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THE TOPICALITY OF GEONOMY

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Abstract: Elemér Szádeczky-Kardoss realized that the entire material and spiritual culture of mankind constitutes an interconnected system, which he named geonomy. He established environmental science, identifying the need for network research. With the use of geographic information systems (GIS), IT technology expands the possibilities of recognizing, interpreting, and examining transdisciplinary connections in their dynamic relationships in many areas. The starting point of environmental modeling is the fact that the processes to be studied take place in a common space – in the field of interpretation of the earth sciences this is the landscape, the space in which the natural, social and economic processes take place, so the study of sustainability is a spatial, multi-faceted decision-making task. We need to reconcile the goals of population preservation and of production with social, cultural and environmental stabilization and nature conservation tasks. The map based decision support we propose provides the exact possibility of multi-aspect decisions in a complex, spatial system. The key to solving this problem is the grouping of the "Big Data" data set, the structuring of the data groups and then the harmonization of the data layers.

Keywords: *environmental science, spatial, multidimensional decision, map decision support, harmonization of data layers*

1. MAPS AND GIS SYSTEMS

The previously unimaginable development of the IT technology toolkit with the use of GIS (geographic information systems) expands the possibilities of recognizing, interpreting, and examining transdisciplinary relationships in their dynamic relationships in many areas. It makes sense that the starting point for the application of dynamic GIS in thematic maps is an expediently structured database.

Although a handmade mining map made in Selmecbánya (Banská Štiavnica) (Mikoviny 1746) is known as the first "overlay map system", this method was soon forgotten. We first used it with István Klinghammer (1994) as a traditional static thematic map system, as an environmental decision support method. The transparent map sheets containing relevant environmental information can be overlapped, so that different combinations of these provide the opportunity to recognize the relationships between influencing factors and the affected variables and the consequences of environmental use in a given space, going beyond previous map representations that only visualize relationships. A brief professional guide draws attention to the possibilities of these. A significant departure from the practice of previous map representations is that the measured data are represented at the measurement point, providing ample space for professional evaluation. (The significance of this is given by the fact that, for example, there can be many changes **between** two measuring points, even showing the same data, e.g. dilution from groundwater and further pollution, etc.!)

Under the guidance of Tamás Rapcsák, we performed the water quality modeling of the Soroksár Danube branch using mathematical methods developed as a support for multi-aspect decision making, where the results of model computations were made compatible with each other in thematic maps. (Balla et al. 1999)

In the preparation of an environmental impact study, the possibility of spatial confrontation of influencing factors and the affected using this method is of particular advantage. During the planning, the overlay system formed from the relevant thematic maps makes it possible to coordinate the needs and opportunities appearing in the same space – the preliminary environmental impact study of the South Buda-Rákospalota (4th) metro line has already proved this (2002).

GIS-based *environmental monitoring* covering the Ipoly catchment area (Miklós et al. 2014), proved that a database built on thematic maps and GIS systems based on traditional geological, hydrological, biological and soil maps can ensure the interpretation and examination of dynamic relationships.

Modeling including the dynamics of complex environmental systems allows development toward *environmental safety* applications (Balogh et al. 2015, Csikós et al. 2015]. By implication, this includes the examination of the effects of environmental elements endangering social facilities, as well as the modeling of the environmental consequences of possible accidents and breakdowns. The modeling of flood inundation for the Bódvár River and then the Hernád was already based on the dynamic modeling of GIS with special mathematical tools (Németh–Dobos 2015).

2. Geonomy

In the obituary of the late Tamás Rapcsák (1947–2008), his colleagues draw attention as a novelty to the fact that "environmental decision-making tasks are essentially multi-faceted decision-making tasks, since environmental aspects such as water, air, noise, vibration, etc. should be taken into account, together with other social, economic and financial aspects. Multi-faceted environmental applications have also opened up new directions for development. GIS systems have proved to provide effective tools for collecting information related to the task of decision, displaying them on a map, and examining time-dependent dynamic relationships. Developments and applications related to multi-faceted decision support have also raised important theoretical and methodological issues." (1994)

There is no doubt that LANDSCAPE is the space in which all the activities of our lives take place. All of the natural, social and economic processes that are the inherent biological and/or social – and consequently also the economic – needs of our existence take place in the landscape. The essence of this was already formulated by Pál Teleki (1917) a hundred years ago, and then the "geographical idea" was filled with exact earth science content by Elemér Szádeczky-Kardoss (1974). He recognized that the entire material and spiritual culture of mankind formed an interconnected system, which he referred to as **geonomy**. He laid the foundations for **environmental science** (Verrasztó 2019) and identified the need for network research today. "This is an impossible challenge for one person, but only one person can do it in a unified approach," praised posterity (Benkő F. 2003). Szádeczky-Kardoss's discovery was based on the discovery of the law of cycles: "Clay-phyllosilicate sedimentation provides the material connection between the solid earth and the mobile zone (hydro-, atmospheric-, lithosphere)… it is… one of the most important foundations of the specific development direction of the Earth… which constantly refreshes the surface used by life processes and ensures its ability to sustain life at all times… The pollution of civilization upsets this balance."

The last hundred years have been characterized by an incredible expansion of knowledge. The improvement of research tools and the proliferation of data and information require the deepening of specialization, which has also resulted in the disintegration of knowledge and the segregation of sciences. In opposition to this, he formulated the need for **synthesis**: "*Geonomy is not only the investigative unit of the earth sciences, but it also comprises the basic biological subject of the origin and inorganic determination of life. The real meaning of geonomy is not in the details, but in the study of the relationship between the details… According to the new results of geonomy, the Earth is a unified active system, each zone of which is connected to the others…*The world explored by physics and chemistry is not the whole of reality. Reality implies complexity." (emphasis added) (Szádeczky-Kardoss 1974) "Earth science research must be approached consciously from two sides: On the one hand, maintaining immersion and precision of the usual professional details, and on the other hand, introducing a generous approach to a synthesis of hitherto unimaginable size. The results of geonomy affect the totality of sciences and are important for the general approach and public education" (Dudich 2003).

The "hitherto unimaginable generous approach to synthesis" is made feasible by today's IT toolkit. At the same time, the synthesis must have a basic structure of systems science, and its scientific result must be the recognition and scientific foundation of network connections. As a practical benefit, we can use *environmental modeling* to base all decisions that affect ***sustainability*** in an exact *multi-criteria decision support system*.

3. SUSTAINABILITY

The real meaning of protecting the environment and nature is to ensure the **sustainability** of our social existence: a development process resp. an organizational principle that "meets the needs of the present without reducing the ability of future generations to meet their own needs". But what are the realistic needs of the present and the future?

The answer to this question would be based on a multitude of social decisions, the common problem of which is that they are ***value-based***. Not only do the diverse social evolutions of ethnic groups influence consumption habits, cultural differences, and different value choices, but our needs for the environment, our habits, our individual tastes, and family traditions also diversify the components and indicators of our wealth and well-being.

The specifics of society's environmental conflicts are, in fact, clashes of concepts of land usage. The expectations of interest groups and the differences of social needs are determinative factors in this, but the conflict of the needs, opportunities and interests of the past and the future is also concentrated in this.

What cannot be the subject of debate is ***natural sustainability*** – behind it are often still little-known but unquestionable natural laws, exact networks of relations, causal connections. We can examine the causes and effects in an exact way through their indicators, we interpret the relationships between the influencing factors and those affected – establishing the protection of our environment, recognizing the necessary and possible measures.

We cannot ignore the fact that many people demand the protection of the environment as **resource protection**. This is undoubtedly a rational concept – at the same time we need to see that a resource is a changing need, a concept that changes in space and time. The demand for flint of our Stone Age ancestors was then more important than energy carriers to us today! Ensuring the sustainability of our social groups and our diverse natural environment requires different resources!

Here we have to mention the concept of the so-called "ecological services" that is prevalent today – where we object in principle to the fact that it regards the satisfaction of value-driven social needs as the starting point as opposed to the unquestionable demand of adapting to natural conditions.

If we want to satisfy today's scientific needs in planning for the future and make use of the possibilities of research and planning provided by modern IT technology, the changing interpretations are out of place; we need an exact use of concepts in environmental protection, nature conservation and spatial planning; we need to interpret, study, and model sustainability for coming generations.

In order to achieve this, the expectations must be enforced not only more effectively than at present, but also with the requirements of systems science and multi-faceted decisions, using IT tools in all regional and economic development concepts that determine the future, environmental use, landscape, the connection of society and its environment!

Today, the European Landscape Convention (Florence 2000) also defines further concepts of *environmental protection, environmental safety, environmental policy, nature protection, regional development and spatial planning* as international commitments (Verrasztó 2017, 2018). The synthesis of all these includes all the demands that we have to satisfy in the spirit of *geographical thought*, with the scientific need of *geonomy*, in order to protect the *unified environmental system* and to meet the need for sustainable development:

"The landscape…

…plays an important role of public interest in the cultural, ecological, environmental and social fields and acts as a resource to support economic activities, the protection, management and planning of which can create new jobs;

…promotes local cultural development and is an essential element of Europe's natural and cultural heritage;

…contributes to people's well-being and the strengthening of European identity;

…it is an equally important part of people's quality of life everywhere: in cities and villages, in degraded and pristine areas, in places that are considered particularly beautiful and places without such qualities," says the European Landscape Convention.

With the need for sustainability, the role and perception of the rural landscape, nature and the environment have undergone significant changes. In addition to the historical task of the rural area, other functions come to the fore. **The "countryside" is not only the scene of agriculture, but also a biological and social habitat.** The community that preserves traditions, the cohesion factors of society, the ecosystems are also functions of nature, environmental, and landscape protection that serve the interests of the community, that produce consumption and service as well as "public goods". If land use and other interventions are driven solely by the need for production, natural and social relations and living space functions will be jeopardized, but the economy cannot be without diversity either. Degradation of the environment leads to a decline in production and poses a serious threat to human living conditions.

Today, urbanization and industrial "development" are growing – in an unsustainable manner – in the same space at the expense of each other, and social and economic activity is growing at the expense of natural life, increasing human health risks and reducing biodiversity. A system of nature and environmental protection based on passive post-sanctioning is not indispensable either, but it is of doubtful efficiency in enforcing interests. The possibilities of our time with the application of IT technology (Verrasztó 2017, 2018) must create a demand for exact territorial planning, which, using *multi-aspect decision support*, establishes all the development concepts and land use needs that have to be coordinated in the shared space – in the landscape**.** Production goals must be coordinated with the increasingly important tasks of population retention, social, cultural and environmental stabilization, and nature conservation.

4. Environmental modeling

The insights of the last half century have led to the social need, political expectation and administrative enforcement of environmental protection (see environmental and nature protection legislation), but their practice has not kept pace with the demands and possibilities arising from the development of either science or technology. We have known for a hundred years from the Academic inauguration speech of chair holder Pál Teleki that the natural and social effects are congregated in the complicated, multi-complex system of the Earth. Geonomy concretized the processes taking place on Earth. The effects of economic activity – its needs and consequences – are undoubtedly realized in those influenced by the natural and social processes. In examining these, we can surpass today's – very limited – practice if we can provide the possibility of exact environmental modeling, which in turn presupposes a number of things:

- the exact use of terms (environment, environmental data);
- exact examination of the territory (environment, landscape, river basin, region) ensuring the system control;
- clarification of spatial data relations (system of landscape factors, common social space, economic relations, etc.);
- definition of aspects of group formation (natural, social and economic components);
- awareness of the basic environmental condition;
- awareness of the process of changes (transport processes, historical and/or social changes, etc.);
- a database that provides the possibility of thematic, spatial, and temporal structuring.

As the starting point of environmental modeling – a tool for the spatial interpretation and examination of **sustainability** – we must see that the environment is a **dynamic system**, and the data set to be examined consists of several subsystems. The dynamics of the subsystems as well as the dimensions, units and properties of the data differ significantly. The change of many elements of change is *not* dynamic; however, natural, social and economic sustainability can only be interpreted by their interconnection based on their contexts and spatial relationships. The exact interpretation and examination of this complex system has so far encountered a number of obstacles.

In addition, a major shortcoming of current practice is that

- there is no social consensus on the environmental objectives and individuals with different life situations, different social groups have different environmental needs;
- there is no scientific consensus on the actual state of the environment;
- economic interests overshadow the territorial, spatial consequences, benefits, damages of the use of the environment;
- the groups involved in the decision-making process have very different demands and their advocacy capacity also differs significantly;
- the groups involved in the decision-making process do not have sufficient knowledge or depth of information about the real consequences of their decisions that are distant in space and time.

It should be noted that economists dealing with the topic point out that the results cannot be condensed into a single measure (as they are based on a variety of arguments) and therefore their generalizability is limited.; this is one of the major disadvantages of the multidisciplinary and participatory evaluation methods used so far.

On the other hand, we would like to point out that it is not even expressed as their demand:

- to study the natural systems in their complexity,
- to specify the factors of influence and those exposed to them,
- for professional consideration of the consequences exerted upon those subjected to them,
- to consider the consequences over time,
- to weigh the potential consequences, which again cannot be concentrated in a single measure,
- for evaluation of the non-generalizable, unique characteristics of the subsystems of the environmental-social system operating as a network.

The **map-based decision support method** we propose includes the demand and possibility of multi-criteria decision support, while it does not need to condense the result into a "single unit of measurement". An infinite number of variations of relationships, alternatives, and the consequences of their spatial and temporal changes can be examined by interconnecting data systems structured in thematic maps. The method is suitable for the exact examination of that spatial decision – the consequences of the decision – which explores the complex and dynamic system of natural, social and economic relations taking place in the *landscape as a given space – in its own system of context.* The key phrase is its *"own system of correlations"*, as the interactions between natural and social and closed inanimate and open living systems within their own systems, as well as their interactions with each other, but also their components, are different and require qualitative or quantitative assessment.

Obviously, the method's accuracy and professional depth depend on the current data upload. The advent of digital cartography, – the digital storage, management and processing of cartographic data – has made it possible to renew this traditional methodology as an essential interface for the operating system of spatial decisions. By its application we visualize what is being said in each field, and at the same time we create the interface for all the relevant factors with which we want to examine the spatial and temporal relationship.

The development of digital maps primarily requires an adequate amount and quality of data. The digital recording of spatial relationships is not necessarily related to cartographic activity; moreover, the purpose of data collection during the establishment of GIS systems is not primarily for cartographic use. Data collection can be independent of graphical methods and can lead to the construction of a database that in most cases contains the following types of data:

- a spatial reference system;
- qualitative and/or quantitative indicators;
- temporal aspects;
- a situation in an environmental relationship system.

The stored data are not characteristic of the map per se, as they are to some extent independent of scale, projection, sectioning, etc., while the ***background maps*** provide an illustration of the relationship with geographical factors, the indispensable visualization. It is advisable to use different systems for maps of different scales – and consequently with different information content – but its selection should be significantly influenced by the specific case-specific objective to be defined, the thematic content to be represented and examined and its target system.

The **map-based decision support** solution we have proposed and developed is suitable for placing the demand and possibility of *multi-aspect decisions* on an exact basis. It presents an alternative with advanages to the previously used social decision-making practice since the ***factors of influence and those exposed to them*** can be linked quite exactly in space and time to a **given, specific land use** – represented and separated in thematic maps, using surface symbols – with the assumed, envisioned and modeled land uses – even up to their sustaining capacity, projecting into the future to the sustainability of the natural, social, and economic components.

“As an interpretive geophysicist, I was faced with the fact that there are plenty of application programs around the world that deal with data collection (which is understandable), yet there are very few projects that focus on geological interpretation of data (which is less understandable). Interestingly, this problem arose as early as 1967 during the debate on plate tectonics theory, formulated by JT Wilson in this way: ’They immersed themselves to such a degree in improving technical procedures, accumulating data, and designing a computer system for storing information as to forget that other sciences have made their problems easy to understand by formulating new principles’ ” – thus, in fact, coming closer to solving the problem…

Magnetic data providing national coverage are now available in almost all countries, which, in addition to examining the oceanic crust, also provide important information for the study of the old continental crust, which bears the results of several rock formation cycles; in that case, however, the magnetic data must be converted into geological information in an adequate and prudent manner. (Kiss J. 2014).

It would have been difficult to characterize more clearly the situation surrounding the demand for ***environmental data*** than it is done in this quote. The INSPIRE directive sets out a number of forward-looking requirements for the collection, management and access of spatial data, but its interpretation, system concept and harmonization of data layers only ensure the expected result based on real data connections. The root of the problem is definitely a systems science question: How do we group our data, how do we draw **system boundaries**? In fact, this is also the gist leading to network research: In a narrower sense, how do we group our data in order to examine environmental protection and, more broadly, sustainability; what do we consider to be the organizing principles of group training?

All science should have as the starting point the study of the **niche**. In the life sciences, this is a space defined by several dimensions of resources within which the life functions and survival of a population become possible, but it is by definition determined by a multitude of physical, chemical, and biological components. We know that biotic factors are also influenced by a number of abiotic components, which are also separated by differences in research methods, dimensions and units of measurement between traditional, segregated disciplines. We can only overcome this with a new research methodology that favors the examination of spatial relationships, considering the data demands of group formation derived from a unified system concept as a guiding principle.

Meeting the social and economic needs of our society no longer affects only the natural foundations of our environment. We need to examine the interactivities and the processes that take place in the factors that determine our living space, touching on many fields of social and economic sciences too. The INSPIRE EU directive creates a need to use the tools and possibilities of our information society to examine our deeper knowledge of the complex conditions of society and its environment in order to preserve the life chances of future generations with as much orderly information as possible. The key to solving this problem is the **harmonization of data layers** provided by this system. The database organized into thematic maps is suitable for basing all decisions that affect ***sustainability*** by *building a multi-criteria decision support system* using real physical, chemical and biological relationships. (Balla K. et al.1999) The starting point of *exact environmental modeling* is that the relationships and processes to be examined take place in a **common space** – this is the **landscape** in the field of interpretation of the earth sciences. (Verrasztó 1979, 2017)

Consequently, we formulate the following objectives for the implementation of environmental modeling:

- The biologically, physically and/or chemically related processes are connected or can be connectable to each other, their spatial relationships should be examinable;
- Influencing factors and those affected can be examined, evaluated and collided together;
- Information and data sets arising from legal obligations (e.g. knowledge of the state of the environment) can be examined in coherent data systems;
- Both spatial and temporal changes can be examined;
- The causal relationships of the indications observed in the individual environmental characteristics should be examinable;
- The GIS system to be developed should be able to satisfy the needs of decision support of official decisions requiring, using and generating spatial data;
- The GIS system to be developed should be a uniform basis for the requirements of the EU regulations on the details of the field;
- The GIS system to be developed should be able to provide information to the widest possible circles of society about the state of the environment and its changes;
- The GIS system to be developed should be able to establish all the social decisions that promote the adaptation of the society to the environmental conditions or to its changes.

We saw all the objectives set out above as achievable by starting from the following premises:

- We start from the basic premise that "**environment = landscape**", so we consider the relationship system of landscape-forming factors as a governing principle in the system of physical/chemical/biological relations of influencing factors and the affected, incorporating into this system the effects generated by society as well;
- We strive to adapt to the system the widest possible range of information and/or data on the widest possible range of influencing factors, the affected and indicators;
- In addition to the nature and boundaries of protected areas that can be clearly and easily depicted on a map, we ensure the possibility of incorporating into our system the protected species and groups by elaborating their characteristic ecological needs;
- By matching the projection, raster and vector data of the basic elements of the information system to be developed, we ensure not only the territorial, but also the real spatial precision to ensure the examination of the real spatial relationships;
- We want to supply exact information to decision-makers by accepting and integrating the spatial needs, data, information and expectations arising from all the regulations and interests pertaining to all of the sectors;
- In order to support the different decision-making problems of decision-makers, the system must be able to manage different influencing factors, those affected, environmental factors and indicators together and in a selectively targeted way, in a map-based system and in a dynamic manner.

The complex spatial approach of DGIS is priority-free; the system implements the fullest possible unity of the used environmental information (maps, related descriptive data), so the system is able to give exact information to the decision-maker by displaying the spatial demand, data, information and expectations arising from the special examination methods, limit values, international obligation, regulation, and sectorial enforcement.

The query, analysis, and evaluation system developed in recent years is an efficient DGIS tool optimized for complex problem management. It is suitable for the comprehensive assessment of the state of the environment, for the modeling of possibilities and risks, for the exploration of hidden connections and values, and for the preparation for emergencies. Thus, in addition to a perceptible increase in efficiency (safety), not only can significant cost reductions be achieved, but *the known and important, characteristic data and known potential changes of the relevant factors of the entire environmental system can be integrated into a unified decision support system. This can support the specific demands of data and information of each decision level or competence with exact data, without compromising the examining need and possibility of the unity of the system.*

5. The need and possibility of investigation of dynamic processes, environmental protection and environmental safety

Although industrial accidents in different parts of the world can be the result of technical failures, for example the one that took place at the chemical plant near the well-known Seveso or at Chernobyl, their consequences can be examined in the same way as the effects of either the eruption of the Eyjafjallajökull volcano in Iceland in 2010 or the accident at the Fukushima nuclear power plant. Not only is their interpretation and examination in the whole environmental system justified, but without the exact modeling of interactions all this is unthinkable. It follows from the scientific interpretation of the environment, the earth science logic of the concept of the environment, and the requirements of the European Landscape Convention, that the study of environmental safety must be based on a structured analysis of risks, analyzing

- the chances of natural risks in a given area;
- what is endangered by hazards of natural origin and how;
- additional hazards the future damage will generate.

In current practice, primarily due to the practice of social division of labor, there is a sharp separation between the tasks of *environmental protection*, the system of social and administrative rules, and the tasks of *disaster protection* [disaster managment] (environmental safety?). In complex systems, it would be no less important to examine:

- how (industrial) accidents (can) affect social and environmental systems;
- how environmental disasters (can) affect social and environmental systems;
- the physical, chemical and/or biological processes that they (can) generate;
- how we can prepare for prevention;
- how we can prepare for the defense;
- how we can prepare for remediation.

Safety as a need for a state free of danger often appears in relation to natural disasters. Approaching from this aspect, the possibility of disasters occurring, prediction of their consequences and forecasting play a role. In our opinion and suggestion, the method for this is also the **tool system of environmental modeling,** with special regard to *the possibilities of map-based decision support and the application of dynamic GIS.*

Starting points for the application of the multi-criteria decision support method (Balla K. et al. 1999):

1) Formulation of the goals as accurately as possible, verbally, in the decision-making forum responsible for solving the problem;
2) Identification of characteristics relevant to the objectives, relevant disciplines and decision-making levels as well;
3) Identification and investigation of environmental conflicts for *all* natural, social and economic relations and all concerned parts;
4) Examining the current situation in terms of goals, including
   - designation of the examination of the necessary parameters;
   - spatial delimitation of conflicts that can be identified with each field study;

   - the scale and dimension of the factors to be examined;
   - identification of external effects,;
   - modeling of the dynamic processes to be studied (eg hydrological relationships, transport processes, ecological services, etc.);
5) Identification of control points and possible action plans and measures;
6) Modeling, including the study of mechanisms of action and the numerical forecast of characteristics for the given scenarios; in this context
   a) selection of possible propagation models for testing, and
   b) selection of relationships between relevant natural and social models;
7) The applicability of the models and the forecast of the impact of possible packages of measures;
8) Evaluation and comparison in the responsible decision-making forum of the packages of measures considering technical and economic aspects.

Naturally, in the case of significant changes, one can return to the same measures. The information system must therefore be able to meet the following demands:

- clear formulation of objectives;
- spatial and temporal documentation of the location of the influencing factor;
- identification of the mechanism of action of the influencing factor;
- possibility of spatial and temporal investigation of the influencing factor transport processes;
- spatial and temporal documentation of the location of the affected;
- identification of the mechanism of action of the affected;
- the possibility of spatial and temporal examination of the affected transport processes.

The database of the information system meeting the above requirements is expediently arranged in thematic maps. The structuring of the "Big Data" data set includes the possibility to evaluate the data components of the information obtained in any way possible, ie the data from either remote sensing or direct measurements, structured in a unified system, in their **context**. The possibilities of thematic cartography also ensure that the location, quantity and/or quality of the object or phenomenon characterized by the data is represented by a suitably selected point, line or surface symbol to interpret the relationship between each data set. Temporal changes are made possible by the mapping of successive state characteristics.

NATURAL PROCESSES – mainly PHYSICAL and/or CHEMICAL PARAMETERS – SPATIAL and TIME physical relationships (eg pressure differences and pressure and temperature differences, a significant part of which are due to eg level differences, where many dynamic factors are also important, but the "static state" characteristic of the "moment of time" characteristic of the basic state is decisive).

The most important elements of the dynamic changes of **SOCIAL COHESION**, typically in SPATIAL and TIME, were the research is focused on **cultural, religious, linguistic and historical** aspects, which are embodied in **traditions, folk traditions, legends, folk music and material folk art**. In essence, this is the "gene of society" (A. Faust 2020). The concept of **the COMMON SOCIAL SPACE** fills the objective space of the LANDSCAPE that can be studied by natural sciences as well, in which the past, the evolution and the present of a **multitude of common actions, beliefs and constructions** provide the points of connection, the possibilities of group formation.

ECONOMIC COHESION is characterized by SPATIAL and TEMPORAL relationships and changes, partly by static and partly by dynamic spatial- and temporal factors. Arguably, the **group organizing principles** of these are the **historical relations**, the **natural and social resources**, the **political-, institutional-, logistical relations**, the **resources of raw materials** and the **division of labor**. We can clearly see that all of these change in space and time. A good example is the transport problems in today's Slovakia, which result from the fact that the historical administrative units and borders influenced by the topography were "reshaped" with "one-sided" decisions satisfying current political needs.

Animation has long been known in modeling dynamically changing factors, even when evaluating natural, social, or even economic processes. Animation is essentially a visualization that provides the ability to structure data on demand. This can be based on historical maps to examine the **basic state** and environmental needs. We suggest that, where available, this should refer to environmental status characteristics recorded in Military Surveys. We are aware of the urbanization, infrastructural, industrial and technological changes that have taken place in the environment since then, and the environmental consequences of all this are everywhere around us. Consequently, all the *influencing factors* that we experience in the *consequences* related to the basic state in the present environmental state can be examined in an exact way.

Animation is excellent for illustrating the spatial interconnection of data characterizing known processes and temporal changes, such as

- propagation of flood and inland waters resp. atmospheric phenomena (direction, speed)
- spread of pollutants in water or air (direction, speed)
- dangerous or endangered factors, risks of objects.

As a result of significant methodological development, the method of modeling beyond the possibilities of animation was implemented to forecast the disaster management risks of Bódva and then Hernád.

As already mentioned, our starting point for the environmental baseline is the map of military survey. We consider the connection – in a system – of environmental indicators as well as of the influencing factors and the affected to be the methodological basis of our development. In the current practice, the lack of this complicates such modeling of the natural processes taking place in the affected area – e.g. flood events resp. their possible technical details and/or accidents, e.g. the rupture of an embankment – that allows for specific local, on stop, and/or individual decisions.

The theoretical basis of the model is the spatial study of the determining physical factors – positional energy, compressive energy and kinetic energy – in the GIS system together but separately. The amount of water flowing from cell to cell is calculated. The flow rate of water is obtained by multiplying the velocity by the cross section. If the cross-section is taken as the total surface of one side of the entire water column, the outflow velocity must be averaged, since at the top of the water column it will be 0 m/s and maximum at the bottom.

The input parameters are essentially physical data that characterizes a cell. The dimensions of the cells determine the accuracy of the model. In the system we developed (Bódva and Hernád) we calculated the pressure of 1 m^2 cells, which results in 75% accuracy in the model. If we were to increase this to decimeter accuracy, we could expect 90% accuracy – but slowing down computer capacity would make this impossible.

For other natural-science-based landscape forming factors we can ensure, for example, the harmonization of the system by animating the ecological changes of the living world over time.

In order to study the relationship between natural, social and economic processes in the landscape with the demand of systems science, the structuring of data systems and group formation is of special importance. We suggest that this should be done on thematic maps, drawing particular attention to the fact that data generated by statistical methods often obscure the point.

This solution also makes it possible to coordinate technical interventions for flood protection with the requirements of the ecological criteria set out in the Water Framework Directive. In addition, we modeled scenarios for the expected events that would take place in the floodplain on the saved side, requiring disaster management interventions. The multi-aspect study of dynamic processes in the same space satisfies specific practical demands.

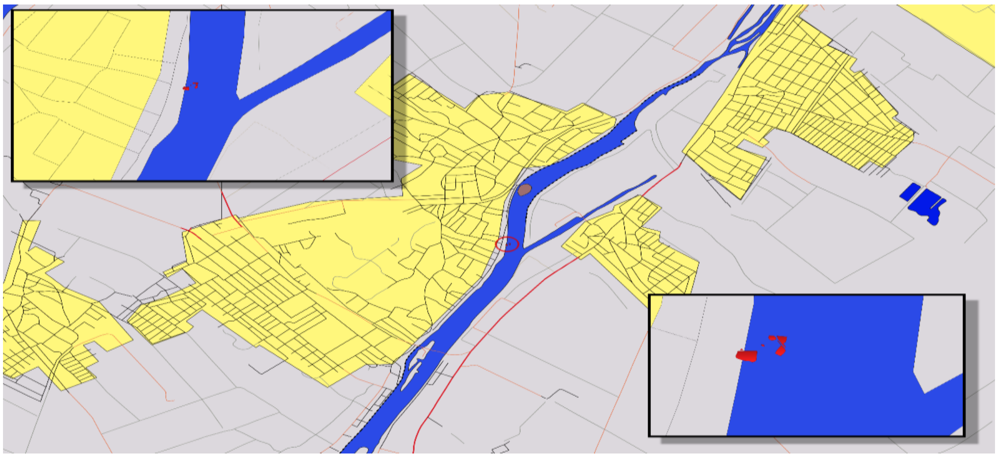
It must be taken into account that the water of streams, springs, and canals connected to the river and flowing into it will rise with its water level. Flooding can result not only from the main river but also from its tributaries. We also have to reckon with phenomena originating outside the river that affect the change in water volume. Prolonged, heavy rain can raise the water level in the floodplain by several centimeters, and sinks can turn into karst springs. Previous significant rain soaking the otherwise dry area can prevent the body of water entering the area from infiltrating the soil. High heat can increase evaporation. Strong, stormy winds can affect the speed and direction of water flow, so we have to take into account the weather factors as well.

The basic condition of the logistics modeling that is part of the project is the accurate knowledge of the natural factors, since in case of a rupture of the embankment, the water flowing to the protected area (here: saved side) flows to the lower areas and in the bays. In addition to topographic factors, the flow rate is affected by a number of factors. For example, infiltration and/or runoff conditions, surface conditions, undergrowth, bushes, forest strips, roads, embankments, drainage channels, caves, sinks, springs, soil characteristics, meteorological conditions, e.g. rain, freezing, water saturation, etc.

The speed of the flood wave flowing through the field depends on the conditions of the soil surface, the height and density of the vegetation, and the amount of sediment brought together. In settlements, structures such as buildings, cellars, roadside ditches, temporary barriers, or dams also affect the flow rate, they can change the amount of water absorbed. The situation is different in the field, where there may be a few centimeters of cultivated plants or one and a half meters of dense vegetation. These can vary from month to month – however, it is essential to take into account the location and needs of the protected objects or objects to be protected – this is how the task of environmental safety and environmental and nature conservation are linked.

As we can see, the essential expectation of the logistics model is the knowledge of the landscape-forming factors that determine the spatial processes taking place in the environment. The accuracy of the 4D model depends on their exactness. Monitoring flood processes requires the existence of a harmonized, spatial database covering the entire river basin, the creation and harmonization of which was a key part of the project. (Balogh et al. 2015, 2017; Németh et al. 2015) The input parameters are essentially physical data that characterize a cell. The dimensions of the cells determine the accuracy of the model. In the system we developed (Bódva and Hernád) we calculated the pressure of 1 m^2 cells, which results in 75% accuracy in the model. If we were to increase this to decimeter accuracy, we could expect 90% accuracy – but slowing down computer capacity would make this impossible.

Our aim with this GIS system was to monitor the flooding situations and their potential consequences during the expected flood events in the Bódva and then Hernád river basin districts, including the modeling of the local, ad hoc and specific consequences of possible embankment ruptures. This is the basis for defining the necessary and possible tasks of disaster management, for making the necessary and possible decisions minute by minute. With the successful implementation, we have significantly contributed to the application of modern IT solutions in environmental security tasks requiring multi-faceted decisions, thus increasing the efficiency of protection tasks, as well as facilitating practical efforts to unify the European Information Space (INSPIRE) through cross-border cooperation.



Map 1. *Szigetszentmiklós and the strictly protected floating bog endangered by pollution (using the Fishing Map of the Ráckeve Danube Anglers' Association and the habitat map of the Danube-Ipoly National Park Directorate)*

To the south from Budapest, on Csepel Island (at Szigetszentmiklós), the damage control of one of the most significant environmental pollution events of recent years and the search for those responsible are still in progress at the time of writing these lines. Thousands of liters of used oil spilled on the island, close to the shore, severely damaging the extremely valuable wildlife of the Ráckeve Danube Branch regulated by sluice from both upstream and downstream.

This outline map visualizes the location of the pollutant, but also shows that when loaded with appropriate data (e.g. oil-using industrial activity) it could help to identify potential culprits. Additional logistical information is essential for planning damage control, hydro-geological information can highlight the vulnerability of groundwater and plotting the flow conditions of the river can help by modeling the spread of the contaminant.

6. Conclusion

Our biological and social existence takes place in a space from which we draw our resources and in which we place our wastes of various consistence. The technical possibilities of our time involve the treatment of waste that does not decompose naturally or only in an extremely long time, and the population explosion and the needs of our urbanized society result in huge amounts of foreign substances. “Overshoot Day” warns society year after year of the unsustainability of the current natural, social and economic way of life.

The changing interpretation of the concepts and the different approaches of different disciplines consist the methodological obstacle both to the control of the processes taking place in the landscape as a space and to the exact examination, modeling and planning of sustainability.

According to our proposal, the geological landscape – in practice a river basin – can be defined as a spatial unit suitable for system control, in which we build the “Big Data” data set into the thematic overlay map system, laying the foundations for a dynamic application of GIS and spatial multi-criteria decision support system and application data upload.

As early as 1974, before Lovelock’s GAIA theory, Elemér Szádeczky-Kardoss recognized and formulated the taxonomic connections of the unified operation of the Earth, and the application of the spatial multi-criteria decision support system and dynamic GIS ensures its practice and the joint modeling of natural, social and economic components of sustainability.

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