GMC And The Challenges of Geography

ABSTRACT
Gelephu sits on widest flat land of the country yet Bhutan's mountain terrain mean the uneven geography is the challenge for any infrastructure development that are necessary for a thriving commercial hub. Bhutan's commitments to ecology conservation is internationally recognised. On top of that Gelephu Mindfulness City (GMC) requires enormous investments to build infrastructure in the terrain, for which the country lack adequate capital. Attempts for foreign investments in the past did not yield desired outcome. Under such circumstances, GMC leadership's task requires fine tuned marketing skills to win the trust of investors that GMC guarantees return on investments.

Keywords: Climate, weather, flora and fauna, vegetation, conservation

Location

Gelephu is located at the foothills of the eastern Himalayas, at an altitude of approximately 300 metres in average (about 984 feet) above sea level. The town is located at 26:50 degree north latitude and 90:30 degree east longitude. This low elevation compared to much of Bhutan, filled with high mountains and rugged terrain, places Gelephu in a unique ecological zone that supports a diverse range of flora and fauna. The town lies near the border with India, making it an important gateway for trade and cultural exchange. The city also lies along the banks of the Mau river, fed generally by mountain floods, which becomes uncontrollable during monsoon seasons.

Elephants also inhabit the surrounding areas and still cause problems for the city, occasionally. Close proximity to two big conservation areas (Manas National Park and Phibsoo Wildlife Sanctuary) provides both opportunities and challenges for the proposed mega city. The region has tropical hot summer influenced by the weather of the Indian plains but has cooler, frosty and dry winter. Despite being small area, climatic condition at the border and northern part of the Sarpang district vary substantially.

Southern border has narrow flat land whereas northern part of the district has high mountains and deep valleys.

Flora and Fauna

Gelephu has rich and diverse vegetation that reflects the region's varied topography. As of 2020, 61 per cent of the land cover in Gelephu region is natural forest, though the total area of land cover decreased by 12 per cent since 2016. The area's unique position at the confluence of the Himalayan foothills and the Indian plains allows for a wide range of plant species to thrive. The major vegetation types found in Gelephu are mixed hard wood forests, paddy fields, wetlands and marsh land vegetation.

The vegetation primarily consists of subtropical broadleaf forests, which are dense and verdant, providing a lush green canopy. These forests are home to numerous tree species, including sal (*Shorea robusta*) and Himalayan cypress (*Cupressus Torulosa*), two dominant species that are of significant ecological and economic importance. Sal forests provide habitat for various wildlife species and are also a source of timber and non-timber forest products for local communities.

Other species in the area include teak (*Tectona grandis*), bamboo, and various types of fig trees, such as the banyan and peepal. These trees offer fruits and leaves that serve as food sources for both wildlife and humans, fostering a symbiotic relationship between the flora and fauna of Gelephu.

The undergrowth in these forests is equally diverse, comprising shrubs, herbs, and grasses that contribute to the ecosystem's complexity. Many medicinal plants are found in this undergrowth, which are traditionally used by local communities for their healing properties. The rich plant diversity supports a wide array of animal life, including birds, mammals, reptiles, and insects, making Gelephu a haven for biodiversity.

Land Uses

Forestland Vegetation

Forests are the prime natural resource of the country, supporting a variety of flora and fauna. Forest vegetation protects the hill slopes from erosion, landslides and plays a major role in regulating the climatic condition of the region. Forests are the dominant land cover of the country occupying about 70 per cent of the total area of Bhutan.

Gelephu is surrounded by lush forests that are an integral part of its geography. The forests in this region are primarily composed of subtropical species, including broadleaf deciduous trees and various coniferous species.

The high rainfall in this area fosters the growth of hardwood trees and supports the cultivation of cash crops such as areca nut. Notably, the dense teak vegetation found along the Gelephu-Sarpang corridor, the Gelephu-Trongsa Highway, and near Setikhare river

exemplifies the lower terrace forest vegetation prevalent in this region. Within the Gelephu area, the forest cover plays a pivotal role in protecting the steep slopes of the mountains that border the town. This protective forest cover is instrumental in mitigating siltation in the southern plains.

Both natural and human-made forests exist. The natural forests are crucial for maintaining ecological balance, providing habitats for wildlife, and supporting the local climate. In contrast, human-made forests, often established for timber production and conservation purposes, contribute to the local economy while also serving to protect against soil erosion and promote biodiversity. The Royal Government of Bhutan (RGOB) has afforestation programmes aimed at increasing forest cover and enhancing the ecological landscape of the region.

Paddy fields

Gelephu and its surrounding region have large paddy fields, which represent a form of irrigated agricultural land. These fields not only contribute to the area's agricultural productivity but also play a role in environmental conservation. By serving as a buffer against soil erosion, they aid in the protection and management of lower river terraces, which are vital for maintaining groundwater resources. A notable concentration of these paddy field wetlands is found along and across the Mau river. During the summer months, the eastern villages across the city are primarily distinguished by their extensive paddy fields, while in winter, these fields are often cultivated with wheat or maize.

Marshland Vegetation

Marshlands, a type of wetland ecosystem, serve as natural water management systems. They support diverse plant and bird species,

and perform essential ecological functions such as groundwater and surface water maintenance, sediment trapping, erosion control, and pollution mitigation. In the Sarpang district, riverbed wetlands encompass an expansive area of 59 square kilometres, making them as the most extensive wetlands in Bhutan. In Gelephu, marshlands are predominantly located along river courses, particularly at confluences where tributaries join the Mau river. Additional marshlands are situated along the Mau River, to the east of the town, extending beyond the municipal boundaries. Some marshlands near the Indo-Bhutan border have been transformed into paddy fields, indicating a shift in land use. These marshlands serve as habitats for winter migratory birds in the region, highlighting their ecological significance.

Fauna and Avifauna Reserves

The diversity of flora and fauna in the Gelephu region can be primarily attributed to its varied climatic conditions and topographical features. According to a survey conducted by the RGOB in 2024, this region is home to an extensive array of flowering plants, comprising over 129 families, 428 genera, and approximately 637 species of Phanerogams. Among these, dicots account for 109 families, encompassing 384 genera and 528 species, while monocots are represented by 20 families, including 80 genera and 109 species. This rich botanical diversity encompasses 180 tree species, 155 shrub species, 72 climber species, and 130 herbaceous plant species. The floral composition of Sarpang district exhibits notable similarities with the plant life found in the Assam plains and North Bengal regions of India. Dominant plant communities in the area include species from the genera Acacia, Dalbergia, Zizyphus, Terminalia, Shorea, Lagerstroemia, and Tectona, among others.

The fauna of Sarpang is equally diverse, featuring a wide range of large herbivores such as Asiatic elephants, Gaur, Sambar deer, Chital, buffalo, barking deer, and wild boar. The carnivorous species include leopards, wild dogs, and various other mammals characteristic of the Indo-Malayan and Himalayan regions. There are over 150 bird species documented. The region hosts 14 species of reptiles, further contributing to its ecological richness[20]. Animals like elephants, peacocks, wild boar and monkeys are common fauna present in the region.

The history of Gelephu provides references to the existence of these animals in the region. The process of urbanisation and conversion of forest lands to agricultural purposes and intense human interference, has resulted in the extradition of these animals from the town and its immediate vicinity. There also exist a few bird habitats in the region.

The Mau river and its tributaries like the Setikhare, the Dhaula, Aipole comprise of the hydrological structure of Gelephu. The Mau river has its watershed higher in the mountains to the north. The Gole river, the Gong river, and the Khar river are some of the major tributaries of these rivers in its initial course apart from the small mountain tributaries and rivulets. These major streams are fed by their own network of numerous minor streams and rivulets through the gullies running down the hill slopes. These streams originate from natural springs, lakes and surface runoffs at higher altitudes.

Land Formation

The land formation in and around Gelephu is predominantly flat, with gentle rolling hills and valleys to the north. This geographical feature allows for a mix of both highland and lowland ecosystems, creating

[20] https://biodiversity.bt/group/Sarpang_Forest_Division

a rich biodiversity in the area. The region's soil is fertile, supporting various agricultural practices that contribute to the local economy.

Damaging flood in the flat region is common in Himalayan basin. Gelephu, a part of this basin, is no exception. The town has already shifted its location twice as a result of flooding of the Mau river. Soil erosion in the higher hill slopes and the resultant siltation in the region is one of the main causes for flooding of rivers. Because of the constant susceptibility to flooding, suitable measures must be taken towards flood protection for Gelephu and the surrounding areas.

Conservation efforts

Despite rich forest resources, Gelephu faces significant deforestation challenges. The pressures of agricultural expansion, urbanisation, and illegal logging have led to a decline in forest cover. Conservation efforts are critical in addressing these issues. The government, along with non-governmental organisations, has implemented policies aimed at sustainable forest management and reforestation. Awareness campaigns educate local communities about the importance of forests for biodiversity and climate regulation, and initiatives are in place to engage locals in conservation practices.

As discussed above, Gelephu is home to various species of birds, mammals, and reptiles, some of which are endemic to Bhutan. Notable wildlife includes the Bengal tiger, Indian elephant, and several species of deer. Conservation efforts are focused on protecting these species and their habitats. Initiatives such as the establishment of wildlife sanctuaries and protected areas aim to safeguard biodiversity.

Climate and Weather

Gelephu's subtropical climate is heavily influenced by its geographical conditions, including warm temperatures, high humidity, and high rainfall. As a result, Gelephu has distinct wet and dry seasons. The monsoon season, which typically spans from June to September, brings heavy rainfall to the region. This period is crucial for agriculture, as the abundant rainfall supports the cultivation of rice and similar other crops that are essential to the local economy. The average annual rainfall in Gelephu is substantial, often exceeding 5000 millimetres, which contributes to the lush vegetation and fertile soils in the area.

Temperature variations in Gelephu are relatively moderate compared to other parts of Bhutan, due to its lower elevation and proximity to the Indian plains. The average annual temperature ranges between 15°C and 30°C, with the warmest months being May to September. During this period, temperatures can rise to around 35°C, accompanied by high humidity levels. Conversely, cooler months from November to February see temperatures drop to around 15°C. This period is generally considered the most pleasant time of the year, attracting visitors who seek to explore the region's natural beauty and cultural heritage.

The weather in Gelephu is not only defined by its temperature and rainfall patterns but also by the occasional occurrence of extreme weather events. Floods, landslides, and heavy storms are common, especially during the monsoon season, and can pose significant challenges to local communities. Unlike in the other regions, rainfall is heavy that causes streams and rivers to swell bringing destruction to land, infrastructures and other facilities. Transport and communication services are often disrupted and crops battered to ground. These events highlight the vulnerability of the region to

climate change impacts, underscoring the need for adaptive measures to enhance resilience.

The effects of climate change are becoming increasingly apparent in Gelephu. Changes in rainfall patterns, rising temperatures, and more frequent extreme weather events have been observed, affecting agricultural productivity, water availability, and the overall ecosystem. Recognising these challenges, the RGOB has implemented climate change adaptation and mitigation strategies. Efforts include promoting sustainable agricultural practices, enhancing water resource management, and investing in infrastructure that can withstand the impacts of changing weather patterns.

Table 1: Maximum temperature in Celsius

	2000	2005	2010	2015	2020
Feb	21.5	23	23	24.4	23.4
May	28.4	29	27	28.0	28.2
Aug	30.3	31	29	29.0	31.2
Nov	23.4	27	25	24.8	27.4
Annual Avg	26.2		26	26.9	27.3

Table 2: Minimum Temperature in Celsius

	2000	2005	2010	2015	2020
Feb	16.7	14	14	16.4	13.9
May	24.2	21	21	24.1	22.3
Aug	25.6	24	23	25.4	24.8
Nov	13.3	18	19	26.9	18.7
Annual Avg	20.3		19	20.7	20.2

Table 3: Rainfall (MM)

	2000	2005	2010	2015	2020
Feb	25.4	33.7	7	00	11.5
May	568.4	901.9	321	318.5	467.2
Aug	999.1	543.0	531	00	1904.1
Nov	24.5	9.1	12	00	3.0
Annual	4806.9	6081.6	2911	1891.7	5024.8

Source: NSB, collated from multiple years reports

Conclusion

Bhutan's journey reflects a profound commitment to environmental stewardship. The mission for a mega city must not erode this stewardship. The ecological balance is important to any urban development and economic prosperity. The GMC mission is a prosperity vision. It should not come at the expense of Gelephu's biodiversity and ecological serenity. The metropolis vision must walk the balance between conservation efforts and developmental goals.

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