权不是适应的措施，而是缓解的。为采取缓解的措施，政府把 CO2 排放降低，安装空气净化和污水净化器，提倡人们买电动汽车。加上政府开始植树造林，绿化祖国。适应的措施是“强化城市低碳化建设，提高建筑能效水平和建筑工程质量，延长建筑物使用寿命，加大既有建筑节能改造力度，建设节能低碳的城市基础设施”(SU Wei, 2015: p. 7). 政府也投资了南水北调工程，提高应对旱灾的能力。

用于本文研究的资料主要是二手资料。大部分的学生参考的著作、学报文章、科学报告等在网上找到了，也有用大学可以访问的数据库和图书目录。

它还使用了在联合国政府间气候变化专门委员会[9]、美国国家航空航天局[10]和绿色和平组织[11]的官方网站上找到的报告和文件。 关于这些释义，学生主要参考了网络版的 Encyclopædia Britannica 和 Enciclopedia Treccani。[12] 至于最新的信息，学生参考了报纸的文章。

[8] 国家自主贡献，Intended Nationally Determined Contributions (INDC)
[9] 联合国政府间气候变化专门委员会，Intergovernmental Panel on Climate Change (IPCC)
[10] 美国国家航空航天局，National Aeronautics and Space Administration (NASA)
[11] 绿色和平组织，Greenpeace
[12] Encyclopædia Britannica 和 Enciclopedia Treccani 都是百科全书，第一个是英国的而第二个是意大利的

## INTRODUCTION

" Climate change is real and is happening now ,,[13]

2018 was the year of awareness for many people for what concerns environmental pollution and climate change that is affecting our planet. At the Oscar's Night nobody would have thought that climate change could have been one of the topics of thanksgiving speeches from the winners, and yet it did. It happened when an actor pronounced the above mentioned simple words. He believed that even if he is a single individual, his influential power could make the difference. The following year, 2019, was the year for many young people to take a stand on the two challenges that our planet, and we as its main inhabitants, must face: environmental pollution caused by human activities and climate changes due to the release of greenhouse gas by the same activities. Also in this case the consciences of the whole world have been moved by a single individual, who was aware that she could be able to make the difference. A young Swedish student every Friday undertook her silent protest by striking for the climate in front of the parliament of her country. The message she wanted to send was simple: human pollution and climate change are huge worldwide problems that can not be ignored anymore, people need to know and be aware of which is the climate situation in this moment. This stance by people who are not scientists or politicians means that this issue is beginning to be a "pop- news". Thus means that common people who until that moment were unaware of (or did not care about) pollution and the consequences of climate change will get more informed by mass media.

The climate and the earth's temperature have naturally changed during the Globe's history, but in the majority of scientists' opinion Climate Change, nowadays, is the consequence of a massive increase of Greenhouse Gas produced by mankind in the last decades. According to Intergovernmental Panel on Climate Change's (IPCC) reports the connection between emission of pollutant and greenhouse gases emissions and climate

[13] L. Di Caprio, Receiving Oscar's Speech, 2018: online

change is not a hypothesis anymore. Statistics and data suggest that temperature's increase has started with the growing use of carbon and its consequent escalation of carbon dioxide (CO2) production. The relationship between pollution and climate change is not difficult to explain. The burning of coal, and fossil fuels in general, is the main cause of the release of pollutant elements. Moreover heat separates the carbon atoms in the coal, releasing CO2. The property of CO2, such as the other GHG, is to absorb infrared radiations emitted from earth's surface and instead of letting them pass and get out of the atmosphere, it reradiates them back to the earth's surface. This process is leading to an accumulation of radiating energy that has the result of increasing the average temperature of the globe.

This unnatural increase of the global temperature is leading to such catastrophic events that affect the lives of men and women around the world. Some of these effects are:

- Higher temperature and increase of drought periods,
- Wilder weather and increased number of hurricanes per year,
- Melting glaciers, shrinking sea ice and rising sea level,
- Warmer oceans and increase of their acidity.

All these events provide a clear example of how human activities are increasingly influencing the environment that surrounds us and, given that the planet is a single entity, its reactions will not be circumscribed to a single region.

The governments of the developed Nations are looking at least to contain the problem, if not to solve it. A first concrete step forward has been made with the Kyoto Protocol approved in 1997, that came into force in 2005. The Protocol foresaw a substantial reduction of CO2 emissions in the air by setting a maximum limit of emissions allowed to each State, but it provided several exceptions. Developed countries with a high percentage of CO2's emissions, for example, could exceed their own limit if they would built, or have paid a contribute to build, environmentally sustainable infrastructures in developing Countries. Moreover they could "buy quotas" of pollution's percentage from countries that had been more virtuous and had stayed below their pollution limit.

Despite the good intentions of the agreement, the results were slow to arrive due to the non-achievement of the minimum number of signatory Countries, and only when Russia signed in 2005, it was possible to start implementing what was planned.

However, the effectiveness of the Protocol is proved to be minimal. The last two IPCC Assessment Reports of 2007 and 2014 show how the climate change we are witnessing is a direct consequence of the increase of Earth's temperature, 95% of which can be attributed to human interventions and activities. In particular, in the last Assessment Report it is stated that the causes of increase in CO2 emissions in recent decades are primarily due to the massive use of fossil fuels and subsequently also to the rise of population and consequent food needs.

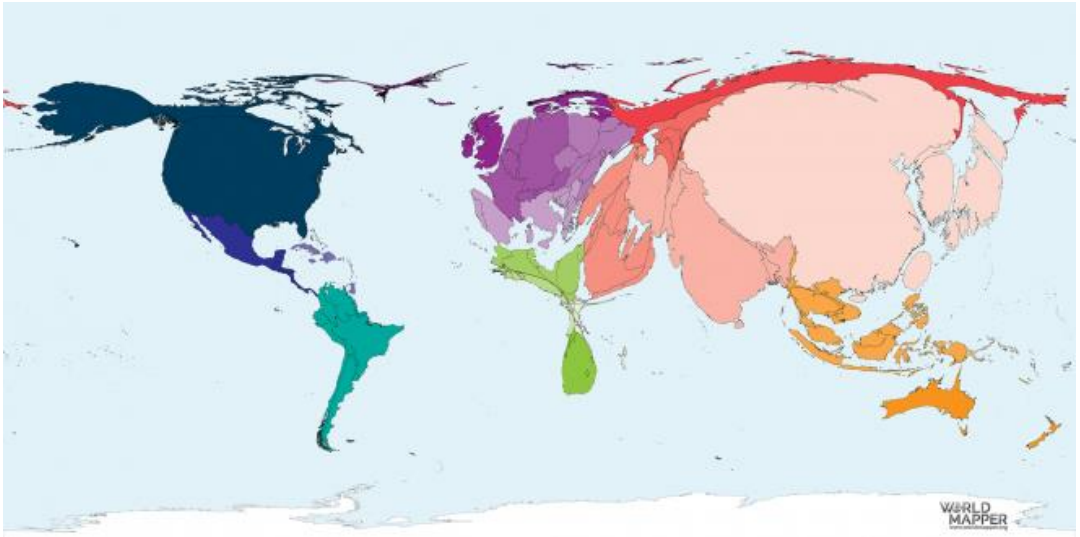


Fig. 1
Carbon Dioxide Emissions in 2015

The geographical area on which the thesis will focus will be China, as the main global emitter of CO2 and as a country with a high vulnerability to risks due to CO2 emission and climate change. Moreover, with one of the world's largest populations, China plays a fundamental role in the fight against pollution. After signing the Kyoto Protocol, it said it was in favour of signing other international agreements as long as they do not limit the Country's development and its economic rise. In fact, China believes that just as the countries involved in the first industrialization did not care about the environmental repercussions but simply thought about their own development, so the countries that are currently facing their industrialization phase must not give up their own development too.

During the last decade, even if it is pursuing the aim of not giving up its growth, China has managed to reduce its consumption of coal (non-renewable source of which it is one of the major consumers), increasing the production of energy from renewable sources.

With 4000 daily deaths due to pollution, China is also one of the most polluted countries in the world and, for this reason, more vulnerable to the repercussions that climate change can have on the territory's environment. In particular, the increase in temperatures highlights a problem that China, especially the northern area, must already partly tackle: water scarcity. The problem of unequal water distribution has distant origins in China, which has always seen the territory split in two, the arid north and the wet south. Climate changes, affecting the regularity of rainfall and the speed of melting glaciers, risk bringing this rift to the extreme, subjecting the north to longer droughts and the south to more frequent floods. Droughts and floods endanger local crops, on which the Chinese people's food supply is still enormously dependent. Droughts and floods also endanger the lives of citizens, who according to the standards of the World Health Organization (WHO) do not enjoy the minimum amount of water in the North and risk their lives in case of floods in South. However, climate change is not the only way to endanger agriculture and the quality of life of citizens, in China the pollution of air, soil and water is a danger that Chinese people face every day.

The dissertation will be divided into three chapters that will deal respectively with: the Chinese perspective of the Human beings and Nature's relationship, environmental pollution on the Chinese territory and the problem of climate change.

In the first chapter the relationship between Nature and Human beings will be analysed not only from a religious and philosophical point of view but also from a historical-practical point of view. At the beginning will be exposed the characteristics that this relationship has in the Confucian and Taoist vision, the main currents of thought born and developed in the Chinese territory, then how nature has been used for political purposes through the Mandate of Heaven (天命, Tiānmìng). Later we will use a more practical point of view observing how men behaved with the environment that surrounded them.

Once we have explained the bases from which the views and behaviours of the Chinese people still originate today, we will explain how the vision of the World for Chinese

people changed during the twentieth century, starting with the fall of the Empire structure in 1905 and the founding of the People's Republic of China in 1949 which, with the leadership of Mao and then of Deng, aimed to become a world power. To conclude the chapter, we will draw a general overview of the principles that govern the human relationship with Nature in this millennium.

The degree of mankind interference in the environment could be noticed not only looking at infrastructures and constructions that can now be seen in every part of China, but also from the increasing of pollution produced, that now it saves neither water, nor the soil or the air.

For this reason the theme of the second chapter will be pollution, in particular the three main forms in which it manifests itself:

- **water pollution**, the topic of this section will be the water problem in China. Starting from the water shortage, we will go on explaining how the little amount of water present on the territory is not always potable due to the wastewater spills in the body of water without first subjecting them to the necessary treatments ;
- **soil pollution,** although it has only recently begun to be analysed, the situation of soil in China is put under pressure by urban expansion and deforestation which together contribute to aggravating its degradation;
- **atmospheric pollution**, coal is its main cause, it has always been used as the main source of energy in most part of the country, not only at the industrial but also at the domestic level.

The aforementioned elements will illustrate the main causes of pollution and their effects, not only on the environment but also on human health. The final part of the chapter will concern the acid depositions, such as acid rain, which are one of the main effects of atmospheric pollution, although they mainly deposit on soil and water. The third chapter will focus on climate change. As previously mentioned, regarding the vulnerability to climate change, China appears to be one of the countries most at risk, not only because of the raising of sea levels but also because, despite being one of the world economic powers, it is still considered a developing country and its population would be the one most affected by the consequences of rising global average temperature.

The chapter will begin with a brief presentation on what climate changes are and the vulnerability to risks that affects China. Then it will be adopted an international point of view, speaking about the international environmental agreements that China has signed with foreign powers. It will be illustrate the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the Paris Agreement. Two of the actions that the agreements required to the developing countries are adaptation and mitigation measures. For this reason the last part of the chapter will focus on mitigation and adaptation processes that the country is taking charge of. We will see the countermeasures that China is trying to adopt to reduce the causes of climate changes (mitigation) and the ones not to be caught unprepared to these changes (adaptation).

The sources used to write this thesis are mainly secondary sources. In order to read up on the subject, the student has consulted books, articles and scientific reports found mainly on the Internet, using the databases and catalogues made available by Ca' Foscari University. She also used reports and documents found on the official sites of the IPCC, the UNFCCC, Greenpeace and the National Aeronautics and Space Administration (NASA). Regarding the definitions the student has mainly consulted the online edition of Encyclopædia Britannica and Enciclopedia Treccani. As for the most recent news, reference was made to articles of newspapers.

# 1. HUMAN BEINGS AND NATURE'S RELATIONSHIP IN CHINA

## 1.1. NATURE IN THE CHINESE TRADITION

### 1.1.1. Philosophy

The environmental problem that China is facing today has ancient roots. It is the result of centuries of exploitation of the territory and of natural resources. Environmental deterioration is a process that started at the beginning of the history of humankind, who have always tried to bend Nature in an attempt to build a better life.

The only reason why in the past centuries the deterioration process has gone on with rates much lower than modern ones must not make us think of a particular deference that man had towards Nature but more than anything else to the lack of technologies that could change the territory more markedly. Wars and the frantic race to development have done nothing but exacerbate this situation by accelerating a process that would eventually lead to the same results.

China is a country so far from the West. This distance is not only physical but also cultural, so perhaps it is necessary to understand on what basis the modern Chinese way of thinking is founded. Certainly in the last centuries Chinese thinking has undergone foreign influences but it has maintained some constants, even at an unconscious level, that have remained unchanged.

Before going on to explain what humans has done concretely for and against nature in the past, it is necessary to briefly explain how philosophies and religion have shaped the connection that Chinese men have with nature. Such relationship is governed by unwritten rules that do not include the subjection of Nature to Man, but a conjunction of the interests of the latter with those of the former. As proof of what has been said, just think of the "Mandate of Heaven" and the consequences that its loss could take to the ruling dynasty. The Mandate was the sacred legitimacy to reign that the sovereign received directly from Heaven. In order to prove himself worthy of the Mandate, the sovereign had to be an example of Virtue and rule the kingdom following the principles of morality and social harmony. In the event that Heaven decreed that the sovereign was no longer worthy to hold its role, it was Nature's task to transmit the message of Heaven

through environmental disasters that hit the population, such as violent floods or long famines. In this system it is possible to note a close relationship between a good governance and a sustainable and prudent management of the environment, in fact famines and floods were nothing more than tangible proofs of territorial and environmental mismanagement.

The theme underlying Chinese folklore and tradition is the important role that nature plays in human life. Nature was a central subject of many works, above all pictorial, which enhanced its aesthetics. In the Chinese perspective, unlike the Western one, man was not created in order to be able to govern the World at his leisure. Heaven created human beings and nature so that they could live together in harmony, humans are nothing but one of the living beings that inhabit the Earth.

Throughout history, many currents of thought have developed in China, especially in the period of the 100 Schools. Very few of them survived the end of that flourishing philosophical period, and even fewer were those that accompanied China to the present days. Confucianism and Taoism both debate the relationship that Human beings had with Nature, but while the former focused on the political and social aspects, Taoism explored the cosmic role of man.

**Confucianism**, born during the period of the 100 Schools, owes its name to the great thinker and philosopher Confucius (Kongzi, 孔子, 551 - 479 BC), and for centuries it was the official philosophy in imperial China. It also became a subject of study for scholars who wished to undertake the State Exams (established in 1313 AD) (Sabattini and Santangelo, 2005). Confucius did not pay much attention to the concept of Nature itself. His attention was more focused on the organization of the society in an iron hierarchical scale and on the concept of "exemplary man".

The noble man (Junzi, 君子), or better the man that owns a noble soul, had to have not only the "ritual behaviour" and the "sense of right", but also the "sense of reciprocal humanity" (or benevolence). Now the question that arises is: what did Confucius mean by benevolence? One way to describe it is "not to do to others what one would not like to be done to oneself", however this definition can be reductive to the human sphere. Confucius

suggests that humans need to be benevolent towards each other and also towards Nature. When Confucius spoke of morality and social harmony, he did not refer only to human society but also to the cosmos (Cadonna, 2006).

Other Confucian thinkers such as Mencius and Zi Si believed that by raising their morality Men could be able to understand the laws of Nature. In particular, Mencius tried to go further and to combine the classical Confucian virtues with that of sympathy, which the man had to feel not only towards his own kinds but also towards plants and animals. Xunzi, another disciple of Confucius, on the contrary believed that after raising his morality and understanding the laws of Nature Man could exploit them to dominate it. The thought that reached up to the present days, therefore, was to respect nature and treat it with benevolence, while at the same time trying to exploit the laws of nature to use them.

Among the various schools of Chinese thought, **Taoism** can be considered the one that comes closest to environmental thought, although at that time the environmental idea did not exist yet. At the base of this current of thought there is an attempt to "return to nature", according to which man, being the only one of the beings that populate the world, has the task of guaranteeing peace and harmony with nature.

Some of the fundamental principles of Taoism are: the Dao 道 (the unconditional nature of the Principle) and the Wuwei 无为 (the non-action). These two principles are closely connected. The Dao represents the very nature (the true nature) of every living being, which humans should respect by letting nature take its course. Here the principle of non-action comes into play. The Chinese word *wei* 为 specifically indicates the action by artificial means, therefore the absence of action does not actually imply that nothing is done. In Laozi this is how it is explained: "One does not act, yet there is nothing that is not accomplished" (Cadonna, 2006: p. 8). This is because, according to the Taoists, man must let the Dao act, and when the man is called to do something his actions must be in harmony with the Dao, and therefore with nature itself. However, this philosophy, while paying great attention to the conservation of the environment, cannot be fully actualized since it sets limits to human action and does not involve any kind of development.

Another current born during the period of the 100 Schools was the **Legism** that saw its moment of maximum splendour under the first imperial Qin dynasty. Laws were the key to a good society, which is why when the population began to increase and the cultivated lands were no longer sufficient to support it, the only solution considered was to apply stricter control and rules. Once the Qin empire fell the philosophy that had characterized it fell into disrepair with it and was replaced by Confucianism, which however inherited part of the law system, even if applied less rigidly.

Around the 1st century AD a foreign religion begins to spread in China, hailing from India: Buddhism. This religion had a different concept of relationship with Nature. Buddhists believe in reincarnation, which means that there is a life after death. The dead person would have reincarnated into another living being depending on the behaviour he or she had held during his or her life. This introduces a kind of equity, because all living things in a previous life must have been human beings. Buddhist monks play a fundamental role in this religion and were also protagonists in the Chinese environmental conservation and protection. The monks respected the life of each anima, they were vegetarians and also had the task of preserving the nature and landscape that surrounded the monasteries.

### 1.1.2. Practices

In China, over time, there was a profound split between the philosophical vision of Nature and how Human beings relate to it in the real world. Although the main philosophy and religions present in China were in favour and promoted respect for Nature and its protection, the reality of the facts was quite different. The attempt to preserve nature was thwarted by numerous wars, economic development and population growth. The wars caused numerous damages not only to the natural environment but also to the cultivated lands causing losses of the crop and of the livestock. These losses were not limited to the war period but also to the one immediately following, in which the winners proceeded to consolidate the power obtained. However the damage to the environment didn't stop during peace periods, it was perpetrated by farmers who cultivated the land intensively

and quickly made cultivated fields infertile and poorly productive. Following the deterioration of the land, the peasants were forced to move and look for another arable land. Although China has a very large territory, it has a limited area suitable for agriculture. Originally it was a fertile country and rich in natural resources, however excessive exploitation and bad management destroyed its environmental wealth.

Chinese territory can be divided into two macro-areas, which differ both in terms of climate and geography and which have the course of the Yangzi river as their natural boundary. In the northern part of the country agriculture has always been based on drier crops, due to the few water resources present and transport was mainly terrestrial. On the other hand in the southern part it has prevailed a submerged agriculture that required a large quantity of water, such as rice, and also transports took place mainly on the waterways. The North was initially the economic and political centre of the Empire, as well as the most densely populated area, while the areas on the south side of the Yangzi were previously inhabited by populations of other ethnic groups and the integration was a very long and fluctuating process. Initially the South was a sparsely populated area, however after a series of migrations from the North to the South during the 4th century AD and progress made in the field of rice farming in the 8th century AD the economic centre forded the river and moved to south, leaving only the court and the political centre in the north (Sabattini and Santangelo, 2005).

At the beginning of the second millennium, during the Song[14] dynasty, due to the excessive exploitation it was recorded that already almost all the northern forests were demolished in order to pursue economic development. The felled timber was used as a fuel for the iron industry, for the production of paper necessary for the publications and used for the extraction of a resin necessary for the manufacture of ink. This excessive exploitation and the almost total disappearance of trees in the North has done nothing but worsen the already existing critical situations. The soil became more easily subject to wind and rain erosion; the watercourses, basically poor in winter and overflowed in summer,

[14] Bei (Northern) Song (960–1127) and Nan (Southern) Song (1127–1279)

became sensitive to precipitation oscillating between periods of drought and floods; the highlands suffered more and more from drought and lack of water.

An additional characteristic that differentiated the two territories was the way they were managed. In the North the land was entrusted to both small farmers and large landowners, in possession of large, poorly managed plots. In the south, agricultural land was managed by yeomen who tried to manage the rice paddy ecosystem they had created (Anderson, 2014). Another gap that was born was the difference in the commitment that the Chinese demonstrated in trying to improve arable land compared to that shown for the conservation of wooded areas rich in natural resources. In short, China did not have an ecological collapse just because it had developed agriculture enough to sustain the population's demand for food without completely destroying the environment. "China has pursued ecologically unsustainable patterns for 3000 years" (Anderson, 2014: p. 262).

Due to the lack of mechanical technologies that could improve productivity, the most popular method used in the management of the fields was the biological one, which further favoured the small farmers who appeared to be more specialized. Within the rice paddies pests and insects harmful to the crop were kept away by other predatory insects, whose numbers were regulated by their hunters, creating a sort of equilibrium system. Thanks to this organization, China became the most productive country in the pre-modern world

In China the population is not composed of a single ethnic group, despite the majority of the population being of Han ethnicity, there are 56 minorities in the territory who during the course of history demonstrated to have greater capacities for managing the territory and resources, having strong ideologies linked to conservation (Anderson, 2014).

One of the biggest problems that arose in Imperial China was Deforestation. In ancient times the main danger for woods and forests was represented by the peasants, who used the technique of shifting cultivation,[15] deforesting ever increasing amounts of land in order

[15] Shifting agriculture is a system of cultivation by plot (field) rotation. In shifting agriculture a plot of land is cleared and cultivated for a short period of time, then it is abandoned and allowed to revert to its natural vegetation while the cultivator moves on to another plot. It has frequently been attacked in principle because it degrades the fertility of forestlands of tropical regions. (The Editors of Encyclopaedia Britannica, 2013: online)

to satisfy the demand for agricultural production, also due to population growth. At the time the emperors themselves believed that having a larger population was a great advantage for the country, as it increased both the entry of taxes, the workforce and the military support. In imperial times the environmental and land management issues were entrusted to officials and governors, who in addition to administrative and fiscal duties also had to build dams, dredge rivers (to avoid flooding) and plant trees. These duties, however, were considered secondary. Few officers commissioned them and even fewer were those who did something concrete.

One of the criteria that decided whether a given forest could have a chance to be saved or not was its role in popular belief. The only forests that survived were those that played a religious role or had some spiritual or magical function. "Religion protected when common economics did not" (Anderson, 2014: p. 281).

These beliefs and traditions were expressed in Fengshui. “Fengshui literally means ‘wind and water’ and is the art of siting dwellings and graves that wind and water will benefit them rather than damaging them” (Anderson, 2014: p. 276). While today Fengshui is used mainly for furnishing and creating harmonious internal living places, originally it was a practice taken very seriously and that dictated the law in the lifestyle of the people who followed it. Being based on tradition, Fengshui sought to explain the behaviours and precautions that were taken by the people, who knew the complicated system of cause and effect that governs Nature and tried to explain it using beliefs and magic. An example may be the choice for the place to build houses. Fengshui prohibited the construction of buildings on cultivated lands or floodplains. To avoid that the population built dwelling in excessively low places, that could be dangerous, Fengshui refers to the dualism of Yin and Yang, that governed the whole World, in the following way: the highest mountain ranges and peaks in the popular tradition were dragons and represented the Yang, while the hills and mountains were tigers, representatives of Yin. The house had to be built in a place where the dragon dominated the tiger, so in a high place.

To conclude we can say that the relationship of Human beings with Nature throughout history has been marked by numerous contradictions. The Chinese landscape was defined

both by factors linked to development, and therefore to bad management, and by spiritual factors, which aimed at the conservation and protection of Nature.

### 1.2. VISION OF NATURE IN THE MAOIST ERA

In the middle of the last century, China was the protagonist of an event that has indelibly marked its history. After a long and bloody civil war, and after the expulsion of the Nationalists who fled to Taiwan on 1st October 1949, the Chinese Communist Party (CCP) leader Mao Zedong (1893-1976) declared the founding of the People's Republic of China. The legacy that the CCP gathered was that of a country on the brink of a crisis, plagued by years of wars, first against Japan and then between the Nationalists and the Communists.
Taken the power, the communists initially carried out those practices that were typical also in the imperial era. They tried to improve some aspects related to conservation and launched projects aimed in that sense. All these good intentions and purposes, however, clashed with a reality that was completely different (Economy, 2010). On a practical level the relationship between humans and nature in the Maoist period was based on very different principles. Although the Unequal Treaties[16] had been cancelled in 1947 after the Second World War, they still represented a sore point for the Chinese. Decades of harassment and humiliation by Western powers could not be cancelled so quickly. If we add to this the numerous defeats and the great vulnerability of the Chinese territory to the great natural catastrophes, often connected to the restlessness of the Yangzi river, it is easy to understand how in 1949 the feeling that animated all Chinese hearts was that of revenge. The purpose of the new government was to eliminate all the enemies that could hinder the rise and could delay the growth of the country, for this reason this feeling of revenge was not only directed against the "human" enemies of the People's Republic but also against the natural ones. It was in the conviction to pursue this goal that Mao altered the society by overturning the main characteristics that had characterized the traditional Chinese

[16] Unequal treaties were a series of treaties and agreements in which China was forced to concede many of its territorial and sovereignty rights. They were negotiated during the 19th and early 20th centuries between China and foreign imperialist powers, especially Great Britain, France, Germany, the United States, Russia, and Japan. (The Editors of Encyclopaedia Britannica, 2015: online)

culture up to that time. The harmony between man and nature and the central figure of the family nucleus were set aside, what had become really important was the welfare of the state and how people could know the forces that govern nature in an attempt to exploit them to prevail over it.

Political repression, utopian urgency, dogmatic uniformity and forced relocation characterized the thirty years of Maoist rule influencing not only the society but also the speed of environmental degradation, which in this period saw a notable acceleration (Shapiro, 2016). In an attempt to increase the welfare of the state Mao thought that China had to become a global power, while maintaining its socialist ideology that had to prevail over everything. Trying to achieve its objective, the CCP concentrated its forces on the industrial sector while implementing agricultural reforms, measures that will have terrible consequences for the environment.


For what concerns industry, the government wanted to increase industrialized urban centres and consequently increase productivity, in particular the steel's one. In one of his speeches Mao said he wanted to achieve Britain's production rates in just a few years, even claiming to match those of the US.

Fig. 2
大力开展以粮钢为中心的增产节约运动 (Start the movement to increase production and practise thrift, with foodstuffs and steel at the centre, with great force!)

As for agriculture, it still represented the bulk of the country's wealth and the sector that occupied the majority of citizens. Despite its efforts focused on industrial development, government was partly able to understand the importance of agriculture as a fundamental sector for the livelihood of the population.

On all these changes the spectre of socialism hovered, which in the Chinese perspective foresaw the overcoming of private property in favour of state property.

### 1.2.1. Militarization

In the history of the early years of the CCP's foundation, the only constant that accompanied it over time was the war. Initially against the Japanese to defend national identity and then against the Nationalists in an attempt to impose their socialist ideology.


Fig. 3
Put organizations on a military footing, put actions on a war footing, put life on a collective footing

The natural consequence of all these struggles was that leaders of the party were not only political but also military leaders. These fighting leaders in carrying out the will to defeat every enemy operated a process of militarization of the society.

The people were divided into battalions and troops and the officials were often appealed with military ranks despite being simple civilians, not to mention the fact that at that time both civilians and military dressed in mimetic-green clothes that recalled members of an army. All these military aspects of everyday life could not fail to be reflected in common language. For this reason all the actions that the government carried out against nature in an attempt to dominate it were appealed as military strategies or battles that the man was forced to perform in order to win over a nature that had often made people suffer. In that period it was not strange to hear sentences such as "conquer nature"[17], "man can conquer nature"[18] (Holst, 2016: p.129) or "victories were won against flood and drought"[19] (Shapiro, 2016: p. 4). At that time, as Shapiro suggests in his book, there was talk of a real "war

[17] Zhengfu ziran, 征服自然
[18] Ren ding sheng tian, 人定胜天
[19] Shuihanzai, 水旱灾

against nature". The waves had to be torn down and all the animals that represented a threat to the wheat harvest had to be exterminated.

All these terms of war and aggression represent a decisive departure from the harmony that until then had characterized the relationship between human beings and nature. Humans are no longer part of nature, as the Taoists preached, but they see themselves as something quite distinct from it and this could only have as consequences a detachment and an abandonment of all those practices that approached an environmental sustainability.

### 1.2.2. 1954, the Yangzi Flood

A clear example of the aforementioned militarization is given by the flooding that hit the Hubei area in 1954. In fact although the areas adjacent to the Yangzi river have always been subject to flooding, that of 1954 was one of the most disastrous and destructive of the 19th century (Courtney, 2018).

In an attempt to defeat the floods to which the river regularly subjected population the government tried to implement a defence plan. So at the beginning of the 1950s it had been proposed and approved a policy to divert the course of water. The idea was to build sluice-gates that when opened would stop the flood from hitting the cities and redirect it towards the countryside. The engineers who designed this project responded to Mao's specific request to protect urban industries from hydraulic risks at all costs. With this in mind, the precautionary measures taken protected the city centre but did not bother to provide any sort of protection to the surrounding countryside.

The government understood that they were not able to win the war against the flood and to make the water go backwards, so they changed their objective: the purpose was no longer to block water but to protect the city of Wuhan. This latter aim was reached but at a high price. Opening the sluice-gates the government had done nothing but letting the water conquer the countryside before it took it by itself. It was a retreat that, thanks to the Wuhan rescue, was transformed by the propaganda of the Party into a full victory against

Nature. The water, once it reached rural areas, caused an exorbitant number of displaced people, not to mention the number of victims or houses under water.

The problems did not end with the evacuation of people. Because of the repressive policies adopted in the early 1950s, there was a diffuse sense of distrust towards the state campaigns so people were reluctant to leave their homes, believing that flooding was an excuse for the state to take over their land.

Those who let themselves be persuaded to move and leave their homes were then left to themselves. The host communities did not prove to be very welcoming towards the displaced people from the countryside, who were seen as a danger. The lack of good hygienic practices and basic infrastructures shortage did nothing but made infectious strains proliferate, which represented a greater cause of death than the flood itself.

### 1.2.3. Political repression : uncontrolled growth of population

The idea of an imminent war in which China should have participated and for which it should have been ready prompted Mao to encourage population growth. Just as in the past, it was seen as an increase in taxation and in military and labour force, so Mao saw in a huge population the key to being able to speed up development and to be able to win in a hypothetical nuclear war. In 1957 during a speech in Moscow he said that he was not afraid of nuclear war, because China had a population of 600 million people and even if half of them were killed, there were still 300 million people left (Mao, 1957).

Repeated warnings from the scientific communities that a population that was too large would be an obstacle rather than a benefit to development remained unheard. Mao continued on his path and the elements that questioned his opinion, and therefore sought to subvert the new order that was being rebuilt, were subject to persecution. Those who survived killings and torture were sent to forced labour in the fields.

In 1957 Mao launched a campaign against all those who were considered "rightist" and consequently a danger to the socialist future of the state. This procedure aimed at safeguarding the country, actually turned into a real "political purge" that allowed Mao to get rid of all his political opponents or his old supporters who were gaining too much

power. The scientific community was deeply affected by these purges, and numerous members who opposed some of Mao's ideas disappeared or lost their respectability. One of the most illustrious names was that of Ma Yinchu,[20] economist and president of the Beida,[21] who opposed the uncontrolled growth of the population, stating that in the long term it would be more of a handicap than an advantage for the development and growth of the country.

### 1.2.4. Utopian urgency : the Great Leap Forward


Fig. 4
乘风破浪，各显神通 (Brave the wind and the waves, everything has remarkable abilities)

Industrialization at any cost and speed in obtaining it. This was the mantra that led Mao to start one of the most ambitious and disastrous projects that the leader of the Communist Party put in place: the Great Leap Forward (1958 - 1960).[22] The purpose of the Great Leap Forward was to accelerate the country's growth process, which was progressing too slowly, in contraposition to Mao's will. The problem of China, however, was that its technological level was too low to face such a rapid growth, then it tried to compensate the poor quality with quantity, and here the "population growth" factor once again came into play, the huge workforce had to somehow replace the lack of technology. Mass mobilizations were used to overcome China's backwardness. It is in this perspective that the party carries out an enormous

[20] 马寅初 (Mǎ Yínchū), 1882–1982, was a Chinese economist
[21] 北京大学 (Beijing Daxue), the University of Beijing
[22] **Great Leap Forward** is the campaign undertaken by the Chinese communists to organize its vast population, especially in large-scale rural communes. They hoped to develop labour-intensive methods of industrialization, which would emphasize manpower rather than machines and capital expenditure. It was the result of the failure of the Soviet model of industrialization in China

social reform that will have a strong impact not only in the immediate but that will have consequences even further in time.

The socialist idea that guided Mao's intentions foresaw the abolition of private property in favour of a general collectivization of all the properties, which then became state owned. This provision particularly affected rural areas, where large landowners and wealthy farmers saw themselves deprived of their possessions that were shared among the people. This provision went hand in hand with the abolition of the Confucian idea of family. The nucleus around which people's lives took place was no longer the family but the commune. People's lives were organized so that they could take place in the community as much as possible, they worked the fields together, ate together in the canteens and often were forced to sleep in big dormitory divided by sex. This system gave enormous advantages to the government that could effortlessly mobilize millions of people in no time.

The negative consequences of this acceleration process, however, far outweighed the benefits. In those years the cultivable lands suffered a strong pressure because of the numerous mouths to feed, this critical situation was then exasperated by numerous famines. This led to a heavy shortage of food and many people died of hunger (it is estimated that 35 to 50 million people died in those years and the mortality rate reached 330 ‰).

All this desire for speed and modernization did not only affect the population but also had a devastating impact on the environment. Heavy industries were called upon to increase their production and ordinary citizens were encouraged to build furnaces in their home gardens in order to actively contribute to steel production, the most immediate consequence was an exponential increase in the rate of deforestation and felling of trees that served as fuel for industries and individuals.

Another devastating consequence was the increase in pollution. Because of "Mao’s war against nature" any semblance of sustainability or respect for the environment was abandoned and in doing so the factories did not put any scruple into pouring the chemical and toxic waste directly into the rivers.

In 1960, once it was clear that the pace of the Great Leap Forward could no longer be sustained by the population and the industrial sector, the idea of industrialization at all

costs and the degree of rapidity with which it had to be reached were set aside, even though the environmental damage was remarkable. However the idea was not entirely forgotten by Mao, in fact in 1966 he tried to propose it again by implementing the Cultural Revolution.

### 1.2.5. Cultural Revolution

A few years after the failure of the Great Leap Forward, Mao attempted to revive a new process of reforming the country's economic and social structure. In 1966 the Cultural Revolution began. Its highlight years will end in 1969 but it will never be completely abandoned until Mao's death in 1976.

Shapiro claims that there is a correlation between the wickedness that man shows towards his peers and towards Nature, and the decade of the Industrial Revolution is the proof. While on one hand Mao tries to make a clean sweep of all his political opponents, on the other he only aggravates the environmental conditions already rendered precarious by the Great Leap Forward. The industrial production recorded a new peak. The transformation processes were carried out without bothering to modernize technologies or machinery. This led to a waste of raw materials and an increase in water and atmospheric pollution, which turned into a loss of biodiversity.

One of the points on which the Cultural Revolution repeatedly struck was the production of wheat, which replaced practices such as afforestation or animal raising. Other wooded areas were demolished to make new fields, the areas previously used for grazing began to be cultivated and even lakes were filled, creating artificial plains destined for agriculture.

#### 1.2.5.1. Industry : forcible relocation

Mao's dream was to build a powerful China, a country that owned political weight and influence in the world. In order to implement this plan all government forces focused on industrial development, in particular the steel industry.

At the beginning all the companies were concentrated along the coasts, but with a war that could start at any time and the risk that such geographical position entailed, being

exposed to the attacks of foreign countries, their location had to be moved. For this reason, an attempt was made to implement a state campaign aimed at re-locating industries in the most internal and secure areas of the country. The chosen places tended to be near rivers and mountains. Inevitably rivers and caves became points of discharge for industrial waste, polluting the soil and water. Usually the population did not seem to care about all these environmental dangers, which inevitably jeopardized the life of the ones who exploited those waters and soil. The only cases of protest that are recorded are those in which the discharges directly affected the crops polluting the crop which was therefore unusable.

#### 1.2.5.2. Agriculture : dogmatic formalism

In Mao's great development project, one of the fundamental points was represented by a dogmatic unification, a sort of conventionality common to all of China. This uniformity was not limited simply to social and political life but was also reflected in agricultural practices (Shapiro, 2016). Chinese farmers, in the attempt led by the government to increase the productivity of the fields, were asked to submit to national wide practices that did not take into account the local conformation of the territory and the morphological and climatic differences that are inevitably very different in such a large country. Often who cultivated the land were young people exported from the cities and transplanted to places sometimes very far from the homelands. They not only got no idea to how that land should be cultivated but also they didn't feel any connection with it.

This form of standardization, replacing the local forms of agriculture developed over centuries, damaged the environment and instead of increasing agricultural production decreased it due to soil degradation. Also in this case the arboreal world was the most hurt. The increase in metal production furnaces implied the increasing need for fuel and firewood, to which was added the need for new arable lands. The only result was the devastating increase in the rate of deforestation.

Now, having analysed all the events that marked the first thirty years of the People's Republic, it is easy to understand how a profound detachment of the human being from the surrounding Nature had been created. The harmony prophesied by Confucius, the Taoist conciliation with nature and the Buddhist reverence for all living beings were drastically replaced by a military and destructive vision that saw men as something superior to nature and for this reason destined to control it.

Looking backward it is possible to notice how the reality of the facts was very different: just as environmental degradation occurred in a period of peace and harmony, the absolute dominion was not conquered during the war.

## 1.3. HUMAN BEINGS AND NATURE'S RELATIONSHIP NOWADAYS

### 1.3.1. Historical foreword

Fig. 5
Pic of China at night from the space

Mao, despite the fact that in the last period of his life was very sick, remained a central figure, a very influential point of reference, and it was so until his death. When this occurred in 1976, panic broke out in the country. Due to the continuous political purges and the removal from the political scene of the persons that had emerged during the Maoist government, it was not clear who would have taken the place of the supreme leader in charge of the country. This moment of transition and great political confusion lasted until 1978, when the leadership of the party was entrusted to old leaders flanked by new members whose merit made them emerge. Among the members of this new ruling class stood out the figure of Deng Xiaoping, a member of the old guard, who took the lead. During the Maoist period Deng had been dismissed several times because of the freedom with which he exposed his ideas, not always in line with those of Mao.

In 1978, China decided to set a new path and follow it. Deng's dream was to see China as an advanced country with some weight in international politics. The goal may seem very similar to what guided Mao. The goal of both was in fact the same, what changed were the means. During Mao's era the race to industrialization was absolutely not put forward the socialist soul of the country with a state-led economy. In Deng's opinion the priority became economic development, even at the expense of the political ideal. In the years of his rise to power, Deng realized that the party was slowly losing its credibility in the eyes of the population. To solve this problem he made sure that the communists leadership of the country and the economic growth were strongly linked.

In an attempt to give impetus to the economy, in 1978 Deng began a process of economic reforms which continues even today. The government decided to focus its forces on some issues, believing that their modernization and development would contribute to the growth of the country and the wellness of Chinese people. Development of the industrial sector, agricultural reforms and international openness were the keys to have a country that had a certain weight on a global level.

**Industry** in the late 1970s was in serious difficulty. All the companies of this sector were state-owned enterprises (SOE) and they stayed alive just because of state help. These huge companies that gave job to hundred thousands of people had lots of problems, especially for what concerns their budget deficits and production efficiency. One of the solutions that the government tried to implement was the closure of some companies that drained the state funds. However this measure did not prove to be decisive. Another tactic adopted was to look for other forms of industrial organization. If at the beginning all companies were led by the State, through various intermediate processes, it was possible to obtain diversification. It was introduced collective companies, joint ventures[23] and companies entirely private. The governments introduced a sense of responsibility and a system of rewards and punishments. In an attempt to limit the continuing losses of state capital, companies were forced to respond to their losses and to be rewarded in the event of large

[23] The establishment of a joint venture using Chinese and Foreign investment in China is subject to the examination and approval of the Ministry of Foreign Economy Relations and Trade of the People's Republic of China.

gains. The government implemented reforms that affected the work world. Alongside new opportunities, new problems emerged. On one hand there were cases of higher wages thanks to production bonuses, on the other hand it also emerged a situation of precariousness that previously did not existed.

Despite the desire to become an industrialized and modern country, in China **agriculture** was still the most important sector, not only in terms of the number of workers employed but also because it provided a certain food autonomy. The importance of this sector was therefore undeniable, however it was true that it needed profound changes that would allow it to develop and modernize. With this objective, the government began a process of de-collectivization by abolishing the communes and giving back to families the role of a productive centre. The "Household Responsibility System"[24] was born. It was also introduced a sort of "market law". The farmers, once the portion due to the state was delivered, were free to sell their surplus production at the price they considered most appropriate. This way the farmers were pushed to produce more and in a more varied way. In fact according to the law of the market, if everyone had produced the same product, the offer would have been very high and consequently the selling price very low.

The de-collectivization of the land was the first problem that arose. Since China was a socialist state, the land, even if no longer a communes' property, could not even be considered private property of someone. The state granted it to the families that worked it but the contract times were so short that the peasants had neither the time nor the desire to make big investments to improve the land. The state then decided to lengthen the time of the permits.

During the Maoist period, China had tried to make its complete self-sufficiency its strongest point. However, Deng was fully aware that in order to grow and become a world power the country needed an openness to the world, an interaction with international organizations and an attempt to attract foreign investment capital. China was already part of the United Nations organization (UN) since 1971, when it took the place of

[24] "It was an agriculture production system, which allowed households to contract land, machinery and other facilities from collective organizations. […] Households could make operating decisions independently within the limits set by the contract agreement." (ZhongguoWang, 2009: online)

the Republic of China (Taiwan). In 1979, during his trip to America Deng built ties with the United States while ten years later Gorbachev went to Beijing (1989, same period of protests at Tian'an men Square).

### 1.3.2. Social problems

The excess of rural labour that was recorded at the end of the 1970s led to a boom in migration rates. A flow of people moved from the countryside to cities or urban centres in the hope of being able to find a job. Urban industries and towns-and-villages enterprises (TVE) had managed to absorb part of the excess labour, however the number of young people entering the work world increased rapidly.

Thus began a social plague that would have repercussions even in the modern world: the Floating population.[25] That was a population of about 80-90 million people (at that time) who wandered around cities or urban centres. They lacked an official residence, state support, medical care and even basic education, that was one of the core point of the Maoist period. Nowadays this problem has not yet been solved. It has gradually worsened, so much that in 2013 "those without household registration - effectively illegal within their own nation - [...] exceed 160 million" (Armstrong, 2013: online).

To verify the economic measures that government intended to adopt to bring benefit to the country, in 1980 four experimental areas were established on the Chinese territory: the Special Economic Zones (SEZ).[26] In these cities domestic and international trade could be conducted without necessarily having authorization from Beijing. Their main purpose was to be areas of rapid economic growth, exploiting incentives that attracted foreign investments and technologies (The Editors of Encyclopaedia Britannica, 2018: online). Concentrating all development efforts in certain areas led to imbalances both at a territorial and at a social level. The gap of territorial imbalance was between the coastal region (where the SEZs were concentrated) and the hinterland as much as between the countryside and the city. For what concerned the society, living standards had risen for

[25] Liugong renkou, 流动人口

[26] Jingji tequ, 经济特区: Shenzhen, Zhuhai, Shantou and Xiamen

everyone and China itself had moved from a *low income country* to a *middle income country* but compared to the growth of the upper class the growth of the lower-middle class was lower, widening the social gap.

Corruption is another aspect that affected the political life of China. The main cause of this problem was that the power of the state was concentrated, if not on a single person, on a single political group. There was the total absence of dissenting voices that could denounce corruption. The government leaders, aware of this problem and of how this undermined the credibility of the party, had undertaken numerous "cleaning" campaigns. Some of the measures adopted were the lowering of the average age of managers, the imposition of limits on the number of mandates that a single man could hold, the elimination of the assignment for life (even if in 2018 the limit of assignments was abolished by Xi). However this scourge was never completely eradicated.

One of the biggest problems that Mao's legacy left was the uncontrolled population growth. The numbers of the Chinese population had reached such a level that they no longer represented an advantage, but instead a threat to the country's economic growth. Scientists, who often said they were against this government campaign, knew that such a large population should be fed and could represent a problem given the increasingly scarce availability of resources. The government in the 1970s decided to implement a family planning policy, trying to limit the number of births thanks to a campaign called Wan Xi Shao[27] (1971-1978), which sought to encourage women to have children later, to wait more time between a child and the next and in general to give birth to fewer children[28] (Yuan Tien, 1980). But when the Chinese population reached one billion, it was understood that the measures taken up to that point were no longer sufficient. In 1979 the "one child policy" [29] was adopted, even if it became law just in 2002. According to this system families were forbidden to have more than one child, although exceptions were

[27] Later, longer, fewer, 晚稀少
[28] Zhou Enlai said "One is not too few, two is good, three is too many." (Yuan Tien, 1980: p. 68)
[29] Yi hai zhengce, 一孩政策

made. This provision was created to solve an existing problem but it created other problems, such as the army of 13 million people not registered. They were second children coming from families unable to pay the fine imposed by local officials to have the second child. Albeit with some modifications, the "one child" remained in force until 2015, affecting several generations of families.

### 1.3.3. Environmental problems

As in the previous period, this attempt to modernize and develop the country asked Nature a price to pay. With the considerable improvement in economic conditions, the demands for raw materials and the exploitation of resources started to become more and more pressing.

The government realized that an uncontrolled exploitation of resources and the endless degradation of the environment would no longer be sustainable for the country. It decided that minimal regulation was needed to protect Nature, avoiding an environmental collapse that would otherwise be inevitable. In the late 1970s it began to issue regulations and laws that could give rise to a small-scale environmental protection policy.

| | |
|---|---|
| **1979** | 1st Environmental Protection Law |
| **1982** | Art 26 of the PRC Constitution[30] |
| **1983** | Second National Conference on the Environment[31] |
| **1987** | National Environmental Protection Agency substituted the EPA |
| **1989** | Final version of the Environmental Protection Law |
| **1992** | UN Conference on environment and development in Rio de Janeiro |
| **1994** | China's Agenda 21 |

During Deng's rule deforestation remained the major cause of environmental degradation. In 1991 the Chinese territory covered by forests was only 13% of the total, with a world

[30] "The state protects and improves the environment in which people live and the ecological environment. It prevents and controls pollution and other public hazards" (Sanders, 1999: p. 1206)

[31] "Li Peng […]declare environmental protection, alongside family planning, 'a fundamental state policy'." (Sanders, 1999: p. 1206)

average of 31%. Despite the forestation, campaigns the number of felled trees continued to grow. Some of the causes were "massive illegal logging, enormous fraud and waste, inadequate prevention for forest fire, poor fire-fighting facilities, false reporting ineptitude and bad management" (Sanders, 1999: p. 1207). The increase in the rate of deforestation was also linked to the "privatization" of trees. They were logged for domestic purposes or to make room for crops. Moreover there was the difficulty to mobilize large masses to carry out public works, due to the abolition of popular communes.

In 1998, in the hope of contrasting the massacre of trees, State Forestry Administration launched an afforestation campaign known as the *Natural Forest Conservation Plan*, which should have been concluded in 2010. The goal of this campaign was to create a database of existing forests by defining areas where the felling of trees would have been limited, if not prohibited. In the beginning the campaign seemed to work, with a decrease in timber production and an increase in forest areas. But in 2003 the rate of logged timber started to rise again. The afforestation had been implemented without thinking about the different local conformations. They planted one or two species of trees everywhere, so as to give more the impression that the new forests were plantations rather than natural areas.

Another cause of environmental degradation was the drastic decrease in grassland, which since the 1950s had registered a decline of 30-50% (Economy, 2010: p. 65). This had contributed to a decline in biodiversity and had deprived the flood waters of places where they can accumulate without causing damage.

With the decrease of forests and grasslands the spread of desertification had become an increasingly concrete risk and sand storms that hit the North of the country were more and more frequent. It is estimated that about a quarter of the Chinese territory was affected by desertification. It corresponded to more than 30% of the population (Economy, 2010: p. 66).

Although on paper the commitments made by China in the protection of the environment were numerous, they take second place if the interests of the companies or economic development were endangered. Despite the activities of the government, the Deng era ended with a greater degree of pollution than when it began.

### 1.3.4. The Three Gorges Dam

One of the dreams that have united all the personalities that have followed one another at the helm of China was the hope of being able to dominate the Yangzi river and its sudden floods, which have always caused numerous victims and an incalculable number of damages. An important step in the direction of "conquering" the Yangze River was made at the end of the last millennium. The project of the Three Gorges Dam, after a century-long incubation, finally saw the light. The never-realized first proposal was introduced in 1919 by the then nationalist leader Sun Yat-sen. After the founding of the PRC the idea of building a dam on the Yangze was exalted several times but was never put into practice due to the scarcity of resources resulting from the Great Leap Forward and the Cultural Revolution. When the final project was approved in 1992, it was criticized on several fronts, not only with regard to human rights but also in terms of the environment. Numerous foreign scientists denounced a danger for the populations that lived in the shadow of the dam. The main reasons of these worries were two: landslides and earthquakes. Since the Yangze River is very sensitive to floods and to seasonal rains, the engineers that take care of the dam lower the water level during the rainy season, to raise it once it is over. This continuous change in water pressure on the soil makes the ground unstable and prone to landslides. For the same reason, since the dam was built on two seismic faults, the resulting instability would have increased the number of earthquakes recorded in the area. The government had caused to displace 1.2 million people for the construction of the dam and promised them a reimbursement that actually arrived only in small part. Many were forced to a second move because of the threat looming over their homes (Hvistendahl, 2008: online).

Protests by environmentalists were about the environmental danger of a project of such gigantic dimensions. The area surrounding the river basin was the home of many animal species typical only of that region and also of a unique flora. The flooding of such specific habitats, the reduction of watercourses in the neighbouring areas and a climate change that such a large body of water could cause would have led to an irreparable loss of

biodiversity, to the extinction of some species (as happened with the white dolphin, 白鱀)[32] and the appearance of species that had never been seen in that river.

Despite the side effects, however, the battle engaged by the government with the Yangze River in an attempt to eliminate the problem of flooding forever seemed to have been won. The flood problem was largely eliminated, but now they had to deal with the opposite problem: drought. Despite trying to blame the shortage of water flow to climate change, it was recognized that the construction of the dam was responsible for the 50% decrease in water (Hvistendahl, 2008). The scarce flow of the river was the cause of the advancement of salt water coming from the South China Sea and of the proliferation of jellyfish typical of those maritime waters, which have altered its balance even more.

### 1.3.5. Last years' turning point

The environmental situation in China started to improve considerably with great results even in the short term only in the last few years. The environmental problems that have accumulated since ancient times certainly cannot be eliminated within a few years. But China is trying to change its mind-set. The environmental problem must no longer be considered a "problem for rich countries", as it was under Mao, and in this direction the leaders are promoting the adoption of greener policies and more sustainable development, which conciliates economic growth and safeguard of Nature (Zanier, 2005: online).

Speaking of development policies we should mention the Five-Year Plans, which since their creation have been a key point for development planning of the country. The environmental question was debated and inserted into the plans for the first time with the drafting of the 6th Plan (1981-1990), the first after the death of Mao. With the succession of plans, it gained importance, becoming an increasingly central theme.

| | |
|---|---|
| **VI** | The new environmental strategy was based on technological |
| **1981 – 1985** | innovation and energy policy |

[32] "The baiji, or Chinese river dolphin, […] lived for 20 million years in the Yangtze River, China. The baiji's demise was rapid and shocking; it went from a healthy population of some 6000 animals to extinct in a few decades" (Wood, 2012: online)

| | |
|---|---|
| **VII**<br>**1986 – 1990** | Establishment of an environmental monitoring system |
| **VIII**<br>**1991 – 1995** | Focus on water conservation policies and recovery of abandoned land |
| **IX**<br>**1996 – 2000** | Sustainable development was defined as an "important strategy for modernization" (Deodati, 2016: p 24) |
| **X**<br>**2001 – 2005** | Special Energy Development Plan, prevision of a reduction of 15-17% in consumption |
| **XI**<br>**2006 – 2010** | The key words of this plan were: reduction, reuse and recycling |
| **XII**<br>**2011 – 2015** | First discussion on climate change, promotion of ecological protection and environmental recovery (all the environmental objectives of the plan were mandatory) |
| **XIII**<br>**2016 – 2020** | Will to change the method of use of resources, foreseen mitigating actions for polluting gases. It was approved the China V [33] |

In 2017 in the attempt of reducing emissions, the "Carbon Market" was established. Since its creation it has proved to be the largest on a global level.('Nasce il più grande mercato del carbonio al mondo', 2017: online) The carbon market[34] aims to reduce polluting gas emissions by using finance as a lever. Companies were forced to pay a tax based on the amount of emissions produced. This way CO2 was treated as a real exchange product, paid by weight. The ineffectiveness of this provision has not been slow to prove itself. Often companies received free-emission permits that caused the price of carbon[35] to fall. Therefore, the pollution costs were so low that they did not encourage a reduction in polluting gases or the use of purifying systems.

[33] Corresponding to EURO 5

[34] For now it includes only the Energetic Industry, 46% of the national production of CO2

[35] In 2017 for each ton of CO2 produced a firm should pay almost 4€ ('Nasce il più grande mercato del carbonio al mondo', 2017: online)

# 2. ENVIRONMENTAL POLLUTION: SITUATION AND COUNTERMEASURES

## 2.1. CHINESE WATER CRISIS

Water has always played an important role in Chinese history. Since ancient times one of the greatest desires of the leaders was to dominate it. This goal has not turned out to be simple, so much that even in our days, controlling floods and droughts is a task that is not always completely successful. Talking about water, one of the main problems affecting China is water scarcity, mainly due to a low amount of resources and an increase in the pollution rate. This situation is further aggravated by an unequal spatial distribution of resources, by economic and urban development, by population growth and also by the high rate of pollution. The last one makes water unusable in domestic life or, in the worst cases of contamination, completely unsuitable for any use.

### 2.1.1. Water shortage

In China the rivers' system consists of nine main river basin groups. The five northern groups (Song-Liao, Huai, Huang, Hai-Luan and interior basin) cover 20% of the Internal Renewable Surface Water Resources (IRSWR)[36] while in the four southern groups (Yangtze, Pearl, southwest and southeast river basin ) flows 80% of the national IRSWR. All Chinese rivers can be enclosed in two macro categories: rivers that flow into the sea (65%) or internal rivers (35%) (FAO, 2011: p. 4). In China, the presence and availability of water is uneven both in terms of geographical location and in terms of time. The northern part of the country is populated by 40% of the total population, however, it holds only one fifth of the national water quantity. On the contrary the less populous southern part has ample access to surface water resources and also has a groundwater system four times higher than that of the north.

The surface water sources available on the territory are fed for 98% by precipitation, while the remaining 2% comes from the melting of glaciers (Jiang, 2009: online). Most of the

[36] The internal amount of a country's water resources which are generated through the hydrological cycle, it includes surface water and groundwater. (Food and Agriculture Organization of the United Nations. Land and Water Development Division., 2003: online)

rainfall is concentrated in the monsoon areas and as we move towards the north-west the quantity decreases due to the mountain ranges and plateaus that characterize the western part of the country and that constitute a sort of barrier. A characteristic of the monsoon areas is that there are not four seasons but just two, the dry and the rainy one. This way the rains are concentrated in short periods of the year, so that 70% of the annual rains falls in only four months (Jiang, 2009: online). This temporal and geographical discontinuity in the supply of water increases the risk of floods (especially in the south) and of drought (more frequent in the north).

Since the 1980s, China has had to face ever-increasing water shortages. In normal conditions among 662 cities surveyed, around 300 failed to guarantee their citizens a sufficient water supply while 110 are in serious water shortages. With regard to large metropolitan areas (over one million inhabitants) almost all of them struggle to satisfy the demand (Jiang, 2009: online).

The development of the economy, the strong industrial growth and the increase in the rate of urbanization have produced that the demand for water showed no sign of diminishing but has gradually increased. Because of this continuous pressure and the strong water instability the amount of water taken from the waterways has become increasingly worrying, so much that some rivers are dried up before they can even reach their delta, destroying entire ecosystems and forcing estuarine species to extinction. The peak of water withdrawals has been reached in the Huai river basin, in the north of the country, where the water withdrawn reaches 91.7%, increasing the environmental risks.

Despite these reckless withdrawals, the water supply is far from being satisfied so that groundwater also started to be used and now has become an indispensable resource for water supply, especially in the north where it makes up for 36.3% of the demand. Like rivers, groundwater is also prey to uncontrolled withdrawals, which can however lead to not less serious consequences, including the lowering of the water table,[37] ground subsidence and the risk of salt infiltration. In the northern part of the country the lowering

[37] "Water table, also called Groundwater Table, upper level of an underground surface in which the soil or rocks are permanently saturated with water […] It also is affected by withdrawing excessive amounts of water from wells or by recharging them artificially" (The Editors of Encyclopaedia Britannica, 2016: online)

of the water table was on average between 20 and 40 meters, however in Beijing there was a striking case as the water table reached a lowering level of 100-300 meters (Xie, 2008b: p. 18). Moreover, since the soil is the result of successive stratifications, the drying up of an aquifer reduces the lower support enjoyed by the upper layers, which therefore tend to sink. These lowering of the ground reduces the size of the groundwater filling them with earth and decreasing the amount of water that can be stored in the future. In coastal areas, there is also the risk that a lowering of the soil can cause seawater to advance.

One of the main causes of water resources exploitation is that rapid industrial and urban growth has not been followed by an equal development and improvement of water and industrial infrastructures which, due to their low efficiency, consume enormous quantities of raw materials despite having a very low output. Water is not an exception, due to the low prices that citizens pay per cubic meter of water they make no effort to save it. In addition, it is clear that concerning the infrastructures there is no time neither the necessary funds for modernization. The unlimited use that is made of water and its overexploitation are made possible by the complete lack of regulation that establishes the limits. In China there are no rules that regulate the amount of water that each individual citizen can use as well as there is no method to quantify the amount of water used in agriculture. Regarding the management of water systems and filtering systems that should deal with purifying wastewater, there is the same geographical gap that characterizes many aspects of China: the eastern coastal area and the western area of the inner land. Water management is strongly linked to the degree of development and economic prosperity of the region. In the poorest areas there is a tendency to give greater importance to economic development, while in the areas where this has already happened one of the priorities has become to improve the quality of life of the region by increasing controls. "The rich and developed provinces and cities mostly located in lower reaches of river basin, enjoy much higher wastewater treatment rates than their poor counterparts"(Xie, 2008a: p. 117).

### 2.1.2. Pollution

To aggravate the already critical situation of lack of water in China it must be considered that not all the water present in the country can be used. According to FAO (2011) pollution is a plague that affects every Chinese river system and leaves no river untouched. 80% of waterways are so badly polluted that they are considered completely unusable and no longer harbour any fish. For rivers near urban areas the estimate rises to 90%, especially in the proximity of heavy industries heavy in the north (FAO, 2011: p. 23). In China, water is one of the most polluted elements and, compared to other world's situations, the Chinese one is one of the most critical.

From the reforms of the 1970s, the large state-owned companies of the heavy industry that had characterized the Mao era started to be substituted by TVEs which, even if smaller in size, were much more numerous and were concentrated in rural areas of the country, giving work to thousands of people. At the end of the 20th century, large state-owned companies began to record a decline in production, which meant a simultaneous decline in emissions and waste.

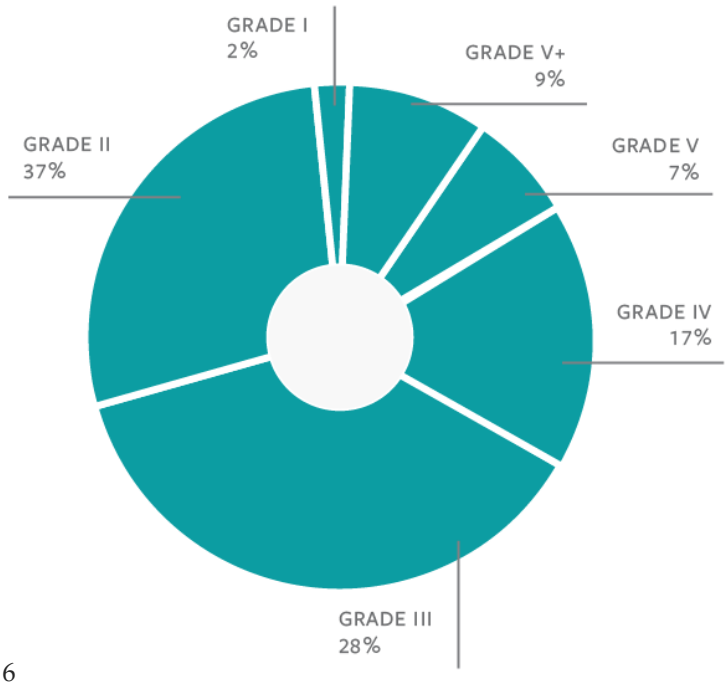


Fig. 6
Surface water quality of China in 2016

However, a decrease in the emissions of certain subjects resulted in an increase by others. Between 1981 and 1995 the volume of waste produced by TVEs increased by 27.8%, with an average growth of 1.65% per year. At the end of this period, in 1995, they arrived to produce 5.9 billion tons of waste, covering 25% of the national amount. Among the various industries, those considered the most polluting were: paper industry, chemical industry and textile industry (Wu et al., 1999: p. 252). Although the amount of industrial

waste was considerable, in 2000 "domestic wastewater discharges have surpassed industrial discharges" (FAO, 2011: p. 24).

During the 1990s the government set itself the goal of reducing the emission of chemistry oxygen demand (COD),[38] together with that of SO2. However, the emissions and water conditions continued to deteriorate until 2007, the first year in which the number of waste spilled into the waters decreased. The main reason why the water pollution rate in China is so high is because the country has failed to develop filtering systems at the same time with economic and industrial development, furthermore the environmental issue has long been completely ignored at all levels of government. Most part of discharges, whether urban or industrial, are discharged directly into rivers and lakes near polluting sources.

#### 2.1.2.1. Agriculture

Agriculture is a sector that contributes and pays the consequences of the high rate of pollution. The reasons that make agriculture an additional source of pollution are the use of chemical materials for the fertilization and the discharge of organic substances produced by animals.

Since the advent of industry and intensive agriculture the traditional and biological methods that in the past had characterized Chinese agriculture were abandoned in favour of chemical (and often toxic) substances. These substances are used by farmers both as soil fertilizers and as pesticides. Fertilizers are intended to increase agricultural productivity and the amount of nutrients present in the soil, but they are absorbed by the soil and penetrate into the aquifers, accentuating their state of pollution. Furthermore, despite the massive use made of it, only 30% of fertilizers are effective (Wu *et al.*, 1999: p. 254). With the abandonment of traditional techniques the idea of "good insects" also disappeared, whose presence would keep away insects and pests that are harmful to the crop as they are predators. As a result of this it was essential to find an alternative method to save crops, so farmers began to use chemical pesticides, highly toxic not only for the

[38] "Chemical Oxygen Demand (COD) is a second method of estimating how much oxygen would be depleted from a body of receiving water as a result of bacterial action." (Woodard & Curran Inc., 2006: online)

environment but often also for human health, which do not kill only dangerous insects but exterminated all of them without distinction.

With the improvement of living standards the diet of Chinese people has changed and the consumption of meat or products derived from animals has been introduced in ever increasing quantities. This has led to an increase in the number of farms and their enlargement. Wastewater and waste from farms were, like all other waste discharged directly into lakes and rivers without them being subjected to any kind of treatment, increasing the quantity of organic waste present in the water.

In addition to paying the consequences of the pollution caused by itself, agriculture also paid a heavy price due to water shortage. In some rural areas water scarcity has reached such high levels that, in order to irrigate crops, farmers used industrial wastewater for irrigation. Obviously this interaction between the agricultural and industrial sectors has had consequences. In 2003 the use of contaminated water to irrigate the harvest led to an economic loss of about 4.3 billion RMB (downward estimate) because it would lead to a loss of harvest, slow down its growth, decrease its quality and increase the problem of soil degradation. The economic loss related to contaminated water does not only concern agriculture, but also the health sector. In the same year the cost of health care in China would have been 66.2 billion RMB, due to the numerous cases of diarrhoea following the consumption of contaminated water. According to one study, the lack of piped water would have increased the incidence rates of diarrhoea in children under 5 years of age by 26%.

#### 2.1.2.2. Eutrophication

Wastewater from cities and urban centres is the main source of pathogens and putrescible organic substances. These substances are present in the faeces that make up the sewage. Therefore all domestic waste contains and can represent a danger not only for human health but also for the ecosystems in which these discharges are released. The decomposition of these sewages requires the presence of bacteria whose work reduces the presence of oxygen inside the water, putting at risk the life of fish and other organisms

that need it to live and therefore altering the balance of the ecosystem. Furthermore, domestic drains are a major source of nutrition for plants, as they are rich in nitrates and phosphates. According to some researchers, however, one of the causes of this increase in nutrients in the water could be found in agriculture, and in particular in its use of chemical fertilizers, which once deposited on the ground, with the first rains will be absorbed and transported up to at groundwater and later in waterways, lakes and even at sea.

An excessive increase of nutrients inside the water would lead to a proliferation of algae which, during the flowering period, would accumulate on the surface, creating a green muddy layer, sometimes even very thick. This layer acts as a barrier between what is above the surface of the water and what is below, preventing the aquatic organisms and living beings from being able to receive sunlight. It also absorbs an enormous quantity of oxygen from the water, removing it from fish and other animals. Its dangerousness would not be limited to this, in fact, the flowering of algae is also dangerous for humans since during this process a toxin, called algal toxin,[39] is released. There are various types of toxins, some of which are harmless, while others are dangerous to health. " Some common types and effects of algal toxins include hepatoxins which damage your liver, neurotoxins which damage your nerve cells, and dermatoxins which affect your skin" (South Dakota Department of Health, no date: online).

### 2.1.3. Human health

The scarcity of water and the poor quality of the existing one have repercussions also on human health. It has been shown that there is a correlation between some types of bacteria present in contaminated water and the incidence of some kind of diseases (such as diarrhoea). Furthermore, the lack of water treatment has resulted in an increase in not potable water consumption which has led to an increase in diseases linked to this cause. According to some studies, pollution from sewage and domestic waste would have a much greater impact on human health than the discharge of chemicals or pesticides. This

[39] "Algal toxins are toxic substances released by some types of algae when they are present in large quantities (blooms) and decay or degrade" (US EPA, 2017: online)

would be mainly due to the fact that this type of discharge in most cases is not treated. It was estimated that in 1996 only 5% of municipal waste was treated before being spilled into the environment, while for industrial ones the rate climbed to 17%. As mentioned above on an industrial level the main danger came from TVE located in rural areas, which had taken the place of large state-owned companies. According to some studies, some pollutants found in TVE would be harmful to health. The possible diseases due to the consumption of these contaminated waters can be divided into two macro groups: infectious diseases and non-communicable diseases. The first group includes diseases that get an almost immediate reaction to the use of contaminated water and are considered more "light". In developed countries they can be cured, while in developing countries they lead to serious consequences, such as diarrhoea, intestinal infections or the like. In the second group, instead, we find diseases linked to long-term use of contaminated water that have a high mortality rate. Cancer is the most common example.

Different forms of pollution determine different forms of diseases:

- Heavy metals, they come from industrial refining and can have direct effects on human health, or affect the fauna that populates the water bodies related to human food chain. The presence of heavy metals in water can cause a slowdown in growth or deformations at the time of birth.
- Other industrial wastes, they may contain toxic (harmless or lethal) substances that undermine the health of fish or those who feed on them. Among the effects of their presence there are intoxication, difficulty in reproduction or immune suppression
- Microbial pollutants, they are the result of the discharge of domestic sewage and can endanger the health of the animals that come into contact with them because they can be a vehicle for diseases (such as typhus or cholera)
- Suspended particles,[40] they reduce the quality of drinkable water for both humans and animals and reduce the penetration of sunlight into water. Their presence can be the cause of slowing down the process of photosynthesis of plants or other organisms (*What are the Dangers of Water Pollution*, no date: online).

[40] Suspended particles are impurities present in water that reduce clarity.

In some cases the incidence rate of these diseases was so high that the towns near the polluted water bodies were renamed "cancer village".[41]

### 2.2. SOIL DEGRADATION

As seen previously, some decades ago China began a process of economic development and industrial growth. This improvement has entailed enormous environmental costs. One of the elements that for a long time has not been considered is soil. China is the country in the world most affected by soil degradation. More than 40% of its land is touched by erosion, salinization and desertification. It was only in the 1990s that China began to care about the land it used and its pollution rate. The reasons that led to this late stance are the fact that soil pollution, unlike air or water ones, is a type of non-mobile pollution: it only concerns the room where pollution takes place and does not infect others. Moreover the most polluted areas are found in the poorest and most isolated regions of the country. The elements that made the first alarm bell sound are: the increase in the number of diseases due to soil pollution, especially due to heavy metals, the food scandals related to the use of toxic substances in agriculture and the changes in land use due to industrialization and urbanization.

In many regions of China, since there are serious problems associated with soil pollution, local regulations have developed much earlier than national ones. At the legislative level, China is still far behind with regard to the environmental issue and does not have any real national legislation, except for the 1989's Environmental Protection Law, which introduced the principle of "Polluters Pay". This principle aims to make the polluters themselves responsible for the polluted plot. In order to do this, some prerequisites have been established prerequisites to facilitate the task of tracing the identity of the polluter. Some of these prerequisites are: land monitoring in case of an ownership change, elimination of contamination where it was present and making companies responsible for their use of the soil. Recently the "Polluters Pay" system has been replaced by the "risk-based

[41] "Small communities near polluting factories where cancer rates have soared far above the national average" (Kaiman, 2013: online)

contaminated sites management" system, which mandated the reclamation industries. A negative factor of this policy is that having by definition increasing their earnings as their purpose, the industries aimed at saving rather than at the quality of work. This way not all the decontaminations made were effective.

In 2014, in an attempt to understand the actual damage that pollution had caused to the ground, the Ministry of Environmental Protection (MEP) and the Ministry of Land and Resources (MLR) launched the first 'National Soil Pollution Survey'. The survey showed that 19.4% of arable land, 36.3% of industrial lands and 33.4% of mining areas did not meet national environmental standards (Brombal *et al.*, 2015: p. 287).

A manoeuvre that wanted to limit the damage, and try to solve it, was implemented in the same year by the MEP, the 'Soil Pollution Prevention and Remediation Action Plan'. The measure aimed to outline what were the priorities on which the authorities were supposed to focus: the protection of cultivable land, the control of polluting resources, the risk management of polluted lands and the identification of the plots that had to be reclaimed. Very often, however, one of the biggest obstacles that the bodies in charge of environmental protection had to face was linked to the information gathered. Local governors hindered the monitoring work by claiming that the data collected represented sensitive material and therefore could not be disclosed.

### 2.2.1. Urbanization

One of the main causes of soil pollution in China, which has significantly reduced the portion of healthy soil suitable for agriculture over the last thirty years, is urbanization.[42] China is the most populous country in the world but up until a few decades ago it has always had a relatively low rate of urbanization. This is undoubtedly due to the policies adopted during the Maoist period that bounded peasants to the land they cultivated and prevented them from moving to urban centres. During the era of Deng Xiaoping this trend has been completely revolutionized. The urbanization rate, which was 17.9% in 1978,

[42] "Urbanization, referring to a growth in the proportion of population living in urban areas, is one of the major social sweeping the globe" (Chen, 2007: p. 1)

began to grow rapidly reaching 40.5% in 2003 (Chen, 2007: p. 1) and almost 60% today (CRI, 2018: online). Growth shows no signs of slowing down, so much as it was assumed that in 2050 the urbanization rate in China could reach 75% (D'Auria, 2013: online). In a few years, China has become the country with the highest number of urban population, succeeding even the United States. China has 166 cities that exceed a million inhabitants, while the States count just 9 (D'Auria, 2013: online). Having such a vast territory, China has developed different models of urban development, which can be enclosed in two macro groups, which follow the geo-economic characteristics of the country.

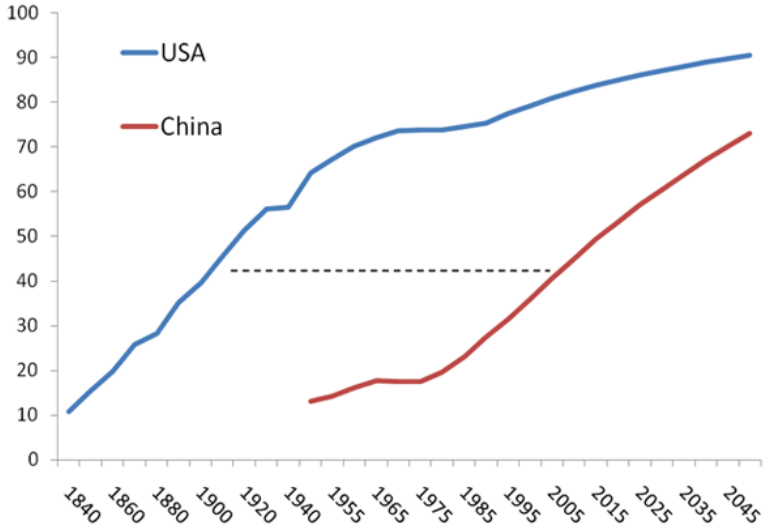


Fig. 7
Percentage of Urban Population: United States and China

The model of coastal eastern China, that is more economically developed, has the characteristic of having a dynamic urbanization always in rapid change, with the birth of new settlements that form a unique urban line along the coastal strip. On the contrary, the model of western China in the hinterland, that is economically backward, is characterized by cities of lower density. In these regions the growth rate of urbanization is fuelled by migrations that push masses of peasants to move to the city. Most of the times they fail to integrate and create slums in which minimum services are not always guaranteed. (D'Auria, 2013: online)

The construction and expansion of built-up areas has a devastating impact on the soil as the building process is irreversible. Once built it is no longer possible to go back. It is estimated that the loss of arable land due to the construction of urban, rural and industrial centres is 21% of the total amount. Cities are responsible not only for the loss of soil and the reduction of arable land, but also for the poor quality of the remaining soil by altering the physical properties of the environment. According to a survey, around 65% of Chinese

cities have contaminated soil by heavy metals or road dust[43] (Brombal *et al.*, 2015: p. 287). According to a report by the MLR, in China the development zones that have been built amount to 6741 and the total area they occupy would be larger than that of 667 cities. The report also stated that 70% of these development zones had been built illegally and that 65% of the areas used had been victim of building abuse (Chen, 2007: p. 8).

### 2.2.2. Agriculture and food security

A topic often linked to soil degradation and pollution is that of food security.[44] Since ancient times China has always been able to support the food needs of its population. However, the population increase and the almost uncontrolled decrease in the agricultural soil threaten to seriously endanger the country's livelihood. Until a few decades ago most of the land cultivated in China was dedicated to the cultivation of grain, a staple food for the Chinese diet. In later times economic development and the consequent enrichment of the population have favoured a slow food diversification. The increase in wages has led to a greater demand for food that derived from animals, fruit and vegetables. At the beginning these requests came mainly from urban areas, but thanks to the revenues increase in rural areas this diversification of the food diet also took place in the countryside. Though, the gap existing between city and countryside has never been completely filled.

During the 1980s and 1990s the government began to implement an "agricultural restructuring" process. It allocated some land previously dedicated to the cultivation of cereals and wheat to other types of crops, such as fruits and vegetables. This has not only led to a considerable loss in grain production (about 62% of the land was converted) (Chen, 2007: p. 4) but also to a drastic change in soil management. The new cultivated products took a quantity of nutrients from the soil greater than grain, consequently to keep the soil

[43] "Road dust consists of solid particles that are generated by any mechanical processing of materials […]. When this dust becomes airborne, primarily by the friction of tires moving on unpaved dirt roads and dust-covered paved roads, it is referred to as road dust" (Khan and Strand, 2018: p. 1)

[44] Situation that exists when "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and preference for an active and healthy life" (FAO, 2006: p. 1)

solution in balance they needed a different supply of minerals and nutrients. To overcome this problem, farmers have increasingly used chemical fertilizers, which have altered the chemical properties of the soil.

As the percentage of the population living in the city increased, agricultural production began to concentrate and become intensive in peri-urban areas, which offered easier access to the market.

### 2.2.3. Deforestation

One of the factors that indirectly affects the quality and health of the soil is deforestation. The felling of trees increases the speed of soil erosion, as the roots no longer retain the earth, leaving it to be eroded by water and wind and, in the event of a sloping ground, increases the incidence of landslides. During the first period of economic growth after the Deng reforms, local officials took advantage of the total absence of laws dedicated to regulating the felling of trees, or defining areas where this practice was limited or prohibited. In the period 1978 - 1986 the felling of trees increased by 25%, and for half of the following decade, out of 140 forest bureaus, 25 claimed to have exhausted all the forest resources present in their territory, while 61 claimed that in their jurisdiction the felling of trees proceeded at an unsustainable pace (Economy, 2010: p. 64). Given the size of the Chinese territory and the forests within it, the problem of deforestation is not limited by national borders but has global repercussions. On the one hand deforestation leads to "wood shortages, altered ecosystems, soil erosion, riverbed deposits, flooding and changing local climates" (Economy, 2010: p. 66). On the other hand, the decrease in forest areas in China can aggravate the situation regarding global climate change "release of carbon dioxide when trees are felled, and from the loss of a carbon sink" (Economy, 2010: p. 66). Furthermore, the loss of forest habitats endangers the biodiversity of those areas, aggravating the situation of those species considered at risk of extinction.

## 2.3. AIRPOCALYPSE

The word airpocalypse refers to an extreme air pollution event, in particular the first times it was adopted talking about the numerous days of pollution in 2013.[45] When this event occurs the high quantity of polluting particles present in the air is so high that it significantly reduces visibility, making the scenario look like a horror movie. In China, the high rate of air pollution is mainly due to the massive use of coal in the country, both industrial and domestic. It is the raw material that provides 80% of the electricity needs and 70% of the national energy needs (Hays, 2008: online). In winter the situation worsens significantly as low temperatures, especially in the north, force the population to simultaneously operate numerous heating systems, all powered by coal, which are added to the industrial furnaces that surround the cities.

Air pollution can be divided into two macro sections: internal air pollution and external air pollution, referring to the place where people breathe toxic and polluting agents. In the first case the polluting particles are released inside the houses. This happens especially in the most backward areas where homes are without chimneys or a system that releases the fumes derived from combustion outside the home. This way, the particles remain trapped and can have high axes of concentration. External pollution, on the other hand, includes all those external polluting sources, such as the exhaust fumes of cars, those of the industries and in winter also the heating systems. According to a World Bank study, only 1% of the Chinese population breathes clean air according to European standards (Hays, 2008: online)

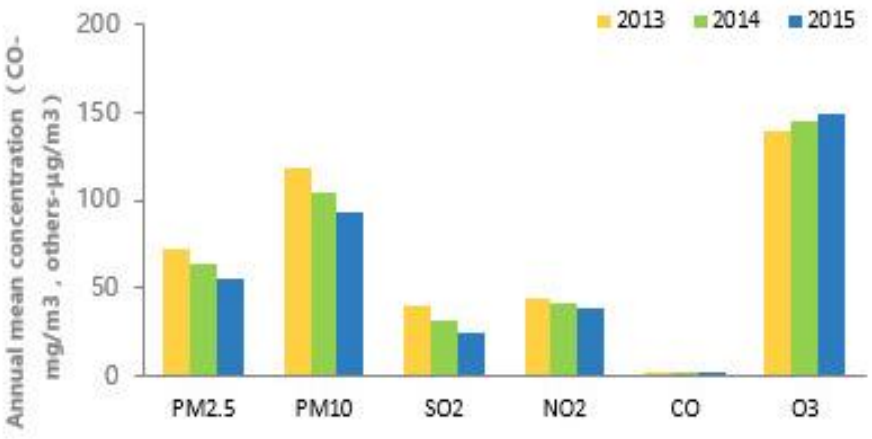


Fig. 8
Average annual mean concentrations of six pollutants in 74 key cities in China (2013-2015)

[45] On 21st October 2013 the city of Harbin, in the North of China, was covered by a smoggy fog and in some quarters of the city the PM2.5 level reached 1'000. (Perrone, 2015: online)

In 2014, when the government was called to host the APEC[46] China 2014, it began a massive campaign to clean up Beijing's skies. This campaign has been so successful that in those days Beijing's sky was strangely blue. This view was so strange for the Chinese that they started calling the blue sky phenomenon APEC blue.[47] At the time it was relatively recent that the government had become aware of the problem by publicly acknowledging that the recurring fogs that covered Beijing, and numerous other large metropolises, were the result of high air pollution rates.

### 2.3.1. Pollutants

According to Greenpeace reports the most polluting elements are: particulate matter, sulphur dioxide, nitrogen oxide, ozone, carbon oxide and polycyclic aromatic hydrocarbons (Greenpeace, 2012: online).

***Particulate Matter (PM)***

One of the most dangerous emissions for human health is that of particulate matter (PM). They are particles of solid material that remain suspended, the best known are PM10 and PM2.5. They have respectively a size of less than 10 micrometres and 2.5 micrometres.

Their degree of danger is determined by their size, entering easily into the lungs the smaller they are, the more they can go deep. "They can enter into the areas where gas is exchanged between the lungs and the bloodstream"(Carrington, 2018: online). This type of particles can be of first production, that is emitted directly from polluting sources, or of second generation. In the second case the particles would derive from chemical reactions occurring in the atmosphere following the emission of different polluting agents, or from the reaction of these with elements already present in the atmosphere.

***Sulfuric dioxide (SO2)***

Sulphur dioxide is a colourless gas characterized by a strong smell. This substance is present in small part in nature, while the majority is produced by human beings through

[46] Established in 1989 Asia-Pacific Economic Cooperation is an organization that promotes the trade and economic cooperation among Asia-Pacific countries. It aims to defend the interests of that region and to promote sustainable economic growth in an attempt to raise living standards and education level (Moon, 2014: online)

[47] APEC 蓝, APEC lan

industrial processes that treat sulphur, such as the combustion of coal for the production of electricity or the emissions of motor vehicles.

***Nitrogen oxide (NO)***

Nitrogen oxides is a colourless gas, toxic to humans and the environment. The main sources of this gas are vehicle emissions and thermal power-generating plants. One of the disturbing aspects of this gas lies in the reactions it triggers once in contact with the atmosphere. Its contact with water vapour generates nitric acid, one of the major components of acid rain. Furthermore through photochemical reactions[48] it can give life to other types of pollutants, called photochemical smog.

***Ozone (O3)***

Normally people think that ozone is a gas that brings benefits to human life as it filters out the sun's rays preventing ultraviolet rays from penetrating the atmosphere and harming living beings. This is true if ozone is found in the upper layers of the atmosphere where it forms a sort of natural barrier. In the event that this element is present in the biosphere (in particular at human height) it can be dangerous to health. At low altitudes ozone is mainly the photochemical reaction product of other air pollutants, which is why its concentration is higher in sunny periods. Unlike other pollutants, ozone rates do not seem to decrease.

***Carbon monoxide (CO)***

Carbon monoxide is a highly toxic colourless gas. It has numerous industrial uses, and it is also present in the combustion gases of the industries that treat it, mainly due to an incomplete transformation of carbon into carbon dioxide (CO2). However, once released into the atmosphere at high temperatures it can complete the reaction and become CO2.

***Polycyclic aromatic[49] hydrocarbons (PAHs)***

PAHs are substances that can be found in nature even if to a lesser extent than those produced by humans. They are polluting substances that derive from the incomplete

[48] They are chemical reactions due to the absorption of energy (through sunlight) by some substances, which generate others. The result of these reactions are usually more acidic and more reductant than the starting ones.(Fleming, Krueger and Longworth, 2018: online)

[49] "Aromatics are a class of chemicals that are still difficult to obtain from biomass, and efforts are currently made to produce aromatics from lignin." (Industrial Biorefineries & White Biotechnology, 2015: online)

combustion of organic materials. Their presence has been traced back to the burning of oil, coal and tar. They are particularly dangerous for those living near coal-fired power plants.

### 2.3.2. Monitoring system

In 2012 China adopted the Air Quality Index[50] (AQI), an international parameter to identify whether an area is polluted or not and to establish the degree of pollution (Air Pollution in China, 2019: online).

In the same period, especially following pressure from domestic and international public opinion, it has decided to adopt a monitoring system for air pollution conditions, making updated data on the pollution status of 1500 cities available. The National Air Reporting System is composed of numerous control centres scattered over the territory that are updated every hour and via internet it reports the concentration in the air of PM10, PM2.5, SO2, NO2, O3 and CO (Rohde and Muller, 2015). Thanks to this monitoring it had been possible to notice that the problem was very widespread in the country.

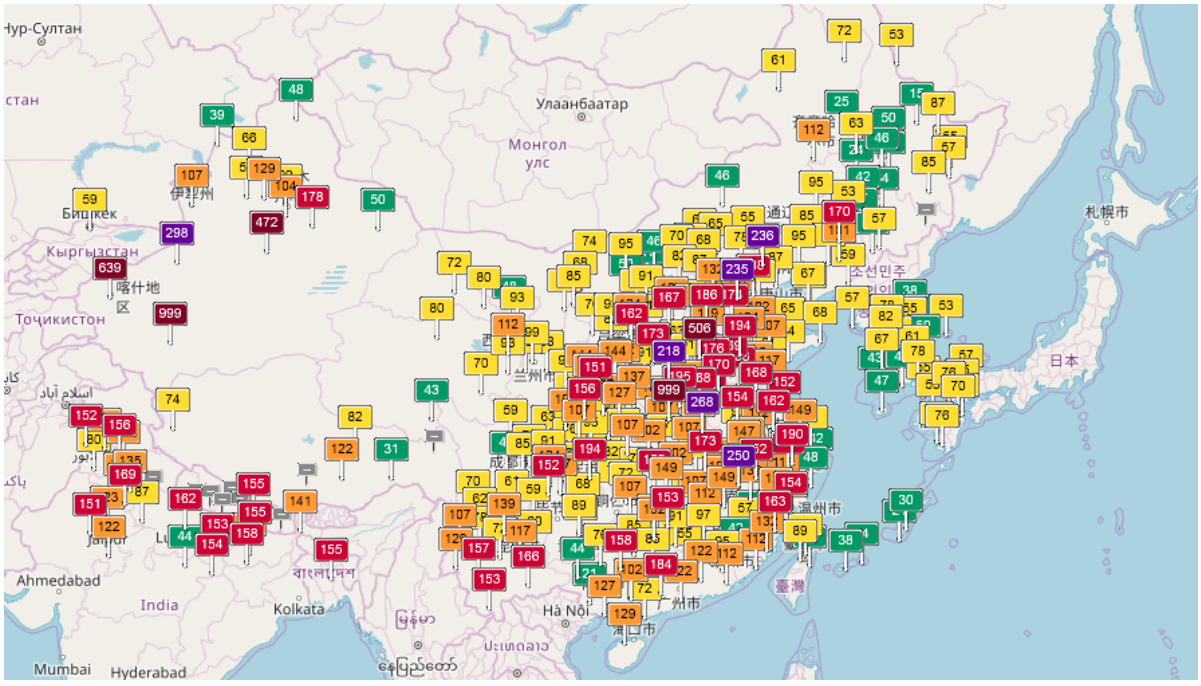


Fig. 9
Real-time Air Quality Index Visual Map, in 20th May 2019 at 16:11

[50] According to the Air Quality Index (AQI) : 0-50 level is considered good, 51-100 is moderate, 101-150 is unhealthy for sensitive groups, 151-200 is unhealthy, 201-300 is very unhealthy and 300+ is considered hazardous (Daily Mail, no date: online)

As for the study of PM, according to the WHO studies, their level in northern China is at least 20 times higher than that considered safe (0-50), while according to other studies about 38% of the population lives in areas that are generally considered insane and 45% is in areas that are classified as "unhealthy for sensitive groups" (Rohde and Muller, 2015: p. 7). This is mainly due to the fact that PM can persist in the air even for weeks and transported by the wind can travel thousands of km.

### 2.3.3. Coal

In China, the main way to produce energy remains coal burning. A process that, through heat, breaks the chemical bonds of the carbon atoms releasing energy. In 2003, 3.6 billion tons were burned in the country. The Chinese not only use a huge quantity of it but also for the most part they use a poor quality one: lignite.

Lignite is a type of brown coal with a high concentration of humidity that contains only 60-70% of pure coal and that has a calorific value near 17 mega joules per kilogram (Kopp, 2016: online). It is a type of geologically young coal and is very close to the surface of the soil, which is why the costs of extractions are relatively low. Having a low calorific value, the quantity needed to produce the required energy is very high, moreover during the combustion the lignite tends to disintegrate increasing the risk of losses. Lignite, and coal in general, is a high-emission fuel. During combustion, coal releases energy as well as other pollutants and harmful substances, that affect environmental and human health:

- Mercury (Hg), it is a heavy metal that can cause problems to the growth of children and damages the immune and digestive system even in adults.
- Sulphur dioxide (SO2), it is not produced directly by combustion but is a secondary generation product. It is formed by the reaction between coal's sulphur and oxygen, and in turn can bind to other substances to form acid particles. Its presence is linked to respiratory problems, such as asthma and bronchitis. It is also one of the causes of smog and acid rain.

- Nitrogen oxides (NOx), it is another source of smog and acid rain whose presence aggravates asthma and makes people that breath it more susceptible to respiratory problems.
- Particulate matter (PM), it is the black ash present in the coal combustion smoke. If inhaled it can cause bronchitis, asthma and cardiovascular problems, as well as increase the mortality rate. In China 60% of PM2.5 comes from the combustion of coal or oil and the combination of these two types of fuels can generate "second particles" deriving from chemical reactions.

### 2.3.4. Fuel

In 2017 the Ministry of Ecology and Environment (MEE) published a report according to which in China car owners were 310 million, with a growth of 5.1% compared to the previous year and a decrease in total emissions from vehicles of 2.5 % (Stanway, 2018: online). The problem of pollution due to road traffic in China is very serious. In the same year the quantity of polluting material emitted by vehicles circulating in the country amounted to 43.6 million tons. The polluting emissions (most of them composed of CO) diminish much more slowly than other pollutants. The standards adopted by China are not very strict and even when established they are not always respected. This is the case of the adoption of the China IV standard in 2008.

Although the standards had changed and vehicle manufacturers had to adapt to it, the fuel with which these "new generation" cars were fed remained the China III standard until 2013, due to the lack of compliant fuel. The fuel quality problem is not easy to solve, in fact the industries do not clean the fuel because the national standards are not high enough to force them to do so, probably because a large part of the commission that decides which standards to adopt comes from the oil industry (Jing, 2015: online).

Furthermore, according to a 2014 survey, 90% of the vehicles did not meet the emission standards, even if on the certificate it was stated the contrary. Despite the private cars "emit twice as they are exhausting in traffic" (Jing, 2015: online) they are not the main source of pollution among road vehicles. The real problem are diesel trucks, especially the

non-compliant ones. Although the trucks that do not meet the standards are only 7.8% of the total vehicles, their NO emissions amount to 57.3% of the total emissions and to three quarters of the airborne PM emissions (Stanway, 2018: online). That is because a non-compliant truck can have an emission of PM even 500 times higher than a vehicle that meets the China IV standard.

Smog does not only come from road vehicles but is a phenomenon that extends to all means of transport. In China there are seven of the ten largest ports in the world, from which numerous tankers and container-carrying ships depart and arrive every day. Each of those ships in order to move, given their size and weight, requires very high fuel consumption, increasing smog emissions. "Oceangoing freighters cause so much pollution that within 400 meters of the coastline are the equivalent of 500 thousand semi-trail trucks" (Jing, 2015: online). The same principle of large transport ships also applies to airplanes that can consume 1 ton of fuel each time they land and take off. In the river areas the situation is not better, although the dimensions of the boats are reduced, they use one of the worst qualities of fuel.

### 2.3.5. Human health risks

As mentioned above, air pollution can have very negative effects on the life of humans and other living beings. The WHO has estimated that in 2015 the premature deaths that could be linked to air pollution in the world were more than 7 million: 4.2 million due to external pollution and 3.8 million due to internal pollution (some subjects were exposed to both) (Carrington, 2018: online). Taking into consideration only China, deaths due to air pollution amounted to around 1.58 million (McCarthy, 2018: online), the equivalent of about 4 thousand deaths per day: 17% of deaths in China (72 thousands of which are caused by ozone exposure).

Airborne pollutants can cause death in case of particularly sensitive individuals or in case of long periods of exposure. However, they are also the cause of a worsening of the living conditions. Entering in the body through the respiratory tract, the problems they cause in humans are mainly related to the respiratory system. It is estimated that in China air

pollution is the cause of 50% of respiratory diseases affecting citizens. According to a study by the UN Development Program, in the most polluted areas of China the incidence of lung cancer is 4 to 8 times greater than in areas where air quality is considered good. Journalist Jing Chai in her documentary "Under the Dome" (2014) states that over the past 30 years in China the rate of lung cancer has increased by 465%.

Air pollution severely affects children, both before and after childbirth. If a mother breathes polluted air for long periods, the foetus could suffer serious physical malformations and mental delays. The growing season is another very sensitive period, those who live in polluted areas grow more slowly than peers who live in cleaner areas.

One of the most studied and most damaging pollutants are PMs, which penetrating into the lungs manage to circulate in the blood and through it they can reach other organs (even the brain). According to a research published in 1993, Harvard six cities study,[51] pollution is also the cause of other diseases, such as diabetes, kidney disease, Alzheimer's and premature skin aging.

## 2.4. ACID DEPOSITION

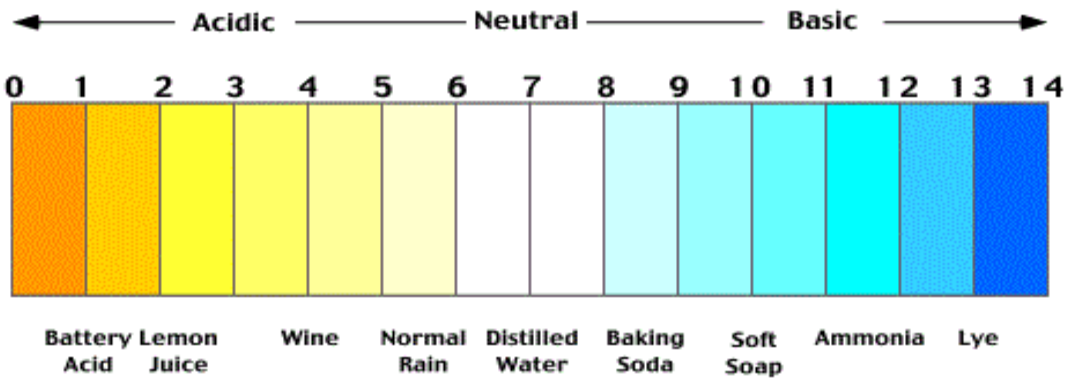


**Fig. 10**

"The quantitative measure of the acidity or basicity of aqueous or other liquid solutions is pH. The term […] translates the values of the concentration of the hydrogen ion into numbers between 0 and 14. In pure water, which is neutral, the concentration of the hydrogen ion […] corresponds to a pH of 7. A solution with a pH less than 7 is considered acidic; a solution with a pH greater than 7 is considered basic." (The Editors of Encyclopaedia Britannica, 2019a: online)

[51] Dockery, D. W. *et al.* (1993) 'An Association between Air Pollution and Mortality in Six U.S. Cities', *New England Journal of Medicine*. Massachusetts Medical Society , 329(24), pp. 1753–1759

Another factor that is highly polluting, destabilizing for the environment and dangerous for human health is acid rain, or rather acid depositions.[52] This type of pollutant is not limited to a single element but is connected in some ways both to water, to the ground, and to the air. Acid depositions are caused by exhaust gas emissions in the air but have repercussions mainly on soil and water sources.

The phenomenon of acid rain is a scourge that has begun to weigh on the world since the emissions of pollutants began to increase, especially following the acceleration in the use of coal and oil in energy production and industrial combustion. Europe and the USA have begun to tackle this phenomenon since the 17th century, due to the Industrial Revolution and the first exponential growth of emissions. However it is only during the 1970s and 1980s that they realized the entity of the problem and tried to find a solution. In China the problem is relatively recent. It is only from the beginning of the 2000s that it was realized acid deposits caused by pollution were a problem that could no longer be ignored, but had to be faced and solved (Larson, 2010: online). The damages that acid rain has caused and still continues to cause are incalculable, not only for the economy but also for the environment and human health. What acid rain mainly causes is the alteration of the acidity of soil and water on which it is deposited, influencing the lives of the living creatures connected to them.

The phenomenon consists in the relapse of pollutants present in the air, mainly sulphur dioxide SO2, nitrogen oxide NOx and ammoniac NH3. These, by binding to oxygen molecules and water, are transformed into sulfuric acid and nitric acid, which are then absorbed by the soil and water on which they fall onto. Acid rains have particularly harmful effects in those regions where the soil has "a low buffering capacity, or low acid-neutralizing capacity" (Butler and Likens, 2019c: online) or in those areas where acid rain has fallen for such a long time that it has debilitated these capabilities. As far as China is concerned, the greatest damage is recorded in the southern part of the country, where the soil is more sensitive to changes in acidity and where it is less rich in acid-neutralizing capacity.

[52] "The many ways in which acidity can move from the atmosphere to Earth's surface. […] Acidity is a measure of the concentration of hydrogen ions (H+) in a solution." (Butler and Likens, 2019a: online)

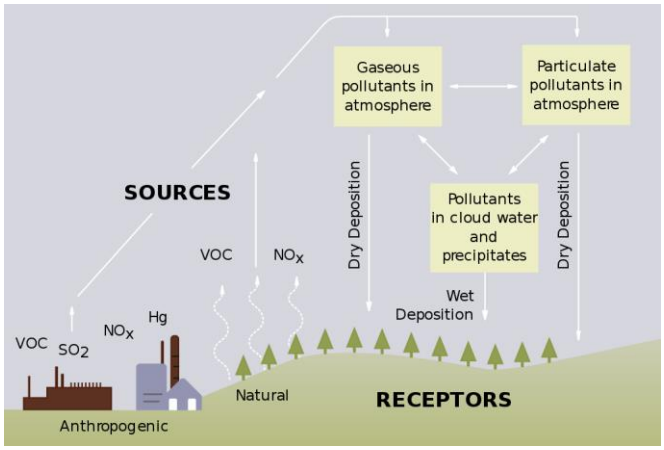


Fig. 11
Processes involved in acid deposition

Acid deposits are divided into two categories: wet deposition and dry deposition. The first includes the participation of water, in any state. The deposits can take the form of rain or snowfall, or even can be dew or mist. The dry deposition, instead, implies the action of the wind. The polluting particles in the clouds are carried by the wind and can settle down even thousands of kilometres away from the point where they were emitted. For this reason acid rain is considered a global issue, which is a question that cannot concern a single country. These pollutants do not have geographical boundaries and the pollution produced in a country can generate acid rain on the opposite side of the planet.

### 2.4.1. Water

Once acid depositions come into contact with water they easily alter its degree of acidity. This can represent a huge risk for the biodiversity of the water bodies that are contaminated. Not all water bodies respond to this variation of acidity in the same way. There may be two cases:

- If the soil on which the water rests is a type of basic soil or with elements of magnesium and / or calcium the variation in acidity as a whole would be minimal, because the soil would act as a natural regulator;
- If the water rests on an already acidic or neutral ground the variation of acidity would have bigger consequences in the absence of elements that can contrast it.

The alteration in the acidity degree of a pool of water can be very dangerous for the biodiversity of the area. Some species of fish are more sensitive than others and even a change in one degree[53] can be fatal to them. In most cases, however, the death of fishes is

[53] It was noted that in a pool with a degree between 7 - 6 it was also possible to find five different species of fish, the species reduced to one if the degree of acidity rose to 4 - 4.5. (Butler and Likens, 2019c: online)

not due directly to the change in acidity but to one of its consequences. The increase in the acidity of the water is capable of triggering a process of solution of the heavy metals already present inside the soil where the waterbody rests, which by mixing them with the water increases the pollution rate. Heavy metals are one of the main causes of endemic fish deaths.

The transformation of mercury is another process triggered by water acidification. The sulphur depositions contained in the acid depositions accelerate the transformation process of elemental mercury into its most harmful form: methyl mercury, a neurological toxin. This type of conversion takes place mainly in marshy or water-rich places, where the lack of oxygen allows mercury bacteria to proliferate. One of the most dangerous characteristic of methyl mercury is bioaccumulation. It means that the amount of toxin accumulated by plankton and microorganisms is then absorbed by their predators, where the toxin binds to fat cells and increases its amount. As the food chain advances, the quantity of toxin present in the organisms is always greater. That means it could be harmful to humans (as the fish is part of its food chain).

A detail that seriously endangers the ecosystems affected by acid deposition is the 'acid shock' that occurs in the spring with the melting of snow. The substances that have accumulated throughout the winter in the snow, once it begins to melt, can be released all at the same time into the surrounding environment. This kind of release could have concentrations that are 5 to 10 times higher than those of simple 'acid rain' and are lethal for eggs or for young fishes (Pidwirny, 2006: online).

### 2.4.2. Soil and forestry

Acid deposits affect the chemical properties of the soil, however the consequences they may have depend on the composition of the soil itself. A mainly lime-based soil will have less problems in neutralizing the increase in acidity compared to a soil composed mainly of siliceous sand[54] or weathered acidic bedrocks (which naturally tends to acidity). What

[54] "[siliceous sand] Surface soil pH is acidic; pH increases with depth to slightly alkaline levels." (Resources, 2011: online)

makes some soils resistant to the increase in acidity due to deposits is the presence of calcium, potassium, magnesium and sodium cations that neutralize the acidifying action. They also represent a source of secondary nutrients for plants, so their decrease due to the increase in acidity also leads to a decrease in plant nutrition. The acidity of the soil also eliminates many other essential nutrients for the plants. This causes a slowing down in their growth process and increase their vulnerability. In a forest the intensification of soil acidity can be the direct or indirect cause of serious problems for the growth and survival of plants. An increase in acidity seriously affects the plant's nutritional process. It drains the nutrients they need and helps release aluminium, a substance that damages plant roots and prevents them from reaching the nutrients they need. A decrease in pH[55] can also have repercussions on the sprouting and growth of new plants. It affects the decomposition and nutrient cycle processes as well, because the organisms that deal with them can not live in environments with a high level of acidity (Pidwirny, 2006: online).

Another factor that puts plant life at risk is nitro saturation. One of the elements that constitutes the acid deposition is nitric acid, whose presence increases the amount of nitrogen in the soil inducing an over-fertilization[56] in the plants and reduces the quantity of alternative nutrients. One more damage that acid deposits cause in plants is related to the fog or cloud water. They deposit directly on the foliage making it difficult to assimilate the necessary water. Their acid concentration could be up to 10 times greater than the simple rain.

The areas located at higher altitudes are more exposed to the risks of acid deposition due to their elevated position. Moreover the temperatures and the rigid climate make the plants more susceptible to damage due to the ice.

The acid depositions, however, could have even more devastating effects. Some scientists have theorized they may have consequences also on the geology of the terrain, weakening the bonds that keep it together and causing landslides. Such as that of 2009 in Jiweishan, in

[55] To say " a decrease in pH" is the same thing to say "an increase in acidity" (ed)

[56] An excessive level of nutrients can be harmful to plants and create other potentially harmful damages such as environmental contamination or a waste of resources. "In particular, above optimum nitrogen and phosphorus levels can lead to excessive plant and algal growth in waterways that can degrade drinking water, fisheries, and recreational areas" (Tracy, 2015: online)

southwestern China, where a wall of shale, probably after an acid precipitation, yielded by sliding and causing numerous deaths (Butler and Likens, 2019b: online). It is hypothesized that the infiltrations of acid rain have altered the physical properties of rocks weakening them and making it easier to break the bonds that kept them together (Zhang and McSaveney, 2018).

# 3. CLIMATE CHANGE: SITUATION AND COUNTERMEASURES

## 3.1. CLIMATE CHANGE VULNERABILITY

> "Climate change is a periodic modification of Earth's climate brought about as a result of changes in the atmosphere as well as interactions between the atmosphere and various other geologic, chemical, biological, and geographic factors within the Earth system." (Jackson, 2019: online)

The earth's climate is a very complex topic that has only begun to be studied in recent centuries. However thanks to many sources[57] it is possible to determine the climatic conditions of earlier times. Scientists are all in agreement that the earth's climate changes are a natural fact that has happened since before the appearance of man. The climatic situation of the earth is closely linked to that of the atmosphere, and since this is a "dynamic fluid that is continually in motion", the climatic conditions are not static. They can vary both in the short term and in longer periods. An example of the first case is given by the succession of seasons over the course of a year: in summer the climate is milder while in winter it is more rigid. As regards long-term changes, the example is provided by the alternation of ice ages and warmer thawing periods. It is thanks to these changes that, where there are mountains now, it is possible to find fossils of corals or tropical fishes.

Climate change can have numerous natural causes, often related to each other (Jackson, 2019: online):

- Solar variability: the amount of solar energy that reaches the earth determines the movements of the atmosphere and the amount of heat. The amount of energy is not always constant and depends on solar storms and sunspots.
- Volcanic activity: volcanic eruptions can bring more or less temporary changes to the earth's climate. In the case of particularly large eruptions the emission of SO2, and other substances that the eruption releases, can reduce the transparency of the atmosphere leading to a lowering of the temperature. In addition to SO2, a certain

[57] The coring taken in the glaciers and in the polar zones are among the most used sources by scientists and are very reliable. Coring also allows the study of periods distant thousands of years from our days. Other sources used are soil coring and sections of tree trunks (study of the rings).

amount of CO2 is released into the air (but also in the oceans if the volcanoes are submerged). This amount compared to that emitted by human beings is considered minimal, but in geological times it could have contributed to the change of conformation in atmospheric chemistry.

- Orbital variation: the orbit of the earth varies over time (geological times), mainly making three changes: the modification of the orbit from circular to elliptical, the modification of the inclination of the earth's axis and the change in the orientation of the axis with respect to the sun. All these changes have direct repercussions on the earth's climate, changing the distribution of the solar rays that hit the earth.
- Greenhouse gas: these are gases that have the ability to absorb infrared radiations reflected from the earth and trap them, preventing them from leaving the atmosphere. This way, the amount of radiations present within the atmosphere tends to increase. The presence of these gases is higher in hot periods while it is lower in periods when temperatures drop. The main greenhouse gases are CO2, water vapour (H2O) and methane (CH4). In our days their presence in the atmosphere is increasing due to human intervention, which is the main emitter (Mann, 2019: online).

All the causes listed above need hundreds or thousands of years, to bring about a significant change in the climate. However, the changes that are occurring at this time are too rapid to blame only natural causes. Human activities have a fundamental role in this process. For this reason, many scientists claim that now we are living in a new geological era called Anthropocene.

### 3.1.1. Anthropocene

The name of this new period derives from the Greek and means "recent age of man". Delineating this age, we try to define the period in which human activities have begun to influence the surface of the Earth (atmosphere and oceans) and its natural rhythms. The beginning of this age is not unique and well defined for all scientists. Some date it back to the time when the large mammals that populated the earth (such as mammoths) became

extinct, while others when humans began cultivating the land becoming permanent. Most scientists, however, argue that the beginning of this era is to be established with the advent of the Industrial Revolution, which with its innovations has accelerated the rhythms of human life and accentuated its impact on the environment which surrounded him/her. The two aspects that characterize the Anthropocene are the new models of energy production and those of consumption of natural materials.

The use of fossil fuels to meet energy needs has undoubtedly improved the quality of life of human beings. Thanks to this, the population has increased dramatically from 800 million in 1750 to 7.4 billion in 2016. The increase in population has also led to an increase in the resources needed for its livelihood, so much that it has reached a point where resources are consumed by people at such a speed that the Earth is no longer able to regenerate them.

### 3.1.2. Greenhouse effect

The increase in the use of fossil fuels has as an immediate effect in the increase in the atmosphere of those gases deriving from combustion. Among them there are not only polluting gases (as explained in the previous chapter) but also greenhouse gases. The accumulation of these gases gives life to the *greenhouse effect*, a process present in nature that has the task of preserving the earth's temperature, making the climate

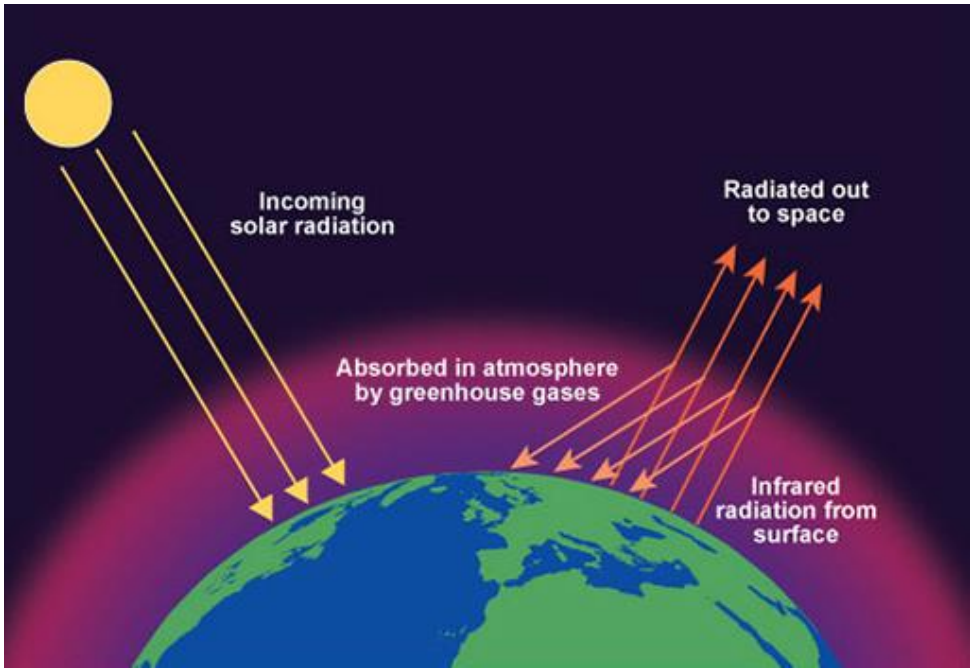


Fig. 12
The greenhouse effect

liveable. Without it, the average earth temperature would be -18 ° C (The Editors of Encyclopaedia Britannica, 2019a: online).

The main gases responsible for the greenhouse effect are: water vapour (H2O), carbon dioxide (CO2), methane (CH4) and surface-level ozone (O3).

- Water vapour is one of the most powerful greenhouse gases and it is also the only one whose concentration does not depend directly on man. The amount of water vapour depends on the rate of evaporation of the water, which in turn is influenced by the temperature of the air. The higher the temperature, the greater the water vapour and the greater is its ability to absorb infrared radiations.
- Carbon dioxide is one of the gases most responsible for the greenhouse effect. It is present in nature thanks to animal respiration, volcanic eruptions and the burning of organic materials. Its natural emissions are balanced by absorption processes that balance the quantity present in the air. The main carbon sinks[58] are the oceans[59] and plants, aquatic and terrestrial, through photosynthesis. Men produce it especially through the combustion of fossil fuel.
- Methane could be found in nature especially in wet and marshy areas, in volcanoes and in polar permafrost. Its balancing takes place directly in the atmosphere. In contact with the gases present in the stratosphere, it decays becoming CO2 or H2O. Rice cultivation, the combustion of fossil fuel and breeding are the main sources of methane produced by man.
- The surface-level ozone must be distinguished from the ozone of natural origin present in the stratosphere. In nature the surface-level ozone derives from the decay of the ozone layer of the stratosphere while as far as human origin is concerned it is the product of photochemical reactions of the CO.

Human activities have increased the presence of these substances, exacerbating the greenhouse effect, making it dangerous for the life of the planet. The enormous quantities

[58] "Carbon sink is any process that removes carbon dioxide from the atmosphere by the chemical conversion of CO2 to organic or inorganic carbon compounds" (Jackson, 2019: online)

[59] The absorption by the oceans of CO2 takes place thanks to the contribution of plankton, marine plants and other organisms that deal with the decomposition of carbon. The amount of carbon that the oceans can decay, however, is limited and once this threshold is exceeded, the assimilation of other CO2 leads to an acidification of the waters.

of carbon produced by human activities are added to those normally produced by nature, and their total far exceeds the amount of gas absorbed by carbon sinks. This, together with the deforestation operated by humans and his demographic growth, is the main cause of global warming, that is an increase in the average temperature of the Earth. From the beginning of this new geological era to the present it is estimated that the average temperature has increased by 1.1 ° C. However if human beings choose to continue along this road, the increase could reach 3 ° C (2.7) by the end of the century. The increase in average temperature, even more so if at such a sustained speed, leads to a change in the climate: "it is global warming that causes climate change. As the planet's temperature rises more than it would naturally, the climate varies "(acciona, 2018: online).

Climate change does not occur uniformly across the globe. In some areas these changes can lead to drought, or on the contrary increase precipitation, and the consequences can have a contrasting impact depending on the area affected. For example, if the increase in rainfall occurs in an arid or semi-arid area, this could favour the emergence of new cultivable areas. Instead, if the increase in precipitation occurs in an area that is already subject to floods, this change could only worsen the situation.

### 3.1.3. Vulnerability

"Vulnerability to climate change is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity."(IPCC's definition in Giordano, no date: online).

Following this definition, the following formula can be used to study the degree of vulnerability of a region:

*vulnerability = potential impact (sensitivity x exposure) – adaptive capacity*

Exposure represents the presence of humans, animals or plants in areas that could be affected negatively by climate change, while sensitivity is the degree to which the system or species taken into consideration are affected by these changes, both in terms of negative

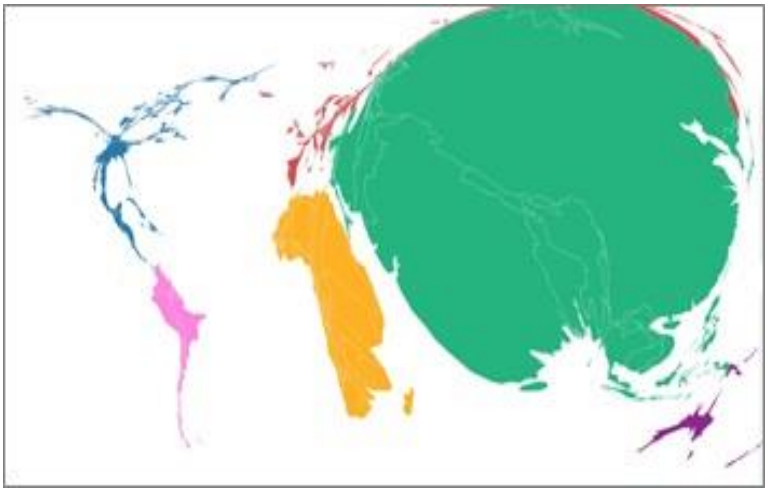

Fig. 13
Vulnerability to risks due to CO2 emission.
Source: Worldmapper

consequences and in terms of positive consequences. The potential impact represents the impact that a given change could have on species or environment without considering the adaptation process. Finally the adaptive capacity is the ability not to succumb to changes, trying to take advantage of them or moderating their damage (Giordano, no date: online). This last aspect is very conditioned by the social structure and the degree of economic development of the population that inhabits the system took in consideration.

Being the developing country with a greater extension, an increasing number of inhabitants and as the main global emitter of CO2, China is one of the states most vulnerable to climate change. The Disaster Relief Department of the Ministry of Civil Affairs claims that in the country "an increasing number of natural disasters are disrupting the lives of 200 million to 400 million people on the mainland every year and sending 10 million farmers back into poverty, causing economic losses of more than 200 billion yuan a year" (Heggelund, 2007: p. 166). The climatic events that are occurring the most in China are "increasing droughts in North China, decrease in runoff of major rivers, flooding in the south, sea-level rise, glacial shrinkage in western China (by 21 percent)" (Heggelund, 2007: p. 166). According to the research conducted on the variation of temperatures in China over the last 100 years there have been an increase in the average annual temperature of about 0.5 ° C - 0.8 ° C, higher than the average increase in the rest of the planet (Li, Lin and Li, 2007: par. 2.1). Furthermore, the Third China National Assessment Report on Climate Change reports that temperatures will rise to 1.3 ° C - 5 ° C (State Forestry and Grassland Administration, 2018: online).

**Floods and droughts**. In recent years the rate of incidence of extreme weather events in the country has increased considerably. It is estimated that the economic losses caused by this type of disaster cover about 70% of the total due to natural causes. Depending directly on the environment in which it is practiced and on weather conditions, agriculture is the sector that is most affected by these variations. In the period 1988 - 2004 the direct annual economic loss as far as crops are concerned would be 2% of the GDP (of the period) (Li, Lin and Li, 2007: par. 2.3.1).

The main causes of economic losses are drought (more present in the north) and floods (very frequent in the south). The regions most affected by drought are those of Huanghe, Huaihe and the lower Yangze basin, which together account for 79% of the areas affected (Li, Lin and Li, 2007: par. 2.3.2). In a country where the price of agricultural products is not determined by the demand-supply ratio[60] but is kept fixed by government policies, a drop in production due to drought has enormous repercussions on farmers' revenues. In the poorest areas of the country there is the risk that a drop in production will bring back the families of peasants, who had just started to be economically self-sufficient, in a state of poverty. On the other hand, floods cause 24% of economic losses due to natural causes. During the 1990s the economic losses caused by the floods amounted to RMB 116.9 billion, or 2.24% of the GDP of the period (Li, Lin and Li, 2007: par. 2.2.1). The areas most affected by floods are concentrated along the low river basins and in the Yangze valley. Being densely populated, these areas have very high economic losses.

**Sea-level rise**. The coast of China is approximately 32 000 km long. As mentioned several times above, this area of the country is densely populated and presents more advanced economic and industrial development than the hinterland regions. For this reason, an increase in sea levels could cause enormous damage, both in terms of population forced to evacuate and in terms of economic damage. Research has shown that sea levels in China have risen over the last 50 years with a higher growth rate than the global one.

[60] In a price system based on supply and demand, the price fluctuation is based on the increase in demand or supply. Specifically, in the event of an increase in the offer there will be a price drop, while in the event of a decrease in the offer the price will tend to rise (vice versa as far as the demand is concerned).

Furthermore, according to a Chinese study, "a one-meter rise in sea level would inundate 92,000 square kilometres of China's coast, thereby displacing 67 million people living in coastal areas " (Heggelund, 2007: 167).

One of the most vulnerable areas to rising sea-levels is the city of Shanghai. If one of the scenarios assumed by the UN were to occur, and the temperature increase reached 3°C, this shown in figure would be the scenario that would appear in Shanghai. The sea level rise would be so high that it would almost entirely cover one of China's most populous and most developed cities. Asia would be the continent most affected by this huge rise in the seas and Shanghai in turn would be the most affected city in Asia with a displacement of around 17.5 million people (followed by Hong Kong with 8.4 millions of people and Osaka with 5.2 millions) (Holder, Kommenda and Watts, 2017: online).

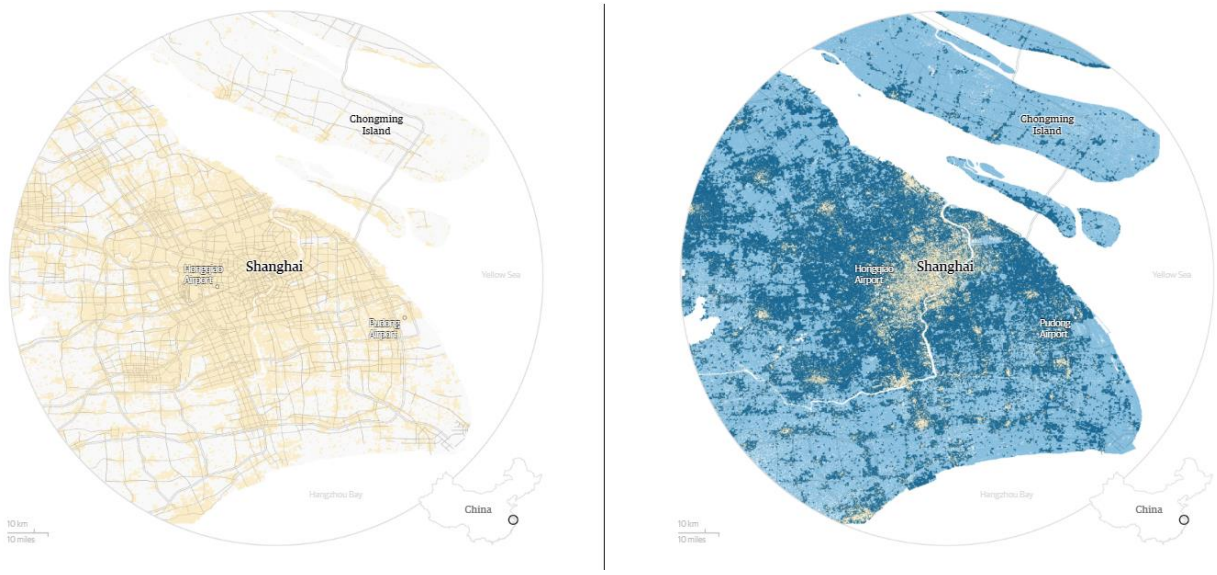


Fig. 14
City of Shanghai today and in the scenario of a temperature rise of 3°C.

**Glacial shrinkage.** In China there are 48,000 glaciers and their surface is so vast that they form part of "The Third Pole", the largest concentration of glaciers and snows outside the Poles. With the increase in temperature the amount of snow and snowfall on the peaks is decreasing, causing the retreat of the glaciers. The new report published by Greenpeace East-Asia reports that the speed of the melting rate is increasing and that since the 1950s, 82% of glaciers have withdrawn (Chen *et al.*, 2018: online). The problem of the melting of glaciers is linked to the already precarious distribution of water resources during the year.

With the increase in melting, the meltwater peak will be reached much more quickly, causing flooding during the spring season and water shortage during the summer (when water is needed for irrigation).

## 3.2. INTERNATIONAL AGREEMENT

The problem of global warming is an issue that scientists and experts have been trying to bring to public attention for decades, but it is only since the 1970s that governments have mobilized and decided to intervene. In an attempt to diminish global warming, slow down the climate change process and diminish the impact of men on the planet, the main nations of the Earth have gathered several times, entering into international agreements.
One of the first international meetings was that of 1987 in Montreal-Canada, where the main topic of discussion was the ozone hole. During that session the signatory countries of the Montreal agreement, which then entered into force in 1989, undertook to reduce their emissions of chlorine-fluorine-carbons (CFCs) and of all those gases that once emitted into the atmosphere destroy the ozone layer that surrounds the Earth protecting it from life-threatening solar radiations.

### 3.2.1. COP1 : Rio Earth Summit

In 1992 the United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro-Brazil and aimed to find a meeting point between economic development and environmental protection. At the end of this Earth Summit (as it was later nicknamed) three conventions were promulgated, one concerning biological diversity, one concerning the problem of desertification and the other on climate change. The United Nations Convention on Biological Diversity (UNCBD, or Biodiversity Treaty) was concerned with the conservation of biodiversity and at the same time "ensure the sustainable use and equitable sharing of genetic resources" (The Editors of Encyclopaedia Britannica, 2019c: online). In the treaty the signatory parties undertook to protect endangered ecosystems, trying to restore degraded ecosystems and enacting laws in defence of endangered species. Furthermore, with the treaty a fund was set up to help

developing countries that due to their economic difficulties could not implement the required measures without external financial assistance.

The United Nations Convention to Combat Desertification (UNCCD), which came into force in 1994, is the only international treaty which deals with land management. It is a binding treaty that bounds environment and development with sustainable soil management.

The third convention stipulated during the Rio Earth Summit is the United Nations Framework Convention on Climate Change (UNFCCC). It is an agreement considered almost universal, given that it was signed by 197 countries (196 nations and the European Union). This was a restrictive document with which the signatory nations committed themselves to reducing the emissions of CO2, methane and other greenhouse gases responsible for global warming. Although the convention was binding, it did not place penalties or punishments for those who did not respect the objective of reducing greenhouse gases, but established that its parameters could be modified by following amendments, called protocols.

The Convention imposed itself on the international scene as it presented characteristics that depicted it as innovative and avant-garde. First of all we must consider that at the time the discoveries and scientific studies made on climate change were not as numerous and certain as they are today and regarding some issues the scientific community was not entirely unanimous. Despite this, the UNFCCC "required Member States to act in the interests of human safety, even in the face of scientific uncertainty" (UNFCCC, no date b: online). The final objective of the convention was to reduce the emission of greenhouse gases (mainly CO2). The hope was, in this way, to slow down global warming, thus allowing species to adapt to the new changes in a natural way. If the change in temperature, and consequently in the climate, continued in such an accelerated manner compared to its normal course, many species would risk extinction due to a lack of adaptability. In the second article of the Convention, one of the key themes around which the entire document is established is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." (The Editors of Encyclopaedia Britannica, 2019c: online). The

Convention played a fundamental role in the fight against climate change. It was one of the first measures adopted in an attempt to combat this phenomenon and fully recognize the role of men in this process of change.

The Convention signatory countries were divided into two macro sections: Annex I and Annex II (or Non-Annex). In the first group there were all the industrialized and developed countries, plus the countries of Eastern Europe where a transitional economy was present. The second group included developing countries. Given the enormous economic gap between these two groups, it was recognized that developed nations, having started to emit large amounts of emissions since the Industrial Revolution, should have been the most penalized as the main historical culprits. For this reason, the countries of Annex I were called upon to reduce the quantity of emissions. In particular, taking as a base reference the emissions of 1990, those of the year 2000 should have been lower. Aware that industrial and economic growth are closely linked to the increase in GHG emissions, developing countries that were at that time facing their growth period, were not obliged to reduce their emissions. The convention accepted this condition, but it suggested to reduce emissions that did not go to undermine economic growth, improving adaptation and mitigation projects (UNFCCC, no date b: online).

In order to overcome the problem of economic and technological disparity, developed countries committed themselves to provide funding and to share their technical knowledge with developing countries. Furthermore, to be able to verify on a scientific basis the implementation of the proposals signed in the agreement, the countries of Annex I accepted to compile a report with the emissions data of each year starting from the base year (1990) and to provide proof of the adopted policies.

Since its entry into force in 1994, the signatory countries have had an annual appointment to be able to monitor and, if necessary, take further measures. This annual appointment is called the Conference of the Parties (COP), the most important of which were COP3 in Kyoto and COP21 in Paris. The last one took place in Katowice, Poland, in 2018 while the COP25 is scheduled for the end of 2019 in Santiago de Chile.

### 3.2.2. COP3 : Kyōto protocol

In 1997 the third Conference of the Parties (COP3) was held in Kyoto-Japan. During this conference an action plan was agreed for the participating countries: the Kyoto Protocol.

The protocol is a "document of implementation of the directives established in the United Nations Framework Convention on Climate Change" (D'Amato, 2012: online). Within this document, it is explained the will to decrease GHG emissions, the subjects to which this reduction is required and the amount of cut required in each country. In this regard, the protocol follows the principle of "common but differentiated responsibility" (UNFCC, no date: online), which means that the objective to be achieved is not be the same for all countries but will vary according to their capacity for reduction and their economic development situation, given that economic growth is closely linked to an increase in emissions. These are the reasons why developing countries have not been set limits: on one hand in order not to limit their economic growth and, on the other, in order to avoid that developed countries could take advantage of their low emissions to reduce their own. Despite the absence of limits, however, even the non-Annex countries were required to take measures to reduce their emissions, in a way that it did not affect their economic growth.

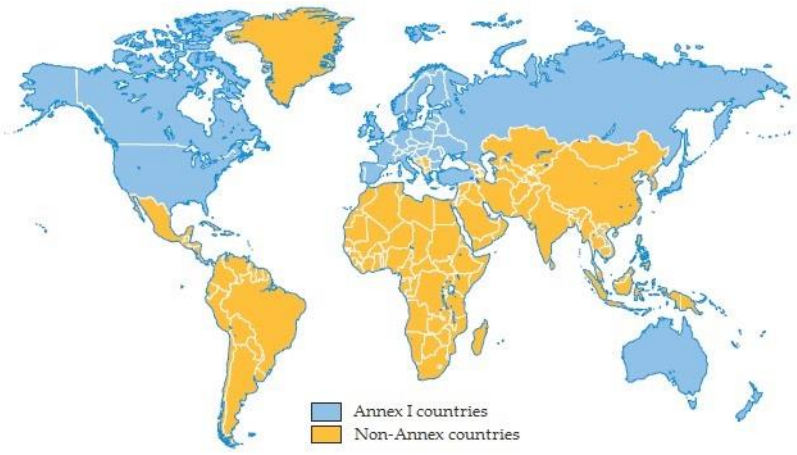


Fig. 15
Annex and non-Annex countries in Kyoto Protocol

On the contrary Annex I countries were required to reduce their emissions by 5% in the 2008-2012 period.

The rules for the implementation of the Protocol were defined at COP7 in Marrakech-Morocco in 2001. They stipulated that in order to enter into force it should be signed by 55 countries that covered 55% of global emissions. This condition was only reached in 2004, when Russia decided to sign the Protocol, allowing it to enter into force in 2005.

The protocol regulations are not rigid and inflexible but allow the use of three mechanisms to cut the costs of reducing emissions, while maintaining the same objective: clean development mechanism, joint implementation and emission trading.

The first mechanism granted by the Protocol, the **Emission Trading**, is explained in Article 17 and provides that each country is given tradable emission quotas: "assigned amounts units" (AAUs). According to this mechanism, the most virtuous countries, that are the ones that need fewer units than the assigned ones, can sell the surpluses to countries that are not able to stay within the units granted to them. This way the GHG emission is treated as normal goods giving origin to a market commonly called 'carbon market', since the gas most traded is CO2. Within this market, units concerning numerous fields could be sold, such as "reduction unit on the basis of land use, land-use change and forest (LULUCF), emission reduction unit (ERU) generated by a joint implementation project and certified emission reduction (CER)" (UNFCCC, no date a: online). To ensure that there are no irregularities, every transaction must be recorded on a register and the transfer of these units takes place under the supervision of the United Nations secretariat for climate change. Furthermore, in order to prevent a nation from ending the units granted before scheduled time, each Party is obliged to maintain a reserve called the "commitment period reserve".

The **Clean Development Mechanism** (CDM) is a mechanism established by art. 12 of the Protocol and active since 2006. It allows countries of the Annex I, who are obliged to reduce their emissions, to carry out a project in a developing country. The project will have to provide for a reduction in certified emissions compared to the emissions it would have had if it had been built by the developing country (UNFCCC, no date c: online).

**Joint Implementation** (JI) follows the same principle, but both countries participating are part of Annex I. The projects must provide for a reduction in emissions, or an increase in sinks, to allow the investor country to earn credits. These projects are mainly carried out in Eastern European countries. The mechanism is provided for by the art. 6 of the Protocol and although projects of this type started in 2000, the credits began to be validated only from 2008 (UNFCCC, no date b: online).

The last two mechanisms benefit both the countries involved in the project. The host countries can enjoy foreign funding and may have the opportunity to get new technological knowledge while the Annex I countries obtain a certain flexibility in the quantity of emissions allowed, thanks to the gain of credits, called 'certified emission reduction credits'. Each credit corresponds to 1 ton of CO2 not emitted and they are added to the units already assigned. Since these projects can be approved, it must be certified that the emissions generated by the building created through the project are lower than those the same building would have if it had been built without the principles of emission reduction.

During COP18 in Doha-Qatar in 2012, the year of expiry of the goals set, it has been made changes to improve and define a new period of action. In addition to the modification of numerous articles and the updating of the GHG list, a new "commitment period" has been set with a term in 2020. The objective of this new period is to reduce GHG emissions by 18% compared to those of 1990 (UNFCCC, 2019: online).

Since joining the World Trade Organization (WTO) in 2001, China has faced such a commercial growth that has led it to become the first world commercial power. However, the land of Confucius does not hold only this primacy. It is also the main producer of CO2, due to the increase in the use of fossil fuels as the main source of energy (at least until 2011). Despite the first place as a producer of CO2, China is considered a developing country in the Protocol, and it has not been imposed limits to be respected. The absence of limits imposed from outside, however, has not prevented it from being able to autonomously decrease its own emissions (related to GDP units), from 2003 to 2013, or to take measures in order to increase its energy production from renewable sources rather than fossils. Furthermore, it has decided to enter into a further international climate agreements as long as these do not obstacle its economic growth.

### 3.2.3. Post Kyōto

From 2005 to 2015, the year in which the Paris-France agreement was signed, little was done to improve the standards and lower the emission targets. The only noteworthy

actions are the Copenhagen-Denmark Agreement signed at COP15 in 2009, and COP16, held in Cancun – Mexico in 2010.

Public opinion had high expectations from the Copenhagen meeting, they assumed participating Parties reached a post-Protocol agreement. This did not happen and at the end of the Summit the only result produced was a political agreement, which was not binding. Despite the absence of a real agreement, the parties (especially those of Annex I) committed themselves to financing a fund to help developing countries, which provided for a transfer of 30 million USD between 2010 and 2012 (C2ES, 2009: online).

The following year, during COP16, the parties achieved a further goal by creating the Adaptation Framework. This document is the proof that governments started to give importance not only to mitigation of climate change in an attempt to slow them down, but also to adaptation regarding changes that are already in place.

### 3.2.4. COP21 : Paris Agreement

In 2015, the nations that are part of the COP met for its twenty-first edition in Paris. Everyone hoped to be able to find a post-Kyoto agreement, which would improve its goals. The treaty was issued in April 2016 and entered into force on November 4 of the same year, thirty days after the prerequisites for its adoption had been met: 55 signatory countries covering 55% of global emissions. Two years after its issue, in 2017, the signatory countries had risen to 125, while today they are 185 (UNFCCC, no date c: online).

Despite the diversity of the objectives declared before the Conference, it was fortunately possible to reach an agreement that points to transparency and clarity of its contents and which requires that each signatory party undertakes to respect the agreements made. The most vulnerable nations, especially the islands of the Pacific, which with the increase in sea levels are in danger of disappearing, clamoured for countries to be more involved and to impose themselves as the maximum temperature increase threshold of 1.5 ° C. On the other hand, the oil and coal exporting countries wanted to slow down the race to greener sources. At the end of the debate an attempt was made to find a line of action that could balance these two deployments by imposing a maximum global temperature increase limit

well below 2°C compared to the pre-industrial era. In the second article of the treaty we can read: "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change"(UN, 2015: online).

In order to obtain this result, the treaty asks the participating countries to reach their emission peaking as soon as possible. It is the moment in which each nation will reach the highest quantity of emissions produced, after that moment emissions can only diminish more and more. By adopting a real vision of the situation, the COP is aware that for developing countries, reaching this peak will require longer time compared to developed countries. For this reason they are invited to try to find a balance, in the second half of the century, between the emissions produced and GHG removal sinks (for example afforestation).

Given the diversity of economic and technological development, COP realized that imposing the same standards and the same timing to each state would have blocked the negotiations even before they began. For this reason Parties were asked to present a Nationally Determined Contributions (NDCs) before the Conference, that is a list of commitments that each nation officially undertook to respect in the following years. These documents must be presented to the COP every five years, respecting the principles of transparency and clarity. They must also be progressive, showing ever greater ambition and gradually improving the goals. The main problem with this line of action is that there is no common plan. Each nation has independently established the quantity of emissions to be reduced, the necessary timing and even the basic level of emissions to be compared with (some have taken 1990 emissions as their base model, others those of 2005). This is the reason why the agreement has been accused by some of not being ambitious enough (Barolini, 2015: online). Another criticism to the agreement is that there are no effective sanctions in place for those unable to fulfil the commitments of their own NDC, as there is no court that can control the actions of the nations. It foresees the establishment of a global stocktake, that is an inventory starting from 2023 will have to be compiled every 5 years, reporting the progress made by the parties and collecting them in a simplified way. The

agreement also deals with the financial aspect, confirming the sum of money that had been proposed in Copenhagen during COP15. The states undertake to set up a fund, mainly financed by the developed states, of USD 100 billion a year until 2020. The intention of this fund is to help developing countries to combat climate change by providing financial support in case of damage due to extreme weather events. "Strongly urges developed country Parties to scale up their level of financial support, with a concrete road map to achieve the goal of jointly providing USD 100 billion annually by 2020 for mitigation and adaptation" (UN, 2016: online). Mitigation and adaptation are two key points on which the agreement focuses, recognizing that the problem of adaptation is global and involves everyone without any distinction.

Finally, the agreement refers to all those who are not part of the Convention, inviting them to seriously consider the problem of climate change and not to remain helpless spectators of this battle.

### 3.2.5. China's NDC

China announced that it had signed the Paris Treaty in 2016, along with the US, during the G20 held in Hangzhou-China. Once again it confirmed its commitment to fighting climate change. China, like all the countries that are part of the COP, has been asked to complete its own NDC. In this document, it is reported that China will do everything necessary to take the path of sustainable development, aiming for green growth and the adoption of low-carbon infrastructure. China also mentions what it calls ecological civilization:[61] a reform of society aimed at tackling the problem of climate change so vast as to represent a new form of civilization.

In the NDC, China states that in 2009 it has already committed itself to reducing its GHG emissions. The goals set by 2020 are to reduce emissions per unit of GDP, to increase the percentage of energy production resulting from renewable sources and to increase the area of land covered by forest (Su, 2015: p. 3).

[61] Shēngtài wénmíng, 生态文明

In addition to this, at national level it has set further goals to be achieved by 2030. By this date the country is aiming to achieve its peaking of carbon, even if it will make every effort to shorten the time. Also the other goals concern the drop in emissions and the increase in what are considered the major carbon sinks. More precisely, by 2030 it aims to reduce its CO2 emissions by 60-65% per unit of GDP, compared to the 2005 reference model, to achieve a 20% energy coverage derived from non-fossil fuels and to increase the forest stock volume of around 4.5 billion m3 (Su, 2015: p. 5).

## 3.3. MITIGATION AND ADAPTATION

### 3.3.1. Mitigation

As the climate changes are closely related to global warming, one of the advanced solutions at the UNFCCC was that of mitigation, namely the reduction of the presence and emissions of greenhouse gases, in an attempt to mitigate the consequences. The main channels through which mitigation takes place are the reduction of human produced GHG emissions and the increase in GHG sinks. Mitigation, as opposed to adaptation, is a topic that must be tackled globally. This is because in order to mitigate the effects of climate change it is necessary that all states move in the same direction, otherwise the efforts made by more virtuous states would be undermined by states that continue undeterred in their bad habits.

Both in the Kyoto protocol and in the Paris agreement, much importance is given to mitigation, especially as regards the policies of developing countries. Although it has been recognized that due to the ongoing economic-industrial development the emissions of developing countries are destined to further increase, in both documents members were invited to increase the presence of GHG sinks within the territory, in so that they could contrast ever increasing emissions (UNFCCC, no date e: online).

Other ways used by nations to reduce their GHG production are the use of renewable sources in energy production, the development of new technologies (such as air purifiers or electric transport vehicles) and educating the population to keep a more responsible behaviour avoiding waste of resources (for example not wasting water).

A further means of implementing mitigation policies is linked to the economic sphere and involves the simplification of capital transfers, especially from developed to developing countries. The most used are the mechanisms introduced by the Kyoto protocol, Clean Development Mechanism (CDM), Joint Implementation (JI) and International Emissions Trading (IET) (UNFCCC, no date f: online); however there are also others developed individually, or in cooperation, by the states. Additional agreements or individual initiatives, or in cooperation, taken by individual states that aim at more ambitious goals are also recognized by the Paris Agreement.

In the ranking of the largest CO2 producers, China has earned the first place, covering 28% of global emissions. Its emissions are 50% greater than those of America, which occupies the second place in the ranking, and four times higher than India's ones, which has around the same population (though the rate of growth of Indian emissions is double compared to that of China) (Lack, 2018: online). Despite this, the country is not obliged by international agreements to reduce its GHG emissions, being considered a developing country, but it is invited to implement its mitigation policies, in an attempt to offset emissions.

In 2009 China already committed itself to reduce emissions, reconfirming its proposals a few years later with the issuance of the 12th Five-Year Plan. In 2015, in view of the COP21 in Paris, the Chinese government released its own NDC where it clearly explained what were the objectives to be achieved by 2020 (taking as comparative data those of 2005):

- Reduction of GHG emissions by 40-45% per unit of GDP;
- Achievement of 15% of the total energy production supplied by non-fossil sources;
- Expansion of forest areas of 40 million hectares
- Forest stock increase of 1.3 billion m3 (Su, 2015: pp. 2-4)

In addition to this, at national level it has set further goals to be achieved by 2030. By this date, in fact, the country is aiming to achieve its peaking of carbon, trying to shorten time. The other goals also concern the drop in emissions and the increase in what are considered the major carbon sinks. More precisely, it aims to reduce its CO2 emissions by 60-65% per unit of GDP, compared to the 2005 reference model, to achieve a 20% energy coverage derived from non-fossil fuels and to increase the forest stock volume of around 4.5 billion m3 (Su, 2015: p. 5).

The main strategies that China is adopting in an attempt to reduce GHG emissions are mainly: reduction of the use of coal in energy production, increase in sinks in the territory and introduction of electric vehicles (EVs) to replace fuel vehicles.

**Coal reduction**. As already mentioned, coal is the main source of energy in China, so if the government wants to limit its use, it must act on several fronts, including both industrial and domestic emissions in the project. At the industrial level, China is working to build more efficient industrial plants that produce the same amount of energy using less coal. As regards the domestic environment, however, there is a dichotomy between emission sources in rural areas and in urban areas. In fact, if in the city the sources of energy production are varied and the proportions are well distributed, in the countryside coal alone covers 65% of energy needs. For this reason, in 2017 the MEE involved the local governments of Hebei, Henan, Shandong and Shanxi in a project to replace coal stoves with new gas or electric ones. At the same time, the ministry made the coal-fire stoves illegal. Natural gas is considered one of the most valid alternatives to coal. Despite being a fossil fuel, it produces on average 50% -60% less of carbon emissions during combustion. In 2017, China became the third world consumer of natural gas, so much so that the following year the China National Petroleum Corporation signed a 25-year contract with an American energy company for the purchase of 1.2 million tons a year of liquefied natural gas (LNG) [62] (China Power Team, 2018: online). Another valid alternative considered by the government is nuclear. In the 13th FYP (2016-2020) the goal of reaching an annual increase of 16.6% in nuclear power capacity was included. In order to achieve the goals set for 2030, the president of China National Nuclear Corporation stated in 2018, that in the country 6 to 8 nuclear power plants will be built each year (Rinnovabili.it, 2019: online).

[62] They are natural gases which, to be easier transported, are reduced to a liquid form through a cooling process that makes them up to 600 times smaller than their gaseous form. (The Editors of Encyclopaedia Britannica, 2018a: online)

**Electric vehicles**. Emissions from vehicles in China represent a good chunk of total emissions. It is estimated that there are around 300 million cars in the country. They are not only very numerous, but the vehicles available are also less efficient than those of drivers in other countries. The fuel used is very bad too, its quality is 2-3 degrees lower than in developed countries (Jing, 2015: online).

In 2016, the government decided to take measures that would put a brake on vehicle emissions. The Chinese Ministry of Industry and Technology has decided to impose limits on fuel consumption and following this measure in 2018 the production of 500 car models was blocked because it was considered unsuitable for the new standards (China Power Team, 2018). The government has been trying to encourage the purchase of electric cars too. In 2017 in China there were about 1.23 million electric cars on the road and their hope is to reach 5 million by 2020. In China, however, the use of electric cars does not reduce carbon production so significantly, as the energy used to recharge them still derives partly from coal, or other fossil fuels, and the production phase of the lithium batteries with which they are equipped, using a large quantity of energy, turns out to be a high emission process (Clover, 2017).

**Afforestation**. "Where to go in spring? Plant trees and make China green." This was the slogan that any Chinese citizen could read on the homepage of the National Forestry and Grassland Administration website in spring 2019 (ZX, 2019: online). With these words they wanted to invite citizens, with the beginning of hot seasons, to go outside and instead of wasting time, dedicate it to something productive, like planting new trees and plants in the hope of making China a greener country. This reflects the second part of the tasks on the mitigation measures that China has officially taken with the international agreements: increase the sinks. The purpose of this soaring of green areas is not to be sought only in the desire to reduce the presence of greenhouse gases and polluting gases in the air but also in the desire to reduce land degradation and climate change. As well as retaining the land by limiting soil degradation and making it less friable, through the photosynthesis process trees turn out to be natural air purifiers.

According to a study by NASA that covers a period of almost 20 years, China, along with India, is the country that most contributes to the greening of the planet: "China and India account for one-third of the greening, but contain only 9 percent of the planet's covered land area in vegetation“ (NASA, 2019: online). India owes its primacy due to the increase in cropland, whereas China has focused heavily on the increase in forests. "The greening in China is from forests (42%) and croplands (32%)" (Chen et al., 2019: online). Worldwide, although China has only 6.6% of the vegetated areas, it has managed to cover 25% of leaf area growth alone (Chen et al., 2019: online).

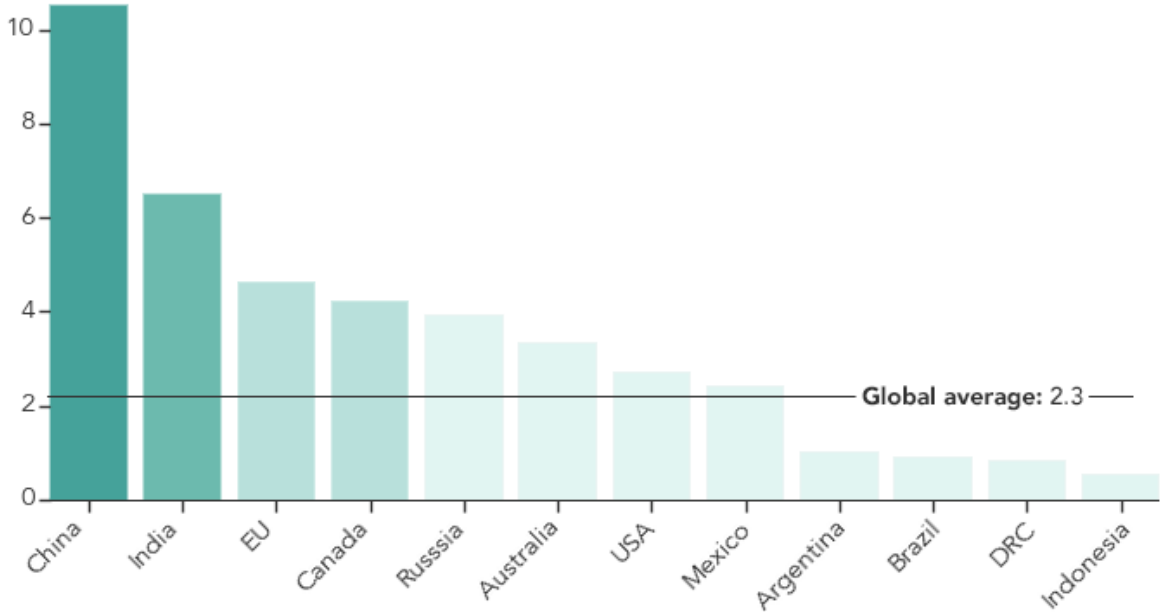


Fig. 16
China and India Lead in Greening due to Human Activity: Change in Leaf Area (% per decade) (NASA, 2019)

In 2018, China declared that it had planted new trees on 7.07 million hectares and also plans to increase the areas dedicated to forests by another 6.73 million hectares by 2019. All the efforts in order to increase the green areas in the country are not carried out solely by the appointed government bodies. For example, the transport sector has committed to making its highways greener by planting trees along them. Even the housing and urban-rural development departments claimed to have increased the size of public parks per capita, reaching 14 m2 per capita (ZX, 2019: online).

One of the problems that afforestation involves is the choice of the trees to plant. It is necessary to plant trees that have a long life and are very resistant, especially to pollutants.

This foresight is of fundamental importance especially in arid areas, such as Inner Mongolia, or in mining areas where soil pollution is so high that it kills tree species that are not resistant enough. Among the plants most used there are some types that, besides being very resistant, are also able to solve the problem of soil pollution "[they] could help absorb heavy metals in the soil and therefore be suitable for local afforestation programs" (Mu, 2019: online).

### 3.3.2. Adaptation

The mitigation process is generally associated with that of adaptation, as the international agreements (from the UNFCCC to the Paris Agreement) encourage developing countries to adopt both measures. According to the definition given by the IPCC, the adaptation is "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects" (IPCC, 2014: p. 5). In a nutshell, while mitigation seeks to eliminate, or at least diminish, the causes of global warming and climate change, this second aspect aims to not be overwhelmed by the changes that are already taking place. A clarifying example can be made by referring to the Shanghai case mentioned above. The mitigation measures would concern the reduction of emissions, with consequent slowing of global warming and rising sea-level. Adaptation instead involves the construction of infrastructures that prevent water from invading the city, minimizing economic losses and preventing damage to people and infrastructure.

In article 7 of the Paris Agreement it is recognized that adaptation is a global challenge that involves all parties. However, its implementation is closely linked to the type of climate change in the area under consideration. Faced with numerous extreme climatic events, China's most common measures of adaptation are physical barriers or economic compensations.

**Water**. Given the serious water problem in the country, one of the main issues that adaptation must address is the unequal distribution of resources in the country. As far as water is concerned, China has established two objectives to be achieved by following the adaptation projects: one regards sustainable development and the use of resources, while the other aims to reduce their vulnerability. The measures taken by the government in this direction have taken place in many forms. First of all there has been a modification and implementation of the laws and regulations in force, both locally and nationally. Then efforts were made to improve the water planning and management system, trying to alleviate water disasters and secure water supply. Over the past 50 years, China has built and reinforced over 277,000 km of dikes and created 85,000 reservoirs. Despite large sums of capital have been spent (since 1998 the Yangtze flood prevention systems have cost about 160 billion RMB) the government has committed itself to increase funding for water resources development and management projects.

The largest adaptation works that the Chinese government has carried out is that of the South-to-North Water Diversion Project. The initial idea of the design was made when Mao was in charge, in 1952. At that time, however, there were not enough funds or enough technological development for a work of this size to be realized. The basic idea of the project is to transport water from the southern part of the country, where it is abundant, to the northern regions that suffer chronically from water scarcity. Overall, the project, which will probably be completed in 2050, involves the construction of three channels, two of which have already been completed. According to the engineers responsible for the work, once the construction of all three channels will be completed, they will be able to transport 44.8 billion m3 per year. The purpose of the work is to not leave the North of China, where most of the population is concentrated, completely without water in cases of prolonged drought. Despite the positive cost-benefit ratio and many advantages, many argue that this solution does not solve the problem. The environmental activist and journalist Ma Jun claimed that the project has a very strong environmental impact, but he argues that a better solution would be to desalinate sea water (Natale, 2013: online). However, modern technologies are high energy consuming

and this solution would solve the problem of water by aggravating that of energy production from fossil sources.

**Agriculture**. Climate change has greatly affected the agricultural field, putting a strain on the country's food security. To overcome this problem, the government has financed numerous projects, both in terms of measures adopted and in terms of new technologies developed. One of the most developed technologies in China (and also in the rest of the world) is plant breeding and biotechnology. With this system farmers try to increase productivity by making crops more suitable for a giving climate. This process can be carried out through laboratory modifications or simply by changing the type of sown (if, for example, the climate in an area has become colder farmers would cultivate plants that are more resistant to cold temperatures).

In China, irrigation of agricultural lands is very developed, it covers 40% of arable land throughout the country. This is also a process of adaptation, as naturally arid areas are made fertile and suitable for agriculture. A method used to have water available for irrigation is to conserve rainwater. Since 2000, in an attempt to reduce water shortage problems, around 5.6 million water ponds, sinks and a water storing capacity of 1.83 billion m3 have been established in the country..

Other measures that have been taken in the agricultural field are those of the increase of investments destined to fight the drought and the acquired ability to be able to change the weather. It may seem strange but in many counties, municipalities and provinces of China, local governments have provided themselves with ‘cannons and rockets’ that allow them, in a completely artificial way, to make it rain or block hail.

## CONCLUSION

The purpose of this work is to provide an overview of the environmental crisis that is occurring in China. The fact that in the philosophies and religions that developed in the past Nature has always played a fundamental role, has not placed any restraint on the environmental degradation that has affected the whole country. We have seen that despite the fact that China is a land rich in raw materials, they have been victims of over-exploitation since ancient times. Back then the rate of deforestation and tree felling had reached a level that caused some local governors to worry as in their jurisdiction the percentage of surface covered by forests had decreased drastically until it almost disappeared in the worst cases. Despite this exploitation, Chinese nature has never been stressed as in the last century. The desire to make China a modern country, to increase its international importance and to make it more commercially competitive has totally eclipsed the intentions of safeguarding the environment and of treating it with the deserving respect for our peers, as suggested by classical Chinese philosophies. The end of the last century and the beginning of the new one were characterized by property speculation, lack of wastewater treatments, increase emissions of greenhouse gases and polluting gases. Impenetrable hazes, bad smelling waterways, huge buildings in the middle of nowhere have replaced fresh water courses and uncontaminated natural landscapes, compromising their ecosystems and altering their balance.

However, the descending parabola of the environmental situation in China seems destined to change direction in the near future. If it is true that from the 1970s to the end of the 2000s the conditions have done nothing but worsen both in terms of pollution and in terms of the emission of greenhouse gases, with the beginning of the second decade of the millennium a light is appearing at the end of the tunnel. According to the international agreements and internal commitments the situation is changing and is destined to improve more and more.

China is embarking on a difficult and intense journey in an attempt to reduce its emissions of pollutants and to start a waste treatment policy that replaces the practice of direct spillage. At the same time, it is working both nationally and internationally on combating CO2 emissions. The enormous economic loss that China is forced annually to pay due to

pollution and climate change, combined with the growing awareness of Chinese people and the pressure from international public opinion, has meant that the government actively engaged in the fight against these two risk factors that threaten the economic and social stability of the country, and of the whole world. Despite the enormous efforts that the country is making, however, significant results are slow to arrive both in terms of fighting pollution and climate change, the two themes dealt with in the previous chapters.

In the second chapter we have noticed how the pollution of China is a problem that does not concern only a limited part of the territory but covers it in its entirety, from water to soil and air. Nothing is saved from the polluting agents that are released into the environment every day. In recent years the government has been working hard not only to reduce polluting sources but also to be able to clean up what has already been contaminated. Although there is no sign of stopping urbanization and urban expansion, we have seen how in an attempt to reduce soil pollution laws have bounded polluting companies to a remediation of the portion of polluted land. As far as water is concerned, purifiers have been introduced and the portion of sewage and wastewater treated before being released into the environment is increasing more and more. Atmospheric pollution, being the one form of pollution most visible to the entire population, is the main challenge faced. The government has established the closure of factories, the circulation of vehicles with alternating number plates and the replacement of old coal-fired heating systems with new gas or electric systems. In addition to this, it has been implemented campaigns to increase the efficiency of the plants, building new ones and modifying the existing ones.

All these measures, however, have turned out to be simple palliatives that manage to record negative growth rates of emissions but fail to definitively solve the problem. For this reason, despite the enormous progress made, China remains one of the most polluting and most polluted countries on the planet. A country where cases of death due to pollution exceed one million victims every year and where the appearance of cardio-vascular and respiratory diseases linked to pollution causes even more victims.

In the third chapter the main theme has been climate change. Initially we verified that China, having the largest population in the world, and being the largest developing country, has a very high vulnerability rate, so it is very exposed to the climate changes that

are occurring on the planet. Aware of this danger hanging over the country's economic and social stability, the government has decided to take measures in an attempt to stem the damage. China has decided to sign international agreements on climate change, provided that their measures did not affect the development of the country. In this way both the problem and its importance were publicly recognized, but at the same time the priority of economic growth was reaffirmed. In the section concerning international agreements, we have seen that China, as a developing country, didn't have the imposition of a reduction in emissions, even if it decided to autonomously set up, but was strongly invited to adopt mitigation measures, which would balance emissions, and adaptation measures, that reduce disruption and damage to infrastructure and population.

In order to achieve a reduction in emissions, one of the first measures taken concerned the closure of factories and the shutdown of coal-fired heaters. The main problem arising from these solutions was the lack of alternative actions. In the absence of another type of heating the citizens were forced to spend the winter in the cold, while the factories, after the levels of pollutants and CO2 in the air had suffered a momentary decline, were reopened. Though the reduction of emissions is having a fluctuating trend, the increase in sinks is recording a constant growth rate, with the increase of green areas within the country thanks to cropland and to forest areas. This environmental improvement is partly due to "warmer, climate change and fertilization from the added carbon dioxide in the atmosphere" (NASA, 2019: online), but human intervention has increased the areas dedicated to forests and the number of trees planted. Although adaptation is a topic that China is dealing with in a lesser way focusing its efforts on mitigation, it has also started projects in this range. It has built infrastructures that help coastal cities protect themselves from rising seas, built infrastructures that aim to reduce drought in the north by bringing part of the water from the south and it is still developing science and new technologies in laboratory research of agricultural products that are resistant to drought and sandstorms.

In conclusion we can say that China, from an environmental point of view, is making a real commitment to become a virtuous country and even if with setbacks these efforts are bearing their results. However it is impossible to think of healing the accumulation of decades of resource exploitation and environmental pollution in just a few years. It will

still take a long time for degraded ecosystems to return to be flourishing as before while some processes, such as the extinction of some species,[63] are not reversible.

[63] E.g. Baiji, the Chinese River Dolphin

## IMAGES INDEX

**Fig. 13** : The carbon map (no date) *Vulnerability: People at risk*, *The Guardian*. Available at: https://www.carbonmap.org/#PeopleAtRisk (Accessed: 17 June 2019)

**Fig. 14** : Holder, J., Kommenda, N. and Watts, J. (2017) 'The three-degree world: cities that will be drowned by global warming', *The Guardian*, 3 November. Available at: https://www.theguardian.com/cities/ng-interactive/2017/nov/03/three-degree-world-cities-drowned-global-warming (Accessed: 2 June 2019)

**Fig. 15** : Gerbeti, A. (2015) 'Protocollo di Kyoto', *Enciclopedia Italiana*

**Fig. 16** : NASA (2019) *China and India Lead the Way in Greeningin*, *NASA - Earth Observatory*. Available at: https://www.earthobservatory.nasa.gov/images/144540/china-and-india-lead-the-way-in-greening

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