



KHARAGPURCOLLEGE

KHARAGPUR

ESTD.:1949

P.O.– Inda, Kharagpur, Municipality– Kharagpur, Sub-Division–
Kharagpur,P.S.–Kharagpur(T),Dist.–PaschimMedinipur, WestBengal,PIN–
721305.

List of the 6th Semester student for Sundarban field survey, Department of Geography
Survey Schedule Date: 27/03/2023 to 30/03/2023

Sl. No.	Name of the Student	Sl. No.	Name of the Student
1	K. Sangita	20	Anindita Chanda
2	Ramen Dolai	21	Sukhendu Mondal
3	Sarit Sekhar Bhunia	22	Deblina Brahma
4	Suvadip Maity	23	Jayashree Ghosh
5	Sanjoy Mahata	24	Gangotri Barman
6	Sagar Pal	25	Buddheswar Hansda
7	Kingsuk Mandal	26	PayelMaiti
8	Rakesh Nayak	27	Akash Singh
9	Poulami De	28	Soumita Acharya
10	Pratik Mahali	29	Jasmin Khatun
11	Debjani Paria	30	Arkaprava Mondal
12	Ankita Maity	31	Ankana Pandit
13	Chandan Mana	32	Alisha Sharma
14	Purnima Mahata	33	Mousumi Khamrai
15	Priti Bhattacharjee	34	Moumita Dey
16	Ananya Das	35	Prasanta Sanbighna
17	Annanya Roy	36	Subhajit Dhara
18	Chhanda Bose	37	Nandini Halder
19	Priyanka Roy	38	Binita Das

Principal
Kharagpur College

25/03/23

List of Teaching and Non-teaching staff for Sundarban field survey, Department of Geography:

Sl. No.	Name of the Teacher and Non-teaching staff	Designation
1	Rimpa Mula	Teacher
2	Dianbandhu Patra	Teacher
3	Mukul Maity	Teacher
4	Rajesh Bhattacharjee	Non-teaching staff





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P.O.– Inda, Kharagpur, Municipality– Kharagpur, Sub-Division– Kharagpur,
P.S.– Kharagpur (T), Dist.– Paschim Medinipur, West Bengal, PIN– 721305.

Ref no.

Date.....

From ,

Dr. Bidyut Samanta

Principal, Kharagpur College

Kharagpur, Paschim Medinipur

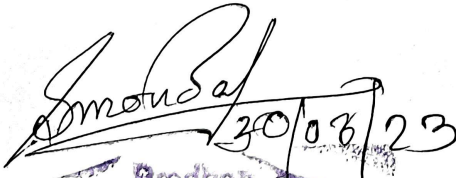
To

The Pradhan
Bally - 2 GP
Gosaba
South 24 Pargana

Respected Sir,

This is to inform you that the Kharagpur College is sending 38 students of 6th Sem (Hons) of Dept. of Geography to Sundarban of South 24 Parganas district under the guidance of Rimpa Mula, Mukul Maity & Dinabandhu Patra, Faculty member of Dept. of Geography also with one non teaching staff Rajesh Bhattacharya from the Dept. of Geography to your locality to fulfill their project work as per Vidyasagar University UG Syllabus.

I wish your Kind Co-operation.


30/08/23
Pradhan
Bally - II Gram Panchayat
Bijaynagar, Gosaba
South 24 Parganas

Principal
Kharagpur College

(6)

Your Faithfully
(Dr. Bidyut Samanta)

Principal
Kharagpur College



An Assessment of Socio Economic and Climatic Hazard Related Vulnerability in Bali-II GP, Indian Sundarbans

**Project report submitted to the Kharagpur
College**

**in partial fulfillment of the requirements
for the award of the Degree of
Bachelor of Science (B.Sc. Honours) in
Geography**



Under the Supervision of:

Rimpa Mula

Dinabandhu Patra

Mukul Maity

Department of Geography

Kharagpur College

Submitted by: Subhajit Dhara

Roll: 1126121 No.: 200091

Registration No.: 1210957 of 2020-2021

DEPARTMENT OF GEOGRAPHY

KHARAGPUR COLLEGE

KHARAGPUR – 721305

2023

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KHARAGPUR COLLEGE

DEPARTMENT OF GEOGRAPHY

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To whom it may concern

To whom it may concern This is to certify that Mr./Miss/ Mrs. Subhajit Chandra
Roll. 1126121.....No. 200091..... Reg No. 1210957.....of
2020-2021..... is a student of B.Sc., Semester- VI in Department of Geography,
Kharagpur College, Kharagpur. In the Project work entitled "An Assessment of Socio Economic and
Climatic Hazard Related Vulnerability in Bali-II GP, Indian Sundarban". He/she had actively
participated in the field work under our guidance and supervision during the academic year 2022-2023,
submitted for partial fulfilment of requirement of B.A/B.Sc. Semester-VI syllabus of Vidyasagar
University also he/she effectively completed the project work. This is an original piece of work done
by the group of students including the candidate.

11/08/23

Rimpa Mula
Department of Geography
Kharagpur College

Mukul Maiti

Mukul Maiti
Department of Geography
Kharagpur College

Dinabandhu Patra

Dinabandhu Patra
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ACKNOWLEDGEMENT

My completion of this project could not have been accomplished without enormous support, help, worthy experience of those people, in front of these immense debt the letter will be always inadequate and incomplete by my expression of gratitude at this stage.

I express my deep sense of gratitude to my guides, Mrs. Rimpa Mula, Mr. Mukul Maity, Mr. Dinabandhu Patra of Geography Department of Kharagpur college, for their excellent guidance. who give me the golden opportunity to this field reports on the topic "An Assessment of Socio Economic and Climatic Hazard Related Vulnerability in Bali-II GP, Indian Sundarbans". I wish to convey my innermost esteem & feelings of gratitude to my teachers for meticulous supervision, illuminating advice and constant encouragement to carry out my project Paper.

I wish to express my reverence and gratitude my departmental teachers- Mrs. Sharmistha Manna, Mr. Safikul Haque and our principal Dr. Bidyut Samanta for their valuable suggestion and help in many difficulties during the project.

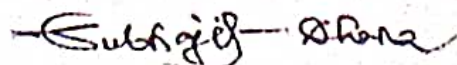
I am also incredibly thankful to our laboratory assistant Sir Tapan Songiri, Sri Sumit Chowdhury, Sri Rajesh Bhattacharya, who helped me whenever I was in need, they were behind me.

I am also grateful to the all inhabitants of the Bali-II GP of Sundarbans for their response and providing information. I also thankful to my entire class mate for their co-operative work, support and help up to fulfil my project.

At last, but not the least my parents and family are also an inspiration for me. So, with due regards I express my gratitude to them.


To the best of my knowledge, the matter embodied in the project has not been submitted to any other university/institute for the award of any degree and it is also more authentic. I am making this field report not only for mark but to also increase my knowledge.

Thanks again to all who helped me.



Signature

Date: - 11.08.23



Chapter –I

Introduction of the Field Study

AN ASSESSMENT OF SOCIO ECONOMIC AND CLIMATIC HAZARD RELATED VULNERABILITY IN BALI-II GP, INDIAN SUNDARBAN

CHAPTER-I

Introduction:

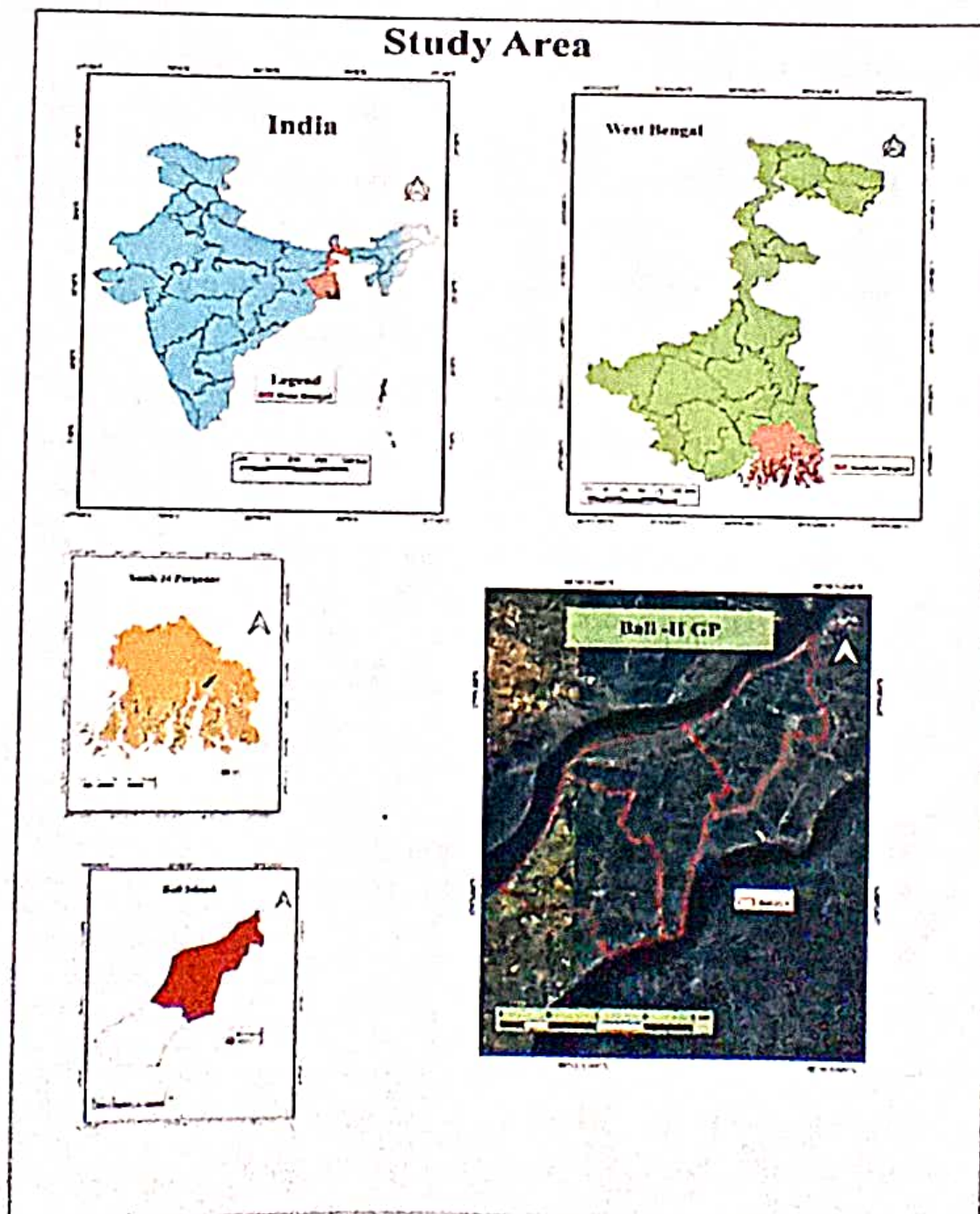
The Indian Sundarbans with its unique bio-geographical composition is prone to hazards like cyclones, storms and floods, making its socio-ecological systems vulnerable to environmental stresses. Sundarbans is situated within the interiors of South 24 Parganas, world's largest delta and home to widespread mangrove forests. The total area of the Sundarbans reserved for mangrove forests includes 10,000 square km, of which Bangladesh has 6000 square km and India has the rest. Sundarbans forest lies in the vast delta on the Bay of Bengal formed by the super confluence of the Ganges, Brahmaputra and Meghna rivers. The area is intersected by a complex network of tidal waterways, mudflats and small islands of mangrove forests. The largest mangrove forest island is named Sundarbans by the name of a tree "Sundari", which means beautiful and this place is also a perfect epitome of beautiful enchanting forest land. Sundarbans is popularly known for eponymous Royal Bengal Tiger, as well as numerous faunas including species of birds, spotted deer, crocodiles and the Indian Python. The forest treasures 330 plant species, 35 reptiles, 400 types of fishes, 270 species of birds and 42 species of mammals. This deltaic coastal region comprises wildlife sanctuary, bio-sphere reserve and world's largest mangrove forest. It has been declared as UNESCO World Heritage Site in the year 1987. The life the people residing here is extremely risky. They largely depend on rivers and forest for life sustenance. Their only mean of communication between the islands is through rivers. Interposed between the sea, rivers, canals and creeks, Sundarbans is inundated twice a day by sea water. A large number of populations in this area depend on the forest for food and income. They ply the coastal lines for crabs and fishes or go deeper into the forest for woods and honey. Risking their life to such extent can make their life vulnerable to tigers. According to NPR report, on an average 25 people on the Indian side of Sundarbans are attacked every year by tigers. Majority of the people live far below poverty line. Subsequently their literacy rate is also very poor. Most of the people residing in this coastal region are illiterate. Health care system of this area is also very poor, people have to go miles by boat in order to avail basic treatment from the primary healthcare centre. The life at Sundarbans is risky, exotic and completely depending on the nature.

Of the more than 100 deltas and islands that together comprise Bali delta region covers some 2000 hectares of area. Bali is a lesser-known island, more prone to neglect. The island has a population count of 17,000 inhabitants. Even after 75 years of independence, Bali has not witnessed much development. Bali island has been victimized by diverse etiquettes of climate-induced hazards and consequently enormous human population displaced, increasing stress of economic demands, enhance

the rate of vulnerability and risk in a diverse manner across marginalized groups and thereby making the region socio-economically assailable.

Study Area:

The study area, Bali-II is a village in Gosaba Block in South 24 Pargana district of West Bengal. Bali II is surrounded by Sandeshkhali II block towards north, Basanti block towards west, Hingalgang block towards north and Canning block towards west. Three Mouzas namely Bali, Bijoyanagar and Birajnagar of Bali II village have been selected for survey.



Objectives:

1. To find out the overall socio-economic conditions of the communities.
2. To understand the common floral and faunal characteristics on Sundarban hydro-geomorphic set up along river bank.
3. To explore the impact of disaster with adaptive and mitigations measure of the communities.

Limitation of Study:

- Time bound for survey was very less, more detail study was not possible.
- To details study, we need to survey a large area, due to time frame and financial resources survey was done with in a limited area.
- It was a risk full and protected zone so work was little difficult to complete quickly, transportation was one of the major challenges here.
- Another challenge was the extreme hot condition in the of this area during the summer condition of peak March and start of April.
- For the data analysis due to unavoidable causes, we are not able to give much time and beside this there was lack of analysis device (computer) in personal level in department, existing device used by other students.
- Due to short day visit the livelihood vulnerability work was based on quantitative work so we cannot go very dept as required. Here need to too much observation for qualitative study.

Scope:

- It was a great opportunity for floral and faunal measure and some environmental or Physical study.
- If we increase the survey time for more in-depth study we can got the clear picture; beside that, instead of cross sectional study long term longitudinal study will more implacable for disaster impact study.

Methodology:

Field work for this study was done over a period of three days at Ball II village in Gosaba block, South 24 Pargana District. Most of the data on socio-economic status, impact of natural hazards was collected from household survey. The main focus of the study depends on climatic hazard and its impact on socio-economic life and also on the environment.

Sources of data:

The task of data collection begins after defining the research problem. There are two sources of data. The primary data those which are collected afresh and for the first time, the secondary data on the other hand are those which have been collected by someone else and which have already been passed through the statistical process.

Primary Data:

The data have been collected at the household level using structured schedule. This information has been collected from the rural people.

More focused and in-depth interviews were conducted with some respondents to generate more meaningful qualitative data and to provide some insights into research objectives. The observation method was also applied as it eliminates the subjective bias, when observation was done accurately.

Secondary Data:

The secondary data has been collected from the census report, gazetteers, other Government reports, libraries and the bureaus of applied economics and statistics. Other important data related to study has been collected from different NGOs, published and unpublished documents and websites.

Sample Design:

A sample design is a definite plan for obtaining a sample from a given population. It refers to the technique or procedure the researcher would adopt in selecting items for the sample. The first step in developing any sample design is to clearly define the set of objects, technically called the universe. Next a decision has been taken concerning a sample unit. Then the size of the sample has been decided upon. The size refers to the number of items to be selected from the universe to constitute a sample (Kothari, 2000). In this case samples have been collected keeping in the view intensity of hazard and effected environment, socio-economic condition of the study area.

- Universe: Rural people
- Sample Unit: One selected Villages
- Sample Size: 122 household in the selected Village.

An appropriate sampling procedure was adopted for the purpose of arriving at a representative sample, which is capable of representing the universe adequately for the study. For the selection of the sample unit, simple random sampling method has been adopted.

The present work will be conducted following a structural methodology divided into respective stage as per requirement.

Table No.11 Methodological Steps

SL. NO	METHODOLOGICAL STEPS
1	<p>PRE FIELD:</p> <ul style="list-style-type: none"> • Survey of available literature • Secondary data and reference • Selection of sampling techniques, designing of the samples and specifying its size • Questionnaire
2	<p>FIELD:</p> <ul style="list-style-type: none"> • Household survey and interview • Village survey
3	<p>POST FIELD:</p> <ul style="list-style-type: none"> • Tabulation of data • Digital cartographic techniques for interpretation • Analysing the data with help of different software like -SPSS, MS-EXCEL. • Preparation of map by Arc GIS.

Survey Discussion

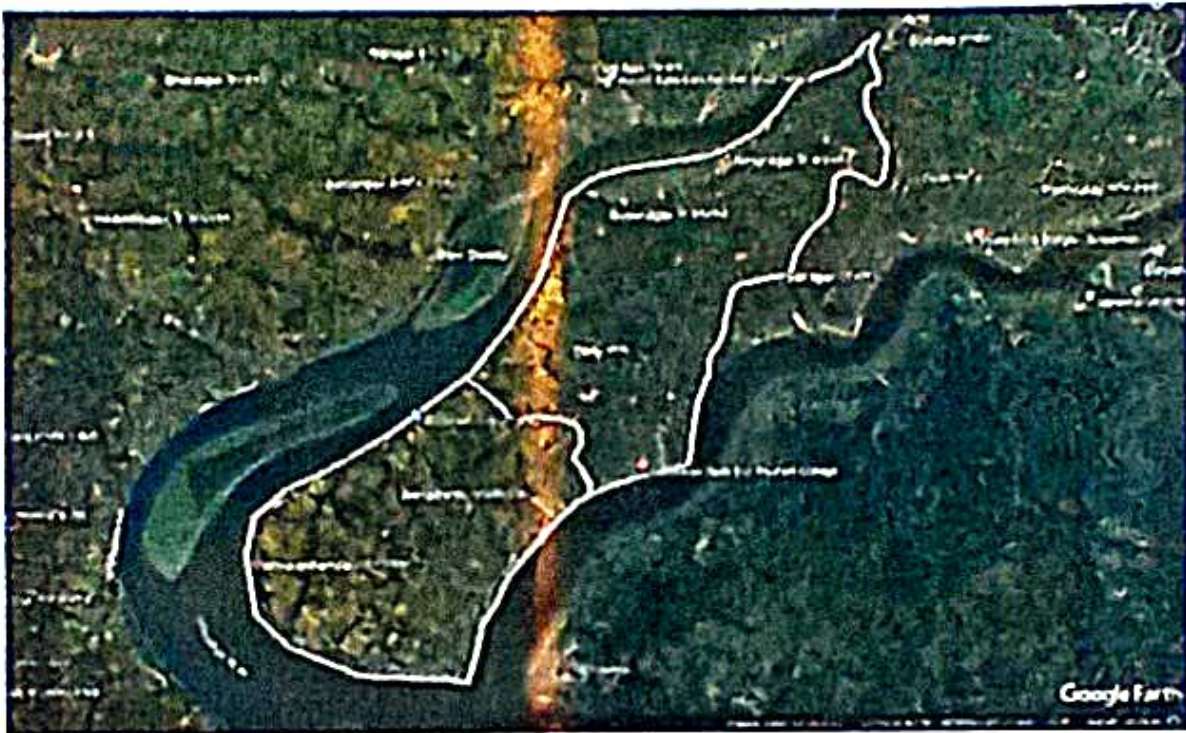


Chapter –II

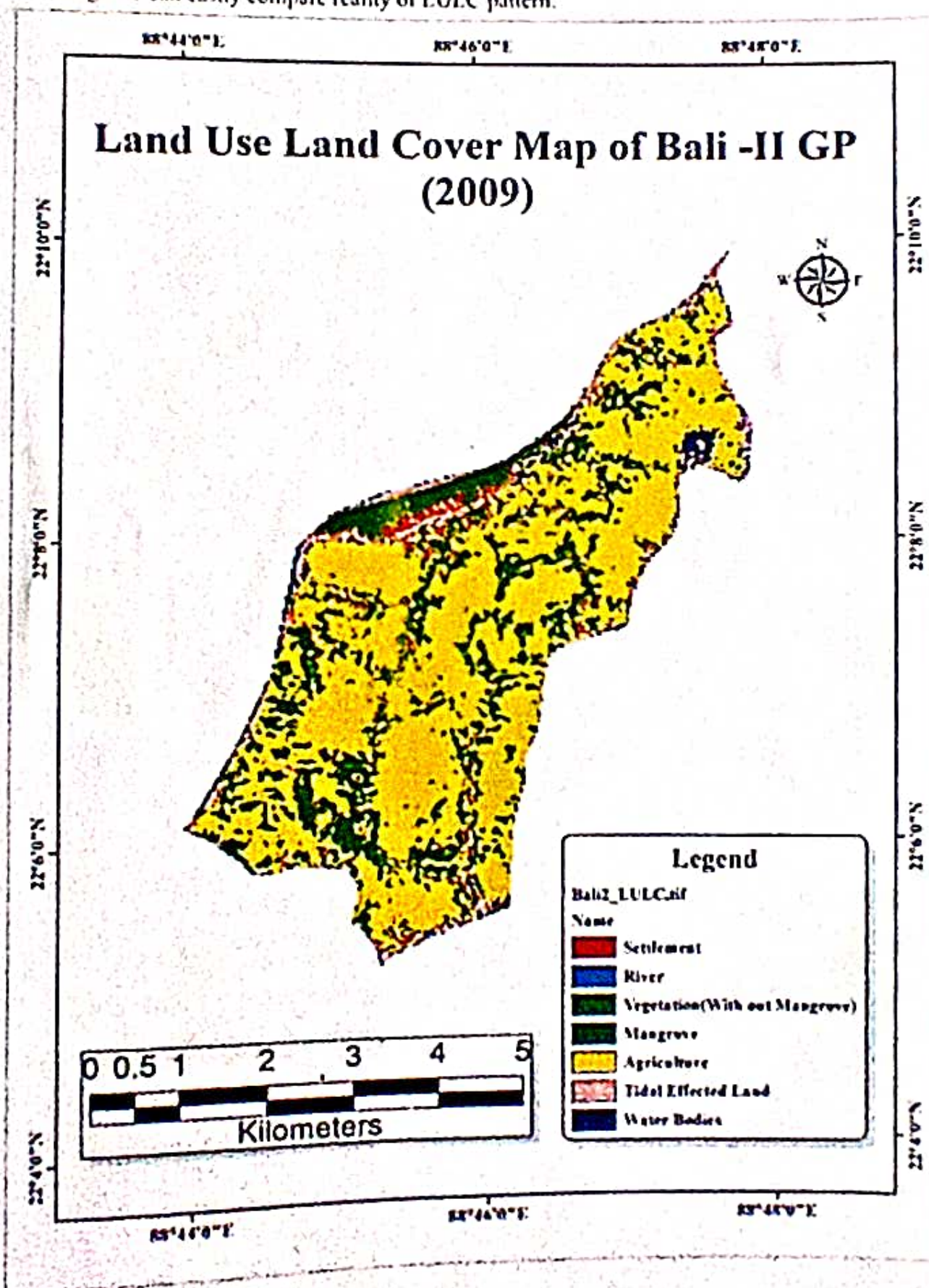
Geo-spatial Analysis of the Study Area

CHAPTER II

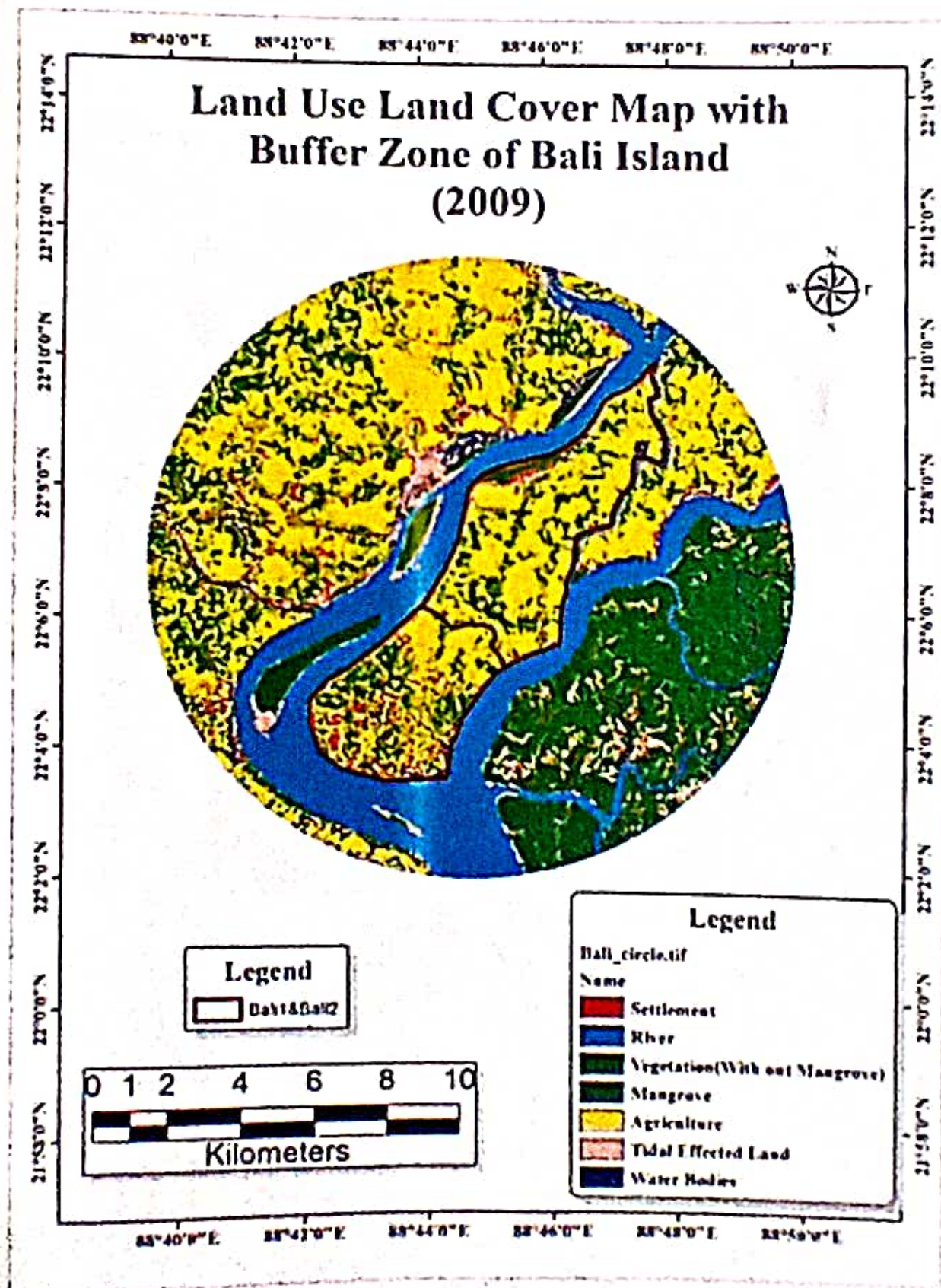
The terminology Landuse and Landcover is usually used interchangeable, it has a specific significance for every phase. Landcover means the surface cover of the land, such as Mangrove, Tidal Tract, Tidal channel, Agricultural land etc



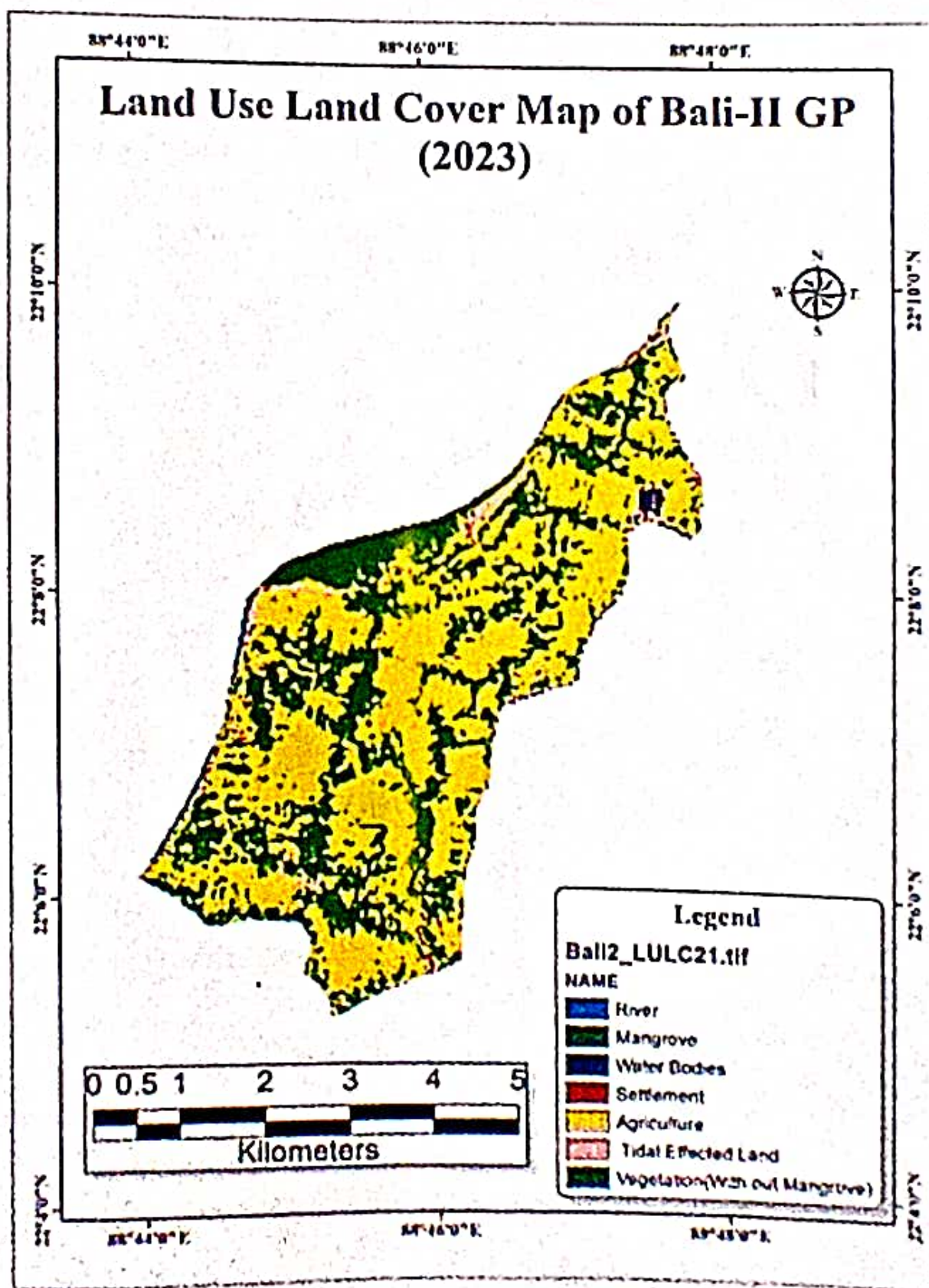
Landuse / Landcover (LULC), refers to the categorization and classification of human activity and natural landscape aspects with in a certain time frame and it is based scientific method. Through this image try to represent pattern of LULC on the peripheral region of Bali-II GP. Depends on that two image we can easily compare reality of LULC pattern.



Here we can observe that majority portion of Bali-II GP (Bali Island) covered by mangrove forest beside the tidal river Datta River. Here, mainly try to compare LULC in between the year 2000 and 2023 in respect to before Aila Cyclonic storm and present context.



Due to Aila cyclone people are affected greatly which also influence Land use changes of Bali Island. Mangrove forest on the coastal region highly degraded on that time. Till now not restore these mangroves in tidal tract region.



Land Use Land Cover Map with Buffer Zone of Bali Island (2023)



Legend	
	Bali1&Bali2
CircleExtract_LULC11.tif	
NAME	
	River
	Mangrove
	Water Bodies
	Settlement
	Agriculture
	Tidal Effected Land
	Vegetation (With out Mangrove)

Chapter –III
Hydro-Geomorphic
Analysis on Datta
river and along the
river Bank

CHAPTER III

Water Velocity:

A simple method for measuring flow rate through an open channel is the Float method. Although not as accurate as a measuring device such as a flume flow meter, the float method can provide an educated estimate. Briefly put, this method involves measuring the surface velocity of the water with a floating object, and then multiplying this velocity by the width and average depth of the channel.

$$V (\text{Velocity}) = \frac{d}{t}$$

Where,

d=Distance Traveled in feet

t= Time traveled in seconds

Average velocity measured through this method mention below-

$$V_a (\text{Average velocity}) = \frac{\sum v}{n}$$

Where,

V= velocity (individual measure)

n=number of times

In this study we measured average velocity of surface water on Datta River. It was afternoon (1:52) time during the measure. We use the simple conventional floating method. Floating time of surface float was measured by stop watch for the specific distance was 20 feet. Average surface velocity is found 0.607158 feet per second. This velocity measure work happen when first time change of water level found after a long time stability (started to increase the water level) that means effects of tide just began.

A study on Sundarban River System identified that 11 high-velocity sites where flow velocity of up to 2.46 m/s was observed for the study period; highest tidal velocity along with the higher tidal ranges was found during the March equinox (March/April), whereas the lowest velocity along with the lower tidal ranges was observed during the summer solstice (July/August). Another interesting results showed that the velocities within the narrow channels were stronger compared to those in the wider channels. A variation of tidal velocities from 0.5 to 1.0 m/s was also observed for other areas for a higher period during a day. This study also found that the shorter flood tide period caused stronger flood tidal velocity than the ebb-tidal velocity (Bhui et al., 2022).

So, finally we can conclude that our simple but quite important and reliable surface float technique is believable because our result is concordant with the above-mentioned research article if we adjust with time of tide and season.

Field book for Surface Water Velocity Measurement of Datta River

Date: 30th March, 2023

Lat: 22° 06' 12.04" N

Long: 88° 46' 14.98" E

Place: Near Datta River

Station: A

Time: 1:52 P.M.

Experiment	Starting time	Finish Time	Distance Cover (f)	Time taking to Cover the distance (seconds)	Velocity of water (f/s)	Remarks
1	1:52:00	1:52:34	20	34	0.588235	Depth of Water = 1.05 m
2	1:54:00	1:54:37	20	37	0.540541	
3	1:55:00	1:55:27	20	27	0.740741	
4	1:56:00	1:56:47	20	47	0.425532	
5	1:58:00	1:58:27	20	27	0.740741	
Average surface velocity					0.607158	

Source: Field survey on Datta River, Sundarban, 2023, Department of Geography, Kharagpur College



Fig: preparation for measure of velocity



Fig. Students using the float method for velocity

Source: Sundarban field survey, 2023

Total dissolved solids (TDS):

Total dissolved solids (TDS) are the amount of organic and inorganic materials, such as metals, minerals, salts, and ions, dissolved in a particular volume of water. TDS are essentially a measure of anything dissolved in water that is not an H₂O molecule. Since it is a solvent, when water encounters soluble material, particles of the material are absorbed into the water, creating total dissolved solids.

TDS in water can come from just about anywhere, including natural water springs, chemicals used to treat the municipal water supply, runoff from roads and yards, and even from your home plumbing system.

In our study area four sample has been taken for study of TDS through TDS meter. one sample from river Datta and another three from tube well of Inside of village. River's TDS came 262 and tube well's water TDS came around 450. Here, It is found that river water has less TDS value compare to Tube well, may several particles such as metals, minerals, salts, and ions are contaminated with ground water, that makes high TDS value. As per WHO guide line TDS scale is given below-

Level of TDS (Million per Litre)	Rating
Less than 300	Excellent
300-600	Good
600-900	Fair
900-1200	Poor
Above 1200	Unacceptable

Total dissolved solids can affect your water quality, your health, your home plumbing system, and even daily tasks, such as cooking and cleaning. By measuring your water for TDS, you can better understand your water quality and how it affects your everyday life, allowing you to make an informed decision to solve your water quality problem and install the most effective filtration system for your home.

Need of Measurement:

Different purpose of measurement is described below-

Taste- High levels of TDS in water affect the taste of your drinking water. Your water may taste bitter, salty or sulfuric depending on the type of dissolved solids present in water

Health Purposes- Water with high TDS is completely safe to drink. However, some substances such as lead, or copper can lead to health hazards.

Maintenance of Filters- Water filtration systems are affected by a high level of TDS. Testing the water purifier systems regularly will ensure that the filters work properly

Cooking- Though high TDS doesn't affect health, it can alter the taste of your food.

Cleaning- High TDS in water leaves ugly spots on your utensils. This type of water also fades the colour of your clothes, leading to a build-up in your sinks, tubs, and faucets.

Plumbing and Appliances- High amounts of dissolved calcium and magnesium salts can cause scale to form in pipes and appliances, reducing their lifespan. The above are the reasons to measure total dissolved solids in water.

FIELD BOOK
Levelling Survey by Dumpy Level
Rise & Fall Method (River Side)

Place: Ball Island

Date : 29/03/2023

Inst. NO: 01

Time: 12:36 PM

Station	Distance	Selected Scale	According to scale	B.S	I.S	F.S	Rise (+)	Fall (-)	Reduced level	Vertical Scale	Detum Line	Remarks
A1	-			0.93					20		10.96	B.M. = 20 m
A2	3.3	1cm	1.65		0.86		0.07		20.07	1 cm	11.04	
A3	5.9	to	2.95		1.23			0.37	19.7	to	10.64	
A4	9.3	2 meter	4.65		1.53			0.3	19.4	0.93 meter	10.32	
A5	12.6		6.3		1.86			0.33	19.07		9.96	
A6	16.1		8.05		0.91		0.95		20.02		10.98	
A7	20.1		10.05		0.64		0.27		20.29		11.28	
A8	23.7		11.85		0.73			0.09	20.2		11.18	
A9	27.2		13.6		0.63		0.1		20.3		11.3	
A10	30.5		15.25		0.98			0.35	19.95		10.91	
A11	33.7		16.85		0.69		0.29		20.24		11.25	
A12	38		19		1.35			0.66	19.58		10.51	
A13	42.2		21.1		0.82		0.53		20.11		11.08	
A14	48.5		24.25		0.96			0.14	19.97		10.93	
A15	53.2		26.6		0.46		0.5		20.47		11.47	
A16	60.2		30.1		0.78			0.32	20.15		11.13	
A17	65.5		32.75		0.5		0.28		20.43		11.43	
A18	70.1		35.05		0.55			0.05	20.38		11.37	
A19	73.7		36.85		0.46		0.09		20.47		11.47	
A20	79.6		39.8		0.47			0.01	20.46		11.46	
A21	85.6		42.8		0.58			0.11	20.35		11.34	
A22	90.2		45.1	0.49		0.32	0.26		20.61		11.62	
A23	97.3		48.65		0.31		0.18		20.79		11.81	
A24	103.3		51.65		0.22		0.09		20.88		11.91	
A25	107.3		53.65		0.16		0.06		20.94		11.97	
A26	121.3		60.65		0.20			0.04	20.9		11.93	
A27	137.6		68.8			0.50	0.3		20.6		11.61	

The Journal of the Survey of the Coast of the State of New York from 1800 to 1805

Part I
 1800

Part II
 1801

Part III
 1802



Lat.	Long.	Wind	Sea	Therm.	Barom.	Time
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00

Lat.	Long.	Wind	Sea	Therm.	Barom.	Time
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00

Lat.	Long.	Wind	Sea	Therm.	Barom.	Time
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00

Lat.	Long.	Wind	Sea	Therm.	Barom.	Time
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00
42° 30'	71° 30'	N. by E.	by S.	58°	30.0	10.00

The
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FIELD BOOK

Levelling Survey by Dumpy Level

Rise & Fall Method (River bank)

Place: Ball Island

Time: 12:30 PM

Inst.NO:1

Date: 29/03/2023

Station	Distance	Selected Scale	According to scale	B.S	I.S	F.S	Rise (+)	Fall (-)	R.L	V.S	Detu m Line(Hight Abov e)	Re ma rk' s
A ₁				3.65				0.14	20		10.23	B M -2 0m
A ₂	1.9	1cm to 3m	0.63		3.79		0.06		19.86	1cm to 1.21m	10.12	
A ₃	4.2		1.4		3.73			0.03	19.92		10.16	
A ₄	5.5		1.8		3.76			0.02	19.89		10.14	
A ₅	7.6		2.5		3.78		0.08		19.87		10.12	
A ₆	11.5		3.8		3.7		0.02		19.95		10.2	
A ₇	13.1		4.3		3.68			0.12	19.97		10.21	
A ₈	15.5		5.2		3.8			0.05	19.85		10.11	
A ₉	17.7		5.9		3.85			0.08	19.8		10.1	
A ₁₀	20		6.6		3.93		0.16		19.72		10	
A ₁₁	22		7.3		3.77		1.3		19.88		10.13	
A ₁₂	29.1		9.7		2.47		0.95		21.18		11.21	
A ₁₃	31.5		10.5		1.52			1.63	22.13		12	
A ₁₄	36.9		12.3		3.15		0.18		20.5		10.64	
A ₁₅	43.2		14.4		2.97		0.03		20.68		10.8	
A ₁₆	47.8		15.9		2.94			0.87	20.71		10.82	
A ₁₇	53.8		17.9	3.66		3.81	0		19.84		10.1	
A ₁₈	63.8		21.2		3.66		0.04		19.84		10.1	
A ₁₉	74.1		24.7		3.62		0.12		19.88		10.31	
A ₂₀	82.8		27.6		3.50			0.03	20		10.23	
A ₂₁	91.3		30.4		3.53		0.01		19.97		10.21	
A ₂₂	96.9		32.3		3.52		0.2		19.98		10.21	
A ₂₃	105		35		3.32		0.65		20.18		10.4	
A ₂₄	111		37		2.67			0.53	20.83		11	
A ₂₅	118.3		39.4		3.2			0.07	20.3		10.5	
A ₂₆	124.4		41.4		3.27			0.08	20.23		10.42	
A ₂₇	131.3		43.7		3.35		0.11		20.15		10.35	
A ₂₈	144.5		48.1		3.24			0.28	20.26		10.45	
A ₂₉	152.3		50.7		3.52		0.17		19.98		10.21	
A ₃₀	160.9		53.6		3.35		0.08		20.15		10.35	
A ₃₁	171.4		57.1			3.27			20.23		10.42	

THE NEW YORK BOTANICAL GARDEN

From Kaul's Island Rice and Fall Method (Along the River Road)

June 1891

Gold 294/1000
The 1000 series



FIELD BOOK

Table For Traverse Survey by Prismatic Compass & Full Method (River Bank)

Place : Ball Island Time : 12:45 PM

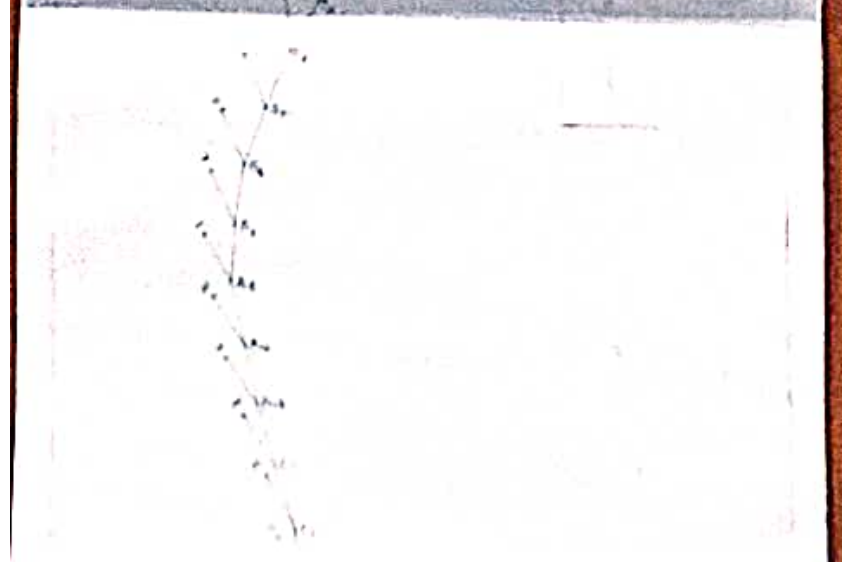
Inst. No:

01

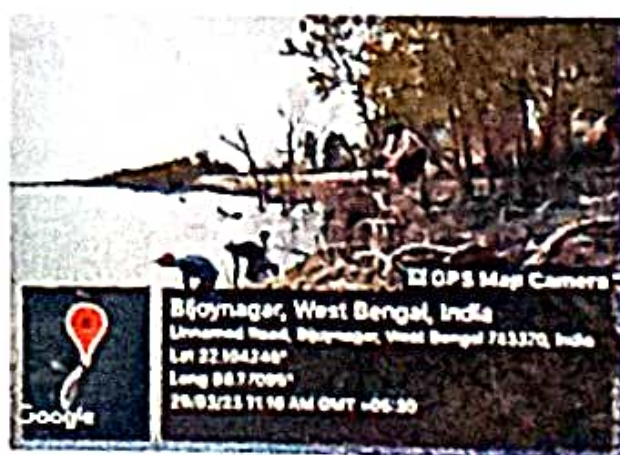
Date : 29/03/2023

Station	Distance (m)	Fore Bearing (F B)	Remarks
A1	10	192°30'	Electric poll
A2	20	195°30'	
A3	30	192°30'	
A4	40	187°30'	
A5	50	193°30'	
A6	60	209°30'	
A7	70	219°30'	Near Pond
A8	80	228°30'	
A9	90	225°00'	
A10	100	221°30'	
B1	110	216°30'	
B2	120	210°30'	
B3	130	206°30'	
B4	140	201°30'	
B5	150	197°30'	
B6	160	188°30'	
B7	170	181°30'	
B8	180	169°30'	
B9	190	166°30'	
B10	200	163°30'	
C1	210	159°30'	
C2	220	173°30'	
C3	230	197°30'	
C4	240	199°30'	
C5	250	202°00'	
C6	260	203°00'	
C7	270	201°00'	
C8	280	198°30'	
C9	290	198°00'	
C10	300	199°30'	

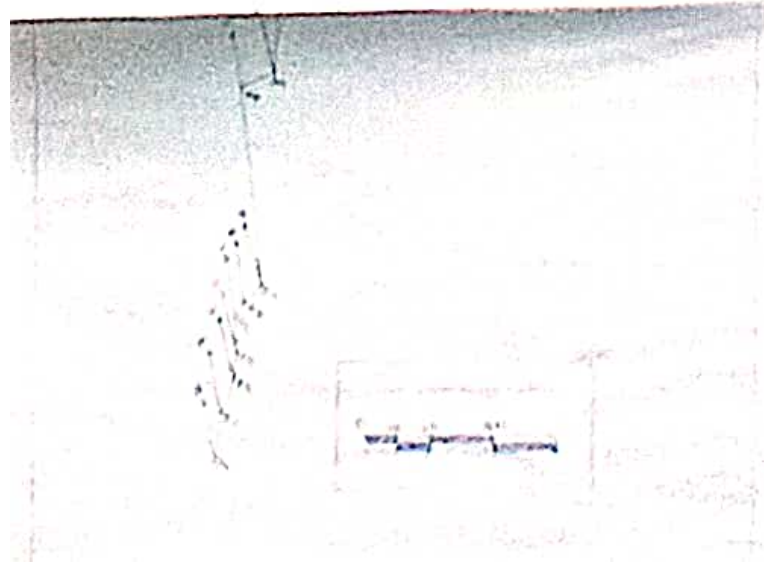
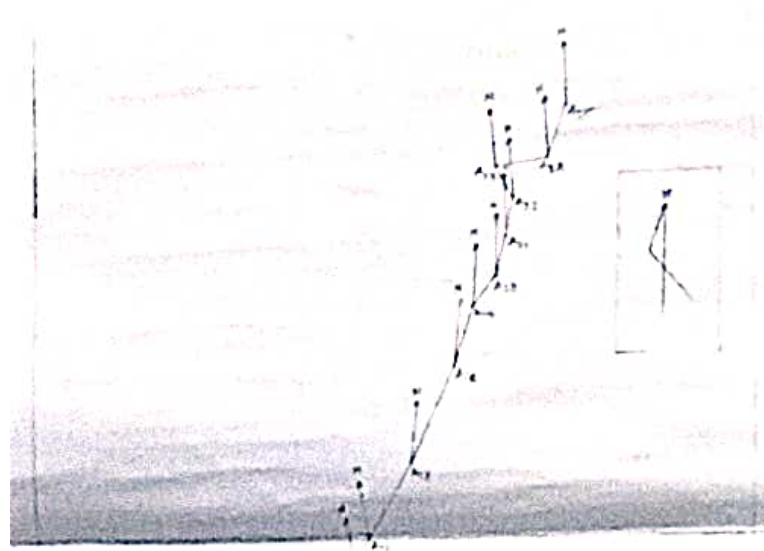
THE JOURNAL OF THE
SOCIETY OF AMERICAN ARCHAEOLOGISTS
PUBLISHED BY THE SOCIETY OF AMERICAN ARCHAEOLOGISTS
AT THE UNIVERSITY OF CHICAGO PRESS



Physical Survey



TRAIL OF 1907 by J. H. ...
 Along the ... of ...
 ...
 ...
 ...





Due to cyclonic storm and high tide in different time period people of the river bank side facing great difficulties. The agricultural land also effected in this time period. People of Hali Island loss their job forcefully started to migration. In the survey time we observe and measure vegetation degradation and embankment failure.

Chapter –IV
Hydro-Geomorphic
Analysis on Datta
river and along the
river Bank

CHAPTER- IV

Vegetation measurements:

Tree crown measurement:

Tree crown measurement is one of the tree measurements taken at the crown of a tree, which consists of the mass of foliage and branches growing outward from the trunk of the tree. The average crown spread is the average horizontal width of the crown, taken from dripline to dripline as one moves around the crown. The dripline is the outer boundary to the area located directly under the outer circumference of the tree branches. When the tree canopy gets wet, any excess water is shed to the ground along this dripline.

Cross-method Average crown spread measurement:

The average crown spread is the average of the lengths of longest spread from edge to edge across the crown and the longest spread perpendicular to the first cross-section through the central mass of the crown.

$$\text{Average crown spread} = \frac{\text{longest spread}}{\text{longest cross spread}} / 2$$

Crown spread is taken independent of trunk position. Spread should be measured to the tips of the limbs, not to "notches" in the crown shape, and at approximately right angles from each other.



Field Book for vegetation characteristics measurement

Place: Station A
Date: 28/03/2023

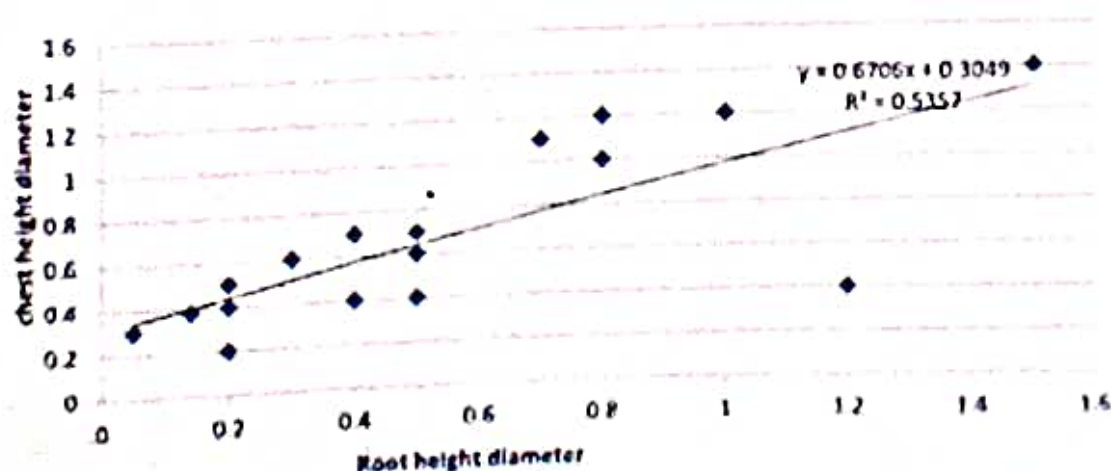
Lat: 22°06'15.16" N
Long: 88°46'15.51" E

Gnd	Tree	Chest height diameter	Root diameter	Crown height	Crown width	Crown width perpendicular	Ground to crown distance
A1	T1	14.5CM	38CM	3 M	2.5M	1.9M	1.1M
	T2	0.5CM	0.3M	2.5M	2.3M	2.3M	1.2M
	T3	0.8M	1.2M	7M	4.9M	5.6M	1.9M
A3	T1	1M	1.2M	5M	6.1M	4.2M	0.9M
	T2	0.2M	0.5M	4.5M	3.3M	3M	1.1M
A4	T1	1.5M	1.4M	8.5M	5.6M	6M	1.5M
	T2	1.2M	0.4M	3.5M	2.4M	2.1M	1M
A6	T1	0.7M	1.1M	8.7M	4.5M	7M	0.8M
	T2	0.4M	0.7M	5M	2M	2.2M	1.2M
B3	T1	0.4M	0.4M	5.5M	1.1M	2.8M	1.4M
	T2	0.2M	0.2MN	4.3M	3.3M	3M	1.1M
B5	T1	0.8M	1M	4.5M	5.6M	4.6M	3.2M
	T2	0.5M	0.6M	7.6M	7.3M	7.8M	1M
	T3	0.5M	0.7M	6.4M	4.6M	2.8M	1.6M
	T4	0.5M	0.4M	5M	4.6M	2.2M	1.1M
C1	T1	0.2M	0.4M	1.9M	1.4M	1.6M	1.1M
C2	T1	0.3M	0.6M	4M	1.3M	4.5M	1.1M

Source: Field Survey at Bali Island, Sundarban, 2023

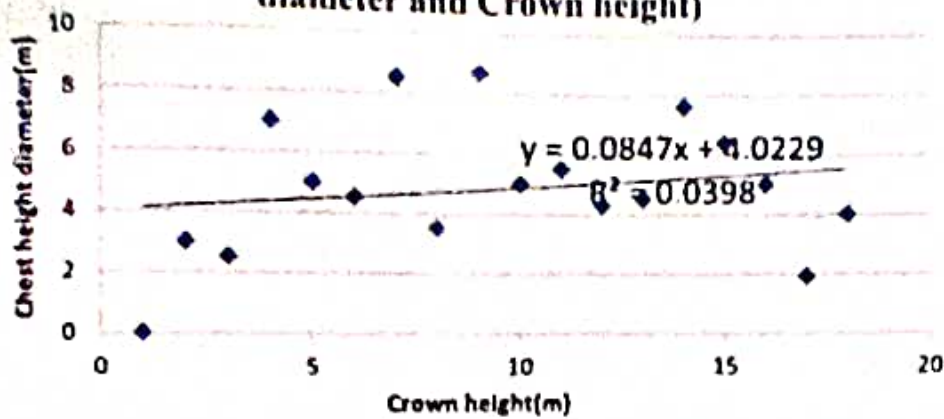
Scatter Plot

(Showing the relationship between chest height diameter and root diameter)



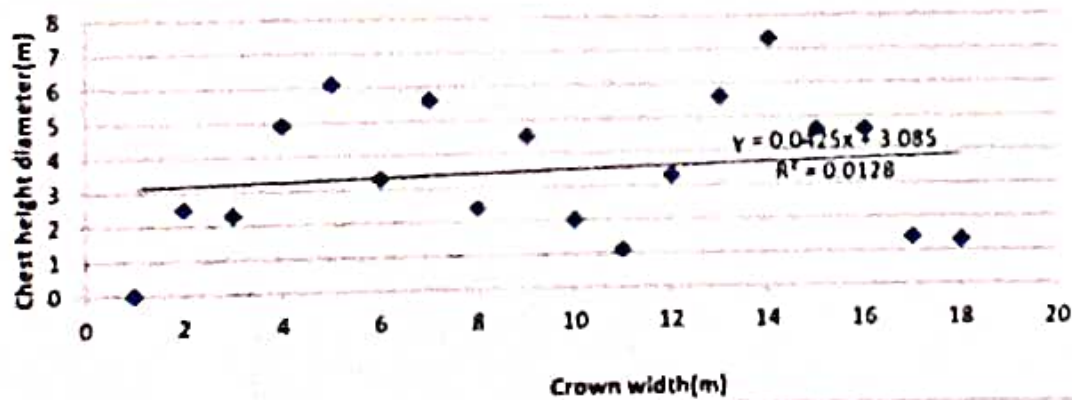
Scatter Plot

(showing the relationship between chest height diameter and Crown height)



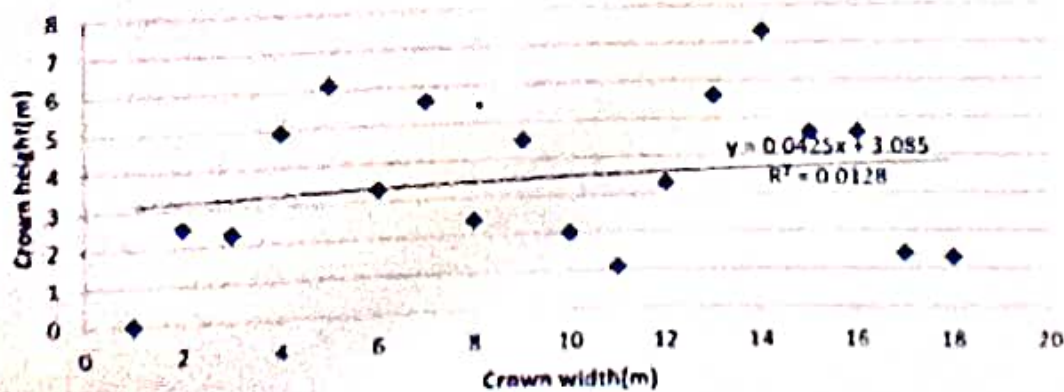
Scatter Plot

(showing the relationship between chest height diameter and Crown width)



Scatter Plot

(showing the relationship between Crown height and Crown width)



Field book for vegetation characteristics measurement

Place: Station B

Lat: 22°06'16.18" N

Date: 28/03/23

Long: 88°46'15.59" E

Grid	Tree	Chest Height Diameter (m)	Root Diameter (m)	Crown Height(m)	Crown width(m)	Crown width Perpendicular(m)	Grown to Crown Distance(m)	Average Crown Spread
A1	T1	0.2	0.4	1	1.3	1.3	1	1.3
	T2	0.1	0.2	0.4	1	0.5	0.7	0.75
	T3	0.038	0.2	0.4	0.8	0.3	0.9	0.55
	T4	0.048	0.3	2.3	1.2	0.007	1.4	0.6035
A2	T1	0.2	0.3	2	1.6	1.5	1.1	1.55
	T2	0.1	0.2	1.7	1	0.6	6	0.8
	T3	0.5	0.8	4.67	5.2	4.2	1.4	4.7
	T4	0.4	0.6	5.22	6.6	4.6	1.4	5.6
A3	T1	0.2	0.5	4	2.4	2	1.8	2.2
	T2	0.2	0.4	3	1.8	1	1.4	1.4
	T3	0.1	0.2	0.8	1	0.6	1.4	0.8
A4	T1	0.6	1	4.2	5.6	5.6	1.7	5.6
	T2	0.5	0.6	6	7	5.8	1.8	6.4
	T3	0.4	0.7	8	5.1	4.8	1	4.95
A5	T1	0.1	0.3	1.8	1.6	1.5	2	1.55
	T2	0.3	0.7	4	3	2.8	2	2.9
B1	T1	0.3	0.7	1.2	3.8	2.3	6	3.05
	T2	0.2	0.2	1.3	1.5	1.1	1.3	1.3
	T3	1.2	0.3	2.5	1	1.1	2	1.05
	T4	1.3	0.4	5	1.2	1.4	1.5	1.3
	T5	0.4	0.8	1.4	4.8	2.4	2	3.6
	T6	1	0.4	3	1.9	1.5	1.3	1.7
	T7	0.2	0.2	4.5	1.9	1.5	1.2	1.7
	T8	0.1	0.3	5.2	1.4	1.2	1.2	1.3
B2	T1	0.2	0.1	1.5	0.6	0.8	1.1	0.7
	T2	1.4	0.4	4	1.7	1.5	1.5	1.6
	T3	0.4	0.3	5	1.8	2	1.4	1.9
	T4	0.2	0.4	2.5	2.2	3.2	1.2	2.7
	T5	0.3	0.5	3.8	2.5	1.3	1.3	1.9
	T6	0.2	0.4	4.5	1.7	1.2	1.3	1.45
	T7	0.2	0.5	2.5	1	1	1.5	1
	T8	0.2	0.4	5	2.2	1.8	1.4	2
	T9	0.3	0.15	6	1.5	1.7	1.4	1.6
B3	T1	0.3	0.4	4	1.6	1.2	0.4	1.3

Field book for vegetation characteristics measurement

Place: Station B

Lat: 22° 06' 16.18" N

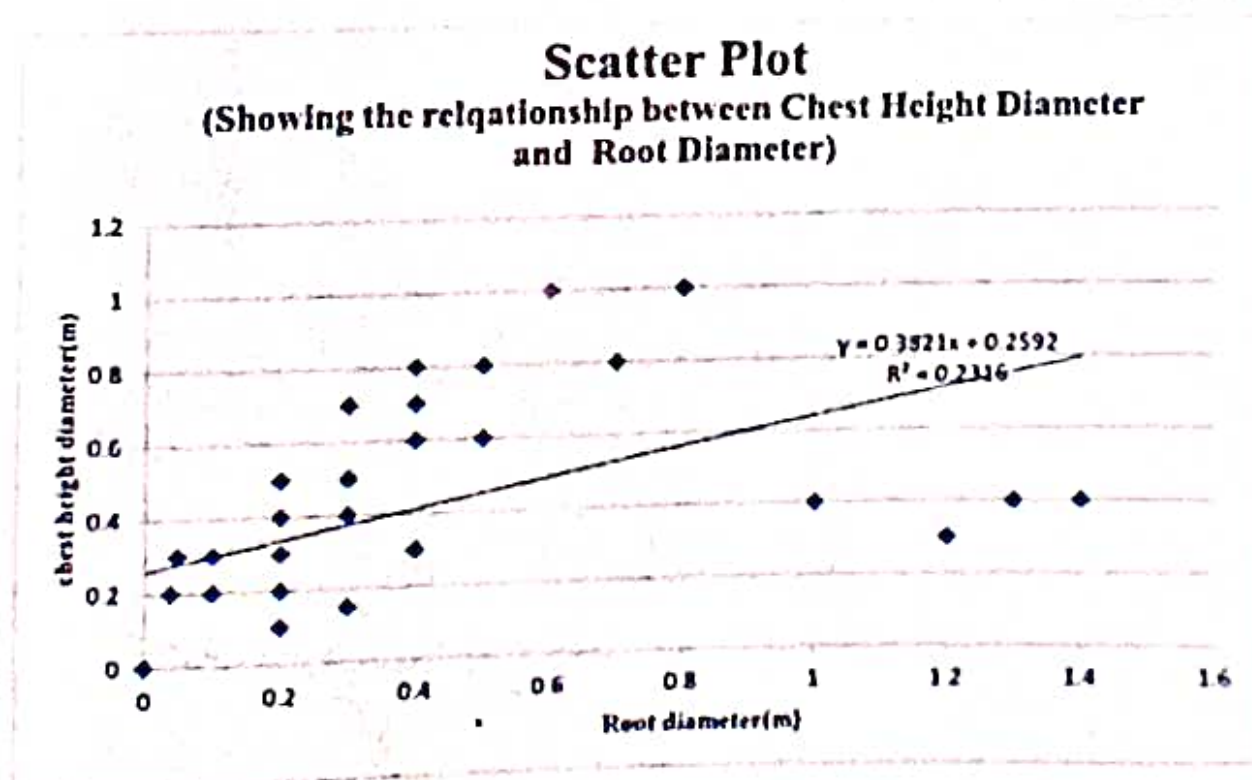
Date: 28/03/23

Long: 88° 46' 15.59" E

Grid Tree		Chest Height Diameter (m)	Root Diameter (m)	Crown Height(m)	Crown width(m)	Crown width Perpendicular(m)	Grown to Crown Distance(m)	Average Crown Spread
A1	T1	0.2	0.4	1	1.3	1.3	1	1.1
	T2	0.1	0.2	0.4	1	0.5	0.7	0.75
	T3	0.038	0.2	0.4	0.8	0.3	0.9	0.55
	T4	0.048	0.3	2.3	1.2	0.007	1.4	0.6035
A2	T1	0.2	0.3	2	1.6	1.5	1.1	1.55
	T2	0.1	0.2	1.7	1	0.6	6	0.8
	T3	0.5	0.8	4.67	5.2	4.2	1.4	4.7
	T4	0.4	0.6	5.22	6.6	4.6	1.4	5.6
A3	T1	0.2	0.5	4	2.4	2	1.8	2.2
	T2	0.2	0.4	3	1.8	1	1.4	1.4
	T3	0.1	0.2	0.8	1	0.6	1.4	0.8
A4	T1	0.6	1	4.2	5.6	5.6	1.7	5.6
	T2	0.5	0.6	6	7	5.8	1.8	6.4
	T3	0.4	0.7	8	5.1	4.8	1	4.95
A5	T1	0.1	0.3	1.8	1.6	1.5	2	1.55
	T2	0.3	0.7	4	3	2.8	2	2.9
B1	T1	0.3	0.7	1.2	3.8	2.3	6	3.05
	T2	0.2	0.2	1.3	1.5	1.1	1.3	1.3
	T3	1.2	0.3	2.5	1	1.1	2	1.05
	T4	1.3	0.4	5	1.2	1.4	1.5	1.3
	T5	0.4	0.8	1.4	4.8	2.4	2	3.6
	T6	1	0.4	3	1.9	1.5	1.3	1.7
	T7	0.2	0.2	4.5	1.9	1.5	1.2	1.7
	T8	0.1	0.3	5.2	1.4	1.2	1.2	1.3
B2	T1	0.2	0.1	1.5	0.6	0.8	1.1	0.7
	T2	1.4	0.4	4	1.7	1.5	1.5	1.6
	T3	0.4	0.3	5	1.8	2	1.4	1.9
	T4	0.2	0.4	2.5	2.2	3.2	1.2	2.7
	T5	0.3	0.5	3.8	2.5	1.3	1.3	1.9
	T6	0.2	0.4	4.5	1.7	1.2	1.3	1.45
	T7	0.2	0.5	2.5	1	1	1.5	1
	T8	0.2	0.4	5	2.2	1.8	1.4	2
	T9	0.3	0.15	6	1.5	1.7	1.4	1.6
B3	T1	0.3	0.4	4	1.6	1.2	0.4	1.1

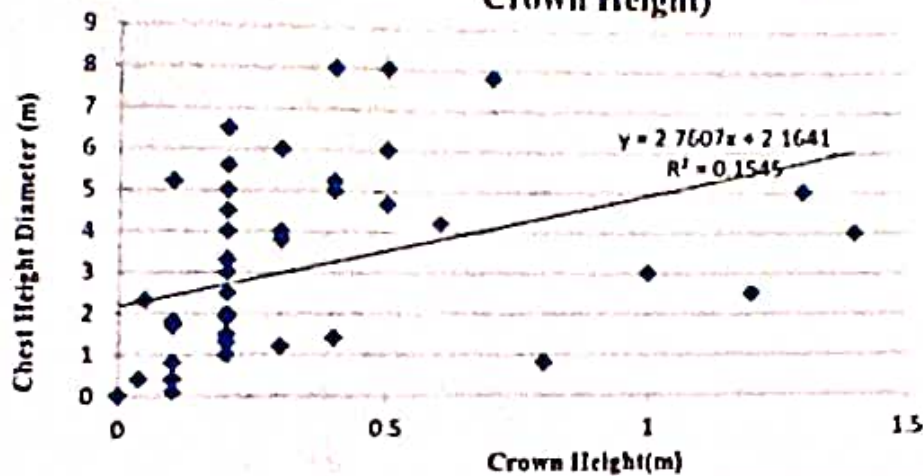
	T2	0.2	0.4	3	17	11	12	14
	T3	0.2	0.5	45	18	14	13	16
B4	T1	0.2	0.4	65	25	16	12	205
	T2	0.2	0.3	25	18	18	13	18
B5	-	0	0	0	0	0	0	0
C1	T1	0.5	0.8	8	57	49	19	51
	T2	0.2	0.3	56	28	26	22	27
C2	-	0	0	0	0	0	0	0
C3	-	0	0	0	0	0	0	0
	T1	0.2	0.3	19	199	28	22	2395
C4	T2	0.8	1	0.8	34	1	19	22
C5	T1	0.1	0.2	0.1	1	12	2	11
D1	-	0	0	0	0	0	0	0
D2	-	0	0	0	0	0	0	0
D3	-	0	0	0	0	0	0	0
D4	T1	0.7	0.8	7.8	8	10	14	9
	T2	0.2	0.3	33	28	25	18	265
D5	-	0	0	0	0	0	0	0

Source: Field Survey at Sundarban, 2023



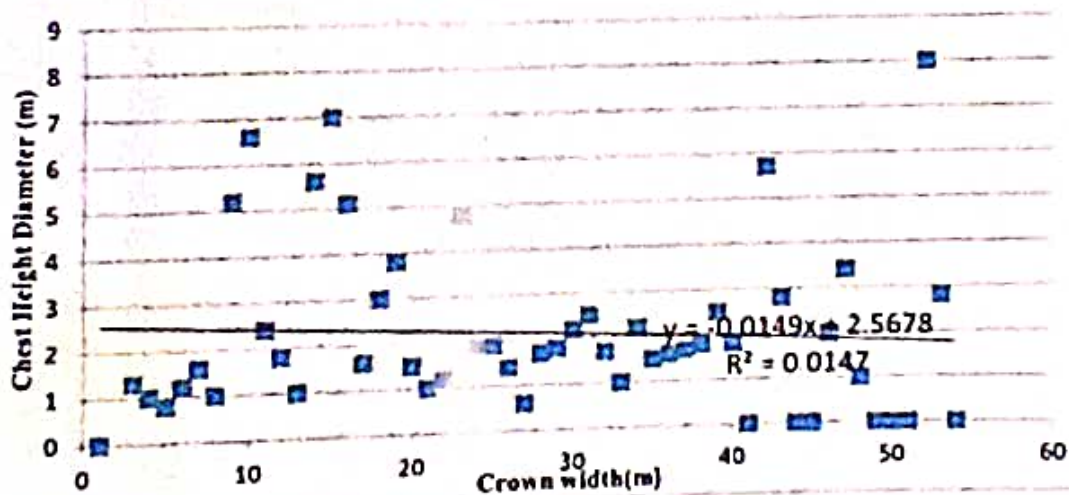
Scatter Plot

(Showing the relationship between Chest Height Diameter and Crown Height)



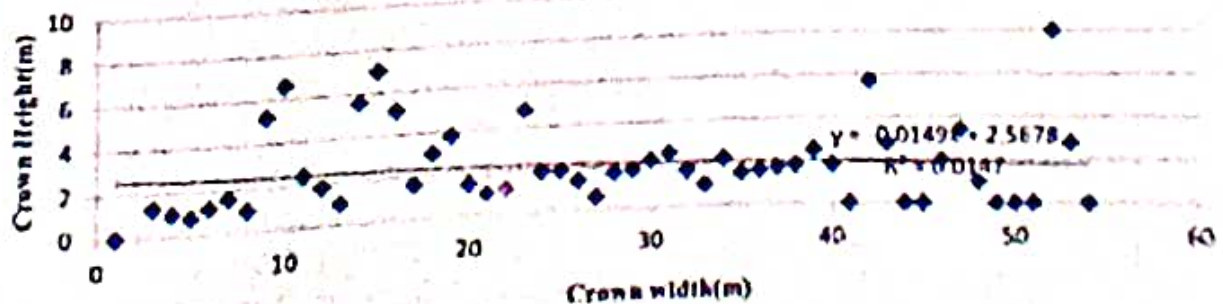
Scatter Plot

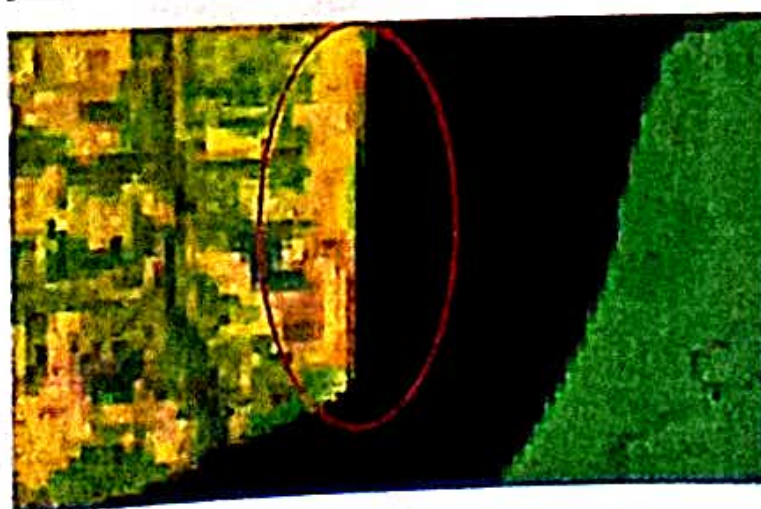
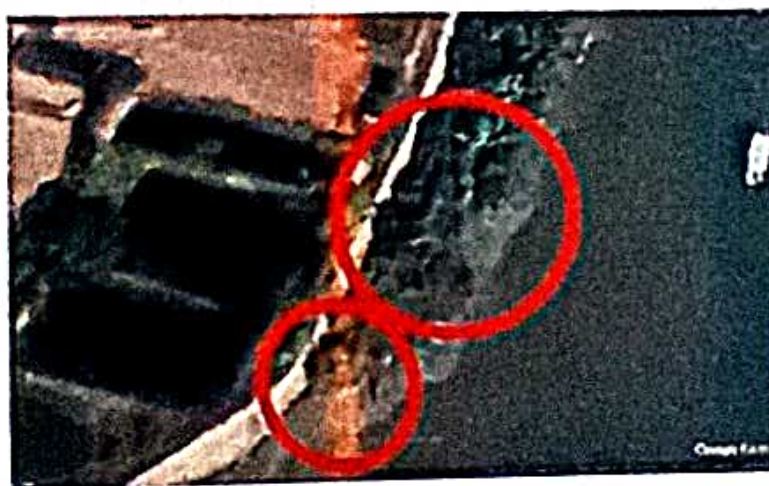
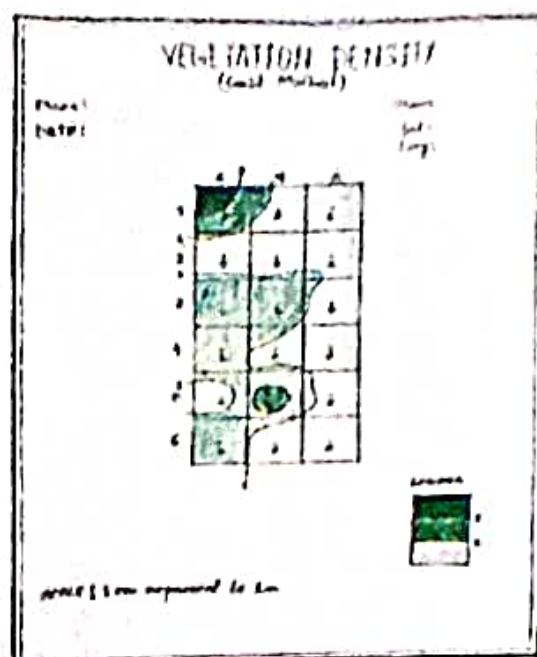
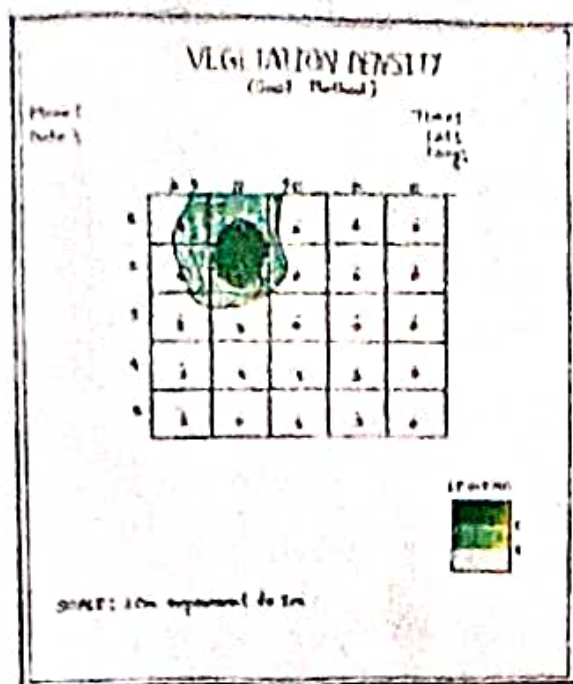
(Showing the relationship between Chest Height Diameter and Crown width)



Scatter Plot

(Showing the relationship between Chest Height and Crown width)





Beside the Datta river at Bali Island we survey about Chest Height Diameter (m), Root Diameter (m), Crown width Perpendicular(m), Crown to Crown Distance(m), Crown Height(m), Crown width(m), Average Crown Spread, Vegetation density. We notice very low vegetation density somewhere in coastal region. According to local people due to heavy catastrophic flood, cyclone and extremeness of tidal activity degraded mangrove cover rapidly.

Vegetation Characteristics Measurement



Field book for Leaf dry mass Measurement

Date: 30th March, 2023

Place: Along the Datta River Bank

Lat: 22° 06' 21.84" N

Station: A

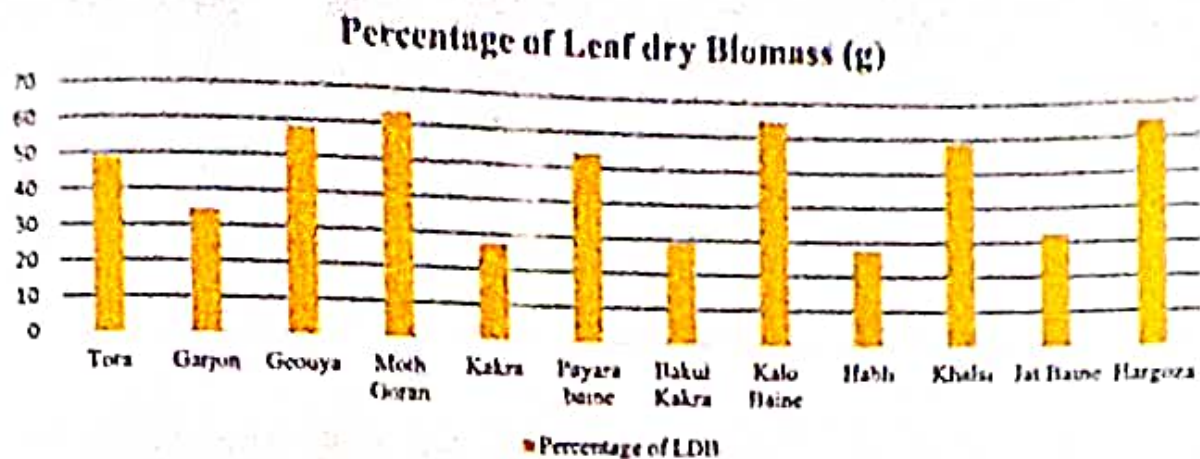
Long: 88° 46' 16.49" E

Sample No	Species name /Local Name	Scientific name	Normal Weight(g)	Dry weight (g)	Leaf dry Biomass (g)	Remarks
1	Tora	<i>Aegialitis rotundifolia</i>	19.81	10.096	9.714	
2	Garjon	<i>Rhizophora apiculata</i>	19.399	12.672	6.727	
3	Geouya	<i>Excoecaria agallocha</i>	38.136	15.78	22.356	
4	Moth Goran	<i>Ceriops. tagul</i>	22.433	8.167	14.266	
5	Kakra	<i>Bruguiera gymnorhiza</i>	14.042	10.149	3.893	
6	Payara baine	<i>Avicennia marina</i>	25.657	11.692	13.965	
7	Bakul Kakra	<i>Bruguiera Parvifolia</i>	68.389	48.381	20.008	
8	Kalo Baine	<i>Avicennia marina</i>	7.039	2.452	4.587	
9	Habli	<i>Thespesia Populne</i>	21.309	15.334	5.975	
10	Khalsi	<i>Aciceras corniculatum</i>	48.399	19.758	28.641	
11	Jat Baine	<i>Avicennia Officinalis</i>	79.139	53.149	25.99	
12	Hargoza	<i>Acanthus ilicifolius</i>	44.432	15.423	29.009	

Source: Field Survey at Bali Island, Sundarban, Department of Geography, 2023

Leaf Biomass calculation:

Leaf dry mass per unit area (LMA) is considered to represent the photosynthetic capacity. Leaf area and leaf biomass have an important influence on the exchange of energy, light interception, carbon cycling, plant growth, and forest productivity. Here a hypothesis actually implies that foliar water mass (leaf fresh weight minus leaf dry weight) is proportional to leaf dry weight during leaf growth. There is convincing evidence for a scaling relationship between leaf dry weight (DW) and leaf surface area (A) for broad-leaved plants. However, several studies on leaf biomass demonstrated that foliar water mass disproportionately increases with increasing leaf dry weight. In this study, we used the data of 12 species of mangroves species that have above mentioned. The study found that Kakra, Moth Goran, Garjon, Kalo baine, Kalo baine species have less leaf dry biomass. In other hand Jat baine, Hargoza, Bakul Kakra have highest change between dry weight and normal weight of leaves.



Traditional and medicinal uses of mangroves:

Aegialitis rotundifolia: Traditionally used for curing pain arising from sundry injuries. At present, there are no scientific evidences of its wound healing properties and few reports have claimed that reduction of pain could accelerate the wound healing process. The leaves of this species are traditionally used as an antidote for insect bites and treatment of pains but no scientific studies have been conducted on its.

Rhizophora apiculata: These trees are rich in phytochemicals and possess antimicrobial, anticancer, antidiabetic, antidiarrhea, antiemetic, and hemostatic properties (Baishya,2020, SETYAWAN, 2019).

Excoecaria agallocha: It is used traditionally in the treatment of various diseases such as epilepsy, ulcers, leprosy, rheumatism, and paralysis. The latex obtained from the bark is poisonous in nature and may cause temporary blindness, thus it is also known as the blind-your-eye mangrove plant. The plant also showed many pharmacological activities such as antioxidant, antimicrobial, anti-inflammatory, analgesic, antiulcer, anticancer, antireverse transcriptase, antihistamine-release, antifilarial, DNA damage protective, antidiabetic, and antitumor protecting activities. Hence, this review could help guide researchers anticipating to undertake further investigations in these directions (Mondal, 2016)

Cerlops tagal: tagal are widely accepted as antifungal, antitumor, anti-larval, antimalarial, antifeedant, antidiabetic, anti-hemorrhage, antifouling (Shamsuzzaman,2021)

In the Philippines, the extracts (barok) from the dried bark (marka tungog or tangal) are used as bittering and fermenting agents for the traditional bahalma. In Philippines bark is used as a remedy for curing diabetes.

Brugulera gymnorhiza: It is a medicinal mangrove, and its fruit (a food material) (BGF), have traditionally been used to treat diarrhea (also known as ulcerative colitis) in folk medicine. However, the mechanism of action against colitis remains ambiguous (Lin,2020).

Avicennia marina: The aerial parts of *A. marina* have traditionally been used for treating rheumatism, small pox, abscess and ulcers (Bandaranayake, 1998, Bandaranayake, 2002). This plant has also been used in Persian folk medicine for treatment of some other infectious diseases. Beside conventional usage, some pharmacological activities such as anti-bacterial use

Bruguiera parviflora: *Bruguiera parviflora* is a tree in the family Rhizophoraceae. Native to the Philippines. It has antimalarial, anti-inflammatory, α -glucosidase inhibitory properties. *B. parviflora* leaves are a potential natural source for the prevention of inflammation and diabetes (Bui, 2002)

Thespesia Populnea: *Thespesia populnea* commonly known as the portia tree, its bark, flowers, and leaves have more curative properties against skin infections and the plant phytochemicals have been used as anti-inflammatory, antidiarrheal, hemostatic, antibacterial, and antifungal properties.

Aegiceras corniculatum : *Aegiceras corniculatum* supports a fight against diabetes. This plant used to cure for asthma, diabetes, and rheumatism. Leaves used as fomentation in rheumatism and neuralgia and used in snake bite (Gurudeeban, 2012)

Avicennia Officinalis: Traditionally used as a Contraceptive, astringent, diuretic, antiulcer, treatment for snakebites, rheumatism, smallpox, skin diseases, hepatitis, leprosy, antitumor, Bronchial asthma, antibacterial, gastro protective, aphrodisiac, boils, and abscesses (Prakashamani, 2019).

Acanthus ilicifolius: The leaves and tender shoot are used in snake bite. The root is expectorant and used in asthma. This when boiled in milk is used in leucorrhoea and general debility (Singh, 2013)

Photo plate 1



Tora: Arqulita rotundifolia



Hargoza: Acanthus ilicifolius



Kalo Baine: Aricennia marina



Habl: Thespesia Ppulned



Khalai: Argemone corniculatum



Jat Baine: Aricennia Officinalis

Photo plate 2



Garjon: *Rhizophora apiculata*



Geouya: *Isocercaria agallocha*



Moth goran: *Ceriops tagal*



Kakra: *Bruguiera gymnorhiza*



Payara balne: *Avicennia marina*



Bakul kakra: *Excoecaria agallocha*

Crab burrows (Crab Hole measure):

Mud Crab are a member of the family Portunidae. They are large crabs with a smooth, broad carapace and possess sizeable claws used for crushing and cutting prey. The two hind legs are flattened for swimming. Mud Crab are generally very dark brown to mottled green in colour. Juveniles feed on planktonic animals, benthic molluscs and crustaceans while adults feed on bivalve and gastropod molluscs (mussels and pipis), small crabs and polychaete worms. Abundance of a species relates to how many members of a species is present within an ecosystem. Abundance can be measured by counting all the individual organisms that occur within the organism, however there are a variety of difficulties in relation to this method.



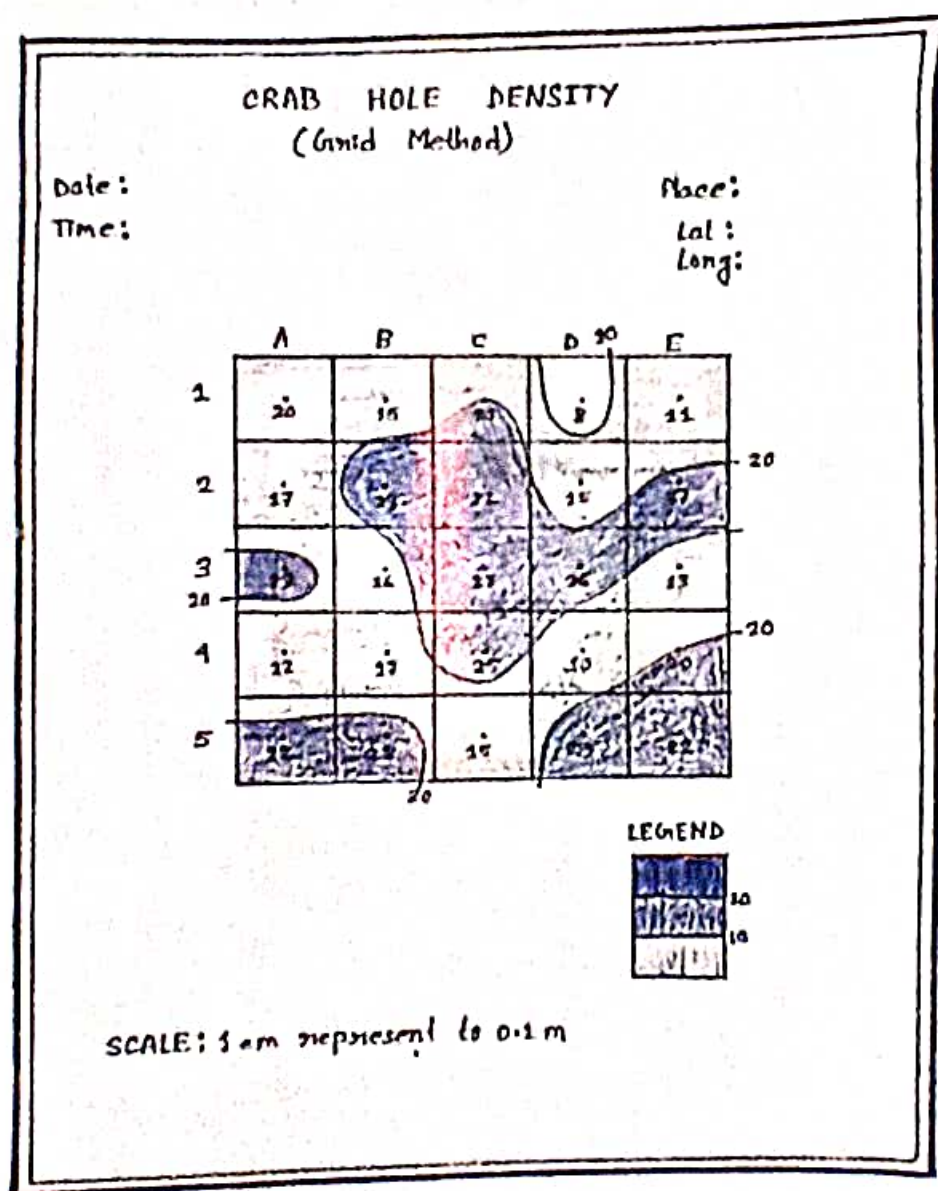
Many mangrove ecosystem services, such as carbon sequestration, are closely linked to mangrove soil water content, which in turn is thought to depend on animal burrow density and the properties of the sediment in which the burrows are constructed.

One of the most obvious ways to differentiate male and female crabs is by looking at their size. In many species of crab, males are larger than females, especially during the mating season. However, size can vary greatly within a species, so it's not always a reliable way to determine the sex of a crab.

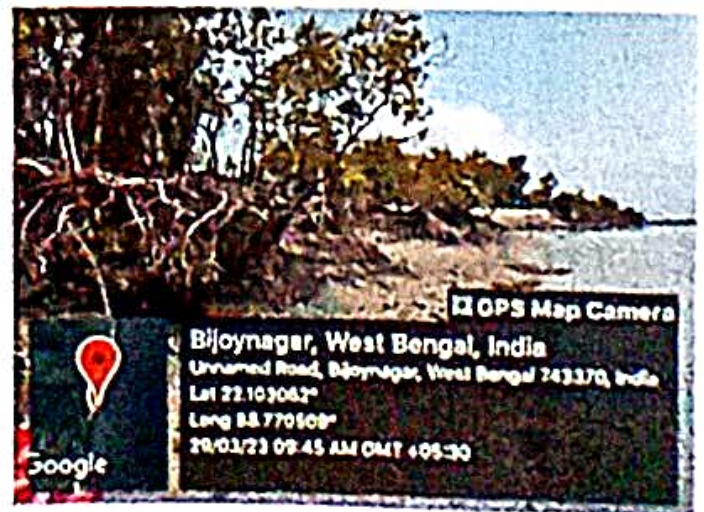
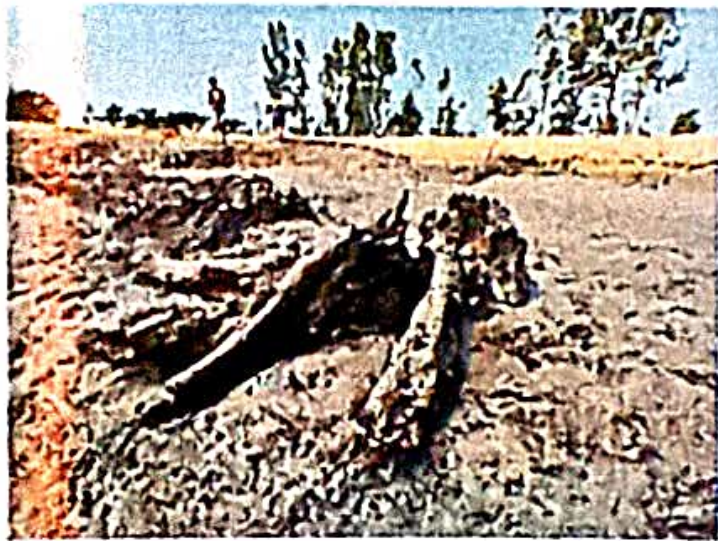
Another way to differentiate male and female crabs is by looking at their abdominal flap, or "apron." In male crabs, the apron is triangular in shape and points towards the rear of the crab. In female crabs, the apron is rounder and wider, and it is located closer to the center of the crab's underside.

Another way to tell male and female crabs apart is by looking at their claws. In many species of crab, males have larger, thicker claws than females. However, this can vary depending on the species and the individual crab, so it's not always a reliable way to determine the sex of a crab.

In our study we measure the density of crab whole in grid method. There is no such pattern is followed here, A1 to E1 grid are near to river side and A5 to E5 are near to bank side. Here also, per grid we measurement done to know the number of holes with maximum, minimum and average wide ness of whole mouth. Highest number of crab whole in hundred square metre is found 29. Lowest diameter of crab while mouth is 1mm and highest diameter of crab whole mouth is 46 mm.



River Bank Erosion



Chapter –V

Socio- Economic Status and Hazard Impact Analysis

CHAPTER V

Societal Status of The Study Area:

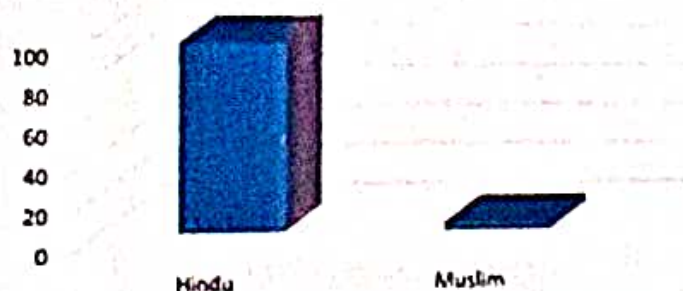
During the survey, 122 household of Bali II village were surveyed. The demographic and socio-economic status of the study area have been highlighted in this chapter

Religion:

The Bali II village mainly Hindu dominated village 95% of the total population belongs to Hindu religion and rest of 5% are Muslim.

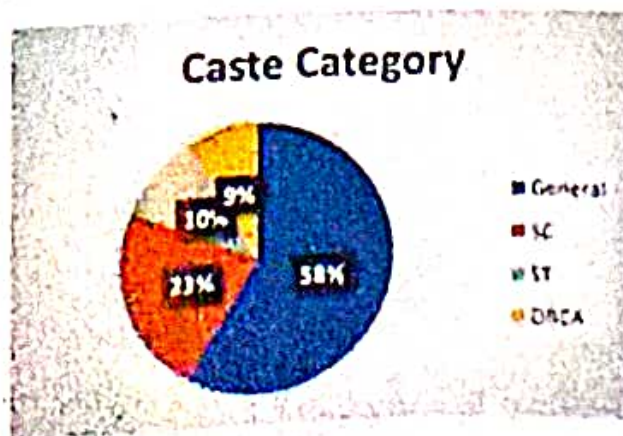
Religion	Percentage
Hindu	95%
Muslim	5%

Religious Status



Caste Category:

	Percentage
General	26%
SC	5.70%
ST	54.92%
OBCA	7.43%
OBCB	4.95%



Age Group:

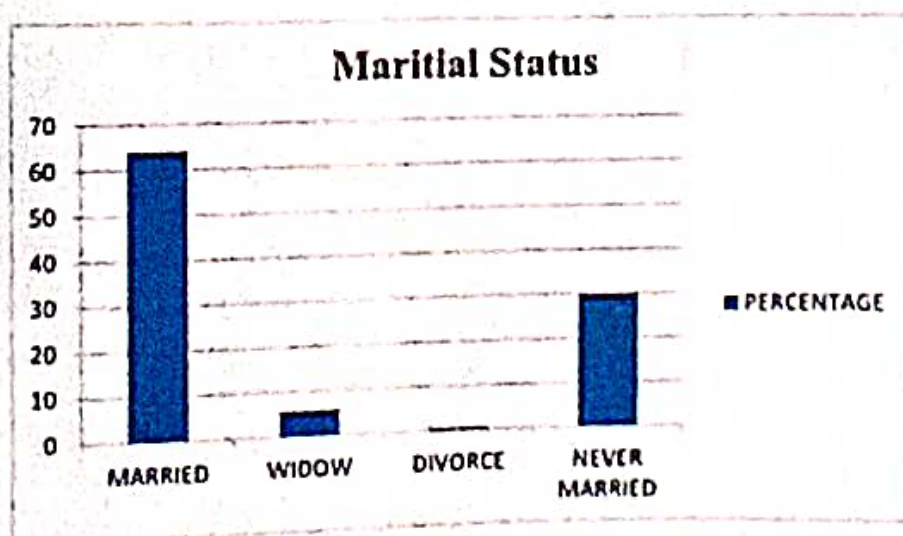
Population have been divided into five groups according to age. Among them there are children 29.17%, working population 59% and old age 11.05%.

	Percentage
Below 15	29.17%
16-30	24.27%
31-45	23.37%
46-59	12.14%
Above 60	11.05

Marital Status:

In our study area it is found that, 64.09 percent of the total population are male and female married, 29 per cent unmarried and 5.7 percent widows and 0.45 percent divorced.

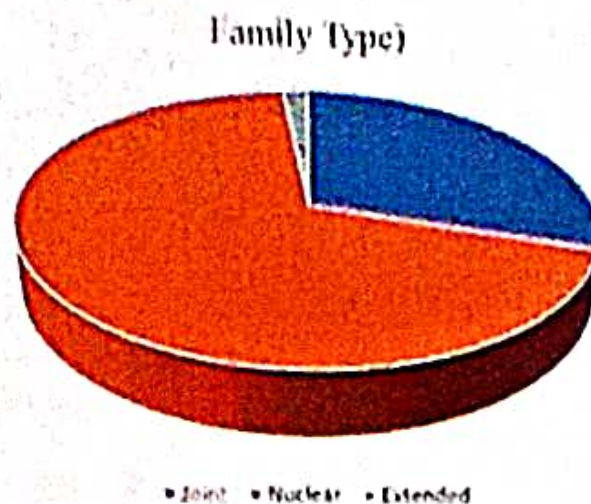
Marital Status	Percentage
Married	64.09
Widow	5.7
Divorce	0.45
Never Married	29.78



Family Type:

Family Type	Percentage(%)
Joint	29.51
Nuclear	68.85
Extended	1.64

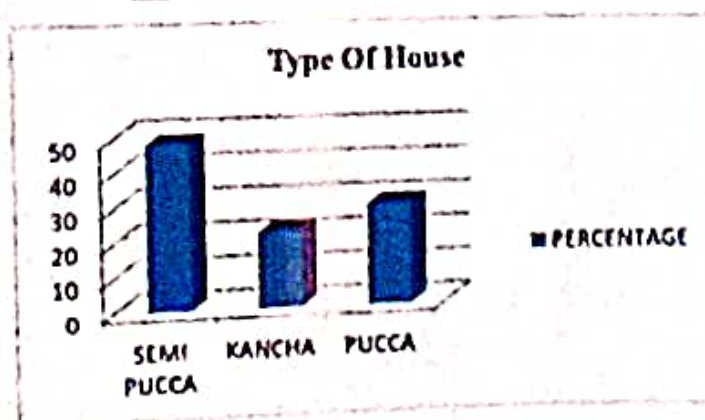
In the study area 68.85% family are nuclear and 29.51% family are joint family.



House Type:

Near about 49% houses of the study area are semi pucca, 22.14% houses are kancha which are made by bamboo, thatch and clay. Only 29.5% are made by brick and cement.

Type Of House	PERCENTAGE
Semi Pucca	48.36
Kancha	22.14
Pucca	29.5

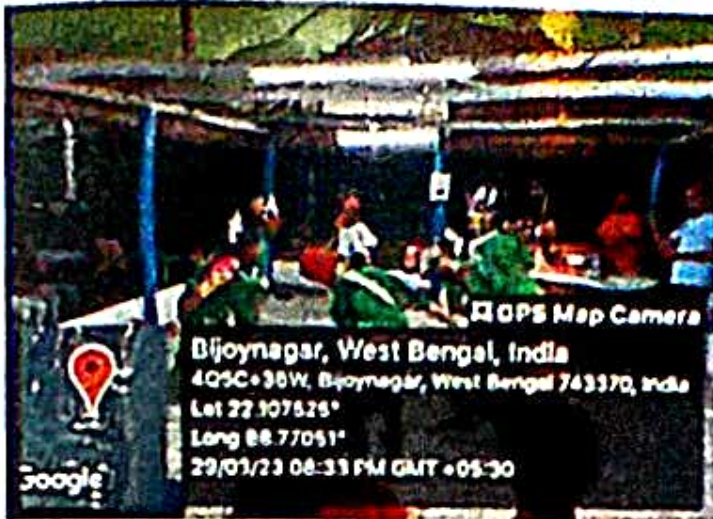


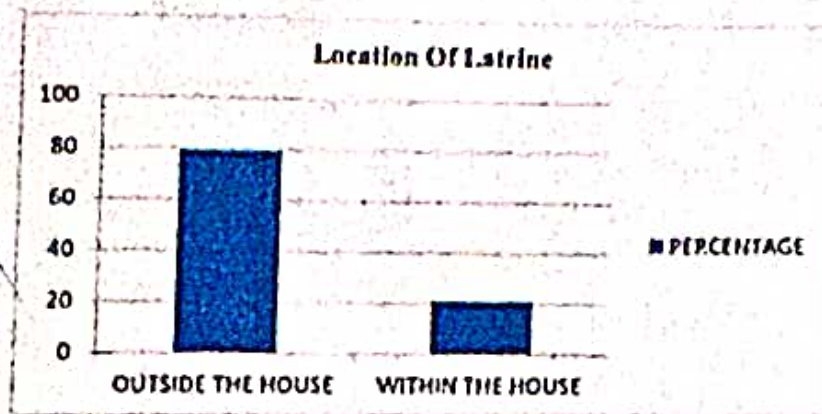
Latrine Facility:

In the study area 79% people use latrine out side of their houses and only 21% people have gotten latrine facility with in the house.

Location Of Latrine	PERCENTAGE
Outside The House	79
Within The House	21

Local Culture

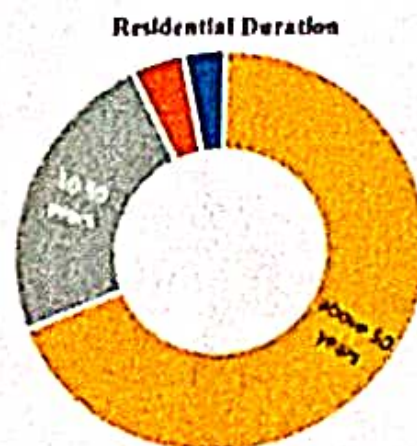




Residential Duration:

In the study area near about 70% people are living there more than 50 years, and maximum people has their own land.

Residential Duration	Percentage (%)
Below 5 years	3.28
5-10 years	4.09
10-50 years	23.77
above 50 years	68.86

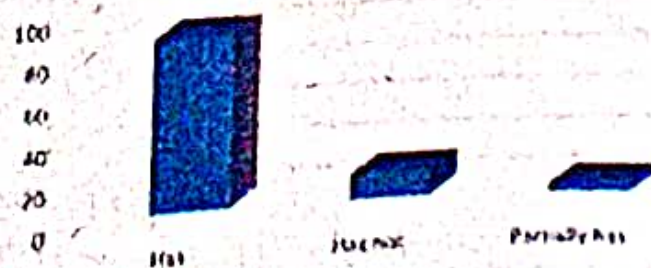


Job Card Facility:

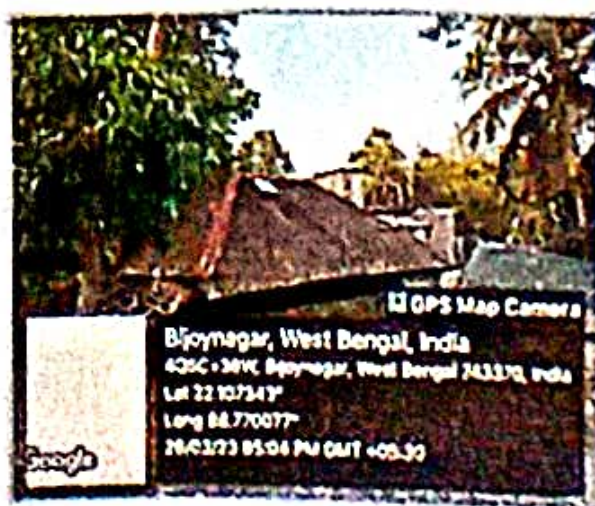
In the study area near about 90% adult people have enjoyed job card facilities.

Job card Facility	Percentage (%)
Has	84.42
Has not	12.29
Partially	4.09

JOB CARD FACILITY



House in condittion



Transport Ways & Road Condition

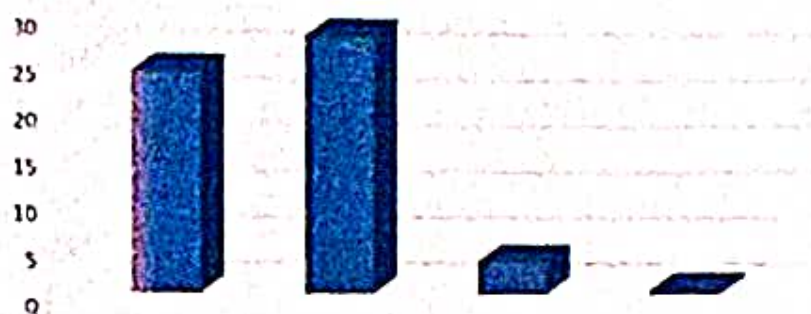


Land Ownership:

In the study area most of the people depends on agriculture for their livelihood generation.

Number of Land (Bigha)	Percentage(%)
Below 1	24
01-04	28
05-08	3.55
Above 8	0.51

AMOUNT OF LAND



Fuel Used for Cooking:

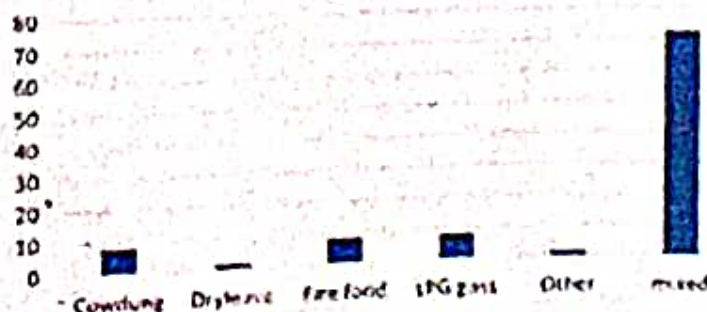
As the study area mainly agriculture-based village, different type of fuel like cow dung, dry leave, fire wood, residue of crop, LPG are used by the local people.

Fuel used for cooking	percentage
Cow dung	8.2
Dry leave	1.64
Fire food	8.2
LPG gas	8.2
Other	1.64
mixed	72.13

Source Of Drinking Water:

Main source of drinking water of this study area is tube well, beside this public tap tanker water facilities are available here.

Fuel used For cooking



Cattle loss in flood: Most of the time people loss their home cattle due water logging condition people only thing about the life of human only and some time there were very less chance to save the cattle like goat, cow etc.

Cattle died in the flood	Total number	Percentage (%)
0	26	26.26
0-5	42	42.42
5-10	14	14.14
10-32	17	17.17

HOW MANY CATTLE DIED IN THE FLOOD



Occupational Force shift:

Flood and other natural disaster have a negative impact on people's life. Many people forcefully migrated to other island, sometime different place in same island some time to city are for new jobs. Though 64% people answered they did not change their occupation, in their life ever. Nearly 37% people change their occupation

Change of the occupation for the flood	Total number	Percentage (%)
yes	42	36.52
no	73	63.5

DO YOU CHANGE THE OCCUPATION FOR THE FLOOD

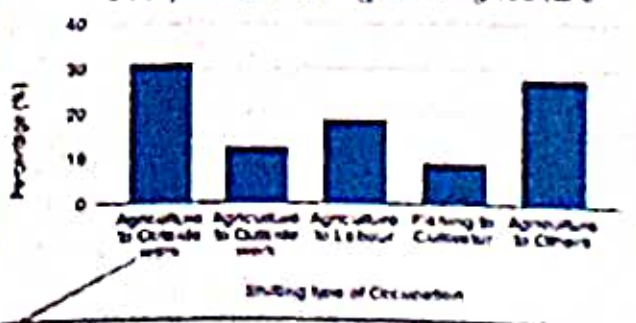


Occupational Shift:

Some people loss his or her land due to salinity of land, may be agriculture was not profitable for after flood, may be no money to buy the seeds. There will be several causes to stop the agriculture. 31% people went outside for work. Some body joined as daily labour, few persons start small business. As fishing is profitable in this area some body start fishing.

Shifting type of Occupation	Total number	Percentage (%)
Agriculture to Outside work	10	31.25
Agriculture to business	4	12.5
Agriculture to Labour	6	18.75
Cultivator to Fishing	3	9.4
Agriculture to Others	9	28.125

Occupational shifting from agriculture

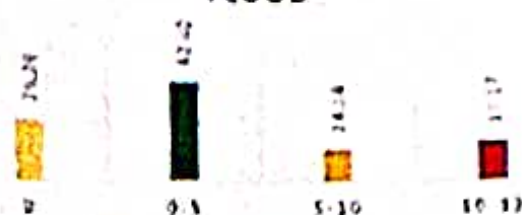


Mangrove density Change:

Mangrove is the main saver of sundaraban, if mangrove destroyed all soil and island will destroy with in a month. But recent days change of climate sea level and extreme cyclone mangrove destroyed, this is natural process. But in other hand due to embankment of river side river water not able to enter

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10-12	17	17.17

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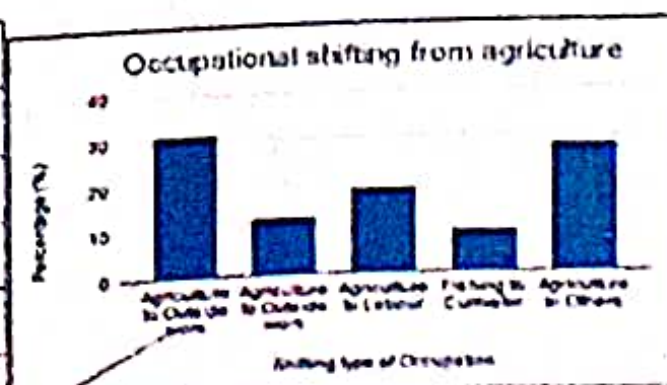
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Agriculture to Others	9	6.25

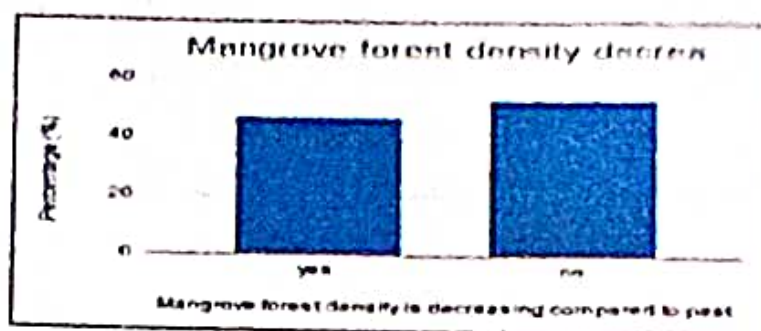


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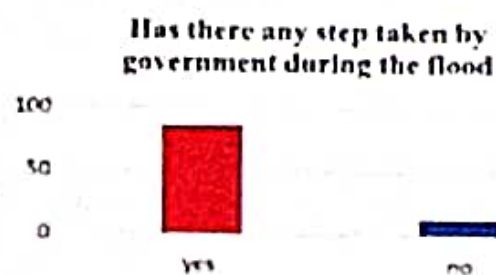
inside the island so mangrove spreading is stopped there. However nearly 47% people believe that on their sincere observation that compare to past time mangrove species density is decreased

Mangrove forest density is decreasing compared to past	Total number	Percentage (%)
yes	54	46.95652174
no	61	53.04347826



Flood control step of flood: State and Central government have role for disaster full zone of country. Sundarban also comes under disaster full zone. Govt. take different initiative for different times. In our Study area nearly 87% people inform that govt. take part in flood management during flood or rainy days where, 13% said no initiative taken by govt.

Government step during the flood	Total number	Percentage (%)
yes	92	86.8
no	14	13.21



Types of facility During flood: What are the main facilities they received from govt percentage distribution is given below. Mainly they receive, Plastic, food, shelter, medicine drinking water etc.

Types of facility	Total number	Percentage (%)
Food supply and water supply	9	8.737864078
medicine	26	25.24271845
Shelter	3	2.912621359
Tripal (plastic)	11	10.67961165
All facility	54	52.42718447

People Survive without Electricity: Nearly 7% people got Regular electricity in our study area. Where most of the people do not get regular electricity. Another question arises in mind that what is the situation happen during flood condition Those who did not get the regular electricity how many days they stayed with out electricity continuously is showing in another table-

Regular electricity		
	total	percentage
yes	8	6.61
no	113	93.4

By observation we noticed that there is only single line crossed from one island to another island. For this reason they use solar and other sources of light. Most of the time voltage of the light stayed as very low.

AVERAGE NO OF THE DAYS SURVIVED ELECTRICITY IN FLOOD DAYS



Mode of transportation during flood: In other time except flood generally they use boat for move one island to other. Eastern side of this island is Datta river so boat is only option and in western side there is a opportunity with terrestrial road network.

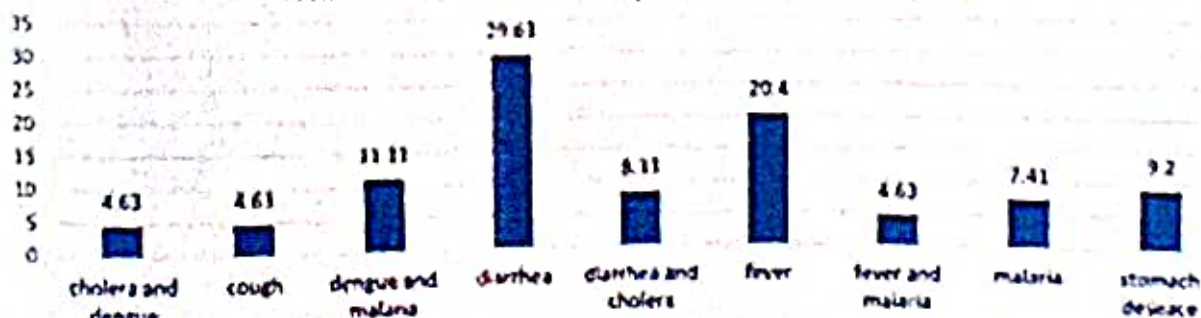
Mode of transportation during flood		
	Total	percentage
boat	57	52.8
walking	16	14.81
walking and others	6	5.55
pushing water	6	5.55
on foot	7	6.48
surviving	3	2.8
no	13	12.04

Which mode transportation do you use during flood



Diseases prevalence after the flood: Flood stopped but disease start. Logged water goes down but at

Which disease are more prevalent after the flood



Diseases prevalence after the flood		
	total	percentage
cholera and dengue	5	4.63
Cough	5	4.63

dengue and malaria	12	11.11
Diarrhoea	32	29.63
diarrhoea and cholera	9	8.33
Fever	22	20.4
fever and malaria	5	4.63
Malaria	8	7.41
stomach diseases	10	9.2

that movement several bacterial and viral disease start. Mainly malaria and dengue spread very rapidly. Cholera, fever, diarrhoea are very common for our climatic condition. Here, in our study area viral fever, Cholera, cold fever, diarrhoea, highly found just after flood happen compare to other diseases. This is a long-lasting disease chain. Pure drinking water, use of mosquito net and following proper protocol can reduce it.

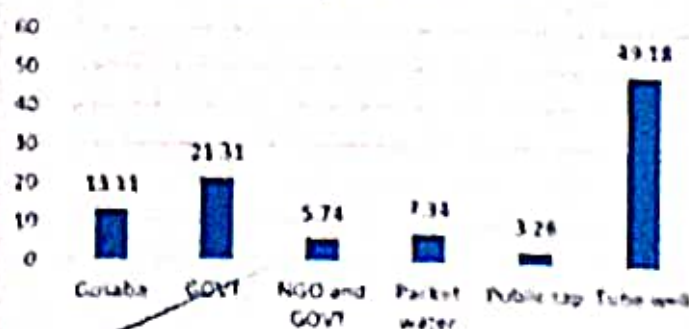
It is found low area are more effected with disease where water accumulated for along time. Mosquito for dengue always born in clear water when for malaria mosquito born in waste and dirty water. Pure water or boiled water is best for drinking can protect diarrhoea.

Source of drinking water during Flood. Most of the island drink salty taste of water, not only from tube well also in deep well provide salty taste of water. In our study area deep well's drinking water is quite good compare to other (by observation and visit taste) area. In flood time it is quite challenge to collect safe and clean drinking water.

Even in flood days nearly 50% people use tube well water, when 21% people use govt. supply water. Those who face serious problem they receive the water from NGO and block level supply.

From where do you collect the drinking water during flood	Total number	Percentage (%)
Water comes from Gosaba	16	13.11
GOVT. supply	26	21.31
NGO	7	5.74
Packet water	9	7.34
Public tap	4	3.28
Tube well	60	49.18

From where do you collect the drinking water flood



Household Survey Time



Chapter –VI

Conclusion

Conclusion:

This study area is vulnerable from all direction due to multi-hazards of nature. Coastal areas are always sensitive where Sundarban mangrove area at risk for soil erosion, flood, mangrove loss, resource and life loss, land salinity and so on. In other hand, livelihood problem faced most of the inhabitants. In Bali-II GP people mainly lost the paddy crop and productive land change into highly salted. Many People loss their best agricultural land due to cyclonic storm and se surge, more than half people informed that they feel environment problem compare to early days, though they try to protect in adverse condition and most of the young male take part for community development especially for most common disaster like Cyclone, Flood. Villagers informed about natural problem like decay of river bank, heavy rain fall, over flow. After a flood water logged more than five days even in simple flood. In our study area nearly half of the people informed that they have migrated due to flood any time in their life but among them most of the time within the island. Not only they force fully migrated but also, they lost their occupation. During physical geomorphological analysis we marked out two erosion spots where river bank eroded due Datta river's huge water pressure in cyclone time. Along the river bank mangrove's all characters are clearly visible. Due to shortage of time, we were not able to more in-depth study of physical measurements but several geospatial analyses give little clear picture. It is found that agricultural land is used those land was existed as salty land after Aila cyclone of 2008. It is not clear why these lands are now used as agricultural purpose for a long day through further study. When most of people informed that mangrove lost that is true but analysis of satellite picture showing that those places are mangrove lost few years ago before Aila, these are regreening by small mangrove sapling in natural way. In our study area daily and monthly income is very low for most of the families; though, by globalization effect life style of every people has changed so people spend money so many other purposes rather than food and shelter. Health is major concern for the island's people. There are few small doctor's chambers, and PHC, CHC but no big hospitals are located there. So, for medical emergency they use water Ambulance. Most of the family collect their drinking water from tube well and tested TDS level good in condition. As some major problem people faced here like transport, medical, environmental hazard so Government need to implementation of many programmes for development of these area with proper monitoring and evaluation.

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Appendix

Socio-economic and disaster impact survey on Sundarban

CONFIDENTIAL
For Academic
purposes only

Sundarban, South 24-Parganas
B.A/B.Sc. Project work on disaster management (6th Semester), 2023
Department of Geography, Kharagpur College, Kharagpur, West Bengal

Survey Schedule:

Informed consent: Namaskar. My name is _____, I am a Graduation student of Geography Department, Kharagpur College, Kharagpur, Paschim Medinipur. I am conducting a survey about Disaster Impact (related problem) on Sundarban also with socio-economic condition of this area. Your household was selected for this survey. The questions usually take about 30 - 40 minutes. Your participation in the survey is voluntary. If you do not want to answer any of the questions, just let me know and I will go on to the next question or you can stop the interview at any time. If you have any questions about this survey, you may ask me. The information of an individual will be kept strictly confidential and will not be shared with anyone. It will be used in aggregate form for research purpose only. Agree: _____ Disagree: _____

Latitude: _____
Longitude: _____

Date: _____
Survey time: _____ AM/PM

A. General Background Information & Household Roster:

1. Background and land related information-

- a) Name _____ of _____ the Respondent
- b) Nationality: _____ c) Religion: _____ d) Caste: GEN/ S.C/ S.T/ OBC A/B
- e) Gram panchayet: _____ f) CD Block: _____ g) District: South 24 Pargana
- h) Family type: nuclear / joint / extended / others i) Family economic status: APL/BPL/others
- j) Residential duration: below 5 years / 5-10 years / 10-50 years / above 50 years
- k) Land ownership: Yes/No, If yes _____
katha/bigha/Decimal/Hectors _____
- l) Agricultural land _____ & Non-Agricultural land _____
- m) Any other cultivation (amount): _____ Fishery/horticulture/crab/falconculture/betel/others
- n) Fuel used for cooking: Cow dung/dry leaves/Firewood/Electricity-Grid/Solar/kerosene/LPG Gas/others
- o) Household assets: Colour television/Bicycle/Motor cycle/3 wheeler car/4 wheeler car/Boat/Transport equipment/room heater/smart phone/A.C Machine/camera/home theater/Refrigerator/others (_____)
- p) Job Card Facility: Has / Partially has / Has not & work opportunity by job card _____
- q) Sastha Sathi Card Facility: Has / Partially has / Has not & ever benefitted by it _____
- r) Kanyashree Scheme Facility: Has enjoyed/ Has not enjoyed/No opportunity
2. Household member information:

Family members	Age	Sex	Marital Status	Educational status	Occupational status	M. Income (peak peak)	M. Income (lean period)

* Codes for column III Sex: Male 1, Female 2

* Codes for column IV Marital status: Married 1, Widow 2, Divorced 3, never married 4

* Codes for column V Education: Just Literate 1, Primary 2, Middle School 3, High School 4 Higher Secondary 5, Graduation 6, Post-graduation 7, Technical 8 Others 9

* Codes for column VI Occupation: Cultivator 1, Agricultural Labourer 2, Forest resources collectors 3 Fishing 4, Crab collection -5, Services 6, Business 7, Others

3. Health centre and its visiting related query-

a) Distance from health centre and visit status of the family members-

Center Name	Distance from home (km)	Visited number of times (from last week month/ last year/ last 5 year)	Mode of Transport (If multiple notes down sequentially using arrow)	Problem types (emergency or not)
PSC				
CHC				
District Hospital				
State level hospital				
Others (Specify)				

b) Nature of health facility which you depend most: i) Self Treatment ii) Quack Treatment iii) Govt. Health Treatment iv) Private Health Treatment v) Help of ethno Botany vi) Chemist vii) Others.....

c) Are you easily avail medicine facility from government hospital. Yes / No

d) Is Govt. take any initiative step for medical camp? Yes/ No. if, yes how long duration?.....

b) Any person affected in COVID-19 in your locality at that time? Yes/No

c) What are the problems major problem faced during covid-19 related to health? (e.g- health check-up, transport, medicine and mention the others problem

d) what happen in emergency health problem

time?.....

c) Water ambulance facility is available in your locality? Yes/No

d) If Water ambulance facility started then is it will profitable for your locality? Yes/No

c) What are the health problem locality faced after-

any

cyclone.....

any Flood

f) Any additional comment of respondent on health

issue.....

B) Information of Housing Condition and Energy consumption of Family

a) Type of dwelling: Own/ Tenement/ quarters/ Garage/flat/apartment

b) Type of house: Katcha/Pucca/Semi Pucca

c) Number of rooms: 1 /2/3/4/5/6 & more / no exclusive room

d) Predominant material of roof: Grass, thatch, bamboo, wood, mud / Tiles or slate/G.I. metal, asbestos sheets / Brick, or stone / Concrete/Any other material

e) Predominant material of wall: Grass, thatch, bamboo, etc / Mud, unburnt/ Burnt bricks with mud / Burnt bricks with cement/ Wood / Burnt brick /G.I. metal, asbestos sheets / Stone / Concrete /Any other material

- f) Predominant material of floor: Mud /Wood, bamboo / Brick, or stone / Cement / Mosaic floor tiles / Any other material
- g) Lavatory or toilet facility: Yes/has not
- h) Type of Lavatory or toilet facility: Covered pit latrine private/Covered pit latrine shared/Uncovered pit latrine/Flush toilet private/shared
- i) Location of latrine: Within the house /Outside the house
- j) Main source of water for drinking: Tube well/Public taps/Protected well/spring/River/falls/pond/Tanker truck;
- k) Distance from water source: (Within the premises /Outside the premises)
- l) Fuel used for cooking: Cow dung/dry leaves/Firewood/Electricity-Grid/Solar/kerosene/LPG Gas/others
- m) Source of light: kerosene/solar/generator/electricity/others
- n) Waste disposal method: Burnt/throw out side/use as fertilizer/convert into non-conventional energy others

C) Hazard and disaster related information:

1. Impact of hazard-disaster on people's life

- a) What natural disaster is more common here? Cyclone/ Flood/others
- b) How many times has been flooding since last five years?
- c) What do you think the reason behind the flood? i) Heavy rain fall ii) Decay of river bank c) water level increase than bank other iv) leakage due to rat hole cyclone v) Storm surges and tsunami vi) over flowing of rivers vii) human unconsciousness viii) others
- d) How long does flood water accumulate? 1 day/2 days/3 days/4 days/ 5 days/ more than 5 days
- e) Please inform me about mosquito and snake disturbance happen after flood/cyclone-
- f) What are damages you face during flood?
- g) In very recent when you face loss of economy by disaster that you can remember?
- h) How much economically lose have you faced?
- i) Do you relocate/replaced during flood? Yes/ no
 - h1) From one island to another island h2) one place to another in the same island
 - h3) Cause of replacement. h4) When replacement happen.
- j) What types of crops mainly affected during flood?
- k) From where do you collect the drinking water during flood?..... & Distance
- l) Do you get regular electricity facilities during flood? Yes/ no, If no, mention the average no of days you survived without electricity?
- m) What mode of transportation do you use during flood?
- n) How many cattle died in the flood?
- o) Do you change the occupation for flood? yes/ no, If yes, mention from which To
- p) Last which year cyclone occur?
- q) What types of damages do you faced after cyclone?..... mention the amount of economic lose(approximately).....
- r) Which natural disaster is more affected the daily livelihood? cyclone/ flood
- s) Which diseases are more prevalent after the flood?
- t) what commodity prices increase more in your region due to flood/ cyclone?
- u) Did you see anybody who collect the soil from the protected wall (that constructed for protection of settlement)

v) Did you observe mangrove forest density or number is decreasing compare to past? Yes/No, if yes then ask any possible causes as per your view.

w) Any steps taken to increase forest density or forest development: by local people:

by govt. initiative.

2. Query related midterm and long-term Impact of Cyclone and flood:

Issues	Time	Duration	Impact	Suitable measure taken by local people
Trouble by Snake				
Vector born disease (e.g., malaria, dengue)				
Salinity of field				
Loss of cattle				
Loss of Home				
Guard wall or river bank erosion behind the settlement				

D) Questionnaire related to women health and their involvement

Ask any ever-married women in the house hold about their health problem related to fishing. Now I want to ask some recent time health problem that mainly women faced in Sundarban area as per present time's research work/news. If you not agree to response then tell me.

f) Do you know any women in your locality/home suffer in anaemia? Yes/No

g) Whether any time you face in anaemia? Yes/No.

h) Do you ever engage with seed prawn collection from river or creek? Yes/No if yes, when

i) You collect the seed prawn due to- meet the family need/self-interest/ hobby/ family member's pressure or anything else

j) where do you/to whom sell it and what is the price value?

k) Generally, how many hours (daily) you spent in water for shrimp seed/fish seed collection?

l) Any Family member who go with you and help in seed collection?

m) Depth of water that women stayed to collect the seed, below knee/ upto knee/below waist/ upto waist/ above waist

n) Any people (women) faced any health problem regarding this fish-seed collection?

Did not fear about your life risk by Tiger crocodile attack? Yes/No if no then ask why?

o) Whether any time in past tiger or Crocodile attacked any men/women in your locality? Yes/no, if yes, then ask her for more details.

p) Do you think there is a dearth of seed prawn compare to earlier. Yes/No, if yes, ask any cause.

E) ROLE OF GOVERNMENT/ NGO DURING THE COASTAL FLOOD AND CYCLONE:

1. Has there any step taken by the Government during the flood? yes/ No
If yes, mention these.
 - a. Food supply
 - b. Water supply
 - c. Medicine supply
 - d. Make new flood shelter
 - e. Giving alert of disaster
 - f.
2. What steps are taken by Government after flood?
3. What steps are taken by Government after cyclone?

SOCIO-ECONOMIC IMPACTS OF COASTAL FLOOD AND CYCLONIC EFFECT:

Give a score about the relevance environmental impact of coastal flood and cyclonic effect (1=Very Low, 2=Low, 3=Moderate, 4=High, 5=Very High)

Social Impact:

- Intensity of social and economic division in the time of disaster: ☐
- Segregation depends on caste and religion base: ☐
- Condition of social interaction in the time of disaster: ☐
- Engagement in the time of disaster: ☐
- Involvement in the time of decision making for prevention from disaster: ☐
- Engagement with social community: ☐
- Involvement in common property resource: ☐
- Others:

ENVIRONMENTAL IMPACT OF COASTAL FLOOD AND CYCLONIC EFFECT:

Give a score about the relevance environmental impact of coastal flood and cyclonic effect (1=Very Low, 2=Low, 3=Moderate, 4=High, 5=Very High)

Loss of Environmental Resources:

- Condition of land and soil consumption: ☐
- Loss of soil fertility of agricultural land: ☐
- Loss of best agricultural land: ☐
- Loss of environmental biodiversity: ☐
- Loss of natural habitats: ☐
- Others:

GENERAL AND PLANNING RELATED QUARRIES FOR COASTAL FLOOD AND CYCLONIC EFFECT:

Give a score about the planning related quarries for prevention from disaster (1= I completely agree, 2= I largely agree, 3= I somewhat agree, 4= Indifferent, no opinion, 5= I somewhat disagree, 6= I largely disagree, 7= I completely disagree)

- > Is Spatial Planning essential from the side of government for protection from disaster?

1	2	3	4	5	6	7
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- > Increasing residential, industrial, and infrastructure land use (at the expense of "nature") is a major environmental problem, drastically reducing biodiversity but also degrading natural land in an unsustainable manner.

1	2	3	4	5	6	7
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- > Is River embankment planning being very essential for protection from hazard?

1	2	3	4	5	6	7
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- > Do you think Climate change is the main reason behind the frequent coastal hazard?

1	2	3	4	5	6	7
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- > Do you think Coastal flood and cyclonic storm main driving forces of land use changes?

1	2	3	4	5	6	7
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- > Huge amount of mangrove degradation occurred in the time of coastal flood and cyclonic storm:

1	2	3	4	5	6	7
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- > Climate Change and a temperature increase of more than 4-5°C will dramatically reduce the available agricultural land.

1	2	3	4	5	6	7
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- > Land is limited, populations (and income) keep growing, so competition for space keeps growing and the price of real estate can only go up.

1	2	3	4	5	6	7
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Signature of the Surveyor