Chapter 24
Land Use/Land Cover Changes in Coastal Districts of Karnataka

Ashok Kumar and Anju Singh

Abstract Coastal environment has an instrumental bearing over the economy of the nation. By virtue of its diverse and precious resources productive habitats, rich biodiversity and its locational advantage to many of the human activities. It contains diverse and productive habitats for human settlements, resource development and local subsistence coastal zones have been among the most heavily utilized area because of their resources. The process of land acquisition for beach resort, hotels and industries has changed entirely the land use pattern of the coastal areas, leading to adverse effects on the environment, as well as on the local people. The increasing population and number of tourism in Karnataka coast, especially in the coastal strips, are the factor which leads to land use and land cover changes in the coastal zone. The area under irrigation, forest cover are increased, whereas the area under unirrigated and culturable waste land is decreased from 1995 to 2015. The coastal backwaters, estuaries, river mouths are well known for their productivity. Some of them are the Aghanashini, Kali, Sharavati, Mulki and Netrani river backwaters, are even today so. With passage of time, Land use and Land cover of coastal area undergoes significant change due to varying natural and anthropogenic causes. So it is essential to monitor the changes in land use and land cover at regular intervals for proper management of natural resources existing in an area. In the present study deals with the land use and land cover mapping and monitoring of the area around the river mouth, urban and village settlements and infrastructural activities Karnataka coast. The satellite data were interpreted based on visual interpretation keys to prepare land use and land cover map of year 1995 and 2015.

Keywords Coastal environment · River estuaries · Coastal features · Harvest food · River backwaters · Land uses land cover · Change detection · Satellite data

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24.1 Introduction

Kanara coast is a land of scenic beauty, located on the western coast of Karnataka state. The coastal area is known for sea, sand and sun. The small emerald on the western coast of Karnataka has natural aesthetic beauty, abundant greenery, beautiful and attractive sandy beaches, temples, churches, colourful and lively feasts and festivals, people with a rich cultural milieu. All these have made the Kanara coast, a prime tourist attraction not only among Indian states but also among the foreign tourists. The coastal region has a wide range of physical and social-cultural variations. The Western Ghats, Plateaus and sandy beaches reflect the geomorphic variations; on the other hand, environment of Kanara coast supports a variety of ecosystems and possesses rich biodiversity. As far as social-cultural identity is concerned, the Kanara coast is known for its prosperity and socio-economic well-being. A striking feature of Kanara coast is that it has varied geographical features with long coastal line, thick forest, perennial rivers and abundant flora and fauna (Dakshin Kannada District Gazetteer 1973).

24.2 Location and Extent

The Kanara coast is located in between 12º27′ and 15º32′ North latitude and 74º05′–75º45′ East longitudes, the total geographic area is 18,732 square kilometre, the coast line is 320 km long and 30–55 km wide in three districts of South Kanara, Udupi and North Kanara. The North Kanara district has 160 km long coastline while 98 km in Udupi district and the rest 62 km in South Kanara. There are three distinct agro-climatic zones ranging from plain coast lands, undulating hills in western part. The Arabian Sea in west and western scarps from east and coastal plain located in between with average width of 22 km. The average height of the region is 70–75 m, but in some places it can be as high as 150 m. There are ten major rivers draining their waters into the shore waters of Kanara coast (Singh 1997) (Fig. 24.1).

There are three districts consisting of total nineteen talukas of which eight are coastal talukas. In which five talukas are in North Kanara, two talukas are in Udupi and only one taluk is in South Kanara district. Kannada, Konkani and Tulu, Marathi is the major regional language spoken in this region. As per 2011 Census, the total population consists about 43, 63,617 with average density of 278 per square kilometre. The sand bars originated in important river estuaries include Netravati-Gurpur, Mulki, Hangarkatta, Gangolli, Sharavathi, Aghanashini, Gangavali and Kalinadi. There are number of sand dune physical features like barrier spits at Tannirbavi, Sasihitlu, Udyavara, Hoode, Hangarkatta and Kirimanjeshwara formed due to change in river course and deposition at mouth region, also causing river migration. Kanara coast has about 95 beautiful beaches that attract many national and international tourists and are suitable for beach tourism (Deshpande 1992).

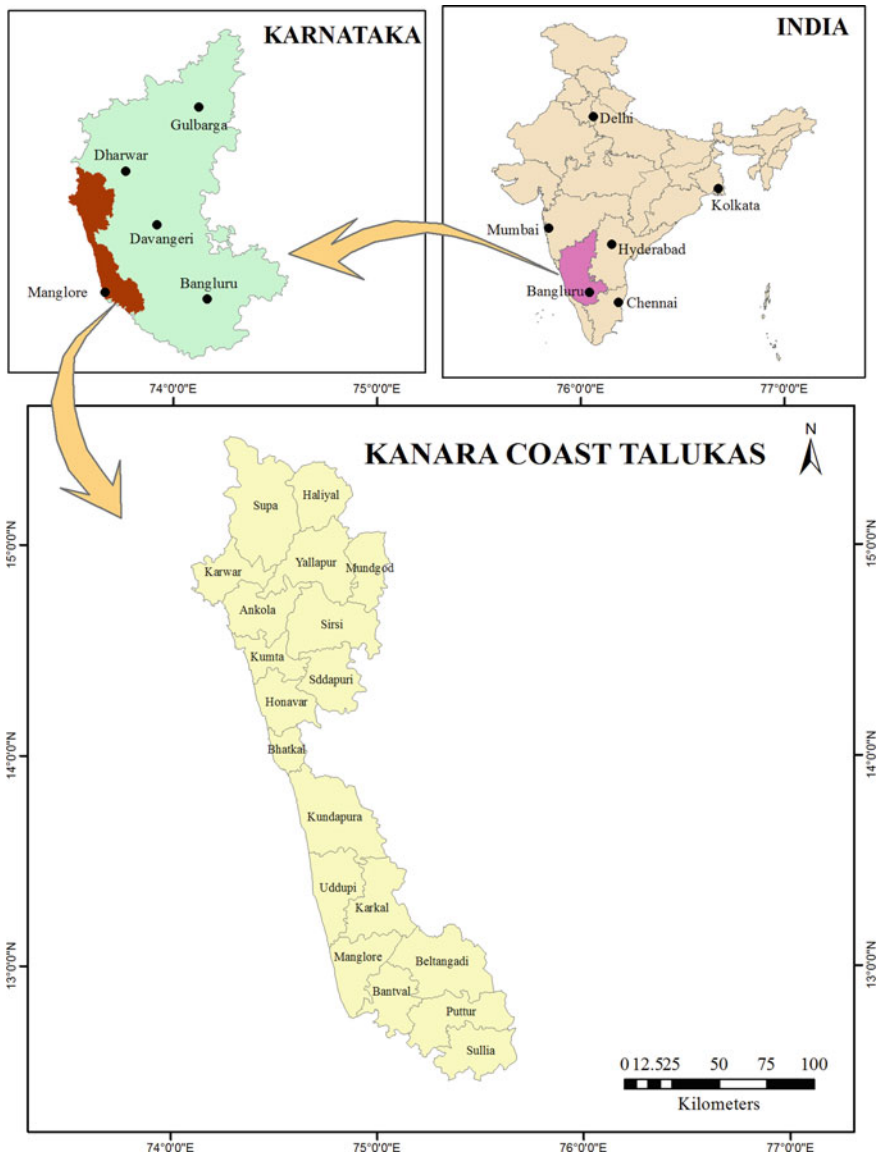

Fig. 24.1 Location and extent of the study area

24.3 Relief Features

The Mysore plateau is located over southeastern part of south Kanara district; it originated with Dharwar system and consists of volcanic rocks, crystalline schist and granites. Several rugged topography covered from western side and the Western

Ghats surrounded from east with 500 to 750 m. The Western Ghats also known as Sahyadri hills with elevation of 600–900 m height, it crosses parallel in all three districts of Kanara coast with unique natural beauty, having more than 10 biodiversity hotspots. The undulating plateau and coast line show the average relief about 1812 m in talukas of Yallapur, Mundgod and Sirsi in eastern part of study area due to sharp-edged Sahyadri hills. Its relief decreases towards western part of Kanara coast with less than 5 m near coast (Fig. 24.2).

The hilly chains of the Western Ghats which run north–south direction, parallel to the coast, act as the backbone of the district. These hills, unlike the rest of the Western Ghats, seldom exceed 600 m. At several places in the district, the hills directly run right into the sea, interrupting the continuity of the sea beaches in Karwar, Ankola, Honavar and Kumta talukas and providing ample rocky inter-tidal and sub-tidal habitats with their unique flora and fauna (Daniels 1989).

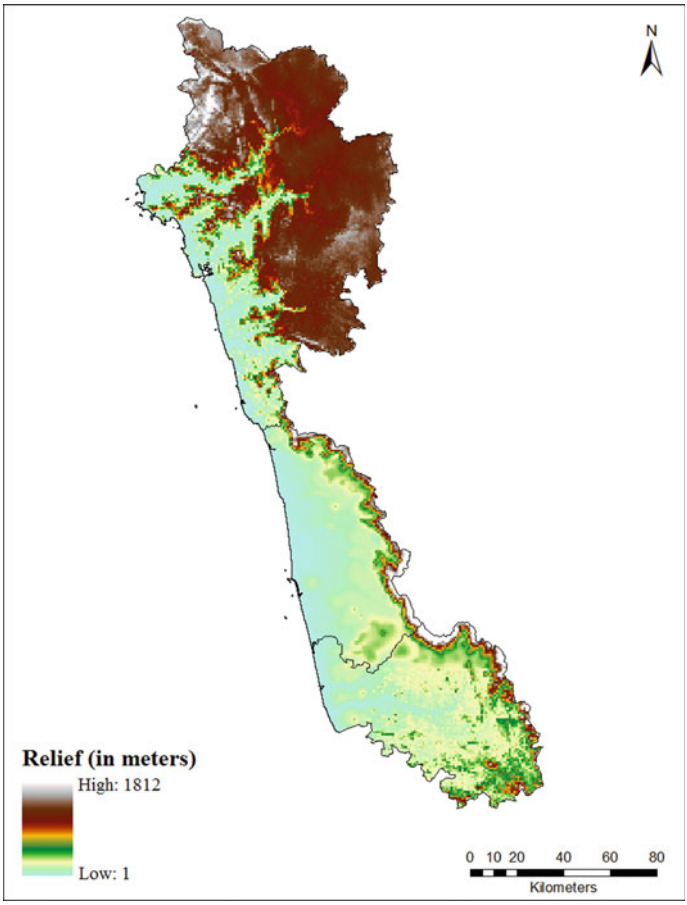

Fig. 24.2 Relief features of Kanara coast

On the river banks, the alluvial plains are found, fluvial basins of alluvial formation are found in the rivers of Kali, Gangavali, Aghanashini, Sharavati, Bedti, Venkatapur, Varada, Varahi, Mulki, Netravathy and Chakra. The *Gazani or Khar* lands are another important part of the plains. These *Gazani* lands are basically alluvial formations, which are favourable for the growth of mangroves. The bays form a part of the inner shelf zone, with depths varying from 3 to 16 m. These aspects represent the evidences for both an emergent and submergent coast, suggesting a compound nature of coast (Bannur 1994).

The coastal plains of Kanara coast are largely wave-cut platform, thus it is an erosional rather than depositional except some beaches. It has varying width of 25 km over Karwar taluka and about 45 km width in Mangalore. The average height is less than 200 m from the mean sea levels. The coastal track is steep-like terraces due to oscillations in the sea levels during the geological past. Features indicating the submergence such as drowned river valleys, lagoons, bars and wave-cut cliffs are common. There are no large river deltas along the coast owing to most active south west monsoon which produces waves with greater height. These washed the coast and carried down the riverine loads into the deep sea (Hegde 1999).

24.4 Drainage

Since history all the coastal rivers are the most important for economic, social and political development and fresh water resource for human beings. It is largely related to the availability and distribution of freshwater riverine systems. Kanara coast is the land of ten major rivers and many small tributaries, with their sources water are from Western Ghats (Chapman 1996). Coastal Kanara region receives heavy rainfall during monsoon period, the depth of flow of these rivers ranges from 9 to 10 m, and the riverbank height is about 12–15 m. Rivers created many magnificent physical features like waterfalls, caves and steep riverine valleys, in the region such as the Jog falls, the Lushington (Unchalli) falls and Magod falls across Sharavati, Aghanashini and Gangavali (Fig. 24.3 and Table 24.1).

24.5 Land Use/Land Cover Change in Kanara Coast

The land use refers to the several uses of land which are primarily the results of human activities on land while land cover refers to the cover of land surface as natural and biological phenomena such as vegetation, water bodies and others resulting due to land transformation. Land use gives an over view of how different patches of lands are being utilized under various anthropogenic activities. Land cover is a basic parameter which evaluates the content of earth surface as an important factor that affects the condition and functioning of the ecosystem. Land cover is a biophysical state of the

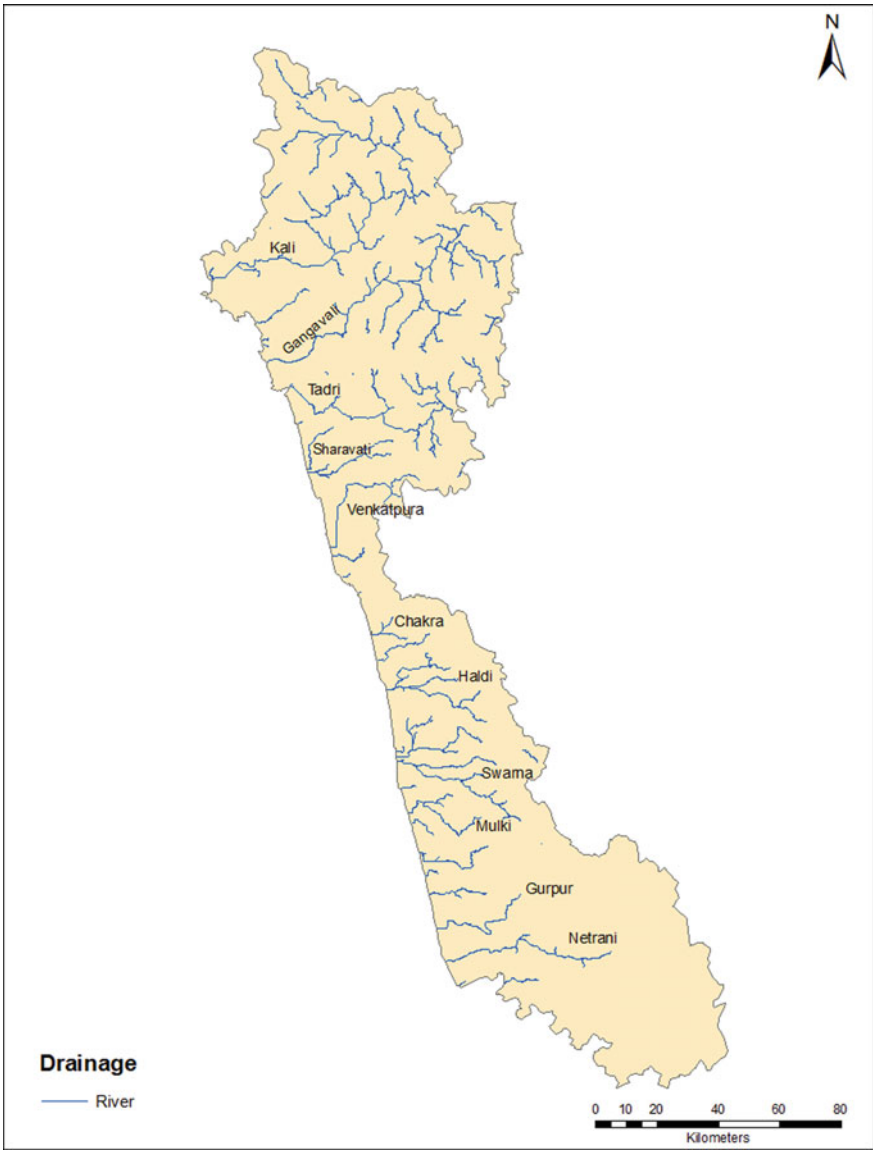

Fig. 24.3 Drainage system of Kanara coast

earth surface, which can be used to estimate the interaction of biodiversity with the surrounding environment.

In recent years, land use land cover analysis plays an important role in the fields of resource management and development studies. Land use and land cover in developmental studies has become increasingly important because the region plans to

Table 24.1 Major river system of Kanara coast

Major river basin	Average-annual flow (mm^3)	Length within the state (km)	Basin area (Sq. kms)
Kali river	6631	184	844
Gangavali/Bedti	4736	161	925
Aghanashini	2556	121	547
Sharavati river	7399	128	755
Venkatapur river	3066	45	335
Varada river	3505	96	244
Varahi	2263	66	756
Mulki	7575	106	3067
Netravathy	12,813	103	3222
Chakra	892	75	336
Total	**51,436**	**1195**	**12,898**

Source Ranganath (2010)

overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of fertile agricultural lands, destruction of water bodies and loss of wildlife habitat (Arveti et al. 2016). Land use changes mostly result from individual and social responses to changing economic conditions, which are mediated by institutional factors. Opportunities and constraints for new land uses are created by markets and policies and are increasingly influenced by global factors. Globalization as such is not a driver of land use change but is a process that underlies the other driving forces land use change as the immediate and principal (Lambin et al. 2003). Change detection is the process of identifying difference in the state of an object or phenomenon by observing it at different time. Change detection in land use land cover can be performed on temporal scale such as decades to assess landscape changes caused due to anthropogenic activities on the land (Yadav et al. 2012). These anthropogenic activities are due to rapid growth of human population and demands of food resources.

24.6 Recent Developmental Activities in Kanara Coast

The last two decades from 1995 to 2015 there is drastically changed the physical landscape of Karnataka coastal districts, owing to rapid growth of settlements and increase in overall population of the rural villages contributing expansion of conversion of valuable forest land into built-up area. The expansion of New Mangalore harbour and other small ports into large ports for fishing and other commercial activities. The project Sky bird is the one of the big harbour of Indian Defence Ministry, which occupied large area and grabbed several islands for experimental purposes.

The improving infrastructure activities like expansion of National Highway no 17 from two lanes to six lanes highway also attracted the rural population to migrate near the highway. Increase in number of tourists from national and international causing upcoming of hotels and recreational centres in Karwar, Ankola, Bhatkal and Honavar. The increase in rural population caused expansion of agricultural landholdings and decrease in per head cultivable land. Conversion of forest land for cultivation, coastal mangroves and river backwater into fishing ponds and paddy cultivation and other aquaculture activities mainly over the low lying areas of river mouth. The traditional agricultural system has been changed into modern sophisticated profit motive cultivation of cash crops, which leading to mono-crop system and loss of fertility, over leaching of soil from high altitudinal areas. The natural water bodies converted into manmade lakes, and river flow has been stopped with construction of Dams and bands in interior parts of coastal talukas. The southern part of Kanara coastal talukas has increased with settlement construction and much change occurred in cultivable lands. But in North Kanara talukas, the land use and land cover mainly caused owing to construction of hotels and expansion of infrastructural activities.

24.7 Land Use Land Cover Change

In the Kanara coastal area, the utilization of land depends upon physical factors like topography, soil and climate as well as upon social factors such as population density, land tenure and infrastructure development. There are spatial and temporal variations in land utilization due to above factors.

The process of land acquisition for beach resort, hotels and industries has changed entirely the land use pattern of the coastal areas, leading to adverse effects on the environment, as well as on the local people. The increasing population and number of tourism in Kanara coast, especially in the coastal strips, are the factor which leads to land use and land cover changes in the coastal zone. The area under irrigation, forest cover are increased, whereas the area under unirrigated and culturable waste land is decreased from 1995 to 2015 (Figs. 24.4 and 24.5).

But maximum changes in irrigated land and forest area have increasing trend but lesser intensity as compared to 1995, there is a decreasing trend in unirrigated, culturable waste land and area not available for cultivation. In the processes of land use and land cover changes, the unirrigated area and change in the vegetation have been affected worst, especially sand dune vegetation and mangroves. However, the plantation constantly been done in the state but the area under plantation is decreasing with the developmental activities, while the area under deforestation is increasing every year. In 1995, the southern talukas of Kanara coast experiences intensive cultivation especially in South Kanara district as compared to northern talukas. Most of urban built-up are located over the coastal zone, and small villages are located over eastern region of study area. Forest cover is maximum in North Kanara talukas but in South Kanara and Udupi, forest cover is located over easten talukas of the district. The fallow/sediment land is maximum in northern Kanara coast, and many lakes, ponds

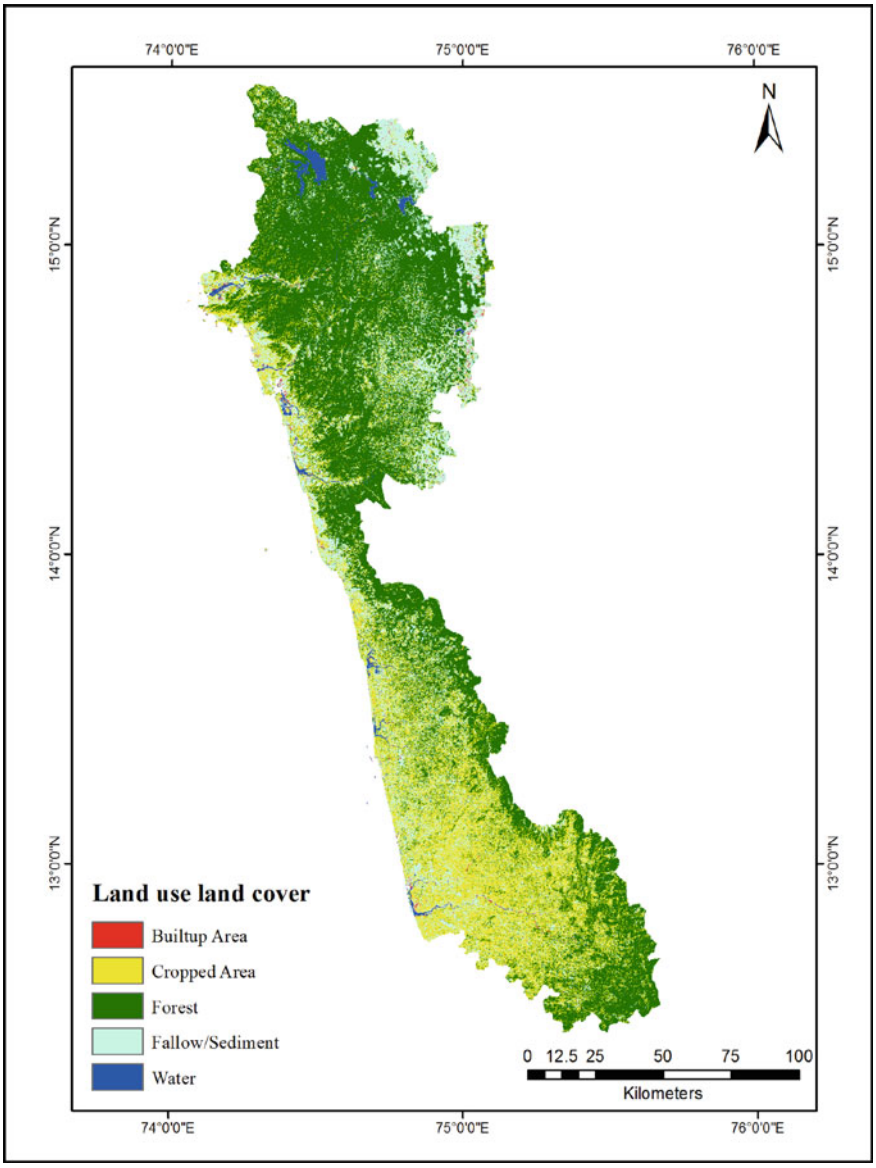

Fig. 24.4 Land use/land cover in 1995

and other water bodies are mainly sharp and swift flowing rivers, covers broad area near estuary region.

In the year 2015, land use land cover changed at faster rate as compared to 1995. The land for agricultural utilization has been increased in southern parts of the study area as well as it spreading towards northern talukas of North Kanara district, the

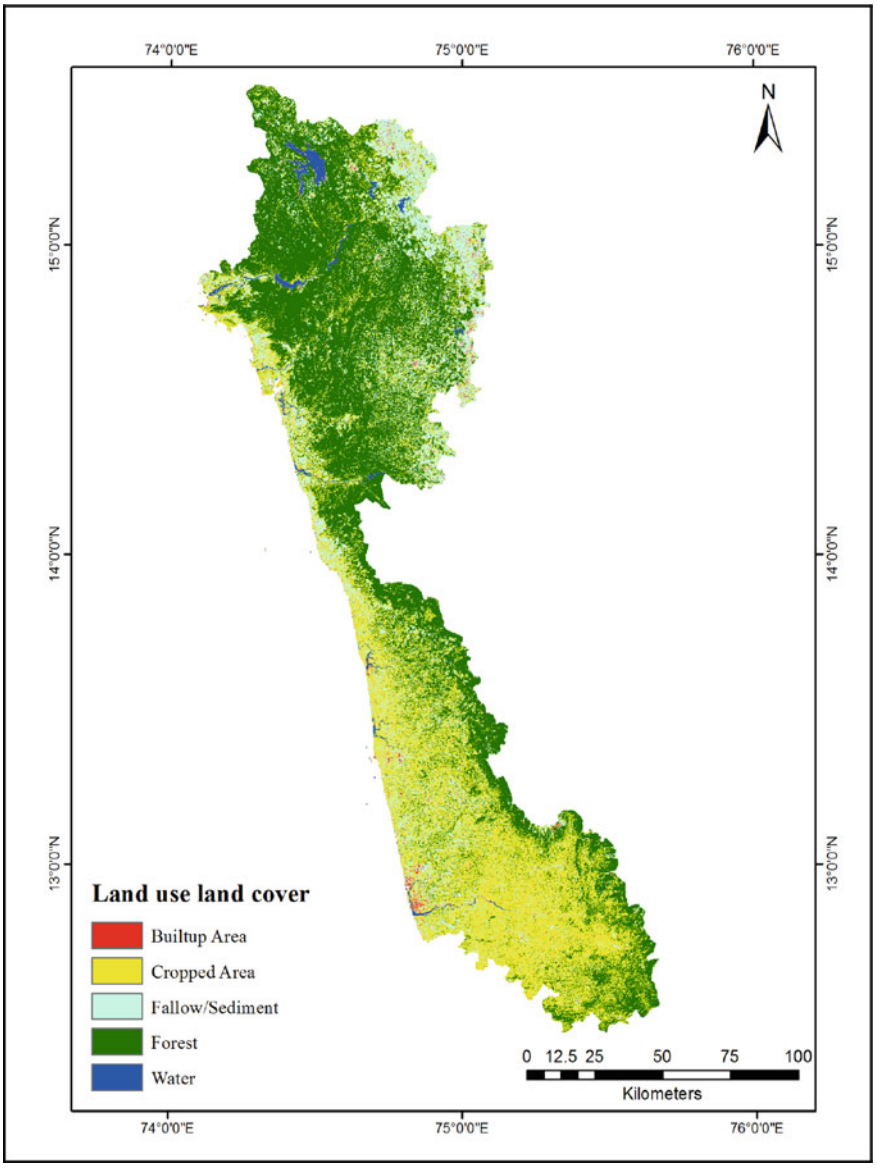

Fig. 24.5 Land use/land cover in 2015

earlier forest land of eastern talukas of Kanara coast was covered with thick forest but recently it has been cut in patches and converted for agricultural and plantation purposes. Forest area is also decreasing due to increase in population and spreading of villages in forest areas and cutting forest for settlement purposes. The built-up area increased especially in coastal area owing to overgrowth of town and cities.

The built-up area is mainly expanding to near sea due to increased tourism and other recreational activities. Therefore, in 2015, forest area is decreased and thick forest remained only in eastern portion of southern talukas and the central hilly regions of North Kanara district. The fallow land increased in northeastern talukas and few patches another talukas. The water river water bodies expanded their water cover area due to building of many dams and reservoirs, river mouth expanded due to increase in backwater cover.

24.8 Vegetation

The strong seasonal climate is found in rain-forested regions of Western Ghats, the Ghats has substantial tracts of the tropical lowland evergreen rain forest formation in areas where there is a dry season of up to seven months. In low land areas, the Sorab Ghat region *Kan* evergreen forest found, in the Karnataka state where annual rainfall is 1500–1800 mm combined with dry season (Whitmore 1984). The Ghat forests have floristically tropical vegetation, yet in the winter dry season, they are exposed to very low temperatures and tree falls to protect from winter cold. Owing to high altitude, ranges stop the clouds and cause the heavy rainfall during the monsoon season for about four months (Pascal 1986).

According to district handbook 2013–14, the forest cover is approximately 10,42,173 hectares with taluk-wise average forest cover is 54,851 hectares and total geographical area is 18,58,506 hectares, making Kanara coast as one of the most forested region in peninsular India. The most of forest cover is under the jurisdiction of the forest department and the revenue department (Fig. 24.6). The coastal taluk-wise distribution of forest area varies each other, the highest of forested land area 1,65,873 hectors in Supa taluk followed by Yallapur with 1,16,986 hectors and lowest is 2902 hectors in Mangalore owing to largest metropolitan city of Kanara coast maximum area is occupied for urban built-up and industrial and harbour developmental purposes. The tropical wet evergreen type forest is found in the eastern part and the tropical moist deciduous type forest facing the western side (Puri 1960). Champion and Seth (1968) have classified the forests of the eastern zone in the category of moist deciduous type and forests on the western slope covered with tropical evergreen type and have included. According to Arora (1961) the evergreen forests, deciduous forests and scrub forests are located in the region (Fig. 24.7).

The total forested area is highest in North Kanara district, but in recent years encouraged social forestry and plantation of trees over waste lands, barren lands, besides roads and plantation of coconut and other fruit-bearing trees surrounding the houses are contributing much for green forest (Fig. 24.8).

The vast forest ecosystems in river estuaries contain great mosaic of various habitats and sub-habitats that support tremendous biological diversity. While coastal sand dune also supports various types of flowering plants and also acts as habitation for small animals and bacteria. Most charismatic species, including flowering plants, mammals, birds and especially many marine fishes migrate twice in year to coastal

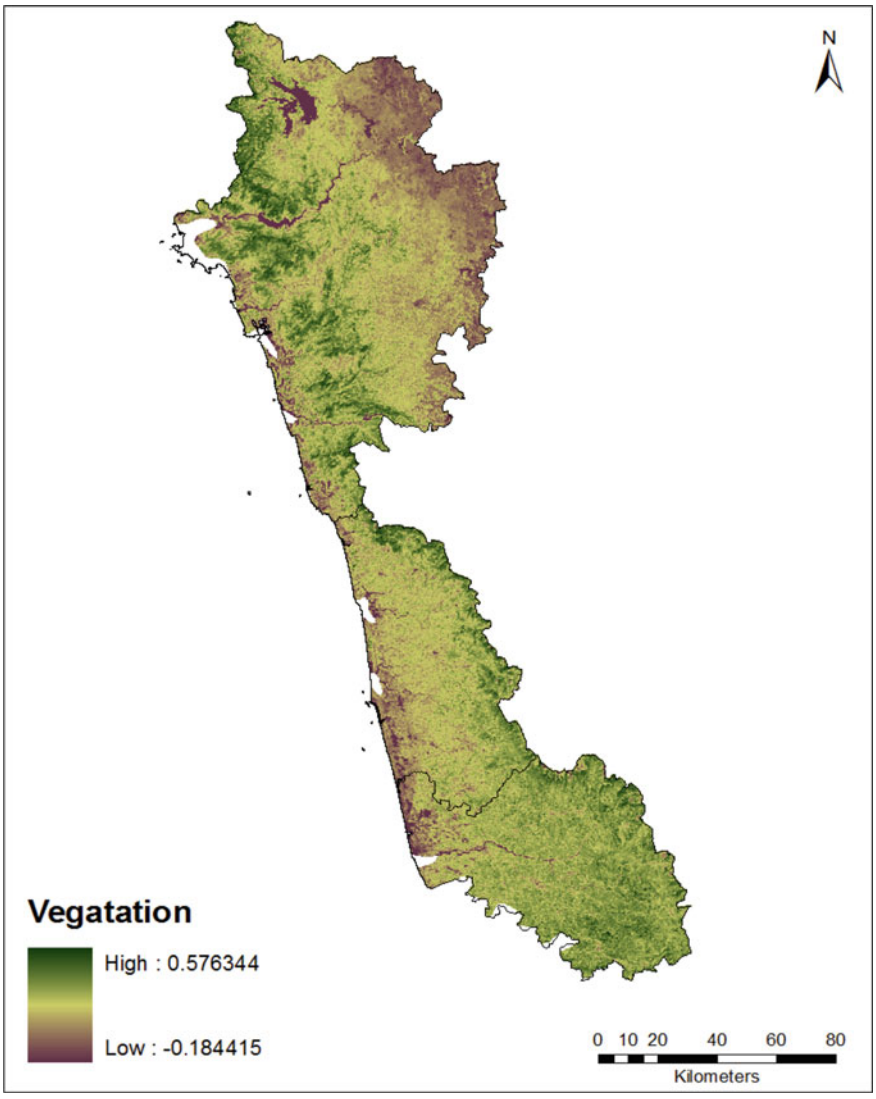

Fig. 24.6 Vegetation cover shown through NDVI in Kanara coast

mangroves areas for hatching the eggs. Therefore, mangrove forests at all major river mouths are very important for coastal biodiversity (Plates 24.1 and 24.2).

These forests of the Western Ghats perform several critical ecological functions that support agro-forestry, agriculture and other forest-based livelihoods in the district. The forests are also the catchments of important rivers such as the Aghnashini, Sharavathi, Kali and Gangavalli.

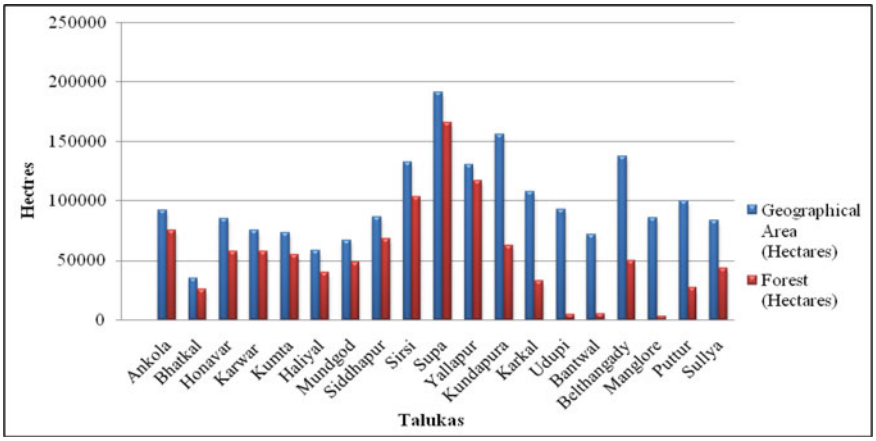

Fig. 24.7 Taluk-wise geographical area and forest cover in 2014 in hectares. *Source* Kanara Districts At Glance Mangalore, Udupi and Karwar, 2014–15

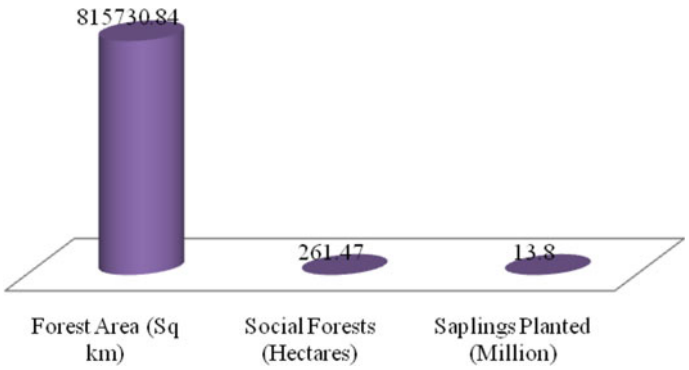

Fig. 24.8 Total forest area, social forestry and planted trees in 2012. *Source* Forest Department Government of Karnataka (2012)

24.9 Conclusion

However, it can be inferred that the Kanara coastal region has an advantageous location in terms of its human and natural resources. The geological formation left many old relic mountains and mineral resources. The region has been under the colonial influence and which has immensely affected the economy, literacy, culture and lifestyle of the people. The economy and the lifestyle are also highly influenced by the geographical features, therefore, the land use and land cover changes show the root of the problems of continuous increasing in population, settlements and decreasing in forest cover causing changes in long-term climate of the region.

Plate 24.1 Mangrove forest in river Haladi Estuary in Udupi taluk

Plate 24.2 Coastal sand dune vegetation in Tagore Beach in Karwar

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