Integrated Research and Implementation in GIScience and Extreme Events: Developing Tools for Mitigation and Response

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Practical decision-making for civil protection based on predicting the impact of natural hazards often involves using assessment techniques and environmental process models linked with Geographic Information Systems (GIS) and latest remotely sensed imagery. Optimum use of these techniques for such decision-support requires careful and coordinated consideration of natural processes, data and model scales, and their related uncertainties. To avoid wasting resources and time on inappropriate data collection, improper model use, and resulting poor decision-making, there is a pressing need for a scientific and functional framework within which to examine implementation and use of geo-spatial assessment tools. To be useful for researchers, engineers, and decision-makers, geohazard simulation approaches must consider the spatial and temporal variability in natural hazard processes and utilize the latest data that is available.

The successful application and implementation of a multi-geo-spatial hazard model at variable scales requires explicit or implicit use of some form of scaling theory applied to the tasks of selection and transformation of appropriate data, and use of results. As a result of the interdisciplinary research, there are five consecutive scaling steps that demonstrate how data and model scale and how information should transform between them (Renschler 2003, 2005). This methodology plays a key role in controlling the efficiency of prediction results and designing appropriate scales of interest for a civil protection manager's decision-making process (Fig. 1).

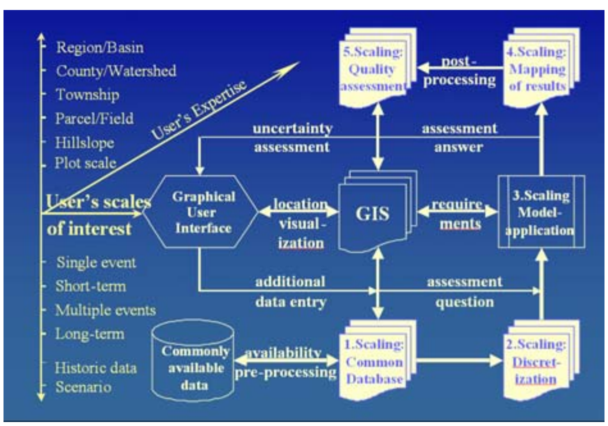

Figure 1: Scaling Theory to integrate GIScience and Extreme Event Analysis: Information processing structure of any spatially distributed environmental assessment tool. Note that a GIS stands for a geo-spatial tool to assemble, process, analyze, and visualize environmental data. The GIS is the glue between the user's scale of interest and the scales related to available process data and models.

This new scaling theory is currently taught in professional/interagency workshops and implemented in the Geo-Spatial Wildland Management Tool (or GeoWEPP) for Burned Area Emergency Response (BAER) teams (Renschler and Elliot, 2005; Fig. 2). The scaling theory can be used as a framework to construct practical procedures for applying any GIS-Model-based assessment tool for natural hazard and natural resource management allowing effective model application based on realistic data availability and environmental settings. As a result, GeoWEPP was used for an erosion potential analysis for various burned areas including the 50,000 acre School Fire, the largest fire in the US in 2005 (Elliot, et al. 2005).

Figure 2: USDA Forest Service Soil Scientist Eric Schroeder (left) and GeoWEPP Research Leader Chris S. Renschler discuss the possibilities of using GeoWEPP software for assisting burned area emergency recovery team activities on the 2003 Overland Fire, Colorado (courtesy of the Society of American Foresters August 2004 issue of "The Forestry Source").

This approach is especially important during a time of crisis when either natural or anthropogenic changes produce sudden transformations of basic information which underpin decisions previously made under the pressure of minimal available time (e.g. combat fighting forest fires, assessing flood risks, analyze earthquakes, landslides, volcanic eruptions, and other natural or man-made hazards). To overcome the limitations of the data due to uncertainties, the labeling of changes and critical regions within target areas of interest will give decision-makers valuable intelligence for better assessment of a particular situation and of possible scenarios.

The results of the integrated Geographic Information Science (GIScience) research focus on modeling extreme events at the University at Buffalo led to the development of a Geospatial Project Management Tool (GeoProMT). GeoProMT is a prototype that allows multiple users to access a centralized repository of quality assured geo-spatial data specifically for environmental modeling. GeoProMT is currently being assessed in teaching and the following interdisciplinary research projects with federal agency involvement/sponsorship: sensor development for fire detection and fire fighting, post-fire soil erosion assessment for forested areas, risk management of volcanic hazards, damage assessment of earthquakes, tsunamis, and hurricanes (Fig. 3).

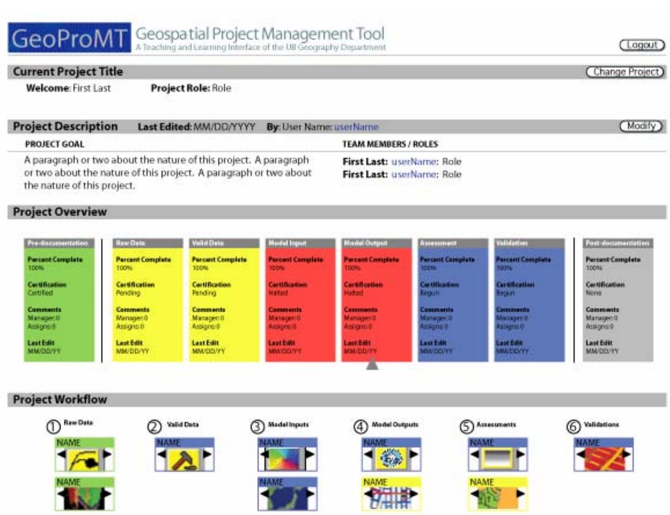

Figure 3: GeoProMT is a prototype that allows multiple users to access a centralized repository of quality assured geo-spatial data specifically for environmental modeling. Such GIScience tools are especially important during a time of crisis when either natural or anthropogenic changes produce sudden transformations of basic information which underpin decisions previously made under the pressure of minimal available time.

Elliot, W.J., S. Miller, and B. Glaza. 2005. School Fire Erosion Potential Analysis. Soil and Water Engineering Research Work Unit - Rocky Mountain Research Station, Moscow, Idaho. 18p.

Renschler, C.S. 2005. Scales and Uncertainties in volcano hazard prediction – optimizing the use of GIS and models. Journal of Volcanology and Geothermal Research 139(1-2), p. 73-87.

Renschler, C.S. 2003. Designing geo-spatial interfaces to scale process models: The GeoWEPP approach. Hydrological Processes 17, p.1005–1017.

Renschler, C.S. and W.J. Elliot. 2005. Geo-Spatial Wildland Management Tool. Funded by the Joint Fire Science Program (JFSP) – Forest Service (US Department of Agriculture), Bureau of Indian Affairs, Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, and U.S. Geological Survey (all Department of the Interior).