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Development History And Prospects Of Eco-Cities

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Abstract. In the article, the history of the emergence of Eco-cities, the founder, terms and theories, main strategies and solutions, development prospects, as well as information on existing eco-cities in the world are presented.
Key words: ecocity, infrastructure, landscape, healthy ecocity, green ecocity, energy, strategy, global problem.

Introduction. At the beginning of the 21st century, significant changes in urban and residential design and planning began with the emergence of new ideas, terms, and theories, climate change, ecological scale, sustainable, and green design planning. During this period, the urban landscape underwent fundamental changes that broke away from old models of interpretation and incorporated new design paradigms. These innovative planning concepts aimed to establish harmonious relationships between the city and nature.

One of the main areas of attention today is the modernization of the infrastructure of large cities, their compliance with international requirements, improvement of transport infrastructure, and solving problems related to the environmental conditions of transport infrastructure (exhaust gases, noise, electromagnetic and vibration). This, in turn, increases the demand for scientific and innovative ideas in this area, including theoretical and practical research, the introduction of international requirements and standards, and the implementation of advanced foreign countries' experiences [12] . This requires studying the history of the development of eco-cities and analyzing the activities of existing eco-cities.

Main article: The initial ideas behind ecocities can be traced back to the formation of a non-profit organization called Urban Ecology in 1975. Founded in Berkeley, California, by Richard Register and a group of forward-thinking architects and activists, the organization worked at the intersection of urbanism, ecology, and community engagement to help shape design concepts that would build ecologically sound cities. Some of their efforts included initiating tree planting campaigns along major streets, encouraging the construction of solar greenhouses, working with the Berkeley City Planning Department to develop environmentally friendly policies, and promoting public transportation.

Based on these strategies, Richard Register introduced the term "Ecological City" in his works in 1987, describing it as a city where people live in harmony with nature and therefore significantly reduce their ecological footprint [2].

The author also presented the best definitions of an ecological city, and illustrated what they might look like in the following image (Figure 1).

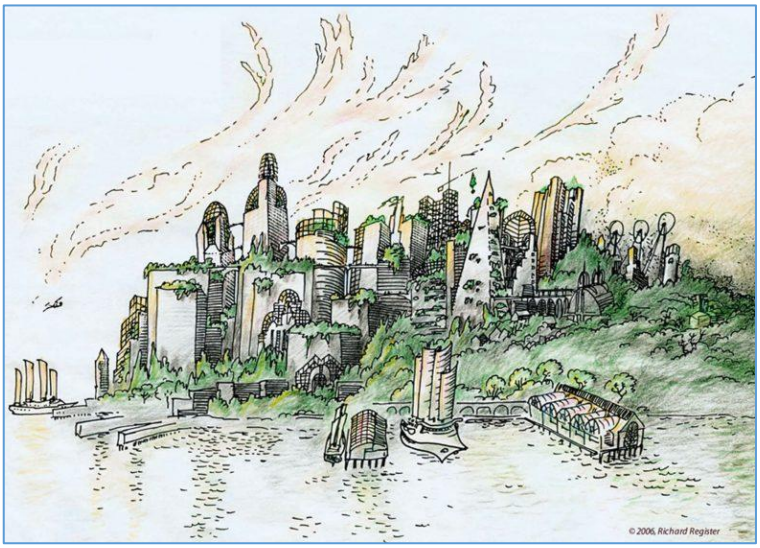

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Figure 1. R. A view of San Francisco's eco-city as illustrated by the Register

Currently, experts in the field have begun to consider the definition of a self-sufficient city in a broader sense and define it as a city that is capable of independently providing itself with food and energy.

Ecological urban design emerged as a response to two major global challenges: increasing urbanization and climate change.

Also, one of the Chinese researchers, Professor Wang Rusong of the Beijing Environmental Science Research Center, defines the concept of an ecological city as follows: - "... an administrative unit with an economically-ecologically efficient industry and a structured socially harmonious culture, and a functional revitalized landscape."

According to other experts, an ecocity can be defined as a human settlement modeled on the sustainable structure and function of natural ecosystems, which are self-sustaining. Simply put, an ecocity is an ecologically healthy city.

Siberian Federal University scientist P.F. Slakov [7] points out that three main ecological directions are emerging in the design and construction of eco-cities today:

1. Creation of "ecological" constructions - environmentally friendly building materials and technologies are being developed (energy-saving engineering systems for housing construction);

2. Introduction of environmentally oriented technologies, utility networks and facilities (environmentally clean energy sources, waste-free production, environmentally friendly transport systems, etc.);

3. Development and application of ecologically oriented principles of urban planning (living in harmony with nature, provided with all necessary things, taking into account future needs, and maximum improvement).

In addition, Canadian scientist S. Mofetta [5] described eco-cities by dividing them into 3 types.

Type 1. “Green” eco-city. The city should preserve and enhance its natural environment, making it greener, more diverse, and more welcoming for its residents. The main goals are to increase the number and quality of pedestrian paths, preserve agricultural land, designate environmentally sensitive areas, and create natural recreation parks for city dwellers.

Type 2. Eco-cities “going beyond city limits”. The problems of this city are the lack of land for residential construction, air pollution, lack of fresh water, congested streets, lack of space for burial, deterioration of local river or lake water quality, acceleration of desertification processes around the world and gradual depletion of natural resources, and insecurity in energy and fuel. Thus, in order to meet long-term plans in the field of economic growth, attention is paid to increasing the adaptive capacity of the infrastructure. The main task of this type of eco-city is the development of engineering infrastructure, including transport infrastructure, water supply and sewage treatment, etc. This leads to a decrease in pollution of the natural and aquatic environment.

Type 3. A "healthy" eco-city is a city that is designed with the "right" of the next generation in its development plan.

Thus, the design of an eco-city is an extension of the social policy of the state. In the process of solving problems of short-term socio-economic goals, the issue of the natural environment of the historical city has been neglected. The third type of eco-city is a city that has economic and social benefits, while ensuring long-term ecological health, resource management and the sustainability of the natural environment. Thus, the task of eco-cities is to have a positive impact on the quality of life and a healthy lifestyle in the city, region, country and the entire planet.

The World Bank defines ecocities as “cities that enhance the well-being of citizens and communities through integrated urban planning and management, harness the benefits of ecological systems, and protect and conserve these assets for future generations.”

The modern experience of creating eco-cities began in the 1960s. This idea was widespread mainly in Europe, North America, and Australia. However, European countries, in particular Sweden and Denmark, have been more active in the field of ecological construction. Germany, Belgium, and Norway have also participated in this process. In general, almost all European countries have joined in the greening of their cities.

The main dimensions of eco-city adopted in many cities of the world include different strategies and solutions to achieve sustainability goals. S.E., a scientist at the Federal Polytechnic School of Lausanne. Based on an interdisciplinary practical study conducted by Bibri in 2020, the following main strategies and solutions of the eco-city were developed [1]:

- Sustainable energy systems;
- Sustainable waste management;
- Highly efficient infrastructure;
- High performance buildings;
- Sustainable transport;
- Greening and ecological diversity.

Nowadays, environmental attitudes and practices are considered one of the most important global challenges in sustainable urban development. These include air pollution, greenhouse gas emissions, increased car use and traffic problems, excessive consumption of non-renewable energy, problems with water use, the reduction of green spaces per capita, and the lack of sustainable urban landscape design [4] .

The world's population is constantly growing, which puts great pressure on cities to develop new cities and creates additional burdens. Cities around the world are increasingly facing the need to build green cities to achieve sustainability. Today, the most serious problems related to urban populations around the world are mainly faced by developed countries.

Ecocities are typically defined by scientists as cities that meet the following *criteria* [6] :

- independent economy and localized resources;
- use of renewable energy (zero energy buildings) and zero-carbon production practices are in place;
- it is very convenient to move around cities on foot, by bicycle, and by public transportation systems;
- the high level of use of technologies that reduce the effects of toxic gases emitted by cars in the city;
- high efficiency of water and renewable energy use in environmental management;
- urban waste disposal sites *(including industrial waste)* should be sanitary and have a waste management system that facilitates reuse;
- High opportunities to provide affordable housing and employment to the part of the population in need of social protection;
- creation of opportunities for local production;
- population demography and the expansion of engineering networks should be taken into account in the city master plan.

Prospects for the development of eco-cities . In general, since the 19th century, the countries of the Western world have entered the era of the industrial revolution. A new way of life, the development of science and industry have had a great impact on all aspects of social life. During this period, problems of a social , economic and environmental nature in large cities of the world have become very acute. In the middle of the 19th century, ecology was born as an independent science. The formation of a new direction, on the one hand, was the result of knowledge about nature, and on the other hand, it became the center of environmental problems that had accumulated on the globe by that time. Architects and urban planners of that time proposed various urban planning concepts aimed at solving new problems created by technical civilization.

The modern practice of creating an ecological city has been developing in Europe, North America and Australia since the early 1960s. Sweden and Denmark in particular have been among the most active countries in the field of green construction. Germany, Belgium and Norway are following in this process. In general, almost all European countries have joined the process of greening their cities.

There are currently six eco-cities in Europe: Malmö (Sweden), Dublin (Ireland), Tallinn (Estonia), Hillerød (Denmark), Hamburg (Germany) and Augustenborg (Denmark).

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In Sweden [8] , in 1993, the government approved the "Ecocycle Act", which marked the beginning of a new stage in environmental protection and the introduction of a "zero-waste lifestyle". The law speaks of the need to "learn from nature and change the ideology of scientific design from linearity to ecocycle". According to Swedish experts, an e-city is a socio-technical system with zero-waste technologies for local waste processing, sewage, heat and water supply, energy supply, and solar energy use. As an example of a holistic ecological system in which the principles of social and architectural ecology are fully implemented, we can cite the city of Malmö, built in 2007 (Fig. 2).

Figure 2. City of Malmo (Sweden)

One of the main goals of transforming this city into an eco-city was to reduce carbon dioxide emissions by 25 percent by 2012 compared to 1990. This goal was achieved through the use of new construction technologies, the development of public transport, the transition of car owners to hybrid vehicles and electric cars, and the popularization of alternative energy and energy-saving technologies.

The main transport in the city is a bicycle. Solar energy is widespread in the city and it is the third largest city in Sweden in terms of the number of solar panels in use. In numbers, this is approximately 3.4 thousand m ^{2} of solar panels with a total capacity of 500 kW.

In Malmö, solar energy is used in two ways:

- for the production of electricity (photo cells);
- for domestic needs and for heating water used for heating (solar collectors).

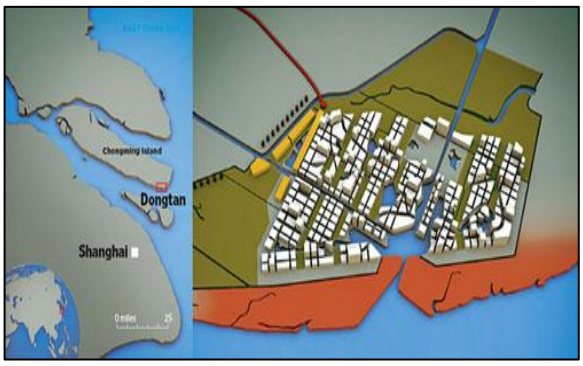
China's Dongtan Eco-City [10]. The project for this city began in 2005 and was delayed by 2010 due to political reasons, with construction scheduled to be completed by 2050. The project was presented as an eco-city model at the United Nations World Urban Forum in China and is the first of four such cities being designed and built in China by Arup (a British engineering company) (Figure 3).

This eco-city project envisages zero greenhouse gas emissions, a fully self-sufficient urban public transport system, water and energy supply, and the use of environmentally friendly building materials, along with the use of zero-energy construction principles.

Buildings and vehicles will also be powered by renewable energy from wind farms, turbines and solar panels. Combined heat and power plants will be built using waste from rice mills. Solid waste and wastewater treatment will be used to treat waste as a resource, producing methane and other energy sources, and much of it will be recycled.

The city's environmental impact will be 60% lower, 66% less energy will be required, and 40% of the energy will be derived from bio-sources with minimal carbon dioxide emissions.

Figure 3. View of Dongtan Eco-City (China).



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China-Singapore Tianjin Eco-City in China [11]. The China-Singapore Tianjin Eco-City is being built 150 kilometers from the Chinese capital Beijing, a result of cooperation between China and Singapore. The newly established city will fulfill the two countries' intentions to combat climate change, protect the environment and save resources. The first agreement on cooperation between the countries on the creation of an eco-city was signed in November 2007.

The city's development includes a national animation park (1 km ^{2}), a film and television park (1 km ^{2}), a science park (0.4 km ^{2}), an eco-information park (0.5 km ^{2}), and an eco-industry (1 km ^{2}). There are also many recreational areas and parks for games (Figure 4).

An ecocity is a platform for introducing innovations and new technologies in the fields of ecology, energy conservation, waste reduction, green building economics, and waste recycling.

In this project, the development of the "Ekoshahar" indicator system was carried out with the involvement of international experts. The system consists of four qualitative and 22 quantitative categories, which are further divided into 51 main factors and 129 main components, 275 target indicators and 723 measures for monitoring the implementation of implemented solutions.

Below are examples of indicators:

1. Economy:
- number of scientists and researchers per 10,000 people;
- assessment of compatibility of urban development with regional economy.

2. Ecology and environment:
- in relation to the maximum permissible concentrations according to national requirements;
- surface water quality level based on national requirements;
- assessment of noise in different functional areas;
- impact analysis on natural water bodies and wetlands;
- analysis of plants used for beautification of the local area;
- assessment of the impact on the local natural environment.

3. Resources:
- assessment of water consumption for domestic and technical needs;
- estimated greenhouse gas emissions (tonnes of co2), compared to national averages;
- evaluation of inner-city facilities certified according to green standards;
- area of publicly available green areas per capita;
- daily water consumption per capita;
- daily waste per capita;
- availability of public places (cultural facilities, sports infrastructure open to everyone) within a 500 m walking radius;
- organization of barrier-free environment;
- level of hazardous and hazardous solid waste processing;
- the level of development of municipal utilities;
- share of energy from renewable energy sources;
- the share of clean water that does not leave the city network.

4. Society:
- share of green transport used;
- share of municipal housing;
- determining the balance of work (in relation to city dwellers);
- compliance with regional principles and policies;
- harmony of socio-cultural life.

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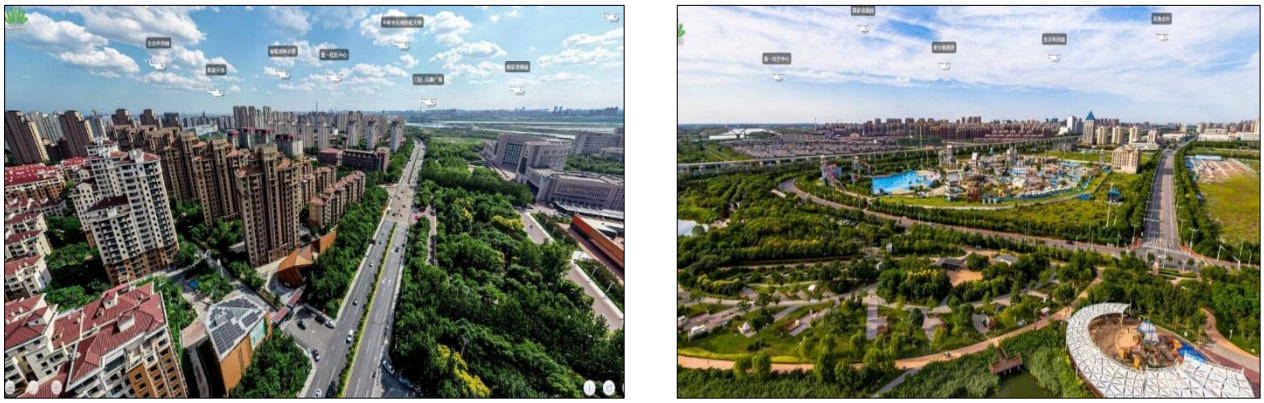

Figure 4. **Tianjin eco-city**

Today, China-Singapore Tianjin, Nanhui , Wuhan, Wuxi, Baoding low-carbon cities, Xiongan, Qingdao and Shenzhen, as well as more than 250 eco-city projects are underway in the country.

UAE [3]. Masdar City – The world's first zero-carbon green city project is being developed in Abu Dhabi. The city, which will run entirely on solar power and other renewable energy sources, will be the world's first eco-city and a model for hundreds of ideas that are now starting construction. The city's buildings will be constructed with low-carbon cement and 90% recycled aluminum. The buildings will use 40% less energy and water than similar buildings.

Construction of the city is planned to be completed by 2025. The budget allocated for the construction of this city is 20 million dollars, it is designed to accommodate approximately 50,000 people and 1,500 business centers in an area of six square kilometers located near the capital city of Abu Dhabi. Architects designed the city to be pedestrian and cyclist friendly (Figure 5).

Figure 5. Eco-city " Masdar City " (UAE)

Russia [9]. In accordance with the instructions of the President of Russia, in 2023 the government approved a program aimed at solving the environmental, economic and social problems of mono-cities. Based on this, it is planned to build a mono-cities ecotourism center and the first eco-city on Lake Baikal . Thus, the first steps have been taken towards the creation of eco-cities in Russia.

It should be noted that renewable energy sources, environmentally friendly public transport, the level of concentration of air pollutants, urban noise, volume of waste water - this is an incomplete list of indicators by which the level of environmental cleanliness of cities is assessed today.

Today, there are about 14 methods for studying the ecological component of cities. However, there is still no single officially recognized list of the "greenest" settlements.

According to industry experts, the most objective methodology is the Green Cities Index, created at the initiative of the British research center Economist Intelligence Unit and Siemens Corporation.

These organizations conduct extensive research around the world. Since 2009, 120 cities around the world have been evaluated annually on parameters such as health and environmental management, air quality, land quality, building maintenance, water supply, transportation, CO2 emissions into the atmosphere, and dozens of other criteria. By analyzing the collected data, the leading cities in the region are identified in terms of the environmental situation.

Conclusion. Based on the above, it can be said that by studying the history and experience of the development of eco-cities in these countries, the prevention of environmental hazards will be determined. As a result, in the process of complex development of the technosphere, while global climate change is taking place, the priority of the human factor, which is the most important requirement of urban planning, will be ensured, and the health of people living in the cities of the future will be guaranteed.

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