

# EDITORIAL

## The challenge of climate change in the city

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Climate change is a global phenomenon that is already affecting our cities, sometimes causing disastrous consequences. Beyond personal considerations on the causes of what is happening, in this editorial, I believe that to understand what is happening about climatic conditions of our planet it is necessary to rely on scientific thinking. More precisely, I will consider the recent IPCC report which took into account over 6000 scientific articles of the last few years. This report highlights above all *“the impacts of global warming of 1.5°C compared to the levels of the pre-industrial period and the related greenhouse gas emission paths, in the context of strengthening the global response to the threat of climate change, to sustainable development, and efforts to defeat poverty”* (IPPC, 2018).

In the absence of a reversal in the trend of greenhouse gas emissions (CO<sub>2</sub>, methane, etc.), the increase in global temperatures will result in a highly probable change in weather conditions over the next few decades: greater frequency and intensity of extreme events, sudden floods with long dry periods, increased temperature and increasingly violent heat waves and, last but not least, a significant sea level rise. The scenarios envisaged by the IPCC report are at +1.5°C, but those with an increase of +2°C are also not neglected, which would be decidedly higher in terms of intensity and frequency. Consequently, the needs of defense / adaptation and the related costs would become exponential for increasing temperatures. Last year's Nobel Prize for Economics was awarded to William Nordhaus for this new emergency, who among the first studied the mutual influences between climate change and economy. He recently expressed himself for the urgent adjustment of the budgets for mitigation rather than finding himself facing the costs of impacts.

Cities are particularly vulnerable to IPCC scenarios, as they are considered “real” settlements. Buildings for housing and for different services, as well as infrastructures such as sewers, bridges, underground lines and roads, can represent the strengths of the place but at the same time become a liability if the local ecosystems on which they are based are not in able to adapt to climate-induced changes. Climate change poses serious threats to urban infrastructure, to the quality of life and to the entire urban system. Not only poor countries, but also rich ones will be increasingly influenced by anomalous climatic events and trends.

On the other hand, however, cities are also the cause of climate change, since urban-level activities are among the main

sources of greenhouse gas emissions. In fact, already in 2006, urban areas were responsible for three-quarters of energy consumption and therefore a similar quantity of CO<sub>2</sub>-related energy emissions, even if with significant geographical differences. In recent years, initiatives have been taken in many cities to tackle climate change with unexpected successes (less pollution, better infrastructure, greater attractiveness, and livability). However, the initiatives will be all the more effective if they are able to integrate the needs of the cities and their environmental management skills. As advocated by the IPCC, but also by the latest climate change conferences (i.e. COP21 in Paris, 2015), a positive result can only be achieved with a coordinated approach and actions at global, regional, national and local level.

However, according to the prestigious PNAS magazine, the awareness of the populations and consequently of those who manage public administrations with respect to climate change is held back by a series of factors (short temporality, expectations, memory, cognitive bias...). Such a brake leads to underestimating the analyzes on climate change that take as reference long-term periods. So far the changes in temperature and the average sea level have occurred gradually over time and therefore were not perceived significantly. Differently for some consequences of the changes manifested as extreme events (for example, cyclones, heat waves, and floods) that have been felt with dismay and concern. Therefore, there is probably a greater need to respond to such extreme events based on current experiences in disaster risk reduction rather than taking action to tackle the problem of climate change (Hansen et al., 2012).

For this reason, an aspect not to be overlooked for urban areas is the management of the approach and actions, as it must have as its object both the causes of climate change and the possible consequences deriving from them. In the first case it will be necessary to act on the planning and on the efficiency of the use of resources, to reduce greenhouse gas emissions, in the second case on increasing the capacity to withstand a city through more efficient rules and technologies to prevent or at least limit the damage that extreme events can cause (Rosenzweig et al, 2011). For both cases, it is necessary to increase scientific knowledge and experiment suitable innovative techniques in order to be able to act correctly. For the reduction of greenhouse gases the actions will find answers in the medium-long term, also considering that

the climate has inertia and, even if we immediately stop our emissions, the temperature would continue to rise a little. While increasing the resilience of the cities to the effects, immediate interventions are necessary, that give answers in the shorter term, also because often it is necessary to repair what has already happened. However, in this case, the actions are not exclusively oriented to the defense against climate change impacts. In fact, they could be directed to the advantage of hydrogeological instability or the protection of biodiversity and at the same time counteracts the effects of climate change. The significant investments that these actions entail generally prove to be a source of benefits rather than costs. However, nowadays, the choice towards conservation, recovery and restoration interventions of ecosystem services for sustainable management of the territory, compared to the so-called hard structures, allows not only an economic advantage. In fact, the so-called ecosystem-based measures aim at strengthening the resilience of ecosystems (Griscom et al., 2017).

Trying to decline some aspects of climate change, we realize that if the global trend predicts temperature increases of +1.5° or even +2°C, in the cities temperatures could reach up to +4°C with seasonal peaks even higher. This condition is derived from the spread of asphalt on the roads, the high density of buildings with conventional plants, the absence of green areas, motor vehicle traffic with fossil fuels, and so on that gave it the name of the urban heat island. The increase indicated above would disproportionately increase the number of hot days and heat waves. The main effects could be health risks for citizens, especially the most vulnerable ones, a further increase in air pollution, an increase in energy demand for seasonal heating/cooling and difficulty in water management. For example, for each centigrade degree of heating increase, a reduction in renewable water resources of at least 20% is expected.

To reduce emissions, water consumption, and heat gain, cities can increase the use of renewable sources. These sources could derive from plants that use the energy of the sun, the wind and the heat of the Earth. Currently, some of these technologies have made it possible to make important progress in the renewable energy sector, so as to be able to reach an advanced level of technical and economic maturity. In this sense, the buildings, which are responsible for about one-third of greenhouse gas emissions could be equipped with solar panels and green roofs, sensors that turn off lights in empty rooms, windows that retain heat and high energy efficiency air conditioning systems. One could even try to subtract "carbon" from the air, generating humidity and filtering the fine dust, creating the so-called "vertical woods", i.e. "turricular" buildings in which several tree species are distributed in the various facades. In addition to the benefits in terms of climate, they allow the creation of biological habi-

tats. Examples of this kind are already present in Milan, Eindhoven, and Singapore. There are also cities where geothermal energy is exploited. Such energy is released by nuclear decay processes of some elements present within the earth, for heating and cooling of buildings and for some industrial processes. These systems are widespread in Sweden, Norway, Germany, and France, and now also in Bolzano, Italy. These could be some of the efforts to reverse the sources of global electricity needs, now covered by three-quarters of fossil fuels for the benefit of the renewable. The latter can lead to undoubted advantages for cities, for example in reducing the level of urban air pollution. In some cities of the world (i.e. New Delhi in India, Linfen in Cina, Tetovo in Macedonia...) the poor quality of air causes a spread of respiratory diseases and even a great number of deaths a year.

In this direction, there should be interventions to reduce transport emissions from transfers within the city. There are many actions that have been activated, but much remains to be done. In fact, while in some cities modal transport has been favored, in others due to the extensive urbanization in terms of surface area it has penalized it. The inhabitants of Hong Kong have such an efficient public transport network with 75% of stations located less than 1 km and half of them at 500 m: that is indicative! Obviously, beyond the coverage of public transport, many cities have opted for low-carbon vehicles. As for citizens who cannot use public transport, the best solution is to go on foot or by bicycle, which both do not create greenhouse gases. In Italy, for example, despite an improvement in the performance of the car fleet and the improvement of fuels, which has allowed for a 20% reduction in CO<sub>2</sub> in the last ten years and a significant reduction in the specific emissions of NO<sub>x</sub> and other pollutants, this was partly thwarted by the growth of traffic in the cities. The situation will change when the car fleet in Italy and in the world will switch from fossil fuels to electric power. Definitely advantageous are the traffic exclusion solutions in the so-called historical centers or the days in which parts of the city cannot be crossed by private cars. However, this is often a restrictive provision imposed by city administrations that to avoid violating the limits of pollutant concentrations, rather than a choice to improve the livability of one's city.

An urban problem that goes beyond the reduction of greenhouse gases, but that affects the efficiency of the use of resources in a city is represented by water management. Most climate change models predict a long-term decline in water availability in the western areas of North America and Asia and in areas of Africa and Europe washed by the Mediterranean Sea. Consequently, in the cities of those areas, but not only, it will also be necessary to dedicate proper attention to the conservation of water resources and the quality of the distribution plants. Currently, it is estimated that 150 million people live in cities with a perennial lack of water and this

condition probably in consideration of trends could reach one billion in 2050. In addition to avoiding waste, through a strong educational process, the challenge to be launched is to capture every drop that falls from the sky by conveying it in cisterns on the roofs and using it, for example, to irrigate. Another help could come from an improvement in the water infiltration process by creating the so-called "Rain Gardens", which absorb excess water and release it slowly. In the cities, in fact, the high density of structures and infrastructures alters the water cycle and favors the presence of water on the surface, contributing to the occurrence of hydrogeological instability during important meteorological events. To allow the drainage of water in some cities were made ramps and sidewalks in permeable materials, very similar to the natural sandy and gravelly soils. Strongly restrictive interventions to obviate the decrease in rainfall and guarantee a minimum of water to all may not be entirely advantageous. In fact, Melbourne health authorities in Australia have realized that the sharp decrease in the flow of wastewater, combined with rising temperatures, will make the discharges warmer and more concentrated, increasing the possibility of pipe corrosion. To compensate for this effect, they proposed to modify the sewerage inspection and maintenance programs.

So far we have devoted a large part of this editorial to some ways to reduce emissions and save water, protecting citizens, but the slow but steady aggravation of the effects of ongoing climate change requires urgent action and measures. We increasingly talk about adaptation, which involves the acceptance of change, but at the same time requires the adaptation of natural or anthropic systems in response to climate change and their effects, in order to reduce their damage, promote resilience and even generate benefits. For this reason, the first cities to be consulted are those located near rivers and oceans, traditionally that setting was for transport and connectivity purposes. However, this natural geographical advantage is now increasing the vulnerability of cities (i.e. Donadio in CSE, 2017), in fact, climate change involves an increase in sea level and therefore in the severity and frequency of storm surges. Global warming melts the land ice, especially that of the polar ice caps, and adds more water to the oceans. Since 1900 it has risen by about 20 cm, nowadays it increases by about 3 mm a year and is accelerating. According to the less pessimistic forecasts, therefore with an increase in global temperature to 1.5° C, an increase of about 65 cm would be reached in 2100. Faced with this rise, 70% of the largest cities in Europe would have serious difficulties being developed for the most less than 10 m above sea level. The port cities of many Asian countries, in the so-called developing countries, such as Kolkata, Shanghai, and Guangzhou, would also be vulnerable to an increase as well as those already technologically developed, as Rotterdam, Tokyo or New York, and imagine what it would be if the

increase were greater! It is not just a question of economic loss, only in Italy the economies of many Adriatic and Tyrrhenian coastal cities are based on beach activities, but also of cultural assets loss. In Italy, the mind goes quickly to Venice, which would be submerged and together with it the monuments that made it famous.

In this context, planning interventions are possible, but it poses enormous uncertainty. Long-term infrastructures, such as flood protection works, major transport systems, large-scale power plants (which are often found near cooling water sources), are generally designed on certain conditions and durations, which today they would not be completely certain. Moreover, the degree of tolerability of some large urban infrastructures such as metros, sewers, bridges existing in many coastal cities is not known in the occurrence of extreme events with an increased sea level. Furthermore, according to these scenarios, the built of new infrastructures in Shanghai, Jakarta, Bangkok, Rio de Janeiro, and other cities adds further complexity to an already difficult setting. An even more difficult problem, and rarely mentioned in the literature, is the possibility (and the potential desirability) that national governments evaluate for some cities the need for relocation and potential abandonment of key infrastructures and areas prone to flooding. This would represent one of the largest losses of value in land and infrastructure and the greatest transfer of economic wealth in human history. This, for example, is what happened in New Orleans that was hit in 2005 by Kathrina, one of the five most serious hurricanes in American history. 80% of the city was flooded, as the flood prevention system turned out to be completely useless. The force of the hurricane and the consequent flooding caused the death of at least 1836 people and damages for 81.2 billion dollars. To avoid new catastrophes, most of the residents have moved to less vulnerable areas, leaving a large number of poor people in the city, in poor housing, at the risk of a new destructive event. This situation could multiply for other cities in view of the probable sea level rise and the consequent sea storms and floods.

The effects of climate change affect not only coastal cities; in fact, flooding after violent rains is becoming an increasingly common problem even for many cities in the hinterland. By the end of the 21st century, extreme conditions are considered to increase between 10 and 60%, with the risk of floods that include the collapse of sewage systems. The volume of sewage released into the environment by the blocked sewer system combined with spills and floods can be considerable, up to 40% in some cities. The construction of defensive works on the river banks can help to break down any abnormal and sudden floods, but also mitigation works upstream of the cities (such as compensating/balancing reservoirs) can guarantee a delay and a lowering of flood height.

The situation will be aggravated in cities where there is an

uncontrolled urban development, with buildings based on natural drainage canals and recent flood plains. In the absence of suitable drainages, the speed and volume of runoff will increase. Furthermore, this increase could have an effect on the less consolidated soils arranged along the slopes close to the new settlements which are not always properly constructed. In the world, there are numerous cases in which anomalous rain events have triggered floods and landslides with damage and victims in the houses that these sediment-laden flows have invaded. For example, in 2013 in India the same amount of rainfall in 6 months rained in just 5 hours, or in 2017 in Colombia and Peru it rained in less than three hours what happens in 24 hours and in 2018 in the Philippines, on a period of 6 months, a large number of tropical typhoons occurred with intense winds and heavy rains. In all these events there were floods from rivers and landslides from the slopes with heavy human losses, damage to property and infrastructure and economic interruptions, especially in the most important settlements. In Italy, there are over a hundred municipalities that in recent years have had significant impacts (flooding, landslides, damage to infrastructure and historical heritage, etc.) due to extreme weather conditions. In these areas, an estimated 7.6 billion euros have been estimated to deal with the emergence of the reported damages. Probably this estimate would have been different if one had acted in terms of prevention. Both with respect to mitigation, which acts on the causes of

climate change, and with respect to adaptation, which instead acts on the consequences, with the aim of reducing the vulnerability of environmental and socio-economic systems to the negative effects of climate change and limiting the damage, cities have a crucial role to play in order to manage what is inevitable and avoid what cannot be managed (Rosenzweig et al., 2015). If it is true that states have a power that individuals, cities, and businesses do not have, it is also true as Michael Bloomberg, a former mayor of New York, said that "*mayors must not wait for national governments or a new global climate agreement to take action. They can do it today, and more and more are those who do it*". Positive signals from local administrators, in fact, are beginning to be there in an increasingly widespread way, also because forms of collaboration have developed between local administrators whose goal is to combat climate change at a global level (Large Cities Climate Leadership Group, World Mayors Council on Climate Change) or continental (in Europe, Covenant of Mayors and Mayors Adapt). Scientists have urged politicians for years to tackle the problem of climate change, asking politicians for effective measures to prevent coordination between nations (see COP). Probably to the reluctance of states that do not perceive the influence of climate change on their territory, local administrators who have a more acute perception will respond. Cities, where the majority of the world's population resides, are key players in tackling climate change: it is in urban areas that the challenge to climate change will be won or lost.

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