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City planning issues for sustainable development

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Abstract

The article deals with the concept of sustainability and sustainable development aimed on creation of modern, eco-friendly, human urban environment and equally fair socially, economically and environmentally. It focuses on city planning as a particular scientific discipline. The authors adapt sustainability concept to the needs and musts of sustainable development of urban settlements introducing techno-genic impact as a component part of sustainability model and propose an innovative methodology of plan-making, based on a set of common general requirements and principles for sustainability and allowing both creative flexibility and participation of decision-makers and citizens on local level. Article gives a comprehensive review of each focused planning issue for every considered area from the sustainable development concept point of view, define their role in creating a comfortable living environment, formulate conditions and make suggestions for their implementation for economic, cultural and environmental development of the urban territories. Such approach permits creating partially or completely the urban environment that meets the needs of its users as well as provisioning of the background for potential development, serving as the basis and guide for action.

Keywords: sustainable urban development, urban environment, city planning, sustainable transportation

INTRODUCTION

Today, 54 per cent of the world's population lives in urban areas and this proportion is expected to increase to 66 per cent by 2050. Nearly half of urban residents live in relatively small – fewer than 500,000 inhabitants – settlements and such settlements are among many of the fastest growing cities in the world [11].

Due to their large diffusion, urban settlements have a great impact on their environment and biosphere. Cities are the places of highest consumption of energy and transformation of material resources, the biggest source of contamination, pollution and waste. Rapid growth of urban population, climate change, social and spatial changes contribute largely to global environmental thread, not only regional, but a global one. Humanity's ecological footprint already exceeds the planet's carrying capacity by more than 50 per cent. Biodiversity is already on a gravely negative trend. At the same time, cities are also the source of environmental opportunities. They have a big potential for the development of smart solutions how to meet human needs and even improve the quality of life with minimal ecological footprints.

Cities of all sizes – no matter whether it is a small urban settlement or a large metropolitan area –result to be a complex system, regulated by multiple interaction and interdependence between such aspects of life of its inhabitants as socio-economic, technogenic and environmental, dynamically changing in space and time. This complexity needs to be handled properly. In order to secure a successful future for urban development and avoid collapse due to depletion of natural resources it's absolutely necessary to balance the efforts of human population to well-being without destroying or degrading the natural environment and achieve global and local sustainability.

The concept of sustainability nowadays is in trend. In the 21st century sustainability science has emerged as a new academic discipline. Sustainable urban development, aimed to help cites to cope with its challenges, has become one of the main tasks of urban planning and design processes, the actual research direction in the Russian Academy of Architecture and Construction Sciences (RAASN) [8]. The term has been used in many forms; in this article we rely on definition crafted by the UN's World Commission on Environment and Development in Our Common Future in 1987, where it is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their needs [9,21].

To achieve a sustainable development, new approaches in urban planning are the must. The sustainable city planning aims at the creation of habitat to comply with the principles of social, economic, and ecological sustainability. This requires not only skillful adoption of modern, efficient, cost effective, technologically advanced and environmentally friendly solutions, but also innovative way of thinking and generation of new social values. Today's urban environment is hardly to

be called a sustainable one. Change in minds and innovative approaches are in need [25]. Evaluation criteria for project decisions along with quality and functionality should be based on such concepts as resource efficiency, biocompatibility, social value, adaptability, competitiveness [26]. Such criteria allow to realize the trial aspect design at all stages of city planning process and enable sustainable development of the urban territories. A successful urban planning agenda will require that attention be given to urban settlements of all sizes. If well managed, cities offer important opportunities for economic development and for expanding access to basic services for large numbers of people. Providing such sustainability components as public transportation, housing, energy, water, sanitation, air quality, recycling, food, culture, education for a densely settled urban population costs much less and less environmentally damaging than providing a similar level of services to a dispersed rural population.

Today, it is widely accepted that sustainability comprises three elements: human, environmental and economic. There are many different models which show how they are related. We continue using three-dimension model, these are seen as "social justice", "environment" and "economic growth" (Figure 1). The three are values are interrelated. Our model illustrates how the long-term balanced development between these elements forms the basis for sustainable development of the urban area [5]. A stable equilibrium of these three pillars will ensure the most efficient and rational management of city land and its resources, the formation of comfortable and eco-friendly urban environment and the solution of social and economic problems of a community. It will provide perspectives and potential for further changes and development. Unlimited possibilities offered by sustainable development concept, determine its contemporary relevance, and increase interest of today's researchers.

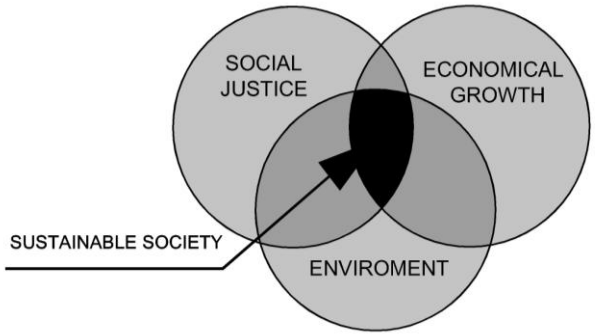

Figure 1. Main aspects of sustainable development concept

BIOSPHERE MODEL FOR SUSTAINABLE URBAN DEVELOPMENT

It is obvious that almost universally accepted definition of sustainable development is vital. It is also obvious that sustainable urbanism can be implemented in cities, towns, and neighborhoods through coordinated leadership and communication. However, dealing with a specific science – urban development and city planning – we acknowledge that architectural and technical aspects have the most relevant influence on territory formation of every urban settlement and can't be studied apart from the main provisions of the concept. Urban environment is an anthropic system different from the natural one. Focusing on the necessity of rational correlation between the technology and the biosphere we have adapted a three-dimension model to urban development, specifying "techno-genic impact" as an element of the system and introducing the concept of biosphere compatibility (Figure 2) [8].

This concept becomes a tool for the city planner to regulate both socio-economic and environmental problems.

Knowledge about man-caused impact allows the analysis of urban environmental dynamics, interrelations and processes and the choose of concrete planning, architectural and engineering practices that prevent or reduce the level and the acuity of environmental problems, ensuring ecological homeostasis of natural environment and humans needs.. On the other hand, the environmental analysis of the city system, heavily influenced by techno genic impact, cannot ignore cultural, scientific and socioeconomic elements. Economic and social growth of the city mutually depends on the transition of process of city planning towards sustainable vision. And sustainable city planning is a key instrument for progress towards improvement.

This transition requires a wide variety of incentives, starting, for example, from training of qualified personnel up to high-tech activities and innovative technologies [6]. Complexity of city systems, reflected on the challenge of biosphere compatibility, needs to combine technological knowledge with the study of self-sustainable natural ecological structures in order to find best planning solutions and practices. Ecological systems represent good examples of natural solutions for material recycling and use of renewable energy and at the same time demonstrate the limits of their capacity. The knowledge of biosphere capacities can be used to find new solutions to improve or prevent environmental performances of the city. The goal of city planners is to select smart methods that can improve living standards of the c minimizing at the same time pressure on the natural environment, for example, reducing the use of natural resources and waste production.

Further we shall consider the main issues of city planning for sustainable urban development, define their role in creating a comfortable living environment, formulate conditions and make suggestions for their implementation for economic, cultural and environmental development of the urban territories.

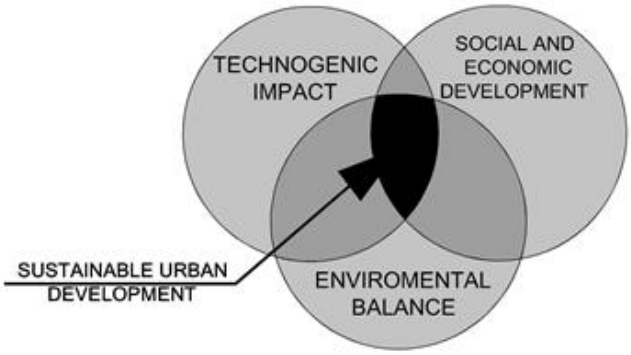

Figure 2. Main issues of concept of biosphere compatibility

PLAN-MAKING METHOLOGY

Sustainable urban development aims solutions that both improve the quality of life on a local level and respond to global environmental crises. Urban planners all over the world search appropriate strategies to generate urban living with a smaller ecological footprint. The starting point of sustainable urban development is always human and environmental wellbeing. It means that the main goal of sustainable planning of the urban object is to create a habitat with efficient resource consumption, least possible use of non-renewable resources and low exploitation costs, predisposed for long-term sustainability, which includes integrated green environment, good living and working conditions.

So, the evaluation of the project for sustainable development should be judged from the point of view of its relevance to the overall goal of environmental protection and socio-economic improvements. The criteria of evaluation should be such as competitiveness, livability, compactness, accessibility, functionality, availability, biocompatibility, social orientation, adaptability for changes and so on, correlated with effectiveness of objectives' attainment and efficiency in terms of costs, time and way of implementation.

Geographical, demographic, social, economic, cultural variety of cities offer wide range of local planning alternatives and different public policy options. However, different scientific and case studies along with the local examples of best international practices exhibit that each urban area has a comprehensive plan for urban development, which contain effective measures necessary to renovate the existing urban settlement, such as: environment considerations, preservation of authentic cultural and historic image, utilization of old structures and buildings, creation of parks, open spaces, comfortable conditions for pedestrians, bicycle users and public passenger transport, development of community facilities. It should be noted that planning of urban spaces involves various actors. Not only government and municipal departments take part in improving urban environment, but also citizens and both business and non-profit organizations.

Planning process consists of different steps. They comprise analysis of current city situation, definition of goals, choose of policies and ways of implementation of the measures aimed at improvement/development of urban settlement. They are interconnected and depend largely upon the variety of individual characteristics and conditions of every city. However, we thorough survey of many different planning instruments, permits to define a constant set of most efficient and effective issues necessary for creation of sustainable urban environment [27]. (Figure 3).

These issues have universal appliance, from the largest agglomerations to private specialized objects and they are already in place all over the world, guiding city planners and land use decision makers in choosing development strategies that help create more sustainable communities. All of them are interconnected to each other. Land-use surveys are an integral component of transport planning; environmental protection, safeguarding and preservation of techno biosphere are of utmost importance to all project elements and so on. Planning of sustainable city is a dynamic process and old methods and patterns of planning and management should be broken in favor of coordinated and cross-sector methods and approaches. One-dimensional perspectives, based on growth, sector or competition, should give place to holistic thinking. Importantly, that planners can also promote sustainable living by creating the preconditions to use, for example, public transport, re-use and recycle materials, local foods etc.

A comprehensive review of each focus issue for every considered area will not only permit creation partially or completely the urban environment that meets the needs of its users, but also provision of the background for potential development. Consideration on each of the component parts from the point of view of "sustainable development" concept should be the basis and guide to action [17].

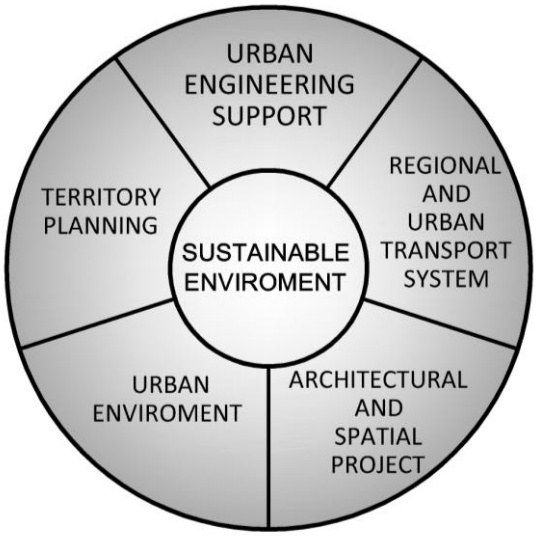

Figure 3 Main issues necessary for sustainable urban design process

TERRITORY PLANING

Territory planning is a key instrument for urban sustainable development: it manages long-term land use, its change and development. Obviously, it depends upon geography, demographic, social, economic situation of the urban settlement, its land uses and the role of public and private actors in defining how the territory is regulated. But the object of territory planning is always the same: to ensure city planning and development and to provide citizens with a livable environment. For that purpose territory planning implies the practice of territory zoning for different urban users: residence, commercial, industrial, open space and, sometimes, mixed uses. Based on a thorough study of city population, its economic activity, and natural, historical, and cultural resources, it should show both the existing conditions and future development of land use in terms of its change, extent and intensity.

That's why public decision makers have an important role in land policies. Today, the Russian planning regulation system for city planning is in the process of active reorganization, so the issues of legal regulation of private, state, municipal and other types of property rights relating to a land plot and real estate are of extreme importance for the developing of socio-economic plans and master Plans.

In Russia, land use is a mandatory section of master plans, developed at the local government level. The same practice is valid for the European Union countries and the USA. Despite the national differences, the effectiveness of this tool is obvious. Guided by local aims, goals and objectives, it shows clearly the future of the city and provides for the interests both of property owners and the society.

Therefore, the land use and building, and planning regulations are the main legal instrument in the implementation of the sustainability concept, and thus require close attention and participation of specialists in different branches of science: urban planners, economists, sociologists and environmentalists. Taking into account the public nature of urban planning documents, the presence of specialists is extremely important both in the process of preparation and public hearings. More than that, decision makers in cities should involve citizens in the process of city's planning and development. The municipal government should encourage learning and cooperation among different city departments. Knowledge and participation can be strengthened by engaging school and university teachers, residents and business.

It should be mentioned also the importance of the policies for the regulatory decision making. Today, the most widespread are: "permissive" and "restrictive" forms of regulations. It's clear that in the first case, the regulations contain everything that is allowed to do, while, in the second one it contains everything that is prohibited to do. There are pros and cons to each form. In every particular case the best choice is the one that is of the greatest effectiveness and efficiency. The duration of such regulations also has the particular importance. International experience shows that frequent changes in regulations negatively affect the development of the territories. Stability in these questions is the key to sustainability of urban environment.

Elaboration of Master Plan for every urban settlement needs a certain set of schemes to illustrate its content. The schemes required for submission are: Schemes of functional zoning, and engineering, and transport infrastructure; architectural-planning projects, several environmental assessment plans.

A comprehensive review of each focus issue for every considered area will not only permit creation partially or completely the urban environment that meets the needs of its users, but also provision of the background for potential development.

ARCHITECTURAL AND SPATIAL PROJECT

Architecture and spatial design are essential to guaranteeing a good spatial composition and innovative, meaningful, both attractive, and functional projects of residential areas, city centers, industrial areas and recreation. Reality cannot be avoid: in order to prevent further degradation and preserve the planet for future generations, architecture should take into account the present social, economic and environmental targets and shift to urban-scale way of thinking with consideration of demographic, spatial and political issues. Architecture and spatial planning and design are that particular creative disciplines that target and are capable to improve and enhance urban qualities of buildings, respond to the architectural and artistic art, provide accessible environment for people with limited mobility and so on, and – that is of utmost importance – implement all these and better the life in a sustainable way [13,24].

More and more people, cities, countries all over the world are starting to act in this way. The abundance of examples show different directions where sustainable projects move. Among those already implemented we like the Academy of Sciences in San Francisco and the center of «Casa de la Mujer», Tindou in Algeria. In Russian Federation, today, the principles and techniques, and policies of sustainable architectural and spatial building are also successfully implemented and are gaining more and more popularity [1,16]. One of the most famous known examples of sustainable architectural and spatial projects is the Olympic Park in Sochi with its complex of sports' and social public facilities.

The lessons learned from many international studies and projects provide for the conclusion that whatever we project or built, there are, again, several basic principles and requirements that are common to sustainable architectural and spatial planning and design.

To us, the "heart" of each architectural project is the Idea that integrates its visual, functional, social and ecological elements and creates an authentic image, character and history [3,6].

In order to implement this Idea in a sustainable way it is always required:

- Proper land use planning to confirm and guarantee the best environmental and economic efficiency of the project [16].
- Good consideration of local historic, cultural, economic and architectural context to ensure identity and long-term comfortable livability of the project, maintain cultural diversity of mankind and promote craftsmanship of local inhabitants.
- Ecological approach to the choice of construction techniques, building materials, energy supply, waste treatment to protect natural ecosystem, also in future, when the building will be demolished and the materials once used become the waste, and provide profit of local population from using local materials [10].
- Environmental engineering support providing use of energy and resource efficiency technologies and renewable natural resources where possible – power of the wind, sun, rain – to preserve natural resources and provide partial or complete independence from the centralized engineering systems [4].
- Interaction with community members and decision-makers to provide support for the environmental, social and economic aimed project initiatives.
- Education of professional new-way-thinking, motivated specialists necessary for implementation of innovative, meaningful projects.

Attention to the above mentioned combined will architectural talent and skill, we are sure, is the main condition for creating architectural urban-scale structure, equally fair socially, economically and environmentally.

REGIONAL AND URBAN TRANSPORT SYSTEM

There is no need to explain why and how urban development depends on transport and why and how they are inherently linked. Today, international planning practice exhibit a common approach to the development of urban planning documents based on a certain set of principles that promote sustainable transport systems in human settlements. Urban road network, constituted by the roads and municipal streets, determines the options of land use planning, shaping the way of the city development and their disjunction causes the most actual transport problems both in small towns and big agglomerations [22]. Delivering a sustainable "city framing" transportation system meets public transportation needs and allows high quality public and residential spaces corresponding to the highest standards of ecological safety, comfort, efficiency and perspectives of city development [2].

International experience in planning and design for sustainable transportation systems [6], exhibits the efficiency of public-oriented transport systems characterized by the promotion of public transport modes [18,23]. Bad public transportation system force people to travel both short and long distances by personal motor vehicles, which cause or aggravate congestion on road and street network, making it constant and leads also to high energy consume. Such situation is relevant to many-many cities and agglomerations worldwide. Transport services become insufficient and non-accessible, increasing also the risk of traffic crashes. Besides, it causes social injustice as well. Rich people have no alternative to travelling by car, while the poor are forced to spend considerable amount of their income on transport in order to access their work place. In order to reverse these trends, cities and transport cities must be rebuilt around the needs of people and communities, allowing free and easy access to public transport.

To us, the best way of delivering quality transport services is to equip the city with the system of Transport Transit Hubs, where passengers have the possibility to be exchanged between vehicles or between transport modes [7, 22].

The advantage of TTH is the joint between two sustainable planning strategies aimed for creating sustainable, urban communities:

- Policy of Transit Oriented Development (TOD), which allows to make public transport viable and effective [15].
- Policy of development "Park-and-Ride" facilities, which allows to reduce congestion in urban areas by controlling the access to the road and street network assisting the use of public transport in congested urban areas [14].

The benefits of the TOD policy for sustainable development of the transportation system and urban community are evident. Free and easy access to public transport decrease the need for private motor vehicles and costly auto-orientated infrastructure. This, of course, means improving ecological environment, increasing quality of transport services, reducing trips difficulty and the risk of lives lost in traffic crashes. But along with pros there are also cons. Existing infrastructures, land use and spatial patterns, economic and political reasons often do not allow the introduction of high-speed passenger transport. Low-speed public transport is more flexible and in such cases, a priority option is the development of Park-and-Ride facilities within the city limits and suburban public Transport Transit Hubs [14].

High-speed access to Park-and-Ride facilities allows a good alternative to further traveling in private car. The car owner can leave his vehicle at the nearest Transport Transit Hub and use public transport mode.

Planning solutions for functional sustainable transport system can be presented using Transport Service Model (Figure 4), illustrating the interconnection of Park-and-Ride and Transit Oriented facilities. It is based on several key policy and design components necessary to its implementation and efficiency, such as:

- Developing transport system integrated into existing structures and neighborhoods.
- Limiting unnecessary use of private cars within urban communities.
- Prioritizing access to Transit Transport Hubs of potential users of passenger transport.
- Providing and managing easy access to parking spaces.
- Encouraging people to use public modes of transportation by making it as convenient and easy as possible.
- Developing high density places that mix commercial and residential uses around Transit Transport Hubs.
- Constructing attractive and cost-effective front-building, providing "eyes on the street".
- Designing comfortable and safe street design, accommodating transport needs.
- Monitoring and evaluation main system indicators.
- Implementing innovative environmental transport technologies.

In fact, the proposed Model of public transport service in urban areas results to be the holistic planning concept for sustainable development of both transportation system and urban community. Integrated transport system, free and easy access to TTH and Park-and-Ride facilities will decrease dependence of the urban communities on high speed roads, oriented for motor vehicle use. Creation of mixed use zones which include residences, public services, commercial ground floors as well as mixed-use buildings easily accessible by foot or public passenger traffic from TTH and connecting public transport stops to pedestrian and cycling infrastructure will decrease the need to travel by private car. The same refers to the accommodation of street design to the needs of public transportation. Inside the urban communities, right-of-way for public transport, wide public transport lanes, sheltered stops with lighting, seating and route information will make travel by public transport more comfortable and safe than by private car. In this way can be realized the postulate of "priority of public transport development", basic trend for sustainable development of transport system both in Russia and worldwide.

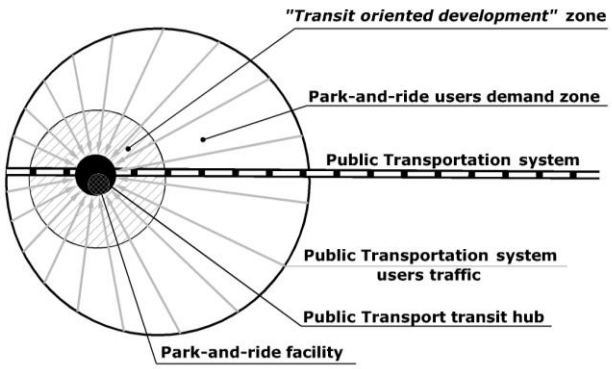

Figure 4. Model of public transportation service

URBAN ENVIROMENT

The significance and importance of environmental protection and preservation of man-made techno biosphere of the city cannot be overestimated [12]. Every urban area results to be a powerful factor of techno-genic impact on the environment, known as residential techno-genesis. The scale of its consequences depends on many natural and man-made conditions. A number of environmental challenges of the city emerge due to high concentration of materials, energy and human resources, and industrial and consumer waste on a very limited area. City uses a variety of fuels, energy, raw materials and semi-finished products, auxiliary materials for different businesses, food and consumer goods, industry equipment, transport, housing and communal services and so on [19]. In process of constant using and recycling, city constantly release a huge mass of solid, liquid and gaseous waste that leads to destruction and degradation of natural landscapes and affects human health, wellbeing and quality of life on the whole.

Environmental monitoring data witnesses changes in the Earth's natural ecosystems, degradation of valuable natural complexes, soil erosion and depletion, and contamination, air and water pollution etc. Anthropogenic impacts of such scale cannot be underestimated. It is not a local change in ecosystems, but, today, an important factor of global climate change. The climate system of the earth consists of five major interacting components: atmosphere, hydrosphere, cryosphere, lithosphere and biosphere enriched with man-made system component.

Attractiveness and land use of the urban settlement largely determines on its natural environment. People always appreciated the access to natural environmental resources and services which range from clean air and water up to such living and working conditions as open-air and noise-free spaces for leisure and work. I this way, state of nature is an important indicator of the condition and quality of the urban environment. Being exposed to diverse loads, nature is able to regenerate and to save itself and all humanity. A city is an aerial of profound changing nature, it reveals to be a special ecosystem. The grade of its destruction depends on its location, the particular geographical situation, the responsibility of the authorities and inhabitants.. The hydrographic network, landforms, natural vegetation distributions form are the basis for the formation natural ecological framework and functional zoning of a city.

These are the reasons for action aimed at maintaining of ecological balance of urban territories and objects − the most relevant trend in urban planning and design.

Ways to solve the environmental problems of the urban environment should be based upon the *ecological imperative*, which implies an absolute priority of conservation of wildlife and species diversity of the planet, as well as protection of the environment from excessive life-incompatible pollution by means of different bans and restrictions that can be applied to different human activities. Obviously, the economic and social growth of any city needs development and improvement of urban planning process. The main aim is to create a comfortable, safe, "stable" environment using modern technological means, innovative technologies and materials, and by means of introducting the concept of resource conservation and promoting sustainable urban regulation policies. Each urban infrastructure and every object must fit the environment in the best non-traumatic, preserving way, efficiently using relief and geology of the designed area, its climatic conditions, strength of the wind, water and sun, the existing flora and fauna. Urban design often is characterized by not so much preserving, but restoring of ecological balance of the area. The current trend is to create an artificial ecosystem inside the object, while building structure and its engineering systems make part of the ecosystem. To ensure the sustainability of the urban environment, the following specific questions should be considered:

- Controlling basic nature exploration sectors.
- Monitoring key environmental indicators.
- Implementing policies of environmental protection and ecological safety.
- Developing environmental activities aimed at reducing anthropogenic and anthropogenic load.

Comprehensive conceptual planning and design based on above mentioned principles for each of the aspects of urban development allows to elaborate a high quality sustainable project of urban environment. Its implementation aims at raising the economic level of the city, attracting investments, resolving of employment challenges. This way, high living standards of the population and the creation of a comfortable living environment shall be guaranteed.

URBAN ENGINEERING SUPPORT

Current generation faces also the challenge of supporting the changing urban settlements in a sustainable manner. In the process of urban expansion and development, in industrial countries, there were formed and built advanced high-tech complexes and systems difficult to manage using the conventional technologies. The focus of urban space has shifted from structural construction to adaptability to environmental requirements and both socio-economic and cultural changes. This way, previously created engineering support technologies do not work.

Sustainable engineering support requires a comprehensive approach and cannot be the sole responsibility of environment engineers, but should involve planners and engineers of all

engineering fields. Engineers play a relevant role not only at creation and support, but also at expertize practices for eco-friendly technologies and materials, so today, there is a growing demand for engineers with the knowledge of environmental issues in construction,

Structural engineer can take different steps aiming to decrease the impact of structural design on natural environment [15]. Between the options available for engineers today are, for example, improving life cycle performance by trying to minimize the initial cost of sustainable construction; using of recycled or other alternative materials for construction and so on.

Such solutions depend on local characteristics of urban settlements and although many options exist today, the long-term challengers still remain and should be considered not only in everyday practice, but also in research and – it is important – in education.

CONCLUSION

This review has discussed various requirements – technical, economic, social and environmental – of urban planning. It has focused on the complexity, integration and interconnection of the issues under consideration as well as on the necessity to act through a multi-level approach. We hope that it will help in sustainable project preparation and allow the best planning solutions for generation of sustainable urban environment.

Our life is changing every minute. We have come to think differently about the city, shifting to the production of sustainable city environment. Who knows what happens to us in say 60 years. There are tendencies and examples of sustainable “places” in a godforsaken places created with a minimum of means, lots of energy and great creativity [20].

To us, what really matters in our modern, full of movement and changes world, is the balance between the disciplines that get projects realized, while recognizing each other’s strength and know-how.

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