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A REVIEW ON VEGETATION DIVERSITY OF INDIA

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ABSTRACT

Diversity of vegetation are collections of plant species and ground cover. India has the richest diversity in the records. India has a diverse and abundant vegetation with their endowed and gorgeous growth with 80.9 million hectares of forest cover. India has 24.62 % total geographic area of forest. In this review paper we have discussed that different regions have their specific vegetational localities. In this paper, there are findings of different materials and methods that are used to study vegetation such as, remote sensing & GIS. India is blessed with different types of vegetation diversity like evergreen forest, thorny forest, tropical evergreen forest, dry deciduous forest etc.

Keywords *: India, vegetation, diversity, forest, remote sensing, GIS*

INTRODUCTION

Diversity of vegetation refers to the collection of plant species and their ground cover while vegetation. Natural Vegetation is the group of plants that have grown naturally for amount of human without interference from human. Virgin Vegetation, also known as natural vegetation, concededly vegetation that grows spontaneously without the help of humans. Humans depend on vegetation for more than only for the products it produces such as food, fuel, timber, medicine and other resources in addition to enjoying outdoor activities like hiking, camping and sightseeing. For life to exist, forests are essential because they prevent soil erosion, conserve water, purify the air and function as a barrier against climate change. India has a diverse and abundant vegetation with their divinely endowed and gorgeous growth with 80.9 million hectors of forest cover. India makes up 24.62 % of total geographical area. India has a wide variety of vegetation because of its varied flora and fauna, which are impacted by the country's temperature and diversity. Forest, grassland, tundra, ice sheet, Mangrove forest, semi-desert or desert vegetation, thorny forest, coastal vegetation, mountain vegetation, dry-deciduous forest & tropical evergreen forests are some of the main varieties of vegetation in India.

Vegetation is characterized by the shape and size of dominant plants, such as deciduous woodland, savanna, marsh, desert, or tundra, rather than by species composition. In a unique plant community, member plant species have a functional connection that allows them to be grouped together. Environmental elements such as heat, light, moisture, wind, fire, soil and nutrients influence plant development and structure. Interaction with other creatures through competition and browsing also impacts vegetation structure. Key features of vegetation include height, growth shape, canopy coverage, number of canopy layers, leaf type, and phenology.

Climate, sunshine, moisture, rain, relief, geographical factors, soil significantly contribute to the variety of flora and fauna. Temperature has a significant impact on vegetation, especially on the Himalayan and Peninsular slopes over 915 meters. Sunlight, influenced by direction, height, season, and day duration, impacts plant growth. Heavy rainfall points have more vegetation than places with fewer rainfalls. Soil conditions in shoreline and delta locations determine the type of vegetation, such as forests of mangroves, wetland areas, and dry forests on the coast. Relief has a profound influence on vegetation, with distinct types of flora found on plains, plateaus, and mountains. India is known for its medicinal herbs, with almost 2,000 documented in Vedas and 500 in widespread usage.

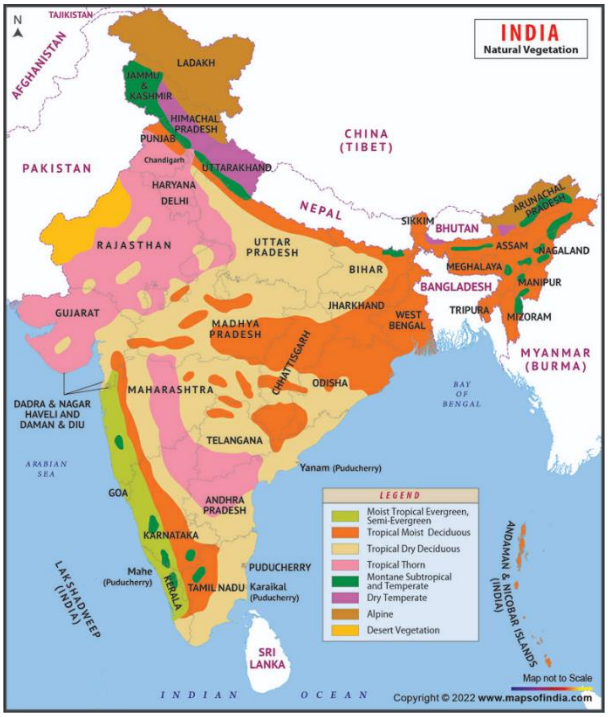


Fig. 1 : Vegetation types of India

The Himalayas' southern slopes are covered with lush vegetation and tree lines, while the Western Ghats' leeward-windward slope is covered with tropical green and seasonal foliage. Temperature and precipitation are climate-related elements, with locations with substantial rainfall and high temperatures containing forests of evergreen trees and xerophytic plants. The natural landscape in India is critical for preserving ecological balance, controlling climate, avoiding soil erosion, and safeguarding biodiversity. It provides economic advantages such as lumber, fuel, plants that are medicinal, including other forest goods. It is an essential component of Indian culture, appearing in religious rites, festivals, art, and literature. Natural vegetation absorbs carbon dioxide, emits oxygen and avoids soil erosion and prevent floods. It provides home for a variety of flora and fauna, including endangered species. It is a significant tourist destination of India, including national parks and sanctuary gardens attracting millions of people each year.

REVIEW OF LITERATURE

The Western Ghats are evergreen forest of southern part of India, a biodiversity hotspot with high proportion of endemic spices, although their diversity and endemism are not evenly distributed. The southern areas with heavy rainfall and short-day seasons contain the most biodiversity and endemic species (Pascal. J, Ramesh, 2004).

The district of Barmer is located in Rajasthan and is an important section of Thar desert. The area is home to several endangered and important medicinal plant species. The region has recorded archaeological activities (Khan. Et.al., 2022).

The Mahanadi Delta and Bhitarkanika mangrove forest are being restored in carefully managed plantings in their environment. Mahanadi and Bhitarkanika has rich diversity in their area (Das Premanand, et al., 1997).

In India, Tamilnadu state, Tiruvannmalai district has an inventory of trees reveals a species diversity equivalent to a dry deciduous forest, with significant species variety and capacity of regeneration. *Albizzia mara* is a dominant species found in this area (Sundarapandian, et al., 2014).

The Barak valley of Assam, that is rich in plant species, has tropical forest which provides several ecological services such as habitat, carbon storage and sequestration. To properly explore this resource, comprehensive conservation strategies including traditional knowledge and collaboration is required (Borah N. et al., 2016).

In Andaman Islands, notably the Baratang Islands, are very rich in species but they are under threat from an expanding human population. The urgent necessity for protection of these

vulnerable island forest emphasizes the importance of their protection. (M. Babu, et al., 2018).

Sikkim, a tiny Indian state in eastern Himalayas is home to the Khangchendzonga biosphere reserve, which provide wonderful vista release of snow – clad mountains, greenery in the forest, temperate and subalpine zone and abundant flora and fauna species. The reserve has alpine meadows with heights ranging from 3800 to 4800 meters above sea level with species of plant varieties rising from April to August. There is mostly alpine vegetation covered in this region (Singh, et al,.2005).

The Morena district of Madhya Pradesh located in the states north – west region, has two different features: Plain & the other one covered with the rivers, ravines and forest. The district is split into five regional areas like Chambal ravines, Karahal plateau, Sabalgarh – Emilia forest tract, Peach marina jura plains and kulaith – baldia forest, all of which are covered with mixed dry deciduous forest (Sikarwar et al, 2023).

The Godavari Estuary in Andhra Pradesh, India has seen major changes in Mangrove vegetation and coastline over the last 60 years, due to rising of mangrove cover in accepted regions, loss of mangrove facing the sea and changes in geography and shoreline (Ramasubramaniam, et al., 2006).

The study was carried out in Namdapha national parks tropical wet evergreen forest of Arunachal Pradesh, North-east India with a priority on active population such as Chakma, Hmar and Wancho. The forest has high species rarity and existence of primitive species such as *Ficus elastica* requires additional care for protection of biodiversity (Nath, et al., 2005).

The Cauvery river deltas regions in Tamil Nadu, India is home to significant mangrove wetlands, with patches of growing mangrove in Pichavaram and Muthupet region. Relative sea level fluctuations in the northern Cauvery deltas have been studied and salt tolerant *Avicennia* species have been determined. Mangrove suffered degeneration throughout the late Holocene as aridity rising. Some dominant Mangrove species *Rhizophora apiculata, R. Mucronta* have been found in the Pichavaram and Muthupet region (Srivastava 2017).

Rampura forest is located in Rajkot district of Saurashtra region of Gujarat. The significant deforestation occurred in the Nature Reserve Rampura scrub forest in India, converting it to savanna. The regeneration tree variety and typical qualities of the forest were examined in the study. There isn't much diversity in the forest and some species could become extinct. The study's four qualitative evaluation sites revealed deficiency of water and soil conditions. (Panchal N.S., et al., 2004).

Kutch is the largest District of India located on western part of Gujarat State. The study explored at the features of woody vegetation community in Bhuj- Kutch, Gujarat emphasis on tree and shrub species, the study discovered that the thorn forest the greatest diversity species with *S. percica* and *P. juliflora* have highest diversity. The vegetation is observed in widespread. (Vaghasiya P. M., et. Al., 2015).

Vegetation diversity was studied at Bediyabedi forest in Saurashtra district of Gujarat state, where major vegetation diversity of tree species like *Prosopis specigera, Acacia catechu, Acacia senegal* are the most common species that are grown in the forest. The tree diversity and regeneration at Bediyabedi scrub forest. This forest constitutes the most diverse plant communities. (Parejiya., et al., 2013).

Due to anthropogenic disturbances such as clear cuttings, hydrological changes, oil spills and climate change, the researchers found that Avicenniaceae is dominant family in Gulf of Khambhat coastal area of Gujarat State. According to the study, monotonous *Avicennia marina* species will be soon dominant in the coastal area. (Devi., et al., 2016).

The study focuses on aquatic habitat of the Bandoli wetland species in Godhra taluka, A dry deciduous forest with monocot grasses and various flora type in Panchal in Godhra taluka, Gujarat State. (Charan., et al., 2019).

The researchers used satellite – remote sensing to analyse plant variety in Jamnagar district of Gujarat state. The findings include type of land use map, that is critical for protection, planning and management plans particularly for Mangrove species. (Bhatt G. D. et al. 2013). The study is based on field work, researchers used GPS location and unsupervised classification to describe the mangrove vegetation of Purna estuary, Navsari district, Gujarat. They found mangrove species and some salt marsh halophytes in the area. Mangroves have a large number of species (Bhatt Sweta., et al., 2009). Data from a remote sensing survey was mapped and plant types and land uses were classified in a study conducted in South Gujarat. With an accuracy of 87.78%, the sub-humid region of 31,495 km^2 was utilised to study and

identify different plant classes and land use classes. It draws attention to the important and endangered species in the area. Used this data for managing coastal area zones, ecotourism and biodiversity protection. (Bhatt, et al. 2013).

According to exploration assessing the variety of plants in Bihar, India's Gaya district, there are 174 kinds gauging 150 different rubric and 58 families presented. Poaceae, Fabaceae, Asteraceae, Rubiaceae were the biggest families. Important value index (IVI), uproariousness in species, Shannon Wiener indicator, distribution of dominance, the equivalency for tree, shrub, and herbaceous layers were among the diversity aspects that were measured in the studies. It was more discovered that the Nagobar point has the most diversity in the Gaya quarter (Chandra, et al,.2021)

Due to the wide resource exploitation of timbers, there is a growing need for sustainable operations. To cover biodiversity and capability of timbers to support mortal actuality, disquisition on leafage and timber dynamics is essential. With examination begging in the seventeenth century, India has rich heritage of traditional knowledge about its timbers. Four case studies show that whereas rudimentary area steadily rises due to carbon sequestration. According to the Kakchi plot disquisition, species that are vastly spread exhibit more changes in stem density and rudimentary area than endemic species. In term of how specific shops, species, and timber reply to climatic variability, these studies can act as early warning system. Putting public – position enterprise into action, analogues impact studies on climate change. (Singh, et al., 2021)

The study concentrated on the foliage structure and variety of the Sal (*Shorea robesta*) timber in Dalma wildlife sanctuary, West Singhbhum, Jharkhand, India. There are 153 species of shops linked with *Shorea robusta* having the loftiest IVI (40.87). Pielou's diversity indicator was topmost in source, Simpson's indicator was loftiest in trees, and Shannon –Weaver's diversity indicators was loftiest in herbaceous shops. According to the studies, the sanctuary's population is varied and diversified. (Lal, Harishankar, et al, 2019)

Angiosperm diversity has been estimated in the unique and fast evaporating Moyar riparian forestland in southern India. In the vertical gallery transects and swash, the exploration discovered 172 species, belonging to 126 rubrics. The Fabaceae, Rubiaceae and Phyllanthaceae were the dominating families. Along swash transect and along galleries, the Shanon diversity indicator was from 2.0 to 3.27 and 1.51 to 2.67, independently. High conservation significance is attended to the Moyar riparian zone. (Nagarajan, et al,.2023)

The Sahastradhara channel in Doon Valley's riparian foliage is examined in the exploration, with an emphasis on how it affects the aqueducts ecological and physical well-being. According to the studies, the Asteraceae family predominant in riparian foliage, with the Euphorbiaceae & Solanaceae following nearly after. An aggregate of 69 factory species from 41 families were detected in the riparian zone of Sahastradhara sluice Dehradun, including shrubs, and trees. Asteraceae was the most common family. (Sharma, et al, 2022)

In Gujarat state, 192 Indian aboriginal taxa were discovered; dicotyledons made up 72 of the species. Two- third were monocots. Four species – *Ischaemum sayajiroi*, *Spodipogon aristatus*, *Tephrosia jamnagarensis*, *Tamarix kutchensis* – are only set up in Gujarat, which is ranked 25th. But *Pycreus dwarkensis* is not set up in any wild areas presently. (Rana., et al, 2017)

In Kerala, Mangroves are important littoral washes, but wetlands and shallow conduits are reducing their size. The purpose of this exploration is to determine changes in the range and composition of species, along with the reasons for population decline and restoration strategies (Pillai, et al, 2015)

The present research endeavours to examine the condition of riparian vegetation in the hill-stream Khanda Gad and its influence on aquatic mites. There were 45 plant species founded, belonging 31 families, the most common being Rosaceae. In aquatic bodies, riparian vegetation regulates sediment load, energy flow, and nutritional balance. (Baluni, et al., 2022)

Research on flora is essential to comprehending the biodiversity and preservation of forests. There are 127 kinds of medicinal plants in the Western Ghats's foothills around the Pilavakkal dam, containing 55 herbs, 23 shrubs, 37 trees, and 12 climbers. The Lamiaceae, Malvaceae, and Fabaceae are the main families. The study helps with flora identification, conservation policy development and the long-term retention of plant resources by offering fundamental knowledge on herbal medicine and conservation status. (Gurusamy., et al., 2022)

An investigation was carried out between 2019 and 2021 in order to compile a list of the angiosperm flora founded in rural Bayad taluka, Arvalli district, Gujarat. Gathering and

cataloguing different kinds of plants in a mostly dry biogeographical area with tropical dry deciduous forest was the goal of the project. Herbarium was created and 471 plant species were identified, together with information on their habits, blooming and fruiting seasons, and location. (Patel., et al., 2021)

In the Nauradehi wildlife sanctuary in Madhya Pradesh, a dry deciduous forest in Central India, a research examined the species composition and varieties of trees. The study categorized regions of fire into five fire severity classifications and identified fire-affected regions using data satellite remote-sensing. There were 3128 trees identified in regions that were not burnt, *Terminalia tomentosa* predominated, while *Tectona grandis* predominated in area was that were destroyed and medium, and high fire zones. (Malasiya., et al., 2022)

The varieties of tree species, population structure, and species richness of the lowland tropical rainforest of Namdapha National Park in Arunachal Pradesh, northeast India, has been investigated. A combined total of 1053 trees, represented 130 species across 44 families, were discovered throughout in investigation. The species richness of tree varied between 98 to twenty varieties in ≥ 10 cm DBH. The woodland had characteristic common to tropical lowland evergreen rainforest. (Deb., et al., 2009)

In Tamilnadu, India's Dharmapuri forest division, the study looks at floristic diversity and plant composition. There were 352 species founded, and shrubs and plants had a greater diversity index than tree species. Larger tree species and fewer seedlings indicate an older forest with less regeneration. (Tiwari., et al., 2018)

64 Medicinal plant varieties from a total of 37 families and 59 taxa are revealed in this study, with emphasis on the wide range of medicinal herbs in the dry deciduous forest of Karnataka. *Garsenia gummifera* exhibits high species eveners, whereas the group Fabaceae has great species richness. There are classified for common, endemic, and endangered plants. (R., Ravi., et al., 2022)

India's forestland was pivotal to the nation's survival, most studies had concentrated on the central Madhya Pradesh Panchmadhi hills. These hills are home to several high-quality timber species. Field excursions were conducted for three days to assess the volume of forestland in the areas. The hills correspond of coarse sandstones and sedimentary jewels, with largely vegetated openings and steep defiles. The study also looked at invasive shops, timber declination and the conservation of the Panchmadhi hill flora. (Bir., et al., 2011)

The study evaluates the structural composition and floristic diversity of Tehsil-Mandvi, South Gujarat. The Lamiaceae, Rhamnaceae, and Asteraceae families accounted for the majority of the 77 plants species that were identified using stratified random sampling. The abundance of woody plant species and the diversity of the forest suggest favourable circumstances. Proper management is necessary because anthropogenic activities and pressure have an impact on species diversity. With the exception of shrub species, the Shannon index demonstrates considerable variety. (Chaudhary., et al., 2022)

The area, temperature, and ecology of Gujarat main megacity, Ahmedabad, along the banks of the Sabarmati river, support a wide variety of foliage. The study examines 1015 factory species from 580 rubrics in 135 families, emphasized the rich and varied foliage of the capital. (Jadeja., et al., 2011)

MATERIAL AND METHODOLOGY

1. Remote sensing software:

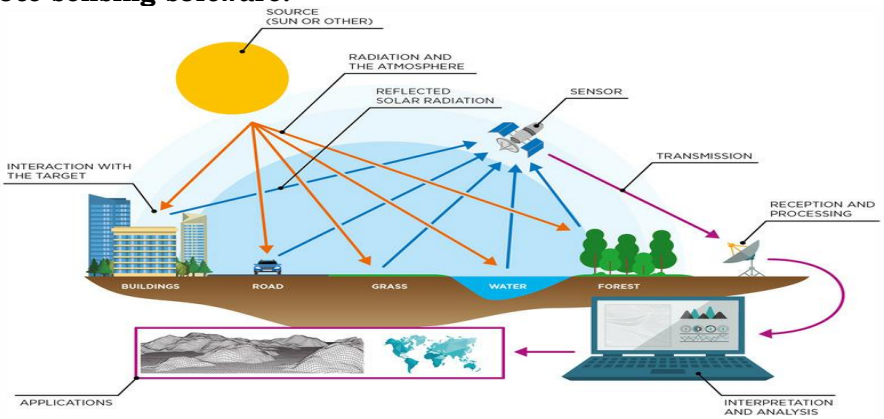


Fig. 2 : Remote sensing

A method that is used for gathering data about surface things without a physical touch is called Remote sensing. It receives data in the electromagnetic radiation (EMR) spectrum's ultraviolet to radio wave portions, enabling quick observation and data gathering across wide distances. The interaction between incident energy and targeted material at a medium surface provides the basis for remote sensing technology. Characteristic variation in the incident EMR or energy, including wavelength, polarization, phase, magnitude, direction and polarisation is caused by surface and volume processes. Through the monitoring and storage of these changes, remote sensing generates pictures that may be interpreted to identify the properties of the things under investigation. It is possible for radiation to reflect in two ways: Widely (in directions) or Specifically (in a mirror, for illustration). The speed of EMR varies as it is sent, and it can be passed on through objects. An object may generate various types of electromagnetic radiation (EMR): Scatter, which releases heat energy into the atmosphere or absorb radiation and discharge it into a medium. (Khargharia Rajneesh., 2021).

2. GIS - Geographic information system software

Geographic information system is a spatial system that manages, analyse and maps various types of data. It connects location data with descriptive data, providing a foundation for mapping and analysis. Geographic information system helps users to understand patterns, relationships and geographic context, improving communication, efficiency and decision making. Maps are the geographic container for data layers and analytics and they are easily shared and embedded in apps, making them accessible virtually to everyone. Geographic information system integrates various data layers using spatial location, allowing users to evaluate suitability, estimate, predict, interpret, and understand data, leading to new perspectives for insight and decision making. Geographic information system apps provide a polished user's experience, bringing geographic information system to life on mobile phone, web browsers and desktops.

There are some components of GIS :

- Maps
- Analysis
- Data
- Software
- Satellite
- Apps

Fig. 3 : GIS

3. Quadrant method

- Materials: Ropes, paper, pencils, steel taps, notepads.

Quadrant and transect samplings are some approaches for measuring biodiversity. Quadrates are square frames that range in size from 1 to 20 square metres and used to assess the percentage cover of individual species. They should be put at random place to eliminate around the region for more trustworthy results. Quadrate sampling is an appropriate method for determining the number of species in the environment. Transect samplings make use of a transect line, which might be a rope or a measuring tape that is marked at regular intervals. At each interval, the type and numbers of certain species are identified and recovered. Both strategies are necessary for accurately representing biodiversity and ensuring ecological health. The transect method is a linear sample methodology for studying vegetation along an

environmental gradient or ecotone, such as tropical to temperate zones, high or low rainfall areas or nearby areas with differing soil types.

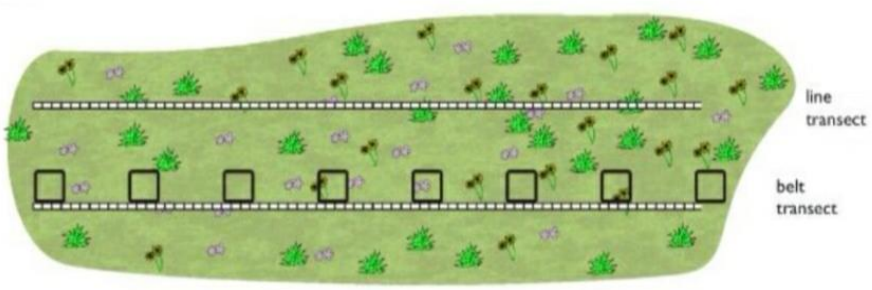
There are two types of transects: Line Transects (or line intercepts) and Belt transects. The numbers and size of transacts vary by area and they are also referred to as 'Bisects' when employed for vertical vegetation stratification. Line transect method includes sampling vegetation solely along a single line with no breath. A metric steel tape, chain or line rope is placed over the vegetation and the observed notes the plants from one end to other. Information acquired from this sort of transect includes the number of species and the trend of distance.

The line transect approach is used to investigate the progressive shift in species composition between two plant type in an intermediate area. The procedures call for a long thread or rope, a measuring tape and two survey's hooks or nails. The thread or rope is strung across the communities and secured with two hooks at either end. Individual plants that touch the thread are recorded, along with their distance from a certain end.

Belt transect are lengthy strips of vegetation of constant width that are specified by the kind of vegetation or strata being studied. The breath can vary from 10 cm in near herbaceous plants to 1-10 m in woods. If a transect is required, mark the lines with deep-seated wooden pegs at regular intervals. Tall wire net fences may be constructed all around the belt to keep isolated. Belts are often split into equal – sized pieces known as Quadrates, with each segment's length equalling the transect's width.

Belt transect aid in determining and comprehending the progressive shift in abundance, dominance, frequency, and distribution of many species in the transitional zone between distinct types of vegetation. Trisect is photographic method that involves shooting a specific plot of vegetation on regular basis to capture the dynamic characteristics of plant species. This is accomplished by fixing the recording device in a consistent direction and height while permanently anchoring three wooden support to a point in the foliage. This approach is useful for monitoring rangelands degradation or recovery, secondary succession in a depleted area, disease dissemination and newly imported weeds. A succession of image create a through and lasting record for comparison.

Fig. 4 : Line & belt transect method



RESULT AND DISCUSSION

The layout technique and findings of the study article on Vegetation Diversity in India vary with various investigators presenting district opinions. Understanding these variations can assist in discussing the study's results. The study article highlights the many forms of vegetation variety in India, with an emphasis on conservation and preservation. Different types of vegetation on their specific area that they recorded in their observation on that area. India has a variety of species that are grown in different areas, which is why they differ from one another. Climate is mostly changing their variation since they were originally founded and after sometime they have major changes that have been observed.

Most human activities decrease their natural vegetation for self-benefits that studies have found out in some articles in that different vegetation of different places, like mangroves, evergreen forests, wetlands, desert forests and some other types, that are found in India. The study finds that wetlands and Ghats are primarily evergreen forests with indigenous species, whereas Rajasthan has a desolated dessert and Barmer district for vegetation protection. Tamilnadu boasts dry deciduous woods, but the Assam Barak valley has tropical forests, the Mahanadi deltas, and the Bhitarkanika Mango species. Nicobar Baratang Islands are diverse

and Rampura has scrub forest and mixed thorny woods. Bediyabedi woodland in Saurashtra region features scrub woods and the Gulf of Khambhat has three Mango varieties. Godhra taluka consists primarily of dry deciduous woods with monocot grasses, while Waghai is primarily composed of dry deciduous forest. The Purna estuary in Navsari district has recorded Mangrove and Halophytes.

CONCLUSION

Vegetation variety is crucial in sustainability of ecosystem because it supports a wide variety of species in addition to preserving balance in the environment. India's expended topography maintains a variety of vegetation. Particularly dry deciduous, thorn forest, mountain forest, tropical evergreen and mangrove forest. Highest vegetation diversity type of India is evergreen forests. These forests, especially mangrove vegetation supports the livelihood of many villagers. Vegetation provides biological, economic and community benefits that include the preservation of biodiversity, protection of coastline, carbon capture and storage and employment. India's vegetation diversity has significant benefits for indigenous people that are dependent on forest for timber, oil, other forest products that are not timber based, healthcare, medicinal plants, nourishment etc. However, present day activities by humans and cultivation of their local varieties affect the ecological balance, which results in modifications of vegetation variation. To maintain the long-term survival of India's different vegetation variation, it is necessary to take required actions for these worries.

We should protect our various kinds of vegetations and forest. Flora, fauna and these forests are solemnly important for biodiversity loss. India is rich in its biodiversity, many people earn from its products, their livelihood depends on this. We should educate people to protect and preserve our diversity of vegetation and help them understand better about this serious matter. Loss of biodiversity impacts on environment and leads to climate change. We should take necessary actions regarding this situation.

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