Ecological trends of the formation of spatial habitat
Environment in architecture: precedents of the future

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Abstract. The article is devoted to the study of the current problem of the formation of an eco-sustainable architectural environment, for which environmental trends of spatial habitat organization in the architecture of the future are revealed. This concept allows us to understand the relevance and necessity of finding new trends in the formation of architectural science and design. The aim of the article is to analyze innovative concepts for the formation of habitat in the architecture of the future to identify environmental trends in their development. The study identifies: ways to develop eco-sustainable architecture as an environmental alternative in the context of an innovative paradigm, techniques for the formation of resource-saving environment as a rethinking of the function of cities and Innovative techniques for creating an artificial habitat in extreme conditions as a safety resource.

1. Introduction
Social and cultural changes taking place in modern conditions have led to the need for a consistent renewal in architectural science of theoretical approaches to the formation of an architectural and spatial environment. The ecological orientation that determines the relationship between architecture and the broader processes that shape the artificial habitat is of great importance. In the theory of architectural space formation, ideas of recent achievements in other areas of knowledge related to the problem of eco-sustainable development of architecture are used.

In this case, architecture opens up new knowledge and stimulates the science for actual inventions of modern designs and materials, as well as on construction technologies. In this regard, in the theory of architecture appear concepts of space formation, their typological signs of occurrence and existence in modern conditions are revealed. In the operational field of architecture theory and practice, with new areas of expertise, high technology and dynamic changes in society, there is a need for constant adjustment of its role and the ability to identify new trends in architecture [1].

2. Statement of the problem
The aim of the article is to analyze innovative concepts of spatial formation in the architecture of the future in order to identify environmental trends in their development. This setting of the problem attracts many specialists involved in the formation of architectural habitat in the context of the future [2]. Among the precedents available in the literary and information environment are the research developments of the study framework, as well as the specific design solutions and the numerous
proposals implemented under this concept. Due to the lack of articulated environmental trends in the formation of spatial habitat in the architecture of the future, the study becomes particularly relevant.

In order to find new trends in this area, it is advisable to consider the innovative concepts of habitat formation that have emerged in architectural science and practical activities. This will not only understand the importance and need to update the problem, but also identify innovative approaches to the formation of an eco-sustainable architectural environment in this context. In this regard, it is of interest to consider some of the innovative concepts that have emerged to create an eco-sustainable habitat for the future in order to identify trends in their development in the following directions.

3. Materials and methods

3.1. Eco-sustainable architecture development as an environmental alternative in the context of an innovative paradigm

In connection with the concern of mankind, against the background of natural disasters, conservation of nature and the economy of its resources, the creation of projects and construction of buildings taking into account ecology is one of the highest priorities of architecture of the future [3]. The problem of limited resources uses contributes to the search for new, relevant solutions in the field of architecture and construction, as well as technological innovations associated with the conversion of ideas of the latest achievements of various fields of science into architectural and construction practice. Research on this issue reveals the following eco-sustainable concepts in architecture.

1. Sustainable city in the context of an innovative paradigm as a challenge to civilization. The concept is a basic eco-trend of modern architecture, which involves maintaining its ecological integrity and natural resources reserves combined with the use of new technologies and various innovations. Renewable energy is an important feature of a sustainable city. This allows the city to reduce its dependence on minerals and make a positive contribution to the ecology of the city. In addition, it is important to create buildings with zero energy consumption, landscaping, energy savings and low energy consumption in buildings. Renewable energy concept instead of minerals creates "carbon-free city" model [4].

2. Eco-efficient approach as a reflection of the development of innovative technologies. Under this concept, cities and regions will move from a linear to a circular or closed system that allows the produce of a substantial amount of energy and materials from garbage. This necessitates the organization of a space with a comfortable internal climate and air quality, as well as the use of recycled materials. Eco-efficient cities will have less impact on the environment, as they will be able to significantly reduce the amount of garbage, as well as reduce the need for natural resources. The urban resilience movement creates a habitat that does not destroy natural resources [5].

3. Photosynthetic technologies as a balance of ecology and technology. The use of photosynthetic technologies in the formation and operation of urban space makes it possible to produce energy and food on the spot as part of urban infrastructure. Photosynthetic process in cities will reduce the negative impact on the environment, will replace the use of minerals and bring significant environmental benefits. There is a positive tendency to include the idea of green infrastructure in urban infrastructure planning and the use of photosynthesis in the life of the city [5].

4. Autonomous energy-efficient objects as a new survival paradigm. This modern direction of research and design can be traced in the project "Water-Scraper" 2010 (Malaysian architect Sarly Adre Bin Sarkum). The underwater object is a multi-storey building "growing down" into the depths of the ocean as an idea of solving problems in megacities. The upper floors of the underwater skyscraper are above sea level. Residential, production and office space are located on the underwater floors [6].

In connection with the problem of floods caused by climate change and global warming, as well as the survival of mankind in the modern world, the project of floating cities "Lilypad" as a floating ecopolis for climate refugees in 2008 (Belgian designer Vincent Collebot) is proposed. Such an island city will use only natural sources of energy (solar, wind energy, tidal energy, etc.), without causing any
harm to the environment. The floating city is designed for 50,000 inhabitants and is fully autonomous. According to the author of the project, this is the most comfortable way to survive any natural disaster [7].

3.2. The formation of a resource-saving spatial habitat as a rethinking of the functions of cities

The new paradigm of sustainable urban metabolism (the city as a complex system of metabolic processes) will require a profound rethinking of cities and their neighborhoods, as well as planning and how to manage them. This will require new forms of cooperation between municipal agencies, as well as there will be a need to use the following techniques to organize sustainable habitat.

1. Organic farming as a rehabilitation of urban space. Growing food in cities can take any form. Examples of the "edible" urban landscape have shown that urban areas can be used to grow fruit trees and edible perennial plants. In this regard, the design and experimental activities associated with the concept of urban farming do not require the redevelopment of the entire city, which can use vacant plots of land for commercial and public farms in abandoned places.

   Such land rehabilitation projects make it possible to make intensive use of urban space. The vertical farm project "Vertical Farm Dragonfly" 2012 (Belgian designer Vincent Collebot) involves the creation of a prototype urban farm with a complex of living spaces, offices and laboratories, as well as facilities for animals. In addition to the food role, "urban farming" solves the problem of further development of green chemistry in order to create a biofuel called "second generation fuel" that uses the energy of plant recycling waste [8].

2. Ecopolises as a new integrated environment of habitat. The concept is related to the formation of a mass movement in the defense of nature and leads to the further spread of such a form of attitude as "environmental consciousness." The idea of an ecological city is an ecopolis, in which the city is considered as a human habitat, giving it an accessible fullness of direct communication with nature. Its main task is to minimize any harmful impact of the city on its surroundings. The development of the concept of ecopolis means the desire to translate the city to the "waste-free technology".

   An example of this concept is the project «Ecopolis» by Santiago Marenco 2010, a global city of the future based on the idea of developing a set of highly differentiated, sustainable and livable modules. These primary units are organized into clusters in accordance with the program, residents and its relationship with the natural world. The Ecopolis facade is equipped with sustainable systems such as solar panels, wind turbines and rainwater collectors. It is a modular design that grows in accordance with different requirements over a certain period of time [9].

3. Mega-polices as ecological re-urbanization. The emerging concept involves the construction of a new, much more capacious and functionally saturated city in a minimal territory, leaving inviolability cultural monuments and providing enough space to recreate natural landscapes. An example of the re-urbanization of the city with the help of separate high-rise objects is the project of the city of the future "Hydro-Net" (architects of the firm "IwamotoScott") for San Francisco 2009. The main idea of the project is the embodiment of "ecotopia" to solve the problems of global warming by actively searching for alternative sources of electricity Concept is supposed to create separate zones with algae ponds to produce hydrogen and the device around them residential arrays. Hydrogen fuel produced from algae will be stored and distributed in nanotubes inside the walls of Hydro-Net buildings, allowing it to be used to maintain buildings' life support systems. Also on this fuel will work cars of the future city [10].

   The same approach can be seen in the “Masdar Eco-City” project in Abu Dhabi, one of the United Arab Emirates (architect Norman Foster) as the world's first carbon-free city. This is achieved through the use of "environmental" car models and recycling. In Masdar City, all energy will be provided by photovoltaic panels, concentrated solar energy, wind, waste processing and other renewable energy sources. The construction will use materials from recycled waste, certified wood, etc. [11].

   Considered eco-sustainable concepts of habitat formation offer a radical rethinking of the function of cities in the system of the entire planet, and also consider not only the technological component of achieving a positive balance between the city and the natural environment, but also socio-
psychological factors. They do not offer specific design solutions, but only priority areas of urban planning, where each concept is a stage for implementation of the following.

3.3. Innovative techniques for creating an artificial habitat in extreme conditions as a safety resource

The problem of creating a safe artificial habitat is very urgent and attracts the attention of many architects and specialists. Reducing the negative impact of extreme areas can be achieved by reducing vulnerability and increasing the ability to withstand such impacts [12]. In the context of the formation of artificial habitat as rehabilitation of the effects of extreme natural disasters are manifested in the following areas of research and project-experimental developments.

1. Systems and facilities to prevent natural disasters. Taking into account both preventable and protective approaches to habitat formation, the authors see the various projects as an attempt at positive interim measures for future flood disasters and typhoons.

The proposal of "Neza York Towers" as a system of flood prevention for cities (authors Israel López Balan, Gabriel Mendoza Cruz, Ana Sara' Lombardini Hernández, Yayo Melgoza Acuautla) 2016 (Mexico) is to gradually replace the network of small storm sewers to collect rainwater. Water merges on the surface of recreational lakes, where the towers act as large natural filters for storing rainwater [13].

In the proposal of “Wind skyscraper” (China) 2017 (authors Shenghui Yang, Xu Pan, Yue Song, Yingxin Cheng, Binci Wang, Yuerong Zhou, Yaying Zheng, Shiman Wang) the design consists of two main correlated parts. The main building serves as a frame of the urban landscape, within which the authors organize many functions, including water retention, storage, temporary housing, research institution and exhibition. The project presents a three-dimensional spatial structure for storing typhoon energy collection devices. The project presented is an attempt to use the typhoon by human intervention [14].

2. Remediation and disaster mitigation. In recent years, natural disasters have intensified and it takes too long to evacuate the city. In the event of a natural disaster or a disease, this problem must be urgently addressed.

Proposed creation of the "Dandelion Vessel" (China) 2016 (authors Wei Ke Li, Sheng Jiang, Xing Chun Zhi Zhang), which can carry people who are in an emergency. When natural disasters occur, an effective evacuation structure can help people to find shelter in the shortest possible time and are ready to get to each home quickly. The station container provides a place to stay and rest residents. Even when there is no disaster, villagers can also go to any place where there is treatment or other means [15].

The proposal of “Mega-Bio-Cell Skyscraper” 2018 (authors Maryam Fazel, Sukaina Adnan Almousa, Maryam Safari) is a skyscraper project that responds to an earthquake before it occurs. In this project, the authors use sensor-sensitive genes in animals, allowing them to detect and respond to signals of environmental change and use them to create a biosensory system to predict powerful earthquakes using genetic engineering tools. The biosensor system is constantly monitored by detectors associated with cameras and other alarm systems, and the interpreted data will be visually displayed in color on the facade of the building [16].

3. Techniques for protecting and rebuilding the consequences of a global cataclysm. The problem of melting Arctic ice is due to the fact that in recent years the reduction of ice cover in the Arctic has become more intense, land ice is also receding, and permafrost is melting. Retreating ice provides easier access to natural resources such as gas and oil, leading to increased human activity that could threaten already fragile ecosystems and the existence of wildlife. Examples include the 2018 “Earth Parasol” (China) proposal (authors Haotong Sun, Zonghao Wu, Fengwei Jia). The concept of solving the problem consists of three structures: the Umbrella system, the cooling system with frozen land and the ash coal cleaning system [17].

The project 2018 “Earth Healer Skyscraper” (China) (authors Dong Jingzhe, Li Boyu, Zhang Zihan, Sun Zhe, Wu Yilun, Yu Yang, Zhang Haohao) is an individual rescue building with a large amount of underground space has a spiral lifting device in accordance with the restorative condition of
the ground. It provides a residential environment with an air purification system, isolates survivors from nuclear pollution. Water from the air is collected through the upper condensing tube and stored in a special device to be used to ensure the lives of people and green plants [18].

4. Technology that controls climate change or correction and the recovery of natural phenomena. In recent years, there has been an increased focus on global warming and its tragic consequences. It is believed that many coastal cities will be underwater after melting polar ice caps. In an effort to save these cities, many architects offer different ideas. Thus, the project “Global Warming City” (Turkey) 2010 proposal (architects Sinan Gunay and Mustafa Bulgur) proposes a number of structures attached to skyscrapers to create a second land level. Instead of preventing flooding, the idea is to use the infrastructure for the secondary city at an altitude of 70 meters above sea level [19].

The project “Global Cooling Skyscraper” (Italy) 2016 (authors Paolo Venturella, Cosimo Scotucci) proposes a concept in which, thanks to the accumulation of heat in a glazed structure, the air flows naturally from hot to cold, creating fast and strong streams. These streams carry hot air away from Earth, cooling the temperature of the entire globe. Air currents restore good climatic conditions and, in addition, generate energy from renewable sources by wind turbines located within structures. This installation is used either to adjust climatic conditions or to energy production [20].

3.4. The North Atlantic current is at risk of stagnation
The project “Re-Flux Project in Greenland” (China) 2018 (authors of Luqing, Tian Runjia, Xu Ziyi, Yuxuan, He Chuyue, Cai Yangqi, Zhu Sunqi, He Run) is located in the Atlantic in the south of Greenland, where circulation in the North Atlantic has problems with the energy exchange. The project helps restore ocean currents and is designed to monitor and adjust the salinity difference between different ocean depths, maintain current course, repair cracks, melt ice sheets and conserve water in the future [21].

4. Results and discussion
In this study, the environmental trends in formation of spatial environment in architecture revealed precedents for the organization the spaces of future in the following directions:

- Eco-sustainable architecture development as an environmental alternative in the context of an innovative paradigm have been considered as part of the concepts identified: Sustainable city in the context of an innovative paradigm as a challenge to civilization; Eco-efficient approach as a reflection of the development of innovative technologies; Photosynthetic technologies as a balance of ecology and technology; Autonomous energy-efficient objects as a new survival paradigm.

- The formation of a resource-saving spatial habitat as a rethinking of the functions of cities analyzed from certain positions: Organic farming as a rehabilitation of urban space; Ecopolises as a new integrated environment of habitation; Mega-polices as ecological re-urbanization.

- Innovative techniques for creating an artificial habitat in extreme conditions as a safety resource have been identified in the following concepts: Systems and facilities to prevent natural disasters; Remediation and disaster mitigation; Techniques for protecting and rebuilding the consequences of a global cataclysm; Technology that controls climate change or correction and the recovery of natural phenomena.

5. Conclusion
The emergence of the above-discussed environmental concepts offers great prospects for use in the architecture of future scientific and technological developments, generating new ideas. This allows to reveal the potential of architecture and most fully meet the needs of society [22]. Design practice demonstrates the need for a close relationship between architecture and scientific and technological advances. The developing progressive direction in the development of architecture, which uses new technologies in the creation of architectural objects, is associated with a new attitude to the value of the environment, conservation and energy conservation.
The practical significance of the results of the study is to gain new knowledge to form a spatial habitat in the architecture of the future. These current areas of research allow us to outline in the theory of architecture new approaches to the development of the principles of its formation and gives direction to searches for the creation of new types of environment of habitats. In addition, it opens up the prospect of using fundamentally new modern scientific paradigms and methods used for development of the spatial environment of the future, as well as open the prospect of using new tools in the architectural formation of the new generation.

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