

THE ROLE OF GREEN BUILDINGS IN THE IMPROVEMENT OF THERMAL AND PSYCHICAL COMFORT FOR THE RESIDENTS OF BIG CITIES

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Abstract: This paper approaches a current issue confronted by the residents of large urban areas, where the cumulative effects of global warming pollutants, dust and noise produced by everyday activities create a permanent discomfort and represent a real threat to their health. One of the solutions for diminishing these effects is the greening of the cities, which is a concept campaigned by many national and international bodies and organizations. This idea can be put into practice through the construction of greenhouses on the roofs of the buildings. Thus, the positive effects of greening the cities are manifested not only by reducing the temperatures during the summer time, air filtration and retention of a significant quantity of pollutants and dust, reducing the intensity of noise, but also by providing a psychological comfort beneficial to people's health.

Keywords: global warming, greening buildings, uncontrolled urbanization.

1. General views on the emergence and the development process of global warming

The main cause of the global warming was generated by the increase of the concentration of CO₂, NH₄ and N₂O in the atmosphere in recent centuries [6]. Before the industrial revolution the concentration of CO₂ was 280 ppm. Nowadays is 400 ppm, which is nearly double and is predicted to be 550 ppm in 2035, if the flow of current emissions of greenhouse gases (GHG) would persist beyond the natural capacity of absorption. In this scenario, in the immediate period the average increase in temperature will be more than 2°C. This prediction is generated based on the rapid growth of the economies of China, India, Brazil, Australia, South Africa, Eastern Europe etc., the fact that the USA has not yet ratified the Kyoto Protocol and that the replacement of fossil fuel with renewable and clean sources of energy is progressing slowly.

The main factor underpinning the global warming process is considered to be the greenhouse effect, which is the term used to highlight the contribution of certain gases emitted naturally or artificially warming the earth's atmosphere by changing the permeability of the atmospheric solar radiation reflected by the earth's surface. This phenomenon was discovered by Joseph Fourier in 1824 [25].

If the Earth's atmosphere, the greenhouse effect warming was responsible enough to allow the development of its plants as we know them today. The main cause of this effect is the enormous amount of carbon dioxide and other similar substances that accumulate in the air layer, forming a "blanket". Substances that act in this regard are freons, methane, ethane, nitrogen oxides, hydrogen, water etc.

The properties of these substances are such that ultraviolet rays give possibility to pass easily. Reaching the surface of the land these rays are transformed into heat, and heat from the ground surface passes back through this layer much harder, so it creates the situation that, "as the quilt is thicker even as it is hot" [7].

Kyoto Protocol [10] addresses the problem of emissions of six greenhouse gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF₆).

According to a 2007 study [26], 22% of global emissions of greenhouse gases come from agriculture, a similar percentage in the industrial sector, but higher than in transport. Cattle, especially transport and feeding them, are at the origin of 80% of emissions of greenhouse emissions from agriculture. Emissions of greenhouse grew faster between 2000-2010 than in the preceding three decades, and nearly half of

the carbon dioxide emissions in the period 1750 - 2010 is due to last 40 years. 2014 IPCC Report Mitigation of Climate Change states that 62% of emissions of greenhouse gases between 2000 - 2010 effect are represented by carbon dioxide. The elimination of these gases by natural processes is much slower than their production. Thus, they will remain longer in the atmosphere, leading to increased natural greenhouse effect. For example, the lifetime of carbon dioxide (CO₂) in the atmosphere between 50...200 years, methane (CH₄) is 12 years and nitrous oxide (N₂O) 114 years [17].

It is estimated that about 35% of total emissions of greenhouse gases released into the atmosphere worldwide, results from the production and distribution of energy. Of the total amount of energy produced in the world, 80% yield based on the combustion of fossil fuels. Extracting these fuels produce CO₂ and CH₄, and their combustion CO₂ and N₂O. In combustion processes, the carbon content of fossil fuels are oxidised and released to the atmosphere as CO₂. Intensifying greenhouse effect does not have the same consequences on the entire surface of the Earth.

Polar regions will be more affected than the equatorial and coastal longer than the inner surface of the continents .

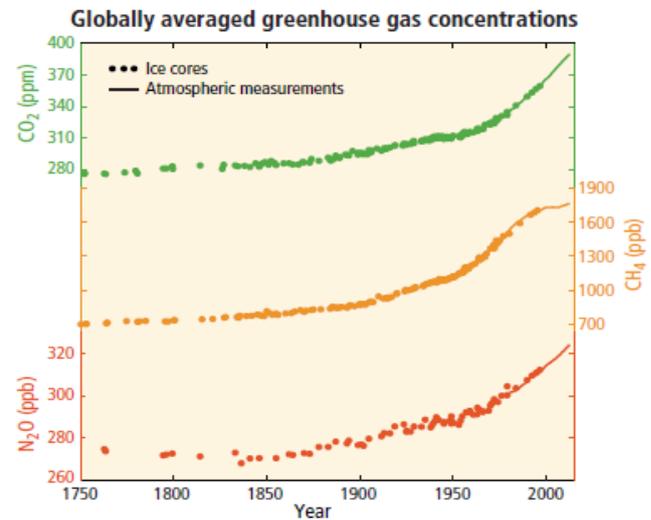


Fig. 1. Variation of CO₂ concentration, NH₄ and N₂O into the atmosphere [19]

Figure 1 shows the evolution of the atmospheric concentration of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) assessed on the basis of information provided by layers of ice (dotted) and direct measurement [19].

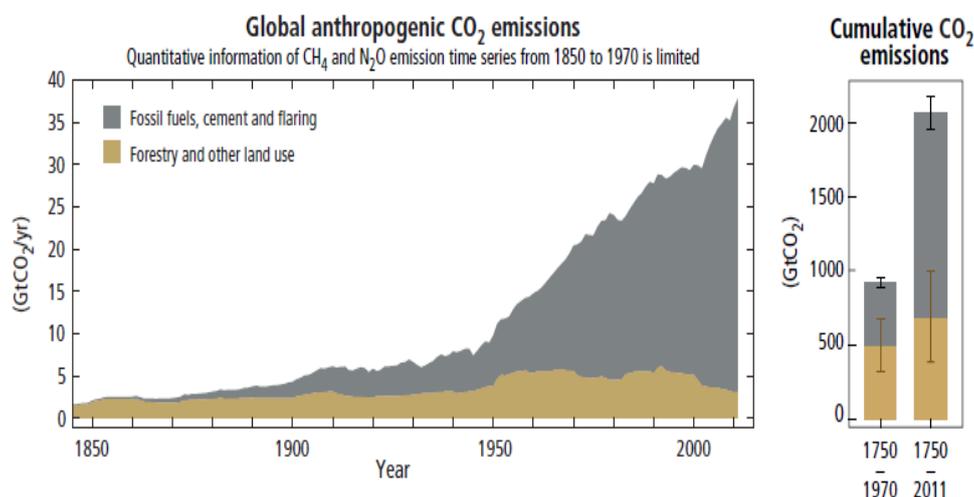


Fig. 2. Global CO₂ emission, the equivalent gigatons [19]

Emissions of greenhouse grew faster between 2000-2010 than in the preceding three decades, and nearly half of the carbon dioxide emissions in the period 1750-2010 is due to last 40 years (Fig. 2).

They come mainly from burning fossil fuels, cement and other combustion and the release to the forests, animals and vegetation zone [FOLU].

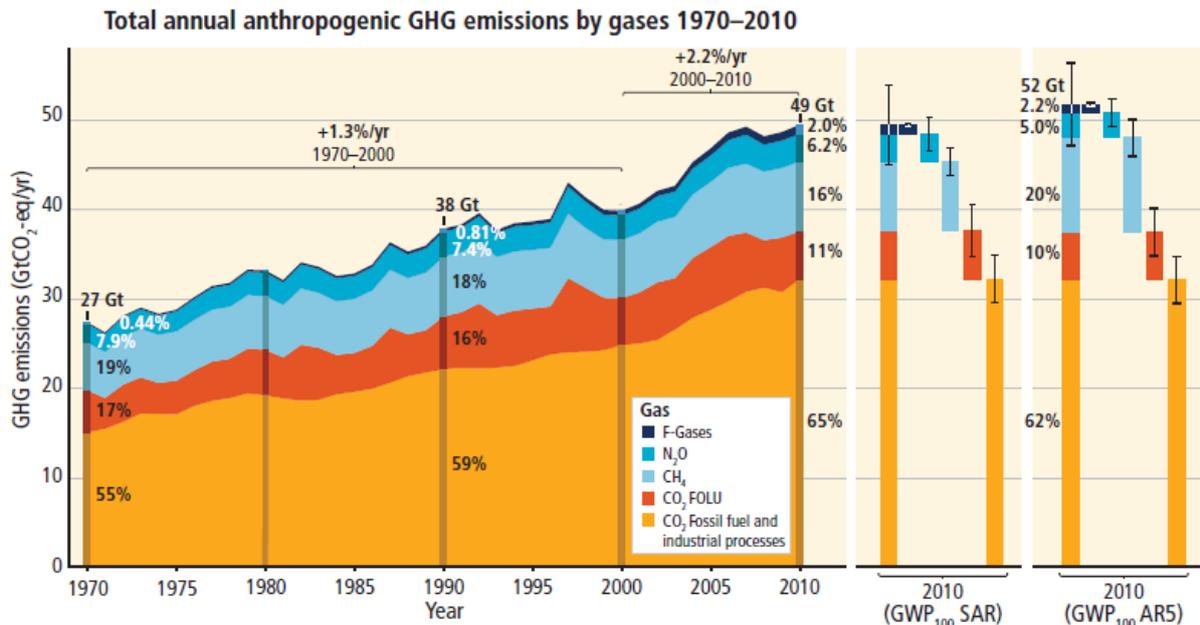


Fig. 3. Total annual greenhouse gas emissions effect in gigatonnes of CO₂ equivalent / year [19]

Figure 3 shows the extent to which participate in forming the total amount of greenhouse gases different sources and how they have evolved individual and overall GHG [19].

Warming of the climate system is unequivocal, experts say IPCC, and monitored developments after 1950 has no precedents in the latter part of

the last millennium. It is considered that during the 30 years between 1983 to 2012 there has been a warming climate more pronounced than in the past 800 years or even than in the past 1,400 years (Figure 4 a and b) [22].

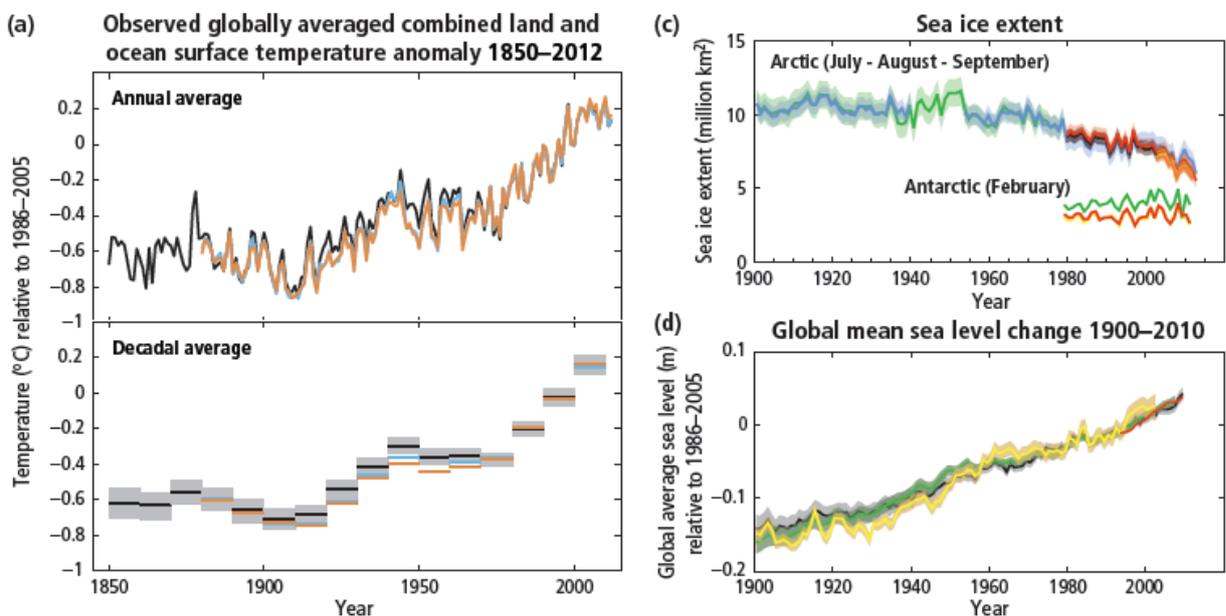


Fig. 4. The average annual temperature variation (a) and decadal (b) of the Arctic ice cap (c) and oceanic water level (d) by 1850 [22]

Experts Intergovernmental Panel on Climate Evolution (IPCC) launched an alarming diagnosis of the dangers of global warming,

meaning that a warming of the Earth 2-3° C above the average temperature in 1990 would have a huge negative impact on all regions of the

planet [5]. By 2080 about 3.4 billion people will suffer from serious shortages of water caused by melting glaciers, while another 600 million people will suffer from hunger from drought, soil degradation and soil salinization. Drought affecting large parts of southern Africa, Latin America, the Mediterranean, Middle East and North Africa.

Excessive heat or fever abnormal specific global warming process, even some risks to public health, especially in urban areas, where temperatures are higher. It confirmed that high temperatures increase the risk of death in people sensitive to the effects of heat stress. The greatest vulnerability presents people aged over 65 years (retired). Also, the heat can cause real disasters, promoting or maintaining forest fires produce human negligence.

The main effect of global warming is represented, however, the drought, which has a devastating impact on food production and hence human health. More serious is that the drought is proving a phenomenon with greater frequency and areas more extensive in countries emerging with large populations where such diseases as pellagra, iron deficiency anemia, hypocalcemia, hipomagnezia, low content of macro and micronutrients (vitamins, minerals), but also weaken the body's resistance to pathogens have devastating effects. About two billion people in developing countries are anemic dezvoltare, and 1.1 billion people worldwide are malnourished.

Experts believe that to avoid a bleak future of the planet, should the 2050 greenhouse gas emissions to fall by twice world and four times in industrialized countries. The optimistic scenario assumes that by 2100 the average global temperature will increase by 1.1-2.9°C.

Specialists with great reluctance regarding such a scenario, especially due to the inertia in ecological systems and huge quantities of CO₂ into the atmosphere collected in the last hundred years [16].

In summary, in presents a variation slightly alarmist five main negative effects of global warming process: rising sea levels and ocean; hurricanes and intensifying storms; drought and desertification; ocean acidification; danger of total extinction.

2. Current aspects regarding urbanization and its correlation with global warming

The fundamental feature of world population in the post war period is considerable acceleration in the growth rate, whose value reached 2% annually. This process has been called plastic explosive demographic. The world's population has increased in the last two decades with 1,146,000,000 inhabitants, or around 46%. Asia contributed to this increase by 700 million, representing 60% of the total, while Europe, North America and Oceania, with just under 140 million, representing 12%. Over the same period the population of Africa grew by 58%, America 56%, Europe 18%, Asia 52%, with 52% of Oceania and Russia 35%. As a consequence, the growth rates in the period 1963-1970 a big fan know: 0.6% annually for the population of northern Europe and 3.4% for the population of Central America.

Following the evolution of the population in Romania, it can show that it follows the European trend as seen in Table 1 [27].

Table 1. *The evolution of the Romanian population, by year [27]*

| Period | Total world, mil /year | Developed regions, mil /year | Developing regions, mil /year | Total world, % | Developed regions, % | Developing regions, % |
|-----------|------------------------|------------------------------|-------------------------------|----------------|----------------------|-----------------------|
| 1960-1970 | 65 | 11 | 54 | 2.0 | 1.1 | 2.4 |
| 1750-1800 | 4 | 1 | 3 | 0.4 | 0.4 | 0.4 |
| 1800-1850 | 6 | 2 | 4 | 0.5 | 0.7 | 0.5 |
| 1850-1900 | 8 | 5 | 3 | 0.5 | 1 | 0.3 |
| 1900-1950 | 17 | 6 | 11 | 0.8 | 0.8 | 0.8 |
| 1950-2000 | 80 | 12 | 68 | 1.9 | 1.1 | 2.3 |

On the other hand, the UN estimated that 7.2 billion people living today, as the global population will grow to 8.1 billion by 2025, most of the increase taking place in developing countries, particularly in Africa [8]. According to UN experts, by 2050 the world population will

number 9.6 billion people, and 2100 are expected to live on Earth nearly 11 billion people. The study reveals that around 2028 India's population will exceed that of China's number, when both countries will have about 1.45 billion people.

Urbanisation is defined as a "process of transformation of social and professional Structure, a restructuring of forms of rural life and the old urban forms after new models" [4]. Also, by means urbanization and urban population growth over time relative to the population of rural areas. In principle, the urban area is the area where they held activities unrelated to agriculture. In most countries and cities have privileged legal status associated with specific administrative forms.

Urbanization is regarded as a factor of social progress, in most situations this offering superior materials socio-rural areas. However, in terms of influence on the process of global warming, urbanization accelerated in the last three decades and included the negative factors. Urbanization is now a trend accelerated growth as it brings a host of facilities to conduct more comfortable life through better access and quality of population to public services (systems of water supply, sewerage, sewage treatment waste management systems, etc.).

The city, however, is a specific ecosystem, a complex of natural and artificial factors that provide a range of facilities to conduct more comfortable life, but that exposes the population to various risks and discomforts, depending on the organization and use thereof. Most often in urban systems, artificial factors extend the natural detriment. Urbanization rate refers to the percentage annual increase in population in urban areas of the country, being inversely proportional to urbanization normal (eg. Africa, South America, Southeast Asia). China alone is expected to move from rural to urban areas in the next 20 years 350 million. Also in this country during the period 25...30 cities will exceed 20 million inhabitants each, with unpredictable consequences for the climate and all aspects of the natural environment in those areas.

The implications of the urban population growth are multiple, standing out mainly [24]:

- pressure on urban sectors (housing, infrastructure, economy, environment, education, health) due to serve the needs of the rapidly growing population;
- increasing urban non balanced in the sense that there is a growing urban excess in one area of a country and the emergence megaorașelor (eg Bangkok is 30 times larger than the second largest city in Thailand and Lima include about 1/3 of Peru's population). Megacities are specific to developing countries, but are also found in developed areas of the world. The most populous

city in 2015 was Tokyo, capital of Japan, with 36.5 million inhabitants, the figure is relative, because the city's population increases every year at least 0.5 million. A similar growth rate is also reflected in Hong Kong, while in mainland China and South East Asia growth rates and large urban areas are higher;

- Economic growth is directly proportional to the increase rate of urbanization, with the exception of most states in Africa and some South Asian.

Today, however, the huge increase in urban population occurs in developing countries, particularly in Asia region (over 55%), which largely determines the character of the contemporary world urbanization less controlled.

One of the obvious characteristics of modern urbanization is rapid growth in the number of megacities (over 8 million) and their population concentration. In the mid twentieth century 7th each country have a city with over 1 million inhabitants, and currently has about 375 Earth agglomerations with population over 1 million, where there are about 37.6% of city dwellers and 17.8% of the world [23].

Compared to the many blessings of urbanization should not overlook its negative effect on environmental degradation and global warming. Concrete and glass have replaced huge green areas, highways annually swallow million hectares of farmland and smog sometimes force people to wear masks to filter respirators. It notes that forced and chaotic urbanization have also caused damage to the environment that are huge expenses for their removal or even impossible for the current generation.

Specialists of global warming have already set changes that will move the planet in the next hundred years. These changes will be felt most in crowded urban areas. Will feel a lack of natural RESOURCES, a decrease of water resources, food, health will be put to hardships, there will be many cases of respiratory, allergy, cardiovascular and gastrointestinal diseases.

The greenhouse effect is manifested more intensely in large urban areas, where buildings with many floors are not only permanent sources of greenhouse gas emissions pronounced, but also additional sources of heat coming from the huge energetic consumption, concentrated in volumes arranged vertical, which provides the connection to the ground is no longer any heat exchange. Total alienation of the individual lost in an urban multi-million exposes it to numerous

mental illness, with negative consequences on yield intellectually and even physically.

Urbanization is regarded as a factor of social progress, in most situations this offering superior materials socio-rural areas. However, in terms of influence on the process of global warming, urbanization accelerated in the last three decades negative factors included the negative factors.

3. The concept of "green city" and its relationship with urbanization and global warming

The concept of green city is increasingly circulated in the context of increased greenhouse effect and pollution continued growth over the planet. In a green city can be found features that make urban life healthier, more pleasant and friendly surrounding ecosystems.

Urbanization less controlled achieved in recent decades, especially in countries developing, but also in Eastern Europe and the developing region of the world, made often by infringement of the urban core, such as on the provision of water and green areas, capable of reducing the negative effects that they cause environmental conurbations. All organizations worldwide, continental, regional or state adopted recommendations, guidelines or laws allowing city dwellers to enjoy decent living conditions, in terms of the environment.

In Romania, the Constitution stipulates in Article 35 "right of everyone to a healthy and ecologically balanced environment." In this context, Law no. 24/2007 [9], regulating and managing green spaces in urban areas states that "The State recognizes the right of every individual to a healthy environment, free access green spaces for recreation in public ownership, the right to contribute to the Lawns at creating alignments of trees and shrubs, in compliance with legal provisions "(art. 6). In the same law, urban green areas are defined as a network mosaic or a system of ecosystems semi, whose characteristics is determined by vegetation (wood, tree, shrub and flower and herbaceous) and includes parks, squares, planted alignments or free land, unproductive plot (art. 6) .

The most important are parks, thanks surface and facilities available, and functions that îndeplinesc.Prin this law "governing the management of green spaces, public interest objectives, to ensure the quality factors environment and health of the population" (art. 1).

In the 319 urban settlements in Romania, where 55.2% of the population lives, due to the trend of permanent expansion of built space, especially in the last two decades has seen, most often, a reduction of green spaces [21]. Thus, if the years 1980-1990 in Romania urban green areas increased from 169.62 to 220.81 km² respectively 30%, after it registered a downward trend until 2006, when it produced a slightly riviriment reaching 202,69 km². Because of this situation, it was that the average area of urban green space in Romania is today only 18 m²/capita, while in Europe it is frequently 25 m²/capita. Given that Rule the World Health Organization is 50 m²/capita and EU standards are 26 m²/capita, that the population of cities in Romania lacks in many cases, the minimum required for spares (Bucharest has only an average area of 9.67 m²/capita). Some studies show that the main value of green spaces derives from their ability to restore the "wellbeing" of persons attending them. They provide the urban population quiet places to relax and reduce stress, to escape from the built environment and traffic. The green areas are responsible, therefore, mainly human needs for recreation and leisure.

No urban population can not ignore endlessly that their cities can be found many places within city limits, different sizes, abandoned (the dispute or the property is not known whom), often acting as a repository for junk. European initiatives, north American, Japanese, etc. on "greening" cities are diverse and interesting . Some cities, such as Philadelphia-USA have already declared "green cities", thereby trying to mobilize a growing number of citizens in activities for the benefit of the whole community .

An important component of the concept of "green city" refers to the cultivation of plants on the roofs and balconies of buildings in major cities to improve air quality and to give a more human aspect of these cities [11]. Among the concerns that arouses a growing interest is the creation of green roofs or buildings that can be grown not only pitch, but also flowers, vegetables or bushes, developing true even organic greenhouses [3]. By growing flowers or vegetables on the roofs and terraces of buildings nature plays a part of the area that was deprived by the construction of these buildings, complement and highlight their architecture and large urban areas gives a little friendlier. A suggestive name for buildings "green" is that of "vertical farm" (vertical farm) [1, 2].

In fact, this aspect are dedicated a lot of research and achievements, which will become apparent hereinafter.

Due to the major advantages of green roofs brought to the residents of urban centers and beyond, people are becoming increasingly interested in their presence in everyday life.

According to research conducted by Penn State Center for Green Roof Research of Pennsylvania State University in USA, the advantages of an ecological mounting roof are obvious, as can be seen in Figure 5.

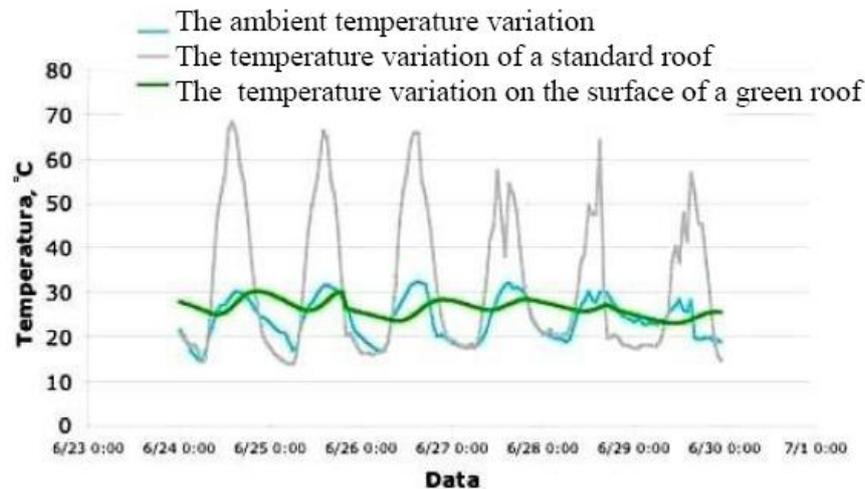


Fig. 5. Variation in surface temperature of a roof standard, compared with that of a green roof [18]

Due to the emergence of a multitude of high-performing materials, there is the possibility of creating cultures directly into the soil surface disposed on the roof allocated. Figure 6 shows an example of planning for cultivation of small rooftop St. Luke's International Hospital in Akashi, Tokyo (Photo: Ian Muttoo on Flickr) [18].



Fig. 6. The ecological roof St. Luke's International Hospital, Akashi, Japan [18]

It should also be chosen plants whose dynamics to match such a project to be viable long time and that can be easily replaced with like.

Travellers can admire the green roof of the airport in Amsterdam (Netherlands), where

landscape architects have managed to create a useful and pleasant ambient environment (Fig. 7) [13].



Fig. 7. Green roof of the airport in Amsterdam [13]

It follows from the results that the establishment of a green roof (ecological) has a number of advantages, among which we can mention:

- retain rainwater as it prevents water run-off by 75%;
- reducing consumption energetic in space under roof, both during winter and summer, acting as a thermal insulator true;

- waterproofing protection from ultraviolet radiation, and freeze-thaw cycles, thus extending the life;

- improving air quality in urban areas, because the plants filter the air and absorb carbon dioxide;

- using green roofs in urban agriculture projects can create a local food system for the community;

- aesthetic improvements and obtain spaces with recreational destinations etc.

Note that achieving a green roof is a very complex action. As remarked Mary Ann Uhlmann in Chapter 5 of [14], such a project should attend: botanists; horticulturists specializing in the environment (for plant selection and maintenance), APLI of horticulture and horticultural academic research; agronomists knowledge of interactions between plants and soil and of agricultural technologies; specialists in soil science; geologists; environmentalists; landscape architects; engineers specialized in civil engineering, thermal and hydro insulation, irrigation and climate control etc.

Green roofs can reduce heating costs or air conditioning in homes with up to 26%, ensuring optimum thermal insulation for the entire year, according to studies conducted by the manufacturer of additives and building materials Sika Romania. Another advantage of this type of roofing is the ability of plants making up the atmosphere to absorb pollution and to prevent excessive emissions of greenhouse gases. At present, the degree of promotion and implementation of green roofs is growing worldwide. Currently, in Germany, 10% of all roofs are environmentally friendly and in Switzerland legislative rules require that any newly built covering an area greater than 500 m² to be achieved using such a system [12].

However, in temperate zones are truly green roofs 6-8 months a year, the rest of the time their effects are much reduced. An improvement of this situation is the location of protected areas on roofs, where plants can be grown throughout the year.

Until recently considered a utopia, the idea of setting up greenhouses on the roofs of apartment buildings, businesses and institutions of all kinds, catch more ground, this arrangement is not only an oasis of tranquility, but also a way that can reduce pollution, noise, dust and the amount of carbon dioxide in the atmosphere etc. Economic aspect should not be neglected that can offer such emissions.

One of the largest global producers of greenhouses Nexus Corporation is the North American company. It produces more than 10 years, among other things, to be located on the roof greenhouses (Fig. 9) [20].



Fig. 9. *Types of greenhouses produced by Nexus Corporation USA [20]*

One such project, shown in Figure 10, was conducted for Florida State University.



Fig. 10. *Greenhouses located on the roof of Florida State University [20]*

Following requests were also placed greenhouses and other buildings such as Arkansas State University, University of California, Centralia Community College etc.

The material used for the resistance structure is extruded aluminum and the coating of acrylic glass was used. Growing plants in greenhouses is preponderant developed in hydroponic system.

Figure 11 shows the culture established in a greenhouse roof at Gotham Greens, Greenpoint, New York, USA.



Fig. 11. Greenhouses constructed on the roof of Gotham Greens, Greenpoint, New York, USA. [27]

Examples of greenhouses located on the roofs of buildings are numerous, they are constantly multiplying, both in Europe and the US.

Conclusions

1. The main cause of global warming is regarded as increasing the concentration of CO₂, NH₄ and N₂O in the atmosphere in recent centuries. CO₂ concentration was 280 ppm (parts-per-million), before the industrial revolution, is now 400 ppm, which is nearly double, and 2035 could be 550 ppm, if the flow actual emissions of greenhouse emissions (GHG) would be maintained beyond the natural capacity of absorption. In this scenario in the immediate aftermath average temperature increase would be higher by 2°C. The main factor underpinning the global warming process is considered the greenhouse effect, which manifests itself more strongly in the earth's atmosphere.

2. The greenhouse effect causes global climate change, but also has positive consequences in the sense that the absence of such substances that the average temperature on Earth to be about -15°C. In the last 50 years about 95% of ambient temperature has risen due to increased emissions of greenhouse gases (water vapor, which cause the greenhouse effect on Earth at a rate of 36...70%, except clouds dioxide carbon in the amount of 9-26% methane, 4-9% ozone in a proportion of 3.7%).

3. An important contribution to accelerating global warming has explzivă world population growth and urbanization out of control in some areas, of which require increasing energy consumption, helping to accelerate the growth rate of greenhouse gas greenhouse, namely global warming .. the fundamental feature of world

population in the postwar period is considerable acceleration in the growth rate, whose value reached 2% annually. This process has been called plastic explosive demographic.

4. One of the obvious characteristics of modern urbanization is rapid growth in the number of megacities (over 8 million) and their population concentration. In the mid twentieth century 7th each country have a city with over 1 million inhabitants, and currently has about 375 Earth agglomerations with population over 1 million, where there are about 37.6% of city dwellers and 17 8% of the world population. The process of formation of cities in developing countries' position is strengthened continuously. In 1975 there were three cities: Mexico City, New York and Tokyo. Today there are 21. For the first time in history the urban population surpassed the rural one. If things go the same way, in 2050 70% of the world population will live in a metropolis.

5. Compared to the many blessings of urbanization should not overlook its negative effect on environmental degradation and global warming. Concrete and glass have replaced huge green areas, highways annually swallow million hectares of farmland and smog sometimes force people to wear masks to filter respirators. It notes that forced and chaotic urbanization have also caused damage to the environment that are huge expenses for their removal or even impossible for the current generation.

6. The concept of green city is increasingly circulated in the context of increased greenhouse effect and the continuous increase of pollution on the planet. In a green city can be found features that make urban life healthier, more pleasant and friendly surrounding ecosystems. Green cities widely used renewable energies, hosting companies using clean technologies, promotes sustainable living and rules adopted both environmental and innovative strategies to promote new environmental concerns.

7. An important component of the concept of "green city" refers to the cultivation of plants on the roofs and balconies of buildings in major cities to improve air quality and to give a more human aspect of these cities. Among the concerns that arouses a growing interest is the creation of green roofs or buildings that can be grown not only pitch, but also flowers, vegetables or bushes, developing true even organic greenhouses.

8. Ecological roofs reduce heating costs or air conditioning in homes with up to 26%, ensuring

optimum thermal insulation for the entire year. Another advantage of this type of roofing is the ability of plants making up the atmosphere to absorb pollution and to prevent excessive emissions of greenhouse gases. Currently, the degree of promotion and implementation of green roofs is growing worldwide.

9. The main drawback is the green roofs in temperate zones, limiting the period of plant vegetation at 6...8 months a year. By comparison, in greenhouses located on the roof vegetation plant is maintained to normal throughout the calendar year.

10. Currently, the idea of location of greenhouses on the roofs of apartment buildings, industrial facilities and public buildings is so successful as firms in the construction of greenhouses devoted to classical and other new companies have focused some of its activity on the design and implementation of this type of greenhouses. Perhaps this is the main reason why most of the greenhouses on the roofs are very similar to those on the ground.

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