Geographical indicators of sustainable development and assessment of the impact on the environment

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Abstract. The indicators of sustainable development are the indices used to evaluate and show the levels and trends of national, regional and global development. The analysis of such indicators is used to forecast the peculiarities of political, economic, social and ecological development of the geographical environment. There are many examples of designing and determining the indicators of sustainable development known today, which have been actively considered since the Rio Conference of 1992. For example, under the UNO Development Programme, the social indicator of sustainable development is the human potential development index, which incorporates such indices, as a person’s expected lifetime (by the moment of his birth), level of education of the adult population and size of the gross domestic product per capita. Presently, the geographical (environmental) indicators of sustainable development are considered to be: Level of degradation of land, water, atmospheric air, plants and animals, eco-systems and landscapes; Scales of using the natural resources; Scales of ecological policy and landscape planning and realization; Outcomes of realization of the national environmental legislation and international conventions; Indicators of the science and education involvement in the study of the environmental problems and realization of the study outcomes; Level of the population environmental consciousness and awareness.

1. Introduction
The indicators of sustainable development can be classified based on various approaches (systemic, complex and target) and strategic policy of a country (view). The classification units may be associated with: The level and state of development (characterizing the processes, efficiency, safety, freedom of action, responsibility, and outcomes of the public activities); The planning, service and management perspectives of landscapes (characterizing the opportunity to respond and forecast).

The environmental problems may also be viewed depending on the individual components of the geographical layer (lithosphere, atmosphere, hydrosphere, biosphere, pedosphere, and landscape). Such an approach is efficient when the natural components are evaluated by considering their resource potential. For instance, the lithosphere may be assessed according to the relief forms or site altitude and opportunities to develop ore deposits or various branches of economy.

The geographical environment and associated environmental problems are closely associated with the social surroundings, which has its effect on many different public activities. Under its impact, the living environment of the society, human psychological approach and opportunities to meet one’s spiritual, personal and material demands form. The study of such associations is necessary both for the
sustainable social development of the society and analysis of the opportunities of the public socio-
economic activities.

On the other hand, a certain portion of the social and economic problems (unemployment, incomes, 
educational opportunities, population dynamics, etc.) have either direct or indirect effect on the 
environmental problems of any level and state of the environment. In this respect, an essential 
indicator of the environmental impact is the process of urbanization and military conflicts [1-3].

2. Models and methods
The Economical – ecological models. The environmental problems are further exacerbated by the 
misbalance seen in some regions of the world between the level of economic development and the 
population growth (increase or decrease). The forms of their manifestation are also different. The 
decrease of the population in some part of a developing country leads to the increased scales of labor 
migration, which more or less contributes to an increased specific weight of the employees. In the 
developing counties, the economic development falls so much back the population growth that the 
excess population is seen as the factor hampering the social and ecological “wellbeing”. In terms of 
excess population, the consumption rates of products increase, and the problems of the rational use of 
the living environment and extracting the natural resources worsen. The lack of products necessitates 
import growth, which further lessens the costs borne to improve healthcare and the environment. The 
situation is further aggravated in the background of the global climate change, i.e. when the problems 
of using water resources or agricultural development for the people living in the arid, semi-arid and 
semi-humid regions of our Planet further worsen.

The economic problems in developing countries are the major cause of exacerbated social and 
environmental problems. In such countries, the dependence on the natural resources is very strong, and 
the scales of ecologically hazardous production (chemical industry, fuel energy sector, extensive 
agriculture, etc.) and disposal of hazardous industrial and toxic waste are high. There are over 200 
nuclear power plants and thousands of large chemical plants operating in the world, which are 
hazardous. Millions of tons of ecologically hazardous shipments are transported via oil and gas 
pipelines, ore deposit tankers and railway lines. Most of them are transported from developing 
countries to developed countries.

The process of urbanization exacerbates some environmental problems. Large settled areas are the 
precondition for a large-scale transformation of the natural environment. The areas of the towns may 
not be large, but they influence large areas around them. The polluted water and atmosphere in the 
towns and cities spread over long distances. Every city has a landfill, recreational and suburban area, 
where the environment is transformed drastically. The utilization of solid waste is an expensive 
activity and is not affordable for many countries in the world [4].

The geographical (environmental) impact can be duly assessed by using versatile scientific 
activities. The diversified nature of impacts is associated both with the natural events and processes 
and outcomes of the human activities. The geographical (environmental) impact is regulated through 
legislation, which more or less facilitates the process of assessment. However, the versatile nature of 
impacts and its intense variation in space and time needs skilled studies and highly reliable 
assessment. Many factors, and not only ecological ones, depend on the impartial assessment of the 
environmental impact [2, 7, 8].

The main goals of the geographical (environmental) impact assessment are: 1. Protection of human 
health, natural environment, as well as cultural and material values, and 2. Consideration of the 
ecological, social and economic interests of the state and public.

Geographical (environmental) impact assessment envisages the procedure of studying the planned 
activity and responses of the environmental elements. It is used to make direct and indirect 
assessments of the impacts of the activity on the environmental components, landscape and 
ecosystems, natural and cultural heritage as well as social and economic development.

The geographical (environmental) impact assessment is the subject of public consideration. The 
implementer of the activity is obliged to publish the information about the planned activity in periodic
printed media. The information about such an activity must provide such details, as the goals, name (description) and location of the planned activity; address where the members of the society can be acquainted with the documents related to the planned activity; and time and venue of the public discussion of the report.

3. Results and discussions

3.1. Impact on the soil
In evaluating the impact on soil, the following factors are taken into account: scales of stripping the humus topsoil layer and its outcomes, likelihood of soil washout or erosion, the impact of the weathering products on the adjoining areas and waters. An impact on the soil quality and stability is mainly expected during the earthworks. The major sources of soil pollution may be weed and pest-killer chemicals and solid and liquid waste, which emit from the used techniques, supply reservoirs, as well as following the leakages or spills of oil products, or other pollutants. For the prevention purposes, it is necessary to manage and dispose such sources in the right manner. In case of individual economic activities, it becomes necessary to strip and store the topsoil, with its volume varying depending on the type of soil. With the aim to maintain the soil fertility and stability, under the Law “On Soil Protection”, it is necessary to identify the locations where the stripped fertile topsoil will be stored. At such locations, the impact of water and wind erosion, as well as mechanical impact on the stored soil layers, must be minimized. As a rule, after the economic activities are over, the topsoil must be used to recultivate the damaged or eroded sites. For the purpose of preventing the soil/ground pollution, the relevant environmental requirements must be taken into account, including: appropriate control of waste management, collection of economic and fecal waters in the vacuum-sealed cesspits, fencing the stationary objects with high polluting potential (e.g. fuel supply reservoirs) with the barriers against the emergency spills; in case of accidental spills, the polluted layer must be stripped and removed from the site in a timely manner [4, 8]. At the stage following the environmental impact assessment, the ecological peculiarities and quantitative and qualitative properties of the project sites containing the humus layer of the relevant soil type are specified. Based on such a study, an approximate volume of the soil to strip and reliability of the temporal storage sites are identified. Moreover, the sites with high risk of soil surface layer pollution are identified, and a program of additional preventive/mitigation measures and planned recultivation measures is developed for them.

3.2. Impact on the vegetation cover
At the first stage of the environmental impact assessment, the following steps are undertaken: exploration of the botanic literary sources and available data on the vegetation in the study region, inventory of the rare and endemic species, analysis of the diversity of the vegetation cover near the economic activity sites, and registration of sensitive habitats of the vegetation and endemic and relict plant species. At the second stage of the environmental impact assessment, regarding the conclusion, a field botanical expedition is planned, and the methods to assess the vegetation envisage: 1. The registration of the Red-Listed plants; 2. The identification of the relict and endemic species; 3. The general environmental impact assessment; 4. The assessment of the impact on the vegetation in the construction and exploitation sites; 5. The assessment of the expected negative impact in the object exploitation phase; 6. Planning the measures to mitigate the expected negative environmental impacts and developing relevant recommendations.

3.3. Impact on climate indicators
In assessing the impact on the climate, the peculiarities of the geographical distribution of its parameters are identified based on the analysis of the data of the weather station located in the study region. Important climatic parameters are average air temperature (absolute maximum and absolute minimum), precipitations (amount and annual sums), humidity (absolute, relative and deficit), wind (direction, velocity and still), the height of the snow cover and number of snowy days, and extreme
climatic phenomena. The main factor of impact on air quality is earthworks, storage or transportation of ground or construction materials, dust from the traffic flows, and emissions from the machines, equipment and heavy vehicles. The vehicles can be considered as the major source of air impact. However, it also should be considered that the transport will be one of the major sources of “greenhouse gases”.

The impact on the atmospheric air quality is assessed by using the regulations setting the air quality standards. There are healthcare standards set as well since the impact on public health depends both on the concentration of the harmful substances and the duration of impact.

The measures mitigating the emissions of harmful substances into the atmospheric air are mostly designated for the preparation and construction phases. The contractor is obliged to accomplish the following mitigation measures: Operating technically non-faulty techniques and vehicles; Watering non-asphalted roads and bare ground surfaces once in every four hours in dry or windy weather; Observing the rules for fill and waste storage to avoid their dusting; Operating vehicles at optimal speeds.

3.4. Landscape impact assessment
In assessing the impacts on the landscape, the geographical peculiarities of the landscapes, scales of natural and anthropogenic impacts, sustainability features and transformation parameters are taken into account, in particular: Type, sub-type and genera of the landscape; Geographical location: geographical units (river basin and orographic units), settled areas, altitude of the site; Relief: dominant slope gradients, forms and types of the relief; Geomorphology: dominant type of a geomorphological process (what is it associated with), geology (what does it support), nature and intensity of the geodynamic processes; Climate: general features, average seasonal temperatures, average annual amounts and seasonal distribution of precipitations, dryness index, comfort/discomfort indices of the climatic characteristics; Soil: type and strength, vertical and mechanical structure; Vegetation: type, strength and frequency, degree of transformation; Type of economic use; Degree of stability; Degree of the landscape transformation [6, 8, 9].

3.5. Socioeconomic indicators
Global economic processes significantly limit the economic welfare of the population in the developing countries, local industry and trade as well as hamper social development and stability of the population. In order to evaluate the economic and social situation, the following indicators must be taken into account: The existing and prospective management of the living environment (space), major areas of settlements and population concentration; Distribution of land, water, mineral and forest resources per capita; Structure of economy (specific weights of industry, agriculture, transport, trade, service and construction in gross domestic product); Availability of the areas favorable to develop economy or settlements; The size of gross domestic product per capita; Medical service quality (including the number of doctors per 10 thousand residents); Level of education (number of people with high or secondary education per thousand residents); Actual and expected lifetime; Population migration (including the number of ecological migrants); Trends of the population natural increase/decrease; quality Amount of quality foodstuff consumption; Structure of the basket of goods and size of subsistence minimum.

The scales of the impact of agriculture on the environment are not a bit less. Such an impact is demonstrated in several aspects: The first aspect is associated with the transformation of natural landscapes and the formation of non-sustainable agricultural landscapes. The agricultural landscapes with certain crops on them (e.g. vine, vegetable gardens, orchards, etc.) are under a frequent and intense anthropogenic impact. They need permanent and purposeful physical and chemical impact to sustain sustainability and receive a maximum outcome for their purpose [6]. The second aspect is associated with melioration. Regular irrigation, particularly in semi-arid and arid regions leads to the soil salination. The salt soils virtually lose their agricultural designation and their fertility takes several tens of years to restore. The third aspect is caused by mechanical land cultivation. The outcomes of the
land cultivation are: the destruction of the natural vegetation, i.e. ecosystem ecocide, changed soil structure, sustainability degradation, mechanical decomposition of soil, activated wind and water erosion, the introduction of chemical substances and degradation of natural fertility.

Land cultivation is followed by some chain ecological reactions. Mineral fertilizers pollute surface and underground waters, penetrate in different kinds of water bodies and contribute to the intense eutrophication. Quite often, the land cultivation, vegetation destruction and change in the water regime entail the process of desertification. Land cultivation is also devastating for the animals and their habitats.

The fast-growing tourism industry is complex and popular and is known for its versatile associations. For this reason, the concept of sustainable development of tourism considers: 1. The compliance of the tourism development interests with the demands of the future generation; 2. The interests of tourism, local businesses, population, administration and other stakeholders; 3. Association of tourism development with the sustainable environmental development (by considering the interests of developing its components, such as natural, anthropogenic and natural-anthropogenic); 4. An interwoven system of tourism and sustainable environmental development (impact of the branch on the geographical systems and impact of the environment on the tourism development) [9, 10].

Mountains play a certain role in agricultural production. Despite the “severe” natural environment of the mountain areas, traditional types of agriculture are used in many regions of the world presenting the forms of harmonious co-existence of the human and nature. This is particularly true with perennial plants supporting some essential functions, including the ecological function of landscapes [2, 9].

4. Conclusion

The best indicator of sustainable development and public activity is the establishment of a cultural landscape, its management and service. A cultural landscape is a visible outcome of a long (historical) relation between the man and nature as well as a part of cultural heritage. It clearly shows the ecological, economic and social culture and identity of the local population. It is associated both, with the historical process and traditional economic and public activities.

The cultural landscape is a part of world heritage; it belongs to everyone. It can be called a mirror of our and nature co-existence. It can give an idea about the landscape potential and ecological properties as well as economic and social values. The conservation of the cultural landscape is the precondition for maintaining national identity and national dignity. The care and correct comprehension of the cultural landscape will improve the quality of life of the future generations, make their patriotic feelings stronger and create the appropriate basis for sustainable development.

A cultural landscape may be: established on purpose (by an architect or gardener), folk (created as a result of the daily activities of a family or rural dwellers), historical (depicting some historical event or activity), ethnographic (presenting a site incorporating a number of natural and cultural elements of the historical heritage). It may also be a town or its district, individual historical monument, ensembles, historical accommodation, engineering communications, archeological monuments, islands, channels, historical-geographical provinces, monuments of nature or associated cultural objects, etc. Under the World Heritage Convention, cultural landscapes represent the “combined works of nature and man”, and with its status, a cultural landscape must support the conservation of not only the monuments of the material and spiritual culture but also biodiversity.

The development of the Cultural landscape management strategy is considered a success if: 1. It improves the material well-being of the local population; 2. Ensures maximum and purposeful engagement of the population in the landscape services; 3. Increases the investment attractiveness. 4. Reduces the scales of impact on the natural environment; 5. Supports decentralized decision-making; 6. Considers the ethno-cultural peculiarities of the local population, and 7. Maintains the opportunities (mechanisms) for considering and changing the different trends of a strategy of development on time and efficiently.
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