International Journal of Environment and Climate Change

Volume 13, Issue 10, Page 1090-1096, 2023; Article no.IJECC.104672
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Assessing Land Use Dynamics of Lower Bhavani Basin Using Multiple GIS Platforms

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Authors' contributions

This work was carried out in collaboration among all authors. Authors may use the following wordings for this section Author BS designed and conducted the study, author BK constructed the methodology and formulated the Google Earth Engine code. Authors VR and KA checked the first draft of the manuscript, author RJ helped in GIS analysis using QGIS. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2023/v13i102755

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/104672

Original Research Article

Received: 14/06/2023
Accepted: 18/08/2023
Published: 24/08/2023

ABSTRACT

Land use describes the actual form of land, such as a forest or open water and classification based on human utilization. Land use map provides the information about the current landscape of an area. In this study, the Lower Bhavani basin's land use and land cover were classified using GIS platforms and data from the Landsat 8 satellite. The platform utilized in this study were Semi-Automated Plugin (SAP) in QGIS and Random forest method in Google Earth Engine (GEE). The findings suggested that both platforms performed efficiently and displayed comparable percentages of land covered by various land use features. The accuracy of the resulting land use

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map was evaluated using a Google Earth image, and it was discovered that SAP and GEE hold 91.8% and 92.6% of the total accuracy. This study aids in evaluating and classifying the various Geographic Information System platforms land use trends.

Keywords: Land use; image classification; QGIS; GEE.

1. INTRODUCTION

Land as a socioeconomic and ecosystem asset, is becoming a scarce resource due to the vast pressure from socio-economic activities which has had a significant effect upon the natural environment thus resulting in an observable pattern in the use and cover of land over time [1,2]. Land use/land cover has therefore become a crucial aspect in natural resources management, monitoring and planning. Although the terms land use/land cover are often used interchangeably, they are two different concepts and both have their own unique significance [3]. The term "land cover" refers to the physical qualities of the Earth's surface, such as vegetation, water, soil, and other physical aspects resulting from human activity, such as settlements, while Land Use, which places a greater emphasis on the social properties of the land [4-6], is the result of reconstruction activities in which humans employ a series of biological and technological measures to manage and regulate the land through time in accordance with predetermined economic and social goals [7].

Land Use / Land Cover (LULC) refers to the classification of human activities and natural elements on the earth surface through space and time. Fundamental, the interactions between land cover and land-use in their spatial and temporal appearances and their changes over time must be understood. Land cover reflects how land use influences and modifies the ecosystem while land use correspondingly reflects the total of arrangements, activities and inputs undertaken in a certain land cover type to produce, change and maintain it [8,9]. The data acquired from landuse/landcover patterns is essential in interdisciplinary planning, administration, and monitoring of initiatives. This type of information provides a better comprehension of different aspects of land use, while also being crucial in the establishment of the policies and programmes needed for development planning. It further allows the monitoring of the ongoing process on the pattern of land use and land cover through time to retain sustainable development. Land use and land cover are an indication of underlying patterns across various ecological and social phenomena [10,11].

Remote sensing being a rapidly advancing tool in natural resource management due to its competence, convenience and thriftiness, has been very useful in providing prompt and accurate information on land use land cover extent over time [12,13]. Remote sensing data is the most common source for detection, quantification, and mapping of LULC patterns due to its suitability for processing, its spatially-explicit representation of the earth surface, its frequent temporal coverage and relatively low observation costs [14-26]. The collection of remotely sensed data facilitates the synoptic analyses of Earth - system function, patterning and change at local, regional and global scales over time [11]

Geographical Information system (GIS) on the other hand, which is usually integrated with Remote Sensing, provides an effective tool for analysis of land use and land cover changes. GIS provides a platform for analyzing digital data that is important for identifying changes, modelling future changes, and transmitting data to plan efficient management [17]. Through the use of satellite imagery, Remote Sensing offers broader terrestrial spatial and temporal information through earth observation techniques with synoptic coverage over large areas at regular time intervals. There is a constant effort to produce land use / land cover maps with greater accuracy and this may be accomplished by employing a variety of strategies, including selecting the appropriate training samples, adding additional input characteristics, using multi-temporal better quality images, improved classification algorithms, etc [18,19].

This study aimed to generate a LULC map of the lower Bhavani basin in Tamil Nadu using Landsat 8 data in QGIS and Google Earth Engine platform and to assess their accuracy. And also provides the trends of present land use pattern in lower Bhavani basin in different GIS platforms.

2. MATERIALS AND METHODS

2.1 Study Area

The Lower Bhavani Basin is a major river basin in the Indian state of Tamil Nadu located in Erode and Coimbatore districts. The basin is a part of the larger Cauvery River basin and has an area of about 1,706 sq. km. It is surrounded by the Eastern Ghats to the north and the Western Ghats to the south. It lies between latitudes 10° 56″ 3′ N and 11° 46″ 14′ N, and longitudes 76° 24″ 41′ E and 77° 41″ 11′ E and has an overall geographical area of 2424 km2. The basin has different landscapes that vary from gentle topography of about 215 m to high-altitude topography of about 1487 m, above mean sea level. The lower Bhavani basin has a semi-arid climate with an annual average rainfall ranging from 575.55 mm to 840.64 mm and maximum and minimum temperatures ranges of 40 °C to 22 °C, respectively [2].

2.2 Dataset Used

Landsat 8 was developed by NASA and the United States Geological Survey (USGS). The multiple band images of Landsat 8 used for classifying Land use land cover in QGIS platform was downloaded from USGS Earth Explorer website (https://earthexplorer.usgs.gov/). And in GEE, Landsat 8 is openly accessible from public repository.

2.3 QGIS (Quantum Geographic Information System)

QGIS is an open source GIS platform that provides editing and analysing the geospatial datasets. A free open source plugin for QGIS called Semi-Automatic classification Plugin (SCP) enables the supervised categorization of land use and land cover from remote sensing images. The general goal of SCP is to offer a collection of integrated tools for raster processing in order to create an automatic workflow and simplify the classification of land cover, which can be done even by those whose primary area of expertise is not remote sensing.

2.4 Google Earth Engine (GEE)

GEE has been acknowledged as a substantial enabler of large-scale mapping, with its powerful capabilities in accessing and processing massive volumes of multi-source, multi-temporal, multi-scale Earth Observation (EO) data through a cloud platform [20]. The users can access GEE and its datasets via an online web-hosted code editor with an integrated development environment that leverages the JavaScript API or via an Application Programming Interface for Python and JavaScript [21]. For classifying land use and land cover Random Forest method was used. The method consists of several decision trees and each class results from the process produced by the decision trees in the Random Forest. The composite images of Landsat 8 was taken for the classification of land use classes in study area.

2.5 Training Data

The five dominant land use land cover classes in the lower Bhavani basin which are water bodies, vegetation, fallow land, build-ups and forest were considered. In SAP of QGIS and Random Forest method of GEE, minimum 25 training datasets were provided for each classes for classifying land use.

3. RESULTS AND DISCUSSION

3.1 LULC Classification

The classification performed using in Semi-Automated Plugin in QGIS for lower bhavani basin is given in Fig. 2 and Random forest method in GEE is given in Fig. 3.

From the classification of images (Fig. 1 & Fig. 2), it was shown that the upper portion of the study area was covered by forest and hilly region and middle parts consists of different land use classes, mostly vegetation. The lower part of the basin for the most part was left barren and predominantly the rain fed crops were cultivated during monsoon season.

The area of each land use classes classified in both platforms were given in Table 1. The result shows that there were only minimal changes in the classification of land use with respect to both the platforms.

3.2 Accuracy Assessment

The accuracy of the image classified from QGIS and GEE platform was studied from Google Earth. From Google Earth, 100 random points were selected and land use pattern was noted down and was assessed to estimate the accuracy of the image classified from both the platforms. The image of the point selected for accuracy assessment is given in Fig. 4.

The assessment of classification of land use and land cover from SAP and GEE holds 91.8% and 92.6%. Both classification techniques showed similar results.

Table 1. Percentage area of each land use classes from SAP and GEE

LULC class	Google Earth Engine Area (%)	Semi-Automated Plugin (QGIS) Area (%)
Vegetation	33.8	32.5
Water Bodies	0.5	0.43
Fallow Land	30.9	32.8
Build-Ups	7.5	7.2
Forest	27.3	27.1

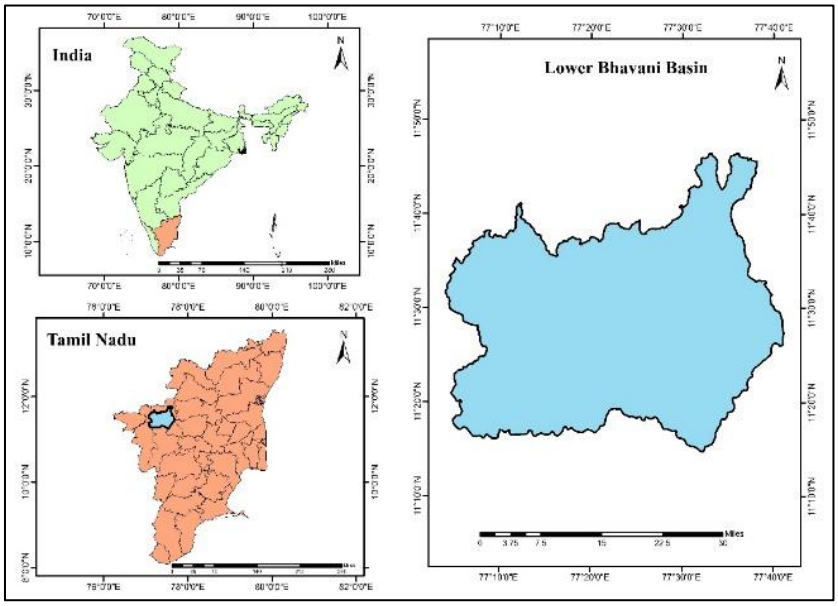

Fig. 1. Study area map

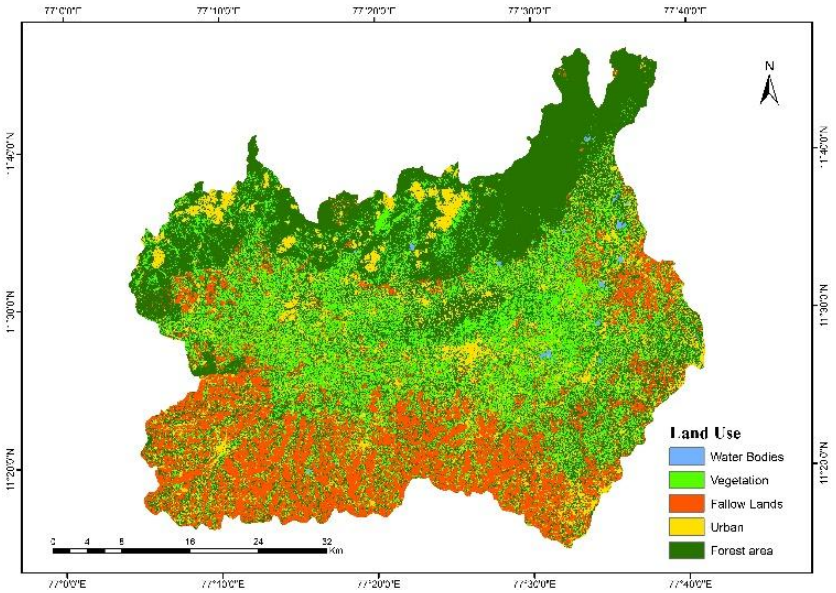

Fig. 2. LULC map generated using semi-automatic classification Plugin of QGIS

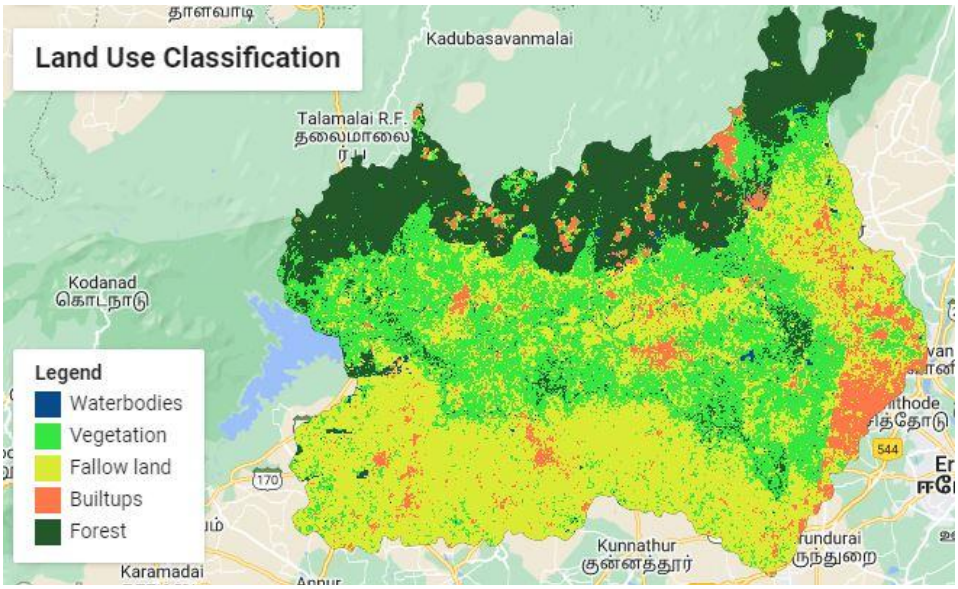

Fig. 3. LULC map from random forest method, GEE

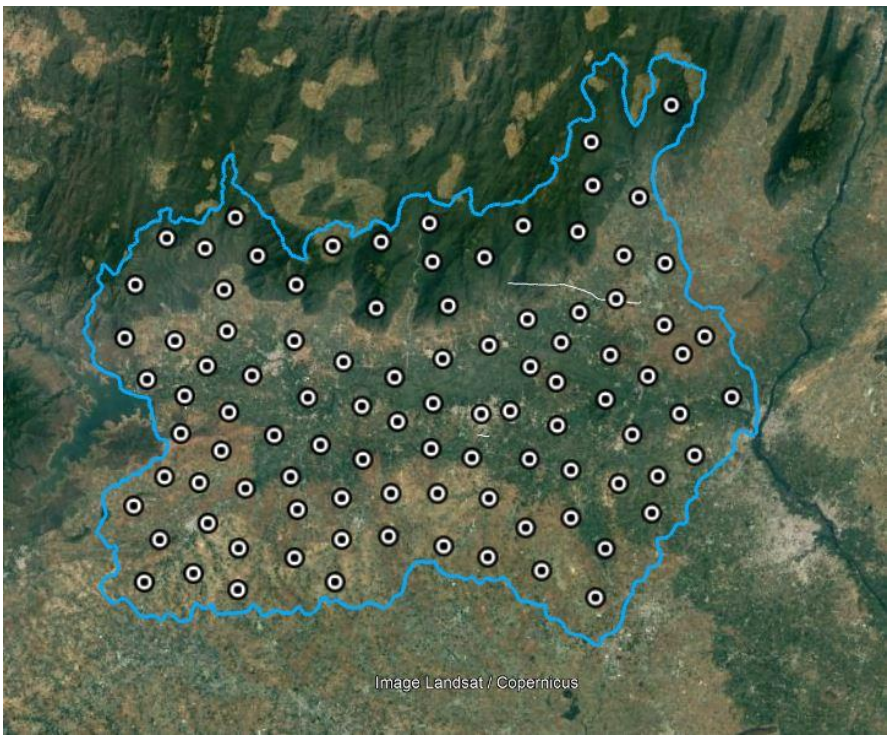

Fig. 4. Points taken for the accuracy assessment of land use classification

4. CONCLUSION

The study utilized the landsat 8 satellite dataset to map the land use and land cover in the lower bhavani basin using SAP in QGIS and Random Forest method in GEE platform. From the map obtained it was shown that lower bhavani basin was covered with forest in the upper portion, vegetation mostly in the middle portion and fallow lands in the lower part. The obtained land use map was assessed for accuracy using Google Earth image and found that the accuracy of classification in SAP and GEE holds 91.8% and 92.6%. Both the classification techniques has the same impact on the classification of land use classes on the basin scale. Further using this

GIS techniques the seasonal and annual patterns of land use can be studied and compared for the basin scale.

5. RECOMMENDATIONS

Land use classification in the lower Bhavani basin showed that the basin was majorly covered with vegetation and farming lands. The seasonal patterns of the land use vary based on the cultivation practices. The larger area classification using GIS platforms helps to understand the variation of land use patterns and to study their classification efficiencies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/104672