

**SUSTAINABLE DEVELOPMENT OF URBAN SYSTEMS:
THEORETICAL ASPECTS**

*A. V. Dudnyk, Ass. Prof., DudnykA@nmu.org.ua,
SHEI «National Mining University»*

The article deals with developing a hypothesis about correlation between a set of factors that determine the attractiveness of a territory of a city and the sustainable development of its urban system. Main trends of current development of urban systems have been analyzed. Special attention is paid to external effects estimation of worsening the environmental situation both in Ukraine and worldwide and to analysis of consequences of such deterioration. It is suggested that availability of land sites in urban areas directly proportional to their price and depends on social and economic factors as well as pollution levels and existence of pollution sources there. A methodological approach has been proposed to evaluate the availability of an urban territory for different kinds of human activities, which is based on analysis of geographical, economic, ecological, demographic, cultural and social factors and the territory's natural resources potential estimation.

Keywords: sustainable development, environmental policy, urban systems, urbanization.

Statement of problem. Since the mid of the 20th century rapid urbanization has been transforming our society in more technological but more unstable and depending on reliability of social, economic and technological subsystems functioning. Big corporations have been investing more money in purchasing of real estates in cities and agglomerations. Since the middle of 2013 to the middle of 2014 corporations spent over US\$600 bln for this purpose [1]. It is caused by the continuing increase of urban population and changes in technologies due to which less people are needed to get the same volumes of products, especially in rural regions. Modern urban settlements concentrate both people and industrial enterprises on comparatively small areas and affects land, atmosphere and water resources. While 54 per cent of the world's population residing in urban areas in 2014 [2], the unsustainable way of urban system development often makes them so-called "demographic black holes" in which death rates are higher than new births. According to The Rio +20 Conference outcome, «The future we want», our cities should lead the way towards economically, socially and environmentally sustainable societies. Such a society must be based on a holistic approach to urban planning and management which are to improve living standards of urban and rural dwellers. Sustainable urbanization requires that cities generate better income and employment opportunities, expand the necessary infrastructure for water

and sanitation, energy, transportation, information and communications; ensure equal access to services; reduce the number of people living in slums; and preserve the natural assets within the city and surrounding areas [2].

The study of recent urbanization trends unveils some significant distinctions between previous and current development of urban systems, in particular, it demonstrates new logics and character of real estate investment by national and multinational corporations. The most important trends are [1]:

– The sharp scale-up of buildings' purchases in megalopolises, including such as London and New York. By now there are about hundred cities in the world, which are the most attractive for investors and developers, though not all of them can be considered as sustainable ones. Foreign corporate real estate acquisitions increased on 248% in Amsterdam, on 180% in Madrid, on 475% in Nanking since 2013 till 2014. At the same time, the pace of growth in other cities was relatively lower – for instance, 68.5% in New York, 37.6% in London, 160.8% in Beijing.

– The extent of new constructions. Since 2008 we can see the extension of acquisitions of dead industrial blocks or underutilized land for site development. In many cases, the former industrial sites are transformed into luxurious corporate buildings or luxury apartments.

– The spread of megaprojects with vast footprints on urban and natural environment.

– The spread of megaprojects with vast footprints on urban and natural environment. These megaprojects raise the density of urban settlements but kill last reservoirs of nature (for instance, forests, lakes and small rivers) and much urban tissue: little streets and squares, density of street-level shops and modest offices, and so on. Sometimes site development occurs in places where the dangerous industrial objects have been located. It demands a methodological approach to evaluate potential sites for urban development, which must be based on a number of social, economic, environmental, demographics and other factors that can be important to make a habitat attractive for people who live there.

Analysis of recent papers. The problems of sustainable development of industrial and urban systems have been studied in many publications of Ukrainian and foreign scholars. In the article written by K. Bogach and A. Bardas, special attention is paid to development of scientific and technical principles of environmentally friendly geotechnologies as a prerequisite of sustainable development of a society [3]. It points up that sustainable projects often cause the imaginary conflict between profitability and additional expenditures on preserving the natural environment in line with a sustainable model of society. According to the authors the most important principle of project objectification is generalized study of complex interactions between economic, ecological and social factors, which helps us to find some comparative criteria for scenario selection. A scenario depends on correlation between multiple economic and ecological goals: sometimes there is much more important to save the natural ecosystems, while in other situations the higher profit may help us to reach the high ecological and social standards. Unfortunately, the work itself does not concretize the

The article of O. Parshak and A. Bardas deals with the main stages of ecological management implementation on industrial enterprise for coastal cities sustainable development. It includes the formalization of criteria which must be considered by business units' administration to provide the sustainability of urban and industrial systems [4]. At the same time, main attention here is concentrated on the interests of industrial enterprises, while local com-

munities are stayed aside.

Marina Alberti's publication deals with the problem of adapting a city to natural environment and underlines the fact that we still don't completely understand the subtle relationship between local and global stability in complex systems: she points out several scientists' hypothesize that the increasing complexity and interdependence of socio-economic networks can produce 'tipping cascades' and 'domino dynamics' in the Earth's system, leading to unexpected regime shifts [5].

Sharon Beder's article is devoted to present sustainable development policies which rest on the assumption that the quest for profit is socially beneficial, that those who are best able to make money should be the ones who decide what technology is used and what is produced and that corporate efforts to satisfy their self-interest in the market place can be utilized to protect the environment [6]. In cities it results in destruction of nature's ecosystems that are crucially important for local inhabitants and ignoring both social and ecological aspects in urban planning.

The problem of Environment Impact Statement (EIS) is considered in other paper in which discussed how stakeholders' values and judgments enter at every stage of the preparation of an EIS and how they may influence the estimation of a project in positive or negative side [7]

In the paper by Karen C. Seto, Michail Fragkias, Burak Güneralp, Michael K. Reilly [8] it is emphasized that often urbanization occurs near lands that are environmentally sensitive and in some cases, protected by law. According to their study, urban areas are growing faster than urban populations, and by 2030 urbanized land worldwide will grow by 590,000 square miles (or 944,000 square kilometers) that decreases the environmental safety of urban lands.

In our recent article "On The Estimation Of The Natural Resources Potential And Environment Quality Of Urban Settlement" we considered city's natural resource potential and capacity of natural ecosystems for self-renewal [9]

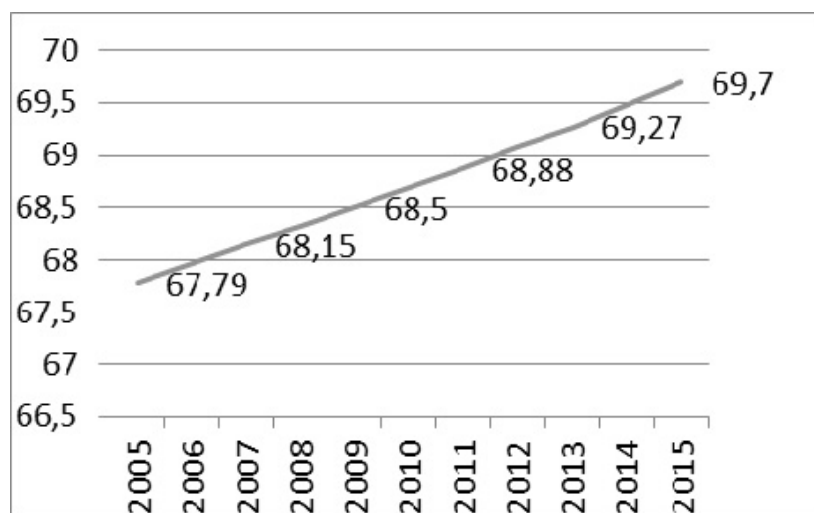
Obviously, there are many papers, which deal with environmental aspects of anthropogenic systems evolution. However, there is a

strong need in developing a theoretical hypothesis about selection of factors that determine the attractiveness of a territory of a city and influence its sustainable development. We are going to do it in our article.

Aim of the paper. Aim of the paper is to develop a hypothesis about correlation between a set of factors that determine the attractiveness of a territory of a city and the sustainable development of its urban system.

Materials and methods. Understanding the co-evolution of urban and natural systems is key to build a resilient society and transform

our habitat. Cities mainly are going to be developed in places that are the most biologically diverse, but the urbanization affects negatively not only landscapes, but pollutes water sources and air, destroys greenery. While concentrating huge amounts of people on comparatively small areas, most of the cities are known as so-called “demographic black holes”. [10] For instance, in Ukraine has been a strong trend of increasing the number of urban population since 1960; however, the trend become always linear since 2005 as it shown the Figure 1.



Source: UNESCO

Fig. 1. Level of urbanization in Ukraine, % of urban population

Ukraine's demographic outlook has changed from a country with a modestly high birth rate to one with more rapid aging and a smaller number of young people [11]

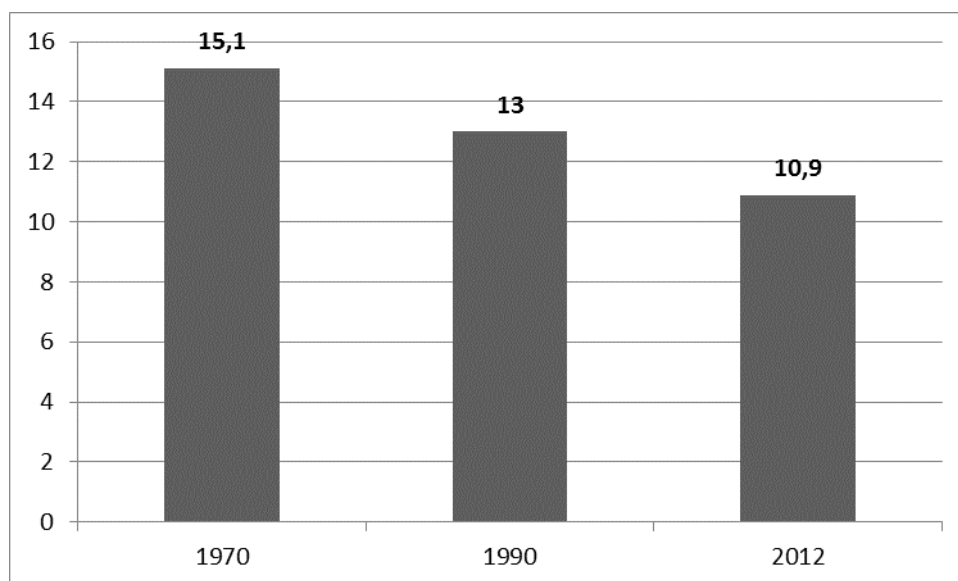
During more than three decades, until the middle of 1980, Ukraine's total fertility rate (TFR) was two children or more per woman. This indicator has been shrinking in cities since 1970th and now remains one of the world lowest – 1.5 TFR in 2013. The changes in crude birth rates, since 1970 until 2012, are shown in Figure 2.

Concurrently with decline of crude birth rate the crude death rate has been growing in Ukraine as it shown at Figure 3.

Such a situation has been caused by not only social and economic factors. The birth rates are higher in rural regions and are lower in big cities and urbanized areas. These indicators seem to be worse in the industrialized southern and eastern regions of our country with the highest technogenic impacts on natural envi-

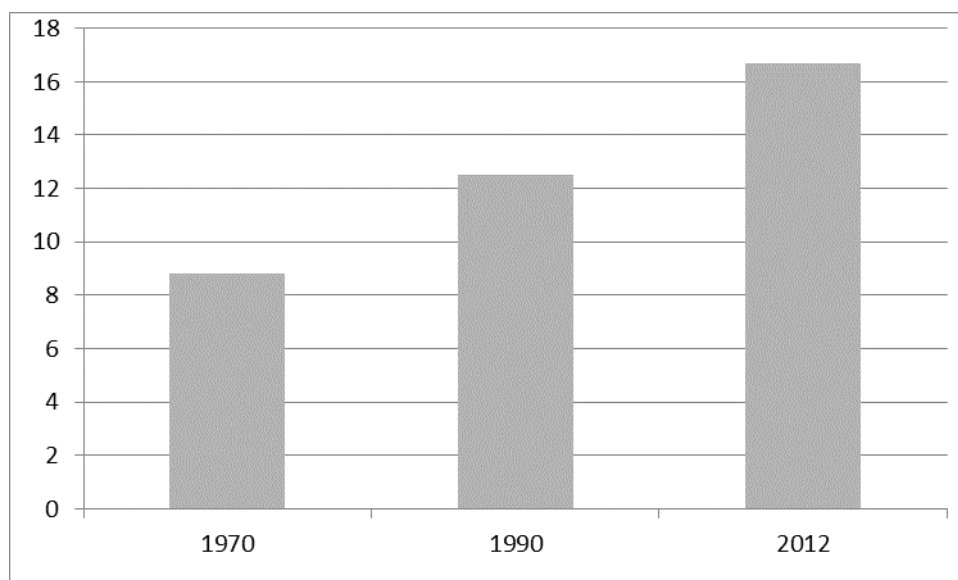
ronment. This situation is not unique - many industrialized and developed nations have the same negative trends in demography. The specific of Ukraine is rather in a combination of a number of negative factors which are typical both for developed (low birth rate, the social model of consumerism) and developing countries (high levels of pollution of the natural environment, multi-faceted predatory attitude to natural resources, high crude death rate).

Overcoming of the current trends is a matter of survival for contemporary Ukrainian society, a necessary condition to maintain its global competitiveness and adapt itself for different challenges. Considering the fact that most of the environmental risks are generated in urban areas - in megalopolises or industrial agglomerations - we need to improve our urban planning and design, enhance the quality of local governments and manage environmental pressures in a better way.



Source: UNESCO

Fig. 2. Crude birth rate in Ukraine, per 1000 people



Source: UNESCO

Fig. 3. Crude death rate dynamics in Ukraine, 1970-2012, per 1000 people

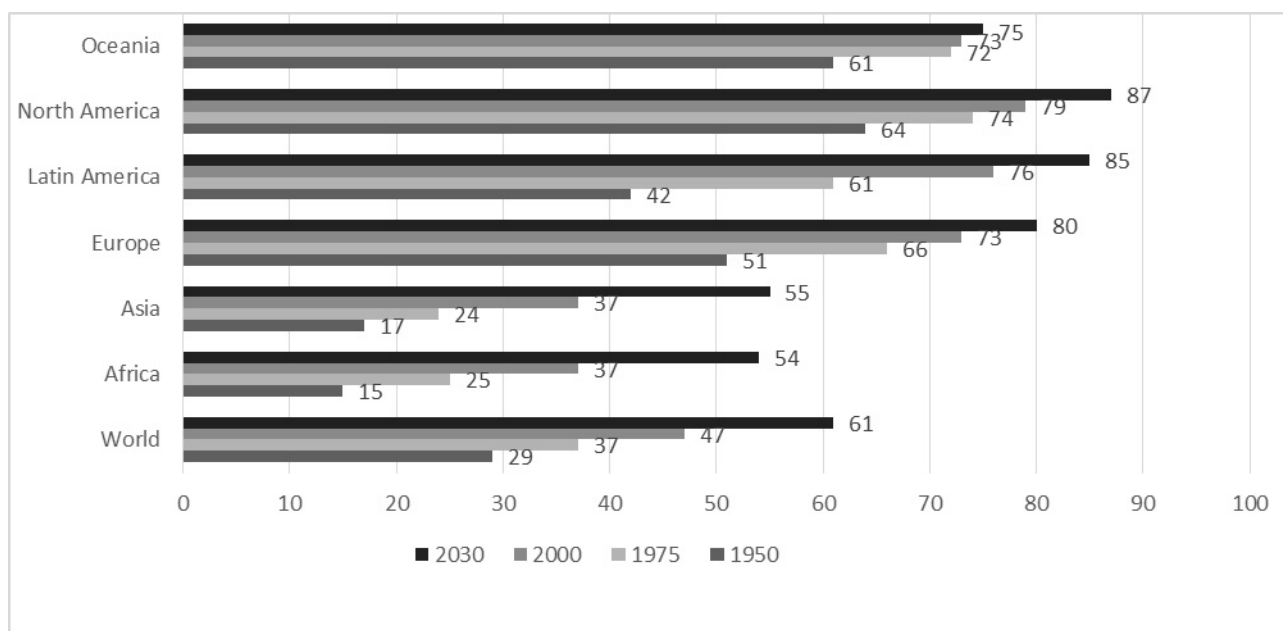
Reforms of urban planning need to separate industrial zones from residential areas develop flexible zoning. Dangerous productions must be removed from urban areas with high density of population and relocated to industrial zones, where risks of technological accidents would be lesser. It would improve the ecological safety of urban systems.

Linking transport infrastructure to residential areas, business and production centers, promotion coordination among metropolitan cities and their satellites would encourage better management of pollution.

The problems described above are not on-

ly inherent for Ukraine but have the global scale. As we can see in Figure 4, developing countries in Africa and Asia have the highest increasing rates of urbanization, as there in 2030 urban population expected to increase up to 54% (in 1.45 times to 2000) and 55% (in 1.49 times to 2000) respectively.

According to a recent study published in *Nature*, written by Johannes Lieveld, director of the Max Planck Institute for chemistry in Germany, «more people now die from air pollution than malaria and HIV combined. They include 1.4 million people a year in China and 650.000 in India. This compares with about



UN, *World Urbanization Prospects: The 2003 Revision* (2004).

Fig. 4. World urbanization prospects till 2030

180,000 a year in Europe.» [12].

World Health Organization has been monitoring on 2,000 cities and based on the gathered figures it affirms that pollution worsening in many countries. As it shown on Figure 5, 15 out of the 20 most polluted places were in India and China. The others were in Pakistan, Iran and Bangladesh. Of the worst 100, nearly 70 were in Asia and only a handful in Europe or the US. Unfortunately, the study did not cover those cities located in the Eastern Europe, like Kam'ianske, Dnipro, Kryvyi Rih and others, where pollution levels are extremely high and very dangerous for population. According to a recent WHO study, the cost of disease and the premature deaths caused in Europe every year by air pollution was more than \$1.6trillion in 2010, nearly 10% of the gross domestic product of the EU in 2013, while the UK was estimated to have suffered \$83bn (£54bn) in costs associated with air pollution [12]. Elsewhere in Europe, the figures were Germany \$145bn, and France \$53bn. The highest was in Bulgaria, which spent an estimated 29.5% of its GDP on the costs of air pollution fatalities.

If traditional concept of city development explained the worsening of urban environment by necessity of economic growth then modern theories of city's sustainable development pay more attention to creation of safety and resilient urban system, which satisfies economic, social

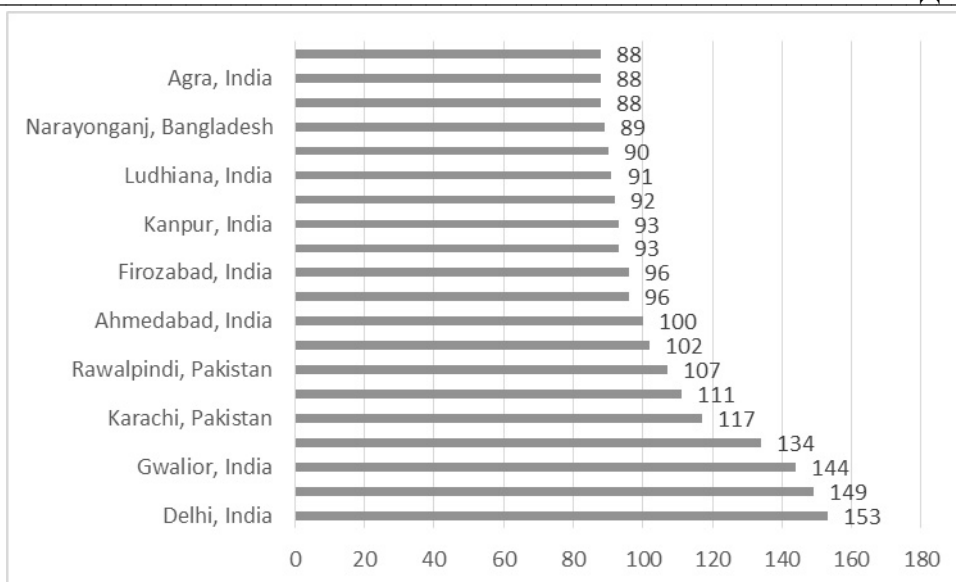
and ecological demands of local inhabitants. It is possible to do it under condition that local societies must find a consensus over main prospects of city development and create conditions for sustainable economic development of urban systems. The prestige and international status of cities, prosperity of their citizens, as well as quality of infrastructure and services, depends on this ability to develop sustainably.

Based on the study of rapid economic growth manifestations in many US cities, Harvey Molotch built a theory of "city growth machine", which explains the essence of its economic and social development processes.

A city growth machine it is not a city itself, but a complex combination of different factors which include [13]

1. Coalition of local elites;
2. Lobbying of city economic growth by the local elites;
3. Lobbying of disparity in incomes distribution by the local elites.

According to Harvey [13], in modern urbanism space of a city transforms permanently. This process is determined by large firms' selection where to locate their own production, research and development centers. It is also regulated by local and central government bodies responsible for control over industrial and agricultural production; the process is also realized through the business activity of private and



Source: WHO

Fig. 5. The most polluted cities in the world (fine particulate matter (PM 2.5), micrograms per cubic metre) [12]

corporate investors, which sells and purchases real estates – plots of land and buildings. Business, for instance, always evaluates the relative advantages of the new location compared to the existing one. As some products in one district become cheaper than in another or as a result of a company's transition from the older type of products to a new one, administrative buildings and production facilities are closing in less attractive places and moving to the new locations. This congruence of business activity to changes of social and economic conditions at a certain territory needs to be modified in order to administrate the public spaces in the better way, to achieve the consistency with environmental factors and guarantee safe and sustainable development of public, private and plural sector there. It means that city public administration needs a set of criteria to evaluate suitability of certain spaces for certain purposes.

In a study of Ukrainian scientist L. Melnyk it has been proposed to determine indicators of sustainable development respectively to the hierarchy of territories: from the smallest plot of land in the city up to the region in a whole [14]. It means that output data of main indicators on the micro-level must be transformed into inputs on meso-level, eventually the obtained values of indicators become inputs for macro-level. As an example of such indicator can be considered an ecological balance model proposed by these authors. It is also known as INSERD model which considers Im-

pacts, Burden, Conditions, Exposition, Results, Actions. Below we describe these indicators as it has been explained by Melnyk and Kubatko [14]. *Impacts* are interpreted as motives which induce people to be engaged in different kinds of activities (such as agriculture or industry). *Burden* emerges as a result of “impacts” influence and is accompanied by pressure on other systems – both natural and anthropogenic. Such pressures may be divided into three types: overutilization of natural resources, transformation of land use, harmful chemical emissions, radioactive, noise and waste pollutions.

Conditions here are understood as a complex of physical, chemical and biological properties of natural ingredients. They defined by quality of air, fresh water, landscapes and ecosystems.

Exposition is a kind of link between the levels of environmental pollution and public health.

It means that negative impacts as usual result in higher morbidity levels. *Result* reflects the dynamic changes in natural environment, which can violate a homeostasis of ecosystems.

Actions are analytical conclusions on possible social, economic and ecological defensive measures on different hierarchical levels.

A scheme of INSERD model is given below, in the Figure 6.

The proposed theory is mainly concentrated on correlation between indicators of environmental pressure caused by anthropogenic

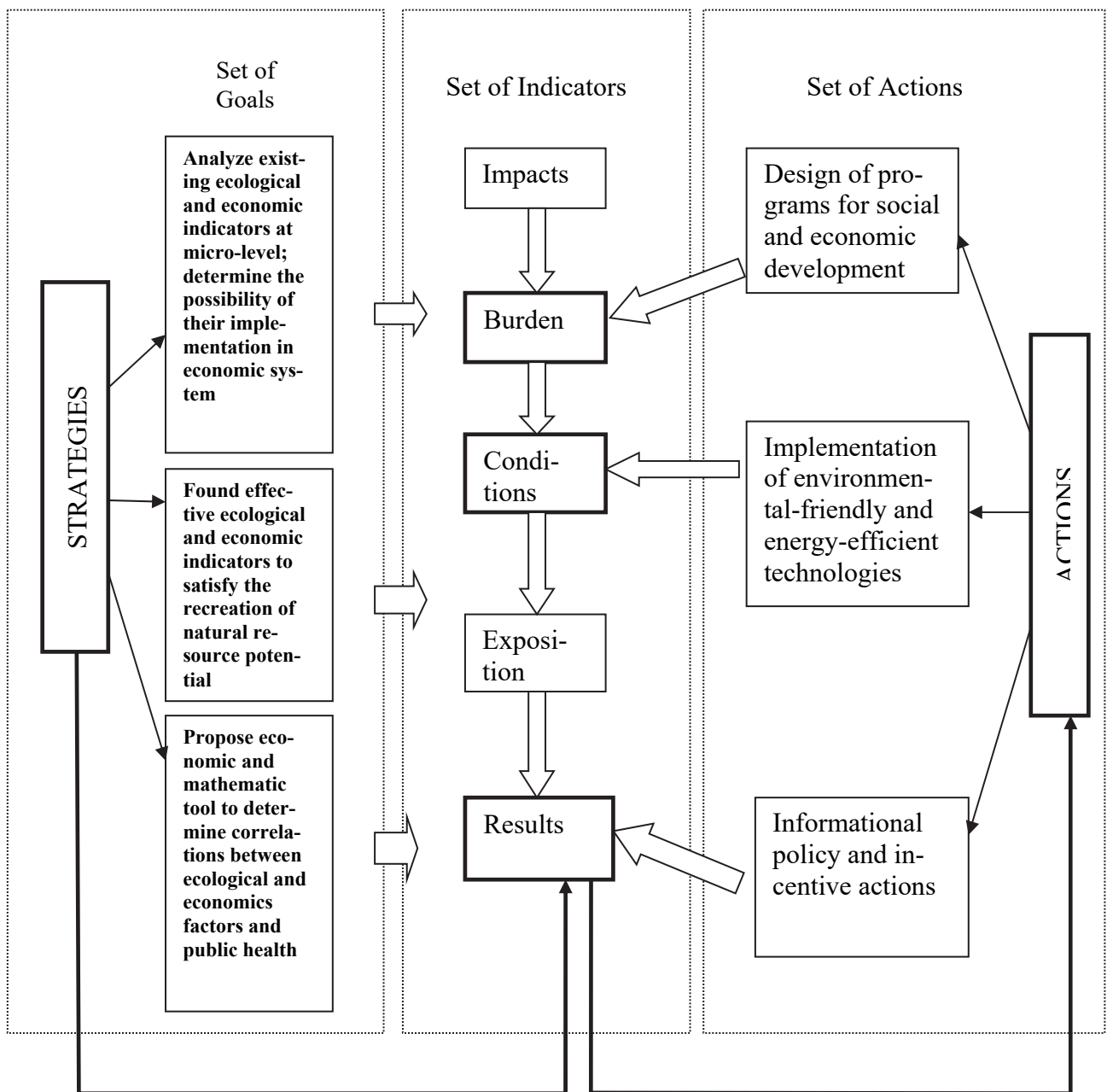


Fig. 6. The INSERD model structure [14]

factors and public health. To understand influence of ecological, social, economic, geographical and other factors on the attractiveness of an urban territory and the sustainable development of its urban system in a whole, we need to formulate a list of the mentioned factors and study their correlation on the main variable. In general, we may assume that the attractiveness of a city space related to the price of land there. In its turn, this price would be a result of conjuncture of demand and proposition. Availability of jobs, infrastructure (motorways and railroads, rapid transit network, administrative buildings, stores, schools and hospitals), sources of pollu-

tion existence (production facilities, transport conjunctions, landfill sites) or unfavourable natural conditions (swamps, unstable soils etc.) may or may not be the factors which determine the attractiveness of land plots for investors. It allows us to formulate two hypotheses.

Hypothesis 1. Attractiveness of land plots in urban areas depends on pollution levels and existence of pollution sources there. Its prices reflect subjective judgments on environmental quality and ecological safety in comparison with estimation of economic prospects.

There is a tendency that people with higher incomes prefer to live in more safety and

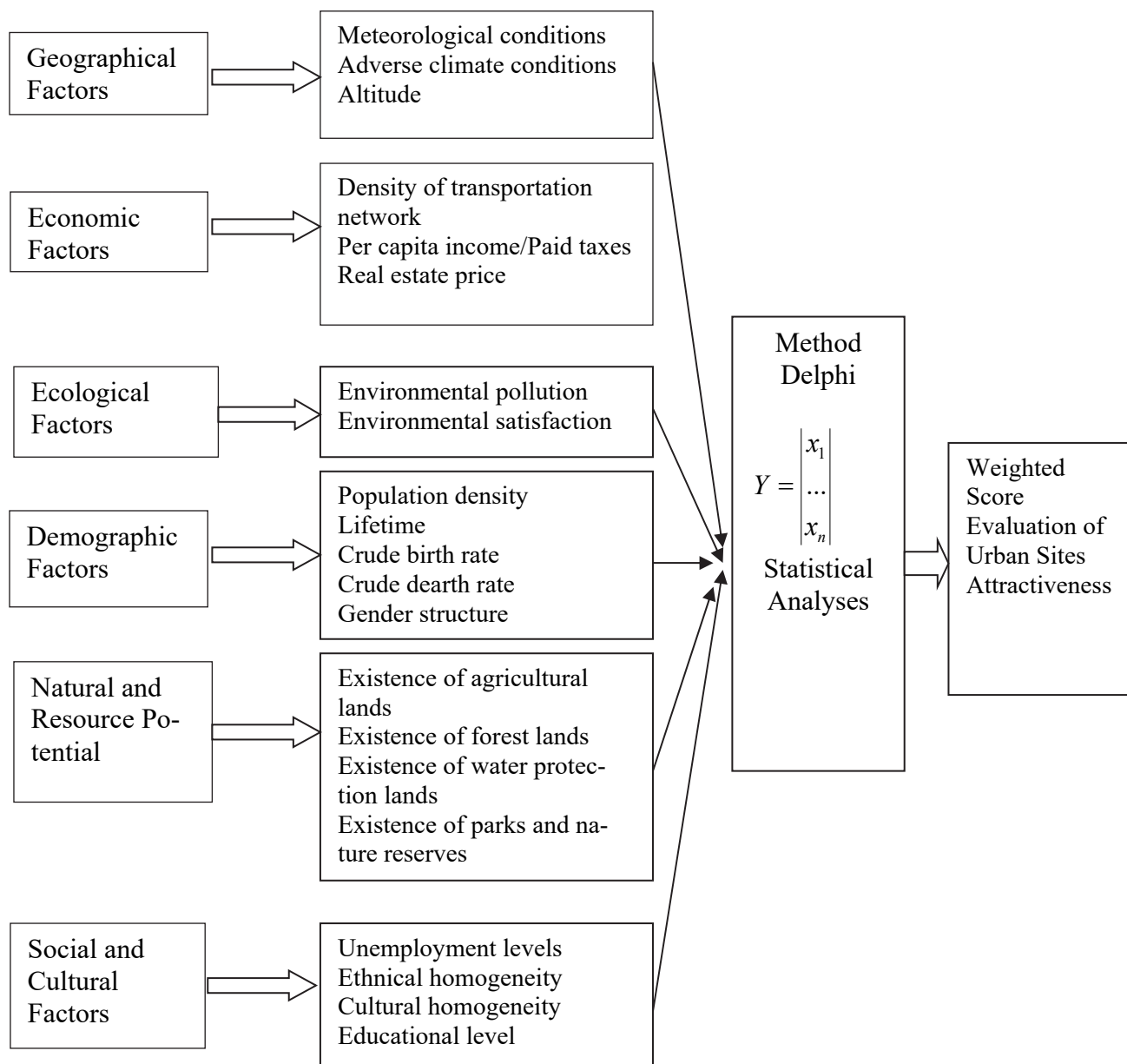


Fig. 7. Methodological Approach for Evaluation the Attractiveness of Urban Territory

sustainable districts. As "sustainable districts" we understand here urban locations with favourable economic, social and natural environment. It means that urban districts where the mentioned conditions will be congruent have the higher demand on land sites and real estate, and consequently - lower level of unemployment, better indicators of a lifetime, the higher level of paid taxes.

In this case, people may judge about the environmental safety based on their own subjective opinion, information from open sources or general estimation of urban site attractiveness which considers the ecological situation there.

Hypothesis 2. Attractiveness of land plots

depends only on economic prospects of a certain urban territory and its prices are function of population density and incomes of local inhabitants while ecological factors are almost ignored.

It is caused by the fact that most of the people who live in a city do not have enough information about ecological risks and pollution levels. Another reason may be the fact that under conditions when economic needs are unsatisfied people are attracted by economic reasons alone while other conditions (including ecological) are underestimated or totally ignored by them.

To estimate reliability of proposed hypotheses we have to measure a number of an-

thropogenic, natural, social and economic factors as it is given on Figure 7.

Conclusion. Our study will be based on gathering and analysis of available statistical data, and will also include designing and dissemination of questionnaires among our potential experts. We are going to invite professional ecologists, inhabitants of different districts of our city and scientists specializing in environmental economics as experts. A precise description of our research methods and results of this study will be presented in further publications.

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ТЕОРЕТИЧНІ АСПЕКТИ СТІЙКОГО РОЗВИТКУ УРБОСИСТЕМ

А. В. Дудник, доцент, ДВНЗ «Національний гірничий університет»

У статті розглянуто питання щодо формулювання гіпотези стосовно існування взаємозв'язку між набором чинників, які визначають привабливість територій міста для інвесторів та сталим розвитком урбосистеми в цілому. Проаналізовано основні тенденції сучасного розвитку систем міських поселень. Особливу увагу приділено оцінці екстернальних ефектів погіршення екологічної ситуації в Україні та у світі, а також аналізу наслідків такого погіршення. Зроблено припущення, що привабливість земельних ділянок міських поселень прямо пропорційна їхній ціні та залежить від соціальних та екологічних факторів, а також від рівня забруднення та наявності джерел забруднення довкілля. Запропоновано методологічний підхід до оцінювання такої привабливості, який базується на аналізі географічних, економічних, екологічних, демографічних, культурних та соціальних факторів, а також оцінюванні природно-ресурсного потенціалу території.

Ключові слова: сталий розвиток, екологічна політика, урбосистема, урбанізація.

ТЕОРЕТИЧЕСКИЕ АСПЕКТЫ УСТОЙЧИВОГО РАЗВИТИЯ УРБОСИСТЕМ

А. В. Дудник, доцент, ГВУЗ «Национальный горный университет»

В статье рассмотрены вопросы формирования гипотезы относительно существования связи между набором факторов, определяющих привлекательность территорий города для инвесторов и устойчивого развития урбосистемы в целом. Проанализированы основные тенденции современного развития систем городских поселений. Особое внимание уделено оценке экстернатальных эффектов ухудшения экологической ситуации в Украине и в мире, а также анализу последствий такого ухудшения. Сделано предположение, что привлекательность земельных участков городских поселений прямо пропорциональна их цене и зависит от социальных и экологических факторов, а также от степени загрязнения и наличия источников загрязнения окружающей среды. Предложен методологический подход к оценке такой привлекательности, основанный на анализе географических, экономических, экологических, демографических, культурных и социальных факторов, а также природно-ресурсного потенциала территории.

Ключевые слова: устойчивое развитие, экологическая политика, урбосистема, урбанизация.

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