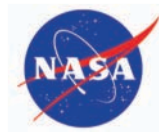


Operational Multi-Scale Forest Biomass Assessment Using Satellite Remote Sensing

SERVIR  HIMALAYA



ICIMOD
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THREE DECADES
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Introduction

Nepal's forests are one of the nation's largest natural resources. Nepal is one of four countries that have been selected by the Forest Carbon Partnership Facility implemented by the World Bank for promoting forest conservation by controlling deforestation and forest degradation. Twelve districts in Nepal have been selected as the most suitable areas for implementing a results-based payment system for Reducing Emissions from Deforestation and Forest Degradation (REDD+) scheme. REDD+ requires a functional monitoring, reporting, and verification system that consists of both biophysical parameters and socioeconomic factors. By integrating remote sensing data and field measurements, above ground biomass can be estimated fairly and accurately and at a reasonable cost.

SERVIR-Himalaya and ICIMOD REDD+ Initiative

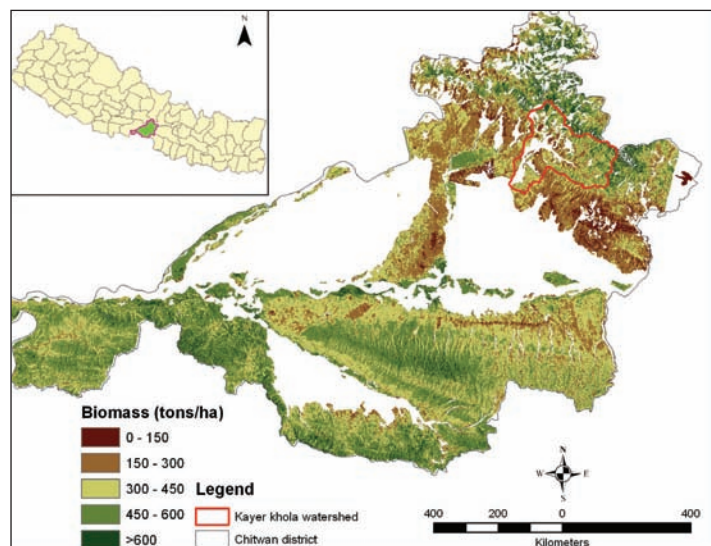
Estimation of biomass using multi-resolution satellite data and ground information was initiated under a REDD+ pilot project in watersheds located in three districts of Nepal: Chitwan, Gorkha, and Dolakha. The study was further extended and up-scaled under the SERVIR-Himalaya initiative with the following objectives:

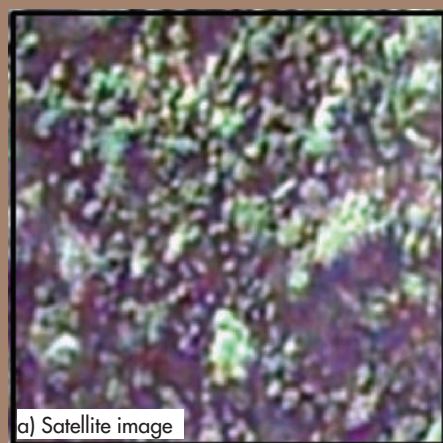
- Develop geospatial approaches for scaling up local level forest biomass measurements to the district level using multi-resolution satellite images

- Evolve a error budgeting and validation system at different levels of assessment
- Prepare sub-national to national level geospatial MRV framework using tested examples
- Develop a customized information system to facilitate the REDD+ monitoring process

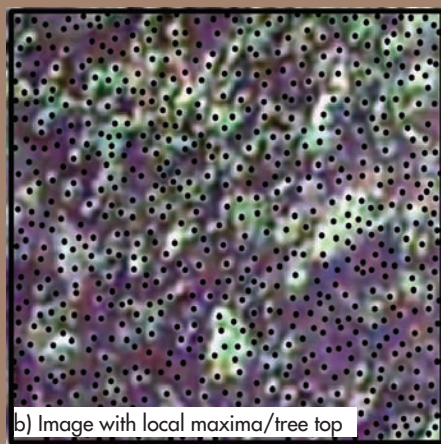
A cost-effective methodology was developed to estimate biomass and carbon stock using very high to medium resolution satellite images (from the watershed to district level) integrated with field measurements.

SERVIR is a regional visualization and monitoring system that integrates Earth observations, such as satellite imagery and forecast models, with in situ data and other information to support timely decision making. SERVIR is a joint initiative of USAID (United States Agency for International Development) and NASA (National Aeronautics and Space Administration). SERVIR-Himalaya is implemented in partnership with ICIMOD with an aim to bridge the gap between scientific knowledge and decision making through applications of Earth observation information in the Hindu Kush Himalayan region. Driven by the motto 'Connecting Space to Village', SERVIR-Himalaya works as a regional resource centre by developing relevant geospatial applications and creating enabling environments for their use.

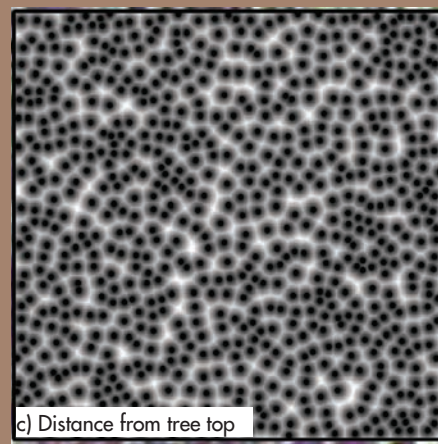




a) Satellite image



b) Image with local maxima/tree top



c) Distance from tree top

Methods

Chitwan is one of the 12 districts that were selected to carry out an assessment of carbon stock with a Carbon Fund set up under the Forest Carbon Partnership Facility. The district was selected for the assessment based on the area's accessibility, data availability, variation in terrain, and an existing REDD+ pilot project in the watershed. The pilot project was carried out in a 23.81 km² portion of the Khayar Khola watershed, within Chitwan District, managed by 16 community forest user groups.

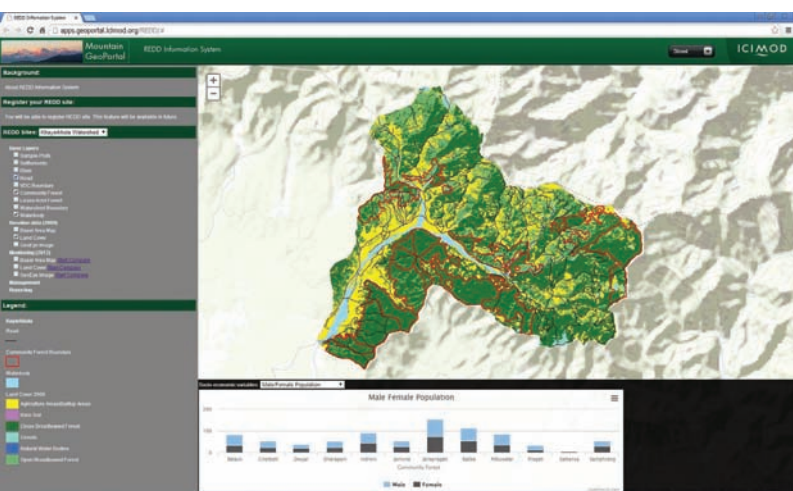
Data on crown projected area (CPA) at the watershed level extracted from very high resolution satellite images were related to estimated field-based biomass values. The established relationship helps to estimate values of CPA and biomass on virtually laid down plots on an ArcGIS Online Base Map for the entire district. The multivariate adaptive regression splines (MARS) modeling technique was applied to calculate biomass across the district using various matrix values such as spectral reflectance, vegetation indices, and topographic profile.

REDD+ Online System

A web-based system has been developed using ESRI's ArcGIS server to publish biophysical (canopy layer, leaf area index, etc.) and social (population, livelihood, dependency, etc.) datasets (<http://apps.geoportal.icimod.org/redd/>). This publicly available system allows users to monitor deforestation, forest degradation, and biomass changes over a certain time period.

Way Forward

The study has been carried out in close collaboration with Ministry of Forest and Soil Conservation and other stakeholders in Nepal. ICIMOD, under the framework of SERVIR-Himalaya, is further developing models and high resolution and 30 m resolution biomass maps throughout Nepal.



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