



## STUDY ON ADVANCEMENT DUE TO TECHNOLOGY IN ECO-FRIENDLY FOREST COMMUNITY- SUNDARBANS

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**Abstract:** The inhabited portions of India's Sundarbans are characterized by severe poverty, which both contribute to and arises from the vulnerability of the population to a growing range of natural hazards. Factors challenging like-sea level rise, salinization of soil and water, cyclonic storms, and flooding have combined over the past century to render this one of the most hazardous areas in the Indian subcontinent. Along with natural disasters every year, the inhabitants are prone to wild animal attacks (crocodiles and tigers). The study will focus on the condition of the inhabitants they live in and the development for advancements in technologies that have taken place in the past decade in the eco-community of Sundarbans.

**Keywords – Technological Advancement, Infrastructure , Eco-Forest Community.**

### I. INTRODUCTION

Sundarbans is the world's largest delta at the estuary of three great rivers, the Ganges, Brahmaputra, and Meghna, which converge at the basin of the Bay of Bengal. It covers an area of 10,000 sq. km, of which 41.5% is in India and 58.5% in Bangladesh .The forest extends over 200 islands, separated by 15 major rivers and 400 interconnected network of tidal waterways that support the largest tidal mangrove forest in the world. The name Sundarbans which means Beautiful Forest is derived from the mangrove tree sundari, which has spectacular yellow-orange flowers. (Building Resilience for Sustainable Development of the Sundarbans through Estuary Management, Poverty Reduction, and Biodiversity Conservation Strategy Report South Asia Region Sustainable Development Department Environment & Water Resources Management Un 2014)

The Indian Sundarbans comprises 19 community development blocks – 13 under South 24 Parganas and 6 under North 24 Parganas district (covering 190 Gram Panchayats [GPs] in 1,064 villages with a total territory of 9,630 km<sup>2</sup>) of West Bengal state. The Sundarbans is one of the most important biodiversity making it a treasure of the world with 84 different mangroves and mangrove-associated vegetation and over 1,500 species of fauna. It is the largest tidal holophytic mangrove reserve in the world. UNESCO declared Sundarbans National Park a World Heritage site in 1987 (Bangladesh Sundarbans in 1997). In 1989 it was further designated as a Biosphere Reserve under the UNESCO Man and Biosphere Programme. The Sundarbans Biosphere Reserve, which covers 9,630 sq. Km and includes 5,400 sq.Km of non-forest territory, covers the delta south to the Dampier-Hodges line and includes the SRF, Tiger Reserve, and human settlements. (<https://www.sundarbanaffairswb.in>)



<https://www.gettyimages.com>

Fig I.1 flood and high tides



<http://geringerglobaltravel.com/>

Fig I.2 villages of Sundarban



<https://www.timesofindia.india>

Fig I.3 waterways on high tides

## II. OBJECTIVE

As we know that the mangrove forest- Sundarbans has faced many ups and downs and it is quite a challenge to live in with the constant fear of flood and high tide along with wild animal attack. Sundarbans is often derived from facilities that we enjoy in cities due to improper transportation. Despite all these challenges there are many improvement and advancement that the Sundarbans have achieved. This paper is mainly set out to focus on the advancement in technologies due to which there is many improvement in the lifestyle and houses of the eco-community of the forest dwellers.

1. To study history of human settlement of the Sundarbans.
2. To observe improvement due to adaptation of new construction materials of houses and techniques to protect themselves from wild-animals.
3. To observe advancement in disaster management's techniques and the time periods of recovery or other alternatives that has been adapted.
4. To observe development of hospitals and transportation system in the villages of Sundarbans.

## III. METHODOLOGY

The research study was conducted by the help of secondary literature study and data collections. For the research study, assessment of the changes occurred in lifestyle and housing of the Sundarbans forest community due to technological advancements in the last past 10 years is followed by-

1. Extensive literature survey on the Sundarbans eco-community.
2. Intensive literature study and collecting all the informative articles on the topic hence channelizing it furthermore.
3. Analysing the collected data and analytical interpretation of the data.
4. Hence drawing a short conclusion about the advancement of the eco-forest communities of the Sundarbans in every aspects over the past years and what more can be adapted.

Pictures and data's have been collected from different sources which have been put into this report to support the discussions. The final output of this report is to analyse the advancements in every aspects of the Sundarbans forest eco-community and what more can be done for that. Some Google questionnaire survey to know the awareness among people regarding the conditions of eco-communities of Sundarbans; and also to put into further information into the study..

## IV. STUDY AREA

Uniqueness of Sundarbans are well known to us but it has two faces; one of beautiful mangrove forests and wild animal and the other face is the poverty stricken under developed eco-community. It comprises of 19 blocks (six from North 24 Parganas and thirteen blocks from South 24 Parganas). For the study of this research paper all the 19 blocks have been taken into consideration. It contains 120 islands of which only 54 islands are inhabited .According to 2011 census about 4.3 million people are surviving in about 4,493.60 sq km inhabited area. (<https://www.sundarbanaffairswb.in>)

## V. DATA BASE

### 1. HISTORY OF HUMAN SETTLEMENTS IN THE SUNDARBANS.

In the era of Emperor Chandragupta Mourya, Sunderbans was first mentioned by the Greek globetrotter Megasthenes (381-312 BC) in his historical report 'Indica'during his visit in India. Human settlement in the Sundarbans dates from the treaty of 1757 signed by Mir Jafar, where the land of undivided 24 Parganas was given up to the British colony, East India Company. The Sundarbans were not populated at that time due to harsh weather condition and natural challenges but settlement in the Sundarbans were done as planned by Clod Russell by clearing of forests and introducing human settlements from different states of India as laborers.(Chapter 4: Indian Part of Sunderbans: A Socio-economic and Demographic Profile 4.1 Sunderbans: A Brief Review n.d.)

Recent population of the Sundarbans Indian delta is a result of immigration as the delta was devoid of any human settlement before colonial settlements. Part of this immigration is from first generation immigrants from the East Midnapore district in West Bengal and Chota-Nagpur as laborers and workers bought by the East India Company administration(Chapter 4: Indian Part of Sunderbans: A Socio-economic and Demographic Profile 4.1 Sunderbans: A Brief Review n.d.) Time and others are from Bangladesh to escape oppression in their places of origin during freedom and separation. In recent years the population is more or less evenly balanced between the two major religions, Hinduism and Islam.

The two main religious communities have existed side by side in relative harmony for generations but even so, disharmony along communal lines was witnessed sometime in the 1940s (Project Title: Enhancing Livelihoods in Sagar Island, Sundarbans Section I Summary of Project n.d.).Amongst the Hindus, about 74 percent belong to the Scheduled Castes (SC) and 10 percent to the Scheduled Tribes (ST); where STs are not within the Hindu fold. (<https://www.sundarbanaffairswb.in>)



<http://maps.nypl.org/warper/maps>

Fig V.1.1 Map of Sundarbans proposed by British colony



<https://en.wikipedia.org/wiki/Sundarbans>

Fig V.1.2 Map of Sundarban at present

## 1 IMPROVEMENT OBSERVED DUE TO ADAPTATION OF NEW CONSTRUCTION MATERIALS OF HOUSES AND TECHNIQUES TO PROTECT THEMSELVES FROM WILD-ANIMALS

Sundarbans consists of 19 community development blocks out of which 13 are under South 24 Parganas and 6 are under North 24 Parganas district of West Bengal state. It has three distinct zones which are The Core zone (1,700 Km<sup>2</sup>), including the primitive area; the Buffer zone (1,225 Km<sup>2</sup>), and the Transition zone, which contains mangrove and non-forest areas. The Sundarbans Tiger Reserve (STR, 2,585 Km<sup>2</sup>), was established in 1973 and contains the subcontinent's largest population of Royal Bengal Tigers. (Ecopsychosocial Aspects of Human-Tiger Conflict\_ An Ethnographic Study of Tiger Widows of Sundarban Delta, India n.d.) Sundarbans is formed of archipelago of 102 islands out of 54 are inhabited by people, while the rest of the area is covered by forests. Constant invasion of high tide and low tide along with other natural factors makes livelihood most difficult and challenging to live in. as most of the occupation of the villagers are crab collectors, farmers, fishermen's, wood cutters, honey collectors etc.; the housing type and arrangement of spaces changes as per their occupations.

The typology depends upon the necessity of the spaces that the dwellers requires. Mostly the building materials are of locally available resources like twigs, thatch, country tiles, Mangalore tiles for roofing or straws, etc. Use of modern building materials are few as the houses are prone to frequent floods, high tides and cyclone; this is because rebuilding of the houses requires comparatively less cost when used vernacular building materials. Another factor that effects the use of vernacular building material is that people residing near estuaries far away from mainland have the constant fear of losing land due to shifting of land because of sea tides and less cost of transportation.

In the village houses, there are few complex design arrangements like thatch roof with attu and kadi baraga roof. The kadi (timber beam) and baraga (timber rafter) applied for flats roof constructions. Villages which are a bit interior from estuaries and coasts have houses made up of modern materials and consist of semi-pukka houses and pukka houses.

The spaces inside the houses depends upon the need and nescicity of the people residing in it. These spaces have evolved greatly over the time from single unit to multiple units having centrally enclosed courtyard as their common interactive spaces. The orientation of the houses are mostly depends upon the wind direction, sun path and topography.

Generally a mound about 2 to 3m above the normal ground level is raised as the region is prone to frequent high tides and floods and then on the raised ground the houses are constructed with some plinth. The settlement patterns of the villages depends upon two major factor namingly caste/religion and the occupation of the villagers. The settlement is generally organic in nature and free flowing. Therefore the villages are settlement areas surrounded by farmer's land, ponds etc and made up of multiple smaller and linear settlements. (Ganguly n.d.)

Types of houses:

- mud houses
- bamboo house
- tin house

Different roof based types:

- roof made of straw
- roof made of big leaves
- roof made of earthen tiles

(Ganguly n.d.)



Fig V.2.1 Wooden pillar and

<https://www.shutterstock.com/>



Fig V.2.2 Straw house with bamboo and mud

<https://www.shutterstock.com/>



Fig V.2.3 Tin roofed house with raised blinth

<https://www.shutterstock.com/>



Fig V.2.4 Bamboo reinforced house with mud

<https://c8.alamy.com/>



Fig V.2.5 PMAY-G houses

<https://www.sudawb.org/>



Fig V.2.6 Brick wall with tin roof

<https://sundarbanchalo.co.in/>

2 ADVANCEMENT IN DISASTER MANAGEMENT'S TECHNIQUES AND THE TIME PERIODS OF RECOVERY OR OTHER ALTERNATIVES THAT HAS BEEN ADAPTED OVER THE PAST YEARS.

Sundarbans forests are prone to natural disasters which cannot be prevented. The geographical location and its adjacent areas making the mangrove forest vulnerable to the natural calamities. Another reason is global warming and climate change that results in these calamities. Some frequent natural disasters that can be taken into consideration are severe cyclones, storm surges, floods, tornados, increasing salinity of ground water, riverbank and coastal erosions.

Tropical cyclones which are caused due to depression in Bay of Bengal have resulted in cyclones like 'aila', 'amphan', 'bulbul', 'fani' etc.

Constant rise in the sea level has caused severe damage by salination of the ecosystem of the Sundarbans and its villages. The joint effect of global sea level change and the intense submergence of deltaic deposits has resulted in the extent of sea level rise which has reached 10-20mm/yr in the seaward part of Sundarbans which includes 10 most vulnerable islands of the Sundarbans. Sea level rise and subsequent erosion have inundated four Sundarbans islands over the past two decades. (Living with changing climate 2012)

A new land and embankment policy along with bamboo barriers has been proposed from the state irrigation department to take over some 6880 ha (Living with changing climate 2012) of land for construction of stronger embankment along the river and sea fronts. In response to the 2009 cyclone, the Aila Task Force proposed a colossal ₹5,032 crore 'Embankments Reconstruction Project' to repair over 700km of damaged and breached embankments. 3,500 km length of the old embankments, built during the British rule some 250 years ago has been restored after cyclone aila and amphan. 5m is the height of the new embankments currently being constructed in Sundarbans. 5000 km is the current length of the new embankments. (<https://www.volvoce.com/>)



Fig V.3.1 Concrete Embankment

<https://www.volvoce.com/>



Fig V.3.2 Bamboo Barriers

3 DEVELOPMENT OF HEALTH AND TRANSPORTATION SYSTEM IN THE VILLAGES OF SUNDARBANS.

**TRANSPORTATION:** The Indian Sundarbans has 42km of railways, 250km of metalled road and 170km of unpaved narrow roads (<https://www.sundarbanaffairswb.in>). The navigable rivers and creeks are the principle source of transportation for the Sundarbans. Although the present transport system is far better than Hunter’s observed made in 1875, most of the people residing the Sundarbans are heavily dependent on boat service for the daily movements. Out of 770 villages in the Canning belt only 220 can be reached by boat services. But this also getting worsening due to silting of the rivers and creeks. (<https://www.sundarbanaffairswb.in>)

The islands of Sundarbans have few numbers of rail services. Since the development by British colonies; on eastern Sundarbans rail service is till Canning and diamond Harbour. In recent year, on January 2006, rail service has extended to Namkhana via. Lakshmikantapur on the western side though sanction for extension was granted in 1984 marking the first ever expansion towards Sundarbans after the independence. There was also a proposal for construction of Road Bridge across Malta River was sanctioned.(Mondal n.d.)

The road network connectivity is very poor in comparison to the other rural states of India. Sundarbans has total 713.47km of surfaced road maintained by P.W.D and 1150.80km length of surfaced road maintained by Zilla Parishad. Moreover total of 8559.52km of unsurfaced road length maintained by P.W.D and Panchayat or Zilla Parishad has been compromised and tangled due to growing population and its need.



Fig V.4.1 Road networks



Fig V.4.2 Road networks



Fig V.4.3 Jetty



Fig V.4.4 Road networks



Fig V.4.5 Road networks



Fig V.4.6 Bridge

(<https://www.sundarbanaffairswb.in>)

**HEALTH:** though the Sundarbans means beautiful forests the human face Sundarbans are not quite beautiful. The humans residing the eco-forests suffers from severe poverty and health problems. The general morbidity rate is higher than the states average; dual burden of communicable and non-communicable diseases, remarkable high prevalence of mental health problems due to factors like loss of property due to natural calamity etc., about half of the children in Sundarbans below 5 years are chronically malnourished. In Sundarbans health care is provided by three types of health care system naming- Public Health Care system, Public Private Partnership and parallel provider- Rural Medical Practitioners.



Fig V.4.7 Clinic boat

<https://www.sundarbanaffairswb.in>



Fig V.4.8 Government hospital



Fig V.4.9 PPP Health center

<https://milaap.org/>

Public Health care system:

Under public health care system facility two sub-divisional hospitals with specialized physicians and inpatient services and about 800 small sub-centres at the village level staffed by trained multipurpose workers are present.

## Public Health facilities in the Sundarbans by blocks:

District	Block	Type of block level hospital*	No. of PHC	No of SC	Population per PHC	Population per SC	
North 24 Pargonas	Hingalganj	BPHC	3	42	52333	3738	
	Hasnabad	RH	3	33	67023	6093	
	Sandeshkhali II	RH	2	35	75117	4292	
	Sandeshkhali I	BPHC	2	35	78305	4475	
	Minakhan	RH	2	29	97034	6692	
	Haroa	BPHC	2	29	102905	7097	
<b>Total North Sundarbans</b>			<b>6</b>	<b>14</b>	<b>203</b>	<b>76056</b>	<b>5245</b>
South 24 Pargonas	Gosaba	BPHC	2	51	120787	4737	
	Basanti	BPHC	3	63	92848	4421	
	Canning I	BPHC & SDH	1	56	285000	5089	
	Canning II	BPHC	1	45	244998	5444	
	Jaynagar I	RH	2	50	123324	4933	
	Jaynagar II	RH	3	47	75312	4807	
	Mathurapur I	RH	2	37	93524	5055	
	Mathurapur II	RH	3	45	74877	4992	
	Kultali	RH	4	43	54555	5075	
	Namkhana	BPHC	4	37	45658	4936	
	Patharpratima	BPHC	3	65	103405	4773	
	Sagar	RH	3	42	61877	4420	
	Kakdwip	BPHC & SDH	2	54	135762	5028	
	<b>Total South Sundarbans</b>			<b>13</b>	<b>33</b>	<b>635</b>	<b>94018</b>
<b>Total Sundarbans</b>			<b>19</b>	<b>47</b>	<b>838</b>	<b>88668</b>	<b>4973</b>

BPHC= Block Primary Health Center, RH = Rural Hospital, SDH = Sub-divisional Hospital, PHC= Primary Health Center, SC = Sub-center

(Mondal 2015)

Fig V.4.10 Public health facilities in sundarban

#### Public Private partnership:

Public private partnership health care system is facilitated by the partnership between Department of Health and FW of GoWB and NGOs to provide mobile health clinic facility to remote islands by water locomotives. Starting from Tagore Society for rural development to four other NGO (SHIS, SVGSS, BSS and SRKA) provides mobile health facilities in 24 villages. These PPPs are facilitated by basic equipment's like x-rays machines, refrigerators or cold boxes for vaccines etc. and reaches to islands which are water locked and cannot be reached by other means of transport system. These PPPs reaches almost every farfetched villages and provides basic medical attentions before reaching to nearby health centres.(Annual report 2014-2015 SSDC)(Chowdhury et al. 2014)

#### -Parallel providers: Rural Medical Practitioners (RMPs):

RMPs are the facility which are provided by village doctors practicing modern medicines without any formal medical training. Although the facilities are governed by non-formal doctors and workers, it has a firm grip over the health care markets and plays a vital role in the Sundarbans.

These facilities have higher rate of patents than public health facilities as these are easy to approach and less costly. Around 16 to 26 patients a day is treated and some of these facilities have beds for opds and proper facility centres affiliated by some private health care bodies outside the perimeter of Sundarbans.(Kanjilal 2010) )(Chowdhury et al. 2014)

## V. INFERENCE

By this paper study the advancement in livelihood and other different aspects of Sundarbans's eco-forest community in the past ten years has been interpreted. The advancement has been noted down below:

#### Houses:

1. Villages which are a bit interior from the estuaries have houses made up of brick and cement wall with tin/ asbestos/grass roof.
2. Houses built under the schemes like PMAY and PMAY-G are provided to some extent in the villages of Sundarbans.
3. There are no specific measures that are adapted for protecting themselves from wild animal attack rather villagers are keen to religious belief and prefer to go for their traditional method when comes to protecting themselves from wild animal attacks. This includes residing in a cluster form with a common open space in the centre and with high boundaries.
4. Houses which are near estuaries and prone to frequent invasion of high tides are built with bamboo and mud with grass roof. The ground are first raised on an earthen mould up to 2-3m and then the houses are built. This raised mould to some extent protects the houses from high tides.
5. Even though some houses are made up of mud/clay, mixture of advanced material like lime, cement and other water proofing materials along with clay/mud has been practiced to make the houses more durables.
6. Even though the roofs are made up of grass and other raw materials they are scientifically made with proper inclination of 22 deg. To make it somewhat cyclone resilient. More over these temporary grass roofs are easily repairable hence people prefers.
7. In the past decade it has been observed that the rate of construction of brick and cement houses, i.e. semi-pukka houses are increasing day by day.
8. Introduction of solar panels on the roofs of the houses and other buildings.

**Disaster management:**

1. To reduce floods, river embankment protections are taken.
2. Land accreditations by bamboo guard wall to provide protection to some extent as much as possible. (Ataur Rahman and Rahman 2015)(Mondal 2015)
3. Plantation of mangrove trees to avoid soil erosion and river side landslides.
4. Fast relief management system by water locomotives and storage of extra fuel in advance so that it could be performed as soon as possible after any natural calamities. (<http://ssdcindia.org.in/disaster.php>)
5. Appropriate notification beforehand of any natural calamities and taking necessary measures for that.
6. DRR toolkits distribution in every villages.
7. Outreached medical camps for the far away and remote villages.
8. Construction of multipurpose cyclone and flood shelter. (<http://ssdcindia.org.in/disaster.php>)
9. When compared between aila and amphan super cyclone, it has been observed that disaster management system has greatly developed since 2009 cyclone.
10. 5m is the height of the new embankments currently being constructed in Sundarbans.
11. 5000 km the current length of the new embankments

**Transportation:**

1. Apart from 42km of railways, 250km of metalled road and 170km of unpaved narrow roads, construction of new roads has been approved.
2. Construction of 1676.025 K.m of Brick Paved Road; 290.582 K.m of Concrete Road and 315.832 K.m of Bituminous Road has been done in the year during the period from 2011-12 to 2016-17(<https://www.sundarbanaffairswb.in>)
3. Construction of 6 (six) numbers of R.C.C. Bridges, namely Saptamukhi Bridge over River Saptamukhi at Gangadharpur – Durbachati, joining Kakdwip and Patharpratima Blocks, Sutarbag Bridge over River Sutarbag at Banstala – Baragheri at Mathurapur – I Block, Kumarpur Bazar Bridge over Atherogachi Canal (Tidal) at Patharpratima Block, Sikirhat Bridge over Sikirhat Khal connecting Joynagar – II and Kultali Blocks, Mridanga Setu at Bolerhat over River Mridanga Bhangha connecting Mathurapur – II and Patharpratima Blocks and Adibasi Bazar Bridge over Atherogachi Canal at Patharpratima Block. (<https://www.sundarbanaffairswb.in>)
4. Construction of 131 R.C.C. Jetty. (<https://www.sundarbanaffairswb.in>)

**Health care centres:**

1. On 31<sup>st</sup> August 2004 with the active support of SSI, the Eye Hospital was inaugurated by the former Health Minister of Govt. of West Bengal Mr. Suryakanta Mishra with 10 beds at SSDC. At present, the 50 bedded SSDC Eye Hospital offers access to affordable eye care to all regardless of their socio-economic status. For mother and child healthcare centre SSDC (Sundarbans social development centre) has been developed; since 2011 till date has achieved greatly by providing service with other NGOs. 54% MAM children has been cured; 65% Children cured rate and 63% LBW children cured rate. (<https://www.sundarbanaffairswb.in>)
2. With the help of advanced technology; SSDC have successfully able to provide more than 10,000 beneficiaries on an average every year medical services through clinic boats. It could give services and reach out to remote villages of Sundarbans. (<https://www.sundarbanaffairswb.in>)
3. Construction of public toilets and wash area and providing awareness to the common people has been achieved over the past decade. (<https://www.sundarbanaffairswb.in>)

**VII. CONCLUSION**

At present Sundarbans have developed incredibly when compared to the past decade. Technologies like sustainable design approaches, motor boat clinics, cement embankments and bamboo barriers, vernacular houses with adaptation to flood and cyclone to some extent is the result of technological advancement in the eco-forest community. Awareness among the people about the surrounding and development of health centres can also be seen when compared to one decade ago Sundarbans. Although many more developments could have been but due factors like poor road connectivity and carelessness of government towards Sundarbans etc resulted in the poor state of the forest community. Through this research it has been observed that many improvements have occurred and many more are yet to be done. If seen through the point of architecture, technologies like floating houses, proper embankments to reduce flood and high tides, development of roads and waterways etc is still left to be done.

## REFERENCES

1. Ataur Rahman, Mohammed, and Sowmen Rahman. 2015. "Natural and Traditional Defense Mechanisms to Reduce Climate Risks in Coastal Zones of Bangladesh." *Weather and Climate Extremes* 7: 84–95.
2. *Building Resilience for Sustainable Development of the Sundarbans through Estuary Management, Poverty Reduction, and Biodiversity Conservation Strategy Report South Asia Region Sustainable Development Department Environment & Water Resources Management Un.* 2014. www.worldbank.org.
3. *Chapter 4: Indian Part of Sunderbans: A Socio-Economic and Demographic Profile 4.1 Sunderbans: A Brief Review.*
4. Chowdhury, Arabinda N, Ranajit Mondal, Kanti Biswas, and Arabinda Brahma. 2014. "Original Paper\* Culture and Stigma: Ethnographic Case Studies of Tiger-Widows of Sundarban Delta, India."
5. "Ecopsychosocial Aspects of Human–Tiger Conflict\_ An Ethnographic Study of Tiger Widows of Sundarban Delta, India."
6. Ganguly, Rupa. "ROLE OF SOLAR PASSIVE TECHNIQUES IN VERNACULAR HOUSES IN WEST-BENGAL IN INDIA." *Number 2*: 1045–50. <http://www.krishisanskriti.org/jbaer.html>.
7. Kanjilal, Barun. 2010. *Health Care in the Sundarbans ( India ): Challenges and Plan for a Better Future.*
8. *Living with Changing Climate.* 2012. www.cseindia.org.
9. Mondal, Biraj Kanti. 2015. "Original Scientific Paper." 65(1): 107–20.
10. ———. "Role of Rural Transport to Infrastructural Development of Indian Sundarbans Exploration of Educational Enhancement and Reflective Observation on Distance Education System through NSOU View Project Geographical Analysis of Indian Sundarbans View Project." <https://www.researchgate.net/publication/332119653>.
11. *Project Title: Enhancing Livelihoods in Sagar Island, Sundarbans Section I Summary of Project.*
12. <https://wb.gov.in/departments-sundarban-affairs.aspx>
13. <https://www.sundarbanaffairswb.in>
14. <http://ssdcindia.org.in/disaster.php>
15. Pani, D. R.; Sarangi, S. K.; Subudhi, H. N.; Misra, R. C.; Bhandari, D. C. (2013). "*Exploration, evaluation and conservation of salt tolerant rice genetic resources from Sundarbans region of West Bengal*"
16. 'Living with changing climate Impact, vulnerability and adaptation challenges in Indian Sundarbans'-Research direction Chandra Bhushan; Lead researcher and writer Aditya Ghosh; Editor Jyotirmoy Chaudhuri; Design and layout Kirpal Singh and Surender Singh; Production Rakesh Shrivastava and Gundhar Das ;Cover Photo Sayantan Bera
17. Educational Outcome: Identifying Social Factors in South 24 Parganas District of West Bengal Jhuma Halder
18. 'Original scientific paper 'SPATIAL EXPLORATION OF THE LITERACY INTENSITY OF SUNDARBAN'-Biraj Kanti Mondal Assistant Professor, Netaji Subhas Open University, West Bengal
19. SUNDARBANS: 'NOT A BLADE OF GRASS GREW...' BY URVASHI SARKAR- [UNDP IN INDIA](#)
20. PEOPLE AND TIGERS: AN ANTHROPOLOGICAL STUDY OF THE SUNDARBANS OF WEST BENGAL, INDIA-Annu Jalais -London School of Economics and Political Science University of London PhD 2004
21. THE SUNDARBANS FISHERS Coping in an Overly Stressed Mangrove Estuary-Santanu Chacraverti-International Collective in Support of Fishworkers [www.icsf.net](http://www.icsf.net)
22. How Worthy is the Sundarbans Mangrove Forest? An Exploratory Study Mohammed Syedul Islam\* Department of Business Administration, International Islamic University Chittagong, Bangladesh
23. Achieving Sustainable Development and Promoting Development Cooperation Dialogues at the Economic and Social Council-Department of Economic and Social Affairs Office for ECOSOC Support and Coordination
24. The Indian Sundarban Mangrove Forests: History, Utilization, Conservation Strategies and Local Perception Aditya Ghosh , Susanne Schmidt , Thomas Fickert and Marcus Nüsser
25. Analysis of coastal land use/land cover changes in the Indian Sunderbans using remotely sensed data Debajit DATTA & Shovik DEB
26. SUSTAINABLE BIODIVERSITY MANAGEMENT OF THE SUNDARBAN: DISASTER MANAGEMENT PERSPECTIVE M. Shamsuzzoha, A. K. M. A. A. Biswas.

