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EVALUATION OF ECOLOGICAL BELTS AND CORRIDORS IN TERMS OF SUSTAINABLE SPATIAL PLANNING WITH SPECIFIC REFERENCE TO THE ISTANBUL CASE

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Abstract. Socio-economic and spatial development tendencies necessitate urgent, multi-dimensional and integrated measures for Istanbul, which highlight once more the importance of sustainable spatial planning for availing appropriate orientations to the human ecology and the future of mankind in general. Spatial planning could be used as an operational instrument to coordinate ecologically sound socio-economic development by aid of pro-active and preventive as well as protective approaches for natural and cultural environments. The sustainable spatial planning for Istanbul, however, requires a certain scenario based on functional continuity of the life-support systems, which are crucial for the entire metropolis and deserve to be regarded with priority in planning and management processes. In this study, the evaluation was considered as the initial step of sustainable spatial planning for the Istanbul metropolis, in which ecological belts and corridors were treated as essential macro-spatial elements. These prime elements were therefore determined as the main guides for design of the prospective metropolitan macro-form model, which would comprise local urban management issues and give projections to lower-scale planning studies from higher-scale viewpoints in hierarchically organised spatial systems.

Keywords: sustainability, spatial planning, environment, Istanbul, metropolitan management, ecological belt, ecological corridor.

AIMS AND BACKGROUND

The demographical and economical structures as well as the current physical development tendencies of Istanbul constitute the core of problems reflected in all dimensions of life, which hinder sustainable development of the greatest metropolis of Turkey. This situation necessitates urgent, multi-dimensional and integrated measures for Istanbul in particular, which highlight once more the importance of sustainable spatial planning for availing appropriate orientations to the human ecology and the future of mankind in general.

Sustainable development requires improving the integration of three interdependent aspects of development, namely: (i) economical, (ii) social and (iii) environmental. Spatial planning meanwhile could be used as an operational

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instrument to coordinate ecologically sound socio-economic development by aid of pro-active and preventive as well as protective approaches for natural and cultural environments. The challenge for planning is to ensure the efficient allocation and rational utilisation of limited financial and human resources, which include nature and landscape, soil, water and air as well for achieving a balanced development. Since spatial planning envisages a long-term perspective by its nature, it is indispensable to incorporate important principles of sustainability[1] into the methodological approaches tailored for meeting factual local needs in order to ensure effective practices.

The sustainable spatial planning for Istanbul requires a scenario based on functional continuity of life-support systems, which are crucial for the entire metropolis and deserve to be handled with priority in planning and management processes. In the survey carried out for Istanbul under such a viewpoint, spatial data at 1:100 000 scale were collected by late 2005 and early 2006. This phase has been followed by conducting an environmental sustainability evaluation. Such an evaluation was considered as the initial step of sustainable spatial planning for the Istanbul metropolis, in which ecological belts and corridors were treated as essential macro-spatial elements. These prime elements were, therefore, determined as the main guides for designing the prospective metropolitan macro-form model, which would comprise local urban management issues and give projections to lower-scale planning studies from higher-scale viewpoints in hierarchically organised spatial systems.

The surveys related to the ecological belts surrounding the Istanbul metropolis in the north and to the ecological corridors as their southward extensions, yielded in two important consequences. The first one is the necessity to assign usage characteristics to the areas considered as ecological belts and corridors with particular attention to associated requirements for perpetuating and/or regaining their functions. The second one is the importance of taking the ecological belts and corridors as nature-based references at all phases of hierarchical planning processes, which give orientation to the local re-structuring endeavours in high density urban areas at lower-scale planning engagements to be carried out in compliance with the Master Plan of Istanbul at 1:100 000 scale.

Ecological corridors. Ecological corridors can be landscape structures of various size, shape and habitat composition that maintain, establish or re-establish natural landscape connectivity. They can have either a continuous or interrupted structure or even the structure of a stepping-stone. Ecological corridors always exist in natural landscapes and fulfill diverse functions. Most obvious of these are being migration routes for birds, ant-routes, badger routes and river corridors for fish migration[2]. Ecological corridors are rarely mono-functional in ecological and societal sense. They are not core areas but they rather function in wider landscapes

by encompassing natural and human features. Ecological corridors can be classified from predominantly natural to predominantly cultural areas as:

- landscape linkages based on long linear protected areas between large ecosystems including continuous rivers;
- conservation corridors with less protected areas which are often along rivers with recreational facilities;
- greenbelts based on protected natural lands surrounding cities to balance urban and suburban growth;
- recreational corridors based on linear open spaces with intensive leisure use;
- scenic corridors based on primarily protected areas for their aesthetic quality;
- utility corridors based on canals, power lines, etc. that have infrastructure functions but also serve for public purposes as well;
- natural corridors based on designated jogging, wandering and biking tracks for outdoor refreshment and training activities.

Relying on the afore-mentioned prime ecological assets and relevant consequences of their planning-related studies and surveys, the article will elaborate on a systematic approach for performing and presenting a pragmatic planning instrument as exemplified in the case of Istanbul. Extending such a methodology to similar planning assignments, where sustainability is paramount, would be an occasion for potential cooperation as anticipated by the organisation of the international workshop on 'The Importance of Ecological Belts Surrounding Metropolitan Cities'.

AIMS OF THE SUSTAINABILITY STUDY FOR ISTANBUL

The study pertaining to practicing the sustainability principle as a partial but essential fulfillment of the Master Plan of Istanbul which was carried out under guidance of the policies related to an integrated approach towards planning and management of land resources. These policies have been amply specified in Agenda 21 of the Rio Conference held in 1992. In this context, the ideal objective of the study was defined as to produce a locally and internationally acknowledgeable paradigm for the implementation of these policies in the case of Istanbul.

Connectedly, the missionary aims of the study were: (i) to identify the landscape linkages and to delineate large linear protected areas between broad ecosystems in Istanbul, which are referred to as the ecological belts; (ii) to define the southward extensions of the ecological belts, which are referred to as the ecological corridors; (iii) to formulate main policies and implementation strategies to produce a guide for the local administrative and urban managerial involvements in lower-scale planning processes; (iv) to demarcate clues of integration between highly urbanised land use forms and ecological corridors, and under the guidance

of all these steps, and (v) to determine an appropriate macro-form model with sustainable spatial planning foundations for the future development of the Istanbul metropolis by all means.

Integrated approach to the planning and management of land resources. Land is normally defined as a physical entity in terms of its topography and spatial nature. A broader and integrative view also includes natural resources: the soils, minerals, water and biota that the land comprises. These components are organised in ecosystems which provide a variety of services essential to the maintenance of the integrity of life-support systems and the productive capacity of the environment. Land resources are used in ways that take advantage of all these characteristics. Land is a finite resource, while the natural resources it supports can vary over time and according to management conditions and uses. Expanding human requirements and economic activities are placing ever increasing pressures on land resources, creating competition and conflicts and resulting in suboptimum use both of land and land resources. If, in the future, human requirements are to be met in a sustainable manner, it is now essential to resolve these conflicts and move towards more effective and efficient use of land and all related natural resources. Integrated physical and land-use planning and management are eminently practical ways to achieve this. By examining all uses of land in an integrated manner, it is possible to minimise conflicts, to make the most efficient trade-offs and to link social and economic development with environmental protection and quality enhancement, thus helping to achieve the objectives of sustainable development. The essence of the integrated approach finds expression in the coordination of the sectoral planning and management activities concerned with the various aspects of land use and land resources management[3].

EXPERIMENTAL

APPLIED METHODOLOGY FOR ISTANBUL

The sustainability study for Istanbul was carried out within the administrative borders of the Istanbul metropolis at 1:100 000 scale. As presented in Fig. 1, the study was realised at three stages, which are basically composed of: (i) setting up the concept and the principles of sustainability (as a general framework); (ii) conducting a 'from-top-to-down' oriented spatial assessment for typifying spatial clusters with due regard to defining respective strategies (as consistent policy instruments for combating environmental pressures and socio-spatial disparities for balanced developments) within the framework of environmental sustainability concept, and (iii) identifying and/or re-formulating the administrative units with particular reference to typified spatial clusters (as action areas and locations for urban management and metropolitan governance approaches), which have to be

developed in compliance with the environmental sustainability and public participation concept.

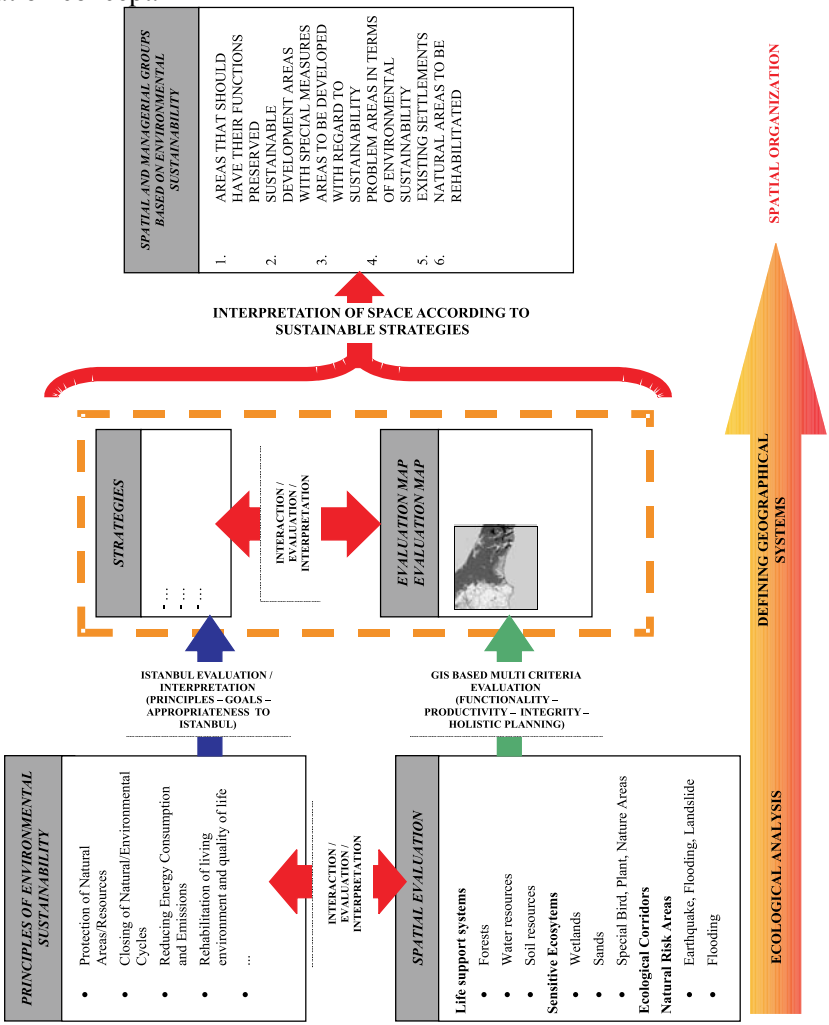

Fig. 1. Methodological approach towards environmental sustainability for Istanbul

At the first stage, the sustainability concept and principles were investigated and defined upon a thorough perusal of domestic and international literature on these issues. At the second stage, these definitions were referred to as building blocks of a conceptual framework for assessment of the metropolitan spatial and life-support systems, which encompass ecological corridors, sensitive eco-systems and natural risk areas within and around the settlement structure. The studies and surveys for determining the natural limits and thresholds have been realised at 1:100 000 scale within the administrative territory of the Istanbul metropolis and also the Istanbul

province, whereby compiling and integrating maps and reports were accomplished in order to ascertain the spatial and natural structure of the area.

In this context, at the second stage: (i) an analysis of natural structure and ecological sensitivity has been carried out; (ii) areas possessing natural and ecological integrity have been determined; (iii) data pertaining to natural risk areas were processed, and (iv) ecological corridors as life-support systems have been identified. Subsequently, main policies and implementation strategies for sustainable spatial planning were formulated. Although a wide range of strategies for sustainable development had previously been elaborated within diverse frameworks for planning of Istanbul, those which are closely related with environmental sustainability and possess specific focus on the city life-support systems were taken into account throughout the study.

At the third stage, life-support systems, ecological corridors and land use data layers were combined and comparatively evaluated in order to distinguish between appropriate and inappropriate land use practices from an environmental sustainability viewpoint. This availed a solid basis for assessing the impacts and pressures of the man-made environments on the natural environments.

Such a methodological approach made it possible to indicate adequate areas for urban development and expansion as well as those which require betterment measures and protection actions in order to avoid unintended pressures and detrimental impacts on the natural structure for the sake of sustainability as presented in Fig. 2. Purposeful compiling and precise processing of data resulted in an 'Environmental Spatial Sustainability Synthesis for Istanbul'. The findings of this stage were collaboratively evaluated with other sector specialists with due regard to current development tendencies. The matching of available natural potentialities and restrictions with development trends and space requirements provided a rational basis for configuring a basic macro-form model which includes spatial clusters with particular characteristics.

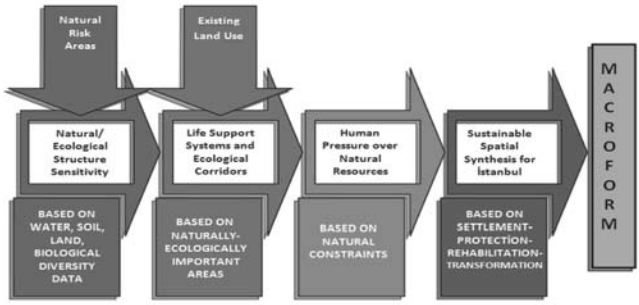

Fig. 2. Sustainable spatial assessment process

NATURAL AND ECOLOGICAL STRUCTURE SENSITIVITY ANALYSIS

Natural and Ecological Structure Sensitivity Analysis was realised in the course of the study by considering the functionality of nature as well as the integrity and fragility of the ecosystems and structures, on which pressures could have irreversible effects. The analysis of concern was realised with respect to diverse data sets which were deemed necessary for environmental sustainability. These were primarily related to:

- water resources (hydro-electrical structure analysis, surface waters and river basins),
- land resources (land utilisation classes, topography, slope analysis),
- biological varieties and ecological structure (flora, sensitive ecosystems, protected areas).

The data layers as constituents of each information set were transferred to the 'Natural Structure Assessment Matrix' (Table 1), whereby an ordinal scale based grading for assessment including a ranking system ranging between '1' (the least important) and '5' (the most important) was applied to all layers.

Using a natural structure evaluation matrix, firstly, the to-date settled areas were interrogated for sustainability as based on the geographical information system (GIS). For this purpose, the data layers related to the natural structure were transferred to Arc-GIS and those locations found suitable after being matched with 52 variables were classified according to their ecological characteristics; such as 'integrity', 'functionality' and 'fragility'. Pursuant to classifying and grading each data layer on the matrix, the borders of the typical areas were defined with regard to the cumulation of recorded grades. Application of cumulative grading method to each data layer resulted in the hierarchical categorisation of areas under 5 main groups, respectively.

Upon completion of the evaluation, it was understood that the data layers would provide inputs for further and lower-scaled planning approaches and connectedly for local administration, urban management and governance related studies. In this regard, spatial and administrative units were classified in 3 main groups by taking into consideration the purposeful utilisation of data layers as decision aids for development.

The data layers which have been subjected to the natural structure sensitivity analysis comprised gradual steps of sensitivity ranging between; (i) those which have inevitable importance and therefore require precautious protection, and (ii) those which have tolerance for human activities but require optimum utilisation.

Table 1. Natural resources evaluation matrix

Criteria	Points				
	1	**2**	**3**	**4**	**5**
1	2	3	4	5	6
Water					
Hydro-geological structure analysis					
extensive unconsolidated aquifer formations					×
extensive consolidated aquifer formations					×
local unconsolidated aquifer formations				×	
local consolidated aquifer formations				×	
local aquifer formations			×		
formations without groundwater	×				
Surface-underground water resources					
surface water resources (lake, dam, etc.)					×
underground water basin (aquifer)					×
inner-basin rivers				×	
inner-basin creek without water			×		
outer-basin rivers				×	
Soil and land					
Soil (land use classes)					
1st class					×
2nd class					×
3rd class				×	
4th class				×	
5th class			×		
6th class			×		
7th class		×			
8th class					×
Slope (%)					
> 30					×
15–30			×		
0–15	×				
Biological diversity and ecology					
Plant cover					
forest areas					×
private forest areas		×			
Ecologically and biologically important areas					
areas with ecological and biological importance					×
Protection zones					
nature reservation areas					×
wildlife reservation areas					×

to be continued

Continuation of Table 1

1	2	3	4	5	6
game reserve and game breeding areas					×
high forests					×
natural protection areas (class I)					×
natural protection areas (class II)				×	
natural protection area (class III)				×	
natural parks				×	
recreational areas			×		

RESULTS

With the aid of pursued method and obtained assessment via the matrix (Table 1) based on GIS, the natural structure sensitivity analysis (Fig. 3) was generated. Connectedly, the derived evaluation from the sensitivity analysis was matched with the other natural resource data layers with specific emphasis to the data layer pertaining to forest areas, for which protection and management status has been recognised in legally strict terms. The output of the overlay analysis was the natural and ecological integrity layer as presented in Fig, 4.

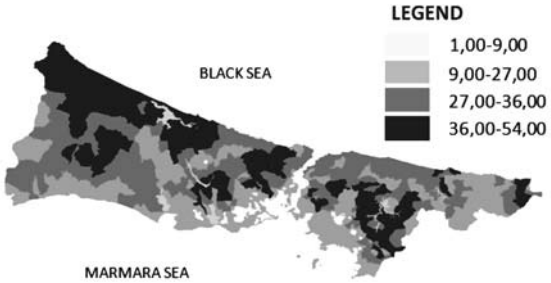

Fig. 3. Natural structure sensitivity analysis

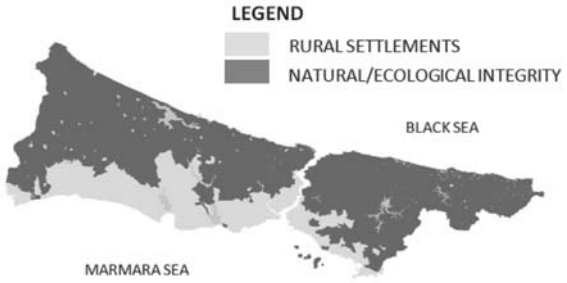

Fig. 4. Areas with natural and ecological integrity

While the determination of ecological integrity areas for the realisation of the human activities on them without any detrimental effect is relevant, on the one hand, natural risks and the affected areas also have to be taken into consideration, on the other. Within this framework, the data layer presented in Fig. 4 were matched with natural risk areas of Istanbul (Fig. 5) in order to obtain safeguard areas with natural and ecological integrity as revealed in Fig. 6.

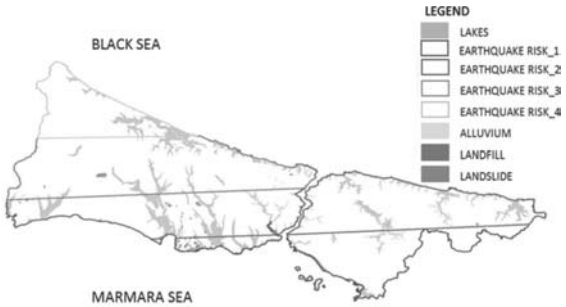

Fig. 5. Natural risk areas

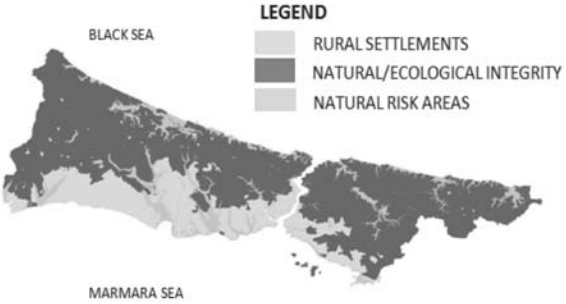

Fig. 6. Safeguard areas with natural and ecological integrity

In the proceeding steps of the study, the natural integrity and natural risk area data layers were overlaid with the borders of fresh water basins. The consecutive step was to identify the borders of the settlement areas, which led to a perception of human habitats within their environmental context as characterised by safeguarded ecological and natural integrity areas. At this stage, the life-support systems of the Istanbul metropolis were identified in northern vicinities, which have southward extensions in the form of corridors as shown in Fig. 7. Such an approach offered an adequate basis to deal more effectively and rationally with local problems within the scope and contents of lower-scale planning assignments.

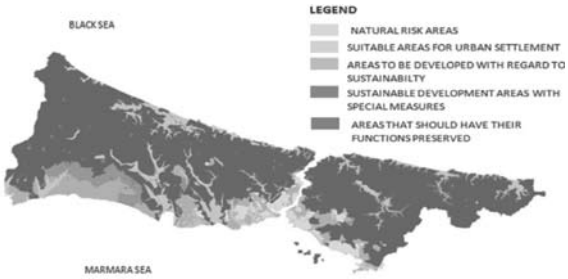

Fig. 7. Life-support systems and ecological corridors

The data layers encompassing the life-support systems and ecological corridors were used to identify the spatial clusters and administrative units in Istanbul, which could well include several neighbour districts as responsibility areas of local government agencies. In this respect: (i) areas that should have their functions preserved; (ii) areas of sustainable development with special measures, and (iii) areas to be developed with regard to sustainability, were defined. Additionally, a life-support system data layer is matched with present land use and physical development tendencies along with on-going quarrying and mining operations. These are the human activities exercised on the natural and geographical setting, which have obvious adverse impacts requiring counter measures for environmental quality upgrading in Istanbul.

As a result of individual elaboration, evaluation and estimation of all layers used during the analysis, the 'Environmental Spatial Sustainability Synthesis for Istanbul' was achieved as an instrumental basis for making decisions pertaining to habitation, protection, rehabilitation and transformation actions. A subsequent output of the analysis was the generation of the synthesis layer, through which 'Spatial and Administrative Units Based on the Environmental Sustainability' were defined (Fig. 8).

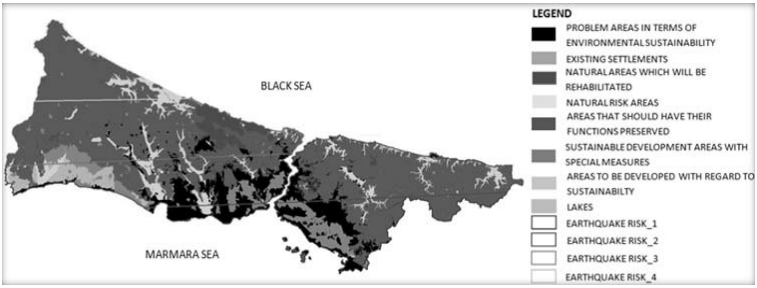

Fig. 8. Spatial sustainability synthesis for Istanbul

Spatial and administrative units based on the environmental sustainability were defined as: areas that should have their functions preserved; areas suitable for

sustainable development with the aid of special measures; areas to be developed with regard to sustainability; problem areas where environmental sustainability is seriously endangered; existing settlement areas, and natural areas to be rehabilitated.

The strategic principles to be followed with respect to the outcome of 'Spatial and Administrative Units Based on the Environmental Sustainability' study underlined the significance of the sustainability of Istanbul with its natural environment for increasing the life standards of its inhabitants. In this context, the strategic aims were defined as:

- protection of natural areas and ecological resources,
- decreasing energy consumption and emissions,
- closing natural cycles for recyclables,
- improving human life environment,
- minimising risks created by the mankind and nature,
- undertaking value estimations for natural assets, and
- monitoring the environment.

In conclusion, the findings of the study were referred as the guidelines for the design of a 'socio-economically' functional and rational as well as 'ecologically' sustainable macro-form model for the Istanbul metropolis (Fig. 9). In accordance with the natural limits and ecological thresholds, certain spatial clusters are determined which either require transformation or management actions for ensuring environmental sustainability.

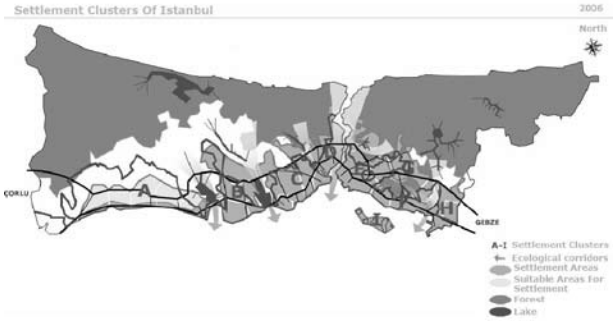

Fig. 9. Macro-form modelling approach in accordance with natural thresholds

CONCLUSIONS

The recent demographic, economic and spatial development inclinations reveal serious symptoms whilst sectoral projections reflect emergency signals indicating that the city own life-support systems will 'in addition to the present situation' be under considerably high pressure. The apparent connection between the natural areas and the quality of human life require holistic and integrated measures to be taken without any delay for Istanbul fragile geography.

Comparison of consequences to be drawn from the realised sustainability studies with current and prospective development trends indicates that Istanbul genuine natural structure has to be preserved, environmental quality has to be upgraded, ameliorations have to be planned and realised in accordance with sustainability principles, quality of life has to be raised, spatial development and urban management approaches have to be elaborated on the basis of the macro-form model as designed with due regard to macro-environmental determinants.

All the analyses and evaluations made during the research and planning study proved that the policy actions adapted for Istanbul should have their central focus on: improving the present situation and quality of life rather than searching for suitable places to inhabit new immigrants in the city; protecting the life-support systems from degrading activities of human beings; taking technical and social measures to protect people from natural disasters; decreasing the pressure on the natural resources, and putting principles of environmental sustainability into practice.

Although all findings of the study provided clues for many follow-up studies, two of them found to be crucial for lower-scale priority planning approaches in Istanbul. The first one is the necessity to assign usage characteristics to the areas considered as ecological belts and corridors in order to achieve functional continuity of life-support systems situated around the metropolis. The second one is the importance of taking the ecological belts and corridors as nature-based references at all phases of hierarchical planning processes, which could well give orientations to the restructuring and rehabilitation of high-density urban areas at lower-scales in compliance with the Master Plan of Istanbul.

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