



REDUCING THE EFFECTS OF URBANIZATION ON GLOBAL WARMING BY PUTTING OF GREENHOUSES ON ROOFTOPS

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Abstract: The paper analyzes the possibilities and difficulties of implementing the concept of "green city", including on the greenhouses located on rooftops in urban built areas, to mitigate the effects of global warming. In this sense it presented some data about the global warming and its effects, but also the rapid development of urbanization process in recent years worldwide, with the risks that this brings to the population and its influence on global warming. An affordable solution to reduce these risks is to make "green cities", including the location of greenhouses for vegetables and flowers or even some trees on roofs.

Keywords: Global warming, green cities, greenhouses located on rooftops.

1. INTRODUCTION

Among the motivations of extraordinary growth of human civilization in the last two centuries is included and relative stability and predictability of the global climate, which allowed an adequate adaptation of flora and fauna, with positive consequences for growth and diversification of food and raw materials resources necessary numerous needs of a growing population. This led to the neglect of negative effects of this development, and when their manifestations became apparent it was found that their removal is extremely difficult or even too late for some species of plants and animals

2. MATERIALS AND METHOD

2.1. Global warming and its consequences

Global warming is defined as "to the increase in average temperature of the atmosphere close to the ground and oceans" [6]. Global warming began to worry after 60s after massive industrial development and increasing gas concentration greenhouse, which are considered largely responsible for this phenomenon. Earth's permanent warming trend in the XXI century is evidenced by many studies. Climate models developed by specialists predict a warming of 1.1...6.4 °C over this century.

Estimates vary because of the unpredictability of trends in emissions of gases causing the greenhouse effect. Even more worrying is that these climate scenarios show that warming in Polar Regions will be increased, which will exacerbate global consequences.

Warming of the climate system is unequivocal, and followed developments after 1950 is unprecedented in the last part of the last millennium. It is believed 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 only in the last 1400 years.

The clear data from period 1850-2012 show a warming trend with (0.14...0.15) °C in the last decade, compared to -0.05 °C at the beginning of surveillance. A similar situation occurs in the oceans, where the polar ice caps have a permanent reduction of surfaces, namely ice volume (Figure1). Surveillance made with satellites show a decrease of the Arctic ice cap at a pace of 3.5...4.1% per decade. In period 1901-2010 the overall level of sea water increased by 0.19 m, higher growth in one century than in the previous two millennia. The main cause of global warming is regarded as increasing the concentration of CO₂, NH₄ and N₂O in the atmosphere in past centuries. CO₂ concentration was 280 ppm 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 gases (GHG) would remain above the natural absorption capacity. In this scenario in the near future average temperature increase would be higher by 2 °C.

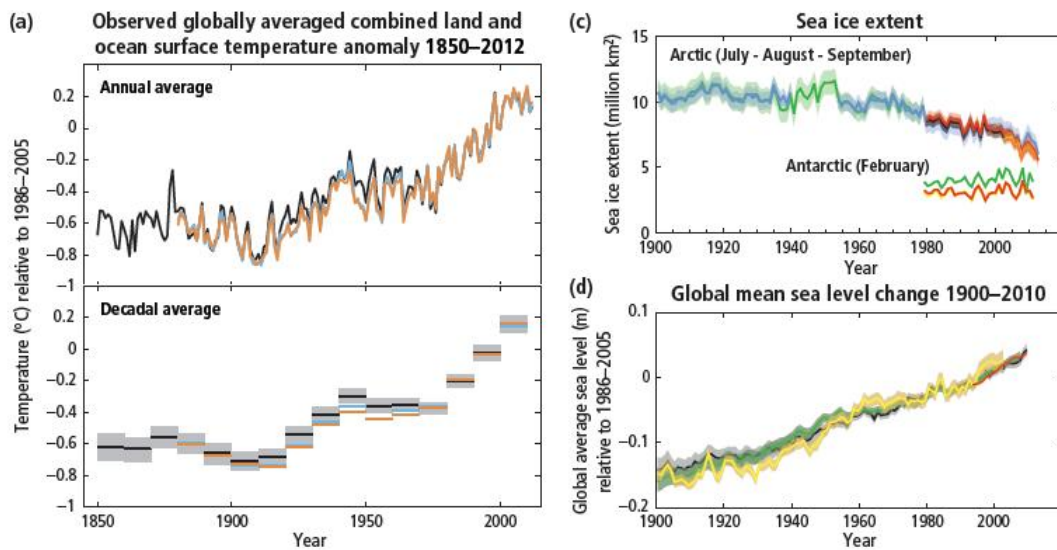


Figure 1. The variation of environmental temperature at land and ocean surface (a) reducing icecap (b) and sea level rise (c) [6]

This probability is supported by the rapid growth of the economies of China, India, Brazil, Australia, Asia, South - East, South Africa, Eastern Europe etc., while the use of renewable and clean sources of energy replacement and retention of CO₂ from power plants hard advancing fossil fuels.

The emission of greenhouse gases (GHG) began in preindustrial era and developed simultaneously with economic growth and population on Earth. It is considered that the largest amount of greenhouse gases (CO₂, NH₄ and N₂O) was issued between 2000 and 2010, their concentration in the atmosphere is higher than at any other time in the past 800,000 years.

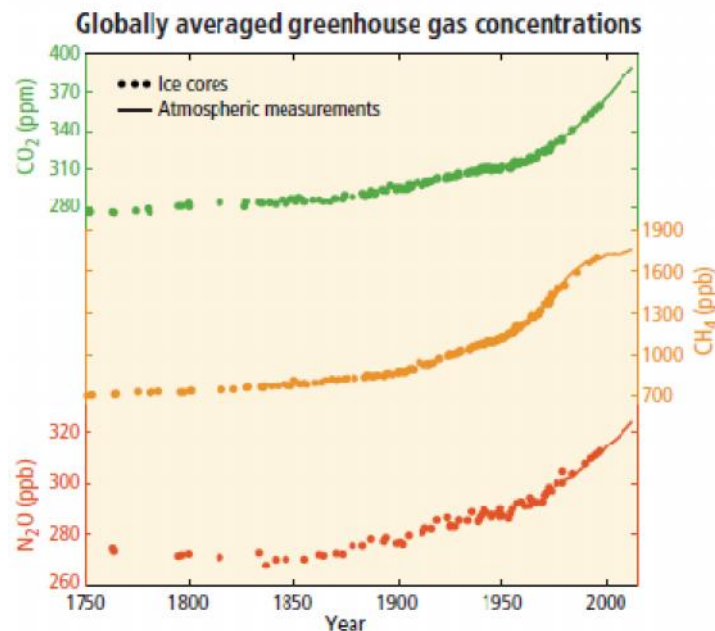


Figure 2. Variation of CO₂ concentration, CH₄ and N₂O into the atmosphere [6]

Figure 2 presents the atmospheric concentration of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), assessed on the basis of information provided by layers of ice (points) and direct measurement. It is believed that half of the CO₂ emissions between 1750 ... 2011 occurred in the last 40 years (Figure 3).

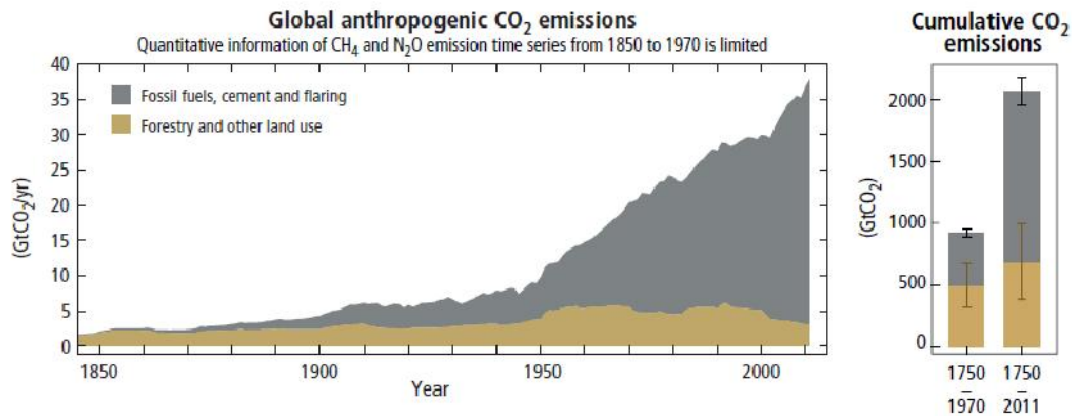


Figure 3. Global CO₂ emission, the equivalent megatons

These come mainly from burning fossil fuels, manufacturing of cement and flaring and release it by the forests, animals and agricultural vegetation. [FOLU]

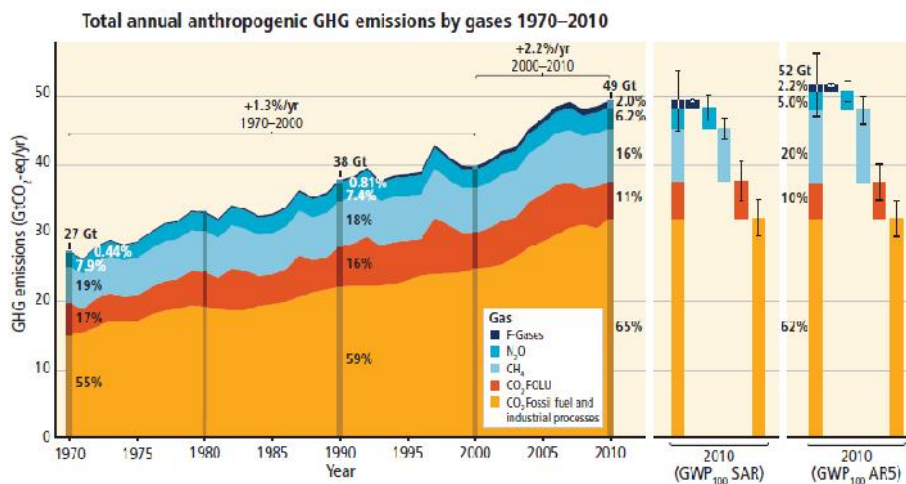


Figure 4. Total annual emissions of gas with greenhouse effect, in gigatonnes equivalent [6]

In Figure 4 is presents the extent to which participate in the formation of the total quantity of greenhouse gas various sources and how these have evolved individual and overall GHG.

Another important cause of global warming process is the massive and uncontrolled deforestation of forests, which leads to increased accumulation of pollutants, global warming and ozone depletion. To curb the negative effects of this deforestation would require a 20% increase forest cover across the whole globe, a situation hard to put into practice, including in some European countries such as Romania, where the phenomenon of deforestation has become a national concern.

Intergovernmental Panel on Climate Experts Evolution (IPCC) launched an alarming diagnosis of the dangers of global warming, meaning that a warming of the Earth with 2...3 °C to the average temperature in 1990 would have a huge negative impact on all regions of the planet [7]. By 2080 about 3.4 million people will suffer from severe water shortages caused by melting glaciers, while another 600 million people will suffer from hunger from drought, soil degradation and soil salinization. Drought will affecting large parts of southern Africa, Latin America, the Mediterranean area, Middle East and North Africa.

Excessive heats or frost abnormal, the specific processes for global warming, involved 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 (retireds). Also, the heat can cause real disasters, promoting or maintaining forest fires produced by human negligence. In addition to the destruction of large areas of forests (as factors stabilizing the climate and air composition), these fires endanger the lives of residents in those areas, and thick clouds of smoke prevents the normal air transport.

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 against pathogens have

devastating effects. About two million people in developing countries are anemic and 1.1 billion malnourished people worldwide are [UNPF, 2001]. It is estimated that the number of undernourished people chronically was during 1996-1998, 792 million, which represents approximately 18% of the total population of the regions concerned.

Experts believe that to avoid a bleak future of the planet, should up to the 2050 greenhouse gas emissions to fall by twice in 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 has 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

Note that the only ones to blame for this situation are the inhabitants of our planet, with their huge propagation pace with growing needs and physical and social utility. It is known that at the beginning of the twentieth century Earth's population approaching 1.5 billion people, while at the end of the century it had surpassed 6 billion [1]. Forecasts in this area are quite pessimistic, many countries with growth rates giant is not able to provide the minimum standard of living for their people, who are trying to migrate en masse to the developed areas of the world in the hope of a better life.

2.2. Urbanization process and the risks for population

Urbanisation is defined as a "process of transformation of social and professional structures, restructuring of rural forms of existence of the old urban forms after new models" [1]. Also, urbanization and growth means while the urban population compared to the population of rural areas. In principle, the urban area is defined as an area where non-agricultural activities take place. In most countries the cities have privileged legal status associated with specific administrative forms. Urbanization is considered a factor of social progress, in most cases this offering socio-materials conditions superior as rural areas. However, in terms of influence on the process of global warming, the accelerated urbanization in the last three decades has and a negativ role [IPCC report, 2014, Table 2.3]. The city is a specific ecosystem [4], a complex of natural and artificial factors that provide a range of facilities to make more comfortable life, but that exposes the population to various risks and discomforts, depending on the organization and use thereof. Most times, in the urban systems, artificial factors extend due to natural factors. The development of human settlements is significantly determinated of the changes wich is produced in the structure of the local economy, in the population structure and culture. It must, however, take into account the limited resources (human, natural and financial available locally), aiming at balanced and effective allocation thereof by the public authorities. They should encourage community and individual civic responsibility, the partnership in implementing local development projects, private initiatives so that positive effects of urbanization to be maximized and to minimize the negative ones. Urbanization rate refers to the percentage annual population growth in urban areas of the country, being inversely proportional to the normal urbanization (ex. Africa, South America, Southeast Asia). Only in China will move from village to city in the next 20 years 350 million people. Also in this country during the that period 25...30 cities will exceed 20 million 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 in particular:

- pressure on urban sectors (housing, infrastructure, economy, environment, education, health) because of needs to serve of the rapidly growing population;
- non balanced urban growth, meaning that excessive urban growth occurs in one area of a country and the emergence of megacities (eg Bannngkok is 30 times larger than the second largest city in Thailand). Megacities are specific to developing countries, but are also found in developed areas of the world (the most populated city in 2015 was Tokyo, capital of Japan, 36.5 million);
- Economic growth is directly proportional to increasing the rate of urbanization, with the exception of most countries in Africa and some South Asian.

In years 50s the number of people in cities has doubled every 20 years, and their percentage in the population of the world increased on average by 7%. Today it is considered that the number of people in cities is higher than the rural population (3.586 versus 3.304 billion). It should be noted that half of Earth's population is in 6 countries: China, India, USA, Russia, Brazil and Japan. The image of the urbanization is different from country to country. On the one hand in 2/5 of the world's countries still majority rural population (Africa, Asia, Latin America), and on the other, the number of cities in 52 countries exceeds 75% of the population (Europe, North America, East Asia). Now the great increase in urban population occurs in developing countries, particularly in Asia area (over 55%), which largely determines the character of the contemporary world urbanization less controlled.

One of the obvious characteristics of modern urbanization is rapid growthin the number of megacities (over 8 million) and their population concentration. In the middle of last century, 7th country each have a

city with over 1 million inhabitants, and currently the Earth has about 375 agglomerations with population over 1 million, where living 37.6% of city dwellers and 17.8% of the world's population [5]. In the process of formation of cities, developing countries' position is strengthened continuously. If in the last half century the urban population in developed countries has doubled, in developing countries the townspeople number increased about six times, and the population of large cities increased tenfold. More than a third of cities with more than 1 million inhabitants are located in the eastern, southwestern and central Asia, and another third is in Europe and North America. In the last half century the list of top 30 cities of the world has changed radically. If in 1950 two thirds of the list was occupied cities in Europe and North America, in 1990 only a third of the list comes from these regions. Cities such as Milan, Berlin, Philadelphia, St. Petersburg, Detroit, Napoli, Manchester, Birmingham, Frankfurt, Boston and Hamburg disappeared from the list of cities leading, being refreshed cities such as Shanghai, Seoul, Jakarta, Delhi, Beijing, Manila, Karachi, Lagos, Istanbul, Lima, Tehran, Bangkok, Dhacca, Sao Paolo, Rio de Janeiro, Hong Kong, etc. Forecasts of development shows that in the future only seven cities large will remain on the list, namely Tokyo, New York, Los Angeles, Paris, Moscow, Osaka and London, the other will be replaced by megacities in China, India, America South Africa.

Evolution and domination urban lifestyle is not a simple accident. Cities provide exclusive opportunities for business, creative activities and riches. Another factor that influenced the development of cities was that here education, health and social services is a higher standard than in rural areas (it is the developing countries). In the world there are countries with urbanization rate (number of population living in urban centers compared to the total population) of 100% (Singapore) or 90% (Australia, Belgium, Israel, Kuwait, Lebanon, Canada, etc.). The performance of the most obvious line of economic development and eliminate the gap between urban and rural regions are evident in countries with high urbanization.

To these blessings 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 cultivated land 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 impossible for the present generation [4].

2. 3. Green city concept and the importance of greenhouses located on rooftops

The concept of green city is increasingly the vehicle in the context of emphasizing the greenhouse effect and the continuous increase of pollution on our planet around. In a green city can be found features that make urban life healthier, more pleasant and friendly surrounding ecosystems. The green cities uses widely the renewable energies, hosting much companies which uses clean technologies, promote environmentally friendly lifestyles and adopted environmental regulations and innovative strategies to promote new environmental concerns [2].

Among the concerns which raises an increasing interest is the creation of green roofs or buildings that can be grown not only grass, but also vegetables, flowers or even creating true ecological greenhouses. By growing flowers or vegetables on rooftops actually part of nature play area which was deprived by the construction of these buildings, ie forced urbanization. According to research conducted by Penn State Center for Green Roof Research of Pennsylvania State University in the US, a roof mounting ecological advantages are obvious, as evidenced in Figure 5.

Due to the emergence of a multitude of smart materials is possible creation of crop directly into the allocated surface disposed on the roof. For it must take into account the structure of the building, the possibility of draining of excess rainfall, and can replace the missing, as appropriate. It should also be selected plant which dynamics to match such a project, which is reliable for a long time and can be easily replaced with other similar ones [2].

Toronto is the first city in the world that has approved legislation that requires new buildings to have green roofs, in other words, ecological. Eco-roofs program was launched by the city authorities who took this measure signals from alarm on global warming dynamics [6]. The Japanese company Suntory Holdings Limited invented an artificial type of soil more porous, more robust and easier than the earth, which can be applied on the roofs and walls of buildings to plant vegetation and temperature in the major cities such refresh. According to Japanese holding company, a sample of 450 grams of artificial soil called "PAFC" (a new substance urethane foam developed by the company specifically mentioned) can absorb as much as a kilo of ground water. Applied to the roof of a house, it enables growth hardwood lawn and plants, which considerably reduces the temperature inside the building [14].

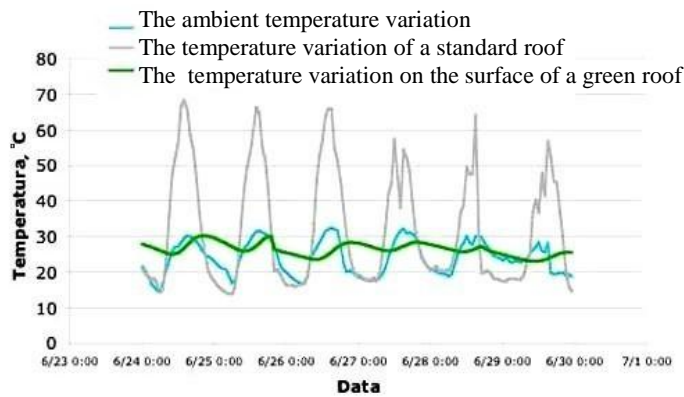


Figure 5. Variation of the temperature of the surface a standard roof in comparison with of a green roof [14]

Green roofs can reduce heating costs or air conditioning in homes with up to 26%, ensuring optimum thermal insulation over the 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 a larger area of 500 sqm to be performed using such a system [15].

Figure 6 shows an example of landscaping for cultivation plants with small dimensions on rooftop of St. Luke's International Hospital in Akashi, Tokyo (Photo: Ian Muttoo on Flickr) and in Figure 7 can see a roof of 120 m² in Shaoxing, Zhejiang Province, China, where he successfully cultivated rice [11], [12].



Figure 6. The roof ecological St. Luke's International Hospital, Akashi, Japan



Figure 7: Growing rice on a rooftop in Shaoxing, Zhejiang Province, China

Until recently it was considered utopian idea of setting up greenhouses on the roofs of apartment buildings, businesses or educational institutions. This idea comes more ground, such an 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 [8].

One of the leading manufacturers of greenhouses is the North American Nexus Corporation company. It produces, among other things, to be located on the roof greenhouses (Figure 8) over 10 years [9].



Figure 8. Types of greenhouses produced by Nexus Corporation USA www.nexuscorp.com

One such project, presented in Figure 8 was developed for Florida State University. Following requests were also placed greenhouses and other structures such as Arkansas State University, University of California, Centralia Community College and others.



Figure 9. Greenhouses located on the roof of Florida State University [9]

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

In Figure 10 is presented an established culture in a greenhouse roof at Gotham Greens, Greenpoint, New York, USA.



Figure 10: Greenhouse built on the roof of Gotham Greens Greenpoint, New York gothamgreens.com

Another example of a rooftop greenhouse is shown in Figure 11. This is the roof of a warehouse in Montreal, Canada, has a total area of 3,000 m² and it is grown in, under hydroponic tomatoes, eggplant, carrots, arugula, and other plants and vegetables [10].



Figure 11. Greenhouse in Montreal, Canada (Lufa Farms) <http://lufa.com/fr/>



Figure 12. Greenhouse in Tucson, Arizona [12]

A greenhouse built from ultra light polycarbonate structure, located on the roof of a parking (garage) in Tucson, USA, can be seen in Figure 12.

A futuristic micro model, to be located on the roof (Globe / Hedron), designed by the Italian architect Antonio Scarponi together with UrbanFarmers will be made to the structure of bamboo and will be commercialized in the near future. This greenhouse shown in Figure 13, may provide enough fresh vegetables for 4 families of 4 people, all year [11].



Figure 13. Greenhouse Globe / Hedron <http://urbanfarmers.com/>

Establishing an ecological roof has a number of advantages among which we can mention:

- retain rainwater run-off water because it prevents up to 75%;
- reducing energy consumption both during winter and summer really acting as a thermal insulator;
- 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 and recreational reasons.

Except for the first aspect, any emissions founded on the roof of a building has all the advantages listed above.

Green roofs can reduce heating costs or air conditioning in homes with up to 26%, ensuring optimum thermal insulation throughout 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 that make up the atmosphere to absorb pollution and to prevent excessive emissions of greenhouse gases.

3. CONCLUSIONS

1. Global warming is a process that increasingly worries Earth's population, its effects are more obvious from one year to another. Warming of the climate system is unequivocal, and followed developments after 1950 is unprecedented in the last part of the millennium precedent. Observations made satellites show a decrease of the Arctic ice cap at a pace of 3.5 ... 4.1% per decade . During 1901-2010 the overall level of sea water increased by 0.19 m, higher growth in one century than in the previous two millennia.
2. The main cause of global warming is regarded as increasing the concentration of CO₂, NH₄ and N₂O in the atmosphere in past centuries. The emission of greenhouse gases (GHG) preindustrial era began and developed simultaneously with economic growth and population on Earth. It is believed that the largest amount of greenhouse gases (CO₂, NH₄ and N₂O) was issued between 2000 and 2010, their concentration in the atmosphere is higher than at any other time in the past 800,000 years.
3. Consider that half of the CO₂ emissions between 1750...2011 occurred in the last 40 years. They come mainly from burning fossil fuels, cement and flaring and the release to the forests, animals and agricultural zone. Massive and uncontrolled clearing of forests leads to increased accumulation of pollutants, global warming and ozone depletion.
4. 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.
- 5 The only guilty of the development process of global warming are the inhabitants of our planet, with their huge propagation pace with growing needs and physical and social utility. It is known that at the beginning of the twentieth century Earth's population approaching 1.5 billion people, while at the end of the century it had surpassed 6 billion. Many of the countries with huge growth rates are not capable of ensuring minimum living standards for their people, who are trying to migrate en masse to the developed areas of the world in the hope of a better life.
6. Accelerated urbanization in recent decades has brought many advantages population of large cities but also many risks. It is this uncontrolled urbanization is an important source of environmental pollution and a negative factor in global warming.

7. Implementing the concept of green city, including the establishment of green roof type greenhouses for vegetables and flowers, is a contribution to reducing negative effects of urbanization, but also improve the comfort of the inhabitants of large cities.

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