

International Journal of Innovative Research in Science, Engineering and Technology

A Monthly Peer Reviewed Journal

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 10, October 2015

Changes of Vegetation Cover Using GIS & Remote Sensing - A Case Study

Saumitra Das

Assistant Professor in Geography, Sonarpur Mahavidyalaya, Sahid Biswanath Sarani, South 24 Parganas, Rajpur,
Kolkata, West Bengal, India

ABSTRACT: Remote sensing is the technique of deriving information about objects on the surface of the earth without physically coming into contact with them. Using various sensors. Remote sensing data can be interpreted by digitally in computer through various remote sensing softwares. GIS is in organized collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate analyze and display all forms of geographically referenced information. GIS study includes geographic data processing, editing, manipulation, management, analysis, display and output of geographic information. Remote sensing and GIS can be applied for environmental monitoring and climate change detection. The proposed system is to detect land cover/land use changes especially vegetation. The land cover is classified into four classes: Forest, Vegetation, Water and Other. ArcGIS will be applied as analysis tools for classification and change detection. Normalized Difference Vegetation Index (NDVI) maps allow comparisons of the spatial and temporal variability in the amount and condition of vegetation. The variability in annual maximum greenness from six years of NDVI data can be computed to determine the area of potentially higher and lower inter-annual variability in vegetation production, and was found to be very useful to estimate the frequency of meteorological and vegetation drought events.

Mapping vegetation through remotely sensed images involves various considerations, processes and techniques. Increasing availability of remotely sensed images due to the rapid advancement of remote sensing technology expands the horizon of our choices of imagery sources. Various sources of imagery are known for their differences in spectral, spatial, radioactive and temporal characteristics and thus are suitable for different purposes of vegetation mapping. Generally, it needs to develop a vegetation classification at first for classifying and mapping vegetation cover from remote sensed images either at a community level or species level. Then, correlations of the vegetation types (communities or species) within this classification system with discernible spectral characteristics of remote sensed imagery have to be identified. These spectral classes of the imagery are finally translated into the vegetation types in the image interpretation process, which is also called image processing. This paper presents an overview of how to use remote sensing imagery to classify and map vegetation cover.

KEYWORDS: vegetation, remote, sensing, spatial, mapping, images, classification, spectral, cover

I. INTRODUCTION

Traditional methods (e.g. field surveys, literature reviews, map interpretation and collateral and ancillary data analysis), however, are not effective to acquire vegetation covers because they are time consuming, date lagged and often too expensive. The technology of remote sensing offers a practical and economical means to study vegetation cover changes, especially over large areas. The mapping approaches as well as their strengths and weaknesses of the above global land cover products. Besides these datasets at the global and continental scales, there have been numerous efforts taken over regional or national extents to map vegetation. An example is the USGS–NPS Vegetation Mapping, a collaborative program between the U.S. Geological Survey and the National Park Service, which began in 1994 with the aim to produce detailed and computerized maps of the vegetation for ~250 national parks across the United States by processing Airborne Visible and Infrared Imaging Spectrometer (AVIRIS) imagery along with ground sampling

International Journal of Innovative Research in Science, Engineering and Technology

A Monthly Peer Reviewed Journal

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 10, October 2015

references. Remote sensing technology not only can be applied to map vegetation covers over land areas but also in underwater areas with focus on mapping submergent aquatic vegetation (SAV), which is regarded as a powerful indicator of environmental conditions in both marine and fresh water ecosystems.[1,2]

A remote sensing sensor is a key device that captures data about an object or scene remotely. Since objects (including vegetation) have their unique spectral features (reflectance or emission regions), they can be identified from remote sensing imagery according to their unique spectral characteristics. A good case in vegetation mapping by using remote sensing technology is the spectral radiances in the red and near-infrared regions, in addition to others. The radiances in these regions could be incorporated into the spectral vegetation indices (VI) that are directly related to the intercepted fraction of photosynthetically active radiation.

In general, images with low resolutions may be adopted only when the high level of vegetation classes are to be identified, while the images with relatively higher resolutions are used for fine-detailed classifications of vegetation. Second, remote sensing imagery may be very expensive and the cost of imagery is definitely a consideration when choosing imagery. From the mapping scale point of view, vegetation mapping at a small scale usually requires high-resolution images, while low-resolution images are used for a large-scale mapping. Third, it raises the issue of the feasibility of using data from different sources to obtain a cloud-free image series over an extended period of time.[3,4] Landsat products are usually used to map vegetation at community level. It is a challenging task to use Landsat images for mapping at species level, especially in a heterogeneous environment. However, when integrating with other ancillary data, it becomes possible to map species. An example of a species level of vegetation classification was implemented in the Amanos Mountains region of southern central Turkey using Landsat images, combined with the environmental variables and forest management maps, to produce regional scale vegetation maps with an overall high accuracy.

III. DISCUSSION

A classification system for different land cover types with a special emphasis on the sparse vegetation cover was developed to resolve problems related to the seasonal changes and the highly variable natural conditions. MODIS (Moderate Resolution Imaging Spectroradiometer) is a key instrument on aboard of the Terra (EOS AM) and Aqua (EOS PM) satellites. Terra MODIS and Aqua MODIS together are able to view the entire earth's surface every 1–2 days. The gathered images from MODIS, including 36 spectral bands with spatial resolutions ranging from 250 to 1 km, are mainly applied to map vegetation dynamics and processes at a large scale. Due to the coarse spatial resolution, vegetation mapping at a local scale or regional scale is not recommended. However, image fusion by combining multiple imagery types can possibly lead to better mapping results. AVHRR imagery suffers certain limitations in calibration, geometry, orbital drift, limited spectral coverage and variations in spectral coverage especially in the early period of applications. Its utility has been restricted because its use often introduces substantial errors at various stages of processing and analysis. Nevertheless, many projects (including GLCC) aiming at mapping vegetation covers at continental to global scales have been carried out using AVHRR for years simply because of its low cost and easy access.[5,6]

QuickBird offers highly accurate and even higher resolution imagery with panchromatic imagery at 60–70 cm resolution and multispectral imagery at 2.4 and 2.8 m resolutions. It is the only spacecraft able to offer sub-meter resolution imagery so far. QuickBird's global collections of images greatly facilitate applications ranging from land and asset management to ecology modeling (including vegetation mapping). QuickBird images are usually used to study special topics in relatively small areas (or at a local scale) since it is impractical to apply QuickBird imagery for applications in large area due to its high cost and rigid technical parameters. The results suggested that QuickBird imagery particularly had a valuable role to play in identifying tree crowns with red attack damages. Similar to IKONOS, images from QuickBird can be used to map vegetation cover at a local scale or used for validation purpose. Besides aforementioned sensors, there are many others. For example, Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) is an imaging instrument flying on Terra. ASTER has been used to obtain detailed maps of land surface, reflectance and elevation in the study of habitat patterns. Note that the principle for mapping

International Journal of Innovative Research in Science, Engineering and Technology

A Monthly Peer Reviewed Journal

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 10, October 2015

vegetation cover from remote sensing images relies on the unique spectral features of different vegetation types. Thus, hyperspectral imagery contains more vegetation information and can be used for more accurate vegetation mapping. AVIRIS, for example, collects images with 224 spectral bands.[7,8]

III. RESULTS

Vegetation extraction from remote sensing imagery is the process of extracting vegetation information by interpreting satellite images based on the interpretation elements such as the image color, texture, tone, pattern and association information, etc. Diverse methods have been developed to do this. Those methods can be broadly grouped either as supervised or as unsupervised depending on whether or not true ground data are inputted as references. General steps involved in vegetation mapping include image preprocessing and image classification. Image preprocessing deals with all preparatory steps necessary to improve the quality of original images, which then results in the assignment of each pixel of the scene to one of the vegetation groups defined in a vegetation classification system or a membership matrix of the vegetation groups if fuzzy classification is adopted. Botanist and ecologist should keep in mind that while image preprocessing is the prerequisite for vegetation extraction from remote sensing images, the preprocessing procedures listed below may not be always needed because some of these preprocessing procedures may have been done by image distribution agencies. Thus, it is recommended to consult with the image distributor and get to know at what level the imagery is (usually including level 0, 1A, 1B, 2A, 2B, 3A, 3B with image quality gradually increased) before imagery purchase. For example, for most sensors, level 3A means that radiometric correction, geometric correction and orthorectification have been processed for the images. Image preprocessing commonly comprises a series of operations, including but not limited to bad lines replacement, radiometric correction, geometric correction, image enhancement and masking (e.g. for clouds, water, irrelevant features) although variations may exist for images acquired by different sensors.[9,10]

Bad line replacement is to determine the overall quality of the images (e.g. missing data lines) through visually previewing the images band-by-band. The visual review is usually done at full extents while attention is focused on identifying lines or blocks of missing data in each band for further repairing. Image line replacement is a procedure that fills in missing lines with the line above, below or with an average of the two.

Radiometric correction of remote sensing data normally involves the process of correcting radiometric errors or distortions of digital images to improve the fidelity of the brightness values. Factors such as seasonal phenology, ground conditions and atmospheric conditions can contribute to variability in multi-temporal spectral responses that may have little to do with the remote sensed objects themselves. It is mandatory to differentiate real changes from noises through radiometric correction in cases where the spectral signals are not sufficiently strong to minimize the effects of these complicating factors. Several methods are available to make radiometric corrections. Some of them are based on complex mathematical models that describe the main interactions involved. However, the values of certain parameters (i.e. the atmospheric composition) must be known before applying them. Other radiometric correction methods are based on the observations of reference targets (e.g. water or desert land) whose radiometry is known. Whatever radiometric correction methods are, they can be classified into two types: absolute and relative correction

Image classification, in a broad sense, is defined as the process of extracting differentiated classes or themes (e.g. land use categories, vegetation species) from raw remotely sensed satellite data. Obviously this definition includes the preprocessing of images. We here simply refer to the process following the image preprocessing as image classification. Techniques for extracting vegetation from preprocessed images are grouped into two types: traditional and improved methods.

IV. IMPLICATIONS

The traditional methods employ the classical image classification algorithms, e.g. K-mean and ISODATA for unsupervised classification or the maximum likelihood classification (MLC) for supervised classification.

International Journal of Innovative Research in Science, Engineering and Technology

A Monthly Peer Reviewed Journal

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 10, October 2015

Unsupervised approach is often used in thematic mapping (including vegetation cover mapping) from imagery. It is easy to apply and widely available in image processing and statistical software packages.

Improved methods usually focus on and expand on specific techniques or spectral features, which can lead to better classification results and thus deserve special attention. Great progress has been made in developing more powerful classifiers to extract vegetation covers from remote sensing images. For example, developed continuous classifications using Landsat data to distinguish variations within Neotropical savannas and to characterize the boundaries between savanna areas, the associated gallery forests, seasonally dry forests and wetland communities. They proved that continuous classifications were better than MLC classification especially in complex land cover areas. [11,12]

In recent years, more advanced methods reflecting the latest remote sensing techniques used in vegetation mapping are seen in literature. Among them, the applications of hyperspectral imagery and multiple imagery fusion to extract vegetation cover are rapidly developed and thus deserve our special attention. Rather than using multispectral imagery, vegetation extraction from hyperspectral imagery is increasingly studied recently. Compared with multispectral imagery that only has a dozen of spectral bands, hyperspectral imagery includes hundreds of spectral bands. Hyperspectral sensors are well suited for vegetation studies as reflectance/absorption spectral signatures from individual species as well as more complex mixed-pixel communities can be better differentiated from the much wider spectral bands of hyperspectral imagery. For example, the hyperspectral imagery from AVIRIS is commonly used in the realm of earth remote sensing. [13]

V. CONCLUSIONS

This paper covered a wide array of topics in vegetation classification using remote sensing imagery. First, a range of remote sensing sensors and their applications in vegetation mapping were introduced to facilitate the selection of right remote sensing products for specific applications. Second, the techniques of image preprocessing and various classification methods (traditional and improved) were discussed on how to extract vegetation features from remote sensing images. Particularly, the extraction of vegetation cover through the application of hyperspectral imagery and image fusion was discussed. Third, a section was dedicated to the discussion of result evaluation (accuracy assessment) of image classification. In short, remote sensing images are key data sources for earth monitoring programs considering the great advantages that they have. For instance, it is more easily obtainable to produce and update vegetation inventories over large regions if aided by satellite imagery and appropriate imagery analysis. A growing number of studies have examined a wide variety of vegetative phenomena (including mapping vegetation cover) by using remote sensed data. [14]

REFERENCES

- 1) Campbell, J. B. (2002). Introduction to remote sensing (3rd ed.). The Guilford Press. ISBN 978-1-57230-640-0.
- 2) Jensen, J. R. (2007). Remote sensing of the environment: an Earth resource perspective (2nd ed.). Prentice Hall. ISBN 978-0-13-188950-7.
- 3) Jensen, J. R. (2005). Digital Image Processing: a Remote Sensing Perspective (3rd ed.). Prentice Hall.
- 4) Lentile, Leigh B.; Holden, Zachary A.; Smith, Alistair M. S.; Falkowski, Michael J.; Hudak, Andrew T.; Morgan, Penelope; Lewis, Sarah A.; Gessler, Paul E.; Benson, Nate C. (2006). "Remote sensing techniques to assess active fire characteristics and post-fire effects". International Journal of Wildland Fire. **3** (15): 319–345. doi:10.1071/WF05097.
- 5) Lillesand, T. M.; R. W. Kiefer; J. W. Chipman (2003). Remote sensing and image interpretation (5th ed.). Wiley. ISBN 978-0-471-15227-9.
- 6) Richards, J. A.; X. Jia (2006). Remote sensing digital image analysis: an introduction (4th ed.). Springer. ISBN 978-3-540-25128-6.
- 7) US Army FM series.2001

International Journal of Innovative Research in Science, Engineering and Technology

A Monthly Peer Reviewed Journal

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 10, October 2015

- 8) US Army military intelligence museum, FT Huachuca, AZ Datla, R.U.; Rice, J.P.; Lykke, K.R.; Johnson, B.C.; Butler, J.J.; Xiong, X. (March–April 2011). "Best practice guidelines for pre-launch characterization and calibration of instruments for passive optical remote sensing". Journal of Research of the National Institute of Standards and Technology.
- 9) Begni G., Escadafal R., Fontannaz D. and Hong-Nga Nguyen A.-T. (2005). Remote sensing: a tool to monitor and assess desertification. Les dossiers thématiques du CSFD. Issue 2. 44 pp.
- 10) KUENZER, C. ZHANG, J., TETZLAFF, A., and S. DECH, 2010: Thermal Infrared Remote Sensing of Surface and underground Coal Fires. In (eds.) Kuenzer, C. and S. Dech 2013: Thermal Infrared Remote Sensing – Sensors, Methods, Applications. Remote Sensing and Digital Image Processing Series, Volume 17, 572 pp., ISBN 978-94-007-6638-9, pp. 429–451
- 11) Kuenzer, C. and S. Dech 2010: Thermal Infrared Remote Sensing – Sensors, Methods, Applications. Remote Sensing and Digital Image Processing Series, Volume 17, 572 pp., ISBN 978-94-007-6638-9
- 12) Lasaponara, R. and Masini N. 2011: Satellite Remote Sensing - A new tool for Archaeology. Remote Sensing and Digital Image Processing Series, Volume 16, 364 pp., ISBN 978-90-481-8801-7.
- 13) Dupuis, C.; Lejeune, P.; Michez, A.; Fayolle, A. 2002. How Can Remote Sensing Help Monitor Tropical Moist Forest Degradation?—A Systematic Review. Remote Sens.