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DON'T IMPROVE IT INTO A FLOP!

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BACKGROUND

Samuel Goldwyn once said that he was suspicious of those who claimed credit for improvement and development. Because he knew improvement claim meant breakdown. Unfortunately, remote sensing (earth observation) technology in poorer countries, often fits the Godwyn's bill as it has malformed into magic bullets with maladies.

Remote Sensing as technology alone is truthful. However, it can be abused to advantage some over others without access because of its high-end technology, over-heating operating cost and the absence of peer-review. This is contentious and dangerous. There is no way of telling what is correct when images are printed as maps and relegated to unwarranted interpretations. My review paper contest that: 1) Satellite imagery is an effective decision tool when combined with field-based survey in obtaining comprehensive temporal information on the distribution of natural resources; and 2) Image analyses in poorer countries, preferably be peer reviewed and progress can be monitored by in-country research institutions through training and workshops in collaborative arrangement with academia, government agencies and donors.

Since the first images from the Landsat satellite came out in 1972, numerous studies have demonstrated global benefits from the application of satellite data that cut across several disciplines. Now, one can measure earth's resources periodically, monitor the environment, and develop strategies for human survival. The enormous scope of the technology is demonstrated by the North American and European farmers who increasingly use real-time data through sophisticated earth observations to combine with other information systems, for planning, managing and forecasting agricultural production.

Any remote sensing study must bear rigor and signature of repeatability and comparison. Comparable data come from clear and well founded methods to express the uncertainty with a level of statistical confidence. However, a majority of studies undertaken in Nepal with remote sensing, seem to be oblivious of these critical, science-based aspects. For that, I reason the followings: 1) Studies (reports, documents and published papers) do not provide methodology formats for comparison; b) Quality information can not be expected from studies that do not describe standardized steps in image processing; and 3) Many reports and papers unduly use satellite images to add credibility, which are not published work.

GROUND RULES

Data from remote sensing image measures the reflected energy of the surface. To convert this data into useful geo-information, higher levels of processing skills and software are required. Interpreting the extracted information demands further science based knowledge and thoughts. The algorithms we follow starting from acquiring, processing, interpreting and displaying vary with the nature of the application domain. The common sense requirements are that they should be scientifically valid and robust. These algorithms might also differ with changing landscapes and the nature of the image data. Hence, the signal processing methodologies to be used must be the state-of-the-art quality and suit Nepal's landscape.

The standard approach for classification of the image to quantify landuse and land cover changes, is to improve with the addition of more analytical steps (Fig. 1). On the contrary, skipping steps deteriorate the quality of information. There might be ten-folds of algorithms in a single step for higher accuracy of the classified image. Therefore, steps are based on peer reviewed publications and systematic ground-truthing. Skipping steps in image processing with sloppy ground truthing and use of maximum likelihood classifier constitute the general trend while providing spatio-temporal information.

THE CUTTING EDGE

Until two decades ago, satellite imagery have had lesser use because of high cost, poor availability and low level of details associated with images. For example, a study result showed that the estimation of the spatial forest

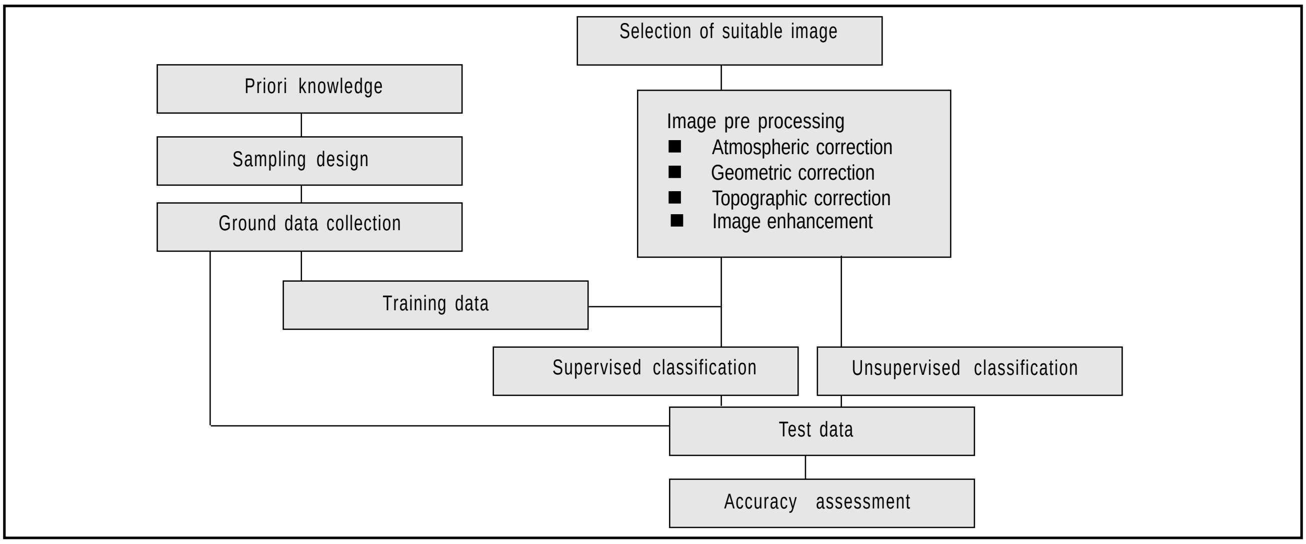

Figure 1. Standard analytical steps in remote sensing for accurate information gathering

variation in Shivapuri National Park using Landsat TM (thematic mapper) imagery was unreliable for monitoring forests characteristics (Sotomayor, 2002). Lately, with more satellites and sophisticated sensors, the cost of the images has dramatically reduced; the images are readily available and the amount of details possible to see in an image, or 'image-resolution", has increased hundred fold. In this regard, Joshi (2006) demonstrated that with high resolution image and algorithms, it was possible to accurately map even understory invasive species. Likewise, advance knowledge on the impact of forest management across space and time was accurately mapped for Nepal (Nagendra et. al, 2005). As the technology continues to evolve and becomes readily available, there is a greater potential for satellite imagery to contribute to understand the human - natural resources dynamics.

Remote sensing can map any or all changes in land cover and landuse and "what if" modelling of mountain environments. High mountain range such as the Himalaya has large and complex relief. Areas of high topographic relief present unique problems because of highly variable illumination angles and reflection geometry. For such, digital elevation models (DEM) can constitute baseline for any mountain geo-referenced information system. DEMs can be computed from optical satellite stereo using sensors such as ASTER or SPOT which have fine spatial resolution with meter-level, vertical accuracy. All these methods require greater degree of mathematical and processing skills.

PIE IN THE SKY?

In Nepal, satellite data are mostly used to determine forest cover and to examine isolated conservation approaches. But, it lacks comprehensive, consistent and reliable use. True potentials of satellite images through standardized, routine operational uses, have not yet materialized. Remote sensing initiative started with the establishment of remote sensing centre in forestry sector in 1981 with the assistance of the Finland Government. Since then, progress in remote sensing has been little. Reasons are high operating cost, fast-paced technology, and lack of self-reliant institutions to benefit from remotely-sensed data. The focus of most institutions and governmental agencies appear to be on applications. Understandably, this is a situation driven by "manufactured" necessity. As a result, little effort is given to advance the knowledge to combine remote sensing and field study. Remote sensing can prove to be a valuable tool for decision-makers only when local situation is taken into consideration for analysis using such technology.

In Nepal, the real value of benefit from remote sensing is not fully understood and priced only as costly expenditure. Policy-makers in Kathmandu, have no idea about the benefits of the earth observation technology. As a result, the technology has reached to a very few donor-based institutions to display as images as maps and ornamental décor in their strategy papers, and reports.

MAKING SENSE

Natural resources are either degraded or being depleted because political decisions are influenced by short-term monetary gains. These external, market-driven decisions are arrested by urban elites and feudal rural lords. The dilemma in the developmental planning is the inadequacy of information on the current land use/ land cover and the available resource base. Without accurate information systems, policy makers have often failed to make decisions or made incorrect decisions. Adequate information systems are prerequisites to natural resources management and administration, yet the country faces severe competing demands necessary to force an information system to reciprocate its policy-making efforts. The only most updated, available source of information on land use of the country is the topographical map prepared by the Survey Department in 1992, suggesting there is no info on what and how land cover types have changed since then and now—a lag of 15 years. The government and its agencies cannot solely be blamed as updating of the information systems through traditional field survey means money and manpower which are beyond the priorities of the country's policy-makers.

Nepal suffers from lack of access to current remote sensing products such as dataset, metadata, models, algorithms and others. Some satellite and airborne images of Nepal are available open-source online while one needs to pay a huge sum of money to get the 15 year old, digitized layer of Topo-map. Inadvertently, the government has blacked-out the geo-information to the plebian minds making it the assets of donor-based institutes. In return, these institutions which have greater experience in remote sensing are stubborn and reluctant to share any information products they have generated, citing the copyright issues. Such blockade of professional interactions has made the cross fertilization of ideas and information between institutes aimed at reaping the maximum benefits of the technological advancement, virtually dormant.

HUMBUG OR REAL?

Although the milestone in remote sensing was the launch of the Earth Resource Technology Satellite (ERTS) in 1972, the bulk of Nepal's scholarly studies using remote sensing, began only recently. Of these, several have documented the extent of forest cover and wildlife habitat (Blamont and Mering, 1987; Millete et. al, 1995; Smith et. al, 1998; Zomer et. al, 2001, 2002; Tokola et. al, 2001; Shrestha and Zinck, 2001; Schweik et. al, 2002; Gautam et. al, 2004; Southworth et. al, 2006).

There are also other studies such as "Forest cover changes analysis of the Terai Districts" (DoF, 2005). In the past, Remote Sensing Centre of the Department of Forest has produced 1:250,000 forest inventory maps. The Department of Forest recently analyzed forest cover change in the entire Terai (20 districts) , using Landsat TM data from 1990 to 2001. This is extensive. The report provides detailed changes for each district with a complete flow chart of the methods followed. Three key results were: 1) Net loss in forest cover was 90.51 km^2; 2) Annual rate of deforestation was - 0.06%; and 3) Annual rate of increase in forest cover inside five protected areas (Koshi Tappu, Parsa, Chitwan, Bardia and Suklaphanta) in Terai, was 0.01%.

In this DoF report, however, methodology on the ground data collection is not described though use of training and testing samples are mentioned. Required preprocessing techniques like atmospheric correction, is not mentioned. Likewise, it reports that digital elevation model (DEM) could not be used because of its unavailability in the Terai districts of Nepal. DEM can be easily constructed from the contour layers or can be downloaded from internet (coarse resolution). The next question is logical to ask when all of Nepal's forest will be covered? Will it take another lag of 10 years?

Feeble are many. A PhD study "Reconciling biodiversity conservation priorities with livelihood need in Kanchanjunga Conservation Area (KCA), Nepal" used a land cover change map derived from satellite images of 1989 to 2000 (Gurung, 2006). An increase of 1% (20.35 km^2) forest cover was deduced suggesting people have conserved more forest. Without doubt, we do believe in community-based resource conservation, but the use of map as evidence concealing its accuracy, merely creates cartographic confusion, ecological uncertainty and can annoy any remote sensing literate. Also, using the result of undefended master theses in PhD publication does not look pleasing. The author has not discussed anywhere about the accuracy of the final map and/or the accuracy of the original land cover maps. There could be more than equal chance that the accuracy of a single land cover map was less than 90%, consecutively making the overall accuracy of the forest change in the map. Considering local forest management, how many patches and patch size (temporal) constitue 20.35 km^2 of forest? Where are they located (spatial)? Were there natural disturbance earlier? How many forest types had such cover increase? Which forest types had significant increase over others? With many questions unanswered, the level of uncertainty is high.

Décor is perhaps the next level of issues. Satellite photos (without data) are widely misused for "beefing up" papers. In the book "Conservation Biology in Asia" two different strategy papers (Gurung et. al, 2006; Chhetri and Sharma, 2007) used the same Kanchenjunga region, suggested identical regional measures to carry landscape conservation approach with similar remote sensing images without analysis. As both argue for conservation, these two papers should have been merged as one, given the absence of remote sensing data. From these, it can be inferred that participatory maps using PRA methods perhaps provide more than satellite photos (not image) because they detail local constraints and highlight issues on land use.

LOOKING AHEAD

It was acknowledged at the Earth Summit and Kyoto Protocol that satellite imagery is the most promising and probably the only feasible way for a detailed mapping and monitoring of forests over large geographical areas. Given the complex fragmentation of coverage of forest in difficult terrain, conventional ground-based survey cannot provide timely and cost-effective information (Kayastha, 2007). Applications of remote sensing require data source, standardised methods, sophistication levels of data analyses and expertise. Therefore, Nepal requires implementation of a comprehensive plan on technology infrastructure, from acquisition of the remote sensing data, through processing and generation of information products, to distribution involving academia, in-country institutions and specific users. Existing governmental structures and institutions involved in remote sensing sector, show that it is not enough. Hence, there is a greater need for more establishments with three interrelated objectives: information management; building scientific capacity, and institutional networking. This is doable through capacity building and mentorship in academia, with a strong development of institutional linkages and bonding them within and outside the country.

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