TU Clausthal

Model-Supported Prediction of the Ecological Impact of Succession Processes Affected by Ground Water

Integrated application of classical methods, geoinformation systems, and methods utilising knowledge-based systems, for the example of environmental-impact monitoring in hard-coal mining operations

– Summary –

In the present dissertation, the methods of environmental planning are extended by a model-supported technique for the large-scale prediction of the impact of succession processes affected by ground water in terrestrial systems. The development is based on an integrative approach which takes into account the very different perspectives of hydrogeology, pedology, plant ecology, expert systems engineering, geoinformatics, as well as soft computing, and adapts them to serve the purposes of ecological impact forecasting. In contrast to the forecasting methods available to date, the general requirements of planning methods, such as orientation with respect to the environmental planning tasks, reliability, objectivity, processing efficiency, transparency, and reproducibility are considered in a comprehensive manner.

The verbal-argumentative method of "integrative succession forecasting" presented by Kelschebach & Nesselhauf[1] constitutes the starting point of the model development. The predominantly qualitative impact information which is implicitly assumed for the purpose has been externalised with methods of knowledge-based systems and employed for the construction of an ecological model, together with further specialised knowledge. Phenomena of fuzziness and vagueness in the representation language have been modelled with the application of fuzzy set theory.

On the basis of easily acquirable data, the fuzzy rule-based model thus developed allows the following, after coupling with a ground-water flow model:

- forecasting of local edaphic ecological conditions (soil humidity),
- estimating impacts on biotopes and land use,
- derivation of hypothetical land use (land use scenarios),
- forecasting the condition of the vegetation cover in the future (biotope-type prediction).

For the treatment of forecasting uncertainties in the planning process, a practicable approach is presented for deriving multiple future scenarios from fuzzy logic environments (fuzzy-based scenario technique).

Spatial and temporal references for the relevant system sections are integrated into the model representation with the use of a geoinformation system (GIS). The general system architecture developed for the purpose is based on close coupling of GIS components with components of knowledge-based systems to yield a *knowledge-based GIS* (KBGIS). Possibilities are described for supporting ecological impact forecasting by synergistic utilisation of the advantages offered by both system classes in a single integrated system.

A prototype for the implementation of the KBGIS is tested for the example of monitoring the impact on the environment caused by hard-coal mining in the northern Ruhr district.

[1] Kelschebach, M. & Nesselhauf, G. 1997: Integrative Sukzessionsprognose zu dynamischen Landschaftsveränderungen. In: UVP-Report, (2), 108–112.