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METHODS AND TECHNIQUES FOR THE ASSESSMENT OF THE ANTHROPIC IMPACT UPON THE ENVIRONMEN – THEORETICAL ASPECTS

ABSTRACT

The environmental research has become a concern of the present society, interested in ensuring a secure and comfortable future, as well as in anticipating and fighting against the natural disasters and catastrophic events caused by human activities, with destructive potential on short, medium and long term.

The environment should be defined and researched as a whole, and the priority focus should be on the analysis of the connections it incorporates, modifying its structure, functionality and dynamics.

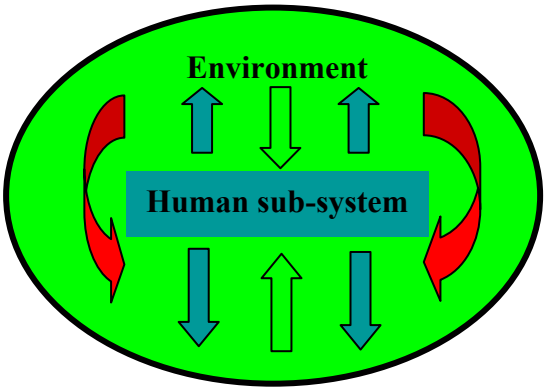
The present study addresses the issue of the anthropic impact upon the environment from the perspective of the conceptual framework of definition, typology and classification, of the assessment methods and techniques and the utilized indices and indicators.

Key words: environment, anthropic impact, assessment methods and techniques.

JEL Classification: Q50, Q51.

1. INTRODUCTION

Man has a double quality in its relation with the environment; he is both a component part of it and beneficiary of the environmental system.



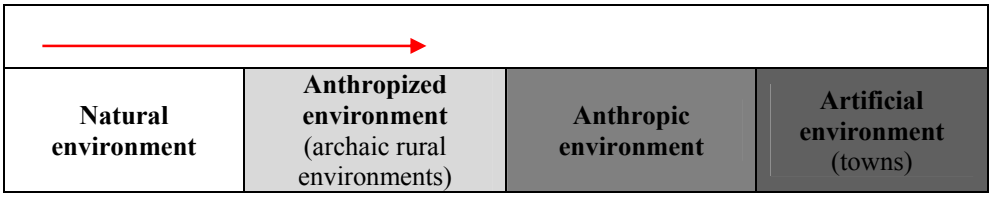
Source: Department of Economic and Social Affairs, Statistics Division, (2013), *Framework for the Development of Environment Statistics,* http://unstats.un.org/unsd/environment

Figure 1. Environment, human sub-system and interaction.

There are multiple linkages between the environment and the human sub-system, from the variety and complexity of natural processes to the demographic, social and economic ones, all of them acting and interacting.

People are dependent on the environment, first to survive and then for different social, cultural and economic needs. The human system is an environment sub-system, using the environment for the habitat, to obtain resources and as a waste recipient.

Environment is defined "by an ecological potential that is a specific capacity for life support and for sustaining the anthropic component" (Armas, I., 2006). We cannot speak today about a "pure" or "natural" environment, but about environments that are in different anthropization degrees. This degree, depending on the size of transformations that man has produced, is linked to the conditions provided by the different types of environment, by the social organization level, by the civilization level and recently, by different interests.



Source: Author's processing based on data from Armaş, I., Damian, R., (2001)

Figure 2. Environments by the anthropization degree.

There are different opinions in the scientific world, some of them consider that man is the first to blame for all the transformations brought to the environment and other consider that "the environment is too ample and complex to be influenced by man" (Wali et all, 2010), being characterized by resilience and a great adaptation capacity.

2. MATERIAL AND METHODS

The present study is a theoretical approach to the problems of the anthropic impact upon the environment and is the result of the documentation studies on this theme from the national and international literature[1].

[1] This paper is a component part of the first research report delivered within the doctoral school: Engineering and Management of Crop and Animal Resources of the University of Agricultural Sciences and Veterinary Medicine – Bucharest and of the Ph.D thesis with the title: *Research on the influence of the anthropic factor upon the rural development in the irrigated perimeters from the North Braila Terrace.*

3. RESULTS AND DISCUSSIONS

The impact upon the environment is defined as "the direct or indirect effect of a human activity that produces a change in the evolution sense of the eco-system quality condition; this change may affect people's health, the environment or the cultural heritage integrity or the socio-economic conditions" (Rojanschi, V., Bran, F., 2004).

The environmental impact concept refers to all the (existing and potential) human actions acting upon the environment, human health and welfare on a territory (Mac, I., 2003, Muntean, O.L., 2004).

3.1. TYPES OF ENVIRONMENTAL IMPACTS AND THEIR CLASSIFICATION

The environmental impacts can be classified as follows:

– Depending on the manifestation form, the environmental impacts can be:
  - **reversible impacts**, characterized by a total or partial return of the environment to the previous qualitative state;
  - **irreversible impacts**, determining the emergence of new types of environments.

– Depending on the nature of the effects produced (geographical location, ecological context, magnitude, duration, frequency), the impacts can be:
  - **negative impacts**, characterized by a series of attributes with significant values for environment quality degradation;
  - **positive impacts**, in terms of man and environment protection safety.

– By the nature and effectiveness of the effects on the environment components (Floca, L., Floca-Reteşan, D., 2002), the impacts are classified into:
  - **temporary impacts** (when the impact takes place on a short period of time);
  - **permanent** impacts (when the impact is maintained for a long or indefinite period).

– Depending on the geographical manifestation scale and the generated effects, we can differentiate (Stoian, L.C., 2011):
  - **strategic impacts** (influencing much larger areas than the zone utilized and exploited by a certain activity);
  - **local impacts** (influencing a limited area related to an anthropic activity or source).

– Depending on the impact intensity, the following are described:
  - **high intensity impacts**,
  - **medium intensity impacts**
  - **low intensity impacts**.

An important and extremely frequent category in the case of anthropic activities is represented by the **cumulative effect impacts**, determined by a series of synergic actions that induce complex effects and are characterized by the accumulation and amplification of the effects in time.

Another classification of the impacts takes into consideration four environment impact categories: **direct, indirect, visual and cumulative**. They should be evaluated on an integrated basis, as they intermingle and are mutually generated, while their consequences are most often difficult to delimit.

a) **Direct impacts**. Almost all the environment components are under the incidence of these types of impacts. We can list a series of effects here, such as: accumulation of heavy metals in water, soil and living components, direct pollution of crops and livestock.

b) **Indirect impacts**. These types of impacts have consequences that occurred discreetly, slowly affecting and changing the environment but, in time, they affected the internal structure of the environment components by air and water pollution, leading to the change of the quality class and soil destructuring.

c) **Visual impacts**. The aesthetical deterioration or degradation of the territorial system and of landscape is a consequence of the visual impact generated by the direct or indirect industrial pollution.

d) **Cumulative impacts**. These are the result of the combination and territorial and temporal overlapping of the first three impacts types.

The specialty literature also highlights other types of environmental impacts (Glasson, J., Therivel, R., Chadwick, A., 1994): physical and socio-economic impacts, short and long time impacts, distributed group and/or area impacts, present impacts and perceived impacts.

A thorough and complex description of all the anthropic impact forms is quite difficult to make. As a consequence, the prevention and control of environmental impacts are actions imposed by the national and international legislation.

3.2. EFFECTS OF THE ANTHROPIC IMPACT UPON THE ENVIRONMENT

The anthropic impact upon the environment can be approached under two aspects: the **cause** (impact source) **and the effects upon the environment components** (the environmental factors). From this point of view, it is considered that there are four types of effects upon the environment (Barrow, M., 1997):

a) ***linear effects***, which result from the increase or diminution of the input of noxae in different environment components; these effects are dependent on the time factor, playing an important role in solving up the conflict problems that may appear;

b) ***amplified or exponential effects***, resulting from chain amplifications of the inputs of pollutants in different environment components; each increase or diminution entails a higher effect than that preceeding it (CO_2, SO_2 emissions, etc.);

c) ***discontinued effects***, which take place relatively slowly until they exceed a certain threshold, after which a catastrophic change is produced (most often this change is likely to happen); these types of effects are of two kinds: chemical effects (accumulation of heavy metals and chemical compounds in soil, which leads to soil destructuring, probably as a consequence of acid pollution or of excessive use of fertilizers and pesticides, which induce disequilibria in the soil structure, leading to its degradation in time) and biological effects (e.g. eutrophication);

d) ***structural effects***, which presuppose spreading of the effects on several physical, social and economic factors (the intense pollution affects the main environmental factors, with social implications – population's mentality change as well as economic implications – ecological losses, health problems, etc).

3.3. METHODS AND TECHNIQUES FOR ASSESSING THE IMPACT UPON ENVIRONMENT

There are over 50 de methodologies for assessing the impact upon the environment (Barrow, C.J. 1997, 2000).

These have at their basis many and varied **methods** and **techniques** coming from the scientific disciplines that investigate the impact upon the environment components (natural and social sciences) or from other domains (management, planning).

The methods refer to different components under evaluation (identification, description and comparison of impacts by the utilization of scaling levels, of their share) and support the collection and classification of data on the environmental impact.

The techniques provide data that can be ordered on the basis of the operational principles provided by the methods. Thus, a technique provides data on an impact parameter, and these data are then utilized by a method that can present and evaluate them. A technique can be also used for the assessment or presentation of the information on the impact, although it acts as a support point for any other method utilized in practice. Any assessment activity of the anthropic impact can utilize more techniques, and the application of the methods is usually controlled by a series of laws, legal regulations and rules into effect (Muntean, L., 2009).

At present, in the specialty literature and in practice, the mostly used methods in the assessment of the impact upon the environment are the following:

a. The ad-hoc methods. These methods were the first utilized and are considered simplistic because they provide only minimum orientation for the evaluator, most often taking the form of simple discussions, without using a precise method or technique (Barrow, C.J., 1997, quoted by Muntean, L., 2009). They are limited to suggesting the manifestation areas of potential impacts, and a series of impacts can be omitted, which limit their value.

b. The methods of the checklists. The simple checklists are based on previously stated opinions and on drawing a hierarchy list of the factors that must be

taken into consideration in the evaluation (Barrow, C.J., 1997, quoted by Muntean, L., 2009). Their importance resides in the identification and specification of the list of impacts, but also in the assessment of the nature and character of impacts (adverse/negative, beneficial/positive, significant /insignificant, on short/long term). The checklists are important as they permit ordering the ideas, facilitate the data and information collection and make it possible to visualize large amounts of data and information, so that the impact can be better focused. In general, the simple checklists describe the impacts and provide a series of measurements and predictions, while the more sophisticated checklists apply impact measurement and scaling techniques. In practice, the checklists can describe or can be organized by development stages of the anthropic project (planning and design stage, construction stage, management stage, etc). Besides the above-mentioned lists, there are ***checklists based on questionnaires,*** which permits the evaluator to identify the possible impacts of an anthropic development in the territory.

c. The thematic maps overlapping methods are derived from the territorial planning and the landscape architecture. The thematic maps make it possible – by overlapping and comparison – to construct a complex and complete image of the sites and routes of impact producing. By the utilization of the Geographic Information Systems (GIS), of aerial images, satellite data and field research, the methods were improved. The above-mentioned methods are important in the analysis of the linear developments of the human activities/projects (the building of roads, railways and channels), but they can also support the land use planning and planning the location of industrial objectives. Mapping permits the identification of best areas for the development of human activities /projects.

d. Matrix methods. The matrices can be utilized for the identification, systematic study, visualization and assessment of impacts. A simple matrix is a combination of two checklists, one that describes the potential or existing impacts on the anthropic activity/project (by columns), and the other one that comprises the environmental and socio-economic conditions that can be affected by these impacts (by rows). The simple matrices can go beyond the identification and ordering of impacts, and the more complex matrices can lead to the identification of indirect impacts. Among the cheapest, fastest and well-tested matrices is the Leopold matrix. This matrix makes the connection between the environmental elements and the anthropic development activities; as it has a standardized form, the user can be sure that no type of impact has been omitted. The evaluation of the size and importance of impacts is a subjective reasoning process that diminishes the evaluation accuracy of the beneficial and less beneficial impacts. The Leopold matrix lay at the basis of other matrix methods and offered a very good visualization of the anthropic impacts upon the environment.

e. The multicriterial methods, which identify the particular attributes of the anthropic development options, assess and compare the different development

alternatives of an anthropic activity. These depend on experts' and evaluators' subjective opinion.

f. The network analysis methods (network-diagrams, phased matrices, system-diagrams, graphs and linear networks) are based upon networks of cause-effect type (network analysis). Most of them are compound methods resulting from the combination of the networks with the assessment matrices. A network uses multiple matrices to quantify the temporal interactions between impacts and to show the entire dimension of the potential impacts.

g. The expert systems are "knowledge based systems" (software) applied in the impact analysis, environmental planning, evaluation and management. The expert systems offer a great data and information potential with regard to impacts and their evaluation and they are used in the environmental audit and management.

h. The quantitative methods are used to compare and identify different impacts. The quantitative methods are based on a series of measurements and standardizations of impacts. Among the frequently used methods, we can mention the value system (based on value judgments and on a complex checklist).

i. The modelling methods. Modelling presupposes specific methods that have in view the creation of models. There are many types of models (i.e. computerized, analogue, conceptual, simulation models) that were applied in ecology, change of land use, pollution evaluation, social and economic studies, regional planning, etc. The simulation models developed for EIM can be useful for the management of an ongoing activity (air pollutant dispersion models). Modelling can be an exercise to simplify the reality with the goal to understand and describe the processes and phenomena or to forecast them. The advantage of these methods resides in the fact that models have the ability to reflect the dynamic character of the environmental system and of the human activity.

j. Methods for cumulative impact evaluation. The correct and systematic identification and assessment of the cumulative impacts is a challenge that attracts the attention and interest of researchers and practitioners and it has also generated a vast literature. A great part of the approaches targeting the assessment of cumulative impacts and effects refers only to the negative ones. This adds to the accumulation of environmental changes by certain different processes and pathways that vary in number, type and spatial-temporal attributes.

The techniques are working levers that provide data that can be used by methods. A method can utilize one or more techniques for reaching a goal, at a certain point in time and space; in other periods or places, the same method can modify the techniques or even replace them, utilizing other different techniques. A complex approach to the assessment of the environmental impact can be based on one or more methods and techniques.

One of the most used techniques is the **Delphi** technique, which takes into consideration the opinion of all environmental experts with regard to the implementation and environmental evaluation of a development project.

Another largely utilized technique in the impact studies and in impact assessment is the **GIS** (Geographic Information System) technique. The GIS technique implies the existence of software products (e.g. products like: ESRI/ArcView, ArcInfo etc), of specialized staff (GIS experts) and of performant computers.

GIS supports the assessment of environmental impact through the periodical update or real time update of data and helps in assessing the cumulative impacts. Thus, it is possible to quantify the cumulative impacts in one locality or region, it contributes to data updating by remote sensing and supports the territorial and environmental planning decisions.

3.4. THE ENVIRONMENTAL INDICATORS AND INDICES

The environmental indicators are measures by which a given situation or trend can be quantified. They are qualitative and quantitative values coming from the observations and direct measurements, which facilitate communication in a common referential language, in the research and assessment of the state of the environment (Iojă, I.C., 2013).

The environmental indicators highlight the interrelations from the biotic and abiotic components of the environment, and their most important utility is that they can signal out trends in the environment, warning about possible processes and phenomena that may take place in the future (Bălteanu, D., Şerban, M., 2005).

The environment quality can be most simply analyzed by comparing the values obtained from monitoring with the maximum accepted values. These are known as maximum accepted concentrations or thresholds.

The specific indicators for air quality assessment for which reference values are established are the following: nitric oxide, sulfur dioxide, carbon monoxide, particulate matter, volatile organic compounds, ammonia and benzene.

For the surface and underground waters, five great categories of water quality indicators are evaluated: *hydro-morphological* (water depth, flow, width, level), *physical* (temperature, pH, electro conductivity, transparency, turbidity and hardness), *chemical* (oxygen regime, nutrients and metals), *biological* (plankton, algae) and *microbiological* (streptococci).

For the assessment of soil quality, three categories of indicators are monitored: *chemical* (balance between the soil solution and solid component, necessary nutrients, contamination level, soil fertility, salinization), physical (soil water infiltration and its retention capacity, soil structure, texture, depth) and biological (active biological matter, diversity of species population).

Biodiversity is characterized by three levels: at species level, genetic diversity (variety of species, of populations, of individuals) and eco-systemic diversity (variations in the biological communities) (Iojă, I.C., M. Pătroescu, 2010). The measurement of biological diversity implies the utilization of certain indicators and indices, such as the richness in species, genes, eco-systems

(Mangalef index, Menhinick index, Simpson index), their diversity and density, their spatial and temporal distribution and variation, endangering level, habitat fragmentation, specificity and efficiency of conservation actions (Iojă, I.C., 2013).

Together with these indicators in the evaluation of environment quality, assessment indicators and indices of green spaces, of the waste and radioactivity management system are also used.

4. CONCLUSIONS

The environment quality analysis should not take into consideration only the past and present situations, but they should also provide perspective projections of the different present environment degradation processes.

The global problems, such as climate changes, bio-diversity loss and natural resource utilization dynamics have long-term implications and need long-term solutions.

The assessment of the environmental problems makes it possible to avoid certain environmental dysfunctionalities, which may not be perceived at present, which were not manifested in the past, but which, in association with different other sources, can become very dynamic in perspective.

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