

Intensive use of energy resources regarding sustainable cities

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Abstract. Intensive development of cities being a factor of fuel-power complex (FPC) development increases the load on its capacity. This has the negative impact on human health and capacity to work. Therefore, it is important to integrate environmental and recreation components into the urban area through designing the system “production–ecology–recreation” and thus ensuring sustainable development of the city.

1. Introduction

An urban area prospects critically depend on its fuel-power complex (FPC), with the latter being the major factor source of pollution, too. As the urban economic system develops, the load on the FPC increases, which negatively affects the environment. Being an attributive factor of modern society development, urban sprawl boosts social production. This is both the cause and the effect for demand to evolve: currently, about 75% of energy carriers are consumed by the population of the cities, and about a half of this energy is spent for public transport. [1] It is also noteworthy that industrial production is concentrated in the cities, which creates a lot of prospects for self-realization and provides higher income. As a result, the city becomes an attractive place for living. The scale and the significance of the urban sprawl is proved by the following facts: currently, about 50% of world population live in urban areas and it is predicted that by 2050 70% will be city dwellers. The number of people living in cities and towns increases by 73 million every year. [2]

2. Materials and Methods

The advantages of urban sprawl are qualified staff, developed transport, educational, and cultural infrastructures, etc. All together these aspects provide intensive social and economic development. According to the rating by the Institute of Spatial Planning, the main industrial centres are located in the cities of the central part of Russia (27%), the Volga region (24%), and in Ural (16%). [3] On the other hand, the development of urban system has an inevitable negative environmental impact: man-made landscapes, reduction of nature component, negative impacts on health and capacity to work caused by near-by location of industrial and residential areas. The latter negatively affects both the environment and human health: chronic fatigue syndrome, steady-state stress, emotional overload, etc. The following data prove the statement above. More than 75% of pollution is caused by urban sprawl and the ecological situation in the region is determined by the absence or presence of the big cities. According to the data by Greenpeace, the plume of pollution and heat stretches up to 50 km and cover the area of 800–1000 km². The demand in energy resources increased dramatically at the end of the XXth – the beginning of the XXI century, which caused an increase in oil and gas recovery and, as a result, great amount of pollutants released. The share of pollutants produced by FPC has increased by



10% over the past years and currently is about 56%, with coal power plant being the major source of pollution. [4, 5, 6]

This negative environmental impact makes it necessary to take into account ecological and recreation components of industrial production, which is the first step towards “production–ecology–recreation” system. This system will lay the foundation for sustainable development of the city. The aim of the research is to outline the approaches which will provide sustainable development of the urban areas and protect the environment in the course of the urban sprawl.

Firstly, it is necessary to determine the notion of sustainable development of the city in the perspective of FPC development. In our point of view, FPC should ensure production continuity and be aimed at the increase in social and economic level of the region, including continuous energy supply and maintaining / improving the quality of human resources. To hit the goal, two different trends in the development of FPC as the source of energy should be taken into account:

- the benefits which determine the level and the mode of consumption;
- the negative impact on the quality of human resources. This impact is double: on the one hand, it is the damage caused to the environment; on the other hand, it is the negative impact on human health and human capacity to work. These impacts may be neutralized either independently (by means of purification plants, de-dusters, etc.) or in combination (creating green zones). Let us turn to implementing the second option, when the territory is used for ecological recovery and recreation. The green zone is created to compensate for the impacts on environment (such as air pollution, noise, etc.) and human health (fatigability, performance decrement etc.).

Integrating the recreation zone into the urban area, one should take into account the following aspects:

- Planning. To create / maintain the consistent architectural composition and to save the traditions, the recreation zones should be incorporated into the existing urban landscape. For example, in Copenhagen the 7000 m² garden is on the roof of the hospital while in London on the roof of the 23-storey building they plant about 100 different types of flowers and shrubs (the unique experience of planting at such height) [7].
- Ecology. It is necessary to identify the particular negative environmental impacts and to create the recreation zone to minimize them. For instance, sulfur dioxide produced by heat power plants and boiler-houses is well neutralized by hawthorn, pear tree, walnut tree, poplar, honeysuckle, white willow, ash-leaved maple, etc. [8]
- Nature and climate. It is important to choose the plants which will ensure continuous compensative effect of the recreation zone. For example, willow, asp, birch, and pine-tree are tolerant of wet soil conditions while ornamental shrubs will not survive in the swampy area. [8]
- Arrangement. The zones should be accessible to visitors and not overloaded. For example, the limit recreational load for forest parks is 50 persons per hectare and for park – 300 persons per hectare.[9]

Recreation can be described in terms of structure and infrastructure. Since recreation as a process is incoherent and diversified, there are different groups of characteristic features to specify it. Here are some of the bases on which varied types of recreation can be identified:

- origin – natural or artificial recreational objects (or their cohabitation);
- type of use – continuous, repetitive, or occasional recreation;
- accessibility – walk-up or remote recreation zone;
- absence / presence of buildings – integrated or newly created recreation zone.

Due to varied classifications, there are different approaches to monitoring recreation and integrating it into the urban environment. The report “Planning Sustainable Cities: Global report on Human Settlements 2009” assesses the effectiveness of urban planning as a tool for dealing with the unprecedented challenges facing 21st-century cities and for enhancing sustainable urbanization. The

Global Report identifies a number of promising trends for bridging the green and brown agendas, including:

- the development of sustainable energy in order to reduce cities' dependence on non-renewable energy sources;
- the improvement of eco-efficiency in order to enable the use of waste products to satisfy urban energy and material needs;
- the development of sustainable transport in order to reduce the adverse environmental impacts on the cities dependent on fossil fuel-driven cars;
- the development of 'cities without slums' so as to address the pressing challenges of poor access to safe drinking water and sanitation as well as vulnerability to natural hazards. [10]

United Nations Conference on Sustainable Development (Rio de Janeiro, 2012) focused on the green economy in the context of sustainable development and the institutional framework for sustainable development. The concept of sustainable cities is supposed to provide:

- reducing use of non-renewable resources;
- sustainable use of renewable resources;
- assimilation of patterns of consumption at both regional and global levels.

As a result, one will face a dilemma in the attempt to reconcile green (environment protection) and brown (human wellbeing) agendas. The brown agenda is very important as it recognizes that all urban dwellers have needs for healthy and safe living and working environments, and places its emphasis on creating economic opportunities which have always been a development factor throughout the history of cities. Cities gradually substitute natural habitat and consume natural resources producing wastes. Today, there is a measure of the impact humans have on the environment, which is called ecological footprint. The ecosystems are characterized by the limits for the safe use of their resources. The principle aim of spatial planning is bridging green and brown agendas, i.e. to save the environment and to enhance the human habitat.

Today, there are new trends (though partially overlapping ones) aimed at achieving the synergetic effect of both green and brown agendas, which is quite important for the current stage of economic development. These trends are detailed below.

Development of renewable energy sources

The use of renewable energy sources results in healthy living and working environments in the city, reduces the consumption of natural fuels and minimizes the negative environmental impact (sun, wind, hydro- and geothermal energy). For example, 0.0125% of sun energy is enough to supply the global demand in energy while 0.5% could totally supply this demand in future. The sun energy which reaches the Earth within a minute is enough to supply the global demand in energy over a year. The developed countries intensively use this source of energy, for instance, in Germany, there are about 15–20 GW of solar photovoltaic plants while their total global capacity is about 40 GW. [11]

Establishing cities with zero balance of carbon dioxide emission

Saving green planting and growing new trees reduce the amount of carbon dioxide emissions and cool buildings and premises, which decreases the amount of electricity used for air conditioners.

The distribution of water and electricity supplies

The water- and energy distribution systems in big cities tend to turn from big centralized networks to smaller district ones. This will reduce the ecological footprint as the city is effectively supplied with energy and water thanks to the advantages of electronic management systems, as well as the efficiently constructed system of water pipelines.

Expanding the surface area for photosynthesis within environmentally friendly infrastructure

It is supposed to create ecological zones within the city for both environment protection and recreation.

What is the situation in Russia in terms of implementing green economy and ensuring sustainable development? The adjusted net savings index which is calculated with regard to macroeconomic indicators adjusted to natural capital depreciation and the negative environmental impact, is negative while for the majority of high human development countries this index is positive. The ecological footprint of Russia (4.4 ha) is less than that of above mentioned countries, which proves that individual load on the biosphere caused by a citizen of Russia is relatively less.

Russia is the global leader in forestry and, as a result, in corresponding ecosystem services. However, the share of fossil fuel in the total amount of energy consumed is greater, as well as the amount of carbon dioxide emission per capita, the amount of city pollutants, the level of natural resources depletion. The social indicator of people's satisfaction with environment protection measures is lower than that in the majority of other countries.

It is worth noting that over the period of 1990–2010 the negative environmental effect of FPC decreased, which was caused by the reduction of oil and gas recovery. Over the two decades the amount of waste water discharge reduced by 40%, as well as air pollutant emissions did. The withdrawal of water from water bodies decreased by 32%. However, the tendency to reduce the use of natural resources and environment pollution changed in 1999 when the economic recovery started. The level of air pollution caused from stationary sources increased and the recovery of natural resources (particularly oil) intensified. The oil recovery increased 1.6 times in comparison with that in 2000. [12]

3. Conclusion

To understand the key issues of the environment and human habitat, one might turn to the effect of decoupling, which is the indicator of the green economy. "Decoupling is the basis for the strategy towards the sustainable and environmentally sound economy. It implies decoupling natural resource use and environmental impacts from economic growth and human welfare". [13] Retention / decrease in natural resources use and pollution accompanied by significant GDP growth in 2000s resulted in reduction of natural resources intensity in the country, i.e. the national economy was decoupled.

References

- [1] *Mir gorodov* 2009 **2** p 4
- [2] Urbanizatsiya mira trebuet soglasovannoy politiki po razvitiyu naseleennykh punktov URL: <http://www.un.org/russian/news/story.asp?NewsID=22297#.VDSkJVfzuDk>
- [3] 250 krupneyshikh promishlennikh tsentrov Rossii (Top-250) 2010 URL: <http://urbanica.spb.ru/?p=1321>
- [4] Urovni i tempy, etapy i perspektivy urbanizatsii URL: <http://www.sociocity.ru/scitys-949-1.html>
- [5] Chronic fatigue syndrome URL: <http://www.neboleem.net/sindrom-hronicheskoi-ustalosti.php>
- [6] Revich B A 2010 *Studies on Russian economic development* **4** 87–99
- [7] Blagoustroistvo i ozelenenie za rubezhom kak eto vyglyadit? URL: <http://baurchi.ru/uslugi/blagoustroistvo-i-ozelenenie-za-rubezhom-kak-eto-vyglyadit>
- [8] Erilin G N 2012 *Ekologiya na predpriyatii* **6** 25–32 (in Russian)
- [9] Moscow city government department for environmental management and protection URL: http://www.dpioos.ru/eco/ru/qa/o_10529
- [10] *Planning Sustainable Cities: Global report on Human Settlements 2009* (London, Sterling, Virginia) p 120
- [11] Shutkin O I 2012 *Ekologicheskie sistemy* **1** 47–58 (in Russian)
- [12] Navstrechu "Zelyonoy" ekonomike Rossii URL: http://www.sustainabledevelopment.ru/upload/File/Reports/ISD_UNEP_GE_Rus.pdf
- [13] Bobylev S N and Zakharov 2012 Green economy and modernization *Economic and environmental outlines of Sustainable Development* **60** p 90