GEOGRAPHICAL PERSPECTIVES ON HUMAN-ENVIRONMENT RELATIONSHIPS AND ANTHROPIC PRESSURE INDICATORS

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There is a growing literature on the study of human-environment relationships undertaken at various geographical scales. Tightly connected to the environmental change research, the topic of human-environment relationships deals primarily with the linkages between the social and physical systems, focusing on the human pressures on the biogeochemical processes and the environmental effects on society. This paper outlines the main areas of interest in the human-environment relationship field, emphasizing the integrative character of this research subject. The authors then consider some methodological approaches to the assessment of human imprint on the environment and on the impacts of environmental change on society. Ultimately, the information extracted from theoretical and empirical studies on human-environment relationships was used as a background for a general framework of anthropic pressure indicators. There were identified three reference categories of anthropic pressure indicators, namely population; economic growth and resource consumption; urbanization. A brief discussion about the future research directions in the field of human-environment relationship research completes this paper.

1. INTRODUCTION

It is largely acknowledged that human activities and environmental change are strongly connected. Empirically, this observation has been continuously investigated under various and more complex forms within the framework of Global Environmental Change (GEC) programmes and research projects (e.g. IGBP – International Global Biosphere Programme, IHDP – International Human Dimension Programme, DIVERSITAS – International Programme on Biodiversity Science, WCRP – World Climate Research Programme, all of these being affiliated to the Earth System Science Partnership – ESSP). Nowadays the research field of human – environment relationships builds on but moves beyond the previous works of environmental geography or human ecology concerning the human impact, focusing on the escalating intensity of the interactions between human and nature (Vitousek, 1997; Mitchell and Lankao, 2004; Vörösmarty and Sahagian, 2000; Sanderson *et al.*, 2002; Martinez *et al.*, 2007). It acquired momentum around the late 90s, closely following the global change research agenda along with the increased performance of models and methods developed for analyzing social and environmental issues, including spatial applications, such as GIS, spatial analysis and remote sensing. If in the beginning, global environmental change studies were done mostly within a distinct field of research rather than interactively, since 2000–2005 the attention has been moving toward approaches that link the social and the biophysical sciences (ICSU-UNESCO-UNU, 2008). Likewise, in the first stage such analyses massively focused on greater understanding of the systems' processes, thus leading to rapid development and availableness of data and, soon after, plural social science perspectives on global environmental change came along (Adger *et al.*, 2005).

Moreover, the emergence of such approaches is not pure coincidence, all of them having been pushed into the forefront of the research agenda by scientific consensus and public awareness of the current environmental challenges induced by and reflected on society. In this respect, the United Nations

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acknowledged the necessity to elaborate an extensive assessment of the current changes in the function of the natural systems and their influence on society. Therefore, Millennium Ecosystem Assessment (2005) points out the major changes in the ecosystem services and their impacts on the human well-being and envisions the main patterns of sustainable ecosystem management over the next 50 years.

Human-environment relationships refer to the interactions and feedbacks between the human and the natural components and, consequently, to the linkages between the social and the geophysical systems (Liu *et al.*, 2007; Leichenko and O'Brien, 2008). The start on the globalization of human activities goes back around the year 1500, coinciding with the discovery of the American continent and the expansion of European productive practices at global level. Nonetheless, the major effects of the human impact on nature appeared first locally and then, as they multiplied and amplified, regionally and globally. Thus, during the last 50 years the impacts of human activities on the natural systems have largely increased, generating important changes at the level of ecosystem functions and services (Millennium Ecosystem Assessment, 2005). Following and documenting this idea, scientists Paul Crutzen and Eugene Stoermer have coined the term *Anthropocene*, analogous to a geological period, denoting the period after the Second World War when human impacts on the environment have intensified and even exceeded the capacity of the natural processes to recover (IGBP Newsletter, 2000).

If in the past human-environment interactions were usually occurring at the local scale, now they occur increasingly at regional, continental and global scales (Liu *et al.*, 2007). This is because synergistic and cumulative effects of local processes land degradation generate effects on global or regional systems (Bălteanu and Şerban, 2005). From this point of view, there is a strong emphasis on cross-scale issues concerning environmental change and on the interscale transfer of information and methods in specific cases of human-environment interactions due to their inherent spatial characteristics.

The paper provides an overview of the central research patterns of the human-environment relationships. There are listed key concepts and issues in the field together with their main definitions and ideas, which are then continued by a systematization of the drivers and scales of environmental changes. The methodological aspects focus on the type of methods required in the field, the purpose being to highlight the integrative character of the human-environment research. The anthropic pressure indicators are classified and selected based on a general framework of three main coordinates: population, economic growth/resource consumption and use and urbanization. The final comments put forward current and future research directions in the field of human-environment relationships.

2. DIVERSITY OF THE HUMAN-ENVIRONMENT RELATIONSHIPS RESEARCH

The field of human-environment relationships operates with a series of concepts and notions. They refer to the causes of environmental change, feedbacks and consequences for the communities, answers of the decision-makers, etc. The main ones are listed in Table 1.

Table 1

Concepts and issues operating in the field of human-environment relationships research

Concepts / Issues	Short description
Population	Demographic dynamics, population mobility, anthropic activities, population consumption and utilization of resources are major population-related drivers of change. Approaches to anthropic pressure and environmental change need to consider the distinction between urban population and rural population. Each of these categories exerts its own demands on the agrobiophysical resources; thus, the effects of the rural population on the areas themselves are different than the effects of the urban population on the areas surrounding the cities, which are a source of primary products for them. In the same way, studies on human-environment relationships consider population-related features in connection with economic issues, with concerns about deterioration of local environmental conditions and with quality of life in general (Conway, 2004; Gray and Moseley, 2005; Adamo, 2009).

Table 1 (continued)

Land use / land cover change	Land use / land cover changes are one of the most significant forms of human-environment interactions and therefore the most studied topic in this field. In many cases, land use changes are investigated at smaller spatial scales, having been considered a local environmental issue (Curran and De Sherbinin, 2004; Entwisle and Stern, 2005; Dumitraşcu, 2006). More recently, they have become a force of global relevance due to their cumulative character, incrementing extension and large increases in energy, water, fertilizer consumption and considerable biodiversity losses (Global Land Project – GLP; Foley *et al.*, 2005; Lambin, 2005; PERN Cyberseminar, 2010; Popovici, 2010).
Path-dependancy	It basically refers to the legacies and the lessons of the past. This is because any human-environment condition is shaped by preceding conditions that reduced or enlarged future options (Turner II and McCandless, 2008). Anyway, under the recognition that the contemporary society has little by way of analogues regarding the anthropic impacts and the effects on the biogeochemical cycles of the Earth System, cautionary flags should be kept in mind about the historical assessments (IGBP Newsletter, 2000). Nevertheless, assessments of this kind can help to reveal potential biases that may result from a more focused spatiotemporal analysis and, also to forge and test theories of human-environment interactions that might guide future actions (Turner II and McCandless, 2008; Lambin, 2005).
Socioeconomic vulnerability to environmental change	Vulnerability is a function of exposure to different, single or multiple, forms of impact either anthropic or natural, or both (depending on the topic discussed), of socioeconomic sensitivity to the consequences generated by different forms of change drivers, and of adaptation capacity (IPCC, 2007; Stern, 2007). It can be said that the vulnerability of a system is the measure that shows the magnitude and the intensity of the impact, and it includes all the physical, social, economic and environmental conditions that define the susceptibility of the system to various stimuli (Turner II *et al.*, 2003; Bălteanu and Şerban, 2005; Metzger *et al.*, 2005).
Resilience and coping capacity	Resilience is the capacity of a system to absorb the external/internal stressors and to maintain an acceptable level of functionality, while the systems' coping capacity is the sum of forces, resources and measures that the society takes to reduce risk by mitigating the negative effects of the impact forms on the environment (O'Brian *et al.*, 2004) (Bălteanu and Şerban, 2005; Vogel *et al.*, 2007).
Adaptation of coupled human-environment systems to change	Adaptation refers to societal responses to the impact of different external stimuli on the system's functionality in order to reduce their negative effects, or, on the contrary, to benefit from the new options of development. In the case of adaptation, as in the case of socioeconomic vulnerability, there are a series of interlinked factors (economic, political, social, and environmental) that generate change and that need to be taken into account when designing adaptation recommendations. For this purpose, different scale scenarios of adaptive capacity are developed in order to capture several possible combinations of cause-effect relationships, which would further serve to policymaking and development planning (Cuculeanu *et al.*, 2002; IPCC, 2007; Stern, 2007; Adamo, 2009).
Non-linearity of the human-environment relationships	Usually, change in the ecosystem services is gradual and incremental (Millennium Ecosystem Assessment, 2005). Nonetheless, there are many examples that show surprising and sometimes abrupt changes in the systems. They are generated by non-linear interactions among the system's components. Actually, the non-linear behavior of the system explains the feedback loops operating between the parts of the system, a distinctive systemic trait (Newell *et al.*, 2005). For example, major changes in the biogeochemical cycles of the Black Sea marine waters in late 70s are mainly attributed to the drastic decrease of the sediment and nutrient delivery from further upstream drainage basin due to anthropic interventions (Reschke *et al.*, 2002; Teodoru *et al.*, 2007). Also, introducing (or removing) species in the system can cause non-linear changes and there are plenty examples in this sense. Although the techniques concerning the predictions of the consequences of human-environment relationships on society are constantly improving, anticipating thresholds is difficult. The high number of variables, their nature and requirements of the models make it impossible to predict the thresholds where the change will be encountered. However, based on the current forecasting methods, science could often warn on the increased risk of change.

Table 1 (continued)

Spatial analysis of human-environment relationships	Human-environment relationships are inherently spatial. Thus, the integration of biophysical and socioeconomic indicators is needed in order to assess the spatial interactions and inferences of various processes, which ultimately express the patterns of human imprint on the environment.
Governance of environmental change	There is a scientific consensus on the implications of numerous human impacts on the functionality of the Earth System at different scales. As such, a sustainable management of the natural resources means greater cooperation among agents, institutions, economic sectors, and better coordinated responses at multiple scales (Schellnhuber *et al.*, 2004; Millennium Ecosystem Assessment, 2005). In this sense, the role of various institutions and governmental frameworks (e.g. multilateral agreements) becomes fundamental with respect to the capacity to implement the management strategies of environmental changes. The contribution of the scientific community resides in well-documented information on the mechanisms of change, and in feasible responses to environmental change for different categories of agents, which need to be recommended in time since the effects of environmental change have been steadily increasing their frequency of occurrence.

3. TEMPORAL AND SPATIAL SCALES OF ENVIRONMENTAL CHANGE AND TYPES OF DRIVERS

The geographical scales at which studies on human-environment relationships are undertaken influence both the topic of the study itself and the expected results. The factors that generate change within the coupled human-environment systems can be grouped according to the scale of the analysis. Therefore, the communities could be affected by *global factors* or by those acting at large regional scales (e.g. the effects of climate change driven factors), *regional factors* (e.g. political changes whose consequences are reflected on land use changes, demography, urbanization, etc.) and *local factors* (e.g. the distance to markets, erosion/land degradation). Moreover, it takes different time lapses until changes are observed, some occurring faster than others. Due to their spatial-temporal dependence, some drivers might be relevant at a certain spatial scale and over a specific period of time, whereas at another scale it might be less significant (Millennium Ecosystem Assessment, 2005). For instance, climate change operates at global or large regional scale while its effects on local scales are unevenly spread and do not extend over a well-defined level. It results that the contexts (environmental, economic or societal) play a significant role when analyzing the human-environment relationships, and more specifically when choosing the scale of analysis for such an issue. Moreover, what services are offered to the communities and to what extent they are used refer intrinsically to the consumption and usage of resources, this being another aspect to be taken into account when establishing the scale of analysis.

Regardless of scale, the anthropic drivers are of two kinds: *direct drivers* and *indirect drivers*. The *direct factors* are those that express the causes of change and affect the system's processes, while indirect drivers act more diffuse within the system and alter one or more direct factors (Millennium Ecosystem Assessment, 2005). Studies of direct drivers are based on changes in the land-use patterns, biogeochemical cycles, climate changes, etc. *Indirect drivers* are those dealing with demographic dynamics, economic growth, consumption of resources, socio-political institutions and culture, scientific and technological change, and are addressed by the social sciences. Both, direct and indirect factors affect the systems at different spatial-temporal scales and are dependent on the demographic-social-economic-political-technological contexts. For instance, climate change is studied at global and regional scale, while the effects of land policy implementation measures at a much smaller spatial scale.

Along with the distribution and/or spatial representation of the anthropic characteristics, the analyses of human-environment relationships underscore the spatial inferences between the socioeconomic and the biophysical components. In this sense, consideration should be given to applications that rely on GIS techniques, remote sensing, spatial and classical statistical models, etc.

Therefore, it can be stated that the spatial dimension of the human-environmental relationships refers to exhaustive spatial analyses that include not only the spatial distributions of anthropic indicators, but also interferences and interactions of various indicators, being constrained by specific environmental and socioeconomic contexts.

4. GENERAL METHODOLOGICAL INSIGHTS INTO THE HUMAN-ENVIRONMENT RELATIONSHIP RESEARCH

At the meeting of the European Alliance on Global Change, September 2010, it was acknowledged and underscored the fact that environmental change is much of a methodological issue as it is a conceptual one since it connects topics from various disciplines. Therefore, the research framework of human-environment relationships is dominated by a strong methodological beat, apart from its major theoretical and conceptual patterns which were mentioned above.

There are several considerations that should be kept in mind when approaching a human-environment issue in a specific geographical context. First of all, human-environment relationships are, without any doubt, inherently spatial and the focus is on the integration of biophysical and socioeconomic indicators. In this sense, models would be an appropriate way to tackle such issues. They are abstract and simplistic representation of reality and range from common classical regressions to complex simulations. Usually, a robust model (either quantitative or conceptual) describes the relationships among the system's components and drivers, based on sufficient theory, data and understanding (Baron *et al.*, 2009). In the case of human-environment relationships, simulation and statistical models need to be parameterized with indicators (or tested against biophysical and societal information) that are often the same as those used to assess the effects of change and/or the existing responses to change (Baron *et al.*, 2009). This is why it is important to ground the anthropic pressure indicators, aspect which is presented in the next section.

An overall framework for human-environment models is given by Clarke *et al.* (2001), who speak of three basic dimensions of such models: time, space and decision-making.

If biophysical processes could be studied independently of the human factor, the anthropic-related processes would imply a third dimension which is the decision-making processes. The first two dimensions refer to the scale of the model, either it is the time scale (i.e. time step and duration) or the spatial scale (i.e. resolution and extent).

Decision-making processes cannot be as concise as time step and duration, and resolution and extent parts of the model. In a human-environment model, decision-making processes refer to agents and, depending on the scale of analysis, they could be at individual, neighborhood, district, or national levels. All these agents can be linked in a human-environment model (Clark *et al.*, 2001). It is worth mentioning that in a spatially explicit human-environment model, the specific institutional and geographic context in which the agent acts can be well captured through the use of boundary maps or GIS layers.

In general, many approaches in the sphere of human-environment relationships use a combination of tools that include spatial techniques (GIS, remote sensing, (a)spatial statistics), subject-oriented indicators structured according to various conceptual frameworks (e.g. DPSIR – Driving Force, Pressure, State, Impact and Response) and public and stakeholders perceptions (e.g. People's Participatory Programs) (Balchand *et al.*, 2007). Yet, there still is a lack of adequate data, particularly in terms of variables time series and scale matching that might constrain the methodological path and thus the results of human-environmental approaches.

Without any doubt the results of the models depend on the available data, but also on the logic the model is built on. Therefore, it is important to careful consider both data requirements for models when choosing the methodology of the human-environment relationship study, and the contextual factors and processes that govern the interactions within the coupled human-environment system.

5. ANTHROPIC PRESSURE INDICATORS

Generally, indicators are used to describe the state or the evolution of a system. Moreover, they suggest the type and intensity of different links among the systems' components and, at the same time, provide information to decision-makers about how some factors affect environmental structures, allowing them to find solutions and picture long-term scenarios (McCool and Stankey, 2004). It can be inferred that the use of indicators does not reside only in observing the effects of some factors on the environment, and therefore the current state of the analyzed system, but also in helping to investigate the effects of decision-makers regarding the mitigation and adaptation to various forms of impact. In this respect, a combined employment of indicators would bring important contributions to the decision-making process in the sense of identifying hot-spot areas, of directing the assistance towards them and of monitoring the effects of the decision-making processes. Usually, hot-spot areas are associated to severe forms of environmental degradation and to their impacts on local communities.

Most of the hot-spot areas are affected by various types of natural and technological hazards. In Romania, for example, frequent flash flood events, landslides, heavy rains and drought phenomena have caused severe damage over time. The Bend Subcarpathians is an area highly susceptible to landslides (Sandu and Bălteanu, 2005; Micu, 2008; Balteanu *et al.*, 2010). Urban infrastructural damages are frequent during heavy rainfall events (Dragotă, 2006), while large agricultural areas in the southern and south-eastern part of Romania are repeatedly affected by drought phenomena (Bogdan and Marinică, 2007; Clima României, 2008). Likewise, technological hazards in Romania are related to accidents caused by the active mining industry and their associated transboundary consequences (Bird *et al.*, 2003, 2005; Zobrist *et al.*, 2009; Sima *et al.*, 2011); water and sediment pollution from active and former mines which generate environmental degradation and, along with the socioeconomic structural changes, contributes to the deterioration of the living conditions of the local communities (Popescu *et al.*, 2003; Dogaru *et al.*, 2009); accidents from salt exploitations, as it was the case of Ocnele Mari, 2001, where the collapse of the gallery ceiling produced a sink-hole and a flood-wave hit the locality (Bălteanu *et al.*, 2006); pollution accidents which are the consequence of outdated technology (e.g. accidents in oil exploitations, in the chemical industry, in the hydrocarbon transport and distribution network, etc.).

It is obvious that the indicators must respond to the topic of the analysis. In this respect, the concept of anthropic pressure operates with those factors that generate changes in the state of the territorial system (e.g. geosystem). So, the purpose of the *anthropic pressure indicators is to measure the intensity and the magnitude with which the drivers are inducing changes that affect the functionality of the natural systems*, thus being a quantitative expression of the drivers of change. Therefore, indicator selection should closely follow the theoretical and analytical issues of the anthropic pressure concept specifically, and of the human-environment relationships generally, without losing sight of the purpose of the respective study. They should be finalized to the end by summary results, reports and/or composite indices (Fig. 1).

As mentioned before, the drivers of change could be direct or indirect, and depending on the scale of analyses, global, regional or local.

The direct factors are largely present in studies on climate change, biogeochemical changes, land use / land cover change, river regularization. Among these, land use changes are the most evident forms of anthropic influence, and the most studied ones in human-environment approaches. Moreover, various kinds of human works (e.g. against erosion, dams constructions, river regularization, etc.) are direct forms of interventions in the environment with implications on the state and functionality of the natural systems. Likewise, environmental pollution, effects of climate change on ecosystem services, overexploitation of resources, or inadequate exploitation of (non)renewable resources, etc. count as direct drivers of change.

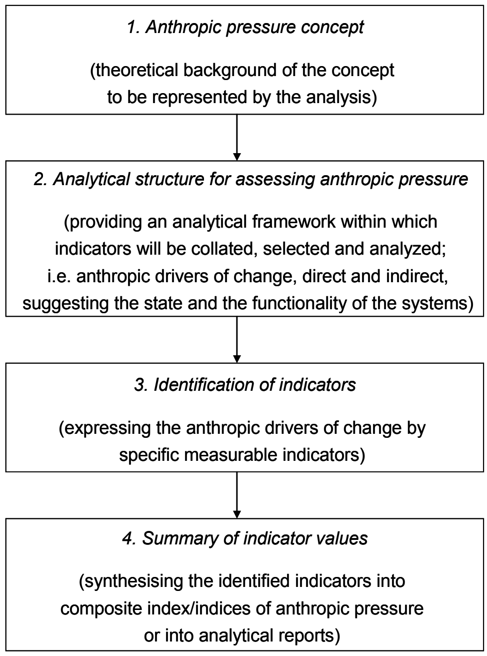

Fig. 1 – Scheme of indicator development (adapted from Wong, 2006).

The indirect factors are referring to demographic dynamics, consumption of resources, economic production and globalization, socioeconomic institutions, political contexts and technological development (Millennium Ecosystem Assessment, 2005). The economic, societal, political and institutional structural changes in Central and Eastern Europe, following the fall of the Iron Curtain and spanning over the transition period towards the market economy, can be considered a notable example of indirect drivers of anthropic pressure. Referring to Romania, the main types of economic restructuring over the last 20 years has entailed changes in the type of property, mode of production, forms of organization, development policies and relationships between the economy and the environment, as well as new demographic dynamics. The effects were seen in the economic decline and high levels of unemployment with many effects on the population's living standard, closure of many big, unproductive plants, decentralization of production, reconversion of industrial units and creation of new opportunities for territorial development, intensification of the external migratory fluxes, depopulation, etc. All of them form a suite of indirect drivers that both, induce/facilitate the environmental changes, and control the intensity and magnitude of the effects of these changes on society, particularly by influencing the levels of resource consumption and the sustainability of production. Moreover, the indirect drivers generate different levels of socioeconomic vulnerabilities to a broad range of stressors, such as climate change and natural and technological hazards.

Studies on environmental change and human-environment relationships underscore the necessity to connect social sciences to ecological/physical sciences (ICSU-UNESCO-UNU, 2008), emphasizing the anthropic factors and the integrative character of such studies. Worth reasserting is the fact that, depending on scale, anthropic factors could be grouped as global (e.g. climate change), regional/national (e.g. managerial decisions with effects on land use/land cover change) and local (e.g. land degradation processes).

Having in view the above-mentioned considerations, the anthropic pressure indicators must be representative for assessments of environmental changes which are induced by anthropogenic factors. Thus, the anthropic pressure is analyzed quantitatively by a series of measurable indicators. The use of indicators has to comply with the decision-making processes concerning a particularly managed problem, and thus, a support for the implementation of measures and management strategies.

Based on the factor-driven change and on various empirical studies of anthropic influence and effects on the environment (Curran and De Sherbinin, 2004; Millennium Ecosystem Assessment, 2005; Leichenko and O'Brian, 2008), the anthropic pressure indicators can be grouped into three major categories:

– population,
– economic growth and consumption/use of resources, and
– urbanization.

Current demographic tendencies, the increased consumption of energy and of land resources and the larger concentration of population in cities are some of the biggest challenges of our century, leading to the intensification of the human-induced impact on the state of the ecosystems and their services.

Population size and density are already prominent issues of the human-environment relationships research. One basic example in this respect is the fact that 13% of the world's urban population lives in spatially highly concentrated coastal areas, being increasingly vulnerable to global environmental change impacts (Fragkias, 2007). Other demographic processes (e.g. migration, ageing, poverty, etc.) alongside with the sociopolitical ones (e.g. the role of the state in relation to the private sector, levels of education, etc.) and cultural factors (e.g. values, beliefs, and norms shared among people) influence the level of resource consumption and the sustainability of production (Millennium Ecosystem Assessment, 2005). Most of these indicators are expressing the indirect drivers of change.

The economic activity has increased in all continents, raising the demand for resources and the levels of consumption. Along with it, development is very much connected with the socioeconomic policy, with technological progress and the use of resources, on one hand, and environmental changes and anthropic impacts, on the other. The per capita income is an indicator widely used in the economy to express the levels of productivity of food and/or industrial goods. An important issue related to this last aspect is the distribution of income and, subsequently, the differentiated process of socioeconomic development which shows the disparities between marginal and affluent areas. From this point of view, the spatial and temporal variability of socioeconomic situations relate to various types of land use, different schemes of allocation of funds, taxes and incentives, various flows of goods, services, capital, information, etc., suggesting the mechanisms with which such indirect drivers of change are operating.

Urbanization is one of the most relevant processes of the anthropic pressure equation, especially in what regards the increase of greenhouse gas emissions into the atmosphere, waste control and urban land use changes expressed either by urban space expansion or by changes of the urban morphology or by both. Based on recent demographic scenarios put forward by the United Nations (2007) and on the IPCC SRES scenarios (SRES – Special Report on Emissions Scenarios), it is estimated that urbanization (seen as urban population vs. rural population ratio) may contribute about 25% to the increase of emissions by 2100. According to the demographic scenarios, the key driving force of urbanization are the changes registered in the supply of manpower to the urban area, precisely the rising numbers of labour force which entailed huge consequences at the level of the economic growth (O'Neill, 2010).

It is worth mentioning that global change research has distinguished a connection between the production of goods and consumption of environmental resources, on one hand, and globalization and its effects on ecosystem services, on the other (Leichenko and O'Brian, 2008). One of the globalization effects is the homogenization of population behavior and attitudes towards consumption in the sense that peoples' preferences for a similar product is increasingly higher, thus reducing the diversity of production and resource consumption necessary for maintaining a normal functionality of the ecosystems (Schellnhuber *et al.*, 2004).

All these three generic categories of anthropic pressure indicators are associated with the elements that form peoples' well-being (living environment, incomes, available resources, etc.), thus representing a way of assessing the relationship between ecosystem services and human well-being. At the same time, they are representative for expressing the indirect drivers of environmental change, in particular, but also the direct factors, especially those referring to land use / land cover change. Table 2 presents a list of feasible anthropic pressure indicators which are grouped by three generic selection categories and which can be used in various analyses of the kind. Yet, the selection of the indicators is highly dependent on the aim of the study, spatial scale, regional specificity and data availability and accuracy.

Table 2

Anthropic pressure indicators

Population	*Demographic characteristics and/or dynamics* - Population size evolution; - Population growth rate and migratory balance; - Percentage of urban population out of the total and urban population growth rate; - Percentage of rural population out of the total; - Population age structure (relevance for the labour force supply on the labour market); - Birth/death balance and population ageing; - Population mobility; - Population density - …. *Social and/or well-being characteristics* - Education (school-age population, educational institutions and teaching staff by level of education, educational institutions by level of education, number and structure of graduates, etc.); - Health (medical-sanitary staff, hospital beds, etc.); - Poverty rate; - Unemployment rate and size; number of employees; - Structure of total household consumption expenditure; - Household demographic size; - .....
Economic growth and resource use / consumption	- Gross domestic product (total and per capita); - Working-age population by activities per national economic branches; - Labour productivity and income per person; - Energy consumption in industry, per industrial branches; - Employee number in the public and private sectors, per activities of the national economy; - Turnover of private units, by economic branches; - Percentage of R&D out of the total GDP; - Incentives for farmers; - Incentives for the energy sector; - Quantification of land use changes (i.e. type and size of the areas converted from one category of use into another); - .....
Urbanization	- Percentage of urban population out of the total population and urban population growth rate; - Density of urban population and of urban settlements; - Extension of the urban area; - Length of water supply network and of sewage system; - Number of days when atmospheric pollutants are in excess of the admission levels; - .....

6. CONCLUDING REMARKS

The human-environment relationships express the linkages and feedbacks between the biophysical and the anthropic components of a system. Studying them is as much a methodological question which requires the integration of biophysical and socioeconomic indicators through feasible models, as it is a conceptual issue related to the connection between the drivers of change and the effects of environmental change on society.

It is obvious that research initiatives on human-environment relationships cover complex, integrative and current societal issues. Such characteristics lead to the necessity to conduct the investigations in a systematic way, in line with the international mainstreams and frameworks on global environmental change, such as the, Earth System Science Partnership – ESSP, European Alliance on Global Change, International Council for Science – ICSU, Social Science Council, etc. In other words, there ought to be a common ground for research in order to reach the necessary consensus liable to directing decision-making processes towards sustainable actions.

A major aim of future research in the field of human-environment relationships is to reduce the information gaps concerning the state factors of the natural systems, the economic valuation and usage of ecosystem services, the location of thresholds where change may occur in the system, the environmental inferences derived from concentrations of population and economic activities, etc. Strong emphasis is being placed on the causal drivers of change (e.g. socioeconomic and political factors), the purpose being to identify anthropic pressure levels on the functionality of natural systems.

Policy-related analyses on environmental changes are another research topic of concern for the human-environment relationships community. They focus primarily on studies of the decision-making effects on the systems' dynamics. Subsequently, major topics of such studies cover aspects of institutional capacity to monitor changes, ecosystem services management and adaptation options to change. In this way, particular importance is given to the role of formal and informal institutions as coping mechanisms in dealing with complex interactions of biophysical and social processes and with the increase of systems' resilience to environmental change (de Sherbinin *et al.*, 2007; Fragkias, 2007).

Likewise, developing and combining climate, land use and demographic scenarios helps identify key anthropic stresses on various ecosystem services and build sustainable management responses to environmental change. From this point of view, creating and improving existent databases, including spatial and remotely sensed data, is a prerequisite for the development of multilevel models and scenarios of adaptation that would act as, both, instruments for policymaking and meeting points between the 'predictive' natural sciences, the semi-quantitative fields of economics and demography and the visionary elements of political and social sciences (Adger, 2005).

The above-mentioned directions could be perfectly integrated into one or more study topics of the human-environment research and comply with the general scheme of resource management stated by Lambin (2005). According to this scheme, *information* (i.e. assessing the current state of the environment, understanding the variability of natural systems and their dynamics under the anthropic influence, providing an accurate diagnostic on the causes of and solutions for environmental change, communicating the environmental information from local to higher-level decision makers without delays and distortions), *motivation to manage sustainably the environment* (e.g. the agents' attitudes towards use of resources, real costs of management practices that are usually ignored, persistent subsidies and tax incentives which in the long run lead to economic inefficiency and degradation of resources, conflicts of interest among agents, etc.), *capacity to adapt to change* (refers to resources, such as rules, institutions, technologies, etc. necessary to implement change) are the three main components of sustainable management of resources.

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