

My research interests concern the multi-criteria analysis and their integration with spatial problems. The general framework is the planning of a wide area and environmental problems. In particular in the framework of risk analysis. The work that I intend to present within the conference is the analysis of the risk for subsidence in Tuzla (Bosnia Herzegovina).

### **Integration between the multicriteria decision analysis and the GIS to obtain a map of risk in the city of Tuzla (BH).**

Ground deformation phenomena affecting the town of Tuzla after severe exploitation of underground salt deposits by means of boreholes and mines were surveyed since 50 years ago. The growing of cavities beneath the town and successive surface deformations have induced several hazard factors such as ground subsidence, deep and shallow fracturing, intense groundwater table oscillations. Fortunately, these processes had no catastrophic consequences such as the formation of sinkholes. Previous studies analyzed the historical database of topographic and piezometric data and highlighted a cumulative subsidence rate up to 12 meters over a period spanning from 1956 and 2003. Fractures arose as obvious result of ground deformation and caused damages and demolitions to thousands of buildings with almost 15000 people injured by such a failure. Nowadays, in order to diminish the deformation processes, a strong reduction in salt exploitation by brine withdrawal have been introduced by the local authorities. This caused an uplift of the water table which represent, itself, a severe hazard affecting the town.

The overall situation required a Risk Assessment through GIS procedure able to define a risk map reporting the most threaten districts of the town with particular focus on the settle environment. The assessment of the Hazard, Vulnerability and Exposure components is therefore a requirement and was carried out using the available geographical dataset.

From spatially distributed data was then applied to a method and in particular a multi-criteria sorting problem to obtain a classification of land according to the specific risk.

The specific risk is the combination of information about the state of nature dell'hazard characteristics, and vulnerability, where vulnerability is indicated with the potential loss of a receiving system according to the action of a hazardous event, of a given frequency and intensity.

In particular the definition of global 'hazard or geo-hazard how it will be called, is a function of four main agents: the density of deep fractures, the density of the superficial fractures, the water table rise and the subsidence.

The four main hazard were then combined to obtain a global hazard. To this end, thanks to expert advice for the application of the method ELECTRE TRI, were built both reference profiles that have been chosen the thresholds of indifference and preference.

For the analysis of vulnerability criteria were considered to be making reference to the physical vulnerability, then that concern the vulnerability of structures and infrastructure, and the systemic vulnerability that concerns the loss of function of the social and economic activities.

Preliminary analysis in a GIS environment were necessary for the homogenization of both vector and raster data, although all data were for convenience convert to the raster data being based on a grid composed of cells of 50 meters.

The show itself was obtained from cadastral data, reported that the value of property in a way that each cell according to the rules of proximity, was given a property value does not depend only on the existing buildings. Once specific risk through the combination of the components of risk and vulnerability, has created a map of the total risk in the city, with a simple operation of map algebra, then using exposure as a factor reducing the specific risk, so that if it had been equal to one, to represent the total loss of vulnerabilities, to the extent of the damage was more than the entire value of the property in question.