Land use and land cover change in first proposed national geopark, Varkala in Kerala, India

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Abstract: The tourism sector is a market that uses cultural and natural heritage as a support for its backbone activities, such as promotion of destinations, accommodation, transportation and catering. Varkala, a coastal town in Thiruvananthapuram district, is a fast developing tourism destination, all the time attracting many national and international tourists. The area covers a total of 29.62 km². Varkala has witnessed great infrastructure since the advent of tourism industry. It has great potential for backwaters, beaches, medical, and pilgrim tourists; the maximum sustainable capacity of an area requires cautious planning of geographically separated access points and placement of tourist’s facility to avoid excessive contacts between different groups visiting the area at the same time. The land use/land cover maps shows that over exploitation of the tourism has resulted in pollution, destruction of natural flora and fauna, natural beauty of the area, pollution of water bodies and beaches, cliff erosion, destruction of the natural environment (fauna and flora), and reduction in tree cover due to uncontrolled development, overexploitation of coastal natural resources and unchecked construction activities. Tourism development based on carrying capacity and sustainable development becomes relevant in this scenario for proper management of natural resources so that the present as well as the future generation may enjoy nature’s beauty and thereby augment tourist flows and revenue. The land use/land cover analysis using remote sensing and GIS shows favourable land use supporting geopark development and immense future tourism sites for development through proper planning and encouragement for attracting geotourism. This paper aims at assessing the land use and land cover change and geopark development in Varkala.

Keywords: land use; land cover; geopark; geological; development; geotourism

1 Introduction

Geopark is a territory comprising a number of protected geological heritage sites of special geological significance, rarity or beauty (Patzak & Eder, 1998). These geological features are representative of a region and its geological history, events and
processes. Geoparks are of special value for science, education, culture and socio-economic development. The geopark is formulated as a land use with specific objectives of landscape conservation, education, management, research and tourism. A master plan should be developed for each geopark that identifies a flexible set of park standards that supports the mission of geoparks. It should include conservation and restoration, education, recreation, and economic development for sustainability (Wei et al., 2012).

Study on effect of land use pattern on geopark development in India is at infancy stage. These geoheritage features are also non-renewable, which means that once they are damaged or wiped out they will be gone forever. These reasons justify that most of the geoheritage resources and geosites need to be urgently protected or at least given due consideration in the land use planning to ensure their sustainability (Ali & Unjah, 2011).

In India, Varkala situated in the state of Kerala is a feasible site for geopark development. It’s a fast developing tourism destination, attracting many Indian and foreign tourists. Varkala has great prospective for backwaters, beaches, medical, and pilgrim tourists. It’s an extremely important geoheritage site. Large-scale tourism development in the study area over the past decades has led to alteration of the cliff landscape, degradation of the natural environment and destruction of coastal ecosystem. Land development sometimes even over development, leads degradation (Barrow, 1991). In the context of conservation and sustainable development of the coastal zone Varkala, it is essential to identify the potential sites for future expansion to arrest over development in the existing areas that has already caused many environmental problems. For the purpose of identifying the geopark and potential tourism sites it is necessary to delineate the present land use system its potentiality and constraints. This paper aims at assessing the land use and land cover change and geopark development in Varkala.

2 Study area

Varkala is a well-known tourist destination and is a coastal town situated in the state of Kerala. It is the suburban town of Thiruvananthapuram (Figure 1). Varkala is located 50 km north-west of Trivandrum city. The study area lies between 8°71′29″ to 8°79′71″N latitudes and 76°67′29″ to 76°74′71″E longitudes. As per 2011 Census of India, Varkala has a population of 40,048 and has an average literacy rate of 88 per cent.

Varkala is the only place in southern Kerala where cliffs are found adjacent to the Arabian Sea. Varkala has two main cliffs viz. the North Cliff and the South Cliff (from North to South) with a maximum elevation of 30 m edging the Arabian Sea and running parallel for about 7 kilometers. These tertiary sedimentary formation cliffs are known among geologists as Warkalli Formation and a geological monument as declared by the Geological Survey of India (Figure 2).

Varkala experiences a tropical climate with more or less uniform temperature throughout the year. The air is humid mostly throughout the year. Varkala has a heavy rain during June–August due to the southwest monsoon. Winter starts from December and continues till February. Temperature rises to a maximum of 32°C in summers and 22°C in the winters. Varkala receives average annual rainfall of 310 cm (RITES, 2013).

Study area enjoys excellent telecommunication facilities. It has fire station, post office and police station. It has government run medical facilities, private hospitals and clinics. It also has government run nature cure hospital near the Papanasam beach.
Figure 1  Location of the study area

Figure 2  A view of Varkala Cliff
at Helipad. Considering its geology and tourist potential, the Government of Kerala has decided to undertake integrated development of this area and is planning to make Varkala first national geopark of the country.

3 Data sources and methodology

Keeping in mind the objective of this paper, the study was based on primary and secondary data sources. The land use/land cover maps were made to establish the spatial and temporal change in the land use pattern of the study area. In order to construct land use and land cover change map of study area, base map of the study area was taken from National Atlas and Thematic Mapping Organisation (NATMO). The data for the spatial and temporal change was taken from Landsat Satellite Imagery of February 2000 and 2014 from glovis.usgs.com. The maps were made using Erdas Imagine 10.0 and ArcGIs 9.3 software. The following flow chart shows the steps and methods which were used during the process of using Erdas Imagine 10.0 and ArcGIs 9.3 Software 9 (Figure 3). Questionnaire survey was also conducted among the visitors, hotels and local community to identify the aspiration of the interviewed people and to assess the status of the infrastructure, environmental problems etc in the study area. Final conclusions were drawn based on the compilation of the land use pattern and findings of the questionnaire survey.

![Methodology of land use and land cover analysis](image)

4 Results and discussion

4.1 Land use and land cover analysis

The land use/land cover maps of 2000 and 2014 were compared and major changes
were noticed in the land use types such as paddy fields, built-up areas and perennial crops with settlements. The table below highlights the comparative area under different land use categories (Table 1). A land use change map of Varkala has been prepared to show the spatial dimension of a pattern and nature of land use change over time (Figure 4, 5, 6).

Table 1  Changes in land use/land cover types and their areal extent

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Land use/Land cover types</th>
<th>Area (km²)</th>
<th>2000</th>
<th>2014</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Backwaters</td>
<td>5.51</td>
<td>5.51</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Beach</td>
<td>0.64</td>
<td>0.33</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Built up</td>
<td>3.23</td>
<td>4.47</td>
<td>1.22</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Perennial Crops with Settlement</td>
<td>10.36</td>
<td>12.12</td>
<td>1.76</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Paddy Fields</td>
<td>2.87</td>
<td>1.83</td>
<td>−1.04</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Plantation</td>
<td>6.99</td>
<td>5.43</td>
<td>−1.56</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>29.6</td>
<td>29.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4  Land use map of Varkala in 2000
Figure 5  Land use map of Varkala of 2014

The total land area of Varkala is around 24.02 km² and backwaters cover 5.51 km². The present land use/land cover pattern of the study area has been classified into 6 major types. Major portion of the area is covered by perennial crops with settlements followed by plantation crops and built-up area. Perennial crops with settlement cover approximately 40 per cent of the total area. Perennial crops represent mostly cinnamon, pepper, ginger and limited number of jackfruit and mango trees. Perennial crop with settlement occupied 35 and 40.91 per cent of the total area in 2000 and 2014 respectively. The area under perennial crop with settlement has increased from 10.36 km² to 12.12 km² (2000 to 2014). There is an increase of 1.76 per cent in 15 years. Among all six categories perennial crops with settlement has witnessed the greatest change.

Plantation crops mainly consist of coconut and banana trees. Banana plant is also cultivated in between the settlement. The area under plantation crops had reduced from 6.99 km² to 5.43 km² from 2000 to 2014. It reduced by 1.56 per cent over past 15 years. As per the data, reason for reduced area under plantation agriculture should be increase in population but ironically there is a decrease in the total population of the study area. The total population of the area was 40,048 in 2011 and 42,373 in 2000 as per Census of India.
Tourism was often considered as an effective way to promote economic growth for coastal areas in developing countries. The influx of tourists in Varkala increased from 15,958 in 2005 to 2,05,783 in 2010 (RITES, 2013). The increase in tourist arrival could reflect on the increase at tourists’ understanding and awareness level (Ali & Unjah, 2011). Hopefully this rising consciousness would augment the sense of belonging among the local people and visitors’ support for all activities related to conservation of geological heritage resources not only in the fragile Varkala cliff, but also in other parts of the country. On the other hand, the tourism expansion over the past 15 years resulted in reduced land area under cultivation. Booming tourism not only led to the increased demand for tourism infrastructure and rapid urban expansion, but also boosted the demand for local food products quickly. However, rapid increase of tourism infrastructures caused environmental issues like violation of coastal regulation zone, pollution of water bodies and beaches, cliff erosion, destruction of the natural environment (fauna and flora), and reduction in tree cover due to uncontrolled development, overexploitation of coastal natural resources and unchecked construction activities (Vivid Corporation, 2013).

Built-up area is the third major category of land use in Varkala. Area of human habitation was developed due to non-agricultural use and which covered residential buildings, hotels and restaurants, transport and communicates and were classified under this category. Settlements were also found mixed in between the farmlands.
The built-up area had increased from 3.23 km² in 2000 to 4.45 km² in 2014. The built-up area occupies around 15.1 per cent of the total area. Due to the increased tourism, more number of hotels were constructed leading to gradual erosion of the cliff. The increase of built-ups area bears negative consequences on geology of the cliff. Irrational tourism and land development is hindering the sustainable development of tourism and geoparks. Tourism-led development restructured the land-use pattern dramatically, which brought about landscape fragmentation, and coastal erosion (Wang & Liu, 2013).

The paddy fields underwent drastic changes from 2.87 kms² to 1.83 km². The paddy fields are reclaimed as fallow land, built up area and perennial crop with settlement. The difference in beach area is mainly due to the cliff erosion and seasonal variations in shorelines. The average beach area in 2000 was 0.64 km² but it reduced to 0.33 km² in 2014 (Figure 4, 5, 6). All along the coast there are five intermittent pocket beaches with a total length of 1.18 km and the width variation of 10–40 m. Except Papanasam and Chilakkur other beaches are seasonal in nature and appear during the period of November to April (Brilliant et al., 2012). Along the coast there are few fishing sites operated by neighbouring fishermen’s in their conventional way.

5 Discussion

A comprehensive land use change has been noticed along the 1.5 km stretch of coast from Papanasam towards Thiruvambadi in the north. Tourism activity is mostly concentrated within this area and is very much crowded with resorts and shops. There are about 90-100 resorts of different categories concentrated within the distance of 1.5 km from Papanasam to Thiruvambadi. The major land use around the south cliff is basically around Papanasam beach. Most of the land adjoining Papanasam beach is under hotels, Janardhana Swamy Temple and commercial activity areas. The area around south cliff requires development for pedestrian movement, necessary street furniture, proper landscaping of the public spaces along the cliff from south to north. The major land use around the north cliff comprises of hotels, restaurants and resorts, the edge of the cliff mainly caters to commercial activities. According to guidelines given by CRZ, up to 100 meters from the cliff edge permanent construction activities are not permitted but there is large number of illegal constructions (Vivid Corporation, 2013). During peak season walkway along the cliff becomes crammed due to overlapping of diverse activities. The major portion of the visits is made during the peak season of November to March. At present, all these visitors are supported within this 1.5 km stretch and there exists problems like congestion, hygiene, land and environmental degradation, unhealthy competitions, insufficient infrastructure and so on. The laterite cliff is slowly getting tarnished mostly due to the developmental activities.

Appropriate relocation of the current activities in the neighbouring areas regarding the prospective for geopark and tourism development can preserve the main attraction of Varkala as a beautiful coastal tourism destination. There is an urgent need of sustainable tourism. Sustainable tourism is not a discrete or special form of tourism. Rather, all forms of tourism should strive to be more sustainable. Making tourism more sustainable is not just about controlling and managing the negative impacts of the industry. Tourism is in a very special position to benefit local communities, eco-
nomically and socially, and to raise awareness and support for conservation of the environment. Within the tourism sector, economic development and environmental protection should not be seen as opposing forces - they should be pursued hand in hand as aspirations that can and should be mutually reinforcing (Aziz, et al., 2011). Ban on the movement of vehicles, waste water outlet construction, ban on the hotel construction and removal of unauthorised drains are some of the steps that can ensure sustainable development in the study area (Anand, et al., 2014). More clean surroundings should be maintained. Towards north up to Kappil, the land use or land cover mapping and field survey has identified potential sites for tourism development. Backwaters fringed by coconut groves, inland boating facilities, and the seashore, all offer attractive scenic beauty. In the lieu of tourist attraction and geopark development, facilities like accessibility, resorts, restaurants etc. should be improved further and the medium to do so is building infrastructure towards these areas (Brilliant, et al., 2012). Abundant land is available for future developmental activities in Varkala.

6 Conclusion

This paper has brought about the land use change dynamics in Varkala applying RS-GIS tools. Varkala has long been a treasure trove for geologists because it can be considered as a geodiversity hot spot of the country. Geoscientists and researchers are coming from all over the world to Varkala to study its oldest sedimentary sequence of cliff formation. Its long and complex geological history makes Varkala a very interesting place where geological diversity is so wide and rich with extremely precious geological features. These geosites are the main attractions in geotourism for now and also in future. Protecting this geosite (cliff) mean that protecting the future of Varkala’s tourism industry. Government of India is planning to develop this area as first national geopark of the country. The geopark development will enhance tourism that will lead to environmental pollution, land degradation, overcrowding etc in Varkala. These key issues are rapidly changing land use pattern of the study area over the past 15 years. So, the government and communities have to take initiative for sustainable development of the region. To ensure the sustainability of geotourism industry area around the cliff needs to be given due consideration in future land use planning. This consideration for land use planning would also mean a better integrated city plan. For this purposed Varkala needs to be accurately zoned and protected or at least put under a management body that will look after its promotion and future development.

Acknowledgement

Authors are thankful to Professor R. B. Singh, Vice-President, International Geographical Union for his valuable advice and Department of Geography, University of Delhi for providing the financial support as Non-NET fellowship.

References


