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Counting Crowns in Nepal

Considered to be the birthplace of the Nepali language, Jumla is known for its biodiversity and spectacular scenery, as well as its lack of development — a 2012 National Population and Housing Census ranked it 68th out of 75 districts. Photo credit: Mr. Madhav Dhakal

Out-of-the-box solution for precise vegetation and land cover mapping

eCognition® software maps tree cover to help authorities devise improvement strategies for the environment and peoples' livelihoods

Highlights

- 30 minutes to run workflows established from customized rulesets that distinguish and map 10 land cover classes
- Change detection in Lorpas' vegetation over a 5-year period (2006–2001)
- An accuracy of 93 % when comparing land classification maps with manual assessment of 60 randomly-chosen sites.

overview

The small communities living in Nepal's high-mountain regions depend nearly exclusively on local natural resources for their livelihoods, yet they have to exploit those same resources in order to have shelter and carve out livelihoods. It's a perpetual Catch-22 that has led to livestock overgrazing, overuse of water and loss of trees.

LOCATION
Nepal

In the remote mountainous region of Jumla, for example, around 90 percent of farmers subsist on agriculture production but their landholdings are so small, it's challenging to harvest sufficient food. So often, families collect firewood, herbs and other ecosystem goods to augment their in-come and food resources.

Compounding the situation, major changes in climate have reduced water availability, increased temperatures and produced a shift in growing seasons—all of which impact agricultural produc-tion, and further drive people to draw from the environment for goods.

The geographic isolation of Jumla and other remote areas have made it difficult for Nepalese authorities to readily see how inextricably linked agricultural practices and environment deterioration have become. This has presented authorities with their own dilemma: how to develop initiatives to both improve agribusiness and strengthen the resilience of the natural resource environment.

To meet this challenge in Jumla, the Ministry of Agriculture and Cooperatives (MoAC) launched a study to help strengthen agribusiness in the region by devising more effective management plans for the local watershed. Using a combination of satellite imagery and advanced land-classification technology, project managers not only produced two land-cover maps showing Jumla's vegetation changes over time, they provided the visual truth to debunk some long-held, local beliefs that Jumla's forests were not being lost to deforestation.

An ICIMOD team manually validated the accuracy of the 2011 classification maps of the Lorpa watershed's tree canopy. Photo credit: Mr. Madhav Dhakal

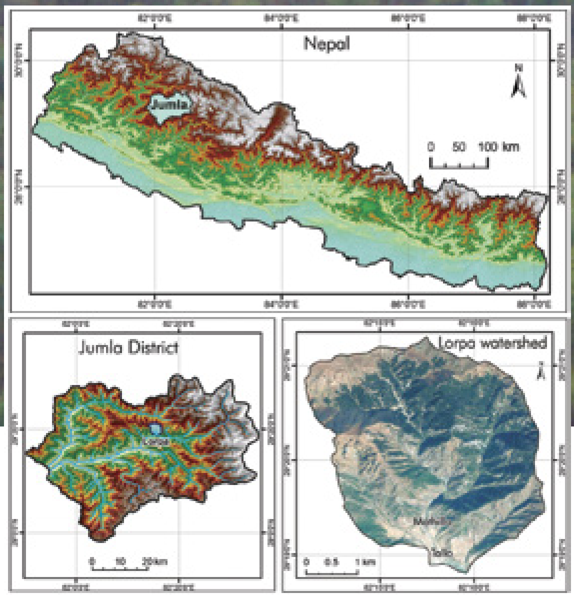
CHALLENGE

Intent on improving Jumla's plight, MoAC in 2010 launched the three-year High Mountain Agri-business and Livelihood Improvement (HIMALI) project. Specifically targeting two watersheds, one of which was the Lorpa watershed, HIMALI's goals were to enhance the communities' socio-ecological resilience to climate change and help design effective local watershed management plans to ensure the sustainability of agribusiness in the region.

To identify and recommend solutions, project managers needed to better understand Lorpa's present vegetation and how its land cover—specifically the forests—had changed over time. Given its geographic isolation, acquiring that picture with traditional, physical surveys would not be feasible.

In order to both assess and map the area's tree cover from the past to the present, the project team needed to have

According to the land classification maps, the Lorpa watershed went from a total of 47,121 tree crowns in 2006 to 41,689 in 2011, amounting to a reduction of 5,432 trees or a loss of 12 percent tree canopy. Photo credit: Mr. Madhav Dhakal



The HIMALI project focused in part on the Lorpa watershed in Nepal's Jumla district, a roughly 20-hour drive from Kathmandu.

geospatial imagery and image analysis technology that would allow them to classify the vegetation, inventory the forest cover down to the tree-crown level and map that over time. The land classification solution also needed to be able to sufficiently handle the complexities of comparing and classifying vegetation within the challenging mountainous environ-ment of steep slopes and dramatic changes in vegetation.

SOLUTION

The responsibility of producing the vegetation-change detection maps fell to Kathmandu's International Centre for Integrated Mountain Development (ICIMOD), a regional knowledge centre serving the eight countries of the Hindu Kush Himalayas.

An ICIMOD team acquired one 2006 QuickBird satellite image and one Ikonos image from 2011 for the change-detection land-cover maps. They also obtained a digital elevation model (DEM) from the shuttle radar topography mission (SRTM) for topographic detail as well as vector data such as buildings, roads and contours. As QuickBird and Ikonos have different resolutions, they integrated the ancillary data with each orthorectified satellite scene to create two separate rule sets within their Trimble® eCognition® software.

After pre-processing and validating the quality of the raster data, the data-processing team used Esri's ArcGIS to calculate multiple indexes to help separate vegetation from non-vegetation are as detail that would be integrated into the classification process. They then wrote customized rules and built two eCognition rule sets to distinguish and map 10 land-cover classes. Specific to the forest cover classes, they instructed the software to automatically delineate individual tree crowns into five size categories. Once the rule sets were complete, it only took the software 30 minutes to run the workflows and produce land-cover maps for 2006 and 2011 showing the change in the Lorpa's vegetation between those two years.

To validate the accuracy of eCognition's automatic tree crown detection, the ICIMOD team chose ten 2.5-acre (1-hectare) sections at random on each pan-sharpened QuickBird and Iko-nos image and manually digitized each visible crown in ArcGIS. They then compared their delineations with the software's and found the 2011 tree-crown classification was 99 percent accu-rate; the accuracy for 2006 was 97 percent.

The maps showed the Lorpa watershed suffered a reduction of 5,432 trees or a loss of 12-percent tree canopy between 2006 and 2011. That equates to a loss of approximately 90 trees per month, the majority of which are those with the largest crown areas of 1,076 sq feet (100 sq m).

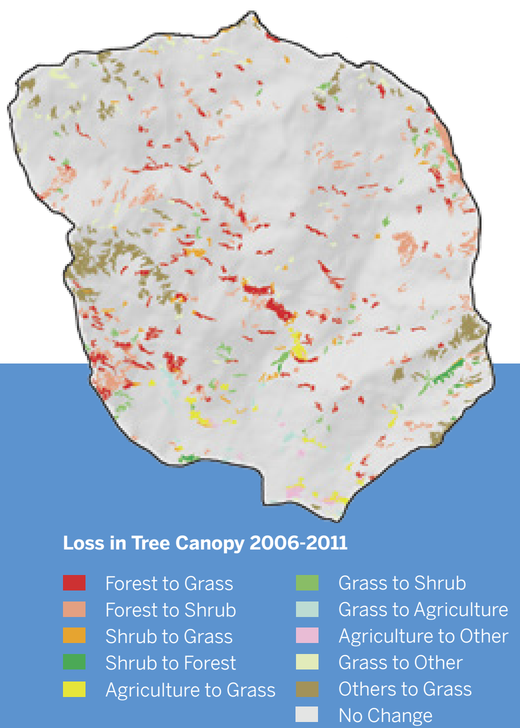
A small team from ICIMOD traveled to the Lorpa watershed to validate the accuracy of the 2011 map results with what was actually on the ground. Field teams manually assessed the vegetation at 60 randomly chosen sites and compared those findings to the land classification map. The overall accuracy was 93 percent.

RESULTS

By compiling accurate inventories and maps of the Lorpa watershed's tree canopy, ICIMOD was able to bring the remote view of the region's environment to Nepalese authorities' desktops. And in presenting the vegetation-change detection maps to officials with both the MoAC and the local district forest office there were audible "gasps" at the clearly visible deforestation in the watershed area. Many officials were under the false impression that forest degradation had been improved in recent years because of successful community forestry programs. The imagery of Lorpa definitively proved otherwise.

However, as sobering as the realization was, the authorities are using the detail of the maps to help devise forestry-specific management programs for the watershed area—a critical part of successfully improving the agribusiness in the region and the livelihoods of its people.

The classification datasets also allowed HIMALI project managers to see how the vegetation has changed over five years, enabling them to better understand the region's roots of historic deforestation and watershed erosion. With that knowledge, they can prioritize investment areas and develop community-centric strategies to help the villages organically grow a healthier agri-business—both for the benefit of their own livelihoods and the wellness of the environment.



Based on eCognition's analysis, the Lorpa watershed lost 12 percent tree canopy in five years.

Analyzing agricultural crops in Lorpa. The HIMALI project aimed to help strengthen agribusiness in the region through more effective management of the local watershed. Photo credit: Mr. Madhav Dhakal

> "Using this powerful geospatial and image analysis software enabled us to cost-effectively assess the ground view and map it repeatedly. It also increased our awareness of the challenges we were facing in order to develop appropriate management plans and use the software to monitor the success of them."
>
> *Kabir Uddin, GIS and Remote Sensing Analyst, ICIMOD*

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