



# How to identify and analyze complex socio-ecological issues?

The Fuzzy Cognitive Mapping (FCM) approach used in identifying key concepts formulated by stakeholders in relation with biodiversity management, Brăila Islands LTSER case study



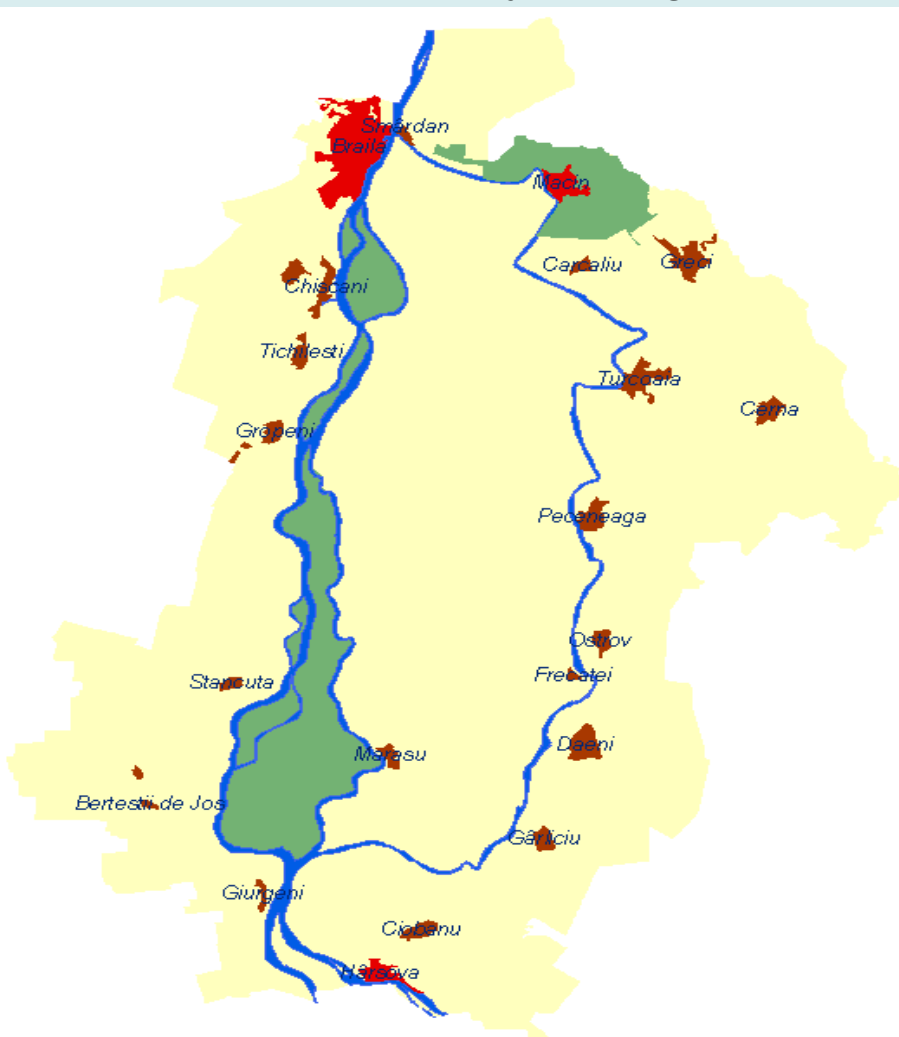
Florinița-Oana Musceleanu, Nicoleta Adriana Geamăna, Cristian Mihai Adamescu, Georgia Lavinia Cosor, Teodora Alexandra Pălărie, Angheluță Vădineanu

Contact: oana@romanianecologicalsociety.ro

## Introduction

In the last century, policies and management plans, aiming to achieve economic growth, had a direct and indirect effect on the Natural Capital's structure and function of the Lower Danube Wetlands System (LDWS). Beginning with the sixties, in a three decade period, extensive alterations of ecological complexes' structure occurred; therefore, nowadays only 18% of the former wetlands functions in a natural system. After 2000, socio-ecological research in the LDWS has focused, among other, on assessing people's knowledge and increase public support for biodiversity management (Vădineanu et al., 2004).

We present a FCM model based on a multi-step approach for identifying and analyzing stakeholders' (from LTSER site, Brăila Islands, part of the LDWS) key concepts formulated in relation with biodiversity management.



## Study area

Surface: 2600 Km<sup>2</sup>

Population: 300 000 (80% urban)

Main pressures: hydro-morphological alterations, agriculture, fishery, industry, fluvial transport, households.

Fig. 1 Brăila Islands, (LTSER Brăila Islands)

## Research questions

Which are the key concepts identified by stakeholders?

What are the main biodiversity research and management issues that need to be addressed?

## Methods

We collected the cognitive maps of three groups of stakeholders and coded them as square matrices. To analyze the structure of cognitive maps, we calculated the graph theoretical indices of the matrices.

Indices: Outdegree, Indegree, Centrality, Density, Hierarchy index, showing the strength of connections or how connected the variables are to other variables, and what the cumulative strength of the connections are, etc. (for definitions and formulas see Özesmi&Özesmi, 2004 ), (Fig. 2)

## Modeling:

FCM has its historical origin in graph theory, which started with Euler in 1736 (Biggs et al., 1976). In 1976, Axelrod was the first to use digraphs to show causal relationships among variables as defined and described by people, rather than by researcher. Kosko (1986) modified Axelrod's cognitive maps which were binary, by applying fuzzy causal functions with real numbers in [-1, 1] to the connections (Özesmi&Özesmi, 2004). (Fig. 3)

## Data:

A number of 18 stakeholders were interviewed during August 2008 in the Brăila Islands, LTSER site, and qualitative data was obtained. The discussions were held with different groups of stakeholders : i) scientists; ii) nature managers; iii) NGO's; iv) local people; v) landowners and fishermen (Geamăna et al., 2009)

## Results

The identification of different stakeholders perceptions of the LTSER area allowed us to analyze and in future research to model the cognitive maps (Fig. 3) which consist of variables, causal relationships between those variables and of strengths of the connections.

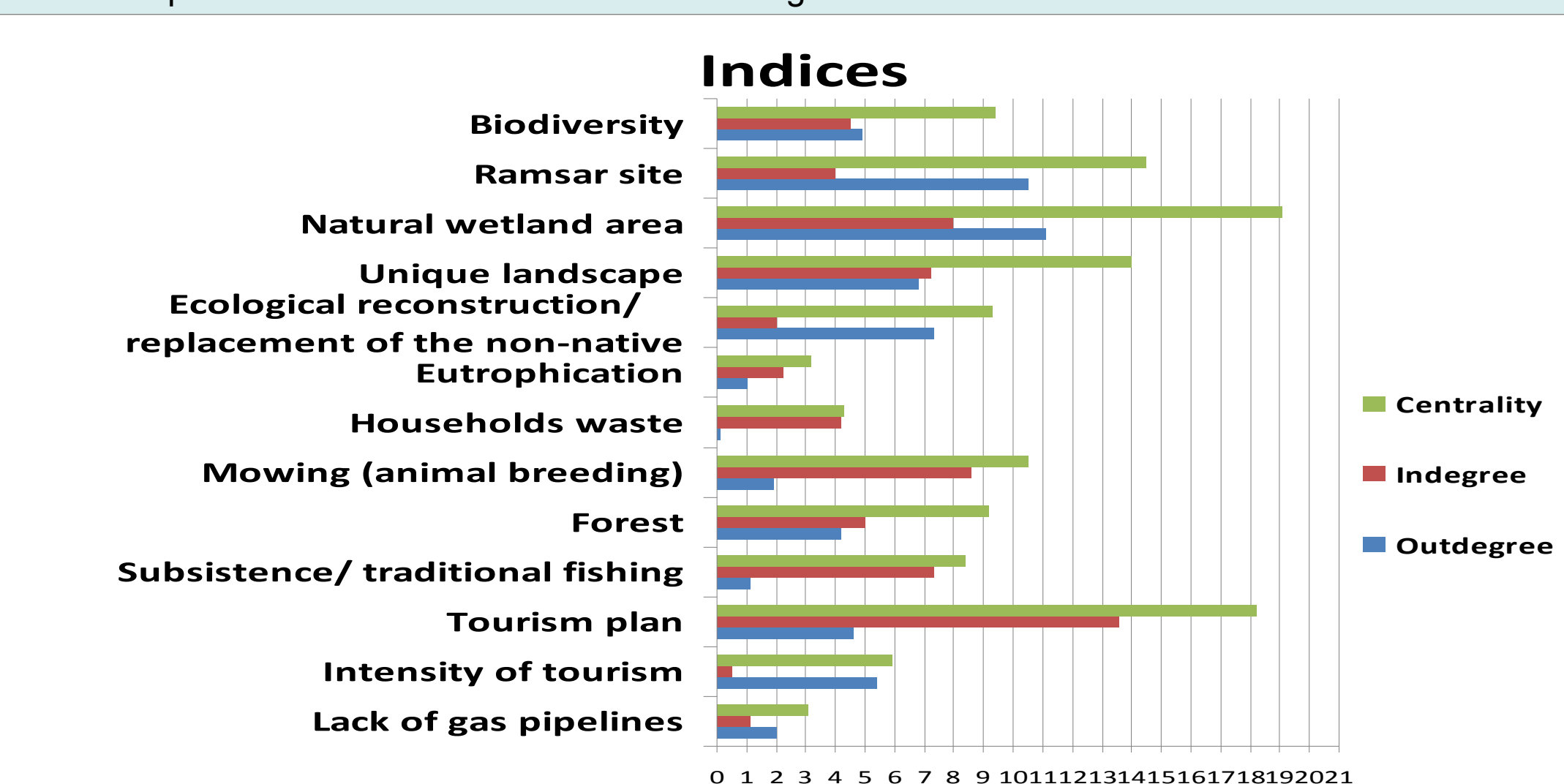


Fig. 2 Indices showing Centrality, Indegree and Outdegree of discussion with stakeholders from Small Islands of Brăila Natural Park administration staff in Brăila Islands, (Adamescu et al, 2008)

## Results

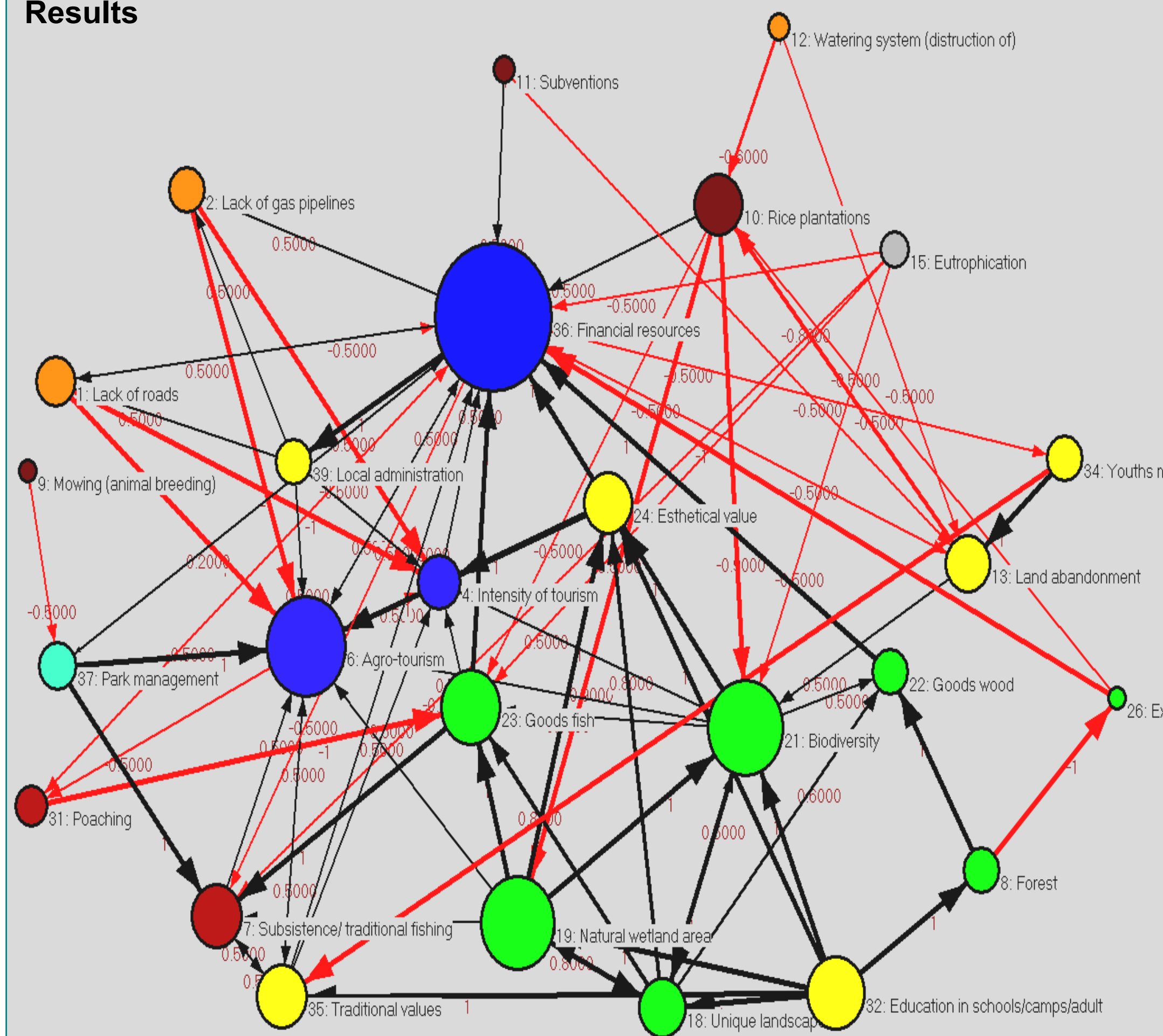


Fig. 3 FCM illustrating Centrality, Brăila Islands, (Wildenberg et al., 2009) based on data by Nicoleta Adriana Geamăna, Georgia Lavinia Cosor, Florinița-Oana Musceleanu, Cristian Mihai Adamescu

## Future work

- Designing an up-to-date structural model that defines the Social Capital/ "The map of socio-economical agents" in the two sub regional complexes: Inner Danube Delta (LTSER site, Brăila Islands) and Neajlov River Catchments, using FCM and ABM (agent based modeling);
- Adapting, testing and validation of a computer model for the studied areas.

## Conclusions

Main issues:

- Fuzzy Cognitive Mapping approach is suitable for i) examining people's perception and attitudes of socio-ecological systems and ii) identifying key concepts that will be used in future information and communication strategies regarding biodiversity conservation in the area;
- FCM can be used for modeling perceptions therefore it presents a social snapshot of how the system works at a given time;
- Could contribute to identifying conflicts at local and regional scale and possible conflict resolutions;
- Future research should focus on stakeholders' perception and opinion assessments in different time periods because their attitudes and perception could change over time therefore the methodology needs further development.

## Literature

Mihai Adamescu, Kirsten Isak, Martin Wildenberg, Riku Varjopuro, Skov Flemming, Tadeusz Chmielewski, Geert Deblust, Minna Kaljonen, Nicoleta Geamăna, Support, promote and analyze the processes of the development of integrated management plans in complex environment, (e.g. LTSER), ALTER-Net Report, 2008

Geamăna Nicoleta Adriana, Vădineanu Angheluță, Luminița Mărmureanu, Musceleanu Florinița Oana, Pălărie Teodora, Ioniță Cătălina, *Significance of social research for biodiversity conservation and sustainable use of wetland services. Case study: Inland Danube Delta*, SEFS6, 17-21 August, Sinaia, 2009

Uygar Özesmi, Stacy L. Özesmi, *Ecological models based on people's knowledge: a multi-step fuzzy cognitive mapping approach*, Ecological Modelling 176 (2004) 43–64, Elsevier, 2004

Vădineanu, A. et. al, *Managementul Dezvoltării – o abordare ecosistemică*, Editura Ars Docendi, București, 2004

Wildenberg, M., Bachhofer, M., Adamescu, M.C., De Blust G., Delgado, R.D., Isaak, K.G.Q., Skov, F., Varjopuro, R. (in prep.) "Fuzzy Cognitive Mapping as tool for environmental management" to be submitted to Environmental Management

**Acknowledgements:** This work was support by ALTER-Net (A Long-Term, Biodiversity Ecosystem and Awareness Research Network)