ISDS

Integrated Spatial Decision Support

Summary

R. DENZER, M. DERSCHANG, R. GÜTTLER, Th. HELL, S. SCHLOBINSKI
Environmental Informatics Group at Saarland State University of Applied Science

PROJECT BACKGROUND AND GOALS

Many different disciplines require decisions related to spatial information. Whether a city council decides about future housing projects, a state decides about future ecosystem protection zones or a distributor decides about a location of a new storage facility: all these decisions are tightly related to the spatial properties of information.

Spatial Decision Support (SDS) is often interdisciplinary and requires information from different data providers. An example for such SDS is land management, where the task involves information from such different areas as geology, geography, water resource management, agriculture, economy and many more. In addition to criteria coming from these different disciplines, optimal use of financial resources is always an important issue. It is always necessary to optimise a decision in order to achieve a maximum of outcome under given financial constraints. As each decision depends on many different - often conflicting - criteria from different points of view, SDS usually becomes a Multi Criteria Spatial Decision Support (MCSDS). Moreover we have to consider the fact, that spatial decisions always include “fuzzy” components, as the basic data is often incomplete the way to combine multiple criteria is subject to interpretation.

Today, there are a number of techniques used for SDS. First, there are systems based on Geographical Information Systems (GIS). Second, there are decision support systems (DSS) based on techniques like decision trees, belief networks or rule bases. AI shells have often been used as the base technology for these systems. Third, simulation models are often needed to predict certain outcomes of a proposed decision. These models range from simple calculations to very complex systems of partial differential equations. Forth, there are often catalogue systems (meta information systems), which organise information present in various departments of an organisation like a government agency. Such catalogues can include advanced query tools.

The first main problem in building a particular decision system for a given purpose is that different decision methods (geographical criteria, thematic criteria, model predictions) have to be combined to present scenarios to decision makers. This means that, if you do not want to build every system from scratch, which nobody can afford, you have to integrate GIS, DSS shells and modelling and simulation systems into one system.

The second main problem in building a particular decision system for a given purpose is the integration of data. Each of the tools usually has a different way to treat data. The different paradigms to treat data are often conflicting as well.

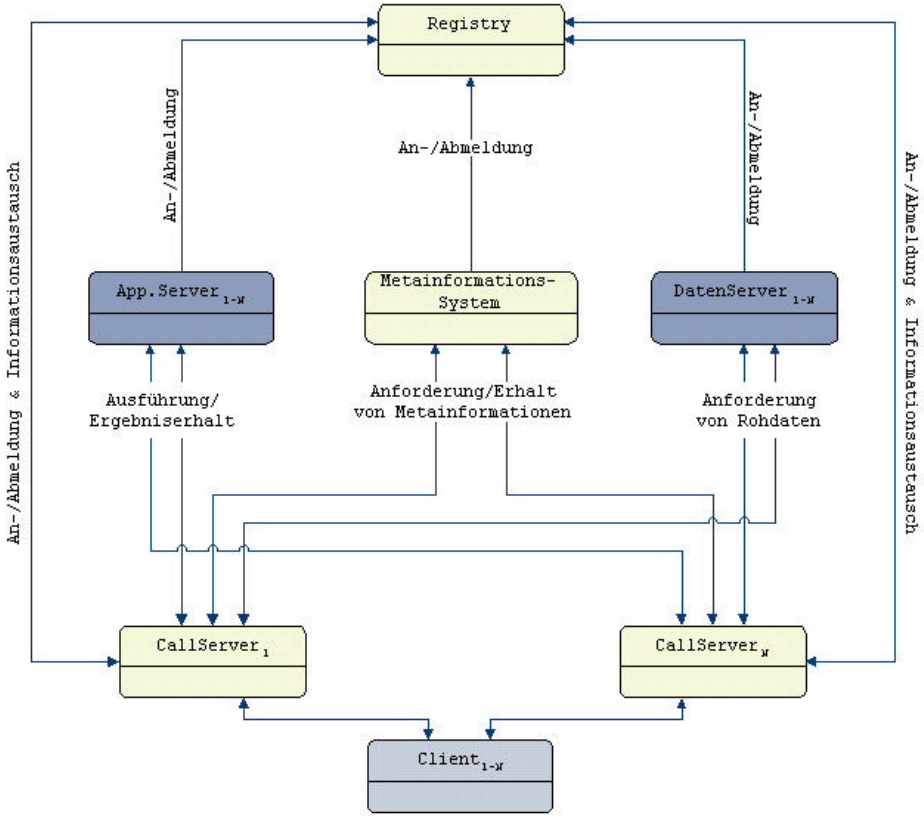
The goal of the ISDS-project was to develop a methodology to overcome this situation. Based on a combination of unique experiences of the 4 project partners Hochschule für Technik und Wirtschaft des Saarlandes (HTW), Environmental Informatics Groups (EIG), University of Guelph, Canada (CRLE), ES Aquatic, Canada, United Nations University, Node for Water Resource Management, Burlington, Canada, it was our goal to jointly develop a reference architecture and a reference implementation for Integrated Spatial Decision Support (ISDS). The reference implementation was validated on Agricultural Non-Point Source Model (AGNPS) with the use of (WuNDa) “Wuppertaler Navigtions u. Datenmanagementsystem”.

SYSTEM ARCHITECTURE OF THE SOLUTION

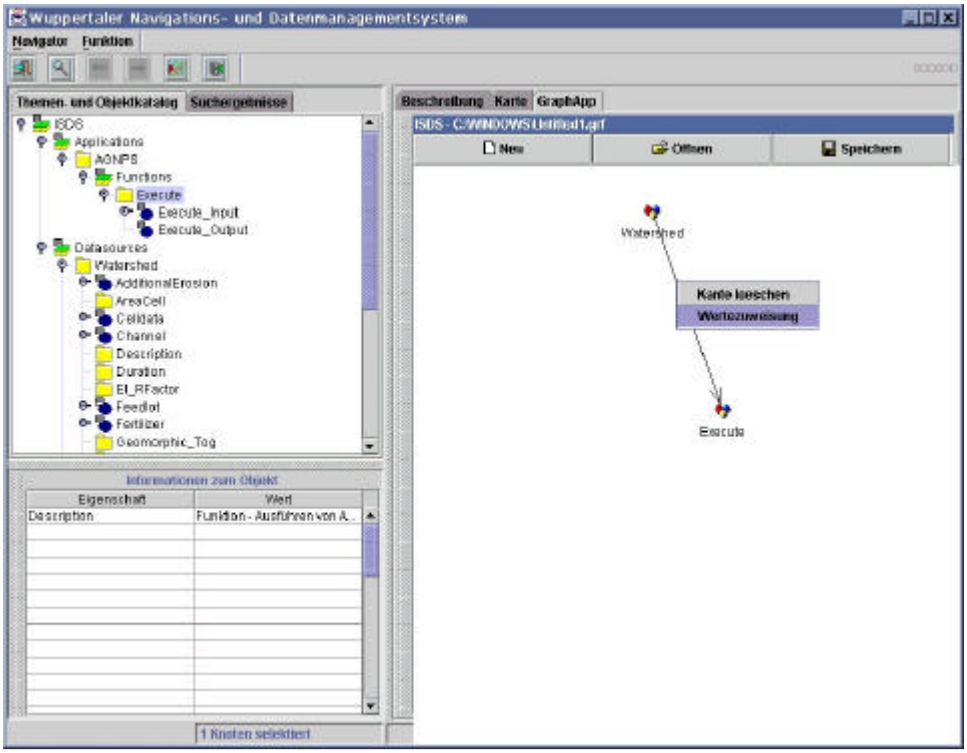
An integration of data sources and software requires a system which describes the integrated information in an general way. On the other side data and software components should be accessible.
A general way to describe integrated sources is metadata. The usage of metadata allows to describe context related and topological characteristics. Additional information to manage data transfer is also attachable by using metadata.
The general concept was implemented using several system components:

- Integration
    - Meta information system
    - Data server : a front-end to one or more data sources
    - Application server : generic adapter for models
- Communication infrastructure
    - Registry : offers online information on available servers
    - Call server : communication manager between clients and the distributed system

System Architecture



user interface



VALIDATION

The implementation was validated with AGNPS and WuNDa.

The "Agricultural Non-Point Source" (AGNPS) was developed by the United States Department of Agriculture (USDA, www.usda.gov) at the "Agriculture Research Service" (ARS) in Morris.
"AGNPS is an event-based model that simulates surface runoff, sediment, and nutrient transport primarily from agricultural watersheds. The nutrients considered include nitrogen (N) and phosphorous (P), both essential plant nutrients and major contributors to surface water pollution. Basic model components include hydrology, erosion, and sediment and chemical transport."
The main objective of the model is to compare the effect of pollution control practices that could be incorporated into the management of watersheds. It is a distributed model simulating agricultural watersheds.

The WuNDa project offers an access to GIS-data and factual data by a unique and simple navigation user interface, based on internet/intranet techniques to the users in different sections of the environmental department of the city of Wuppertal. The system is based on the SIRIUS tool set.

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