Chapter 14
Dynamic Changes of Plantations in the Selected Watershed Project Areas of Andhra Pradesh Using Bhuvan Geo-Information

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Abstract IWMP aims to enhance the judicious use of natural resources, particularly based on soil and water conservation measures. NRSC/ISRO has designed and developed the required technological interventions (Srishti & Drishti) for monitoring and management of IWMP watersheds through Bhuvan-Integrated Watershed Programme (IWMP). In order to analyze the changes in plantations, IWMP watershed projects corresponding to 6 Agro climatic zones of Andhra Pradesh were selected as they facilitate the specific growth scenario of Plantations in these IWMPs. Dynamic changes in plantations provides us the information of Land cover changes which helps in implementing the sustainable developmental activities in the IWMPs for the growth and for balancing the hydrological cycle properly. The procedure to detect changes in plantations involves a comparison of two or more satellite images acquired at different times that can be used to evaluate the differences in spectral responses. The method of change detection involves analysing the changes in plantations using online Bhuvan geo information and analysing through image processing techniques.

Keywords Bhuvan · IWMP · Change detection · Image processing
NDVI · Per pixel based image analysis · Object based image analysis

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1 Introduction

Remote sensing technology in combination with geographic information system (GIS) can render reliable information on Plantation cover. Urban growth, in population has been a major factor which has altered natural vegetation cover, due to anthropogenic activities. The results of these have left significant effects on local weather and climate. The use of remote sensing data in recent times has been of immense help in monitoring the changing pattern of Plantations.

The analyzation of the dynamic changes of plantations in the IWMP (Integrated Watershed Management Programme) watershed projects provides us the information of Landover changes which helps in implementing the sustainable developmental activities in the IWMPs for the plantation growth and for balancing the hydrological cycle properly.

The current study focuses on the change detection of plantations and their spatial distribution. Spectral characteristics of features may change over time and these changes can be detected by collecting and comparing multi temporal imagery. Change detection procedures intend to find and where appropriate, to interpret the alterations of objects or phenomenon between the different acquiring times t1, t2, … tn. when using multi temporal remote sensing image data, the value of an image pixel or object at time t1 can be compared with the value of the corresponding image pixel or object at time t2 in order to determine the degree of change. The change analysis includes visual interpretation using Bhuvan geo based information and then confirming the changes using image processing techniques. The image processing methods for change analysis involves both per pixel based image analysis and object based image analysis methods. This is because the coverage changes were affected by the seasonality and the potential usage of high resolution satellite images for the extraction of information from local to national scales.

2 Data and Software Packages

In this study satellite data of Resourcesat-2 LISS-IV data and Planetlab imagery Rapideye and Planetscope are used. For the change detection multi temporal satellite images (T0 & T1) were used. T0 data is acquired from LISS-IV and T1 data is acquired from planet labs satellite imagery. The LISS-IV sensor is a multispectral high resolution camera with a spatial resolution of 5.8 m at nadir. The payload provides multispectral imagery covering a swath of 70 km as compared to 23 km swath of Resourcesat-1. The data is acquired in three spectral bands namely visible and near infrared (B2, B3 and B4). Planet's satellite constellations image the entire world every day. The planetscope analytic data is orthorectified, multispectral data from satellite constellation with four multispectral bands namely blue, green, red and near infrared and having ground sample distance of 3.7 m (at reference altitude of 475 km).

Software packages used were Arc GIS 10.2.1 which is used for discovering geographic information, analysing the information and for creating maps. ERDAS IMAGINE 2016 is aimed primarily at geospatial data processing and for the enhancement of digital images and for the image processing methods that are involved in change detection. eCognition 9.1 used for extracting information from images using a hierarchy of image objects (group of pixels) and is used for image segmentation and classification processes. It solves image analysis tasks through earth science based rule sets and workflows.

2.1 Study Area

For analyzing the changes in Plantations six Agroclimatic Zones of Andhra Pradesh were considered. The Agroclimatic zones facilitates understanding with respect to specific growth scenario in Plantation. Agroclimatic zones refers to soil types, rainfall, temperature and water availability which influences the type of plantations. Therefore to study and analyze the Plantation growth, different IWMPs from each district corresponding to these Agroclimatic zones were selected. They are North Coastal Zone (Vizianagaram), Godavari Zone (West Godavari), Krishna Zone (Prakasam), Southern Zone (Kadapa), Scarce Rainfall Zone (Ananatapur), High Altitude and Tribal Areas Zone (High altitude and tribal areas of Visakhapatnam) (Fig. 1; Table 1).

Fig. 1 Image showing the six selected IWMPs of Andhra Pradesh

Table 1 Represents the study area

Districts	Type of agro climatic zones	IWMPs
Anantapur	Scarce rainfall zone	IWMP-32
Kadapa	Southern zone	IWMP-29
Prakasam	Krishna zone	IWMP-36
Visakhapatnam	High altitude tribal zone	IWMP-11
Vizianagaram	North coastal zone	IWMP-10
West Godavari	Godavari zone	IWMP-01

3 The Hybrid Method

Hybrid method of change detection involves analyzing the changes in plantations using web portal Bhuvan Geo information and through image processing techniques.

3.1 Change Analysis Through Bhuvan Geo Information

The primary analysis of changes in plantations were observed and identified in the six IWMPs of six different agroclimatic zones of Andhra Pradesh using Bhuvan geo information and the changes that are associated with these watersheds were identified as mainly two kinds, they are increase in plantations and felling of plantations. The increase in plantations was further categorized into two types namely large plantation associations and moderate to small plantation associations. The felling of plantations were also categorized into two types namely removal of small patches of plantations and removal of large patch of plantations. These different categories were considered as instances and were identified by visual interpretation using Bhuvan geo information for all six IWMPs that have been selected each for one district of Andhra Pradesh. The total number of instances for each category was given in Table 2.

The large plantation associations were considered as one instance. For illustration from Table 2 the more number of instances of large plantations established that were identified in Southern zone i.e., in Kadapa district IWMP-29 are 25 instances. Figure 2 illustrates the association large plantations (Fig. 3).

3.2 Change Analysis Through Image Processing Techniques

This paper gives an overview of the analysis using both pixel based and object based methods. The object based methods which aim to delineate readily usable objects from imagery while at the same time combining image processing and GIS

Table 2 This table depicts the change analysis of plantations using Bhuvan web based Geo information system

S. no.	Type of change	Vegetation change	Godavari zone	High altitude tribal zone	Krishna zone	North coastal zone	Scarce rainfall zone	Southern zone	Total
1	Planting	Large plantations established	12	10	7	6	5	25	65
		Moderate to small plantation established	56	51	34	16	69	128	354
2	Felling	Removal of small patch of vegetation	9	0	6	2	1	4	22
		Removal of large patch of vegetation	1	0	0	0	0	0	1
		Total	78	61	47	24	75	157	442

Fig. 2 Identifying the association of large plantations on Bhuvan Srishti

The moderate to small plantations that are established are shown in the below image

The removal of large association of plantations are shown by the image below

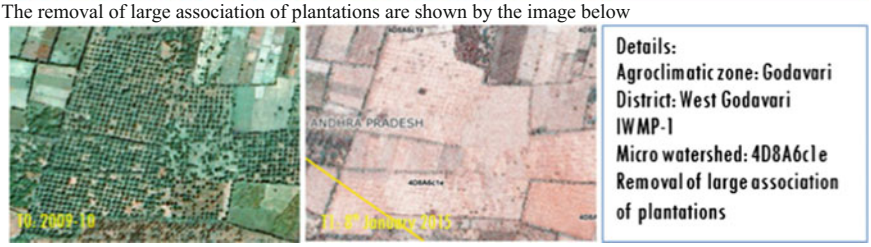

Fig. 3 Identifying the plantation changes in Bhuvan IWMPs

functionalities in order to utilize spectral and contextual information in an integrative way. To avoid salt and pepper effect image can be divided into homogeneous regions prior to classification, instead of classifying the individual pixels. The most common approach used for building objects is image segmentation. High resolution satellite images offer great spectral heterogeneity and spatial variance. Because of spectral heterogeneity and spatial variance in the image, segmentation techniques were used. With this approach, segments not only have spectral properties, but also region based metrics as shape, texture, structure, size and context. Object-based image analysis (OBIA) involves pixels first being grouped into objects based on either spectral similarity or an external variable such as ownership, soil or geological unit. Many variables may be determined, categorized as spectral, shape. Spectral variables are mean value and standard deviation of a specific spectral band; shape variables include size, perimeter and compactness. This can be achieved from ecognition tool which used patented image segmentation and classification processes (Fig. 4).

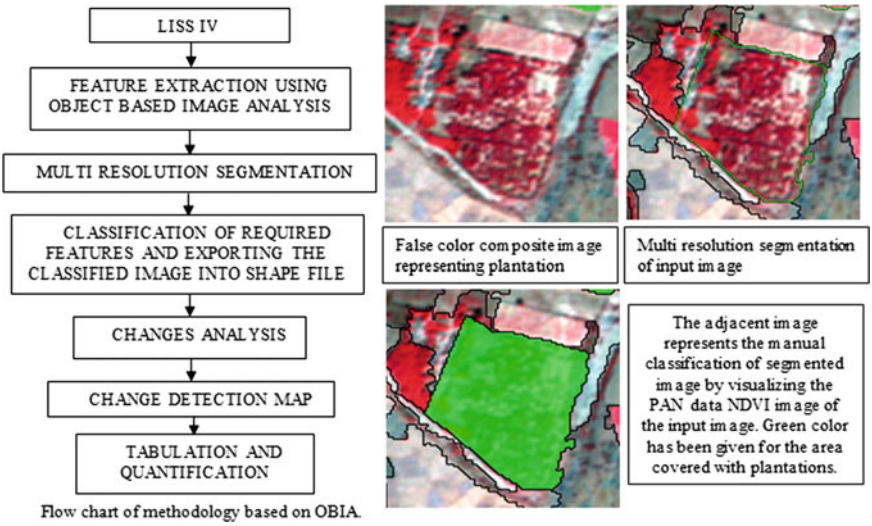

Fig. 4 Change detection using object based image analysis method

A pixel has been the basic unit of image analysis and change detection techniques since the early use of RS data. An image pixel is the atomic analytical unit in these techniques whose spectral characteristics are exploited to detect and measure changes mostly without considering the spatial context. In this paper image differencing method has been applied.

3.3 Image Differencing

Two precisely co-registered multi-temporal images are used to produce a residual image to represent changes. The difference can be measured directly from radiometric values of the pixel or on the extracted/derived/transformed images such as texture or vegetation indices. In this paper we have considered the vegetation indices i.e., NDVI of two multi temporal images for change detection [1].

Mathematically, the difference image is:

$$\mathrm{Id}(x, y) = \mathrm{I1}(x, y) - \mathrm{I2}(x, y)$$

where I1 and I2 are the images obtained from t1 and t2, (x, y) are the coordinates of the pixels. The resulting image, Id, represents the intensity difference of I1 from I2. This technique works only if images are registered. The NDVI image of T0 data and the NDVI image of T1 data were given as inputs to the image differencing tool in change detection tools. The obtained difference image, T0 data (LISS IV) and T1 data (Planetscope) were compared for the confirmation of change detection and

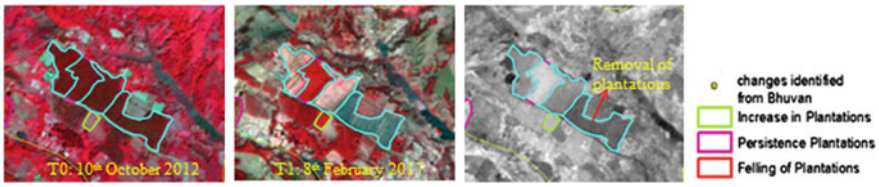

Fig. 5 Change detection using image differencing method [2]

exported to Arc GIS for creating polygon features for the changes obtained and then quantified (Fig. 5).

4 Results and Discussions

In the present study the dynamic changes of plantations in Anantapur district IWMP-32 belonging to scarce rainfall zone of the six agro climatic zones of Andhra Pradesh were detected using the object based image analysis method performed separately on each of the multi temporal data. In this study area along with the plantations, a great change in natural stream vegetation has also been identified. The number of increase in plantations, number of felling of plantations and the number of persistence plantations of periods T0 and T1 were briefly depicted in the Table 3.

The total area under the plantations that are identified in Anantapur IWMP-32 over the time period T0 (3rd March 2012) is 71.48 ha and the total area under the felling of plantations that are detected through object based analysis for the T0 data is 17.03 ha. Similarly the total area of plantations and the area under felling of plantations for the T1 (12th December 2015) are 112.65 and 69.49 ha (Fig. 6).

The changes in plantations were identified in Kadapa district IWMP-29 belonging to the southern zone of the six agro climatic zones of Andhra Pradesh were detected by the method of integration of Bhuvan based analysis with the image differencing methods as shown in Fig. 7.

Table 3 Changes that are identified in T0 and T1 data of Anantapur IWMP-32

Count of object ID	Class name T1		
Class name T0	Natural stream vegetation T1	Plantations established in T1 data	Area without any plantations
Natural stream vegetation T0	227	55	160
Plantations T0	18	36	18
Area without any plantations	217	82	

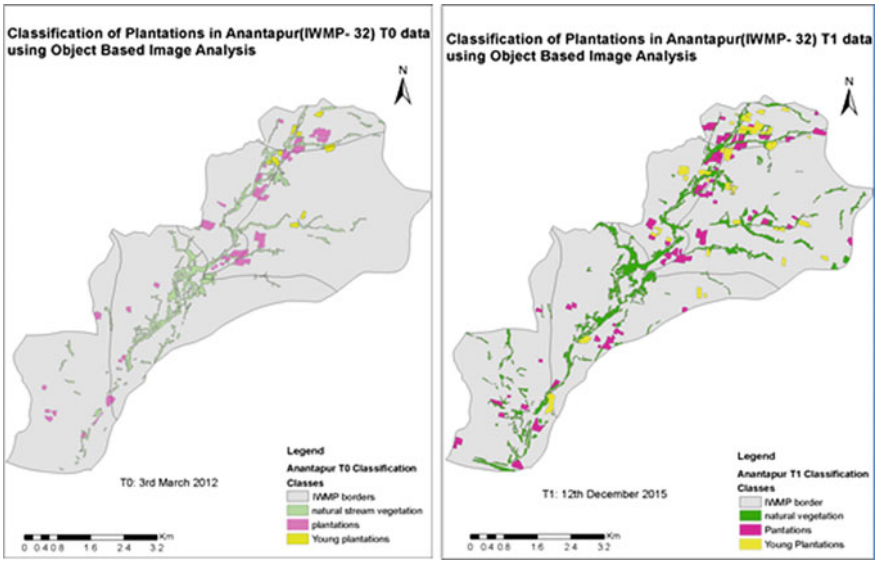

Fig. 6 Change detection in Anantapur IWMP-32 (T0 & T1) using OBIA method [3]

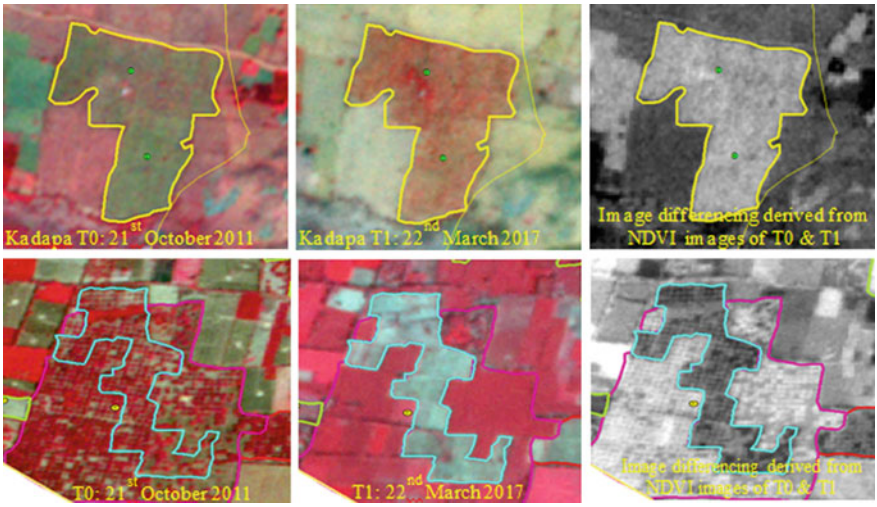

Fig. 7 Image showing the Increase in plantation and felling of plantations

The total increase in the area of the plantations = 370.44 ha and the total area under the felling of the plantations = 2.11 ha (Fig. 8).

Similarly for all the six IWMPs of different agro climatic zones of Andhra Pradesh the dynamic changes of plantations were identified by both the Bhuvan

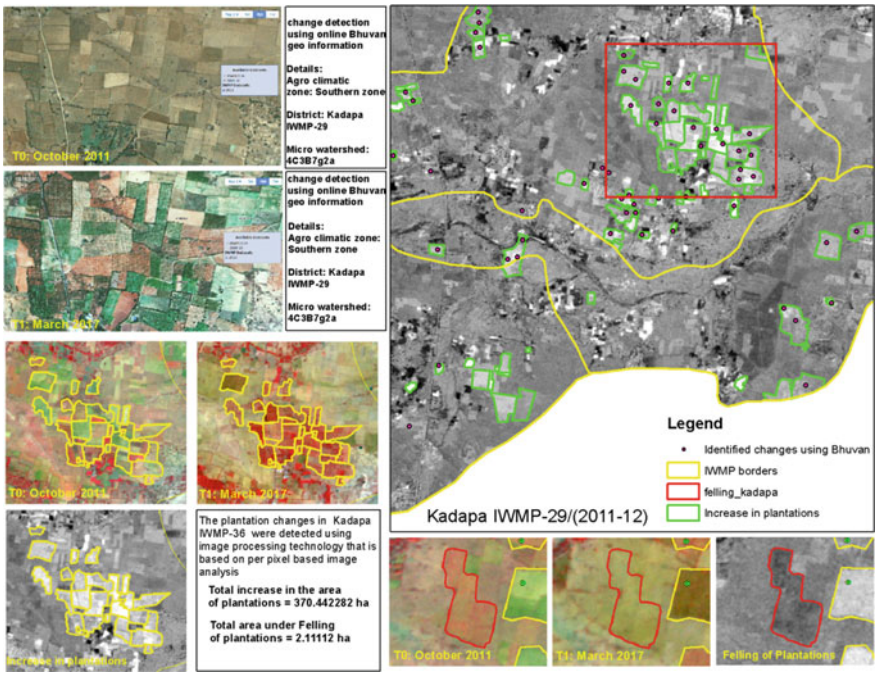

Fig. 8 Change detection through image differencing method in Kadapa IWMP-29

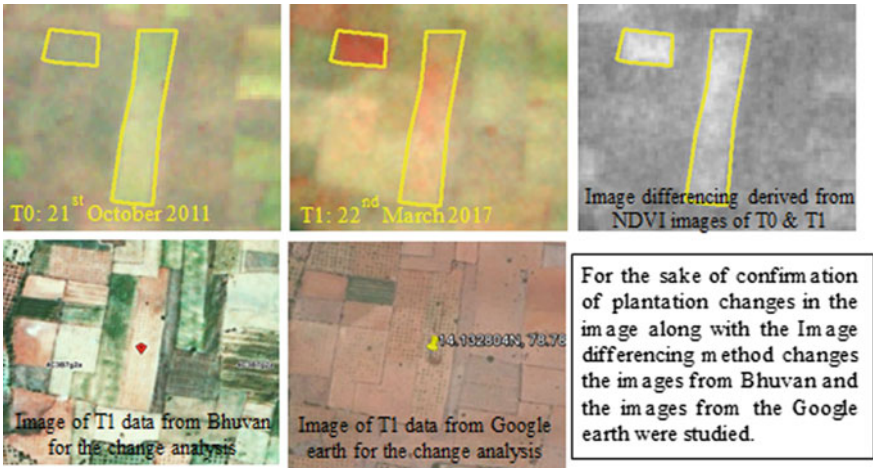

Fig. 9 Image showing the Young plantations through image differencing method

Table 4 Showing the changes in plantations in different IWMPs of Andhra Pradesh

S. no	Type of agro climatic zone	Districts	IWMPs	Total increase in plantations (in ha)	Total area under felling of plantations (in ha)
1	Southern zone	Kadapa	IWMP-29	370.44	2.11
2	Krishna zone	Prakasam	IWMP-36	213.47	41.24
3	High altitude tribal zone	Visakhapatnam	IWMP-11	11.87	5.24
4	North coastal zone	Vizianagaram	IWMP-10	61.34	11.35
5	Godavari zone	West Godavari	IWMP-01	125.62	32.35

based geo analysis and through the image processing techniques involving both the per pixel based image analysis methods and the object based image analysis method (Fig. 9; Table 4) [4].

The total area under the persistence plantations (plantations that were remained unchanged) that are identified in the West Godavari district IWMP-01 is 157.00 ha and that are identified in Vizianagaram IWMP-10 are 500.72 ha.

5 Conclusions

Remote Sensing data of multi spectral spatial and temporal data acquired through space borne remote sensors is of immense help for monitoring requires in watershed project. In the present study multi temporal data sets in conjunction with GIS, pixel based and object based image techniques are used to study the changes in Plantations in the watersheds that helps in implementing the sustainable developmental activities in the IWMPs for the growth and for balancing the hydrological cycle properly. In this study it is observed that by integrating the Bhuvan based analysis with the image processing methods, the dynamic changes in plantations were quantified.

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