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.

Land Cover Mapping

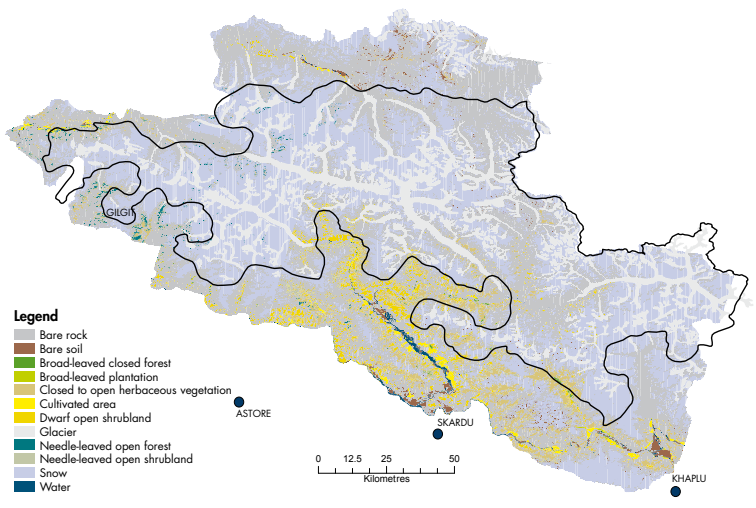
Case studies in three protected areas

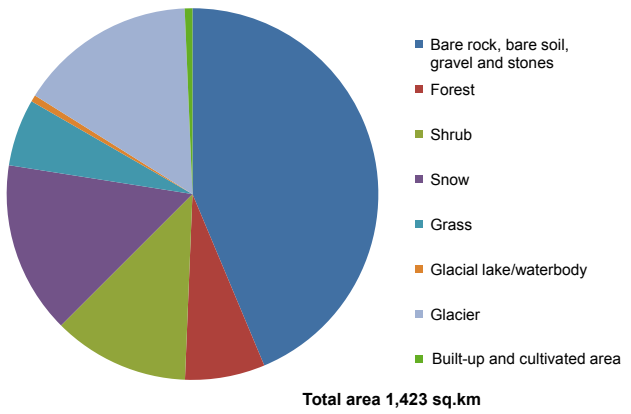
Land cover maps are used to help view the spatial relationships between different types of social and physical information and to make inferences. Potential uses of land cover data are many and varied, they include assessing ecosystem status and health, understanding spatial patterns of biodiversity, land use planning, deriving landscape pattern metrics, and developing land management policy. Land cover changes are the most easily detectable indicators of changes in ecological systems. The direct observation of land surfaces at repeated time intervals is particularly useful, since this periodic data can be used to detect changes and provides baseline information for planning and monitoring, as well as for evaluating development interventions in diverse applications.

Remote sensing for land cover mapping

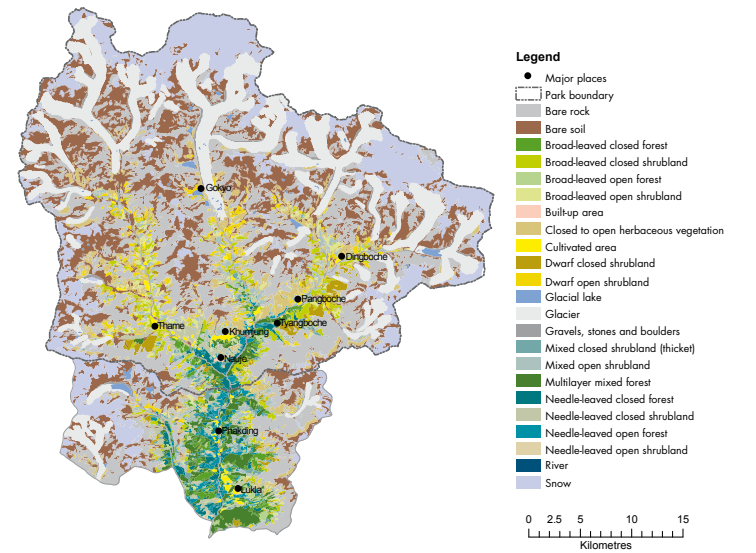
Remote sensing is the tool of choice for land cover mapping as it is possible to cover vast areas efficiently. This is especially true in the Hindu Kush-Himalayan region which covers a vast and sparsely populated area, much of which is very poorly accessible. In recent years, the ready availability of global satellite data has led to the development of many different datasets with different legends and classification methods for mapping land cover. While these datasets are often in agreement in terms of total area and general spatial patterns, there is limited agreement on the spatial distribution of the individual land classes. In order to use remotely sensed data sets from different sources, it is first necessary to 'harmonise' the land cover classification to reduce the differences and make it easier to compare datasets recorded in the same place at different times using different systems.

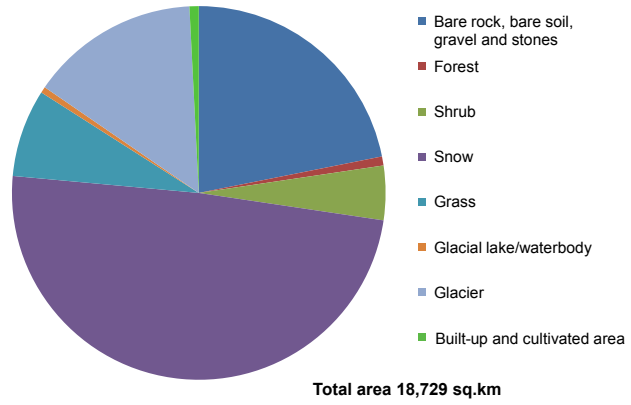
Central Karakoram National Park



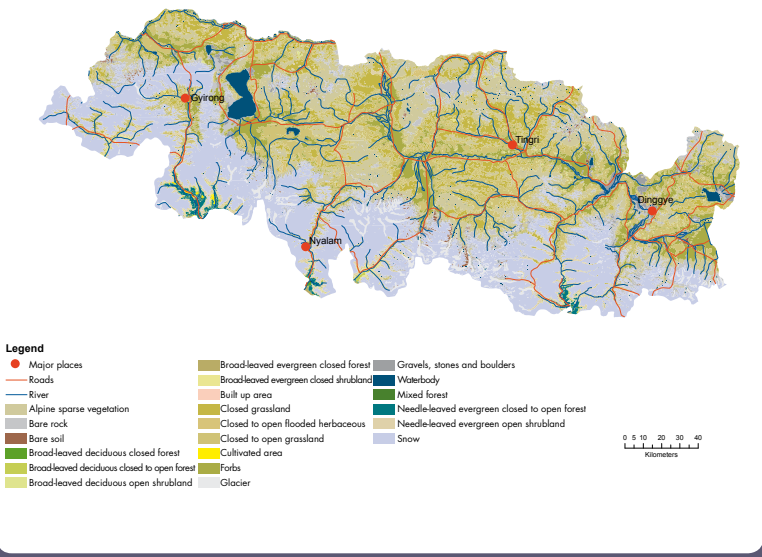


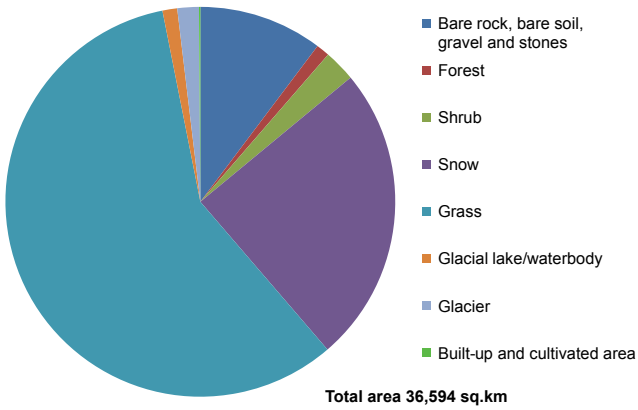
Sagarmatha National Park and Buffer Zone





Qomolangma National Nature Preserve





Classifying land cover

Case studies were conducted in three different protected areas within the Hindu Kush-Himalayas: Sagarmatha National Park and Buffer Zone (Nepal), Central Karakoram National Park (Pakistan), and Qomolangma National Nature Preserve (Tibet Autonomous Region of China). The areas are of very different size and the land cover mapping results are being used in different types of applications. The three areas are a special focus for

Central Karakoram National Park

the Hindu Kush-Karakoram-Himalaya (HKKH) Partnership Project, a three year regional initiative which ended in 2009, supported by Italian Development Cooperation, and implemented by IUCN in partnership with ICIMOD, Ev-K2-CNR, and CESVI.

A multi-scale approach to land cover mapping was used to help understand the linkages at different scales. The Land Cover Classification System methodology developed by the Food and Agriculture Organization of the United Nations and United Nations Environment Programme (FAO/UNEP) was used because it allows aggregation at different levels of detail and responds to the growing need for access to reliable and standardised information on land cover and land cover change. Workshops were organised in Nepal and Pakistan in collaboration with FAO's Global Land Cover Network on the need to harmonise land cover classification within the project framework. The participants developed preliminary legends for land cover mapping, which were further refined after fieldwork.

Qomolangma National Nature Preserve

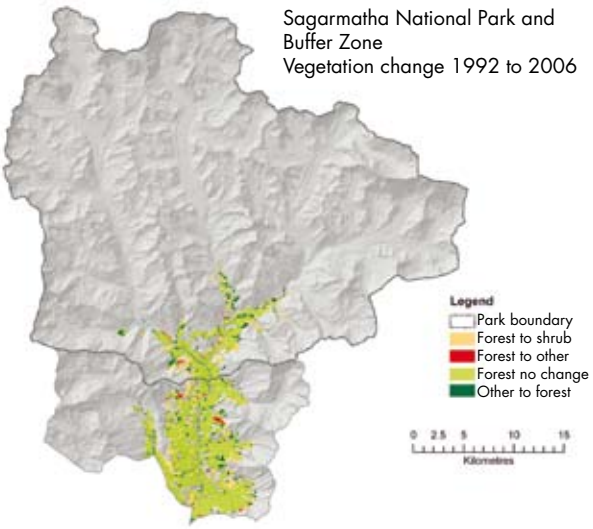
In the chosen methodology, remotely sensed satellite data is processed using an automated information extraction technique called 'object-based image analysis' for land-cover classification. Object-based image analysis is emerging as a promising methodology in automatic information extraction; it produces significantly better classification results compared to conventional pixel-based methods.

In this method, the image is first broken into meaningful image objects or 'segments' through a process called segmentation. The object-based technique uses spectral features as well as texture information, neighbourhood information, context information, and other related ancillary data to assign specific classes to the segments. Different parameters such as normalised difference vegetation index (NDVI), normalised difference snow and ice index (NDSI), and normalised difference water index (NDWI) are also used for better classification of vegetation types, soils, rivers, lakes, snow, and ice.

The classification is refined through an iterative process of ground truthing, that is comparison of representative sample areas with the directly recorded situation on the ground.

Land cover in the protected areas

The object-based image analysis that was used enabled land cover to be assessed quickly, efficiently, and accurately from the remotely sensed images. The number of land classes in each of the protected areas varied according to the number of vegetation and land cover types within them. The charts summarise the results of the land cover mapping in the three areas; clearly the Central Karakoram National Park has a much drier climate than the Sagarmatha National Park and Buffer Zone, and the Qomolangma National Nature Preserve has a very different topography from the other two.



Changes in the Sagarmatha National Park

The land cover change analysis from 1992 to 2006 in Sagarmatha National Park and Buffer Zone, showed a decrease in forest area of 0.27% (384 ha). Although there was an increase in broadleaf and needle leaf forests, it was accompanied by a decrease in multilayer mixed forest, Shrub, grass, and glacial lakes showed increases in area of 0.16%, 1.32%, and 0.17%. There was a significant decrease in snow area (-8.0%) and increase in bare rock area (+ 6.7%).

Building regional capacity

Regional and national workshops organised by the Hindu Kush Karakoram Himalaya (HKKH) Partnership Project brought together scientists and professionals from the three project sites, who work in diverse fields such as forestry, agriculture, ecology, natural resources, biodiversity, and conservation. Together they harmonised the land cover mapping at the three pilot sites. This is was a clear move forward from the traditional approach, in which national land cover mapping in the region tended to be carried out primarily from a forestry perspective. Two added benefits of this collaboration were that it generated awareness among all the participants of the need to harmonise classifications in land cover mapping, and it helped to build capacity to work with common tools used in the conservation and management of protected areas.

Looking ahead

The methodology is being extended to other applications beyond the project level and efforts are underway to build a consensus at the regional level on the development of a harmonised and standardised land cover mapping system. ICIMOD has already joined with FAO's Global Land Cover Network to develop an institutional framework. National organisations in the region have started working together, and the technical resources required have been allocated through a regional workshop held in Kathmandu in 2008. National workshops have been conducted in Bangladesh, Bhutan Myanmar, and Nepal since then. The next step is to help build the capacity of national partners in the region so as to develop a harmonised classification system at the national level. This will pave the way for a harmonised land cover mapping of the entire Hindu Kush-Himalayan region.

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