第IV部門　Relationships between Components of the Social, Eco- and Geosystem in Arda River Basin, Bulgaria

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1. Introduction

Studying disaster risk processes requires a profound knowledge on social, ecological and physical environment regarded as systems where hazardous events evolve, take place and cause damages to people and economy. For the task of researching disaster risk in terms of soil erosion, floods and heavy metal pollution in the scope of Arda river basin, Bulgaria, implementation of ISM (Steward, 1981a.) provides feasible results for:

(1) Recognizing the social, ecological and geosystem together with their elements;

(2) Finding out the relationships and their direction between elements of the 3 systems;

(3) Categorizing and ordering elements in accordance with cause-effect interactions and determining what the source of disaster risk event is, how does it impact the various components of the 3 systems and what the consequences are;

2. Development of ISM Graph

The multitude of processes and phenomena involved in disaster risk occurrence and effects can be described in a better way by analyzing the most important components of social, eco- and geosphere by ISM approach. In order to be correctly performed, the data needed have to be collected, proceed and analyzed on several stages.

	industry (wood, textile, construction...)	deforestation	soil erosion	heavy metal pollution	water utilization system	flora & fauna	daily life	tourism	agriculture	transportation & communication	flood	mining (metallurgy)	mineral resources	natural disaster risk	environmental disaster risk
industry (wood, textile, construction...)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
deforestation	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
soil erosion	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1
heavy metal pollution	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1
water utilization system	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
flora & fauna	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
daily life	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
tourism	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
agriculture	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
transportation & communication	1	0	0	0	0	0	0	1	0	1	0	1	0	0	0
flood	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
mining (metallurgy)	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
mineral resources	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
natural disaster risk	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0
environmental disaster risk	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1

Table 1. Binary matrix for the selected elements.

(1) The total number of components involved in social, ecological and geosystem is to be fixed. In that way, 15 elements have been derived which are presented in the matrix below.

(2) Next stage of work involves setting the elements into a matrix (Warfield, J., 1973.), and assigning them binary values (either 0 or 1), depending on if there is any relationship between them or not. Data input into a binary matrix is performed in order to establish the possible cause – effect relationships between components.

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(3) The final stage involves setting up of a graph model based on the matrix above. It depicts the order of elements from input to output level, and their cause-effect relationships exhibited by a single-direction arrow. Deriving model form the above matrix is performed by sophisticated rearrangements of the data in various matrices so that finally the systems elements are ordered according to their significance in cause-effect relationships.

3. Results Obtained and their Interpretation

In the case of ISM Analysis Graph Developed for the Purpose of Studying Arda River Basin, Bulgaria, the 15 aforementioned components are ordered on 7 levels.

The first topmost level involves as an input factor the nature disaster risk. It originates from instantaneous, rapidly occurring nature events that take place in the geosphere and its appearance cannot be avoided or controlled in any way. The direct effect of nature disaster risk refers both to water utilization system and floods.

Second level of graph comprises mineral resources, transport and communications and the water utilization system. The former two components can also be considered as input factors as they influence the industry, mining and metallurgy.

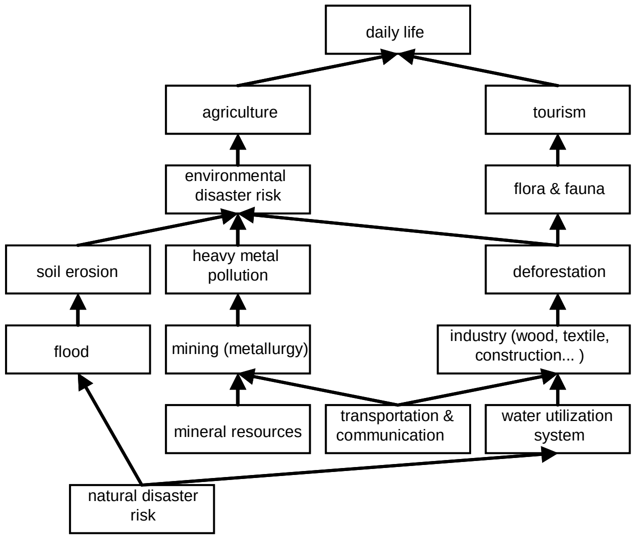

Fig. 1. ISM Analysis Graph

The 3-rd stage comprises industry, mining and metallurgy, and floods bound with disaster risk. They are not more input factors but their influence towards other elements located down the graph is considerable.

The 4th floor of the graph reveals 3 disaster risk processes – deforestation due mainly to the industry (timber, and also household), soil erosion owing to floods, and heavy metal pollution descending from metallurgy and mining. Much of the disaster risk has its origins in elements belonging to the social system and controllable by humans, only soil erosion being related to floods and nature disaster risk.

5th layer consists of flora and fauna as main constituents of ecosystems, and environment disaster risk summarizing various types of nature and man-triggered disasters. The effect of flora and fauna links towards tourism, as the former appear to be premises, and of environment disaster risk towards agriculture.

Agriculture and tourism are, to a high extent, impacted factors with direct effect to the daily life and show to be the output of entire system. Application of this graph as a final product of ISM analysis not only visualizes the interactions of components and their behavior, but also provides valuable insight of how to approach and what method to apply when studying disaster risk in Arda River Basin, Bulgaria.

4. Outlines for Future Research Work on the Target Area

ISM graph provides the basic scheme for further implementation of multi-factor analysis on the studied components;

Structurizing the elements make easier application of system approach when interpreting the obtained results on the systems elements under investigation;

Basing on the ISM graph and the binary matrix belonging to it, an algorithm for programming the impacts on the output, the daily life, can be elaborated and thus eventual prediction of future negative effects and developments may be possible.

References

[1] Steward, D., The Design Structure System: A Method for Managing the Design of Complex Systems. IEEE Transactions on Engineering Management, vol. 28, pp. 71-74, 1981a.

[2] Warfield, J., Binary Matrices in System Modeling. IEEE Transactions on Systems, Man, and Cybernetics, vol. 3, pp. 441-449, 1973.