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Change Detection Across Geographical System of Land using High Resolution Satellite Imagery

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Abstract : The awareness of land usage and land cover assessment is very important to understanding natural resources, their utilization, conservation and management. In recent years remote sensing and Geographical Information System have gained importance as vital tools in the analysis of temporal data at the district and citylevel. The present study evaluates the effectiveness of IRS P6 LISS III Images in the year of February 1990 and IRS LISS IV Mx Images in the year of March 2012 and computer aided GIS techniques by using Erdas Imagine, in measuring the land use and land cover change detection within the study area, Kiliyar Sub Basin in Palar Basin, Tamil Nadu. The assessment factors are categorized in to five broad land use and land cover classes were identified, they are namely water body, agricultural land, hills, green forest and settlements. This study will identify the agricultural growth, urbanization and industrialization.

Keywords: Landuse, Detection, Imagery, Remote Sensing.

1. INTRODUCTION

The pre-processed and classified imagery are used as input for hybrid model to find the land use management. In Remote Sensing, the images have to be updated from year to year. In many situations, changes are identified in the landscape features during the update of satellite images. In order to interpret the images, the changes are widely identified. Land management and land planning requires a knowledge on the geography of the landscape. Understanding current land area covered and its utilization, along with an accurate means of monitoring changes over the period of time, is vital to any person responsible for land management[8]. Measuring current conditions and the change can be easily achieved through land cover mapping. This process quantifies current land resources into a series of thematic categories, such as water body, paved surfaces, settlement and forest.

In remote sensing, identification of the changes that are occurring across the land area of the Earth surface is uniformly processed with more than single images acquired on the same geographical region at different time interval. Detection to the repeat-pass nature technique of the satellite orbits, remote sensing images can be assimilated in regularity over a given target area. Since then it becomes the ideal source of information against the performance is analyzed for repeated changes[4].

The variation identified across the surface of the landscapes will narrow to a stage and will conclude that only few surface on the earth remains in natural state across the changes. While examining with the multispectral high resolution satellite images, will lead to the finding of change-detection problem will share several list of observation. This experimental process requires exact classification and modeling on the concept of change[1].

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2. LAND USE LAND COVER MAPPING

This investigation is a broad source for maps of current Land Use/Land Cover for every part of field in Kiliyar sub basin. This regional map allows you to view, zoom and pan digital map as layers[3]. Which includes

1. February 2002 - IRS P6 LISS III
2. March 2012 - IRS LISS IV Mx
3. 2002 – 2012 - Changes based on modified 2002 release

Land use and land management practices have a foremost impact on Kiliyar sub basin natural resources like water, soil, forest, mineral, and mammals. The fundamental study is on the impact of human settlement and the propionate resource development across Kiliyar sub basin is the fundamental to assess the condition and trend of Kiliyar in terms of land and water[9]. Land utilization information can be used to derive solutions for natural resource management issues such as mineral assessment, water quality and land degradation.

3. METHODOLOGY

This method refers to an inclusive use of three different methods mentioned above. There exist two distinctive hybrid methods: One is to use various methods in different detection phases and then analyze the derived results comprehensively[5]. The advantage of this technique is that it makes a complete usage of virtues of many algorithms and obtains a better change detection results rather than single method. This problem would result in complex algorithm with low efficiency.

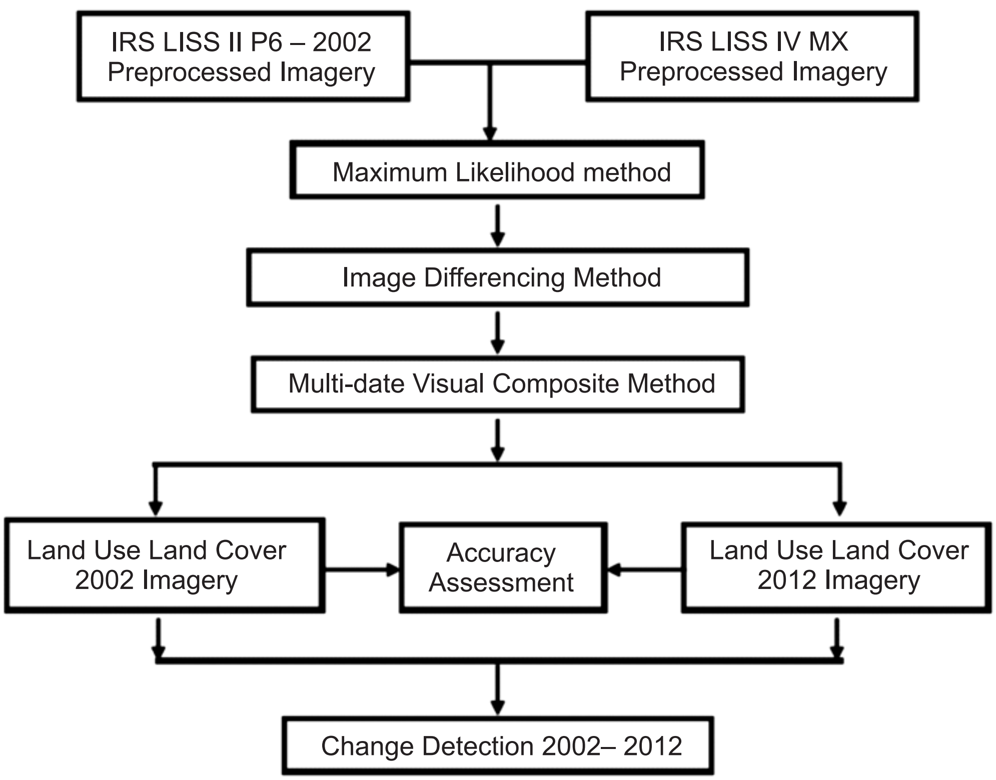

Figure 1: Methodology for Land Use / land Cover Change Detection

Theoretically, the hybrid method is efficient method. However, it is difficult to select best combination for given application case, classic trial-and-error procedure has to be used just to make the problem more complex. This reason limits widespread application as the hybrid method. Though the common principals to decide on the hybrid algorithm can be described as combination of different data sources, features, detection levels and so on, it is still cumbersome one to choose the combination because different application will have same combination but results may be different. However, without doubt the hybrid method is one of future trends[7].

This phase introduces the hybrid method with different combination of image with different detection and multi-date visual composite change detection on the images. In this image algebra, it introduced the highlight change model.

4. PSEUDO CODE FOR HYBRID CHANGE DETECTION ALGORITHM

Step 1: Input the Preprocessed Classified Imagery

Step 2: State the Change Detection Problem

Step 3: Using Hybrid detection Method

Step 4: Quality Assessment Assurance

Step 5: Display Change Detection Difference and Highlights

4.1. Preprocessed Remote Sensing Imagery

The initial step involves the input to be given for pre-processed imagery, which is imagery should be geometrically rectified and registered classified imagery. In this phase is used IRS P6 LISS III and IRS P6 LISS IV are been preprocessed[1]. Geometric rectified by using Hybrid Mathematical model, resampled by maximum likely method, enhanced by clustering using RGB and L Based Fuzzy C Mean algorithm and finally hybrid Classification method. These are discussed in the previous chapter. The rectified imageries will then process into the change detection process.

4.2. Category the Change Detections

The Second stage involves defining the study area to find the change detection, specifying the frequency of change detection, for instance: seasonal, yearly identification of the classes from an appropriate land cover classification system. In this hybrid method, Kiliyar sub basin has been selected for change detection year-wise and categorized in to five classes of lands namely Water Body, Settlement, Forest Land, Agriculture Land, Waste Land. In this phase mainly focuses to find the trend in agriculture and settlement land, to decrease in agriculture and increase the settlement land to identify population's growth. As a result, it directly implies change in economic growth.

4.3. Hybrid Change Detection Method

This hybrid method proposes a new feature with this imagery differencing; imagery highlights the changes that are identified between the two images. The hybrid method uses two different methods namely image differencing and Multi-date visual composite. Hybrid method is used two different types[2]. There are

1. The initial type is ***Procedure-Oriented Hybrid Analysis***, which involves the utilization of different detection techniques and its detection procedures.
2. The second type is ***Result-Oriented Hybrid Analysis,*** which uses different changes detection techniques and then the various are analyzed.

This method creates complete use of the advantages of many methods in order to incur the major changes in the detection results. On the other hand, the hybrid change detection method is complex, difficult to perform and not very effective because it depends on the characteristics of other techniques[1].

Hybrid method change detection merges the advantages of image differencing and Multi-date visual composite image change detection, which will be used as the input to derive the land cover map from IRS imagery between the years 2002 to 2012 in study region. The results are extra accurate than using individual techniques[3]. The existing method results are compared with improved hybrid change detection result and decision different classifier. The result has shown a better accuracy compared with the usual change detection technique.

4.4. Quality Assessment Assurance

The accuracy of change detection depends on many factors are as follows including precise geometric registration and calibration or normalization

1. Available and quality of ground reference data
2. The complexity of landscape and environment
3. Methods or algorithms used
4. The analyst skills and experience and
5. Time and cost restrictions

It has summarized the main errors in change detection, errors in data, errors caused by preprocessing, errors caused by change detection methods and processes, errors in field survey and errors caused by post processing[5].

5. TESTING AND RESULTS

The satellite data sets of Kiliyar IRS P6 LISS III of the year 2002 and IRS LISS P6 IV MX of year 2012 were rectified in ERDAS imagine application by geometrical reference to the satellite image data which is rectified by Survey of India (SOI) topological sheets of the specified region is detected by giving latitude and longitude values[3]. After geometrically referring to the satellite data it was opened in ERDAS Imaging and by visual interpretation the classes were recognized and they were digitized as shape files to create a complete land use or land cover map for both the digital data sets of the study area. Attribute information is also obtained similarly Based on the changes those have taken place between the two data sets have been carried out and presented in graphic representation[8]. The details are discussed below

5.1. Spatial Distribution of Land Use Categories -2002s

IRS LISS III imagery of February 2002 has been visually analyzed and classified for different kinds of land use in Kiliyar sub basin region and The spatial distribution of land use is assessed geographically and their aerial extents quantified are show in below table-2.

Table 2

Land Classification Scheme for 2002's

Land Classification Scheme		*2002s*	
Land Use Category		*Sq. Km*	*%*
Water Body	River, Canal and Tanks	141.83	15.09
Settlement	Towns, Villages and Companies	10.19	1.08
Forest Land	Scrub forest	7.88	0.84
Agriculture Land	Wet land and dry land	648.00	68.94
Waste Land	Land With or without Scrub, Stony waste barren rocky	132.01	14.04

The table-2 shows the spatial distribution of study region land in 2002. Agriculture was the highest as 68.94%, water body land 15.09%, Waste land 14.04%, followed by settlement 1.08% and the least and forest 0.84%. The chart of land use spatial distribution is shown in figure-2 and different categories of land use and its feature classified shown in below figure-3.

The following figure-3 shown in 2002 land use satellite imagery and the figure-2 of spatial distribution changes in different category

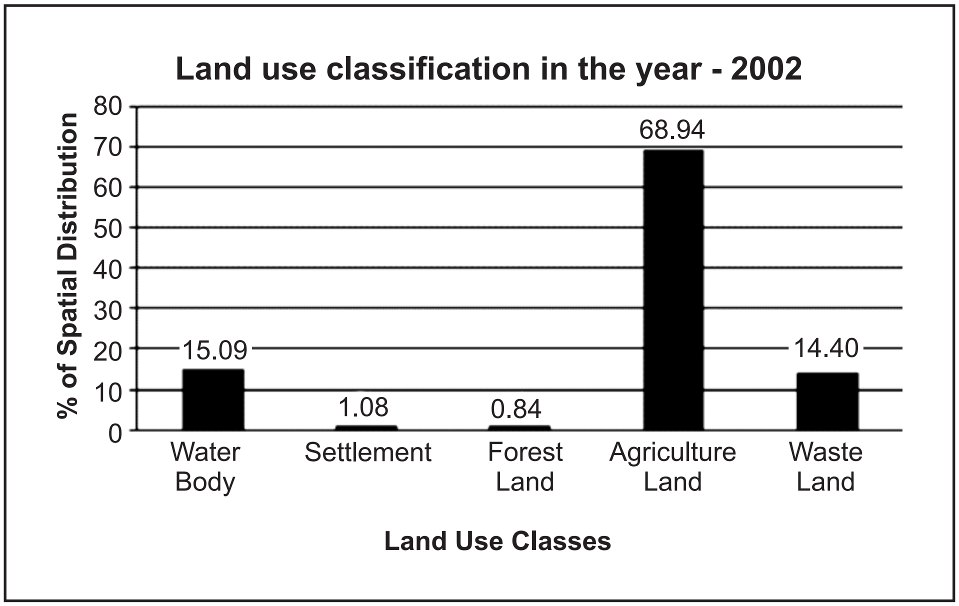

Figure 2: Land Use of Kiliyar Region – 2002s

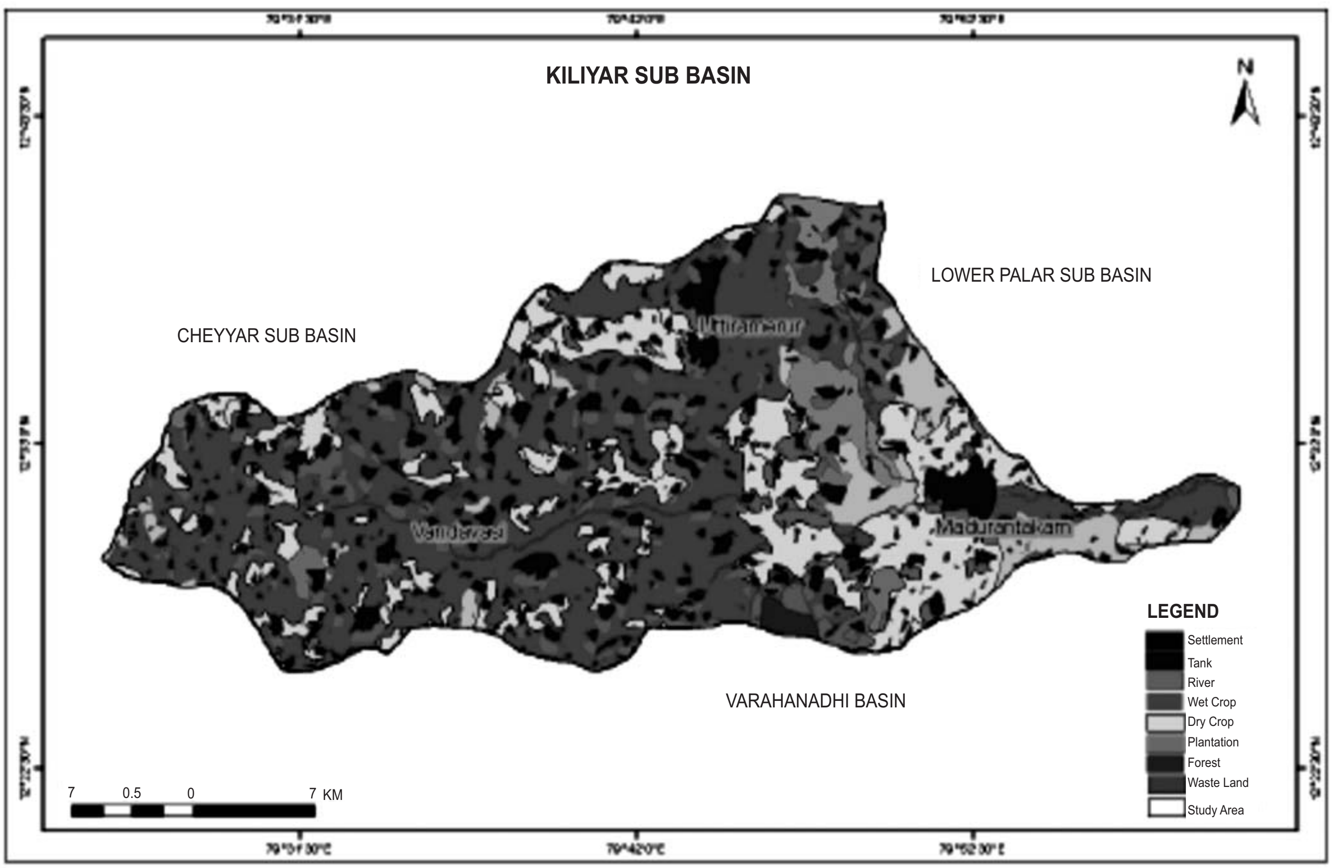

Figure 3: Land Use Satellite Map for Kiliyar Region – 2002s

5.2. Spatial Distribution of Land Use Categories -2012s

IRS LISS IV Mx imagery of February 2012 has been visually analyzed and classified for categories of land use in kiliyar sub basin region. The spatial distribution of land use is analysed usder GIS environment to quantify their aerial extent for February 2012 as shown in table-3.

Table 3
Land Classification Scheme for 2012's

Land Classification Scheme		*2012s*	
Land Use Category		*Sq. Km*	*%*
Water Body	River, Canal and Tanks	132.77	14.13
Settlement	Towns, Villages and Companies	24.58	2.62
Forest Land	Scrub forest	10.06	1.07
Agriculture Land	Wet land and dry land	603.23	64.18
Waste Land	Land With or without Scrub, Stony waste barren rocky	169.27	18.01

The table-3 shows the spatial distribution of study region land in 2012. Agriculture land was the highest as 64.18%, water body 14.13%, Waste land 18.01%, followed by settlement 2.63% and the least and forest 1.06%. The chart of land use spatial distribution is shown in figure-4 and different categories of land use and its feature classified shown in below figure-5

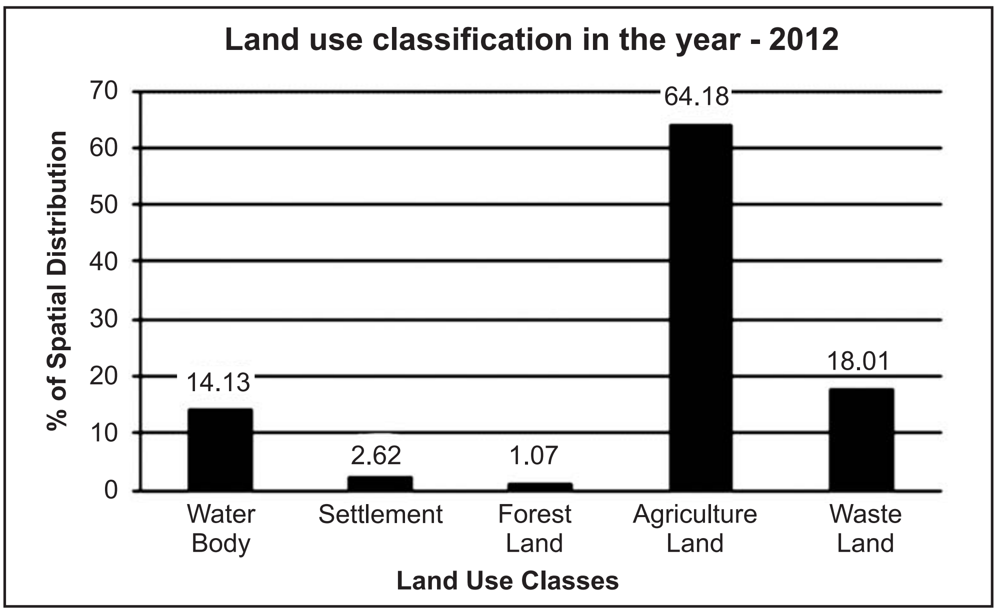

Figure 4: Land Use of Kiliyar Region – 2012s

The following figure -5 shown in 2012 land use satellite imagery and the figure 4 of spatial distribution changes in different category

5.3. Land Use Change Detection for the Period (2002-2012)

The Overall Changes in the spatial distribution of land use or land cover detection by using hybrid change detection method between 2002 and 2012 is shown in table-4.

Table 4
Loss and Gain for Land Use for 2002-2012

Sl. No.	*Land Use Category*	*Area in Sq.Km*					
		2002	*2012*	*Gain*	*Loss*	*Variation*	*%*
1.	Water Body	141.83	132.77	–	9.06	9.06	8.42
2.	Settlement	10.19	24.72	14.53	–	14.53	13.50
3.	Forest Land	7.88	9.92	2.04	–	2.04	1.89
4.	Agriculture Land	648.00	603.23	–	44.77	44.77	41.58
5.	Waste Land	132.01	169.27	37.26	–	37.26	34.61
Total		939.91	939.91	53.83	53.83	107.66	100.00

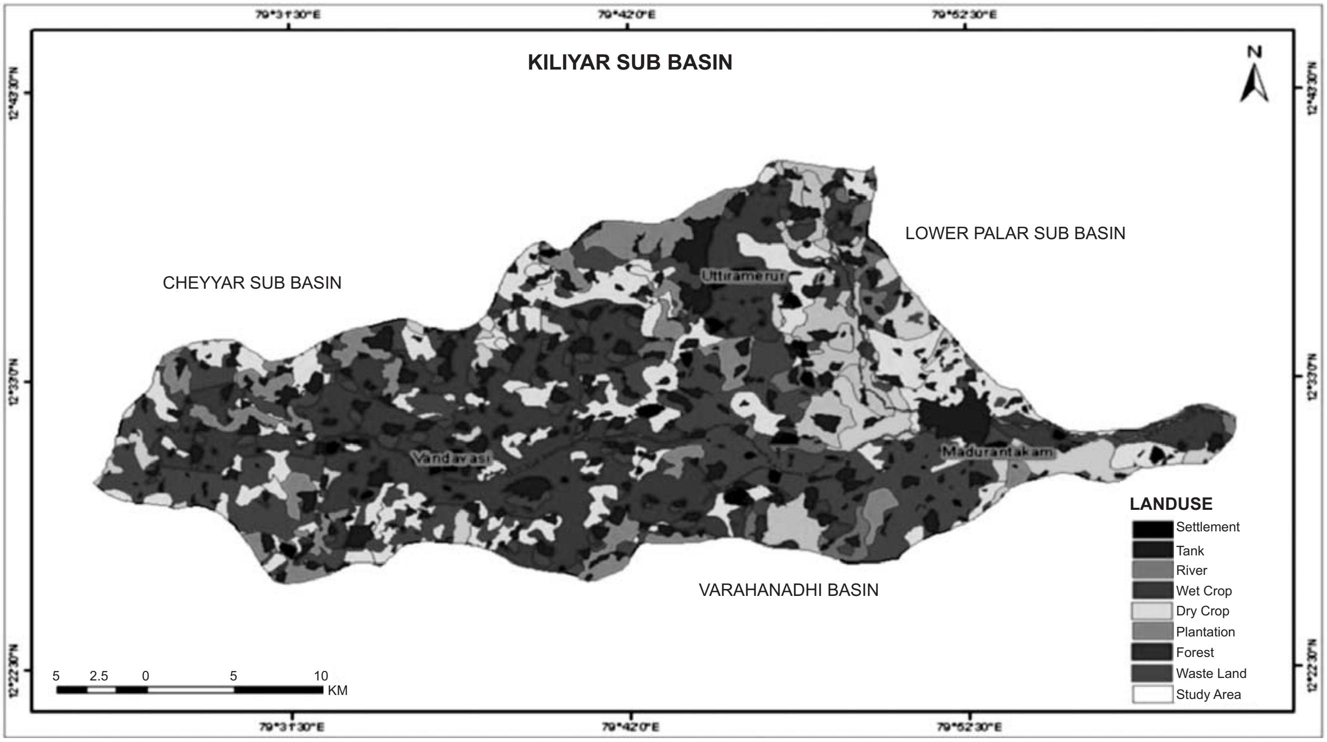

Figure 5: Land Use Satellite Map for Kiliyar Region – 2012s

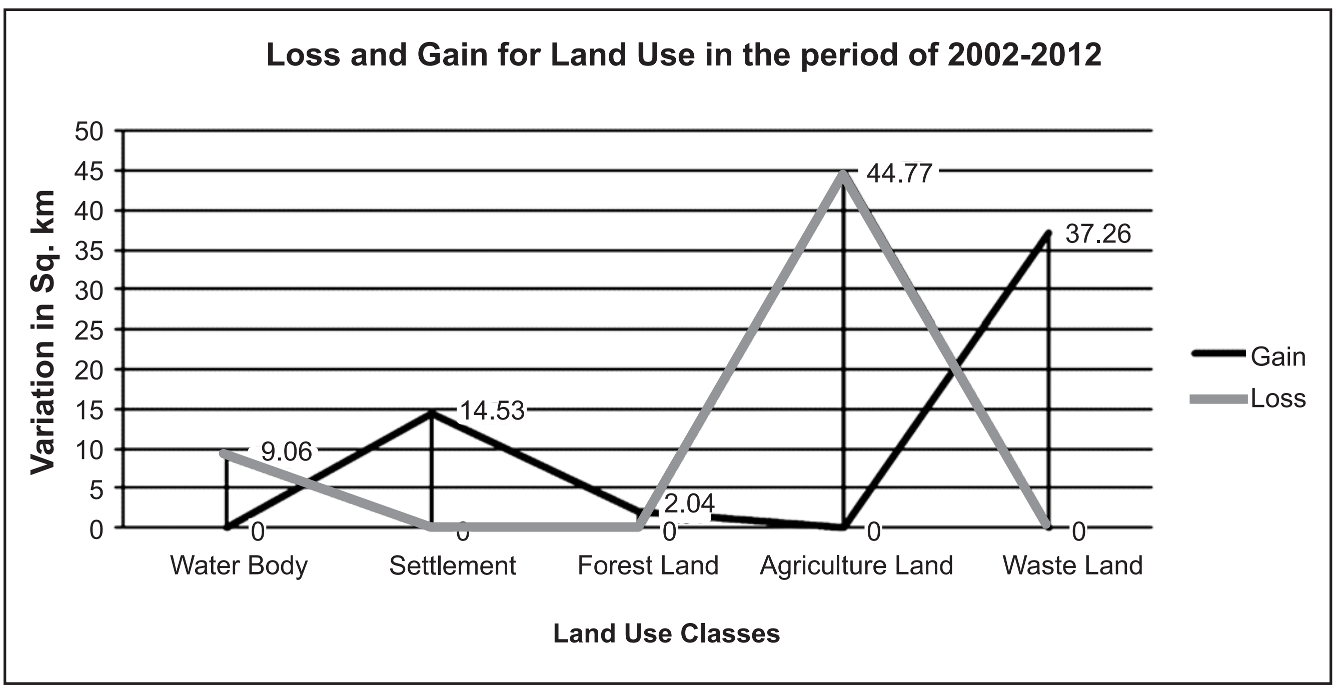

Figure 6: Loss and Gain for Land use Classes period of 2002-2012

The table-4 described the land Increasing trend of land use is identified on the following. Firstly, waste land showed the highest increase by 34.61% which identifies land was prepared for future settlements and other uses. Secondly, settlement was increased significantly by 13.50%. The reason was apparent that increasing in population, growth of industrial activity, widening of highways and so on. Finally, forest land cover showed a minimal increase by 1.89%. Decreasing trend of land use was found as the highest in Agriculture land was decreased alarmingly by 41.58% which shows rapid increasing humanity utilization. Finally, water bodies showed decrease by 8.42% which is evidence for encroachments of water bodies and deficiency in water management policies.

The data shows that the area under agriculture has been drastically reduced from 69.54% in the year 2002 to 2.33% in 2012. A reduction of 5.56% area under agriculture has been identified. This is the fact of study region has been classified as urban and semi urban category. The decreasing of agriculture land could be due to slow and balanced growth of urbanization by the way of residential and commercial constructions.

The area under water body's in the year 2002 was 15.09% whereas the result on the area has identified a considerable decrease to 14.13% in the year 2012. This is a decrease of 0.96% which has endorsed the declining trend of aquaculture activity in the selected study area. This may be due to numerous problems surfaced during the last decade in the aquaculture fields. These include the vital defect of aqua farms resulting in a drop of productivity and quality of the product. This has badly affected the agriculture and farmers. This perhaps could be the reason for the decrease of area under aquaculture.

The drains are usual streams or rivulets of lesser scale. There is no significant change during the study period of the years from 2002 to 2012. Whereas the area identified under waste land has increased from 14.04% in the year 2002, 18.01% in the year 2012, an increase of 3.96% over a decade. This increase has resulted to the fact that due to various socio-financial reasons farmers have migrated from actively practicing agriculture. This tendency has increased in very recent times and perhaps caused this increase.

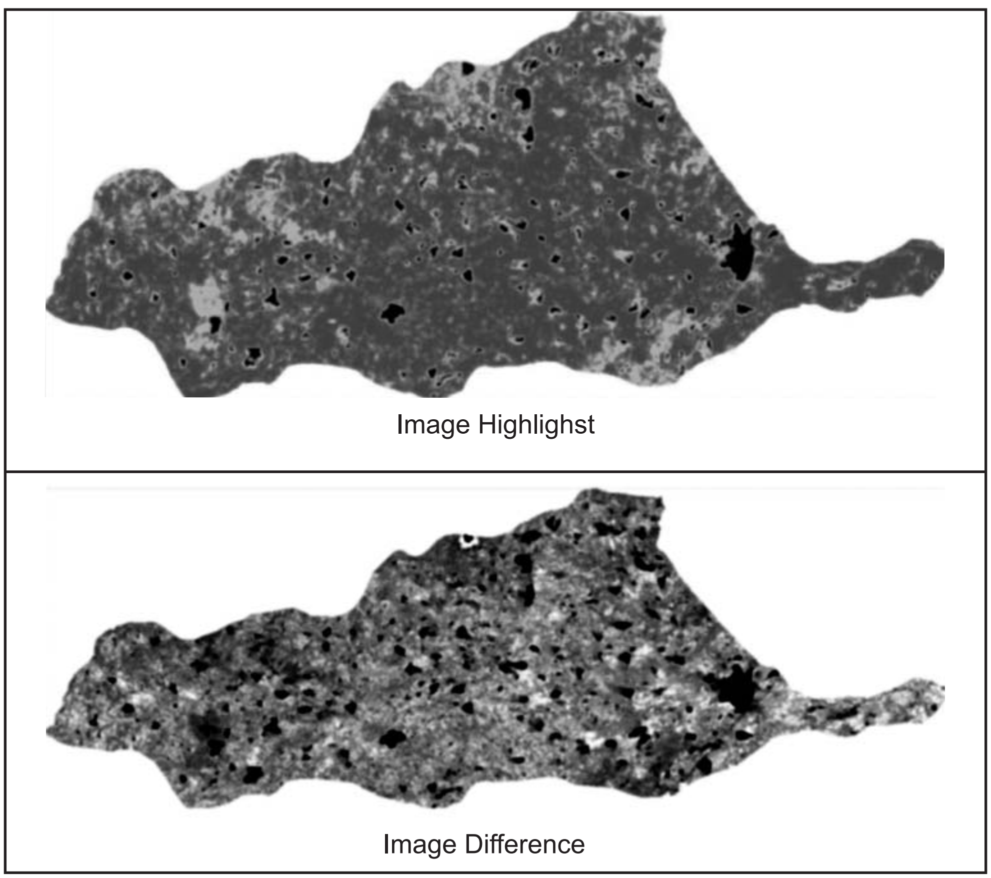

Figure 7: Loss and Gain for Satellite Map for Kiliyar Basin

5.4. Accuracy Assessment for Change Detection

Accuracy in assessment techniques of change detection originate from those of remote sensing images classification. It is accepted to extend the accuracy assessment techniques for processing single time image to that of multi spectral image. Among various assessment techniques, the most applicable and widely used is the error matrix of change detection. User's accuracy is compared with procedure accuracy[5]. In recent years, some alternative methods have also been used in analyzing and evaluating the change detection of land use or land cover classes.

The Table-5 contains the error matrix that an image analyst has set to determine how well a classification has categorized a descriptive subset of pixels used in the training the process of the supervised method[10]. This matrix stems from classifying samples are trained set pixels and catalog the known cover types used for training (columns) versus the actual classification of Pixels into each land use and land cover group by the classifier (rows). An error matrix has articulated several characteristics against various change detection performance.

Table 5

Error Matrix for Hybrid Change Detection

Classes	*Water Body*	*Settlement*	*Forest*	*Agriculture*	*Hills*	*Row Total*
Water Body	*360*	1	8	1	0	370
Settlement	0	*390*	15	4	0	409
Forest	2	52	*390*	0	1	445
Agriculture	1	0	84	*253*	2	340
Hills	0	54	2	13	*28*	97
Column Total	363	497	499	271	31	*1661*

Table 6

Accuracy of Change Detection

	Accuracy in Percentage (%)	
Classes	*User*	*Producers*
Water Body	97.29730	99.17355
Settlement	95.35452	78.47082
Forest	87.64045	78.15631
Agriculture	74.41176	93.35793
Hills	28.86598	90.32258

$$\begin{aligned}\text{Overall Accuracy} &= (360 + 390 + 380 + 253 + 26)/1661 \\ &= 421/1661 \\ &= 5.55\end{aligned}$$

The training set pixels that are predicted into the proper land use categories are located majorly along diagonal path of the error matrix. All non-diagonal elements across the matrix will represent the commission of errors or commission[5]. Omission errors correspond to non-diagonal column elements. Commission errors are mostly represented as non-diagonal row elements. Several other measures for instance, the overall accurateness of classification can be computed and derived from the error matrix[11]. It is determined using the method of dividing the total number correctly classified pixels against the total number of pixels referenced. Also, the correctness of individual categories can be computed by dividing the total number of correctly classified pixels in each category by either the total number of pixels in the relevant rows or column.

Producers accuracy indicates how well the preparation sets pixels of a given cover type are classified and can be determined by dividing the number of rightly classified pixels in each set by number of training sets used for that category[6] (column total). Accuracy is computed by dividing the total number of rightly classified pixels in each category by the total number of pixels that were classified in that same category (row total).

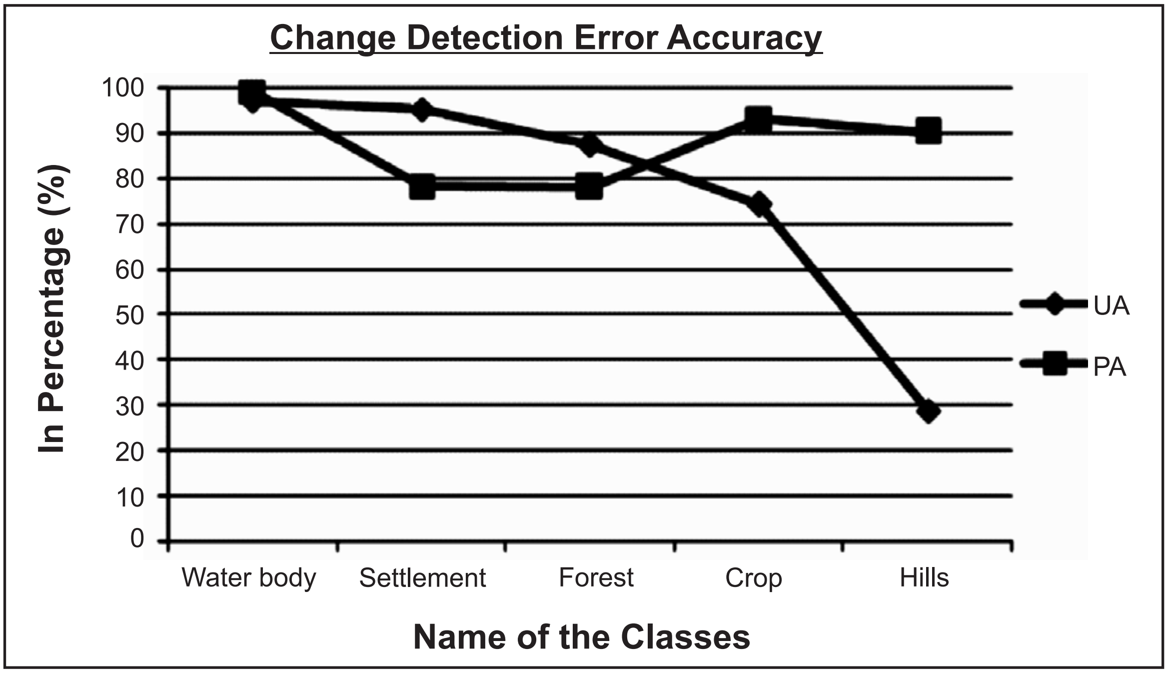

Figure 8: Error Accuracy of Change Detection

The figure-8 is Change Detection error measures which was extracted from various classes of the imagery. The prediction of the classes have been shown in the table-5 is also drawn as a graph. The overall accuracy is calculated using the values in the table-6. The highlighted values are the corrected values of all classes. The overall accuracy 85.55% is derived. However, there is no difference between producer's accuracy ranges user's accuracy ranges. This error matrix is derived based on training data set. The result indicates that, the training samples were spectrally separable and the change detection works was done in the training areas. The table generated for various classes by using classifier performance to generate the results.

6. CONCLUSION

This work is done on IRS P6 LISS III Images in the year of February 1990 and IRS LISS IV Mx Images in the year of March 2012 that has exposed that land use and land cover of Kiliyar Sub Basin in Palar Basin, Tamil Nadu. Both this are analyzed to identify the changes that has been identified and detection over a decade on the selected region. Primary assessment is done for a decade on the agriculture land, the agriculture has decreased of about 5.53%, , Proportionate decrease is also identified with the water bodies 15.09% which was the primary source for agricultural development. Then green forest and hills which is the natural base for the rain conservation and renewable resources has also decreased to the percentage of 14.04% of forest, 3.96% for Hills. This has also influenced the annual rain fall of the selected study area which has hugely impacted the agricultural sector. This has highly resulted to the migration of the farmers as daily wages in industrial sectors and others in order to meet out their day to day settlement. This migration ratio has resulted with increase of 18.01% which cause the major problem of urbanizing the rural, development of industry on agricultural lands etc., which is the major problem identified in the Ecological disturbance.

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