GIS, RS and GNSS in Whatever

Geographical Information Systems (GIS), Remote Sensing (RS) and Global Navigation Satellite Systems (GNSS) offer oversize opportunities for monitoring and managing many facets of our vulnerable world. Particularly in developing countries, geo-information technology provides enormous potential for tackling the broad pallet of problems that tend to be branded by many of us with the tag ‘unsolvable’. Induced by increased human population, intensification in agricultural land use and industrialisation, deforestation, soil erosion, degradation in wildlife habitat, loss of biodiversity and pandemics such as HIV/AIDS seem to be a never-ending story.

Step by Step

How can GIS, RS and GNSS be of help in contributing to finding solutions to these alleged unsolvables? How can GIS, RS and GNSS lend a hand in releasing the chains of destruction shackling the forces for good on Earth? To find answers we need to ask along what lines does a typical monitoring or geo-management task proceed? The steps involved in any such task consist of sampling design of the data-collection process, actual data collection, data storage, data processing, analysis, visualisation, data management and data dissemination. These steps are usually carried out using standard methods and field protocols. But before undertaking the first of these the monitoring or geo-management objective has to be specified: without a predefined objective nothing can be done. The objective might, for example, be to pursue disturbance and fragmentation of tropical rainforest over time to reveal spatial patterns, or to follow the spread of a disease over space and time.

Database and GNSS

Key and essential here is the availability of all relevant data from which core parameters can be calculated in an appropriate format. Existing sources are very valuable to start with. Depending on the objective, such sources may include topographic maps, forest maps, soil maps, Digital Elevations Models (DEM), contour maps, ortho-rectified aerial photos, archived satellite images and non-geodata records. Frequently a GIS project will result in a great abundance of data, and for the smooth retrieval and management of all of this the use of a sophisticated DataBase Management System (DBMS), such as Oracle, is no superfluous luxury. Often geo-data is stored in paper-format, so that the essential features first have to be selected, digitised and stored as GIS layers in the database. Here geo-referencing comes in, which aims at relating each and every position on the map to the corresponding location on the ground. The collection of the necessary ground control points can be fruitfully done using GNSS.

Classification

GNSS is also useful for collecting the location of training samples and other ground-truth when multispectral satellite images have to be classified. Multispectral classification requires the availability of a remote-sensing image-processing package such as Image Analyst. A simple but effective land-use classification method is provided by the Normalized Vegetation Index (NDVI), which is calculated per pixel as a function of the red (R: 0,62Åµm -7Åµm) and near infrared (NIR: 0,7-1,5Åµm) band: NDVI = (NIR - R)/(NIR+R). The value range of NDVI lies between 1 and -1. When essential features cannot be extracted from existing sources, nothing remains but to abandon oneâ€™s office chair for the field. Mobile mapping devices, which basically integrate GNSS, GIS, geo-database and mapping in one compact handheld tool, are optimised for collecting data in the field as GIS input. GNSS can also be used to test the accuracy of geo-data already stored in the database by field check.

Aiding Analysis

When it comes to carrying out analysis, a broad pallet of functionalities is available in todayâ€™s commercial GIS packages. Buffer and overlay operations appear most useful. For example, when a rural village relies on firewood for cooking, one may create buffer zones and overlays of GIS layers to identify forest areas in the vicinity of the village suitable for planting species of wood used for fuel. A functionality fruitful for transportation analysis is the network operation, from which the shortest routes between a cluster of locations can be computed or the movement of railway passengers simulated. Another useful functionality is sight analysis, which can, for example, identify in a forest area the optimal locations for erecting fire watchtowers. Visualisation abilities enable communication of analysis results to others through the production of thematic maps, schemes and so on.

Web-based GIS

The exchange of information between different GIS systems is becoming increasingly important, and this is where Web-based GIS comes in. A Web-based GIS is usually constructed as a three-tier architecture consisting of the client side, the server side, and the database component. From the client side users send queries or requests to the server via the internet. Next the server communicates with the database, where the requested information is compiled by the database engine. Finally the result is stored as, for example, a map in JPG format, and sent to the client. Depending on the GIS functionality present at the client side, the user may carry out zoom, pan, query and other operations on the retrieved map and other data.
In trying to get across all this sophisticated stuff one sometimes overlooks the fact that the crux of success for GIS, RS and GNSS in whatever application is the availability of accurate, detailed and up-to-date geo-information. And that’s where the surveyor comes in.