RESEARCH ARTICLE

Impact of Land Use Changes on Ecosystem Services and Habitat Integrity: A Case Study of Majuli River Island, India

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Abstract

The assessment of ecosystem services is a popular subject in India and internationally, yet a consistent system of evaluation indicators and methods is still lacking. Utilizing a framework of evaluation criteria for ecosystem services, extensive data collected over the years from forest resource inventories and public sources were used to perform a comprehensive and dynamic assessment of the quantity and value of ecosystem services on Majuli Island. The ecosystem services of any environment vary depending on local people's awareness. Majuli is the world's biggest inhabited river island by area and the world's ninth most populous river island. Furthermore, Majuli is vulnerable to climate change and global warming, which are diminishing the ecosystem services of India's biggest populated river island. A broad study of the ecosystem services of a landscape is beneficial for framing policies and formal laws to ensure sustainable development for sustainable development of degrading ecosystems shortly and to secure the socioeconomic status of local people. There is an increase of 3061 km^2 in human settlement from 2002 to 2012. Again, from 2012 to 2022 human settlements have increased to 3136.28 km^2. Similarly, the area of agricultural land has increased by 15,917 km^2 in 20 years, from 2002 to 2022. To compromise this increase in agricultural and human settlement areas, natural habitat has decreased by 22,683 km^2 from 2002 to 2022. The most significant increase was observed in the ecosystem service value related to food production (agriculture). However, throughout the study periods, the values of the other 16 categories of ecosystem services declined to various extents. The results of this research are crucial for decision-makers and land-use planners who require site-specific information on how land use and land cover (LULC) impact ecosystem services. This study indicates that the total and specific ecosystem service values have decreased during the periods examined, largely due to a considerable rise in agricultural and built-up areas, primarily at the detriment of natural habitats. Therefore, it is vital to reverse the trend of diminishing natural habitats to maintain and protect the ecosystem service values of Majuli Island.

Keywords: Ecosystem services, Natural capital, Human intervention, Ecosystem management, Majuli Island, Cultural landscape, Climate change, Tourism.

Highlights

- Majuli Island is the world's largest river island, supporting the human population through various ecosystem services.
- Majuli Island experiences diminishing effects of climate change through frequent floods and continuous erosion of riverbanks.
- The frequent floods in the Bharamputra River disrupt the ecosystem services provided by Majuli Island.
- This study provides prospects for the conservation and restoration of ecosystem services provided by Majuli Island to the local population.
- The present study is a benchmark for reforming future policies.

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Introduction

The most frequently used terms are land cover and land use. Land cover pertains to what is present on the surface of the earth, such as vegetation, water, and bare soil, while land use relates to the intended purpose of the land, like recreation, agriculture, and wildlife habitat (Fisher *et al.*, 2005). While land cover is concerned with the physical and biological characteristics of the land, land use focuses on how humans utilize the land (Fuladlu, 2022). According to Goldewijk and Ramankutty (2004), significant changes have occurred in the land use and land cover (LULC) of the planet's surface. By altering the structure and pattern of LULC, human activity can modify natural ecosystems and ecological habitats (Li *et al.*, 2018), leading to changes in ecosystem services (Sun *et al.*, 2021). Humans benefit economically from changing land use types, while ecosystem services are drastically altered or unbalanced. Examples of these changes include disaster prevention, water resources, air quality, and other detrimental effects on human health. Due to changes in ecosystem patterns and processes, LULC has significantly changed in recent decades, which has

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remarkably affected ecosystem services (Gashaw *et al*., 2018). Over time and space, the effects of LULC change on ecosystem services vary, lowering their total monetary worth. Numerous studies have been conducted globally to evaluate the shift in ecosystem service valuing (ESV) brought about by LULC changes at the local level. Unprecedented LULC changes brought on by human activity, therefore, result in the deterioration of ecosystem services, exposing their capacity to deliver services that could impact the welfare of future generations as well as other services (Alcamo *et al*., 2005). As a result, one of the major causes of the loss of ecosystem services has been identified as LULC modification (Tekalign *et al*., 2018). In addition, the increase of agriculture, urbanization, deforestation, drought, and inadequate land-use planning all contribute to LULC shifts by causing significant losses in ecosystem services (Gashaw *et al*., 2018; Shiferaw *et al*., 2019).

The ecosystem benefits human beings both directly and indirectly. These benefits are scientifically termed Ecosystem Services (ES) and addressed in four categories: provisioning, regulating, cultural, and supporting services (Malignedm Ecosystem Assessment Report, 2005; Tian, N *et al*., 2015). Human beings reap a wide range of benefits from ecosystems that are integrally aligned to human existence and wellbeing (Comodesnza *et al*., 1997; MEA, 2005; TEEB, 2010). Humans extract ecosystem services in the form of goods and services through both direct and indirect modes of utilization (Fedele *et al*., 2017; Leviston *et al*., 2018). The composite study of different intertwined ecosystem services primarily requires a conclusive valuation approach (Masiero *et al*., 2019; Tinch *et al*., 2019). The Millennium Ecosystem Assessment (MEA) (2005) was a flash point in redefining the traditional concepts about ecosystems, especially focusing on assets and services drawn from different ecosystems. Ecosystem services are categorized by many researchers as materials and non-material benefits gained by humans (Costanza *et al*., 1997; Nelson *et al*., 2009; Vizzarri *et al*., 2015; Englund *et al*., 2017). In 2005, the Millennium Ecosystem Assessment (MEA) framed ecosystem services in four categories- Provisioning services, regulating services, supporting services, and cultural services. Ecosystem services are further categorized according to their total economic value (TEV) in two categories- direct use value and indirect use value. Direct-use values are precise to directly consumable resources derived from a particular ecosystem, whereas indirect-use values include the mechanisms contributed by the ecosystem to regulate other functions of an ecosystem, such as pollution control, pollination, nutrient cycle, etc. Indirect-use values cannot be gained in terms of monetary values or consumable objects. The economy's well-known provisioning services include products derived from ecosystems, such as food, fiber, fresh water, and genetic resources. Benefits from controlling ecosystem processes, such as those affecting water quality, air quality, erosion, pollination, and natural hazards, are included in the category of regulating services. It can be concluded that provisional services include direct-use values of an ecosystem, whereas regulating services are indirect-use values derived from an ecosystem. The non-material benefits that humans extract from the ecosystem through aesthetic experience, recreation, spiritual amelioration, knowledge enhancement, and education are known as cultural services. Supporting services, which include functions like soil formation, photosynthesis, nutrient cycling, and species habitats, are prerequisites for the viability of life on Earth (De Groot, 2002; MEA, 2005; Englund *et al*., 2017).

Inherently mixing the environmental and social sciences, the idea of ecosystem services is multidisciplinary and requires interdisciplinary cooperation for thorough assessments (McDonough, K *et al*., 2017). Daily, G. C. (1997) and Costanza *et al*. (1997) initially reported the term Ecosystem Services. Since then, many researchers and policymakers have elaborated on ES as an important tool in different ecosystem management and sustainability. Ecosystem Services were presented with a sustainable perspective for resource management after the MEA project (2005), TEEB (2010), and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (2012) presented ES with the political approach. Since then, policymakers followed scientific investigation for decision-making (Aznar-Sánchez *et al*., 2018). Ecosystem services are considered natural capital (Ojea *et al*., 2012) and thus its implementation for human welfare is counted as a composite effect with other forms of capital through an interactive approach (Costanza *et al*., 2017)

After Ecosystem services were proposed as natural capital, the counter effect of human beings on the ecosystem also became a great political, economic and social concern for policymakers (Ojea *et al*., 2012). The health and way of life of millions of people are at stake due to the continuous and fast deterioration of ecosystem services followed by poor management policies of ecosystems (Egoh *et al*., 2007; Aerts and Honnay, 2011). Rukundo *et al*., 2018 appealed for a justified policy to balance the forest ecosystem services exploitation and human needs to attain sustainable development of forest ecosystems. MEA (2005), for the first time, introduced ecosystem services globally (Cuni-Sanchez *et al*., 2016). Later, TEEB was sponsored by the United Nations Environment Programme (2010), the European Commission, and the Intergovernmental Platform on Biodiversity and Ecosystem Services (2012) spotlighted the interlinkages between biodiversity and ecosystem services. The growing awareness about ecosystem services at the international platform inaugurated new journals, especially for *Ecosystem Services*, some of which are entitled *Ecological Economics* (Braat and de Groot 2012; Ninan and Inoue 2013b). The objective of their journals is to introduce scientific temperament in the validation of ecosystem services so that policies can be reformed for the sustainability of ecosystems. The introduction of the ecosystem services concept cemented the bond ecosystem and the local people, as local people were aware of the correlation between biodiversity and services they extract from the surrounding ecosystem (De Beenhouwer, 2013); Tekalign *et al*., 2018), eventually realizing them the importance of biodiversity and its conservation. The ecosystem services concept also draws the attention of the urban population to understand the importance of rural or tribes surviving with traditional and Indigenous knowledge. Forests support a wide range of biodiversity, so it can be considered a major source of ecosystem services (Vizzarri *et al*., 2015). The forest Ecosystem preserves the indigenous culture, affords millions of people a sustainable livelihood, and stocks 40% of the world's terrestrial carbon, which counts as mitigation of carbon amount in the atmosphere (Tekalign *et al*., 2018). Unfortunately, forests are degrading due to various natural and human-intended reasons. The continuous degradation of forests alters the composition, structure and functioning of forests. Human intended degradation is very intense and of high frequency that reduces the ecosystem services of forests. Any disturbance negatively affects the biodiversity, which is correlated with the ecosystem service stocks of any ecosystem, so degradation of the forest ecosystem results in lowering both the quality and quantity of ecosystem services (Egoh *et al*., 2007; Aerts and Honnay, 2011; Tadesse *et al*., 2014; Balvanera *et al*., 2014; Tolessa *et al*., 2017; Tekalign *et al*., 2018). The offset of ecosystem services lengthens the resilience tendency of the ecosystem (Brockerhof *et al*., 2017). In 2018, Aznar-Sánchez *et al*., briefly explained the negative role of climate change, increasing urbanization and agricultural practices for forest degradation and deteriorating ecosystem services. To maintain sustainability in ecosystem services, it is important to maintain forest resources. Forest resources fluctuate on both spatial and temporal scales and simultaneously affect the dependency of the human population on forest ecosystem services. It can also be concluded that ecosystem services assessment is primarily based on evaluating the forest resources used by humans. The present study aims to systematically understand the effect of increasing anthropogenic activities on the extraction of tropical forest ecosystem services in Majuli Island.

Categories of ecosystem service-

In 2005, the MEA divided Ecosystem services into four major categories.

Provisioning ecosystem services

category mainly includes the basic requirements that local people extract from the ecosystem, such as Food, Firewood, Freshwater, Ornamental resources, Bio-chemicals, Natural Medicines, etc. (MEA 2005).

Regulatory Forest Ecosystem Services

Regulatory services include the phenomena that control and maintain phenomenal cycles of the ecosystem, such as climate regulation, air and water quality regulation, pollination, and pest or disease control etc. (MEA 2005)., Among the various regulatory forest ecosystem services climate change regulation is the most focused study by the researchers. Through photosynthesis, atmospheric carbon is fixed in forests and grasslands in the form of vegetation. Vegetation of an ecosystem is defined as the primary productivity of the ecosystem is a measure of productivity of that particular ecosystem (Brinckerhoff *et al*., 2017). Plants also contribute to the sequestration of atmospheric carbon in soil and is a major factor in estimating soil carbon stocks. Thus, carbon, which is a greenhouse gas, is mitigated from the atmosphere and this is supportive of climate change regulation. Also, the primary productivity of ecosystems further provides provisional ecosystem services. Carbon sequestration has attracted many researchers to validate primary productivity in the form of carbon market values (Ninan and Inoue, 2013a; Morri *et al*., 2014; Huxham *et al*., 2015; Ninan and Kontoleon, 2016; Kibria *et al*., 2017; Wang *et al*., 2018). Researchers used various methodologies and models to evaluate the carbon sequestration potential of an ecosystem in monetary values and carbon tax. A few of them are carbon market price (Morri *et al*., 2014; Huxham *et al*., 2015; Kibria *et al*., 2017; Wang *et al*., 2018), carbon tax law method (Li *et al*., 2017), carbon tax using InVEST model (Kibria *et al*., (2017).

Next to climate change mitigation forest ecosystem services and erosion regulation services of forest ecosystems were also evaluated for economic and biophysical values. Song *et al*., (2016) highlighted air quality regulation of forests and measured the SO_2 and NO_2 sequestration potentiality of forest in South Korea. The vegetation of forests also imparts soil formation and soil conservation services.

Supporting ecosystem services

Supporting ecosystem services includes pedogenesis photosynthesis, nutrient cycling through various biogeochemical cycles etc. (MEA 2005). Soil formation and photosynthesis are interlinked with regulating ecosystem services.

Cultural ecosystem services

Cultural ecosystem services are non-materialistic values such as education, aesthetics, cultural heritage, and spiritual and religious values drawn by humans (MEA 2005). According to Chan *et al*., (2012), non-monetary values of cultural ecosystem services were given less attention, due to which cultural ecosystem services were given less priority. Later Lara-Pulido *et al*., (2018) also stated the increasing priorities of provisional services over cultural services. Cultural ecosystem services are not assessed as primary inducement for decision-making policies rather, only a few specific aspects of cultural ecosystem services are studied (Milcu *et al*., 2013).

Forest ecosystem provides a wide range of ecosystem services as it includes a vast array of biodiversity. India recorded 30% of the total area as forest area at the onset of 20^{th} century, which was later reduced to 21.34% in 2015. One of the basic reasons for the degradation of forest ecosystems in climate change and it should be noted that India ranks 14^{th} in vulnerability to climate change (Global Climate Risk Index 2019). India occupies about 16 types of forests confined to specific parts of the country with a wide focus on the northeastern forest area. The state-Assam includes about five categories of forest further divided into 18 sub-categories of forest ecosystems. Assam is well known for the widest river of India- Brahmaputra and Majuli island (largest inhabited river island.) Both Brahmaputra and Majuli island are the environmental incentives for the state and country as well. Brahmaputra River is the lifeline for the people of Assam, also Majuli island is situated in the lap of the Brahmaputra River basin and is honored as the largest river island in the world. Majuli Island is well known for supporting tourism in Assam. Unfortunately, Majuli Island is shrinking in area due to continuous erosion. This natural practice of continuous erosion of river bank areas of Majuli island is a threat to the biodiversity and the localities of that island. Saikia, (2019) briefly explained the susceptibility of the Brahmaputra valley towards flood. Brahmaputra river valley flood plains experience a loss of 3521 million properties annually (India Water Portal, (2012). The assessment of ecosystem services fosters biodiversity

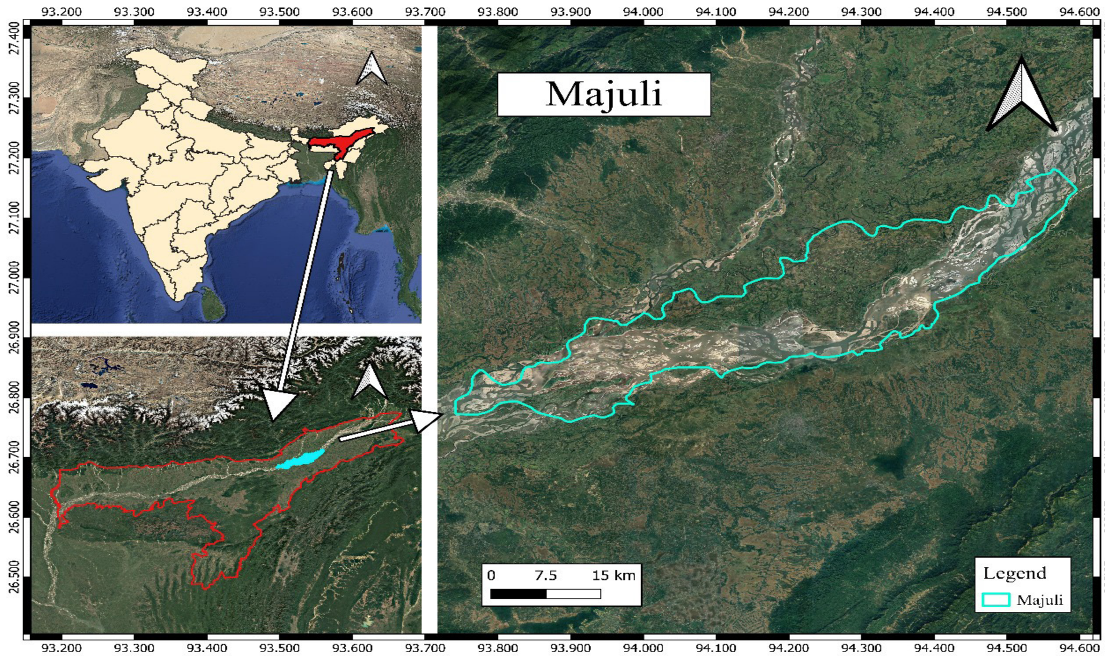

Fig. 1: Location of Majuli Island in Assam, India

conservation, and management sustainability of natural resources through the formation of environmental policy. It is a promising approach for understanding the interdependency of humans on ecosystems and simultaneously the effect of humans on the regulation and maintenance of ecosystems (Jax.K. *et al*., 2013). This study is well-focused on ecosystem services provided by the forest ecosystem of Majuli island and unbinds the effect of human intervention on the ecosystem services of Majuli island. To analyze and predict the dynamic changes of ESV brought on by LULC, the geographical and temporal dynamics patterns of LUCC in Majuli Island are evaluated in this work.

Understanding ecosystem service dynamics in an ecosystem undergoing LULC change is the first step toward developing more practical and sustainable land-use planning methods (Martínez-Sastre *et al*., 2017; de Groot *et al*., 2012). Therefore, it is possible to connect the significance and advantages of appropriate land management to land planners, policymakers, and managers by demonstrating how LULC changes might disrupt ecosystem service values in Majuli Island.

Study area

Majuli is the largest river island, covering a total area of 1250 square kilometers, extending over 26° 45′ to 27° 12′ N latitude and 93° 39′ to 94° 35′ E longitude (Fig 1.). The area of Majuli Island is continuously eroding due to the Brahmaputra River and now it is confined to 650 square kilometers (Devi, 2012). In 2020, the area of Majuli Island was marked through satellite image analysis. It was found that the island has shrunk to 423 km^2. The island supports a population of 167,304 people distributed in 192 villages. Among the total population, 14.3% belongs to Schedule Caste and 46.4% is from Schedule Tribe, specifically the Mishing community (Census of India, 2011). Majuli island experiences a hot and humid climate with an annual average rainfall of 2,100 mm and a mean temperature of 24.1°C. Nearly 48 % of the total area of Majuli Island receives high range frequency of continuous floods, riverbank erosion, landslides and a great loss of biodiversity, eventually degrading the ecosystem services are distinguished as high flood susceptible zone (Saikia *et al*., 2020). Vegetation in Majuli Island consists of dense trees, grasses, shrubs and aquatic plants (Fig 2). Though agriculture is the primary occupation followed by people in Majuli Island, people also adopt livestock rearing, fishery, pottery, weaving, etc., as secondary sources of income. Rainfall is an important asset for agriculture, but the disturbed pattern of rainfall causes flooding and degradation of agriculture in Majuli island (Fig 1). Increasing rainfall patterns, continuous flooding, landslides and erosion are primary natural disasters responsible for ecosystem deterioration in Majuli island. Low-flood zones have an exposure index of 0.40, while the exposure index of high-flood zones is 0.72 (Saikia *et al*., 2020).

Fig. 2: Vegetation of Majuli island

Methodology

Data for the study was collected both from secondary and primary sources. Primary data was collected through field surveys and face-to-face interview techniques. Images were prepared using ArcGIS software for the last 20 years. NDVI and LULC images were prepared for the years 2002, 2012, and 2022 (with a gap of 10 years) to analyze the changing land use pattern within these 20 years (Fig 3). The effect of climate change can be mapped by analyzing the ecological changes w.r.t fluctuating abiotic factors for a minimum of 20 years because climate change is a long-term process. Through LULC maps, the human intervention in reforming ecological structure, composition, and functionality can be interpreted. Secondary data is collected through the Web of Science and SCOPUS databases.

Results and discussion

Majuli Island and ecotourism

Majuli is blessed with a wide range of natural assets that attract tourists. Majuli is an eye-catching hotspot for tourism and ecotourism. Rural tourism, adventure tourism, Cultural and Religious tourism. Majuli is a biodiversity hotspot and satisfies the search for cultural and natural authenticity. Through tourism, the indigenous and traditional values, art and craft, culture and bio-heritage of Assam are explored at both national and international levels and also provide an alternative source of income for the rural population. Through tourism, the traditional knowledge and unique culture of the community is preserved. Shankardeva, in 15th century, introduced Neo-Vaishnavism (Hinduism) in Majuli Island, which later proliferated throughout the whole state, and so Majuli is entitled the 'Cultural Capital of Assam' (Sahay & Roy, 2017). Majuli Island is honored as the "Cultural Heritage Site of Assam". The braided flow of the Brahmaputra River has developed several islets, in addition to other wetlands and ox-bow lakes – occupies 14% of the total area of Majuli Island (Roy *et al*., 2020).

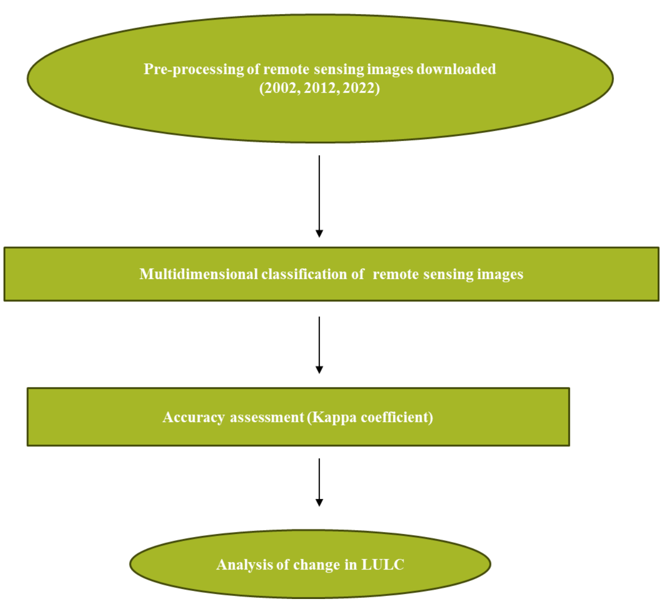

Fig. 3: Flow chart of methodology- LULC (Land use Land cover)

Table 1: Changes in the area (hectares) for different land use categories for the 20 years

LULC Class	*2002*	*2012*	*2022*
Agricultural land	7896	15894	23813
Settlement	1831.05	4892	8028.28
Wasteland	19252	8892	12533
Forest	42125	37608	19442
Sandbar	32236	29848	37888
Waterbody	14589.4	20793	15997

The data from the LULC images shows a frequent change in different land use types for the last 20 years (Fig 5; Fig 7; Fig 9). In 2002, the human settlement was over 1831.05 hectares of the total geographical area of Majuli Island (Fig 5; Fig 6). However the human settlement area increased in 2022 up to 8028.28 hectares (Fig 4). The Ecosystem services provided by the forest ecosystem are important both at the global and national levels (Grammatikopoulou, & Vačkářová. 2021; Mengist *et al*., 2019). In 2002, 2012 and 2022 area covered by human settlement was 2, 4 and 7%, respectively (Figs 6, 8, & 10). As the human settlements increased, forest cover decreased. Similar results were observed by Mengist *et al*., (2019). The increasing population destroyed forests for settlements and agricultural land. Forest cover in Majuli island has decreased from 42125 hectares in 2002 to 19442 hectares in 2022 (Table 1). The magnitude of disturbance in an ecosystem is expressed in the form of the mortality rate of vegetation in the ecosystem. The extent of degradation of the forest is proportional to the loss of five major ecosystem services: carbon sequestration, wood production, flood and erosion protection, recreation, and habitat loss, leading to the eradication of several indigenous species. The quality and quality of biomass (wood) is correlated to carbon sequestration in that particular ecosystem. The growing biomass is a measure of carbon sequestration potential, whereas deforestation of biomass reflects the carbon emission of the same ecosystem. However, the area covered by water bodies in Majuli Island shows an uncertain trend (Fig 4).

Traditional knowledge – adaptability of localities

About 21% of the population in Majuli Island is below the poverty

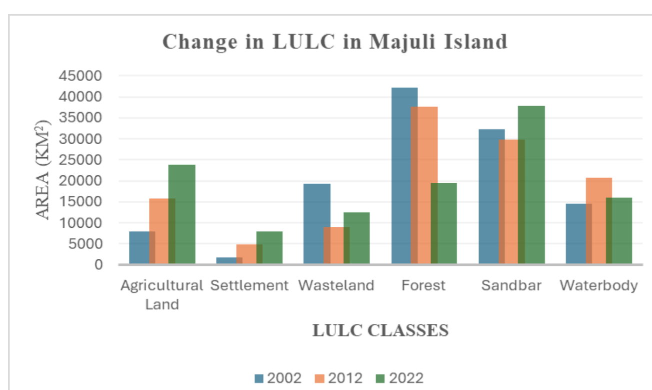

Fig. 4: Graphical representation of different LULC patterns

line and owns small-scale/cottage industries – boat manufacture, wooden work, sericulture, livestock rearing, handlooms, etc as a secondary source of income (MCLMA, 2020). Agriculture is the primary source of occupation on Majuli Island. Also, agriculture addresses extreme liability towards climate change- flood and erosion (Aryal *et al*., 2020). The traditional lifestyle of the local population corresponds with indigenous knowledge, eventually presenting better alternatives for adaptive capacity. People prefer traditional "Chang Ghars" to manage flood conditions and wild animals (Das and Mukhopadhyay, 2018) (Fig 12). Indigenous People use a traditional and cost-effective course of action –afforestation along the river bank to alleviate the footprints of climate change (Sarma, 2013; Robinson and Herbert, 2001). *Barringtonia acutangula* (freshwater mangrove) is preferred for plantations in high flood-prone regions to check flood and erosion (fig 11; Fig 13), concomitantly finding an alternative

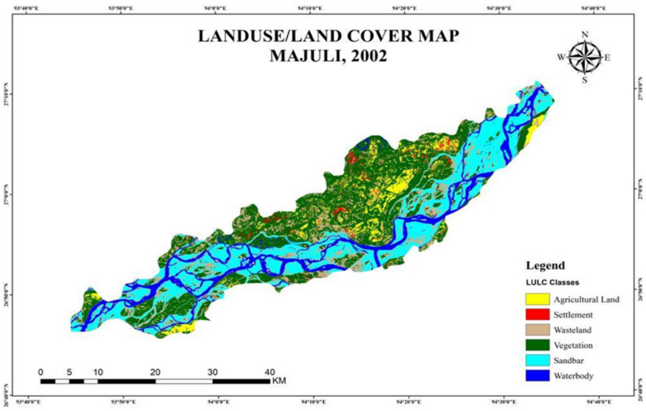

Fig. 5: Land use and land cover patterns in Majuli island in 2002

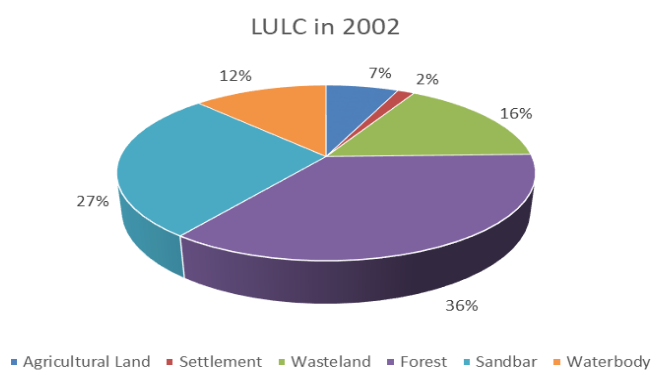

Fig. 6: Percentage of the total geographical area under different land use classes

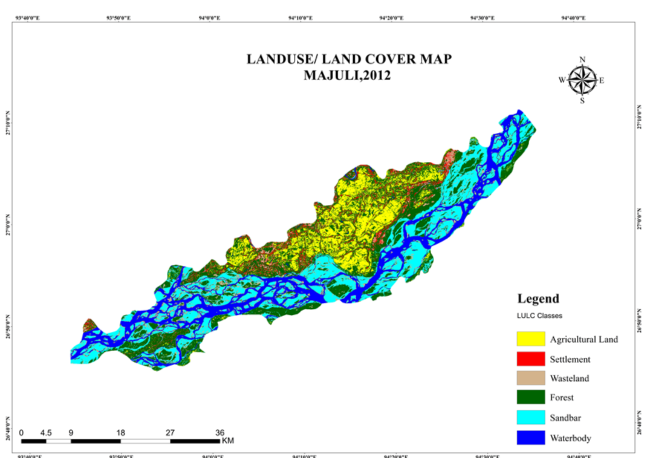

Fig. 7: Land use and land cover patterns in Majuli Island in 2012

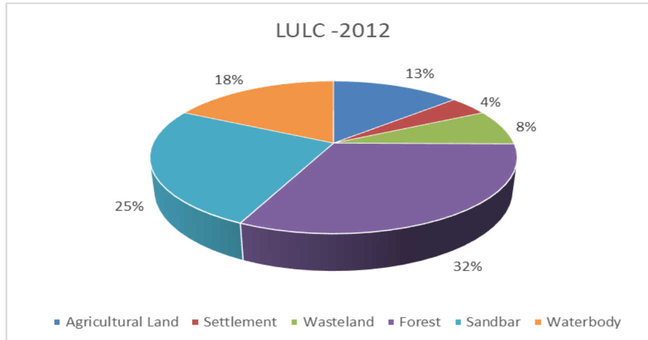

Fig. 8: Percentage of the total geographical area under different land use class-2012

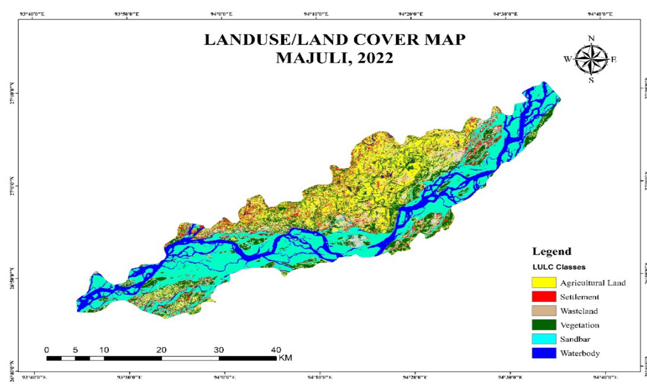

Fig. 9: Land use and land cover patterns in Majuli island in 2022.

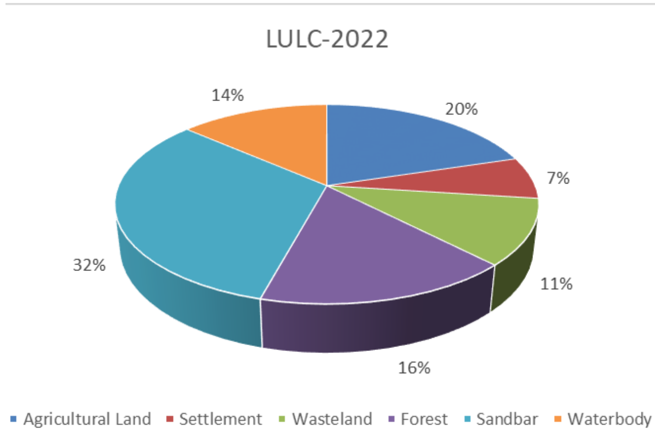

Fig. 10: Percentage of the total geographical area under different land use class-2022

Fig.11: Traditional approach by local people to control erosion

Fig. 12: Traditional houses-Chang Ghar

Fig.13: Traditional method to mitigate the flood flush

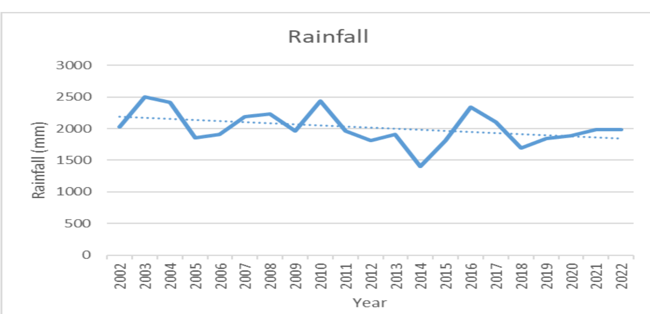

Fig. 14: Rainfall pattern in Majuli Island (2002-2022) Pai et al., (2014)

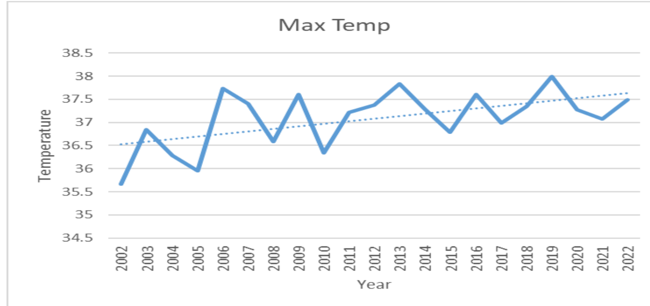

Fig. 15: Maximum temperature in Majuli Island (2002-2022) Pai et al., (2014)

source of energy (Saikia *et al.*, 2020). People in Majuli island are rural and have financial limitations – this is an important factor declaring the susceptibility to disaster-related challenges (Hazarika *et al.*, 2020; Sahay, 2017). Native people of Majuli island embrace traditional approaches – increase resilience towards disaster through traditional lifestyle, traditional and cost-effective farming practices, practicing sustainable housing, and land–use patterns (Singh *et al.*, 2019).

The yearly rainfall and maximum temperature data highlight the climatic conditions in Majuli island for the last 20 years (Figs 14 and 15). The trend lines of the graphs prepared for the meteorological data explain that rainfall has a decreasing trend while maximum temperature has an increasing trend. Since the year 2018, rainfall in Majuli Island has had very slight fluctuations.

Conclusion

The geographical area of Majuli Island is reducing due to continuous flash floods and erosion which cause loss of historical assets, biodiversity hotspots, and cultural heritage sites. The people of Majuli island are facing challenges to withstand the vulnerability of their traditional values, ethics, resources, and ecosystem services. Majuli Island still enjoys finite sources of transportation and communication, and these limited options of transportation are even disconnected during floods. Also, without proper information in mass media, tourist temporizes their plans to Majuli island. Majuli offers a lot of potential for ecotourism pursuits, including bird viewing, sailing, cycling, rafting, hiking, and so on. However, due to a lack of coordinated effort on the part of residents, government, and commercial organizations, the ecotourism potential of the region has not yet been fully realized and maintained to accommodate visitor expectations. To maintain the tourism industry that safeguards the livelihood standards of people in Majuli island, it is necessary to freeze the ecosystem services of Majuli Island. Apart from ecotourism Ecosystem services also secure the interests of local people and reduce the vulnerability to natural disasters. In Majuli island, forests are pivotal in defending from natural hazards (such as flood, erosion, and landslides), climate change regulation (carbon sequestration), providing provisional services, providing fuel, recreational values, safeguarding biodiversity, and promoting tourism, which has both social and economic values. It is concluded that human settlements have decreased the natural habitats. Moreover, the localities are manipulating the forests to meet their needs without considering the concept of sustainability. Poor management of ecosystem resources and the continuous occurrence of Natural disasters result in the loss of ecosystem services. Long-term degradation of ecosystem services changes the structure, function, and composition of the ecosystem. Local people are to be made aware of the importance of ecosystem sustainability to extract maximum benefits and maintain the ecological structure of an ecosystem.

Author Contributions

V. S., A.S. and S.A. designed the experiment; V. S. collected the data and analysis. V. S., A.S. and S.A wrote the initial manuscript. S.A. and B.K. H. contributed to the result verifications and manuscript proofreading. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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