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Riparian Angiospermic vegetation of Gujarat: A review

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Abstract

Rivers are considered the cornerstone of human civilization all throughout the world. Humans are inextricably linked to the riverine ecology, as seen by the presence of villages, cities, industrial facilities, and irrigated agriculture along the riverbank. The term "riparian ecosystem" refers to vegetation communities that have been created along the banks of rivers or streams, which are interfaces between terrestrial and aquatic ecosystems. Species-rich environments and higher biomass production rates are characteristics of riparian vegetation zones, which are distinguished from other nearby forest communities. Farming in riparian zones is a common practice along riverbanks that disrupts the natural processes of wetlands and has an impact on riparian ecology and ecosystem services. The biodiversity of most Indian rivers is extraordinarily abundant. Approximately half of the aquatic flowering plants in the world are found in India. The Rivers of Gujarat serve as the main supply of fresh water, and they flow most heavily during the monsoon season. There, The Narmada, Tapi, Mahi and Purna are significant perennial rivers *Poaceae* and *Fabaceae* are the dominant family in the Gujarat River and other families like *Typhaceae* and *Verbenaceae* are less found. *Ipomoea, Cyperus, Euphorbia, Cassia, Ficus, Zizyphus, Crotolaria, Corchorus, Alysicarpus* are found in Riverbank of Gujarat.

Keywords: Riparian Vegetation; Angiosperm; Biodiversity; Ecosystem

1. Introduction

Around the world, rivers are regarded as the foundation of human civilization. The existence of towns, cities, industrial sites, and irrigated agriculture along the riverbank demonstrates how inseparable human species are from the riverine ecosystem. Naturally, humans have a significant detrimental impact on the composition and functionality of riparian ecosystems (NRC, 2002; Sunil *et al*., 2010). The term "riparian ecosystem" refers to vegetation communities that have been created along the banks of rivers or streams, which are interfaces between terrestrial and aquatic ecosystems (Gregory *et al*., 1991; Sakthivel *et al*., 2019). Streamside and gallery forests are other names for riparian ecosystems (Brinson, 1990; Sakthivel *et al*., 2019). Species-rich environments and higher biomass production rates are characteristics of riparian vegetation zones, which are distinguished from other nearby forest communities (Brinson, 1990; Decamps & Tabacchi, 1994; Sakthivel *et al*., 2019). Numerous plants species dwell in a mosaic of microhabitats created by floods, which contributes to their great species richness (Swanson *et al*., 1982; Gregory *et al*., 1991; Sakthivel *et al*., 2019). Farming in Riparian Zones is a common practice along riverbanks that disrupts the natural processes of wetlands and has an impact on riparian ecology and ecosystem services (Gopal *et al*., 2002; Nagaraja *et al*., 2016). There is significant spatial variation in the reported values of native species richness, composition, and productivity due to disturbances brought on by intensive use of the riparian zone for agricultural purposes (Aguiar & Ferreira 2005; An *et al*., 2002; Corbacho *et al*., 2003; Gopal *et al*., 2002; Smakhtin & Anputhas, 2006; Nagaraja *et al*., 2016).

The Indian subcontinent is traversed by numerous seasonal and permanent rivers that span the whole country. Most Indian rivers are incredibly rich in biodiversity (AM *et al*., 2024). India is home to around half of the world's aquatic

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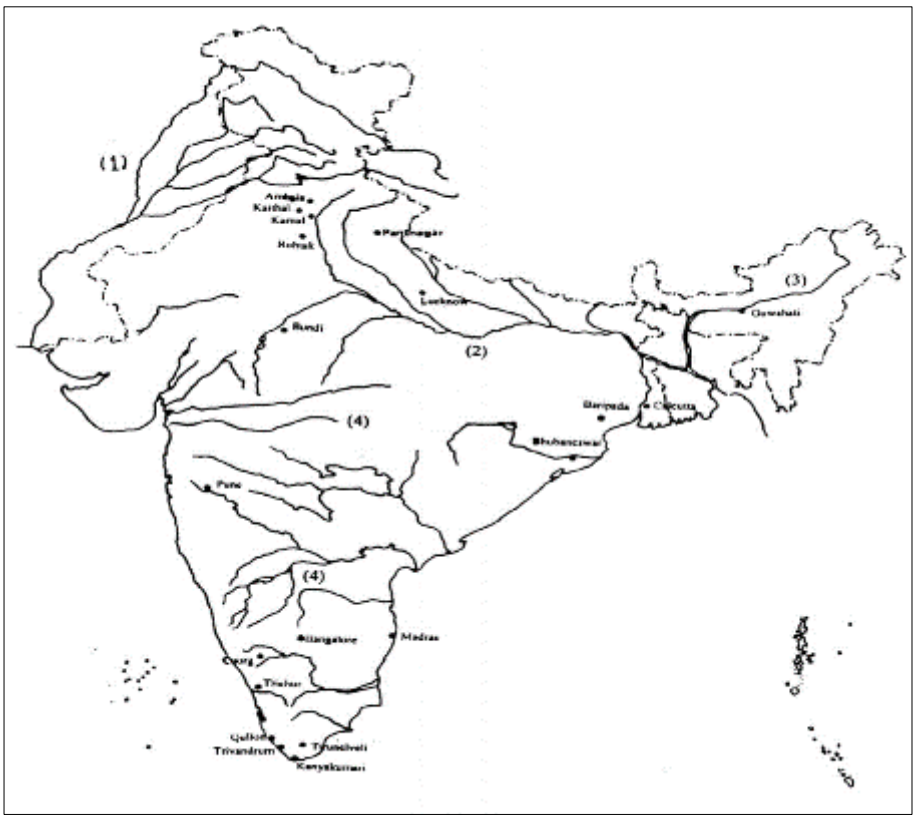
flowering plants (Nagendran and Arkel, 1981; Mukherjee & Kumar, 2020). The largest, most successful, and most diversified main group that makes up the dominant vegetation are the angiosperms, or blooming plants. Because of the complexity of the riparian ecology and a lack of understanding, research on riparian vegetation is still in its infancy in India. A "River Regulation Zone" is being considered by the Indian government in order to preserve riparian habitat and keep riverbeds clear of extensive development and encroachment (Cullet *et al*., 2012; Gopal *et al*., 2002; Nagaraja *et al*., 2016). The study of plant communities, including their composition, evolution, and relationships among its constituent species, is known as phytosociology (Pott & R, 2011). It is helpful to gather information about the population dynamics of each species under investigation and their relationships with other species in the same community. In addition to understanding previous changes and predicting future ones, phytosociological research is crucial for preserving biodiversity and natural plant ecosystems. The primary goals of phytosociological study are to evaluate species richness and diversity and to comprehend floristic vegetation characteristics (Rao *et al*., 2015).

2. Rivers of India

The Indian subcontinent's geological setting and monsoonal climates produce several large rivers with distinctive sediment transport and hydrological characteristics. After flowing through vast alluvial plains, many rivers end up in open oceans, having their source in active mountain belts (Sinha *et al*., 2012). There are 25 river basins in India, including major and minor river basins. The Indian subcontinent's rivers are divided into six main categories:(1) large Himalayan rivers that were antecedents; (2) river fed by the foothills of the Himalayas; (3) cratonic rivers that flow north; (4) peninsular rivers that flow west; (5) peninsular rivers that flow east; and (6) coastal rivers that run along the Western Ghats Escarpment (Jain *et al*., 2020). Rich biodiversity is supported by rivers, which are an essential component of freshwater ecosystems. They are crucial to preserving the hydrological cycle. The vegetation that provides a range of ecosystem services, such as nutrient and pollutant filtration, erosion control, flood mitigation, water purification, and food and habitat for aquatic and terrestrial animals, is crucial to the riparian riverine ecosystems (Kalmkar *et al*., 2023). By supplying food, riverbank vegetation supports river biotic interaction (Cummins *et al*., 1984; Dey & Panigrahi, 2021). Water availability is the primary determinant of plant species diversity (Rundel & Sturmer, 1998; Dey & panigrahi, 2021). About half of the world's aquatic flowering plants are found in the Indian subcontinent. India is home to 326 species of wild crop relatives and has contributed 167 species to global agriculture, making it a significant hub of agrobiodiversity (Raju *et al.,* 2010).



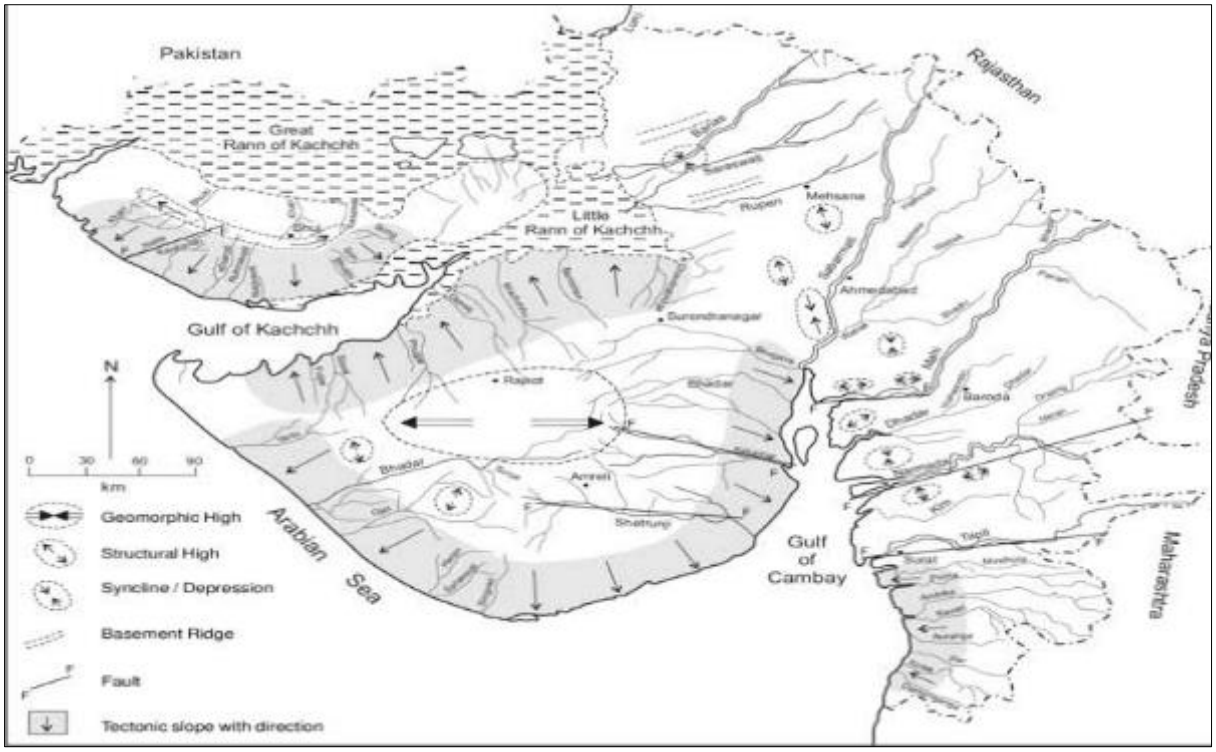
(Image source:SAC, https://www.researchgate.net/profile/Prof-Madan)

Figure 1 Map of India showing distribution of Rivers

3. Rivers of Gujarat

Gujarat is located in India's far west. Its sub-humid, dry, and semi-arid tropical climates are distributed throughout the state. As stated by GES, In Gujarat state, there were 2106 angiosperm plant species in 2000, representing 13% of all angiosperm species in India and belonging to 161 families (Patel *et al*., 2020).

India's westernmost state is Gujarat. Its Arabian Sea coastline is the longest in India, measuring about 2,340.62 kilometres, according to the new data of Survey of India.The dry Kutch area and the Western peninsula (Saurashtra) are divided by the Gulf of Cambay. From the northern district of Banaskantha to the southern end of the state, the hill ranges of Saputara in the east, Sahyadri in the southeast, and Aravalli in the northeast from the state's eastern border. Gujarat state is distinguished topographically by a peninsula and a sizeable central alluvial plain, which are divided by the Gulf of Cambay. The largest district, Kutch, is located north of the peninsula, and the vast Kutch ran forms its northern edge. The Tapi, Narmada, and Mahi are the three most notable rivers that flow continuously westward across the plain. Rainfall is guaranteed throughout the plain, with the exception of the northernmost portion. The 19.60 million hectares of the state make up roughly 6.0% of India's total land area (Pandey *et al*., 2009). Gujarat is one of the Indian states where heat waves have a significant influence. Gujarat's daytime temperature is generally consistent over the plains, with the exception of the winter months, when they tend to rise southward. In the Gujarat region, may has the highest mean temperature of 40.1 degree Celsius, making it the hottest month. The summer temperatures in Gujarat are warmer than those in the Saurashtra and Kutch sub-division. In Gujarat state, the maximum temperature increases from January to May by 5 to 14 degrees Celsius at different places as one travel from south to north (Ray *et al*., 2013).



(Image source:SAC, https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcTYycvLEySogMl0cBpYlCrwoMIFnNEhSYlSHA&usqp=CAU)

Figure 2 Map of Gujarat showing distribution of River

4. Riparian Vegetation of Gujarat

The State's River serves as the main supply of fresh water, and they flow most heavily during the monsoon season. There, The Narmada, Tapi, Mahi and Purna are significant perennial rivers. There are roughly 17 major rivers in Gujarat mainland, 71 in the Saurashtra region, and 97 in the Kutch region (Sankhwal *et al*., 2015).

The west-flowing Mahi River rises in Minda village in the state of Madhya Pradesh and flows into Gujarat after passing through a tiny area of Rajasthan. According to Sankhwal *et al*., (2015) 328 flowering plants species from 230 genera and 73 families were identified. Among these the 51 species from 34 genera and 8 families comprised the monocotyledons, whereas 275 species from 195 genera and 65 families represented the dicotyledons. With 37 species and 27 genera, the

Poaceae family was the most prevalent. With 11 species, *Ipomoea* was determined to be the most prevalent of the plant genera, followed by *Cyperus* and *Euphorbia* each have 6 species. The genera *Cassia* and *Ficus* each have five species. And the *Zizyphus, Crotolaria, Corchorus*, and *Alysicarpus* have 4 species.

In Gujarat state, the Sabarmati travels through hilly regions in the north, plain surface areas, and occasionally results in river vally (Kotar). According to Maitreya, (2006) an analysis of the local plant species, there are roughly 542 species of Angiosperm flora, comprising native and naturalized plants, spread throughout 384 genera and 114 families. Of these 542 species, 459 are classified as Dicotyledons and 83 as Monocotyledons. Out of the 384 genera, 66 belong to the Monocotyledons and 318 to the Dicotyledons. 93 of the 114 families are Dicotyledons, and 21 are Monocotyledons. The *Fabacese,* which have 43 sp., are the main family of the Dicotyledon. There are 25 sp. in the *Asteraceae*, 25 sp. in the *Euphorbiaceae,* 19 sp. in the *Convolvulaceae,* and 15 sp. in the *Cucurbitaceae*. With 34 and 11 species, respectively, *Poaceae* and *Cyperaceae* are the two largest families among Monocotyledons.

In the Sabarmati and Mahi River estuaries and adjacent riparian areas, Patel *et al*., (2020) investigated the diversity of angiospermic plants. There were 26 different families of flowering plants in their research area, with herbaceous plants predominating. The 40 species that were identified included 2 tree species, 8 Shrub species, 28 herb species, and 2 grass species.

Shah *et al.,* (2015) also examined the riparian vegetation of the Mini River of Vadodara and found that the herbaceous layer predominated and that there was no variability in the tree species because of the high levels of anthropogenic activity. Throughout the riverine system, exotic and invasive plants including *prosopis sp.* and *Lantana sp*.

In Gujarat, the Banas River is a significant source of water and wildlife. The Banas River rises in the Aravali range's Khamnor hills and travels all the way through Rajasthan to Gujarat's Banaskantha district. According to Jha *et al.,* (2023) There have been 520 angiosperm species identified, among them 340 genera and 101 families. *Poaceae* is the largest family among the 101 families in terms of genera, whereas *Fabaceae* is the second largest family in terms of species. However, in terms of species, the *Asteraceae, Acanthaceae, Euphorbiaceae, Convolvulaceae, Mimosaceae, Malvaceae, Cyperaceae* and *Cucurbitaceae, Caesalpinaceae* are in 10th place and represent a comparable number of species.

The main tributary of the Banas, Sipu rises from the Sirohi and Mount Abu ranges in Rajasthan state's Sirohi region. The Abu Hills are situated between the Sipu and Banas sub-basins. About 70% of Mount Abu Hills direct runoff flows into Banas, while about 30% of empties into the Sipu River. According to Panjani *et al*., (2018) There were 22 species found in 18 genera and 12 Angiosperm families. Of all the aquatic and wetland plant species that have been identified, 41% are annuals or perennials, 36% are perennials, and 23% are annuals. *Cyperaceae* family comprises 8 species, followed by the *Potamogetonaceae, Hydrocharitaceae*, and *Scrophulariaceae* families, each had two species. *Apocynaceae, Asteraceae, Lythraceae, Onagraceae, Najadaceae*, and *Polygonaceae* are among the 8 families. There was only one species representing *Typhaceae* and *Verbenceae.* The *Cyperaceae* family emerged as the dominant family, followed by the *Potamogetonaceae, Hydrocharitaceae*, and *Scrophulariaceae.*

The Ozat River originates close to Visavadar in Gujarat, Western India. The investigation was carried out in the Junagadh distric of Gujarat, India, at specific locations along the Ozat River by Chudasama *et al.,* (2022). *Parthenium hysterophorus* (100%) and *Panicum repens* (100%) have the highest frequency among these 37 plant species, followed by *Eustachys paspaoides* (100%). The species with the lowest frequency were *Syzygium cumini* (10%), *Musa paradisiacal* (10%), *Ficus benghalensis* (0.1%), and *Tecona grandis* (10%). The densest density is found in *husterophorus parthenium* (61.74). The plants *Syzygium cumini* (0.1) have the lowest densities. *Chionachn egigantea* had the highest abundance (78.2). The plants *Tecona grandis* (1), *Ficus benghalensis* (1), *Musa paradisiacal* (1), and *Syzygium cumini* (1) had the lowest abundance. *Eustachys paspaoides* had the highest relative frequency (74.99%). *Syzygium cumini* plants had the lowest relative frequency, at 4.76%.

The Purna River coastal wetland, which is situated in the Gulf of Khambhat in the southern part of Gujarat, India, On the west coast, is the site of the current study. The Purna is a perennial river that flows through South Gujarat's Navasari district. According to Kumari & Pathak, (2025) The major bioaccumulation was observed in *Avicenna marina*, followed closely by with *Bruguiera cylindrical, Acanthus illcifolius,* and *Sonneratia apetala*.

Patel and Patel, (2016) documented a total of 25 plant species from the research region surrounding the Meshvo River in the Dehgam Taluka of Gandhinagar District, Gujarat, which are divided into 7 genera of the *Convolvulaceae* family.7 species were identified as cultivated, while the majority of the species in the study region were wild.

The ecological status of the Sip River's riparian zone, a tributary of the Narmada River in the Central Region, was investigated by Lakhera *et al*., (2020). Their research indicates that riparian vegetation may be more disrupted by changes in land use patterns. During their examination, the most prevalent activity in the riparian are was agriculture. The loss of riparian cover in the study area was exacerbated by the wide variety of crops that were cultivated along the banks of the Sip River. The degradation of the Sip River's riparian area is caused by human activities like development, the conversion of forest land for agriculture, and deforestation in the area.

5. Role of River in Angiospermic Vegetation of Gujarat

Throughout the world, rivers are strategically significant waterways that supply essential water resources for household, commercial, and agricultural uses (Isiri *et al*., 2023). The river and the riparian ecosystems that surround it offer a wealth of plant and animal species a home, as well as crucial ecosystem functions including flood control, irrigation, and water supply (Panwar *et al*., 2016; Jha *et al.,* 2023). The riparian vegetation in the forest zone is essential because it is rich in species. In addition to providing a corridor for wildlife movement, the preservation of the riparian vegetation helps the local population, including fishermen and tribal members, make a living. Both the biological conservation of species and the preservation of river water quality depend heavily on the minimum width of riparian vegetation in the agroecosystem zone. A key component of freshwater ecosystems, rivers sustain a wealth of biodiversity and are essential to the hydrological cycle (Kalamkar *et al*., 2023). River networks are increasingly being impacted by a number of anthropogenic stressors, including population growth, urbanization, aridification, aquifer withdrawal, and a lack of distinction between desert and urban areas. Nevertheless, river and their lowland floodplains are frequently home to abundant riparian biodiversity and significant carbon reservoirs (Ielpi *et al*., 2022).

6. Threats to Riparian vegetation

Climate is known to be influenced by variations in plant species and community structure, as well as latitude and altitude. A number of factors, including as climate change, rapid population increase, and anthropological practices like urbanization, industrialization, overgrazing, and deforestation, cause it to visible risks and potentially irreversible loss. Ecological instability, changes in soil structure from physical weathering, and rock depletion brought on by deforestation along with vegetation eventually led to floods and upset the structure of all-natural flora. This hazard is more common in areas with high population densities, which raises resource demand and ultimately manifests as overexploitation of the natural resources that are accessible, such as overgrazing, deforestation, and overexploitation (Ali *et al*., 2022).

7. Conclusion

The lowland area of Earth is home to river, which are also home to a variety of natural ecosystems, dense populations of people, and huge organic matter reservoir. River play a vital role in supporting angiospermic plant diversity. Angiosperms are the dominant species. *Poaceae* and *Fabaceae* are the dominant family in the Gujarat and other families like *Typhaceae* and *Verbenaceae* are less found. *Asteraceae, Euphorbiaceae, Caesalpiniaceae, Convolvulaceae, Cucurbitaceae*, Families also found in Rivers of Gujarat. *Ipomoea, Cyperus, Euphorbia, Cassia, Ficus, Zizyphus, Crotolaria, Corchorus, Alysicarpus* are found in Riverbank of Gujarat. Riparian vegetation provides essential ecosystem services, including water filtration, soil stabilization, and habitat provision for aquatic and terrestrial species. Human activities, such as deforestation, agriculture, and urbanization, have significantly impacted riparian vegetation in Gujarat. Establishing protected areas, such as national parks and wildlife sanctuaries, is crucial for conserving riparian vegetation in Gujarat. Promoting sustainable land-use practices, such as agroforestry and permaculture, can help reduce habitat destruction and fragmentation. Raising awareness and involving local communities in conservation efforts is essential for protecting riparian vegetation in Gujarat.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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