ICIMOD

FOR MOUNTAINS AND PEOPLE

Information series on geographical information and remote sensing systems in mountain environments

Geographical information and remote sensing systems play a special role in the Hindu Kush-Himalayan region in support of informed decision making. This series of information sheets presents information on basic technologies, approaches, and applications related to geographical information and remote sensing, and used or developed by ICIMOD, as a background for understanding for policy makers, development workers, and others.

Decision Support Toolbox

for mountain protected area management

Ecosystem management of mountain protected areas involves planning and policy decisions that have ramifications at the local, national, and regional levels. Choices on such diverse aspects as tourist flows, energy demands and supply, solid waste disposal, and many others can have many consequences for both poverty reduction and biodiversity conservation in these areas. There is a great diversity of protected areas in the Hindu Kush-Himalayan region, but they have many elements in common in terms of the needs and challenges of ecosystem management. Thus it can be useful to develop a common framework, and a common set of tools, to support decision making in protected area management, and to serve as a management-oriented research framework where data, knowledge, and best practices can be shared.

ICIMOD has developed a Decision Support Toolbox (DST) to support institutional capacity for systematic planning and ecosystem management of protected areas in the Hindu Kush-Himalayan region. The toolbox was developed under the Hindu Kush-Karakorum-Himalaya (HKKH) Partnership Project supported by Italian Cooperation and implemented by IUCN in partnership with ICIMOD, Ev-K2-CNR, and CESVI. The Toolbox was conceived as a collection of hard and soft system methodologies, including participatory modules and computer based tools, to provide a set of integrated but also self-contained tools to support decision making. Many of the tools are map and model-based or require other locally relevant data, and by definition have to be specifically modified and/or populated to meet the needs of an individual protected area. These tools should be considered as a framework (rather than a final product) that can be applied in any given protected area.

The toolbox was developed using Sagarmatha National Park and Buffer Zone in the Everest region of Nepal as a pilot case. Participatory methods such as P3DM, scenario planning, and qualitative modelling exercises were carried out to develop a systematic view of the Sagarmatha Park over space and time. The final Toolbox product uses the Sagarmatha study as a working example, but the principles, framework, and modules can be applied or adapted to any protected area in the region.

System dynamics modelling for ecosystem management

The Decision Support Toolbox uses a system dynamics approach to study the different aspects of ecosystem management in mountain protected areas. This approach consists of development of system dynamics models that can simulate and quantify the behaviour of the system over time, allowing users to explore the complex interrelationships between different elements lying within the system. Most of the modelling processes of dynamic systems lack the spatial component, even though there is an important feedback between time and space in such (dynamic) systems. The tools allow integration of spatial and temporal aspects in modelling which faciltates understanding of the ecosystem.

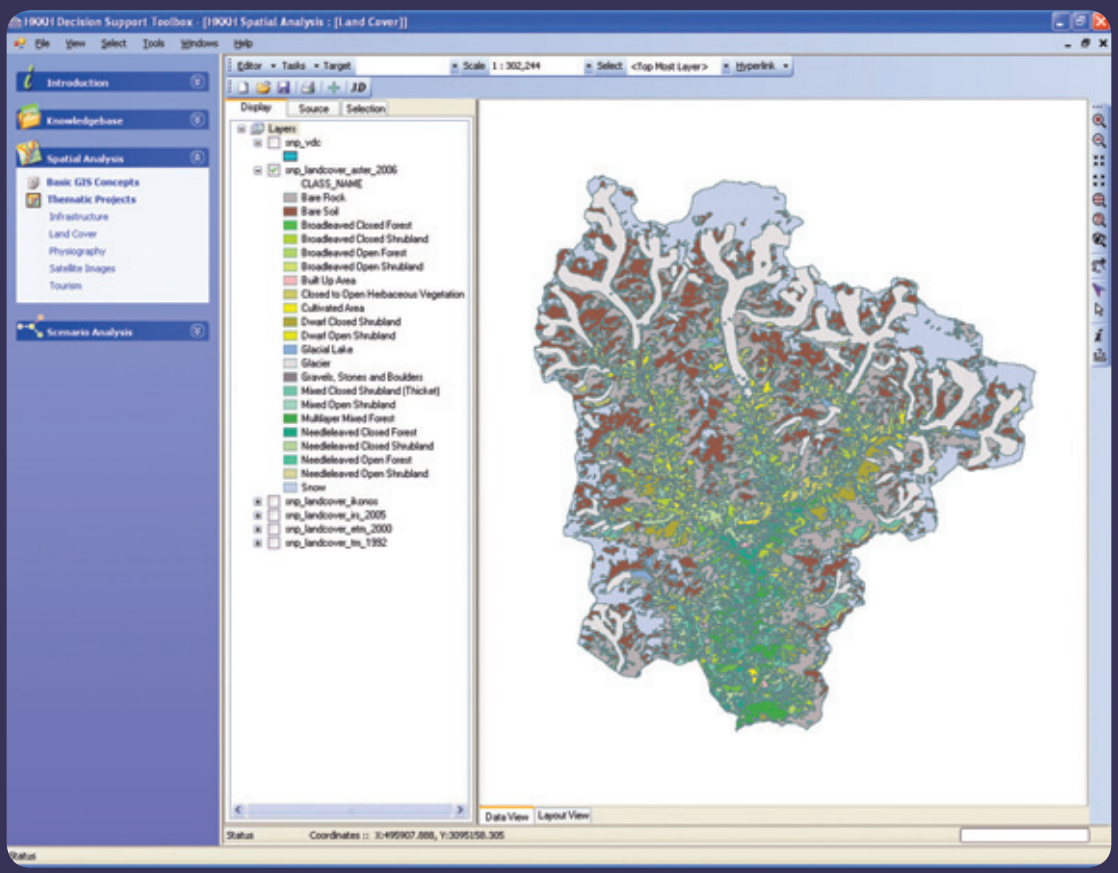
One of the main objectives of the project was to promote a systems approach as an appropriate frame of reference for the conservation and management of protected areas. System dynamics was chosen as a tool for investigating the interconnected issues of protected area management because of its ability to provide a holistic view of the system. The software's user-friendly interface allows even users with little or no knowledge of system dynamics to run the models.

The toolbox

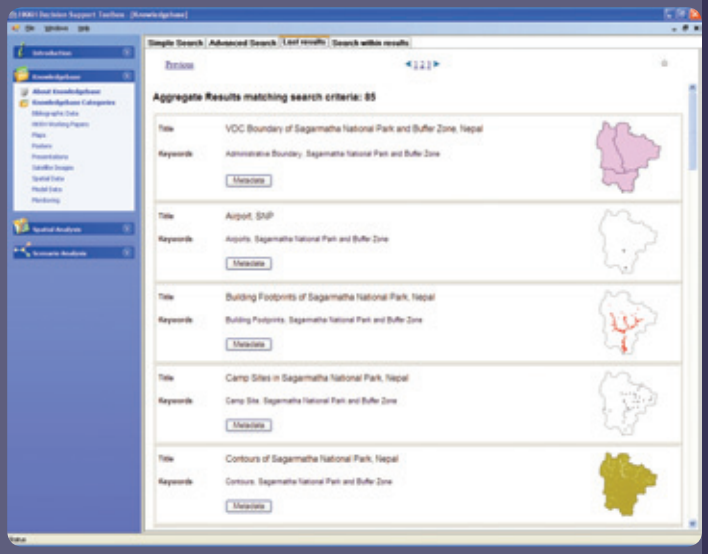
System dynamics models

A number of separate system dynamics (quantitative) sub-models were developed to address key management problems: for example tourist flow, energy demand and supply, solid waste, and indoor air pollution. In a first step, qualitative models were constructed to describe the expected relationships between different factors using concept mapping software (CMapTools). These were transformed into quantitative system dynamics (sub) models through iterative testing using Simile software. The system dynamics models were developed at appropriate spatial and temporal scales for the particular problem using locally relevant data. Simile allows a composite model to be constructed containing selected individual sub-models linked in a clearly defined manner within a single model. The composite model can be used to study behaviour change in all models when policy levers are changed in just one. Individual models of similar temporal scale were combined to give two composite models: a daily '**Tourism and population dynamics**' composite model and a monthly '**Solid waste, energy, indoor air pollution, water pollution and forestry**' composite model.

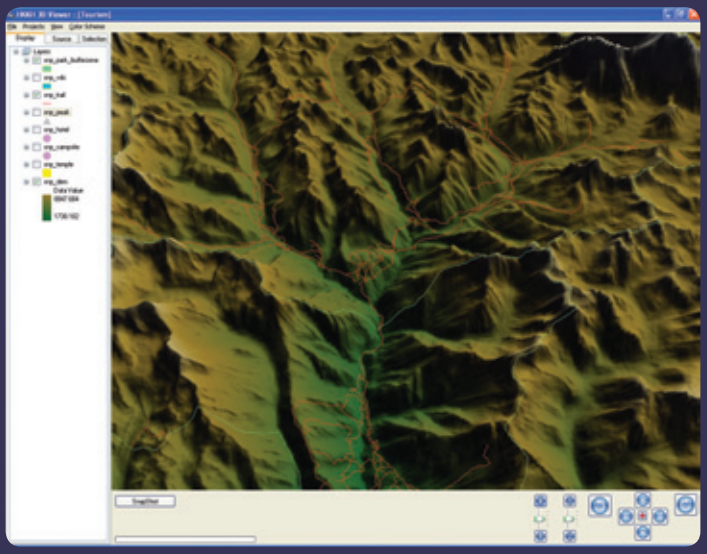
Spatial analysis module



Knowledgebase module



Spatial 3D viewer



Application modules

The Decision Support Toolbox has a modular architecture with three application modules: Knowledgebase, Spatial Analysis with Spatial 3D Viewer, and Scenario Analysis. These are integrated using the **Decision Support Toolbox Software**. The software enables integration of spatial components into the system dynamics modelling, thus enabling better understanding of the functioning of the ecosystem.

Knowledgebase Module

The **Knowledgebase Module** is a metadata management system which uses the open source GeoNetwork platform from the Food and Agriculture Organization. It stores over 15 hundred metadata of various kinds such as literature, spatial data, satellite images, and models, and lets the user access these through browse and search facilities.

Spatial Analysis Module

The **Spatial Analysis Module** provides basic GIS functions and geo-processing tools for viewing, creating, editing, and analysing spatial data, and a platform for integration and management of the data.

The **Spatial 3D viewer** allows dynamic visualisation of the landscape terrain in 3D. The GIS layers and satellite images can be draped over the terrain for better visualisation.

Scenario Analysis Module

The **Scenario Analysis Module** allows the system dynamics models to be run with input and output linkages to the GIS layers. It contains two sub-modules: the Qualitative Analysis Sub-Module and the System Dynamics Sub-Module

The **Qualitative Analysis Sub-Module** allows users to browse and view graphically the qualitative models developed in the concept mapping software.

The **System Dynamics Sub-Module** allows the users to follow the dynamic behaviour of complex ecosystems, as in protected areas, over time. Users can run the system dynamics models and adjust model parameters and policy levers to generate different scenarios over given time intervals. Furthermore, the model run output can be linked to the spatial layers so that the user can interactively view the output of the system dynamics models on a map.

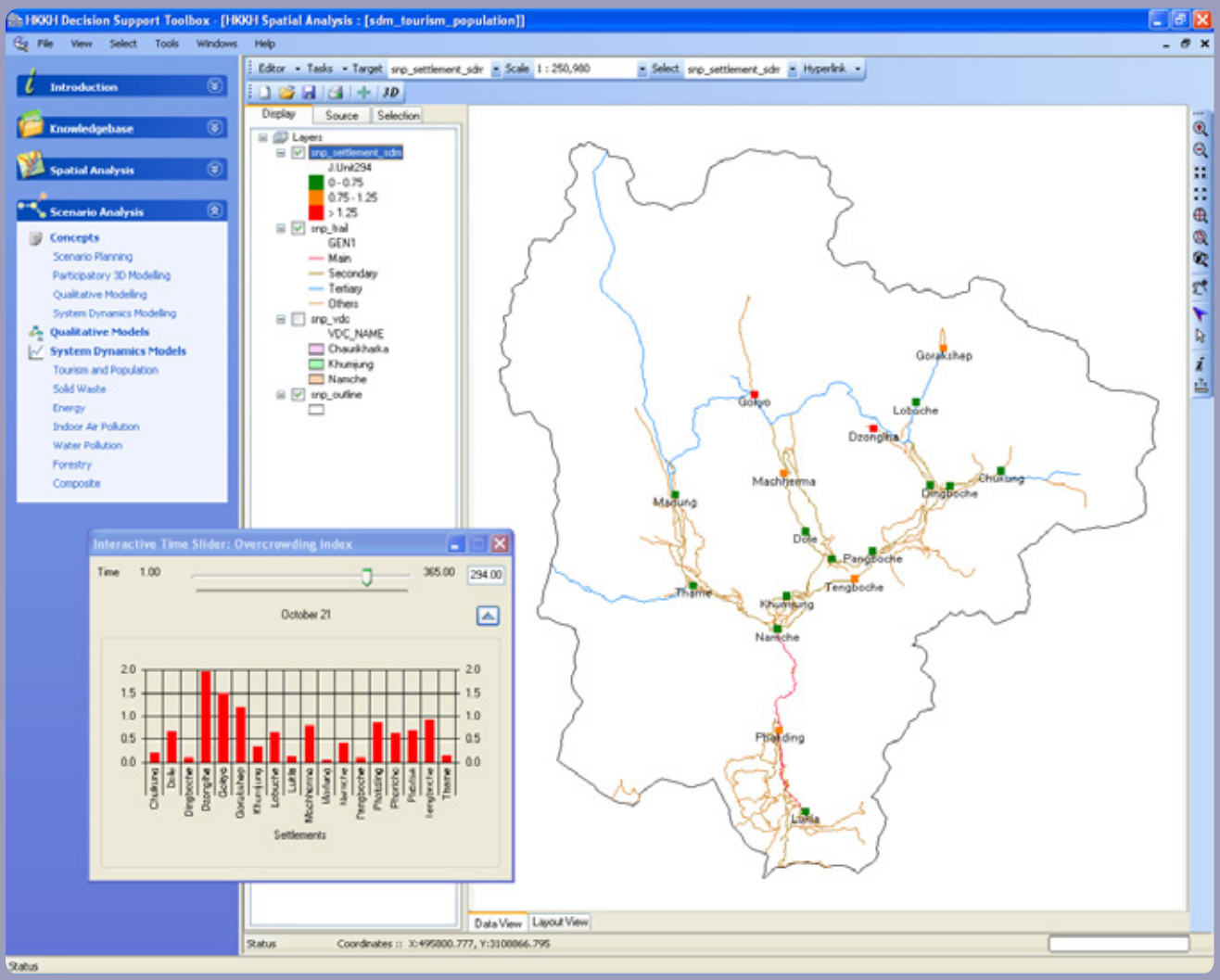
Data package

The toolbox software is bundled with the relevant data, metadata, and models from the Sagarmatha example, so that the users can readily start adapting the software and entering their specific data and own models (if appropriate) ready for use in their decision making processes.

System dynamics model run output in spatial analysis module

The image shows typical output of the systems dynamics model for Sagarmatha National Park and Buffer Zone (SNPBZ). It displays the output of 'Tourism and population' model showing the overcrowded settlements of SNPBZ in red. An interactive time slider allows the users to visualise the overcrowding in the form of both map and chart on any given day of the year.

Visualisation of system dynamics model run output in Spatial analysis module



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