ANNUAL REPORT

July 2021-June 2022

SPARRSO

Bangladesh Space Research and Remote Sensing Organization (SPARRSO)

Agargaon, Sher-e-Bangla Nagar

Dhaka 1207, Bangladesh

ANNUAL REPORT

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SPARRSO

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Dream of Self-Reliance

"We are a hopeful nation. We achieved independence with the sacrifice of three million martyrs in the war of liberation. To make that independence meaningful, it is necessary now to achieve economic emancipation. We want to live keeping our heads high. We want to be the builders of our own future."

-Sheikh Hasina, Honourable Prime Minister

The People's Republic of Bangladesh

Dhaka, 28 February 2016

Chairman
Additional Secretary
SPARRSO

Foreword

It is my pleasure to present the Annual Report on the development activities, research work and achievements of Bangladesh Space Research and Remote Sensing Organization (SPARRSO) carried out by the authority and thematic research divisions for the financial year of 2021-2022.

I would like to pay glowing homage to the Father of the Nation Bangabandhu Sheikh Mujibur Rahman, in whose tenure the space application related activities were embarked on Bangladesh since after the independence in 1972. During the tenure of the Father of the Nation, Earth Resources Technology Satellite (ERTS) Programme as well as Space and Atmospheric Research Centre (SARC) was established. Later SPARRSO has been formed merging those two entities. With the passage of time, SPARRSO is now turned into the national space agency of Bangladesh.

We are committed to fulfill the requirement of space research and remote sensing technology through attaining Sustainable Development Goals (SDG) related research. Over the years, all research projects had been outlined in terms of SDGs. The efforts would go in the upcoming year considering the country's need to be developed. SPARRSO has been substantially contributing to environmental, climate change & global warming issues, national disaster preparedness programs and predominantly contributing to diversified earth-resources, management and monitoring functions over the years. It provides accurate, valid and reliable information to the government and relevant organizations to facilitate their decision making process.

In accordance with its national research mandates, SPARRSO continues to develop a greater scale of collaboration and connections with partners and research organizations in Bangladesh and abroad. Besides, in requirement of fulfilling SDG goals and 2041 visionary plan of honorable Prime Minister Sheikh Hasina, SPARRSO has also set up short, medium and long term plan in this financial year, that will guide this organization to move forward to next decades.

In this opportunity, I would particularly like to acknowledge the continued support of the Ministry of Defence and we are also looking forward enthusiastically, the same to the years to come. The Board of Directors and I continue to be inspired by the scientists, engineers and support-staff of SPARRSO, who work tirelessly for the progressively development of this organization maintaining a high global standard for space science and technology.

I thank the Editorial Committee and my colleagues for their effort in preparing and publishing this report.

Md Abdus Samad

Member

SPARRSO

& Convener, Editorial Committee

Editorial Note

On behalf of the Editorial Committee, I am glad to introduce the Annual Report of Bangladesh Space Research and Remote Sensing Organization (SPARRSO) that briefly accounts the activities of the organization performed during the fiscal year, July 2021 to June 2022. The report is going to be published in fulfillment of Section 14(1) of the SPARRSO Act 1991.The report gives a consecutive overview about the applications and usefulness of space science and technology including Remote Sensing (RS), Geographic Information System (GIS) and Global Navigation Satellite System (GNSS) for surveying and mapping of natural resources and monitoring of natural hazards in the country. Notably, we have tried to focus on the annual research activities. This report also brings to light the various achievements of SPARRSO and its participation at national, regional and international events. These are highlighted to promote the use of the earth observation techniques for the greater benefits and welfare of the people of Bangladesh and access to the knowledge of country's resources on a national, regional and global comparative scale.

It is a great pleasure for the Editorial Committee to express the heartiest gratitude to the Senior Secretary of Ministry of Defence (MoD) and Chairman of SPARRSO for their kind advice and cordial cooperation. I would like to acknowledge the contribution of SPARRSO Scientists, Engineers, Officers and Staff for their passion, support and contribution in preparing their respective divisional activities, which are the main contents of this report.

The editorial committee apologizes for any inconsistency in the document and being late in bringing this publication to light. Constructive criticism, suggestion, advice and personal recommendation from anyone for further improvement in preparing our future reports will be highly appreciated and sincerely considered. We pray to Almighty Allah for His blessings to overcome the continuing global crisis having courage and strength to work hard for the betterment of the people in Bangladesh and across the globe.

M. Mahmud Ali

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CHAPTER 1

INTRODUCTION

Bangladesh Space Research and Remote Sensing Organization (SPARRSO) is a multi-disciplinary research organization established in 1980. It began its journey as a statutory body in 1992 under the Act 29 of 1991. SPARRSO has been applying space technology in peaceful purposes for the benefit of the nation. It carries out research works in various geo-disciplines that includes atmospheric science, agriculture, forestry, fishery, water resources, environmental sciences, geological science, oceanography etc.

The organization is functioning under the supervision of the Ministry of Defence and is governed by the direct instructions and guidelines of the SPARRSO Board. In Bangladesh, SPARRSO is the focal organization of Asia Pacific Space Cooperation Organization (APSCO). Within the framework of APSCO, SPARRSO is implementing various programs on space science research, space technology development and space technology application domains.

As its regular course of duties, SPARRSO produces required databases, information and maps which are supplied to different Ministries, i.e., Agriculture, Food & Disasters Management, Environment & Forest, Land, Fisheries & Livestock, Defence and others. It also provides information to different departments and organizations, such as Bangladesh Meteorological Department, Bangladesh Bureau of Statistics (BBS), Forest Department, Department of Disaster Management (DDM) etc. Upon any specific request that requires space application from the government organizations, it will generate and supply the information for ensuring human safety and security and finally contributing towards national development.

This annual report for the fiscal year of 2021-2022 briefly describes the research, study and operational activities implemented during the reporting period. In addition, it also includes the participation of the officials in training, conferences and meetings organized primarily in virtual platforms during this Covid-19 pandemic situation. The list of publications of the officials for the reporting period is also included in this report.

1.1 Functions of SPARRSO

1. Peaceful application of space science and remote sensing technology in different disciplines of science including Agriculture, Forestry, Fisheries, Geology, Cartography, Water Resources, Land use, Weather, Environment, Geography, Oceanography, Education etc. and conducting research for the development and application of this technology.

2. Providing research results and disseminating relevant information to the Government and different agencies as mentioned in section 1.

3. Informing government about the space and relevant policies of different countries and advising government in this issue on policy decision.

4. Conducting survey, training, and research using space science and remote sensing technology and collaborating with different national, foreign or international agencies.

5. Formulation of development project for conducting research on space and remote sensing technology and its implementation taking prior approval from the Government

6. Taking necessary steps to perform the above activities.

1.2 SPARRSO Board

SPARRSO is governed by a Board consisting of Chairman and four Members. As of 30 June, 2022, the members of SPARRSO Board were as follows:

Name	Position in Board
Mr. M. Mahmud Ali	Chairman (Additional Charge)
Mr. M. Mahmud Ali	Member (Research)
Mr. M. Mahmud Ali	Member (Application) (Additional Charge)
Mr. M. Mahmud Ali	Member (Technology-1) (Additional Charge)
Mr. M. Mahmud Ali	Member (Technology-2) (Additional Charge)

1.3 Manpower

List of existing officer of SPARRSO is enumerated below: (As of 30 June 2022)

Sl	Name	Designation	Phone (Office)	Email
1	Mr. M. Mahmud Ali	Chairman (Additional Charge)	+88-02-48117692	chairman@sparrso.gov.bd
2	Mr. M. Mahmud Ali	Member (Research) (Joint Secretary)	+88-02-48118572	membertech1@sparrso.gov.bd
3	Mr. M. Mahmud Ali	Member (Application) (Additional Charge)	+88-02-48118572	membertech1@sparrso.gov.bd
4	Mr. M. Mahmud Ali	Member (Technology-1) (Additional Charge)	+88-02-48118572	membertech1@sparrso.gov.bd
5	Mr. M. Mahmud Ali	Member (Technology 2)	+88-02-48118572	membertech1@sparrso.gov.bd
6	Mr. Mohammad Sanaul Huq	Financial Adviser (Deputy Secretary)	+88-02-48118582	fadviser@sparrso.gov.bd
7	Mr. Jalal Uddin Ahmed	Director	+88-02-48118581	admin@sparrso.gov.bd
8	Dr. Md. Mahmudur Rahman	Chief Scientific Officer	+88-02-48120373	mahmud@sparrso.gov.bd
9	Dr. Md. Abdus Salam	Chief Scientific Officer	+88-02-48118564	salam@sparrso.gov.bd
10	Mr. Md. Nur Hossain Sharifee	Chief Scientific Officer	+88-02-48117688	nhsharifee@sparrso.gov.bd
11	Mr. Md. Shahjahan Ali	Principal Scientific Officer	+88-02-58155951	shajahan@sparrso.gov.bd
12	Dr. Mohammad Shohidul Islam	Principal Scientific Officer		shohidul@sparrso.gov.bd

Sl	Name	Designation	Phone (Office)	Email
13	Mr. Abdullah Yousuf Imam	Senior Scientific Officer (on higher study abroad)		imam@sparrso.gov.bd
14	Mr. Md. Abdul Kader	Senior Scientific Officer (on Lien)	+88-02-48113700	imrankadir@sparrso.gov.bd
15	Mr. B.M. Refat Faisal	Senior Scientific Officer (on higher study abroad)		refatfaisal@sparrso.gov.bd
16	Mr. Sumangal Chakma	Senior Engineer	+88-02-58154829	schakma@sparrso.gov.bd
17	Ms. Nasrin Sultana	Senior Scientific Officer		nasrin@sparrso.gov.bd
18	Mr. Mohammad Imrul Islam	Senior Scientific Officer		imrul_islam@sparrso.gov.bd
19	Ms. Farhana Tazneen	Senior Scientific Officer		farhana@sparrso.gov.bd
20	Mr. S.A.M. Arif-Ul-Haque	Senior Scientific Officer		sam_arif@sparrso.gov.bd
21	Mr. S M Ahsan Habib	Senior Scientific Officer		ahsan@sparrso.gov.bd
22	Mr. Md. Mahmudul Haque	Chief Administrative Officer (Acting)	+88-02-48110814	mahmudulhaque@sparrso.gov.bd
23	Mr. Md Monirul Islam Khondoker	Finance Officer (Acting)	+88-02-9134006	kmanirul@sparrso.gov.bd
24	Mr. S M Ahsan Habib	Librarian (Additional Charge)		ahsan@sparrso.gov.bd
25	Mr. Rubel Kanti Dey	Information Officer	+88-02-58154816	rubelkanti@sparrso.gov.bd
26	Mr. Rubel Kanti Dey	Store and Procurement Officer (Additional Charge)	+88-02-48113308	rubelkanti@sparrso.gov.bd
27	Mr. Md. Mahmudul	Administrative	+88-02-48117503	mahmudulhaque@sparrso.gov.bd

Sl	Name	Designation	Phone (Office)	Email
	Haque	Officer		
28	Mr. Md. Manirul Islam Khandaker	Accounts Officer	+88-02-48117401	kmanirul@sparrso.gov.bd
29	Mr. Mohammad Mahdi Hasan	Scientific Officer		mahdi@sparrso.gov.bd
30	Mr. Jagobandhu Some	Assistant Engineer	+88-02-48118583	jsome@sparrso.gov.bd
31	Mr. Muhammad Sharif	Assistant Engineer		sharif@sparrso.gov.bd
32	Mr. Md. Abdur Rahman-Al-Mamun	Scientific Officer		rahman.almamun@sparrso.gov.bd
33	Mr. Md. Ariful Islam	Scientific Officer		ariful.islam@sparrso.gov.bd
34	Mr. Milan Kumar Shiuli	Scientific Officer		milan.shiuli@sparrso.gov.bd
35	Mr. Md. Farid Uddin	Scientific Officer		farid.uddin@sparrso.gov.bd
36	Mr. Md. Naim Islam Talukder	Scientific Officer		talukder.naim@sparrso.gov.bd

CHAPTER 2
RESEARCH AND APPLICATION ACTIVITIES

The research and application activities of SPARRSO have been providing valuable inputs for planning in different sectors and finally contributing to sustainable development in the country. Under the Annual Research Program of SPARRSO, sixteen research projects were approved for implementation in the financial year of 2021-2022.

Among the implemented projects, two research projects belong to the agriculture sector. One project was dedicated to the district wise acreage estimation of Aman & Boro rice using feature based spectro-temporal characterization of remote sensing data. The objectives of this project are to develop an appropriate methodological framework to generate timely information on the acreage of boro and aman rice in Bangladesh particularly on the spatial extent, condition and growth. The study area covers eight districts in Bangladesh located at different regions of the country. The study used Senntinel-1 and Sentinel-2 satellite images. Another study was implemented by the Agriculture Division related to the detection of crops at the early stage of life cycle using microwave and optical images.

Two projects were related to the Forestry sector and the study area of those projects are located at the Sundarbans Mangrove. Monitoring of long-term changes in the Sundarbans mangrove due to coastal erosion with the analysis of causal factors has been implemented in this period. In the first phase, change analysis was conducted in the extent of Sundarbans over the last five decades (1973-2020) and long-term changes (1930-2020) were assessed for the selected islands. In this second phase of the study, the people's perception on the driving forces and mechanisms of coastal erosion was investigated. Another research project on Sundarbans was dedicated to develop the methodology for mapping the changes in dominated species in the northern part of Sundarbans Mangrove forest. The study found that the Kankra (*Bruguiera gymnorhiza*) is gradually replacing Sundri (*Heritiera fomes*) and mixed Sundri Gewa (*Excoecaria agallocha*). The result of the study will be helpful for the decision makers and forest mangroves to understand the current stand dynamics of the mangrove ecosystem over the last few decades.

The research project of the Water Resources Division was related to find out the trend of rainfall related Low Pressure System (LPS) over Bangladesh. The study collecting data for the period of 1958-2015 found that the trend of rainfall related to LPS over Bangladesh shows an increasing trend, especially over the coastal regions of Bangladesh. Another study of the Division was related to the spatio-temporal analysis of coastal vegetation as a proxy indicator of climate change in Bangladesh.

Land use and land cover changes and its impact analysis were studied in two different regions of Bangladesh; one study area was located at the north-eastern part of the country and distributed in haor regions and another study was covered in the south-eastern hilly region. The study on the Land Use and Land Cover (LULC) change in the Tanguar Haor quantified the LULC changes in the period of 1973-2020 and explored the impact of these changes to fisheries habitat. Another study explored the LULC changes in the Teknaf and Ukhia Upazila of Cox's Bazar District due to Rohingya refugee influx from neighboring Myanmar in the region.

There was a demonstration project implemented during the last fiscal year. Within this study, prototype satellites, satellite ground control stations / data receiving stations have been manufactured. The system performs two-way communication between the space segment, i.e. satellite and ground segment, i.e. ground station.

There were two projects related to reviewing the existing systems and methods. In one project, management of a satellite ground control station was investigated. In another study, establishment of Assembly, Integration and Testing (AIT) Laboratory and Cube-Satellite Development in SPARRSO were investigated.

Apart from the above investigations, there was research that studied the geomorphological and meteorological condition of landslides in the south-eastern hilly region of Bangladesh. Another study was dedicated to identify objects from satellite images by developing a lightweight machine learning based model. The research related to the thunderstorm study considered six districts, i.e. Sylhet, Sunamganj, Moulvibazar, Chapainawabganj, Kishoreganj and Cox'sbazar as study area considering the recent casualties caused by this disaster. Observed meteorological data were used to find correlations between thunderstorms and meteorological variables (pressure, temperature, clouds, and others). Field surveys & secondary data were used to identify thunderstorm hazard zones and analyze intensity, vulnerability and casualties. The research

project is on-going and will be completed in the financial year of 2021-2022. The research projects implemented in the last financial year have been briefly described in the subsequent sections.

2.1 Atmospheric Research Division

Title: Study on Intensity, Vulnerability and Casualty of Thunderstorms over selected Districts in Bangladesh and Development the Correlation between Thunderstorm and Meteorological Variables based on Observed, Radar and Satellite data (Phase-1)

Background

Bangladesh is the most disaster-prone area in the world. Almost every year the country has to face many disaster events i.e. tropical cyclones, storm surges, tornados, floods, flash floods, norwester's, land slide, heat & cold wave and so on. In the recent years severe thunderstorm with associated lightning incidents are becoming more frequent and claiming more lives than the past. A thunderstorm is a violent weather disturbance. Fortunately, most of the thunderstorms are spatially small and temporally short-lived. Only a small fraction of all thunderstorms is classified as severe thunderstorms. It forms when moist, unstable air is continuously lifted vertically into the atmosphere. Strong or severe thunderstorms include some of the most dangerous weather phenomena, including large hail, strong winds, and tornadoes. Some of the most persistent severe thunderstorms, known as thunderstorm, rotate as do cyclones.

Research Objectives

The main objective of this study is to increase the understanding of thunderstorm & associated lightning hazard in the context of Bangladesh and support risk reduction initiatives for saving lives. The present research carried out a systematic process to understand intensity, casualty, vulnerabilities of thunderstorm & lightning hazard based on the observations and satellite data. The specific objectives of the study are:

i. To analyze the intensity, vulnerability and casualty of thunderstorms over selected districts in Bangladesh
ii. To study and understand the formation mechanism, characteristics and feature about thunderstorm over selected districts in Bangladesh

iii. To find out the correlation between thunderstorms and meteorological variables (i.e. pressure, temperature, cloud and others)

Methodology

This is a study where to analyze the current thunderstorms scenario of Bangladesh. It mostly considered observed & satellite data to understand the characteristics of a thunderstorm and is established a relationship between the thunderstorm and meteorological parameters (i.e. pressure, temperature, cloud and so on.). There are selected 06 districts as study areas considering the recent vulnerability and casualty due to thunderstorms. The districts are Sylhet, Sunamganj, Moulvibazar, Chapainawabganj, Kishoreganj and Coxsbazar. The observed thunderstorm data and meteorological data is used to find the correlation between thunderstorms and meteorological variables and field survey & secondary sources of data (newspapers & publications, online sources) is used to identify the risk zones of thunderstorms and analyzed the intensity, vulnerability & casualty. The different steps of the procedures are given below:

- Analysis of thunderstorm events considering mesoscale weather phenomena, geographical positions and field survey data.
- Examine the formation mechanism and characteristics of a thunderstorm
- Analysis the intensity, vulnerability and casualty due to thunderstorms and find the variation/trend of them.
- Analysis the sensitivity of the thunderstorm with individual meteorological parameter.
- Find out the correlation between thunderstorms and meteorological variables.

Results

1.1. Analysis of Thunderstorms Events

The total number of thunderstorms occurred in the year is considered as yearly thunderstorms. Data is collected from BMD for the year 1990 to 2020. Yearly total thunderstorms are presented in Figure 1 and trend of yearly thunderstorms over Srimangal is also shown in Figure 1. From the Figure it is found that the trend of yearly thunderstorms is decreasing with time. January to December monthly total thunderstorms are also shown in Figure 1 for the year 2015 to 2020 and monthly thunderstorms for all the year (2015-2020) over Srimangal.

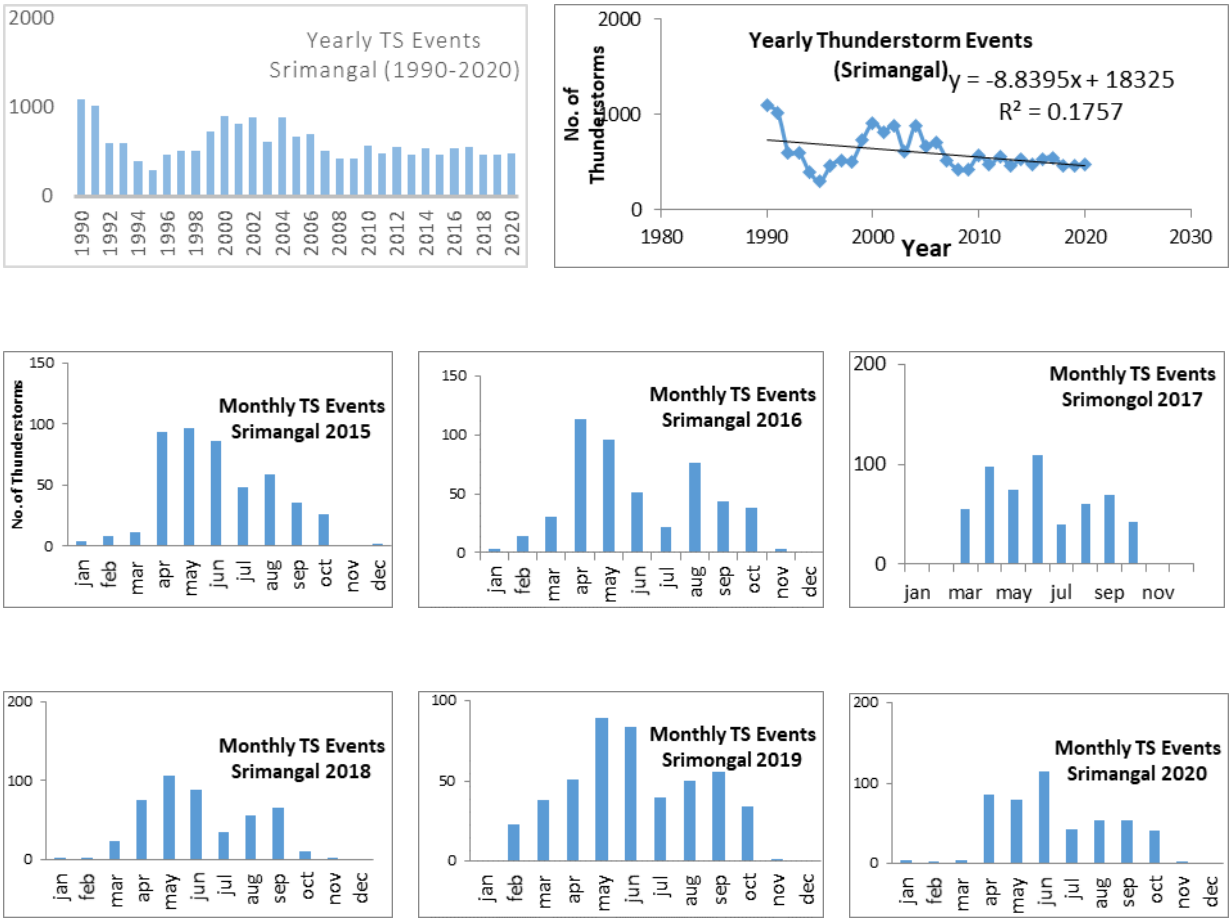


Figure 1. Yearly, Yearly Trend and Monthly total thunderstorms from 2015 to 2020 in Srimangal

1.2. Analysis of Yearly Cloud Coverage

The yearly average cloud coverage over Srimangal for the year 1990 to 2020 is shown in Figure 2 and the trend of average cloud coverage is also shown in Figure 2. From the Figure, it is found that the trend of yearly average cloud coverage is decreased with time. The monthly average cloud coverage over Srimangal for the year 2015 to 2020 is also shown in Figure 2. From the analysis, it is found that the intensity of thunderstorms is increased in the months of March, April, May & June compared to cloud coverage while from July to February, it is decreased.

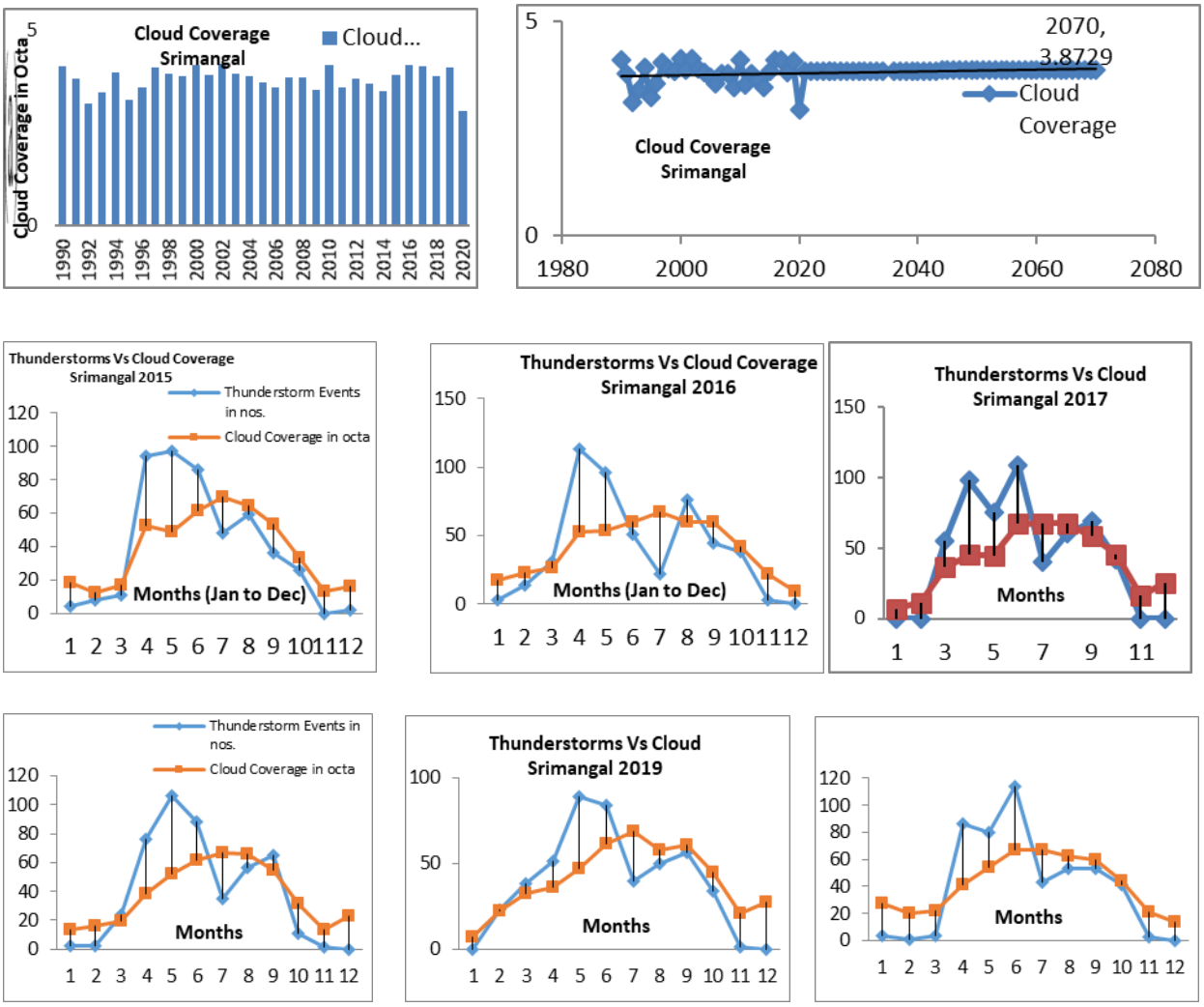


Figure 2. Cloud Coverage versus thunderstorm activities from 2015 to 2020 in Srimangal

1.3. Satellite Base Information

Lifted Index (LI) can be computed using computer algorithms but can also be determined graphically. To do this, generally, the parcel is lifted from the portion of the planetary boundary layer that lies below the morning inversion. Cirrus reflectance is very important for quantifying the effect of cirrus clouds on the earth's radiation budget and the cloud effective radius is important to understand the atmospheric condition especially the precipitation conditions of the atmosphere, Figure 3.

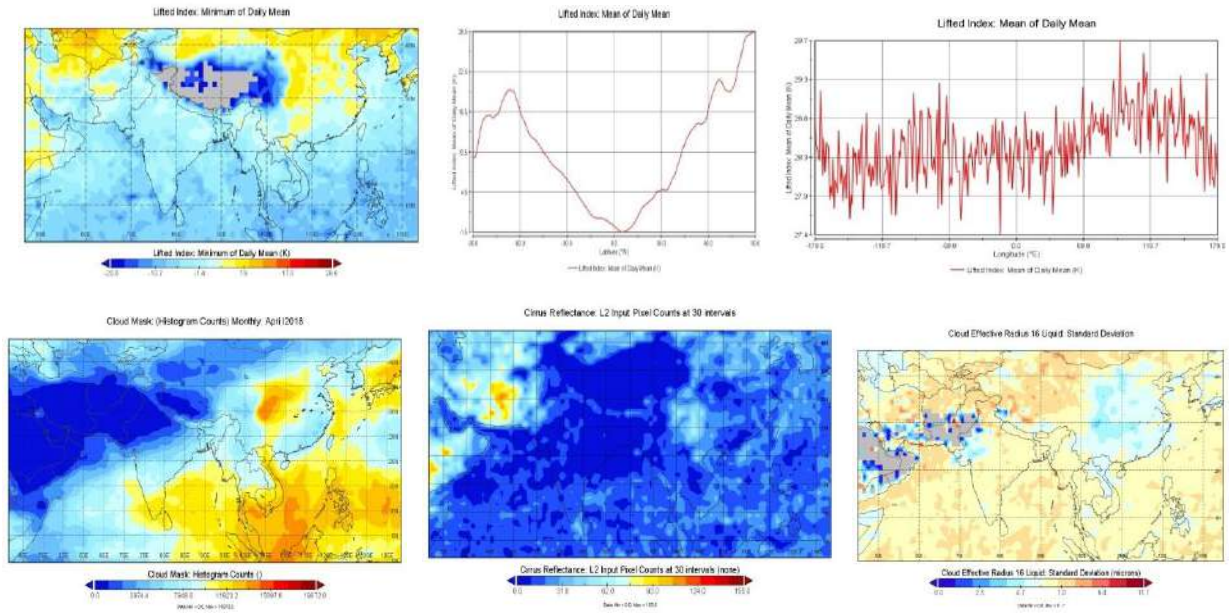


Figure 3. Lifted Index (LI), Cirrus reflectance and cloud effective radius from MODIS sensor of Aqua/Terra

2.2 Agriculture Division

Title: District Wise Acreage Estimation of Aman & Boro Rice using Feature Based Spectro-Temporal Characterization of Remote Sensing Data

Research Problem/Statements and Objectives

Precise, appropriate and timely information on agricultural crops is a major concern under the prevailing circumstances. Satellite remote sensing technology offers an effective means for monitoring agricultural crops at large scale on a repetitive basis. Proper utilization of such technology is to be ensured to provide necessary information support to national food security programs. SPARRSO being the national focal point of remote sensing technology has been regularly monitoring the major agricultural crop in the country for the last two decades and has been providing important information support to the government. The major activities include estimation of crop area particularly for Aman and Boro rice in the country.

The principal goal of this research was to develop an appropriate methodological framework to generate timely information on the acreage of boro and aman rice in Bangladesh on a small administrative scale (district scale).

Research Methodology

This method uses a decision tree approach and it also uses an additional mask based on Sentinel-2 images. All of the processes used to develop the rice field maps up to the final merging were

performed in the Google Earth Engine (GEE) platform (https://earthengine.google.com/). Preprocessing to generate the backscatter coefficient (σ^0), the Sentinel-1 GRD images accessed on the GEE platform were preprocessed by applying five Sentinel-1 Toolbox corrections developed by the ESA.

The temporal behavior of Sentinel-1 VH σ^0 over each rice reference field region was analyzed to determine the threshold values for the mask. In all rice reference field regions, a local VH σ^0 minimum was observed during the irrigated period. Subsequently, VH σ^0 increased and reached a peak within a few months. Thereafter, during the latter part of the rice cultivation period, VH σ^0 maintained a high value or decreased slightly.

I. Masks Used for Provisional Extraction of Rice Fields

i. Settlement Area (SA) mask: A mask for Settlement area was made based on an updated version of the Hansen Global Settlement Change map (v1.6, 2000–2018). Pixels with a Settlement area covering more than 30% of the pixel area were specified as Settlement pixels.

ii. Local Maximum & Minimum (LMM) mask: The local maximum σ^0 value and the local minimum σ^0 value of the Sentinel-1time series within 90-day moving windows were calculated for each Sentinel-1 image from the period between Transplant Start (TS) and Harvest End (HE). In this study, the thresholds of the local minimum and local maximum σ^0 values were determined by analyzing the temporal behavior of Sentinel-1 VH σ^0 values in the rice reference fields. Figure 4 shows the local minimum Q3 VH σ^0 value during the irrigated period and the local maximum Q1 VH σ^0 value between the end of the irrigated period and HE for each rice reference field region. In all Aman rice field reference regions; the local minimum Q3 VH σ^0 value was smaller than −15 dB and local maximum Q1 VH σ^0 value was above −15.2 dB. Therefore, pixels with a local minimum VH σ^0 larger than −15 dB or a local maximum VH σ^0 smaller than −15.2 dB, were masked on each Sentinel-1 image for Aman rice. Whereas, in all Boro rice field reference regions, the local minimum Q3 VH σ^0 value was smaller than −21dB and local maximum Q1 VH σ^0 value was above −15dB. Therefore, pixels with a local minimum VH σ^0 larger than −21dB or a local maximum VH σ^0 smaller than −15dB were masked on each Sentinel-1 image for Boro rice. The VH σ^0 of Rice fields shows a very distinct minimum when the Rice fields are irrigated just after transplanting and a maximum

during the heading stageof the rice plants.

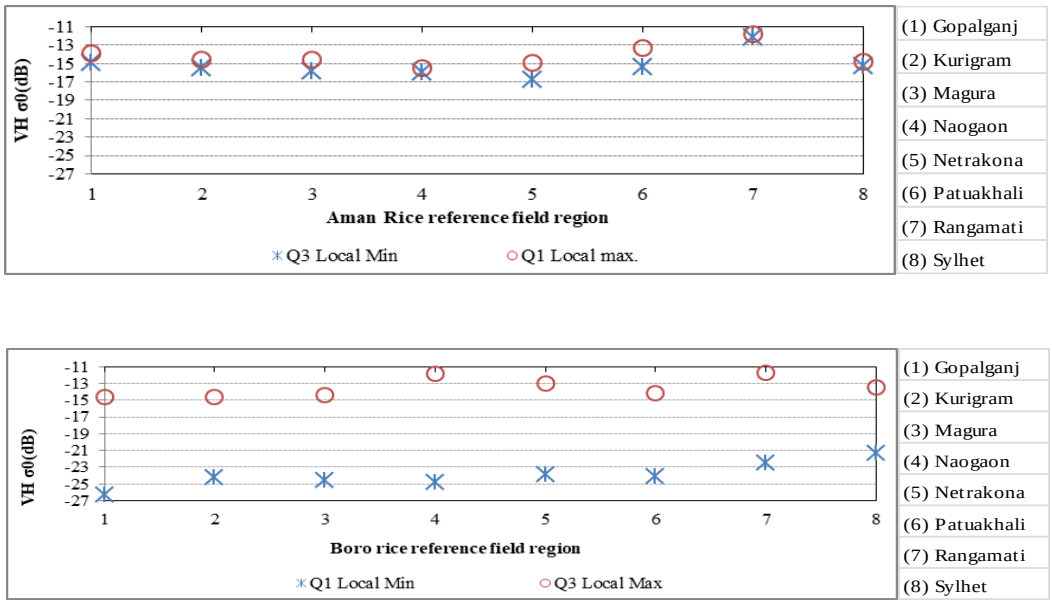


Figure 4. The Local Minimum Q3 Value During the Irrigated Period and the Local Maximum Q1 Value between the End of the Irrigated Period and Harvest End in Each "Aman Rice" & "Boro Rice" Reference Field Region.

iii. Local Variation (LV) mask: Local variation values were calculated for each Sentinel-1 image by using the equation: $\text{Local variation} = \text{Loc max VH}\sigma^0 - \text{Loc min VH}\sigma^0$.

Local maximum VH σ^0 and local minimum VH σ^0 are the values calculated for the LMM mask. Pixels with a local variation of less than 0.2dB were masked on each Sentinel-1 image. This threshold value, which was also determined by analyzing the temporal behavior of Sentinel-1 VH σ^0 values in the rice reference fields, was selected to differentiate vegetation with clear seasonality from land covers with a constant low or high backscatter such as water bodies and urban areas. It should be noted that the SA mask was applied to the entire Sentinel-1 time series, whereas the LMM and LV masks were applied to each Sentinel-1 image composing the Sentinel-1 time series. The pixels of Sentinel-1 images during the irrigated period that were not masked by any of these threemasks were extracted as provisional rice field pixels.

II. **Mask Based on Sentinel-2 MSI Environmental Indexes**

"Sentinel-2 indexes (S2I)" mask: The provisional Rice fields extracted by the VH σ^0 threshold were reexamined by using water and vegetation indexes, LSWI, NDVI, and EVI, calculated from Sentinel-2 MSI images acquired during the irrigated period. The LSWI is sensitive to the total amount of liquid water in vegetation and its soil background, and the NDVI and EVI are sensitive to variations in the vegetation. Previous studies have revealed that relationships among the LSWI, NDVI, and EVI can be used effectively to extract irrigated areas. The local maximum "LSWI−NDVI" and "LSWI−EVI" values within the 10 days after the date that the Sentinel-1 image was acquired were calculated, and pixels in which the local maximum "LSWI−NDVI" and "LSWI−EVI" values were both smaller than 0 were masked. The pixels of Sentinel-1 images acquired during the irrigated period that were not masked by any of the four masks were extracted as rice fields.

Results

Proposed high-resolution rice field mapping method that uses Sentinel-1 SAR time series images was supplemented by Sentinel-2 optical images. Although some rice field mapping methods combining SAR and optical images have been proposed previously, those methods used optical images as fundamental data for rice field extraction; therefore, they could be seriously affected by gaps and biases in the optical images due to cloud cover. In contrast, in our proposed method, the Sentinel-2 images are used only as ancillary data to produce masks based on water and vegetation indexes. As a result, gaps in the Sentinel-2 images did not adversely affect the rice field mapping accuracy. In this regard, this method is expected to have an advantage for detecting rice fields at a broad scale.

The efforts in this study are a step toward providing more accurate rice field maps wherever rice is grown. Because rice cultivation methods and cultivation environments vary greatly from region to region, it is important to confirm whether this method is applicable to mapping rice fields in other parts of the country. We found that the new method worked well in most of the study areas except Rangamati but overestimated in some regions. This implies that the method can be improved by applying additional masks and thresholds such as a more detailed classification of cultivated crops and land cover types, and by conducting validations over broader and more diverse areas.

2.3 Forestry Division

Mapping Changes in the Mangrove Forest Ecosystem Using Satellite Sensor Data

Our world is progressively facing the threat of global climate change. Among different ecosystems in the global, mangroves forming in the low-lying coastal regions, would be one of the severely affected ecosystems of global climate change and sea level rise. One of the consequences of sea-level rise would be the changes in mangrove species formation in different ecological zones. Currently, it is not clear how species composition in the Sundarbans mangrove is changing over the last decades.

The objectives of this research are to develop a methodology for mapping the changes in dominated species composition in the Sundarbans mangrove and assess the changes using satellite sensor data in the study area. The Study area was located in the northern part of Sundarbans mangrove belonging to the largest continuous mangrove forest in the world. The approximate size of the study is around 272 km^2. The area is purposely selected in the region where there is a rapid change in dominant tree species composition; the mixed sundry-area has been replaced by Kankra.

Landsat 5, Landsat 7 and Landsat 8 images of 1988, 1989, 2000, 2010 and 2022 were used in the analysis. In addition, QuickBird-2 satellite images of 2004-2005 and Worldview-2 satellite images of 2021 were utilized in the study. Landsat image of 2022 was classified using Object Based Image Analysis (OBIA). Interpretation was done for 2022 with the assistance of field validation. The interpretation was extended for the 1988-89 satellite images, which was assisted by the published maps and documents.

The statistics of Mangrove classes for 1988 and 2022 is presented in Table 1. It shows that the area was dominated by the mixed class of Sundri –Gewa in the late 1980s (i.e. 1988). The class has been replaced by Kankra in many places in the 2020s (i.e. 2022). The total area of Kankra dominated places was 165 in 1988 while it was 2,279 ha in 2022. On the other hand, themixed-classs Sundri-Gewa was 15,969 ha in 1988 and it was reduced to 12,583 ha in 2022.

Table 1. The statistics of major classes in the selected part of Sundarbans mangrove in 1988 and 2022

Serial	Class Name	Area (ha)	
		1988	2022
1	Sundri-Gewa	15,969	12,583
2	Keora	15	15
3	Kankra	165	2,279
4	Others	11,234	12,506
Total		27,383	27,383

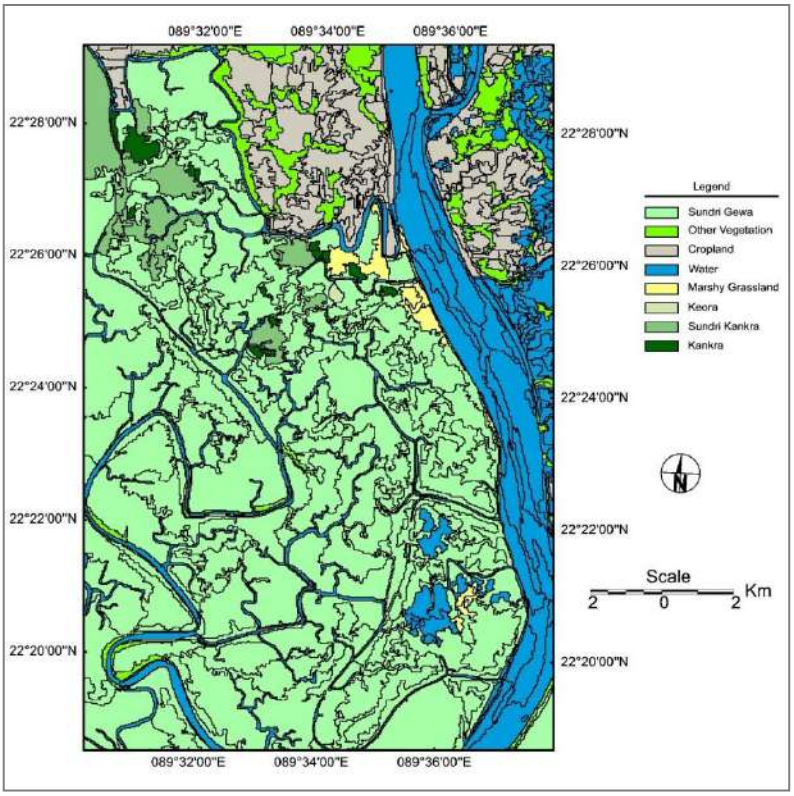


Figure 5. Mangrove species distribution map of the study area for 1988

The study found that the Kankra (*Bruguiera gymnorhiza*) is gradually replacing Sundri (*Heritiera fomes*) and mixed Sundri Gewa (*Excoecaria agallocha*) trees in the study region **(Figure 5 and Figure 6).** The reflectance and separation possibility of Kankra from Sundri and

Sundri-Gewa composition was analyzed with the digital reflectance value of atmospherically corrected Landsat-5 and Landsat-8 images of 1988 and 2022, respectively.

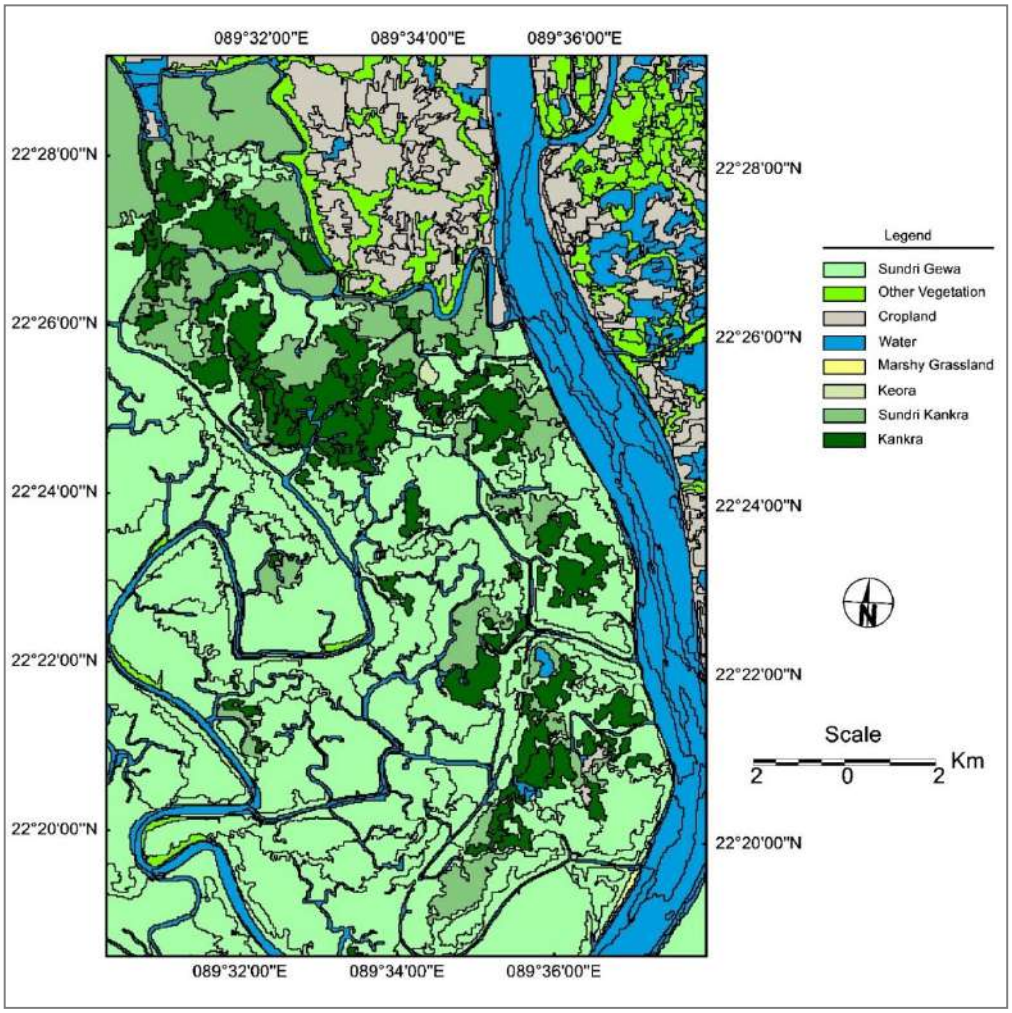


Figure 6. Mangrove species distribution map of the study area for 2022

In the current study, it was found that appreciable changes are noticed in the dominant species composition in the selected parts of Sundarbans mangrove over the last three decades. The species class Sundri and Sundri-Gewa have been replaced by Kankra in the north-western part of Chandpai Forest Range covering the compartment number 30 and 31. The result of the study will be helpful for the decision makers and forest mangroves to understand the current stand dynamics of the mangrove ecosystem over the last few decades.

2.4 Water Resources Division

Title: Trend of Rainfall Related to Low Pressure System over and around Bangladesh

Research Problem/Statements and Objectives

During the monsoon season, prevailing south-westerly carries abundant moisture from the Bay of Bengal to the land of Bangladesh and its surrounding region and causes heavy downpour especially to the windward side of the mountains **(Figure. 7).** One of the common and major rainfall bearing phenomena of the Indian monsoon region is Low Pressure System (LPS). LPS is the anomalous atmospheric cyclonic circulation which causes heavy rainfall over Bangladesh, West Bengal and Central India during monsoon season. Around 60% of the peak rainfall days over Bangladesh happen due to LPS reported by some literature. Because of the low and flat topography of this country the sufferings of the people of Bangladesh due to consecutive days of heavy rainfall has no bounds. The inter-annual variation of rainfall over the Central India and Southeast Coast of India is regulated by this LPS (from literature survey). There is no study on how the rainfall of Bangladesh is linked to the LPS in an inter-annual time scale. The present study will try to make such a relationship in an inter-annual time scale. Moreover, strong LPS was found decreasing from 1958 to 2015 (revealed in last year), it is worthy to find out the trend of rainfall related to strong LPS days over Bangladesh.

The aim of the present study is to find out the trend of rainfall related to LPS over Bangladesh. The associated objective of this study is to identify the potentially rainfall affected area due to the LPS. This study also reveals the relationship of the LPS to the rainfall over Bangladesh in an inter-annual time scale. The findings of this research will guide the policy makers to make long term planning and take necessary management action.

Research Methodology

The reference area for the detection of LPS covers the area of 15° N to 30° N and 80° E to 95° E which is shown by the outer black box region in **Figure. 8**. The Japanese Reanalysis-55 (JRA-55) 6 hourly atmospheric dataset with a spatial resolution of 1.25°×1.25° grid has been used for the detection of LPS.

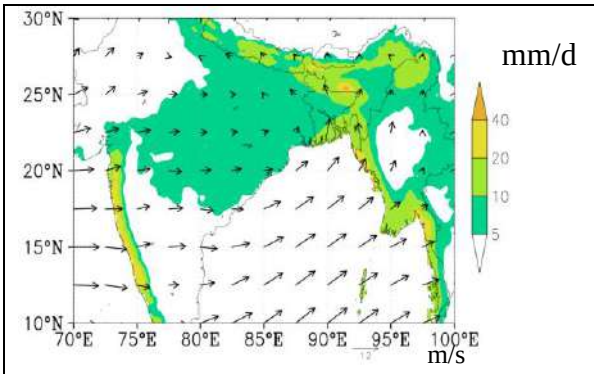


Figure 7. Climatological rainfall and horizontal wind in and around Bangladesh during monsoon season. Shading denotes the surface rainfall (mm/d) and vector indicates the wind at 925-hPa level (m/s).

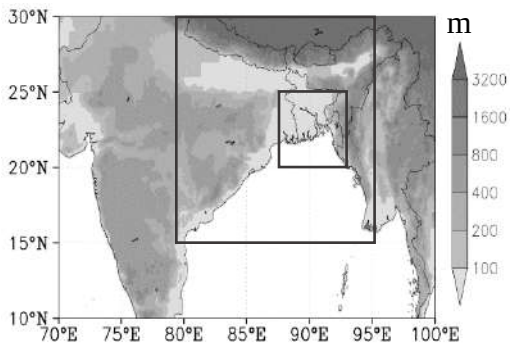


Figure 8. Topography in and around Bangladesh. Outer black box indicates the reference area of LPS detection and the inner black box indicates the area for which average rainfall is calculated.

APHRODITE (Asian Precipitation - Highly-Resolved Observational Data Integration towards Evaluation of Water Resources) daily rainfall dataset with a spatial resolution of 0.25˚×0.25˚ has been used to meet the objectives. Statistical analysis is performed to convert the daily rainfall data to monthly and then annual seasonal mean for monsoon season. Similar statistical analysis for the strong LPS days, weak LPS days and Number of LPS days' rainfall data are performed as well. Data processing and the statistical analysis were performed in Linux by shell scripting and using Grads 2.02 software. For the visual representation of the output MS Excel and Grads have been used. In the present study the trend of rainfall related to strong LPS are shown since the significant decreasing trend of strong LPS was found in previous year.

Results

From **Figure. 9(a),** it is very clear that strong LPS days carry the wet episode for the whole Indian subcontinent except the southern India and north and north-eastern part of India and Bangladesh. Rainfall intensity is found more than 20% high over Central India, south-east coast of India and southern part of Bangladesh during strong LPS days. Rain ratio is calculated using following equation:

$$\frac{(B - A) \times 100}{A}$$

Here, A=LPS or no LPS days daily average rain rate during monsoon season

B=Daily average rain rate during monsoon season

Area average rainfall is calculated for the area of 21° N to 25° N and 87° E to 93° E (Fig. 2) which covers most of the area of Bangladesh. The northern part of Bangladesh is not included in the present study for the calculation of rainfall since the rainfall of this region is not affected by the rainfall of LPS (**Figure. 9a).** Daily annual LPS related rainfall over Bangladesh shows strong correlation (0.71) with the daily annual rainfall during monsoon season. From **Figure. 9(b)** it is clear that the inter-annual variation of rainfall in Bangladesh during monsoon season is strongly regulated by the rainfall of LPS days.

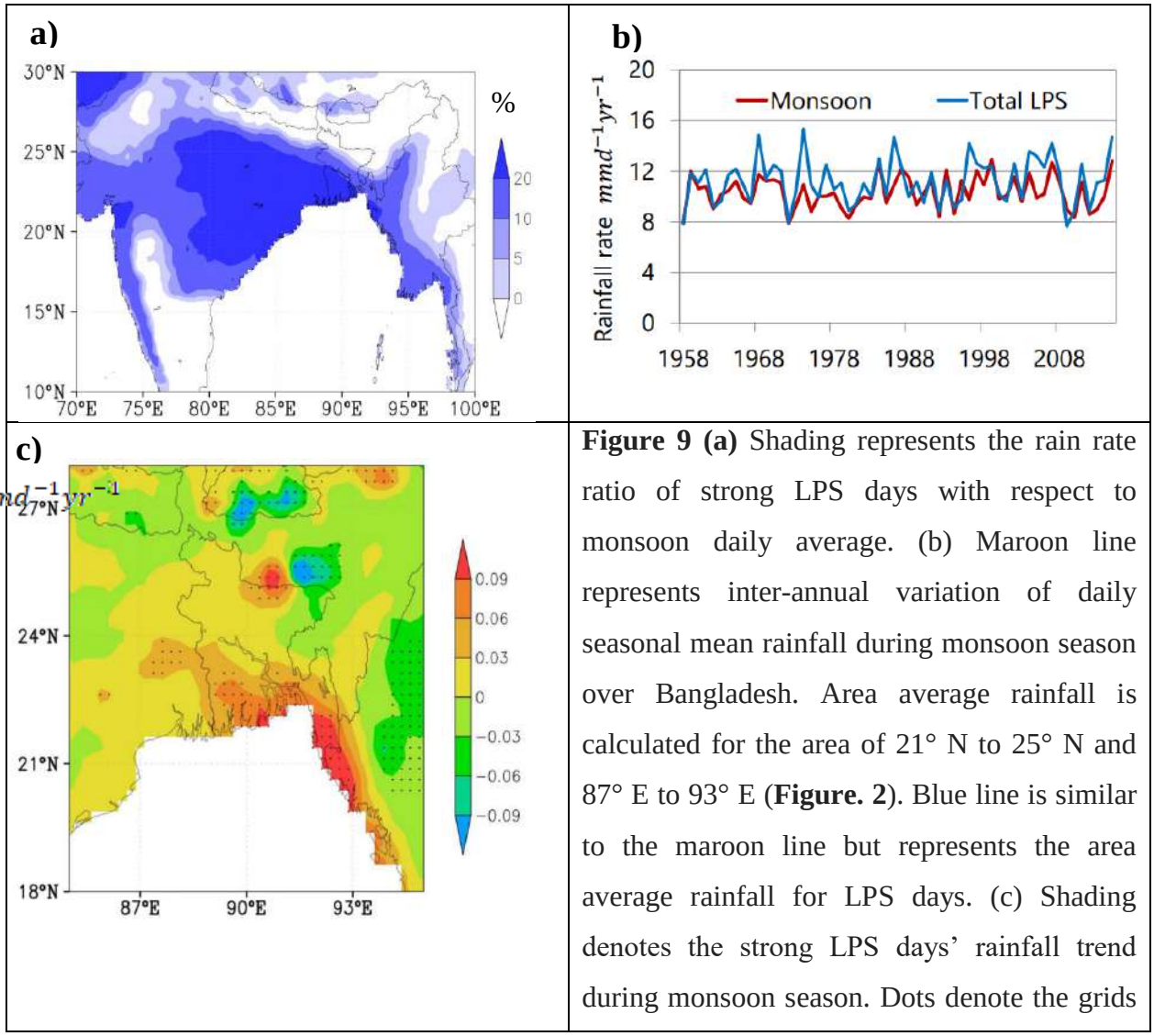


Figure 9 (a) Shading represents the rain rate ratio of strong LPS days with respect to monsoon daily average. (b) Maroon line represents inter-annual variation of daily seasonal mean rainfall during monsoon season over Bangladesh. Area average rainfall is calculated for the area of 21° N to 25° N and 87° E to 93° E (**Figure. 2**). Blue line is similar to the maroon line but represents the area average rainfall for LPS days. (c) Shading denotes the strong LPS days' rainfall trend during monsoon season. Dots denote the grids

	having statistically significant rainfall trends (p=0.1).

Rainfall related to strong LPS over Bangladesh shows increasing trend (**Figure. 9c**) specially, over southern coast of Bangladesh (p=0.1). Because of the global climate change the warming of the atmosphere enhance the water holding capacity of the air. Due to the large amount of moisture in air strong LPS causes heavier rainfall than expected when it rains.

2.5 Photography Division

Title: Analysis of Land Cover Changes on Teknaf and Ukhia Upazila of Cox's Bazar District due to Rohingya Settlements

Background

Land use and land cover change studies are important in Bangladesh since in many areas of the country these changes are taking place for various reasons. Ukhia and Teknaf are two mostly affected Upazilas of Cox's Bazar district due to the Rohingya crisis in South-East Bangladesh. So, these areas have been selected as the study area considering the location, refugee population, number of camps etc. (**Figure. 10**). The effect of the refugee crisis on the host community's environment and natural resources has become an emerging topic.

The objectives of the research were

1. To identify the land use and land cover Changes due to the Rohingya settlement in the study area.
2. To prepare a Land use and Land covers (Change Detection) Map.
3. To identify the underlying causes of land use and land cover changes.

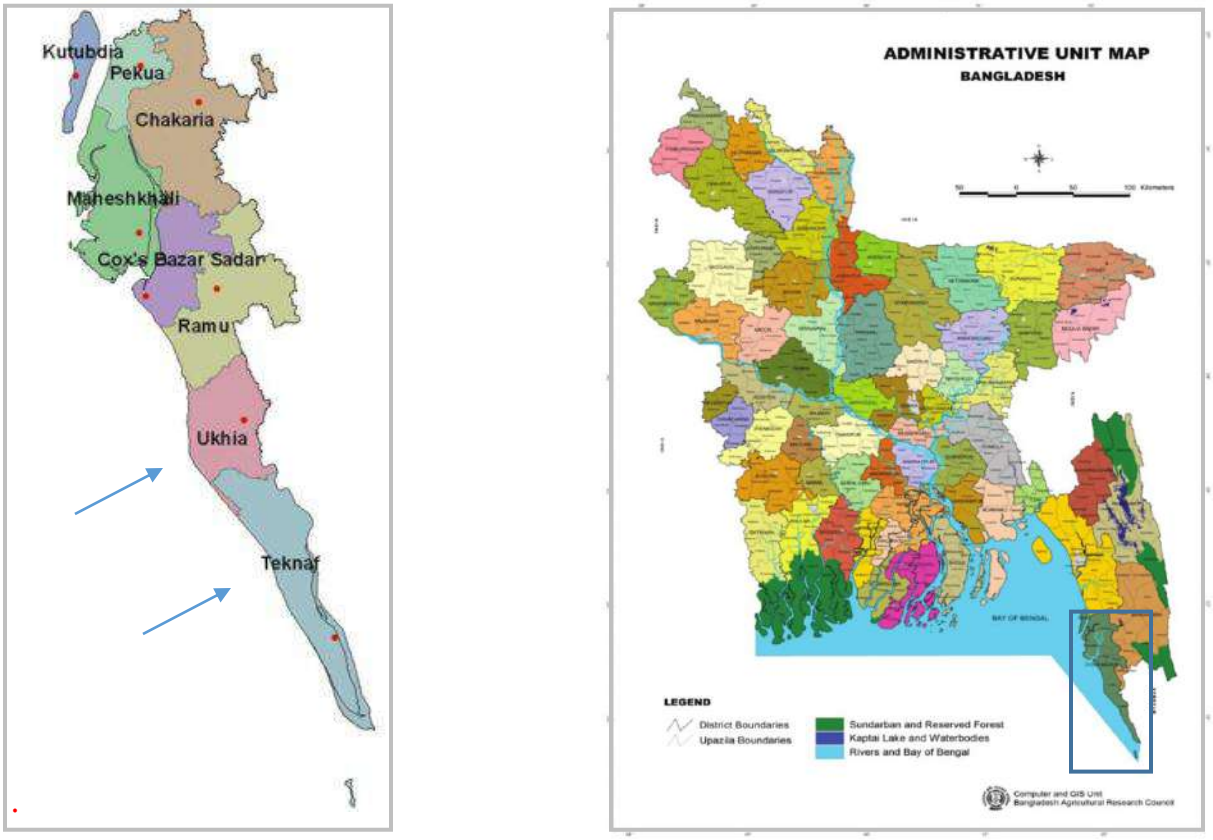


Figure 10. The Location of the study area

Methodology

Sentinel-2 satellite image of 2016 and Planetscope satellite image of 2020 were used in this study. Satellite image was Geo-referenced to Transverse Mercator (TM) Projection utilizing Linear Transformation Matrix with the Nearest Neighborhood re-sampling strategy. Pre-processed data were interpreted and land use and land cover information was delineated by on-screen digitization procedure. Land-use changes were identified for the years 2016 to 2020. The research methodology is presented in **Figure. 11.**

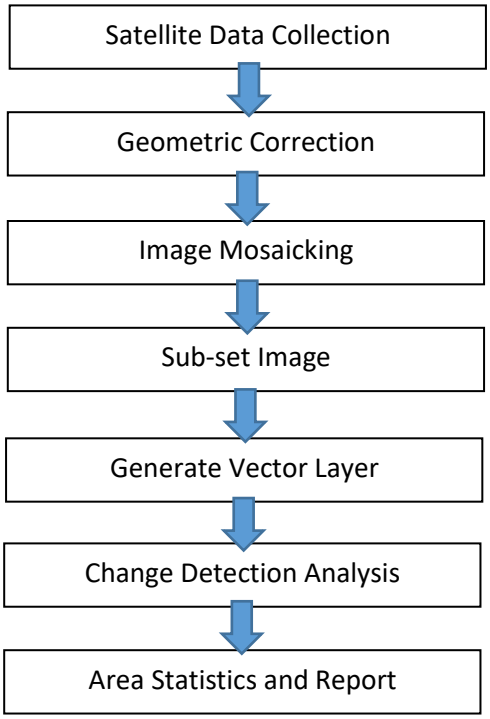


Figure 11. The representation of project methodology

Results

In the study, we found a significant alteration in land use and land cover of that region. The results of changes are presented in Table 2 and **Figure 12** for Teknaf Upazila and Table 3 and **Figure 13** for Ukhia Upazila. The information on the satellite image interpretation indicated that in Teknaf Upazila, the coverage of Forest / Shrubs Class was 161.20 sq. km in 2016, while the class decreased to 129.32 sq. km in 2020. We noticed that the agricultural land area was reduced by 1.91 sq. km during 2016-2020. On the other hand, the land used for settlements was 57.26 sq. km in 2016 which was increased to 79.63 sq. km in 2020. The increase in the settlement area was 22.37 sq. km. In 2016, there were no Rohingya settlements but in 2020 there were 8.44 sq. km of Rohingya settlements. In 2016, 17.72 sq. km of land was used for salt cultivation but in 2020 it was increased to 26.47 sq. km as the total increase was 6.67 sq. km. In 2016, water-bodies covered an area of 57.41 sq. km but in 2020 it was decreased to 55.82 sq. km. Total decrease was 1.59 sq. km during the period. In 2016, Bare Land, Roads and other areas covered 91.38 sq. km of land but in 2020, it was decreased to 87.20 sq. km as the total decrease was 4.18 sq. km.

Table 2. Land use land cover changes in Teknaf Upazila (2016-2020)

Class Name	Land Use and Land Cover		Land Use and Land Cover Change 2016 to 2020 (Area in sq. km)
	2016 (Area in sq. km)	2020 (Area in sq. km)	
Settlement	57.26	79.63	22.37(Area Increased)
Rohingya Settlement	0	8.44	8.44 (Area Increased)
Forest and Shrub	161.20	129.32	31.88(Area decreased)
Salt-bed	17.72	26.47	8.75(Area Increased)
Agriculture	3.71	1.80	1.91 (Area decreased)
Water-bodies	57.41	55.82	1.59 (Area decreased)
Others	91.38	87.20	4.18 (Area decreased)

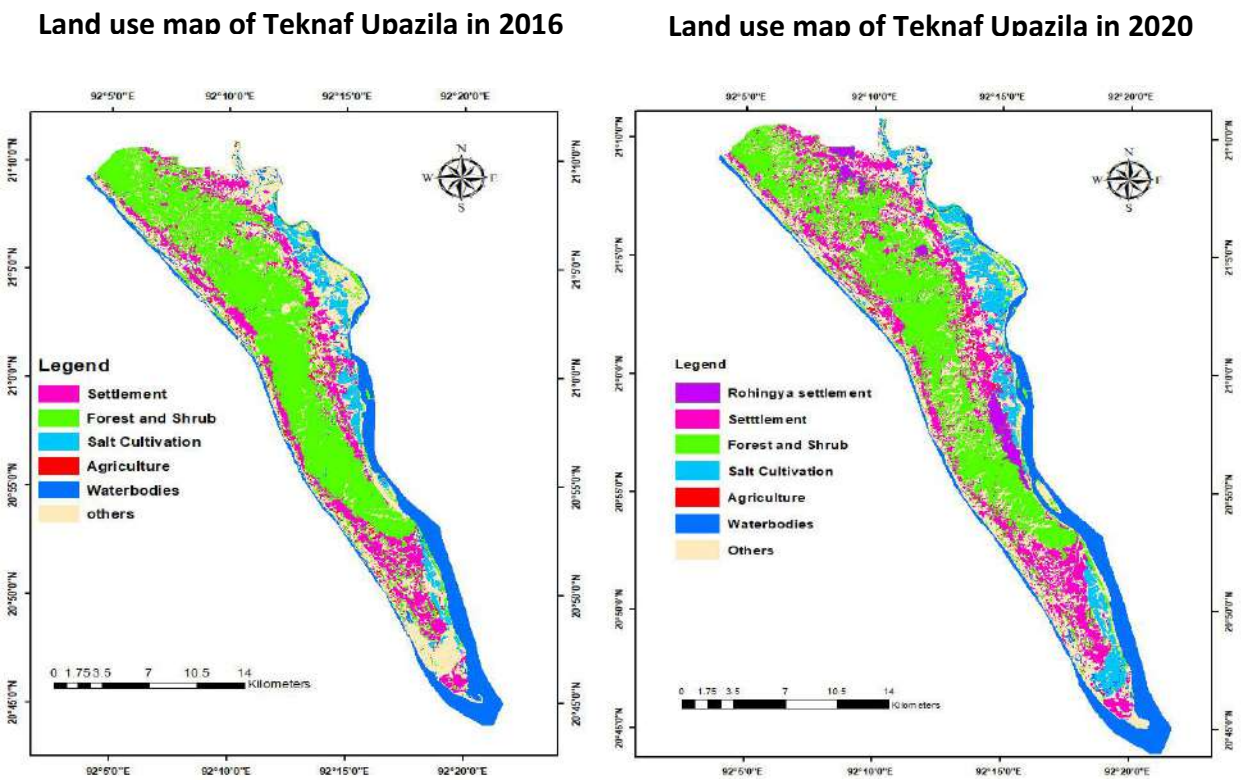


Figure 12. Land Use and Land Cover Map of Teknaf Upazila for the year 2016 and 2020

Table 3 Land Use and Land Cover Changes in Ukhia Upazila (2016 to 2020)

	Land Use and Land Cover		**Land Use and Land Cover Change**
Class Name	**2016 (Area in sq. km)**	**2020 (Area in sq. km)**	**2016 to 2020 (Area in sq. km)**
Settlement	60.96	100.9	39.94 (Area Increased)
Rohingya Settlement	00	11.49	11.49 (Area Increased)
Forest and Shrub	128.68	78.59	50.09 (Area decreased)
Water-bodies	8.02	4.48	3.6 (Area decreased)
Others	60.07	62.9	2.83 (Area Increased)

Similarly, information obtained from the satellite image interpretation and analysis for Ukhia Upazila indicated that the extent of Forest and Shrub Class was 128.68 sq. km in 2016, while it was decreased to 72.33 sq. km in 2020. We noticed that the agricultural area and salt cultivation area in Ukhia Upazila are very small and therefore, we omitted this class. On the other hand, we found that the land used for settlements was 60.96 sq. km in 2016 and it was 111.35 sq. km in 2020. The increase in settlement area was 50.39 sq. km. In 2016, there were no Rohingya settlements in the area but it was identified as 11.49 sq. km in 2020. In 2016, 8.02 sq. km of land was identified as water bodies but in 2020 it was decreased to 4.42 sq. km; the total decline was 3.60 sq. km. We found that 60.07 sq. km of land which was classified as Bare Land, Roads and other areas in 2016 was decreased to 58.77 sq. km in 2020; the total decrease was 1.30 sq. km.

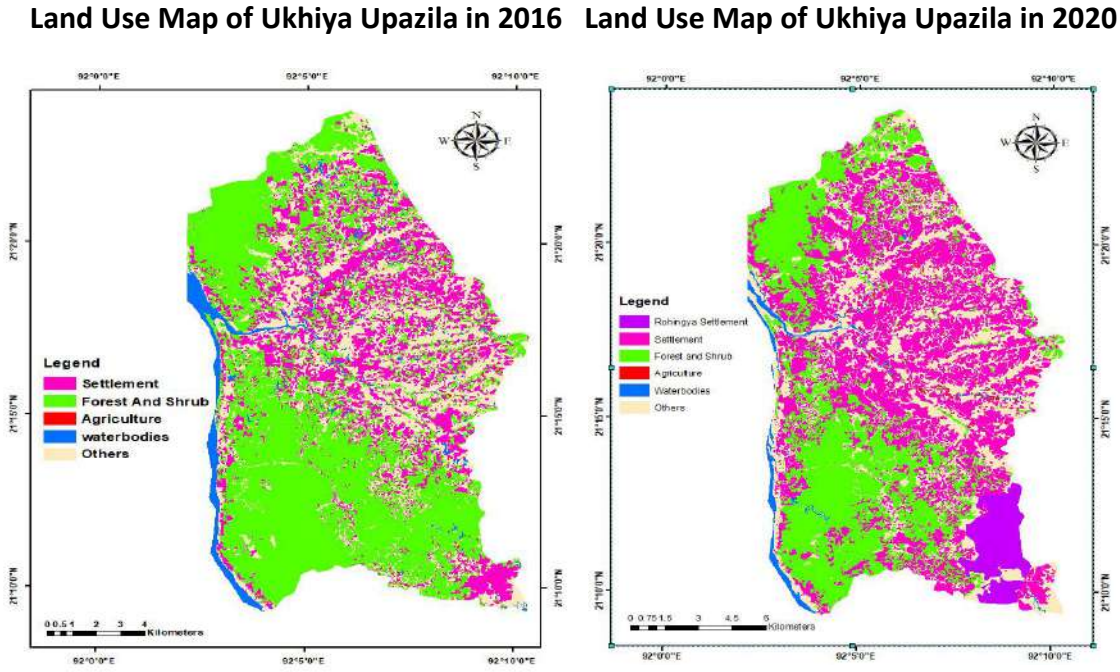


Figure 13. Land Use and Land Cover Map of Ukhiya Upazila for the year 2016 and 2020

2.6 Fisheries Division

Title: Spatio-Temporal Dynamics of Land Use Land Cover in Tanguar Haor and Its Impact on Fisheries Habitat

Introduction

Wetlands are an important source of global biodiversity which provide essential support to both the ecosystem and the livelihood of the dependent communities. Wetlands provide habitats for many special plants, birds, mammals, reptiles, amphibians, fish, and invertebrate species. Bangladesh possesses several types of wetlands, including rivers and streams, freshwater lakes and marshes, haors, baors, beels, water storage reservoirs, fishponds, flooded cultivated fields, and estuarine systems with extensive mangrove swamps (Banglapedia, 2021). Tanguar haor is one largest fresh water wetland and mother fishery in the haor basin of Bangladesh that has been identified as an area of national and international importance and attention. The Government of Bangladesh has declared it as an Ecologically Critical Area in 1999 due to gradually overexploitation and degradation consequences of its natural resources. Degradation of wetland habitat, sedimentation in the haor basin, destruction of breeding ground, illegal and destructive fishing practices, rainfall anomaly, early summer or early winter, indiscriminate use of pesticides and herbicides, fry and brood fishing, and lack of implementation of natural resources management strategy are the main factors for the reduction of fish population and their genetic diversity in the haor areas (Aziz et al., 2021; Sunny et al., 2020; Mamun et al., 2013). So, both natural and anthropogenic factors have significant impact on wetland biodiversity declination (Aziz et al., 2021). Changes in land use and land cover also poses threats to fish species diversity by shrinking fish habitat, breeding ground and reduce the overall water area. Detection of spatio-temporal change pattern and information can help in sustainable use and management of wetland resources (Rahimi et al., 2020). Remote sensing (RS) and geographic information system (GIS) are now providing cost and time-effective tools for advanced ecosystem and socio-economic management. Collection of multi-temporal remotely sensed data facilitates the synoptic analyses of earth- system function, patterning, and change at local, regional and global scale over time. RS and GIS derived information can also provide important link between intensive, localized ecological research and regional, national and international conservation and management of

biological diversity (Wilkie and Finn, 1996; Haque and Basak, 2017). The present study will take the advantage of RS and GIS techniques and information collected from field observation for studying the spatio-temporal dynamics of Tanguar haor and its impact on fisheries habitat.

Aim and Objectives

The present study aims to assess the nature, significance of Tanguar haor and to delineate the past and present condition and change in the haor area in order to understand the impact of change on fisheries habitat. The specific objectives are:

1) To identify the extent of land use and land cover (LULC) in Tanguar haor in temporal domain.
2) To explore the changes in land surface temperature (LST) in Tanguar haor over time.
3) To identify the seasonal pattern of water extent in Tanguar haor.
4) To investigate the impact of changes in LULC and LST on fisheries habitat in Tanguar haor.

Methods and Materials

To attain the aim and objectives of this study integrated RS-GIS technology is implemented. The study focuses on the changes of surface features over a long period (1973 to 2020) that delineates the land use land cover change of the study area. For this historical analysis this study uses the satellite data of Landsat series. Along with multispectral data Landsat also provides thermal data that are used in the analysis of LST in the study area.

Figure 14. Study area.

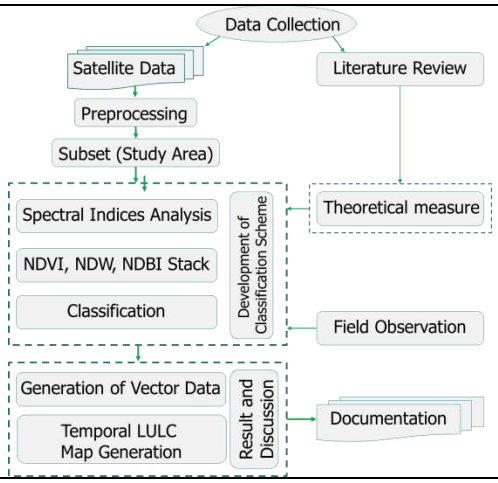


Figure 15. Methodology of the study.

season, multispectral data is not effective because of cloudy weather. So for the analysis of seasonal pattern of water extent this study takes the opportunity of using Synthetic Aperture Radar (SAR) data (Sentinel-1 satellite) provided by European Space Agency (ESA). The methodological flowchart of the present study is given in **Figure 15.** This study attempts to identify the LULC of Tanguar haor in temporal domain. After preprocessing the data this study generates some spectral indices such as NDVI, NDWI, NDBI etc. Then the spectral indices are stacked with a view to perform classification. Unsupervised classification of k means algorithm has been applied in the stacked spectral indices data layers. The classification has been applied targeting four classes that are 1) Water 2) Dense Vegetation 3) Sparse Vegetation and 4) Bare Land. Along with the satellite data analysis the study conducts field survey that helps to understand the natural settings of the study area and characters of surface features. Field observation also supports to understand the perception of the local people relevant to this study. This research uses optical and infrared datasets of Landsat satellite series from 1973 to 2020 for LULC and LST analysis. This study also uses the Sentinel-1 SAR data form January to December in 2020 with a view to identify the seasonal water extent of the study area.

Results

Tanguar haor is an ecologically critical area as it is situated in such a location where the ecosystem of the haor is not only dependent on its own area but also on the surrounding area that covers the Meghalayan hill ranges. This study finds that the haor is receiving huge amount of sand that is coming from the Meghalayan hill ranges through the montane channels **(Photograph 1)**. Huge amount of sand transportation is filling up the canals that are connected with Tanguar haor. This sand transportation hinders the natural flows of water that ultimately impacts on the ecosystem of the haor along with the fisheries habitat.

Photograph 1. Filling up canals with sand that comes out through the channels from Meghalayan hill ranges.

This study finds some hotspots using the multitemporal Landsat images. The local name of hotspot 1 is Bagli and hotspot 2 is Nongiri (**Figure 16).** Hotspot 1 and 2 are identified as areas of stone and coal exploitation. The temporal maps show that before 1990 the stone and coal exploitation was insignificant. But with the passage of time exploitation has been increasing remarkably. Hotspot 2 shows similar scenario as the stone and coal exploitation has been increasing gradually that causes unusual phenomena like flash flood and sand transportation. These unusual phenomena ultimately cause adverse impact on the ecosystem of haor along with fisheries habitat.

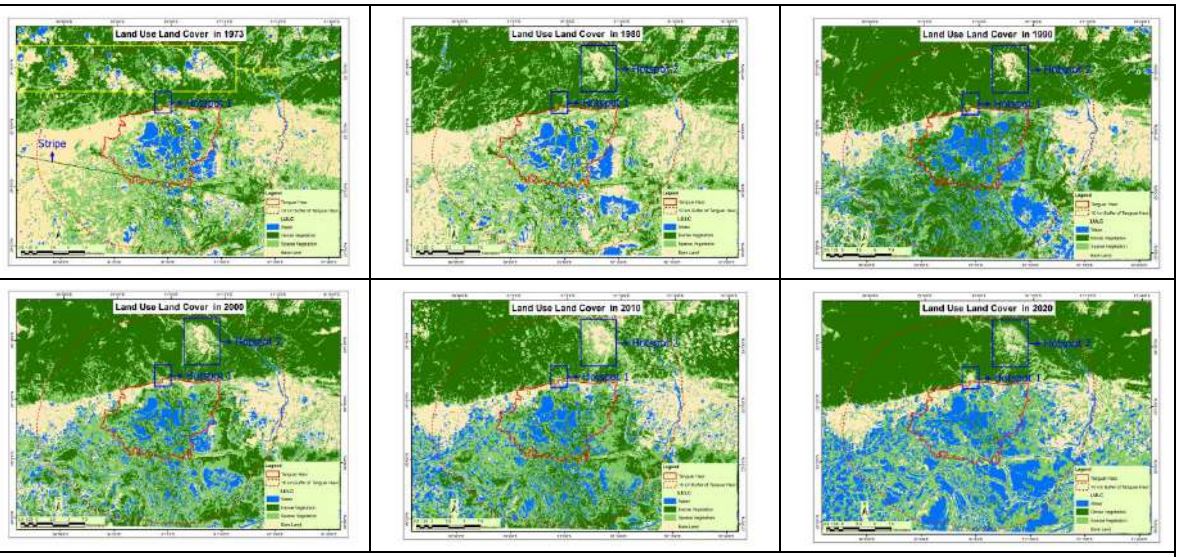


Figure 16. Land Use Land Cover (LULC) maps of Tanguar haor from 1973 to 2020.

Figure 17 displays the scenario more clearly as the LST has been increasing gradually all over the study area. It is noticeable that the LST of hotspot 2 starts to increase in 2000 and LST rises more in 2010. But LST decreases in 2020 compare to that of 2010. Temporal maps of Figure 4 show that LST is normal in hotspot 1 during 1990 and 2000 but LST starts to increase in 2010 and goes up.

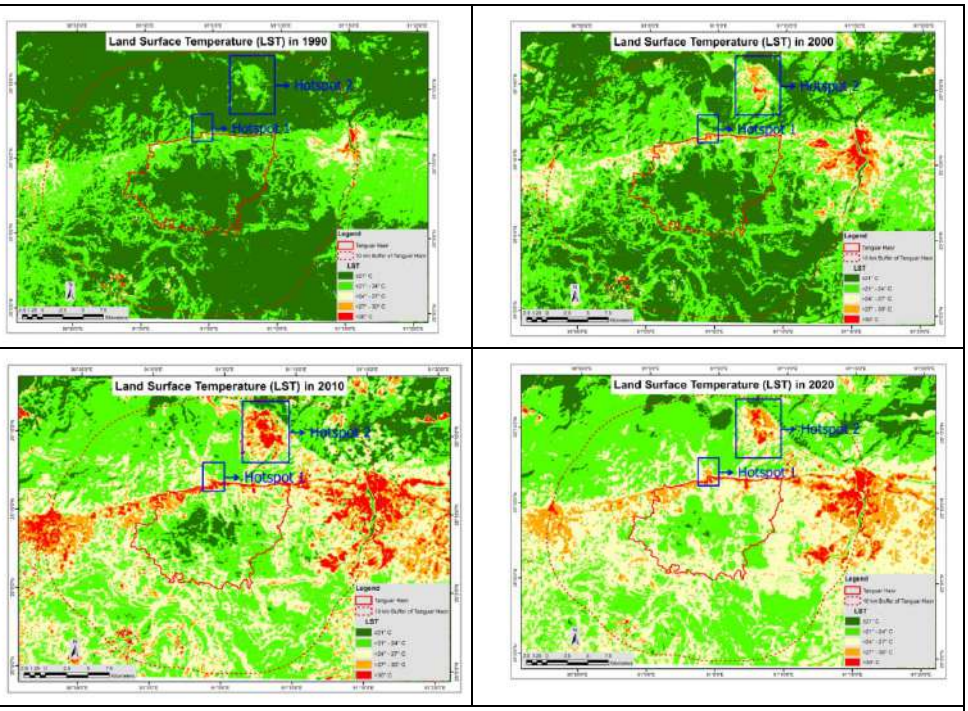


Figure 17. Land Surface Temperature (LST) maps of Tanguar haor from 1990 to 2020.

In 1990 and 2000, the LST of Tanguar haor area is below 21˚C. In 2010, the LST starts to increase and in 2020, most of the area of Tanguar haor consists of LST greater than 21˚C. This gradual increase of temperature has an adverse impact on the Tangur haor ecosystem and its fisheries habitat. Figure 5 shows the extent of water during the year of 2020 in Tanguar haor. In **Figure 18**, first map shows the the water extent in 05 January 2020. In 05 January 2020, water exists in Tanguar haor and its surrounding area. As January is the month of dry season, water extent decreases with the passage of time. The maps following 05 January 2020 show that water extent area is decreasing. When the water level reduces farmers starts to plant boro rice in the wet area. But Tanguar haor is different from the other haors. Most of the dried areas of Tanguar haor remains fellow as these areas are used as grazing land. Tanguar haor is such an critical area which contains water in some beels all the year round. These beels are the last pool of fisheries. Water extent starts to increase in the month of May. In 22 May 2020 water extends slightly whereas in 28 May 2020 the whole Tanguar haor and its surrounding area inundates entirely. This inundation continues till November and during December inundated area starts to turn up. The temporal analysis of LULC and LST demonstrates that the Tanguar haor has been experiencing different changes in its ecological environment. The haor receives huge amount of

sand that fills up the canals and water-bed of haor. So the water depth decreases that ultimately impacts on the habitat of deep water fish.

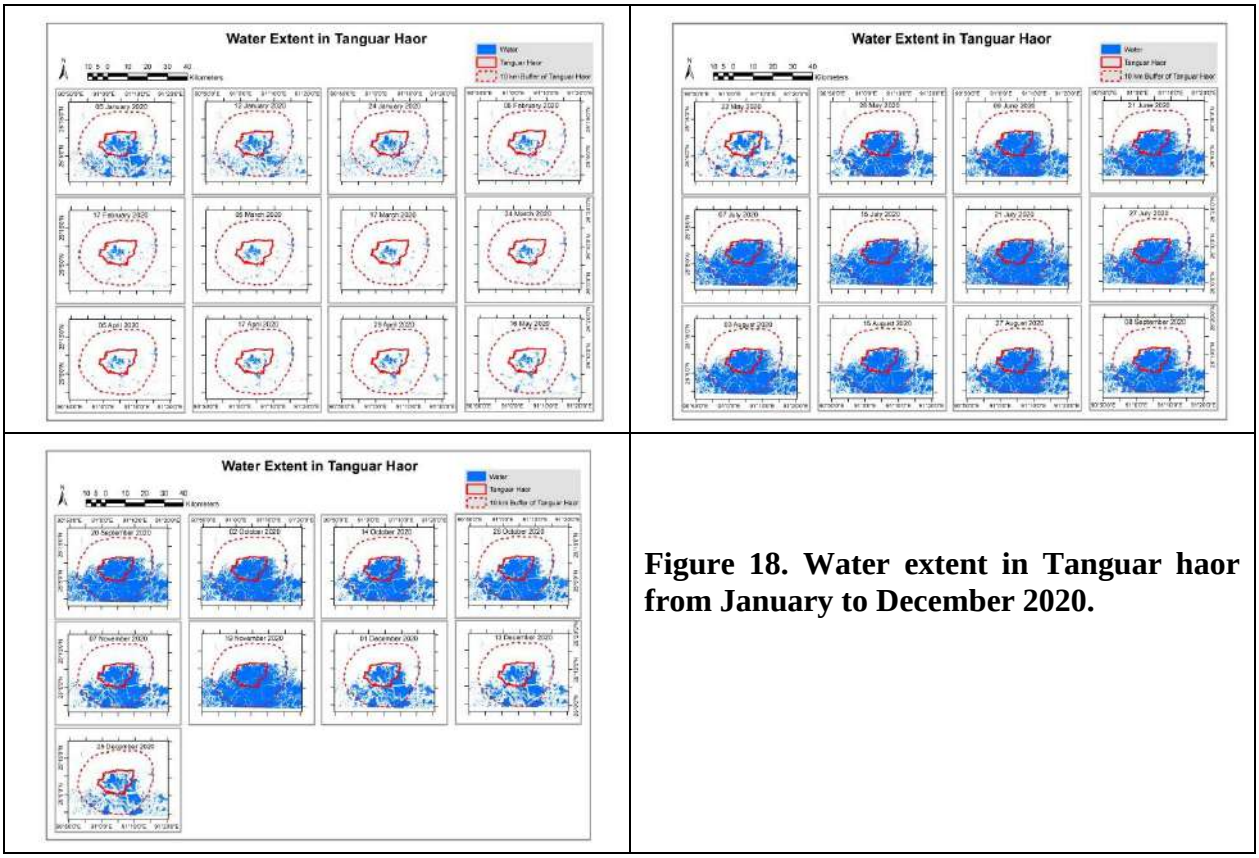


Figure 18. Water extent in Tanguar haor from January to December 2020.

Temporal LULC demonstrates that population around the Tanguar haor increases so that people use to catch fish more drastically as the demand of fish increases. Since the fishing rate increases in the haor, remaining amount of fish decreases gradually. Temporal LULC shows that agricultural practice has been increasing in and around the haor. After harvesting the boro rice, the stems of rice plants remain in the field. This stems of rice plants are then inundated by water and decomposed. Sometimes flash flood inundates the boro rice that is ultimately decomposed. This decomposition of rice plants deteriorates the water quality that is harmful to the fisheries habitat. The study reveals that LST in and around the Tanguar haor increases. This increase in LST impacts on the favorable environment of fisheries. The temperature sensitive fishes may not survive in higher temperature. In inland waterbodies of Bangladesh, fishes use to breed in marsh areas. Fishes use to migrate from open water areas to marsh areas in order to breeding. Construction of crop protecting dams hinders the natural flow of water and closes the migratory

routes of fishes so that fishes cannot migrate to the marsh areas for breeding that ultimately impacts on production.

2.7 Geology Division

Title: Study of the Geomorphological and Meteorological Condition of Landslides in the South-Eastern Hilly Region of Bangladesh

Research problem/statement and Objectives

Geologically Bangladesh is part of the Bengal Basin which has been filled by sediments washed down from the highlands on three sides of it, especially from the Himalayas. Because of the geographical location, Bangladesh experiences the highest amount of monsoon rainfall and annual average rainfall among the SAARC (South Asian Association for Regional Cooperation) countries Intense rainfall from both the Indian Summer Monsoon and tropical storms act as potent triggers for landslides in areas with steep slopes and poorly consolidated. Landslides are mostly sporadic and localized in nature that's why these do not receive maximum media attention like other hazards (earthquakes, floods, cyclones, and hurricanes). But statistics show this is one of the most catastrophic geological hazards causing extensive economic losses, physical damages, and fatalities all over the world. Landslide is becoming one of the regular geological hazards especially in Chattogram, Chattogram Hill tracts, Cox's Bazaar region. A significant number of landslide hazard locations exist in these areas that make many communities vulnerable to slides which may result in severe damages and socioeconomic losses. To predict landslide, geomorphological, topographical, and meteorological factors should be under consideration. It is essential to understand under which conditions of these factors are responsible for landslides.

Research Methodology

Information has been collected as much as possible through documentation review on recent past landslides. This information has been verified through a detailed field survey. Rainfall data has been prepared regarding the meteorological conditions of recent past landslides through analysis of satellite-derived rainfall data and in situ rainfall data from Bangladesh Meteorological Department. Different layers are generated of study areas through scanning and georeferencing

of a geological map, soil map, and topographic map. With the help of ERDAS Imagine image processing software, landuse maps has been generated from satellite images of two different time frames i.e. one is after landslide and another is before the landslide. Finally, all generated layers have been analyzed in ArcGIS software.

Results

More than 800 landslide location and related information have been collected through field survey, existing literature, scientific article and newspaper and plotted in a map (**Figure 19**). Inventory map has been prepared indicating of these all landslide locations. There were some other landslide locations that could not be identified as local people have little knowledge on landslide. From the Landslide inventory map, it is seen that landslide areas are located at the northern western part of Chattogram and Bandarban Sadar area.

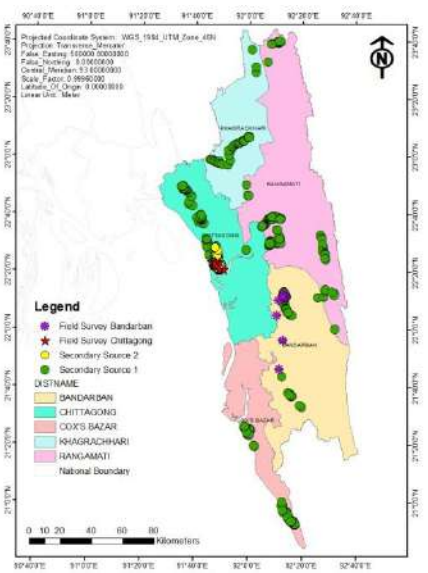


Figure 19. Landslide location map.

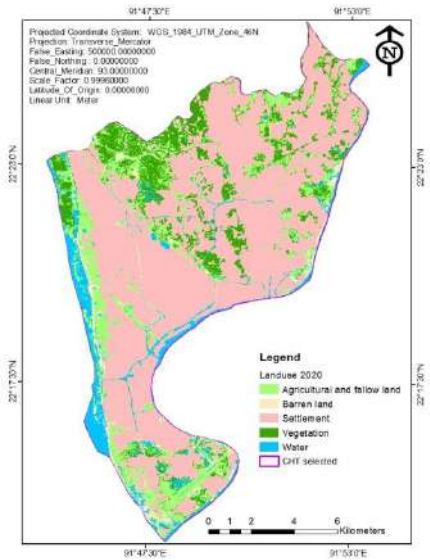


Figure 20. Landuse map of Chattogram area of 2020.

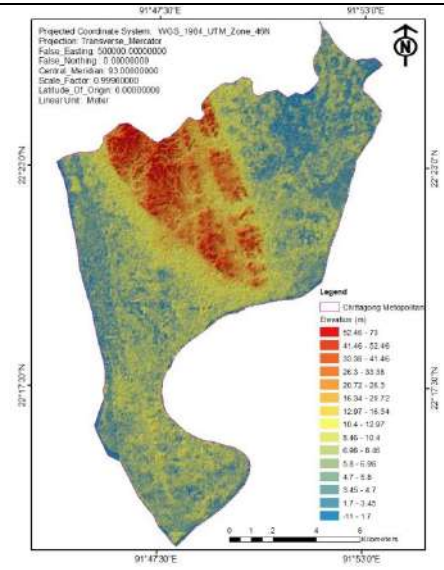


Figure 21. Elevation map of Chattogram area.

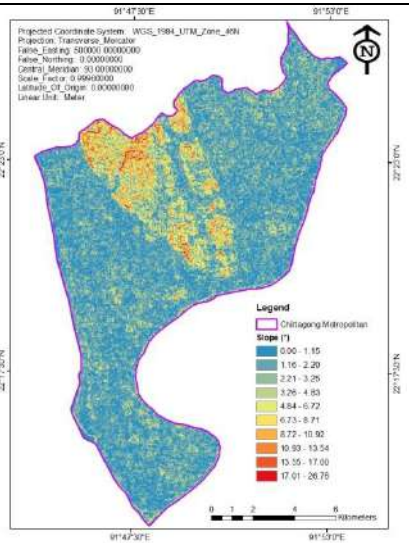


Figure 22. Elevation map of Bandarban Sadar upazila

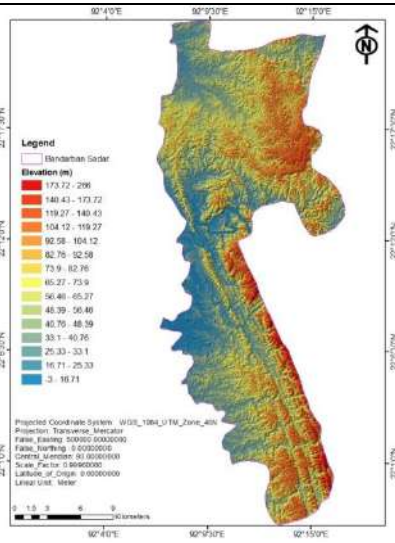


Figure 23. Slope map of Chattogram area.

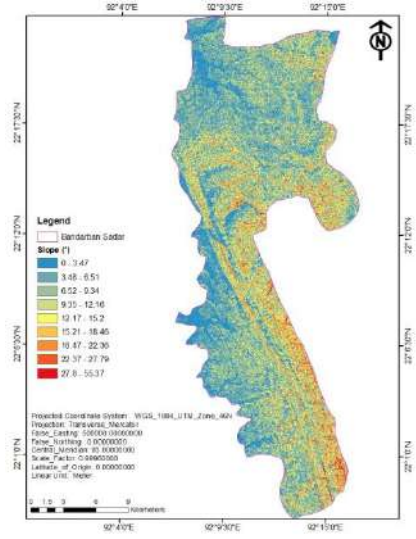


Figure 24. Slope map of Bandarban Sadar upazila.

Total five landuse classes was identified in the study area from image analysis viz agricultural and fallow land, vegetation, water, settlement and barren land **(Figure 20).** Among these classes Settlement is prominent in Chattogram and Vegetation is prominent in Bandarban.

Most of the landslide locations are situated in Urban Soil in Chattogram which lays on Dupitila, Tipam and Bokabil Formation. Elevation of Chattogram area ranges from 20-73m with 4 -13 degree slopes. However, scenario of Bandarban is different with Brown Hill soil. Soil texture is mostly Silt Loam WS Sandy Loam Soil. And elevation of this area ranges from 80-266 m with 6-18 degree **slopes (21-24).**

2.8 Space Physics and Rocket Dynamics Division

Title: Advanced Study for AIT Laboratory and Cube-Satellite Development in SPARRSO

Research problem/statement

It has indeed become a major stepping stone for a developing country like Bangladesh as it will help to place Bangladesh to become one of the key players in the space program especially among the neighboring countries in South East Asia like Malaysia, Thailand, Indonesia, Brunei, Philippines, Singapore and others. Space borne systems (spacecrafts, satellites, equipment etc.) are assembled and integrated in special facilities called clean rooms in which temperature, humidity, pressure and the numbers of particles are continuously monitored and regulated. Moreover, they are subject to stringent environmental tests in order to make sure that they can withstand the harsh conditions of space. The facilities in which all these activities are performed are called Assembly, Integration and Test (AIT) centers.

Research objectives

The objectives of this research work are as follows

1. Recommendation for the development of AIT laboratories in SPARRSO
2. Recommendation for the development of a remote sensing cube-satellite for Bangladesh
3. Searching cooperative partner for the space technological development in SPARRSO

Research Methodology

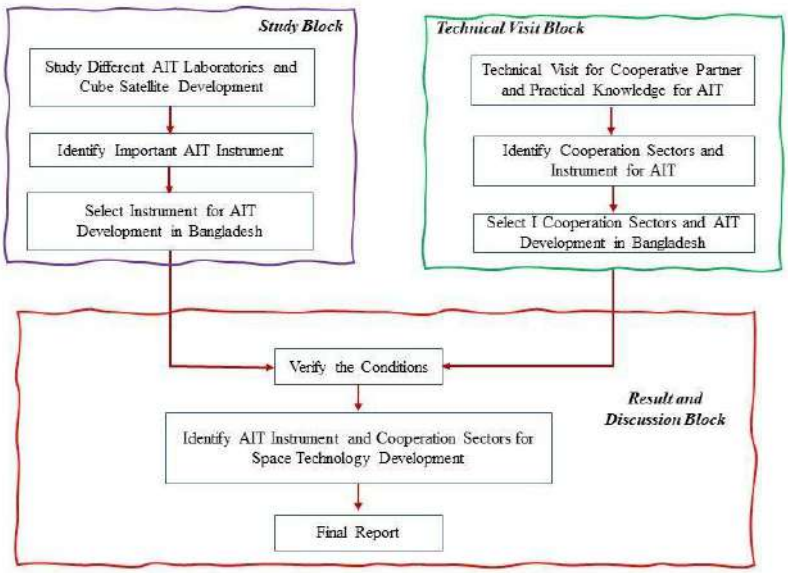


Figure 25. Methodology Diagram of Research work

Results

Considering the actual needs, the ability to acquire technical capabilities, the emergence of new technologies, etc., we need to design, build and test a maximum of 500 kg of satellites. A review of AIT laboratories in different countries of the world shows that the following equipment will be required for the design, develop and test of maximum 500 kg satellite. Below are two images of the design:

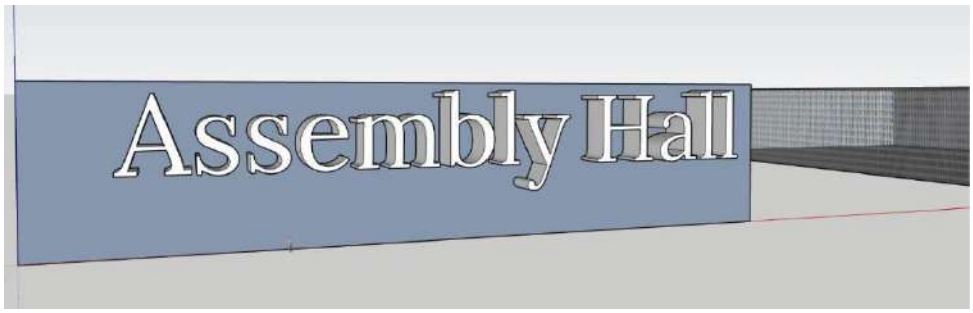


Figure 26. Design assembly hall using Sketch up

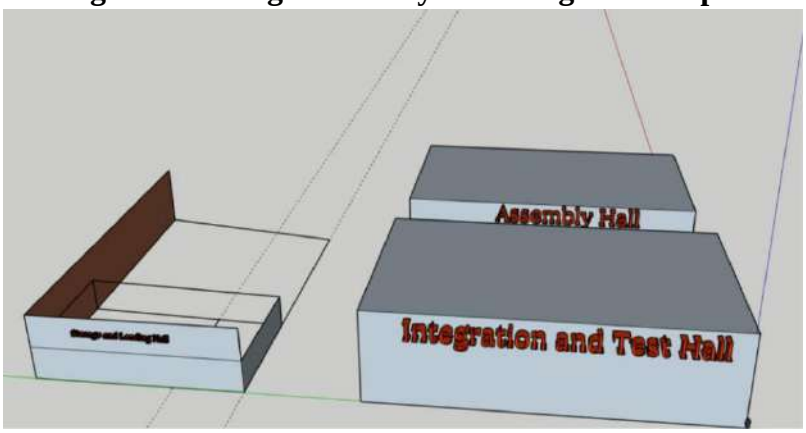


Figure 27. Design three hall using Sketch up

Propose Major Test Equipment's

Serial	Test name	
1	Vibration	289 kN
2	Acoustic	9.79 m x 7.54 m x13.54m 20 Hz-10,000 Hz
3	Thermal [d x L]	3m (dia) x 3.5m
4	EMC	5m x 3m x 5m
5	Mass Properties Measurement	1,000 kg

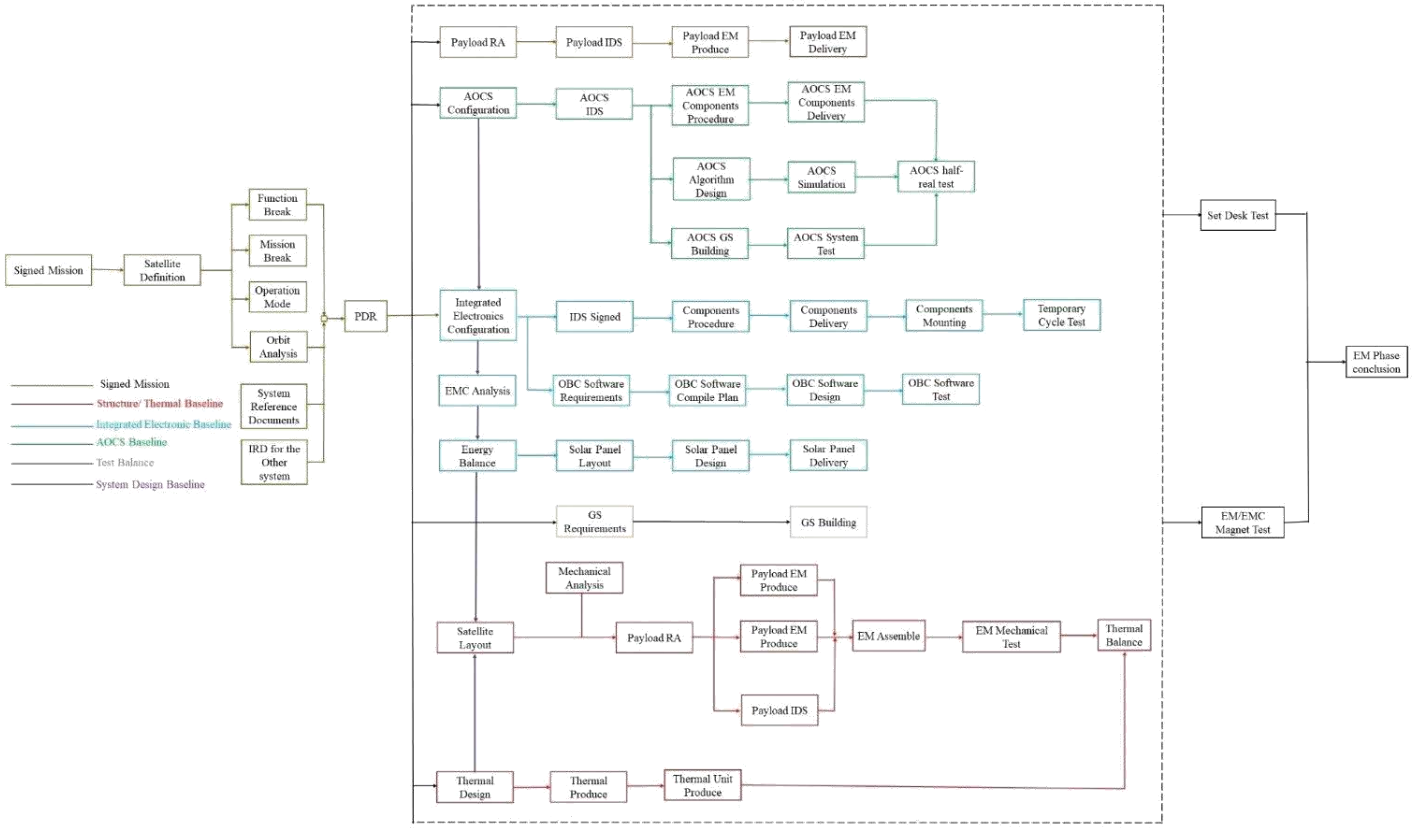


Figure 28. Cube satellite test procedure

2.9 Ground Station Division

2.9.1 Title: Study on the Management of a Satellite Ground Control Station.

Statement of the Project

Bangladesh Space Research and Remote Sensing Organization (SPARRSO) is the focal space organization of the Government of Bangladesh. SPARRSO has both geostationary and polar orbiting satellite ground stations for satellite data reception it hasn't sufficient potency to achieve a whole satellite system with its own technology. SPARRSO is going to enter the arena of space technology through its short-, medium- and long-term planning. One of the significant components of this plan is to operate our own satellite. Presently SPARRSO has no proficient manpower for the operation, receiving, maintenance and management of space and ground segments of the satellite system. Bangladesh is operating Bangabandhu-1 Communication Satellite Ground Control Station now which is the country's first state-owned satellite. SPARRSO may avail the opportunity of attaining practical knowledge on the operation, maintenance and management of such a ground station. This project is a technical study to acquire knowledge about satellite ground control station systems. This report on the operation, maintenance and management of satellite control stations may be useful as a knowledge base for future satellite ground control stations of SPARRSO.

Project Objectives

- ✓ To acquire integral ideas on the operation and receiving of the satellite control station.
- ✓ To acquire knowledge on maintenance and management of the satellite control station.
- ✓ To acquire knowledge about satellite ground station systems.
- ✓ To prepare a knowledge base on future satellite ground control stations of SPARRSO.

Methodology

- ✓ Establishing supervision links with the Bangabandhu-1 satellite control station through official communication.
- ✓ Acquiring practical knowledge through interview/discussion with the relevant manpower of the B-1 satellite control station.
- ✓ Studying books and publications on Satellite Technology.

Results

Configuration of a Satellite System

The Space Segment Contains one or several active and spare satellites organized into a constellation.

The Control Segment Consists of all ground facilities for the control, monitoring and for management of the traffic of the satellites (TTC stations).

The Ground Segment Consists of all the traffic earth stations depending on the type of service considered. These stations can be of different sizes, from a few centimeters to tens of meters.

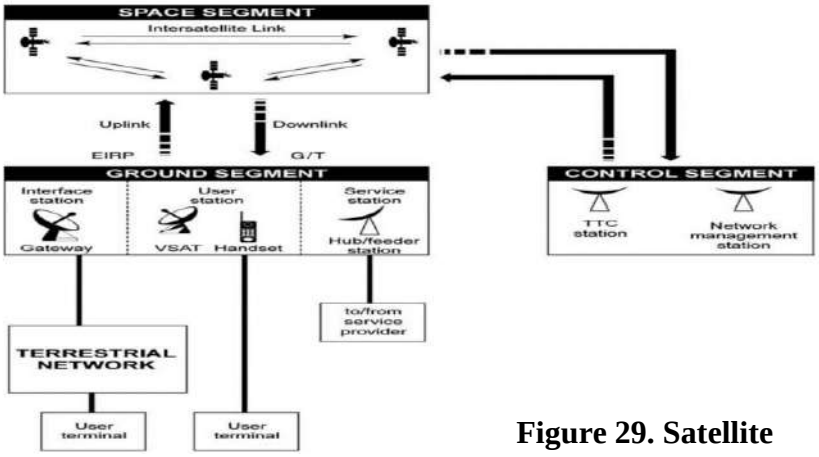
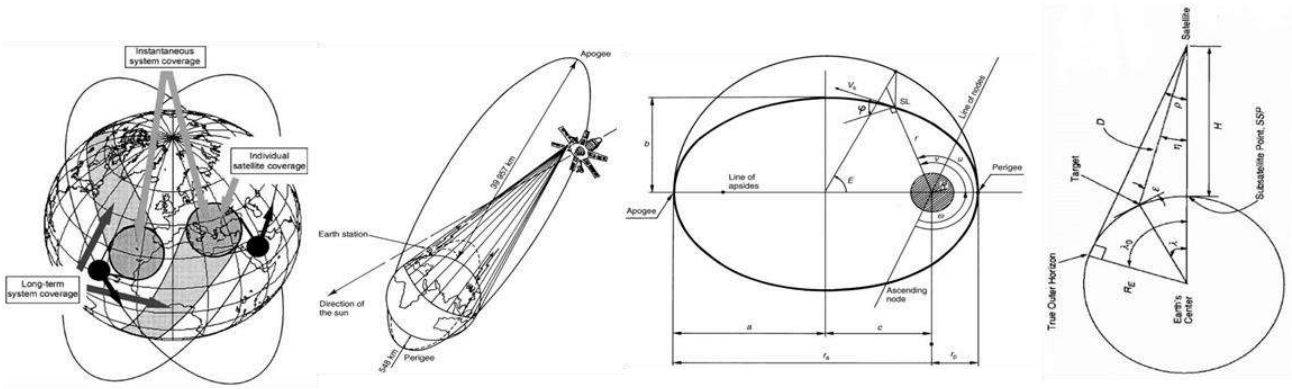


Figure 29. Satellite communications system, interfacing with terrestrial

Satellite Orbit Management



$b = a\sqrt{(1-e^2)}$, $c = \sqrt{(a^2-b^2)}$, eccentricity $e = c/a$, distances from the centre of the earth to the perigee, $r_p = a(1-e)$, and to the apogee, $r_a = a(1+e)$.

if e = 0, the trajectory is a circle, if e < 1, an ellipse, If e= 1, a parabola, if e > 1, a hyperbola.

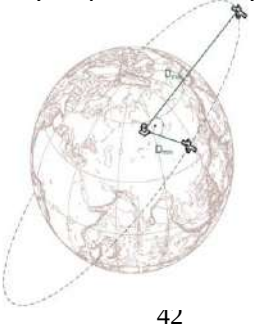
Propagation Delay Calculation

The magnitude of the propagation delay depends mainly on the slant range (distance between ground station and satellite)

$$D_{min} = R_E \frac{sin(\lambda_{min})}{sind(\eta_{min})}$$

$$D_{max} = R_E \frac{sin(\lambda_{max})}{sind(\eta_{max})}$$

$$\lambda_{max} = 90^\circ - \epsilon_{min} - \eta_{max}$$



Here,

D_{min} , D_{max} = minimum & miaximum distance

λ_{min}, , λ_{max} = minimum & maximum Earth central angle

η_{min} , η_{max} = corresponding nadir angles

ρ = Earth angular radius

ϵ = Grazing angle

$$sin(\eta_{max}) = sin\rho \cdot cos\epsilon_{min} \qquad sin\rho = \frac{R_E}{R_E + h}$$

Telemetry, Tracking & Command (TTC)

- ✓ It consists of different electronic sensors that are used to measure temperature, radiation level, power supply voltage, fuel pressure etc.
- ✓ Computer with data processing software used to monitor, store and decode the telemetry data for detecting the immediate status of the satellite by the ground station.
- ✓ tracking during the launching and orbital positioning of the satellite.
- ✓ This system also tracks the exact position of a geostationary satellite trying to shift due to different disturbing forces in space.

Network Management Station (NMS)

- ✓ NMS provides services such as management of satellite terminal's channel requirement and network access, remote management of satellite terminals for land, sea and air satellite communication systems, and offers a switching infrastructure for the communication configurations of satellite terminals.

Frequency Allocation by Region

Region 1: Europe, Africa, the Middle East, the former USSR;
Region 2: The Americas;
Region 3: The Asia Pacific, except the Middle East and the former USSR.

Bangabandhu-1 Geostationary satellite Ground Control Station

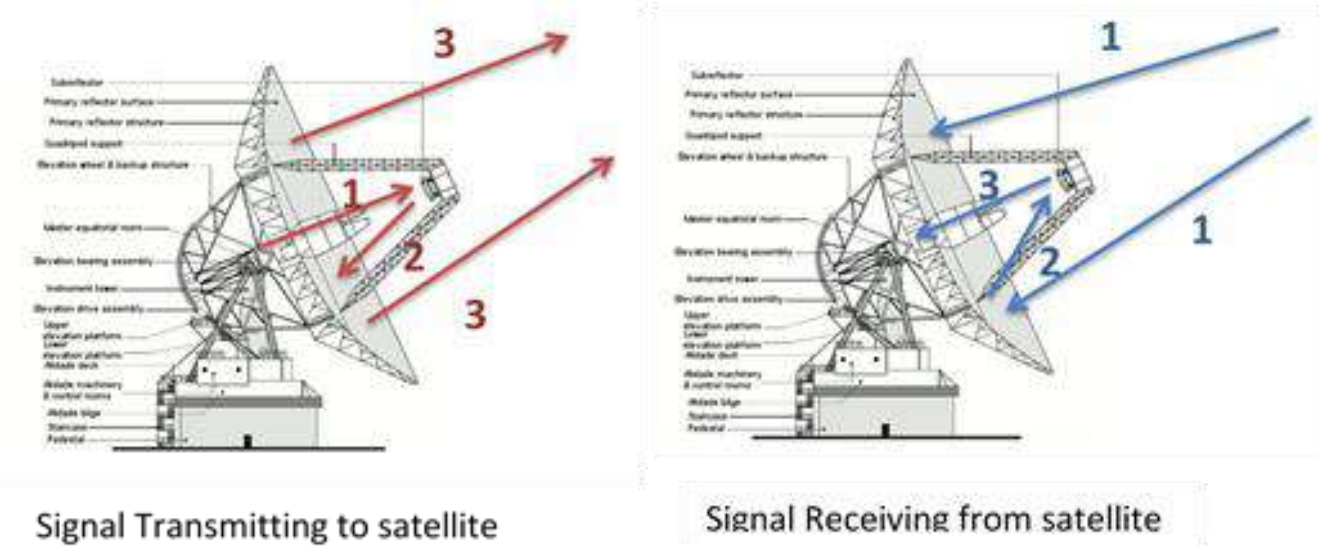
The Bangabandhu-1 is controlled by two ground stations, which are used for primary and backup site operations and control centers. B-1 was Launched on 12 May 2018 from cape carnival, Florida by Falcon -9 rocket. Its length is 3.5m, width 2.5 m and 80 feet long with solar panel. It has an agreement with Russia for the orbital slot for 45 years. Its position is at 119.1° East and its launching mass was about 3700 kg on falcon 9.

Transponder & Bands

- ✓ Number of Transponders: 40
- ✓ 26 Ku band & 14 C band transponder
- ✓ Number of occupied transponders: 14 (7 C-band & 7 Ku-band)
- ✓ Number of unoccupied transponders: 26
- ✓ Uses MCPC technology (Multiple Carriers Per Channel, VSAT): C-3
- ✓ Uses DSNG (Digital Satellite News Gathering) for live telecast.

Solar Panel & Fuel

- ✓ GaAs cells used for solar panel
- ✓ 9.4 kW power generated by the solar panel
- ✓ 6.5 kw needed for payload
- ✓ Monomethyl hydrazine (MMH)**;** $CH_3(NH)NH_2$ & Li-ion Battery (190 Ah)
- ✓ Total Amount of Fuel used: 2204 kg (Propellant)
- ✓ Fuel already used: 1504 kg (first 10 days)
- ✓ Remaining fuel: 700 kg (Enough for 16.55yrss)



Satellite Inclination & Eccentricity correction

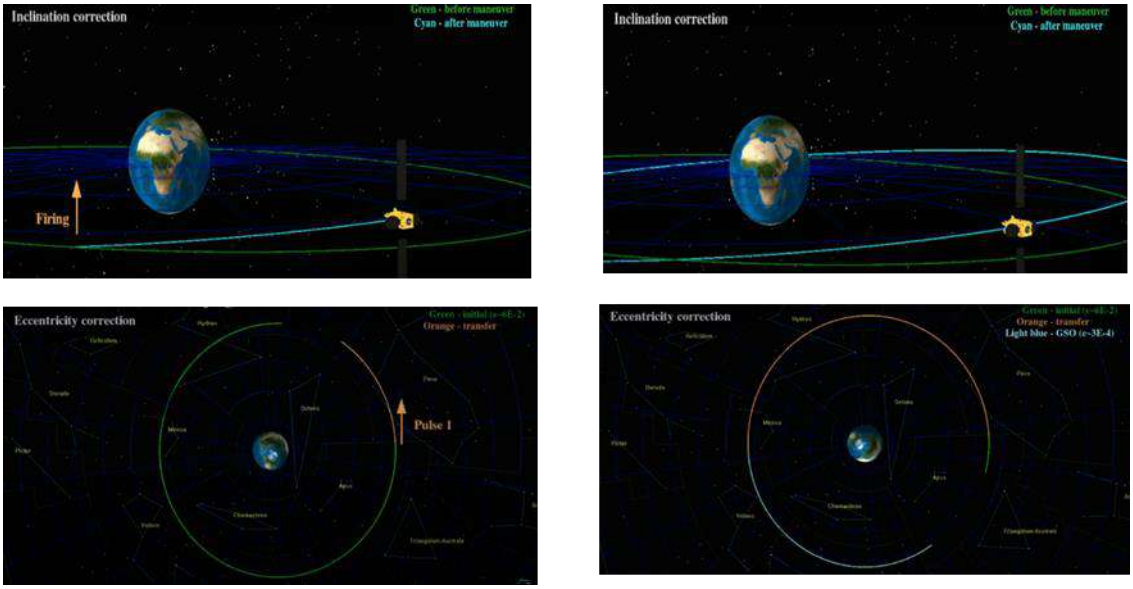


Figure 30. Satellite Inclination & Eccentricity correction

Satellite Security

- ✓ SOCC uses its own defined algorithm for encrypting data end to end
- ✓ From the end-user VSat Communication only provide data connectivity
- ✓ When they provide internet to the user end, they just use NAT which integrates a private IP with a public IP to secure the communication.

- ✓ Using private IP hackers are not able to get access to anything.
- ✓ SOCC only allowed VPN-based domain control login inside the intranet.
- ✓ Private Key Encryption (reserved in satellite system)
- ✓ If SOCC gets compromised by hackers, then the hacker will get access to that computer only. There is no way to get inside the signal intercept without the keys.

Software

- ✓ System Software: Linux
- ✓ INSAT 3D
- ✓ PROX
- ✓ Flight Dynamic Software (FDS)
- ✓ Dynamic Satellite Simulator (DSS)

Regular Periodic Work

- ✓ N/S maneuvering & E/W maneuvering
- ✓ On-Orbit Propagation (OOP) update
- ✓ Decoder Check, Gyro health check & PM health
- ✓ Eclipse Monitoring

2.9.2 Title: Demonstration of Two-way Communication Between Prototype Satellite and Ground Station and Data Acquisition from the Satellite Unit.

Research Statement and Objectives:

Bangladesh Space Research and Remote Sensing Organization (SPARRSO) is the focal space organization of the Government of Bangladesh. This Demonstration project has been completed in the year 2021-22 to provide technical knowledge of two-way communications, remote control, and data acquisition (digital image, temperature, air pressure, humidity, height, Angular velocity, Acceleration, etc.) which will pave the way for advanced projects for future development of Ground station, Satellite and Rocket Launching capabilities.

The key objectives of this project are:

- ➢ To construct a prototype of a Satellite and Ground Station (control & receiving both).
- ➢ To acquire knowledge about two-way communication between the units.
- ➢ To remotely operate the units from work station (Software can be developed in future phases).
- ➢ To acquire data (Digital image, temperature, height, air pressure, humidity, GPS, Magnetic axis, Angular velocity, Acceleration etc. are expected) from the Satellite unit and store them in work station.

Methodology

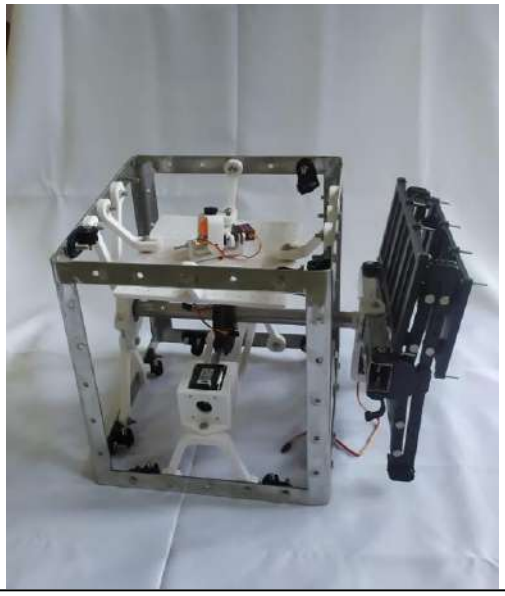
- ➢ Acquiring knowledge about the ground station and satellite sub-systems from different books and publications.

- Study about Control System, Sensors, Wireless communication, Micro-controller and Robotics.
- Construct Prototype of a Satellite and Ground Station.

Project Demonstration Steps

- Sending command from Ground Station to Satellite unit
- Ground station antenna positioning from Work-station.
- Camera motion and direction control.
- Transmit Image and acquired data from Satellite unit.
- Store received data in Work-station.

Segments of the Project

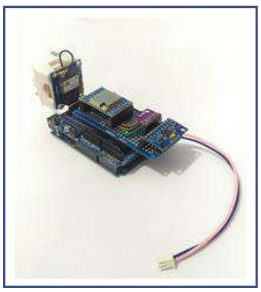
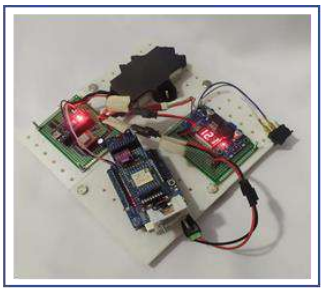


Prototype Satellite

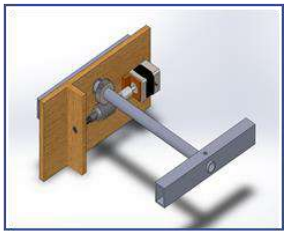
Data Receiving Station

Workstation Screen

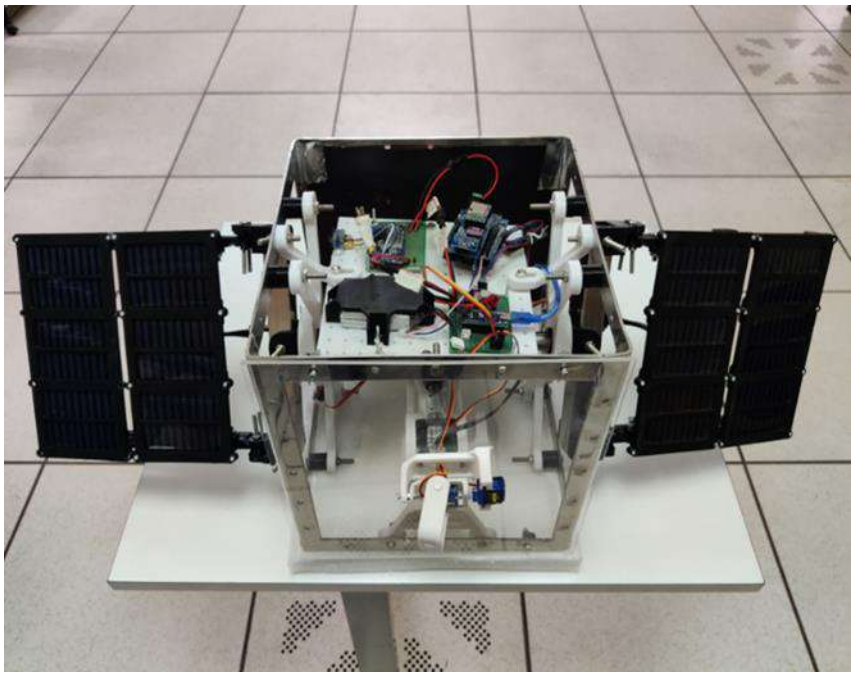
Electronics Components and Set-up:

Prototype Satellite Electronic Sub-System

Solar Array Rotation Control Mechanism



Prototype Satellite with Deployed Solar Arrays

Expected Output

- Acquire basic level practical knowledge about the construction and operation of Ground station and Satellite sub-systems.
- Knowledge base to be used for future Ground Station and Satellite design and construction in SPARRSO.

Results

Research and Development (R&D) on Space Technology requires a lot of time, dedication and investment along with skilled manpower. This project has provided us with basic knowledge about satellite sub-systems, ground station, communication system, control

system, sensors etc. Proper Lab facilities, Simulation Software, instruments, components etc. are required for further Research and Development.

Satellite unit successfully transmits real-time image and sensor data which are received by antenna and displayed in workstation as well as website. Antenna rotation and positioning, solar array deployment and rotation are also done successfully.

In future, better version of the prototypes (Drone, Rover, Small Satellite) with more reliability and functionalities will be designed. Application Software will be developed to access acquired data through Computers and cellular devices for variant application.

2.10 Instrumentation and Data Processing Division

Title: Development of a Lightweight Machine Learning Based Model to Identify Objects from Satellite Images

Statement of the Project

It is an end-to-end algorithm to generate open water cover mask, specially conceived for L2A Sentinel 2 imagery from MAJA1 processor, without any a priori knowledge on the scene. It can also be used for Landsat 8 images and for other multispectral clustering/segmentation tasks.

This detection technique algorithm uses a multidimensional agglomerative clustering technique on a subsample of the scene's pixels, to group them in classes, and a naive bayes classifier to generalize the results for the whole scene, as summarized in the following picture.

Project Objectives

The key objectives of this project are

- ✓ To build a machine learning model to detect objects within a short time from satellite images so that the model needs minimum level of resources.
- ✓ To reduce the usage of hardware resources (High configuration RAM, Processor e.t.c) for simple object identification from satellite images using artificial intelligence.
- ✓ Design and development of a web-based platform so that users can interact with the model remotely from anywhere. They can input image through the application interface and get output in web platform, thus they do not need to get access in physical server.

- ✓ In Extending this model for other applications that are relevant to satellite images identification and making a package/module application in future.

Methodology

- ✓ **Literature review** Studying related research papers and state-of-the-art works in the field of satellite image processing. Our study will also include various developed models that are being currently used in satellite image processing.
- ✓ **Qualitative type questions** To intend to go into deeper into the problem I will do surveys by making open ended questions in written/web-based questionnaire from the experts whose are working with satellite image processing in Bangladesh including SPARRSO officials.
- ✓ **Analysis/Comparative study** To find out the suitable solution for removal of console-based output and short time processing, compare between the data from literature study and information obtained by qualitative open-ended questions.
- ✓ **Analysis existing models** Study and analysis existing models and get idea to extend or develop a new one to identify objects rapidly from satellite images.
- ✓ **Sharing** Sharing the analysis report and thinking with the advisors.
- ✓ **Coding and development** Implementation of advises using computer programming languages.
- ✓ **Validation of Model** Validate the developed app/model and analyzing the finding.
- ✓ **Report writing** After the findings then write a report on the developed model.
- ✓ **Sample process** Study -> Analysis -> Sharing -> Choosing Programming languages -> Pseudo Code -> Write code -> Ready the emulator -> Input image -> Process -> Store data -> Internal Calculation -> Retrieve data -> Show output -> Validation.

Segments of the Project

- ✓ Coding.
- ✓ Getting desired output.
- ✓ Web interface design.
- ✓ Validation of the model.
- ✓ Finding multiple objects.
- ✓ Output verification.
- ✓ Report writing.

Tools, Satellite Images, DBMS and Programming Languages to be Used for This Purpose

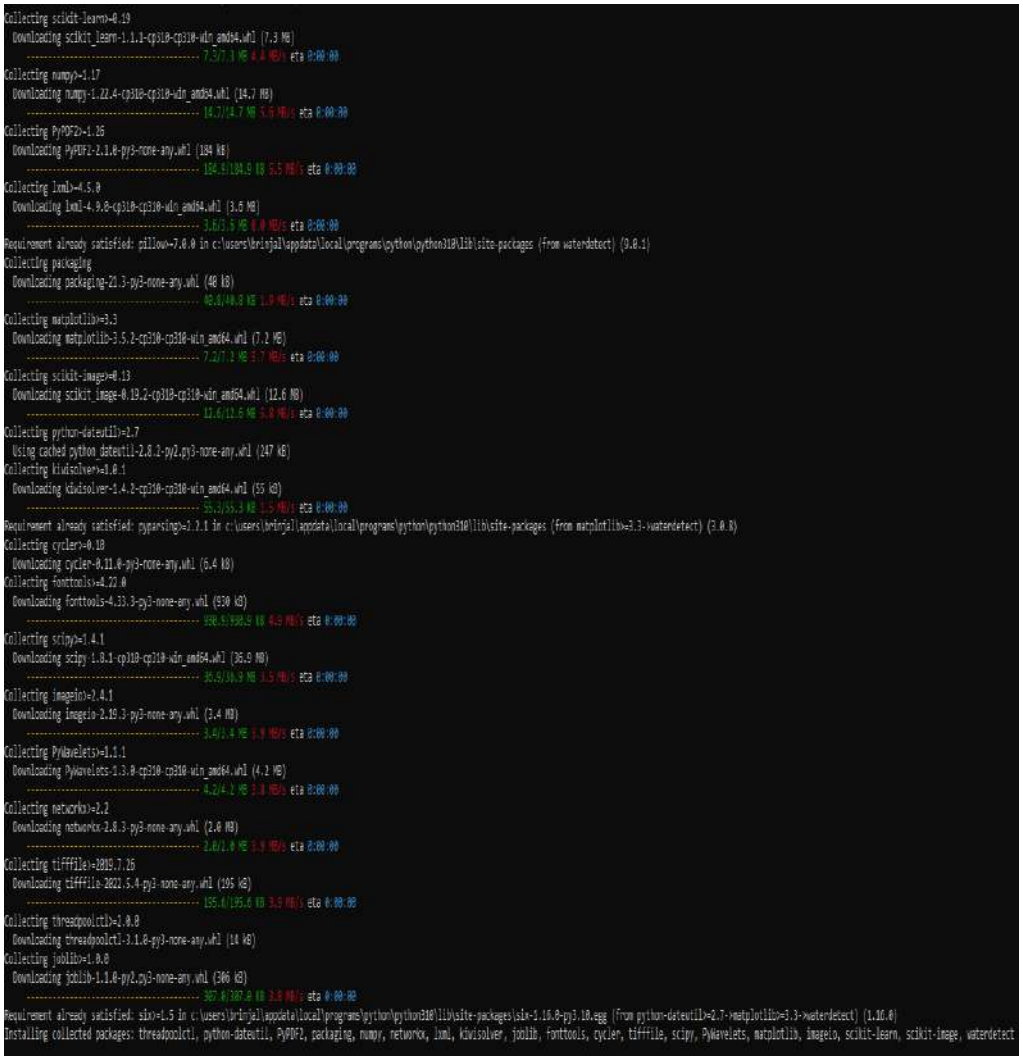
- ✓ Python
- ✓ PHP
- ✓ MySQL/MariaDB
- ✓ JQuery/Angular JS
- ✓ NodeJS
- ✓ Apache
- ✓ Santinel 2 images
- ✓ Landsat 8 images

Rational behind the Selection of Programming Languages

- ✓ Python is worldwide recognized for the artificial intelligence and machine language because of simplicity and understandable by humans, which makes it easier to build models for machine learning.
- ✓ It has rich library to get variable parameters from satellite images.
- ✓ PHP is the world's widely used programming language for dynamic web development and it is completely open-source product and no operating system platform dependency.
- ✓ Like Unix, Linux, Windows, MacOS. Also, other scripting language like JavaScript, jQuery, Angular JS can easily interact with PHP. It works within HTML DOM element.
- ✓ Robust reusable OOP coding is very easy in PHP compared to other programming language.
- ✓ MySQL/MariaDB is an opensource database management system. Python and PHP is very compatible with MySQL/MariaDB.
- ✓ Python will extract data from satellite images and analyze the data obtained from the satellite images. After that it will store data into the database.
- ✓ PHP will interact with the database and then represent data to the user in a web browser. It will maintain the user's accountability and security.
- ✓ jQuery/Angular JS is a powerful JavaScript framework which enables to customize the DOM element.
- ✓ Makes the user interface beautiful/colorful by interacting with the CSS and HTML code for web-based data representation.

- ✓ NodeJS is one of the popular programming languages which can interact with the server side and client side.
- ✓ To reduce the server load NodeJS is very effective. It can handle the browser automation.
- ✓ So that multiple users can use the same application at the same time without any process thread blocking.
- ✓ Apache is a webserver software which is an open-source software and free to use. Widely used webserver and easy to integrate with Multi Operating system. It can be used as a CGI. PHP and NodeJS can easily implement with this Apache webserver.
- ✓ By using this Apache webserver, it is possible to make the application available on the web version and easily accessible from any desk, anywhere from the world.
- ✓ Without the Apache webserver the MySQL/MariaDB will not work.

AI Scripts Configuration



Expected Output

- ✓ A lightweight application to identify objects correctly from satellite images with higher accuracy and representing the output in the web-based platform.

Final Output

- ✓ It can work with Landsat 8 and Sentinel 2 satellite image only.
- ✓ Need to input the Function argument and class will take the parameters then process the given input folder image and after processing it will give output as a file.

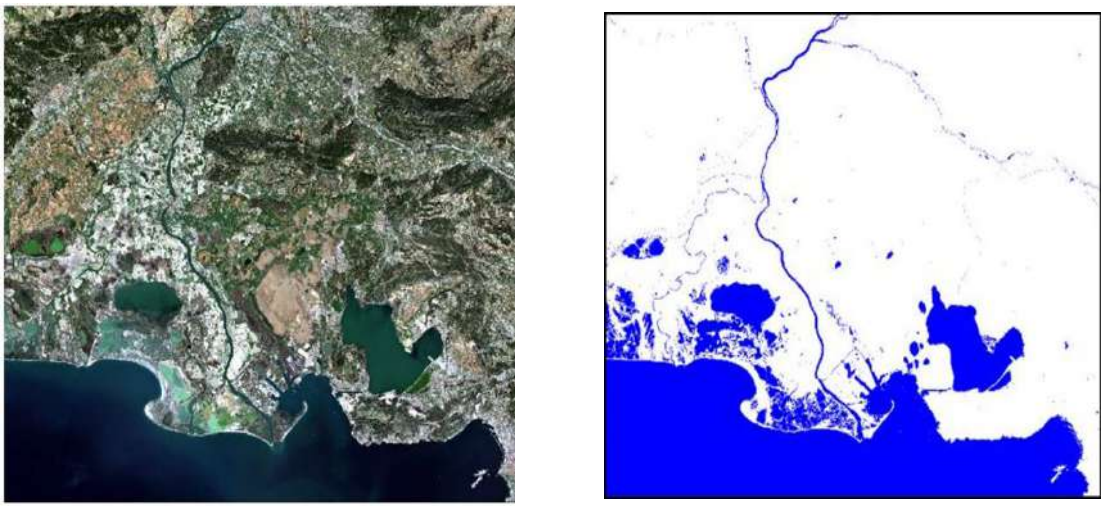


Figure 31. Sample Input (left side) and Output (right side) using the AI script

CHAPTER 3

DEVELOPMENT PROJECT

Blue Economy Project

A development project titled "Establishment of a Geographic Information System of the Coastal Areas of Bangladesh and a Marine Fishing Zones Identification System Based on Remote Sensing and GIS Techniques" is under implementation since January 2019 and it is expected to be completed in 30 June 2022. Shortly it is called as "Blue Economy Project of SPARRSO". Estimated budget of the project are Taka 335.00 lac.

Objective of the project

Ultimate objective of this project is to support activities related to Blue Economy (BE) through providing information on coastal geo-morphology and fishing zones in the Bay of Bengal.

To fulfill this ultimate objective following two specific objectives are being perused,

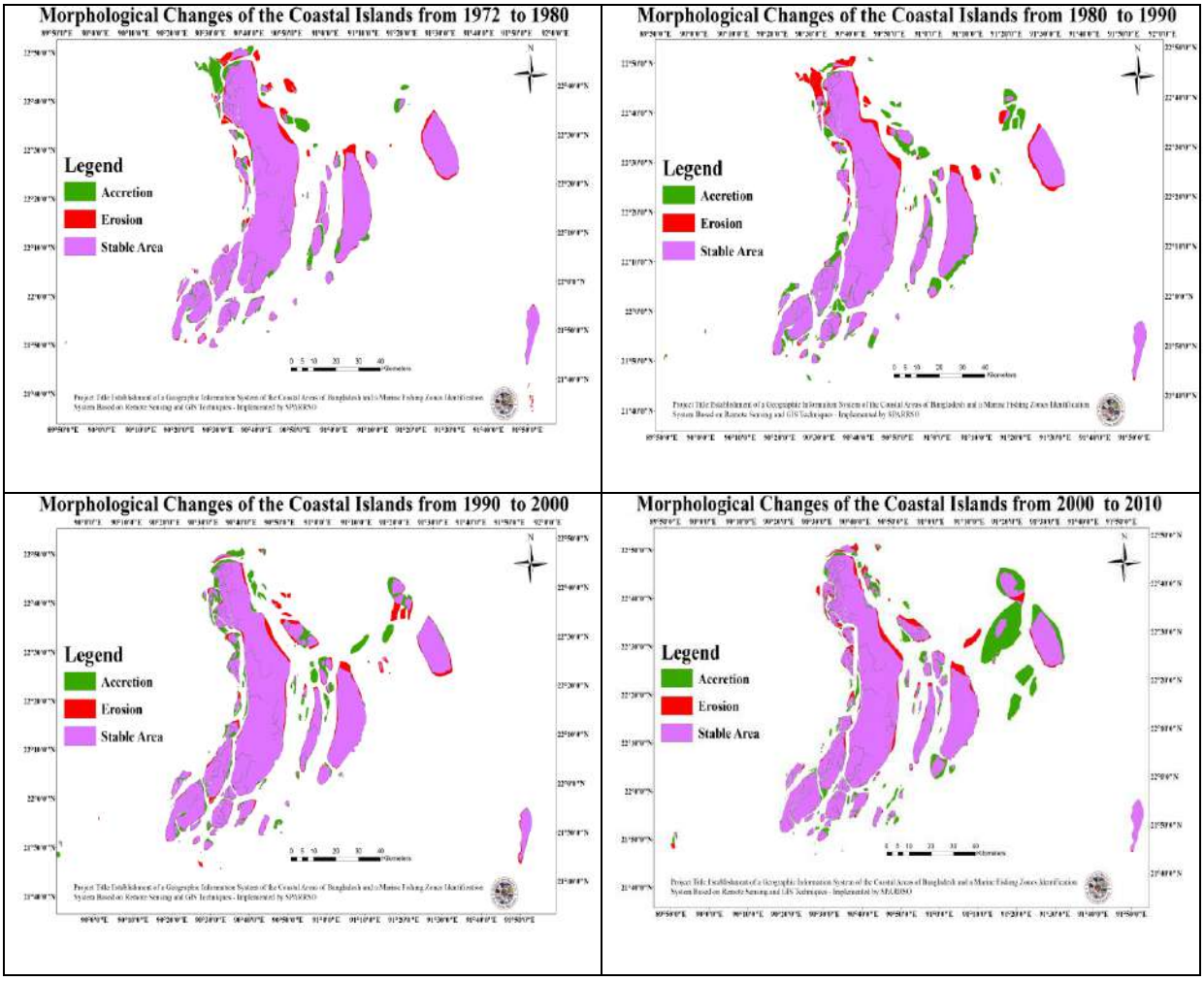
1. Establishment of a Geographic Information System (GIS) of the coastal areas of Bangladesh to provide information on coastal features (Coastline, Islands, Tidal flats, Rivers etc.).
2. Establishing a system for identifying potential fishing zones in the Bay of Bengal through space technology applications.

Bangladesh Navy, Bangladesh Coastguard, Survey of Bangladesh and Department of Fisheries are the stakeholders under this project.

Outputs of the Project

The project has been undertaken to support the activities related to 'Blue Economy' through providing information on coastal geo-morphology and fishing zones in the Bay of Bengal. There is greater national interest behind the issues have been addressed the project Establishment of a Geographic Information System of the Coastal Areas of Bangladesh and a Marine Fishing Zones Identification System Based on Remote Sensing and GIS Techniques' implemented by SPARRSO. There are two components under the project namely 'Coastal GIS' and 'Marine Fishing Zones' identification and mapping system.

The geo-spatial datasets of the coastal areas of Bangladesh has been prepared for last five decades since 1972-1980 to 2010-2020 using remote sensing data and the results were verified after incorporating the field data. Rivers, coastal islands and tidal mudflats of the coastal area were identified and map has been prepared along with the statistics. Here, in 1972 and 1980 island area is almost equal, 308729.99 ha and 307807.36 have respectively and then from 2000 to 2020 the island area was increasing significantly, 330020.97 ha, 362081.80 and 381713.15 ha respectively. Accretion and erosion also took place along coastal islands and the coastline as well. Morphological changes on the coastal islands has also been studied for five decades where the accretion was higher in the decade 1980-1990, 1990-2000 and 2010-2020, erosion was higher in 2000-2010. At the end it has been found that during five decades islands accretion was much higher, almost double during 1972-2020.



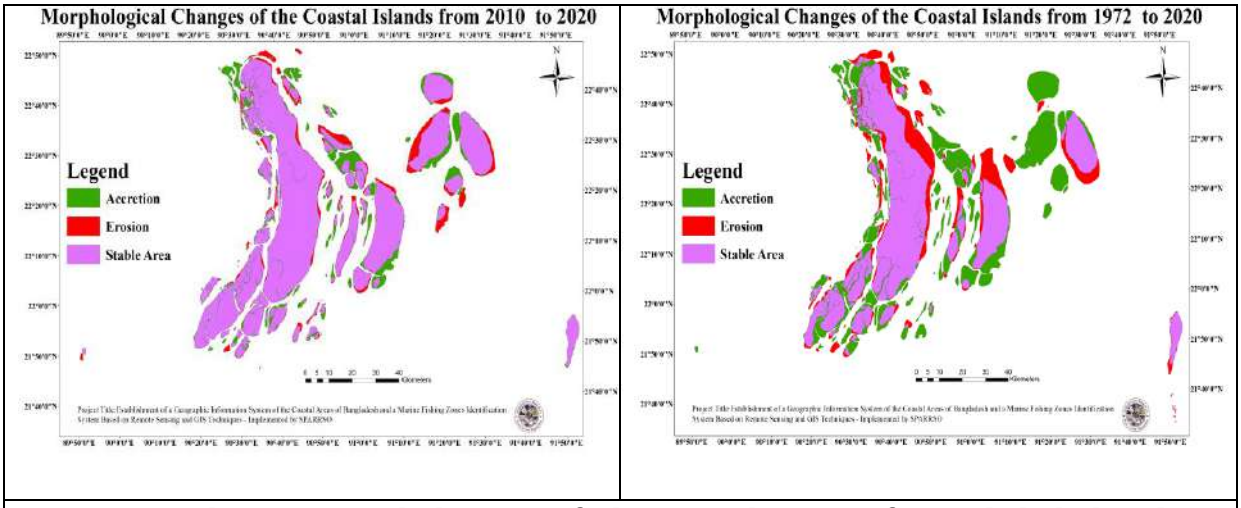


Figure 32. The geo-spatial datasets of the coastal areas of Bangladesh has been prepared for last five decades since 1972-1980 to 2010-2020.

For coastline accretion was dominating in 1980-1990, 1990-2000 and 2000-2010 decades where as in 2010-2020 the erosion was dominating. However, it has been found that in the study area overall accretion for coastline was higher than erosion during 1972-2020.

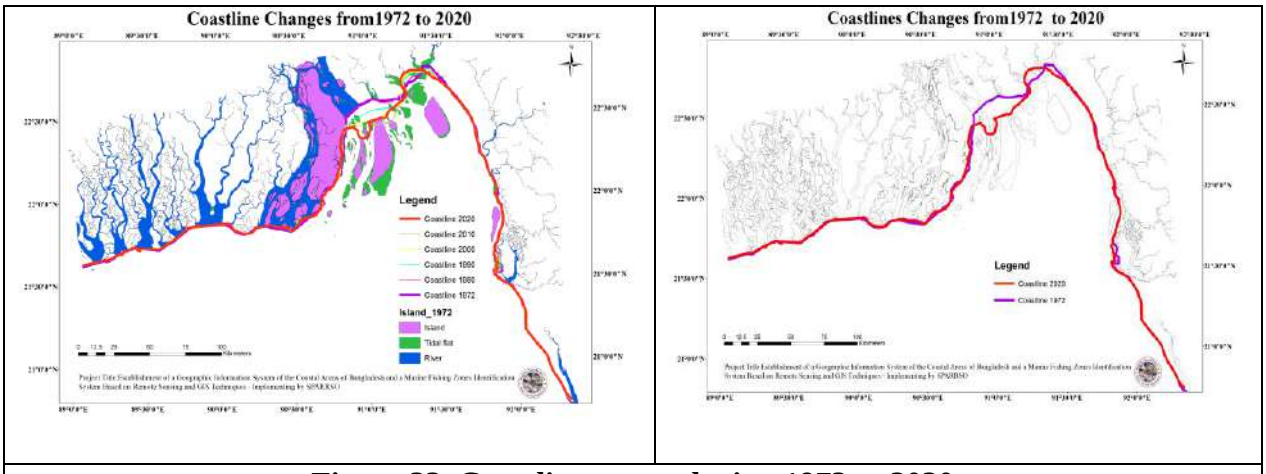


Figure 33. Coastline status during 1972 to 2020

These data sets will provide extended supports to many development activities in the coastal areas of Bangladesh and smooth planning for navigation along the coast. The datasets will also be valuable source for the researchers and academicians addressing eco-environmental and climate change issues related to coastal geo-morphology.

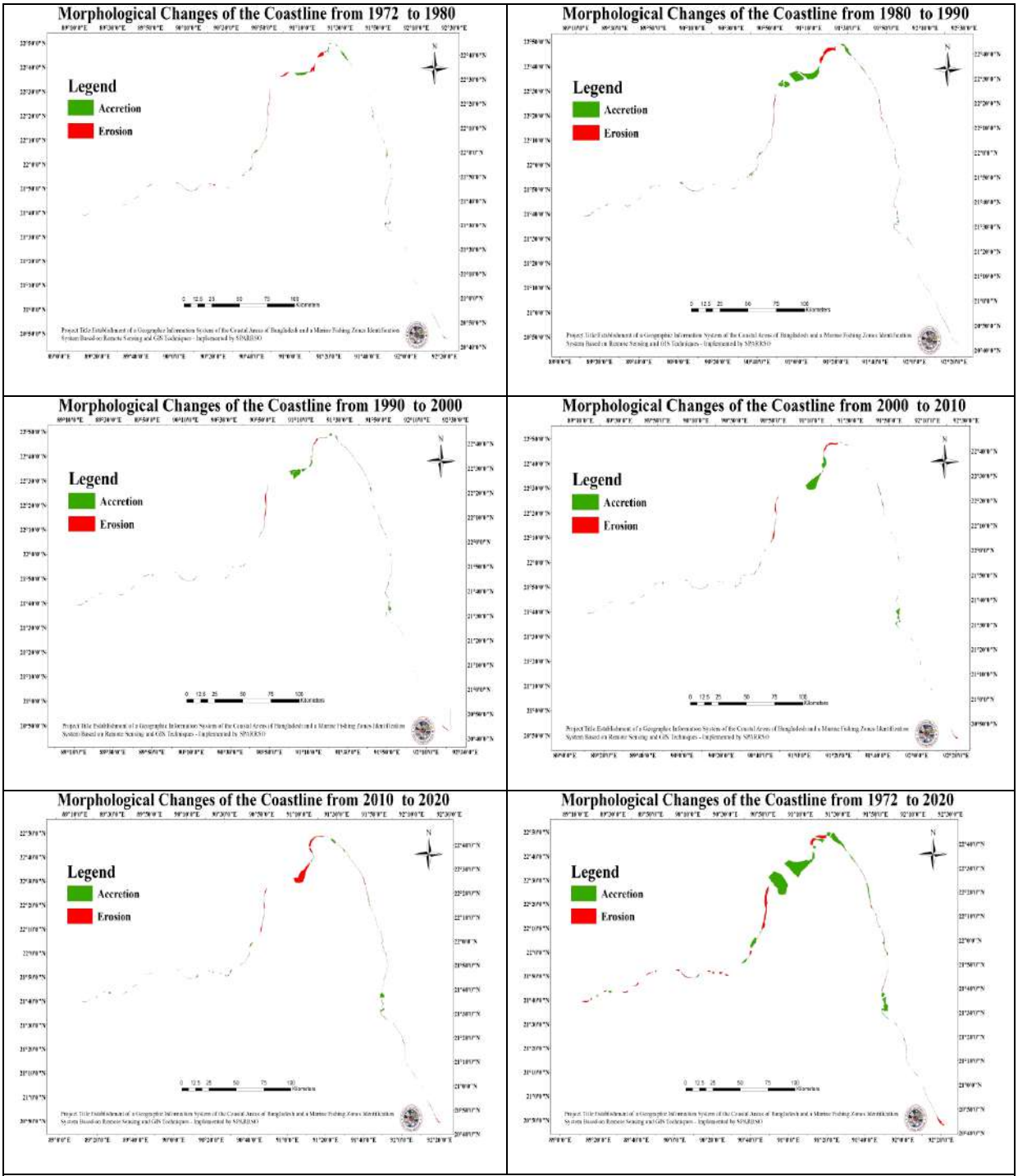


Figure 34. The geo-spatial datasets of the coastlines of Bangladesh has been prepared for last five decades since 1972-1980 to 2010-2020.

Remote sensing data derived parameters namely Chlorophyll-a (Chl-a) and Sea Surface Temperature (SST) were used for identification of potential fishing zones in the study area of Bay of Bengal. Potential Fishing Zone (PFZ) in the Bay of Bengal was identified using satellite data along with in-situ data collected from the sea. Results indicated that the higher potential fishing zone is near the coast and lower potential fishing zones are further away from the coast and there is also intermingling between higher and lower potential fishing zone. Remote sensing based fishing zone identification and mapping system has been established under this project will contribute for highly productive and sustainable harvesting of fishes in the Bay of Bengal. The system will provide information on the location of fish abundance; it will help to implement the conservation strategy through reducing the area of observation by the law enforcement agencies.

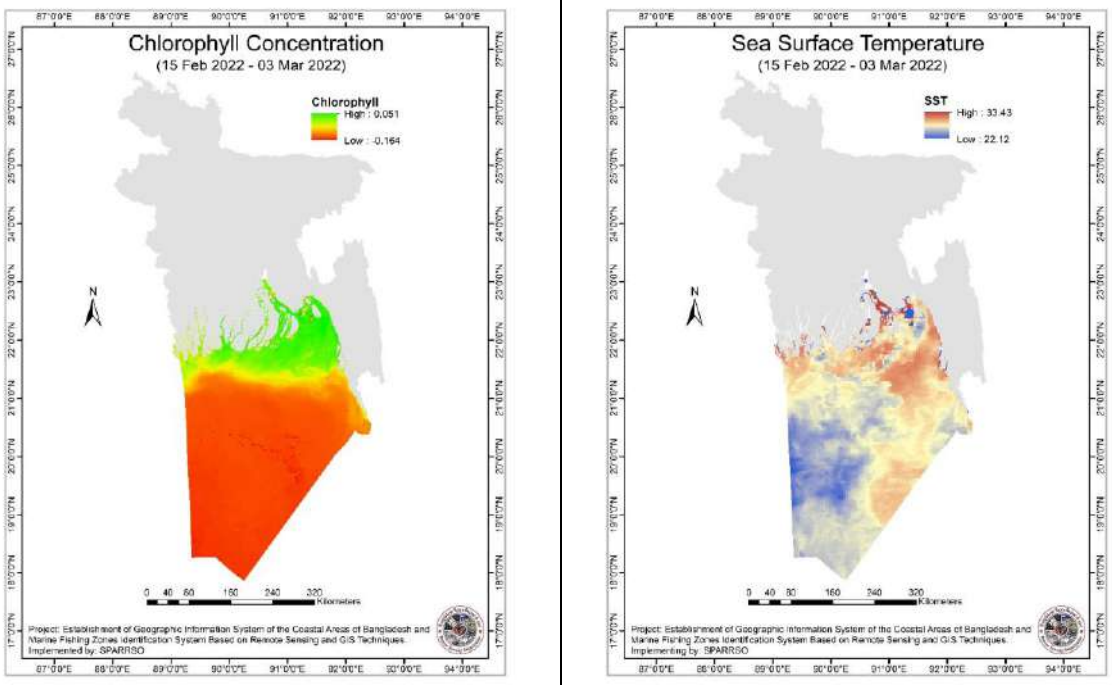


Figure 35. Left, algorithm derived mean Chl-a during 15 February 2022 to 3 March of 2022 calculated from reflectance product of Aqua-MODIS satellite. Right, SST product for the same period and from the same satellite.

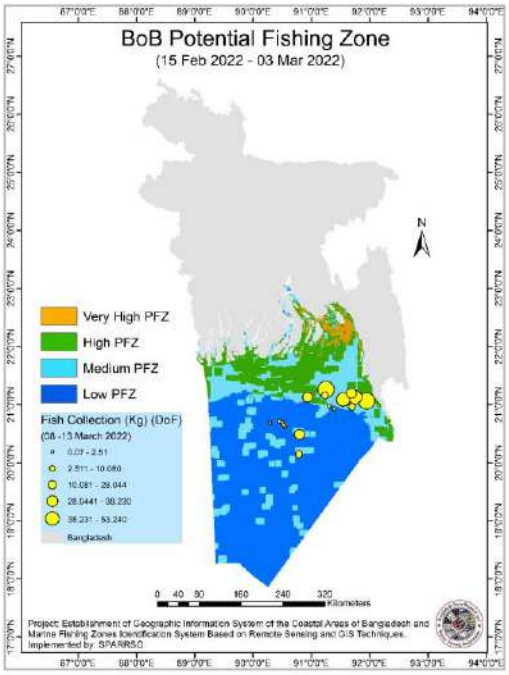


Figure 36. Potential Fishing Zones Identification in the Bay of Bengal, during the above mentioned period. Shading represents the potential fishing zones during the marine fisheries survey of Department of Fisheries (08 March - 13 March, 2022). Yellow circles indicate the fish collection points and amount of fish during the survey.

A unique example of inter-organizational cooperation and partnership has been demonstrated under this project. Bangladesh Navy and Bangladesh Coast Guard have provided invaluable supports for in-situ data collection from the Bay of Bengal using their ships and personnel. Department of Fisheries also has given their support with marine survey vehicle and officials during further sea data collection and checking potential fishing zone map. Thus the budget of the project for data collection reduces significantly. A model of rational budgeting and knowledge sharing among inter-organizational experts has also been practiced here under this project.

Photograph 2. Few snaps of in-situ data collection during six sea cruises with Bangladesh Navy and Bangladesh Coast Guard.

The project will not be ended up here after this completion rather it will open up the beginning of providing the further continuous benefits to the relevant stakeholders in the country. SPARRSO will start to supply information on the coastal features and fishing zone location as soon as the completion of the project.



Photograph 3. Few snaps during the sea cruise with Department of Fisheries

The Geographical Information System (GIS) of the coastal area of Bangladesh will be operated by the Oceanographic Division and the fishing zone identification system will be operated by the Fisheries Division of SPARRSO.

The geo-spatial data generated under the Coastal GIS component will be disseminated to the institution level through the National Spatial Database Infrastructure (NSDI) gateway of Survey of Bangladesh (SoB).

Maps and information on the location of potential fishing zones will be supplied to the marginal fishermen through the Department of Fisheries (DoF). However, frequency of data dissemination depends on availability of cloud free satellite images.

Final Dissemination Seminar of the Project

Final dissemination seminar on the project namely "Establishment of a Geographic Information System of the Coastal Areas of Bangladesh and a Marine Fishing Zones Identification System Based on Remote Sensing and GIS Techniques Project" was held at Bangladesh Space Research and Remote Sensing Organization (SPARRSO). The project was implemented by SPARRSO under the Ministry of Defence (MoD), Government of the Peoples Republic of Bangladesh. Dr. Mohammad Yamin Chowdhury, Secretary, Ministry of Fisheries and Livestock, was present as the Chief Guest and Senior Secretary, Ministry of Defence Golam Md Hashibul Alam presided over the seminar. Mr. Md Zafar Ullah Khan, Chairman of SPARSO, gave a welcome speech at the seminar and technical presentation was given by the Project Director of this project Dr. Md. Abdus Salam, Chief Scientific Officer, SPARSO. Mr. Mohammad Imrul Islam Senior Scientific Officer of SPARRSO and Research

Team Member of the Project also gave presentation potential fishing zones (PFZ) identification.

The seminar was also attended by Mr. Muhammad Abdur Rauf Howladar, Director, Defense Survey, Bangladesh Survey Directorate, Dr. Md. Niamul Nasser, Professor and Chairman, Department of Zoology, University of Dhaka and Mr. Md. Mahmud Ali, Member (Research), SPARSO as Chief Discussant along with the concerned officials of various Ministries and Departments.

Dr. Mohammad Yamin Chowdhury, Secretary, Ministry of Fisheries and Livestock mentioned that the initiatives taken to identify potential fishing zones using remote sensing technology in the Bay of Bengal is really commendable and timely actions. Thus the fishermen will be benefited and a sustainable fish harvesting will be ensured to a greater extent.

Photograph 4. Final Dissemination Seminar of the Project.

Golam Md Hashibul Alam, Senior Secretary of the Ministry of Defence, said that the GIS database which has been derived under this project will help to the better management of coastal zones and secondly the potential fishing zones identification maps will indicate the better harvesting of fishes in the Bay of Bengal. Thus it will also accelerate the "Blue Economy" activities undertaken by the government and hence further enrich the national economy and help in promoting Bangladesh to the list of developed countries by 2041.

CHAPTER 4

ADMINISTRATIVE AND FINANCIAL ACTIVITIES

4.1 Administration

4.1.1. New Chairman of SPARRSO

Mr. Md. Zafar Ullah Khan joined Bangladesh Space Research and Remote Sensing Organization (SPARSO) as Chairman on 16 February 2022. He joined Bangladesh Civil Service Administration Cadre in 1989. He holds Masters in International Relations from Dhaka University, Post Graduate Diploma in Development Studies from Japan and Master's Degree in Financial Management from UK.

Photograph 5. Mr. Md. Zafar Ullah Khan warmly received by M. Mahmud Ali, Member (Research) (Joint Secretary), Member (Technology-1) Member (Technology-2), Member (Application) (Additional Charge)

During his career he was assistant commissioner in Sylhet; Senior Assistant Secretary in ERD, Ministry of Public Administration and Ministry of Finance; Worked as Consul of Bangladesh Mission in Jeddah, Deputy Director of NGO Affairs Bureau, Deputy Secretary of Ministry of Textiles and Jute. Before joining SPARSO as Chairman, he served as Secretary, Member and Acting Chairman of this organization for a long 5 (five) years.

4.1.2. New Member of SPARRSO

Mr. M. Mahmud Ali joined Bangladesh Space Research and Remote Sensing Organization (SPARRSO) as a Member (Joint Secretary) on 29 August 2021. He joined Bangladesh Civil Service in 1999. During his career, he worked in the Bangladesh Planning Commission, Planning Division, Energy and Mineral Resources Division (EMRD) and Ministry of Women and Child Affairs (MoWCA). Before joining SPARRSO, he served as a Joint Secretary, Ministry of Women and Child Affairs.

He holds Masters in Urban and Regional Planning from Bangladesh University of Engineering and Technology (BUET). Currently, he is a part-time Doctoral Student at BUET. He attended to various workshops, training programs in USA, UK, Germany, Japan, Australia, China, Singapore, Malaysia, Thailand, South Korea, UAE, and Indonesia. In addition to these, he also studied at Massachusetts Institute of Technology (MIT) & University of California, USA, and University of Manchester, UK. He is a heritage lover, traveler, explorer and researcher.

4.1.3 Board Meetings

SPARRSO is governed by a Board consists of Chairman and four Members. In 2021-2022 Financial year there were Three (03) board meetings held, which are listed below:

Serial No.	Number of Meetings	Date
01	Special Meeting	18/07/2021
02	118th Board Meeting	23/11/2021
03	119th Board Meeting	11/01/2022

4.1.4. Retirement and Post Retirement Leave (PRL)

During this tenure, 04 Officers and 14 Staffs went for retirement after finishing their PRL period. Although, 02 Officer and 05 Staffs also have gone to post retirement leave (PRL). The names of Officers and Staffs according to the effective date are written in chronologically

Mr. Md. Nuruzzaman, Technicialn-1, has gone to retirement with effect from 12 August 2021. He joined SPARRSO on 01 August 1981 and served the organization for more than 38 years.

Mr. Md Abu Taleb Pramanik, Senior Scientific Officer, has gone to retirement with effect from 01 December 2021. He joined SPARRSO on 30 April 1985 and served the organization for more than 34 years.

Mr. Md. Amirul Islam, Security Guard, has gone to retirement on 29 December 2021. He Joined at SPARRSO on 29 April 1985 and served the organization more than 34 years.

Mr. Md. Abdul Mannan, Office Sohayak, has gone to retirement with effect from 01 January 2022. He joined SPARRSO on 20 April 1985 and served the organization for more than 33 years.

Mr. Md. Rafiqul Islam, Security Guard has gone to retirement with effect from 30 January 2022. He joined SPARRSO on 20 April 1985 and served the organization for more than 34 years.

Mr. Md. Firoj Molla, Assistant Engineer has gone to retirement with effect from 02 February 2022. He joined SPARRSO on 25 April 1985 and served the organization for more than 34 years.

Mr. Md. Mominul Haque, Driver has gone to retirement with effect from 02 February 2022. He joined SPARRSO on 04 February 1985 and served the organization for more than 34 years.

Mr. Md. Abdul Gani Mia, Driver has gone to retirement on 02 February 2022. He Joined at SPARRSO on 01 August 1983 and served the organization more than 36 years.

Mr. Md. Abul Kashem, Office Sohayak has gone to retirement with effect from 12 March 2022. He joined SPARRSO on 01 August 1981 and served the organization for more than 40 years.

Mr. Md. Khairul Alam, Technician-1 has gone to retirement with effect from 18 June 2022. He joined SPARRSO on 17 January 1985 and served the organization for more than 34 years.

Mr. Md. Atiar Rahman, Technician-1 has gone to retirement with effect from 28 June 2022. He joined SPARRSO on 05 February 1982 and served the organization for more than 39 years.

Mr. Md. Shorab Uddin, Driver has gone to PRL with effect from 15 November 2021. He joined SPARRSO on 09 February 1985 and served the organization for more than 36 years.

Mr. Md. Humayun Kabir, Chief Scientific Officer has gone to PRL with effect from 26 November 2021. He joined SPARRSO on 12 October 1982 and served the organization for more than 39 years.

Mr. Md. Abdul Bari, Senior Tecnhnician has gone to PRL with effect from 24 December 2021. He joined SPARRSO on 11 December 1985 and served the organization for more than 36 years.

Mr. Md. Tajul Islam, Office Sohayak has gone to PRLwith effect from 31 December 2021. He joined SPARRSO on 18 April 1985 and served the organization for more than 36 years.

Mr. Md. Abu Taher, Security Guard has gone to PRLwith effect from 31 December 2021. He joined SPARRSO on 01 November 1983 and served the organization for more than 38 years.

Mr. Md. Abdullah Zahir, Senior Scientific Assistant has gone to PRL with effect from 31 December 2021. He Joined at SPARRSO on 25 April 1985 and served the organization more than 36 years.

Mr. Md. Abu Mohammad, Principal Scientific Officer has gone to PRL on 28 February 2022. He Joined at SPARRSO on 20 April 1985 and served the organization more than 36 years.

4.1.5 Promotion

In the 2021-2022 financial years, there are 01 Officer and 04 Staffs got promotion. The name and effective date of respective officer and staffs are listed below:

Sl No.	Name	Promoted Post	Effective Date
01	Mr. Md. Shahjahan Ali	Principal Scientific Officer	05/12/2021
02	Ms. Jebunnesa Khatun	Senior Scientific Assistant	04/04/2022
03	Ms. Sultana Rajiya	Senior Scientific Assistant	04/04/2022
04	Ms. Shahin Sultana	Senior Scientific Assistant	04/04/2022
05	Mr. Sarkar Aslam Uddin	Senior Scientific Assistant	04/04/2022

4.1.6 New Officer and Staffs

In order to meet up different level of employees' vacancy, Bangladesh Space Research and Remote Sensing Organization (SPARRSO) has successfully accomplished the different level other recruitment process for the officers and staffs during the 2021-2022 financial years. Under some following some regular process like as police verification, medical examination. Bangladesh Space Research and Remote Sensing Organization (SPARRSO) got 8 new Officers. Their name, post and date of joining are listed below:

Sl No.	Name	Post	Joining Date
01	Dr. Mohammad Shohidul Islam	Principal Scientific Officer	13/09/2021
02	Mr. Md. Abdur Rahman-Al-Mamun	Scientific Officer	30/03/2022
03	Mr. Md. Ariful Islam	Scientific Officer	30/03/2022
04	Mr. Md. Shamim Reza Saimun	Scientific Officer	30/03/2022
05	Mr. Milan Kumar Shiuli	Scientific Officer	30/03/2022
06	Mr. Md Farid uddin	Scientific Officer	30/03/2022
07	Mr. Md. Naim Islam Talukder	Scientific Officer	30/03/2022

Bangladesh Space Research and Remote Sensing Organization (SPARRSO) got 7 new employees. Their name, post and date of joining are listed below:

Sl No.	Name	Post	Joining Date
01	Mr. Sonjoy Das	Security Habildar	23/12/2021
02	Mr. Jakir Hossain	Security Guard	23/12/2021
03	Ms. Sharmin Sultana	Office Sohayak	23/12/2021
04	Mr. Md. Mamunur Rashid	Skilled Worker	01/02/2022
05	Mr. Md. Mehedi Hasan	Junior Engineer	13/02/2022
06	Mr.Md. Jewel Rana	Library Assistant Cum Typist	13/02/2022
07	Mr. Tonmoy Kumar Nondi	Stenographer (PA	13/02/2022
08	Mr. Md. Al-Amin Hossain	Accounts Assistant cum Typist	13/02/2022
09	Ms. Ishrat Jahan	Office Assistant Cum Computer Typist	06/03/2022
10	Ms. Md. Zual Rana	Office Assistant Cum Computer Typist	06/03/2022

4.2 BUDGET AND EXPENDITURE

SPARRSO meets its recurring expenditure from the revenue budget of the Government. It also earns revenues through selling of products like maps, photographic prints, providing services and project works on payment basis. The revenue budget and the expenditure for the financial year July 2021 to June 2022 are given below:

Organization and Code	**Financial Year**	**Allocated Budget (BDT)**	**Revised Budget (BDT)**	**Expenditure (BDT)**	**Remarks**
SPARRSO & 131003300	2021-2022	202000000	192600000	154615229	unspent Tk. 37984771 has been deposited in the government treasury.

Photograph 6. A Virtual meeting of the Budget Management committee, chaired by the Senior Secretary of the Ministry of Defence was held on May 26, 2022, along with the Chairman and Financial Adviser of SPARRSO.

4.3 Store and Procurement Section

In the light of the demand letter for the financial year 2021-2022 obtained from various departments/divisions/branches of SPARRSO, The HOPE (Chairman, SPARRSO) approved Annual Procurement Plan (APP) including 24 (Twenty-Four) Packages. SPARRSO spent Tk. 3,36,47,812 (Three Crore Thirty-Six Lac Forty-Seven Thousands Eight Hundred Twelve) by following PPR rules and regulations in the financial year 2021-2022. For procuring Goods, Works and Services related packages, different method such as Open Tendering Method (OTM) (National), Quality and Cost-Based Selection (QCBS), Direct Procuring Method (DPM), Framework Agreement through OTM, Request for Quotation (RFQ) etc. have been applied according to the Public Procurement Act (PPA) -2006 and Public Procurement Rules (PPR)-2008. Through the E-Gp system, SPARRSO have procured about Tk. 1,23,71,997(One Crore Twenty-Three Lac Seventy-One Thousand Nine-Hundred Ninety Seven).

Description of procurement packages for Goods/Works/Services are listed below:

Package No	Description of procurement packages Goods/Works/Services	Procurement method and Type
1	2	3
GR1	Procurement of Laptop	E-Gp (OTM)
GR2	Supply and Installation of Sound System for SPARRSO Conference room	E-Gp (OTM)
GR3	Lot:1 Procurement of Image Processing software	OTM
	Lot: 2 Procurement of GIS Processing software	OTM
GR4	Procurement of Furniture	OTM
GR5	Supply and Installation of Server	E-Gp (OTM)
GR6	Procurement of Equipment /Materials for research project	OTM
GR7	Procurement of Satellite and Tidal Data for research project	DPM
GR8	Procurement of Stationary and Sweeping materials	Framework Agreement
GR9	Lot:1 Procurement of Electrical Materials	Framework Agreement
	Lot:2:Procurement of AC, AC repair and Servicing	Framework Agreement
	Lot:3 Procurement of Computer Accessories and Security Cameras	Framework Agreement
	Lot:4 Procurement of sanitation and hygiene related materials	Framework Agreement
GR10	Procurement of Photocopy Machine	RFQ
GR11	Procurement of Crest for SPARRSO	RFQ
GR12	Procurement of Tools and Materials for Research Project	RFQ
GR13	Procurement of Printing Items	RFQ
GR14	Repair and Maintenance of Furniture	RFQ
GR15	Repair and maintenance of 275KVA Diesel Generator	RFQ
GR16	Engine Overhauling of Car-Dhaka-Metro-GA-31-7534	RFQ
GR17	Repair works of Engine of Car Dhaka Metro-Kha-13-1479	RFQ
WR1	Renovation works of SPARRSO Board Meeting Room	RFQ
WR2	Procurement of renovation work of SPARRSO Administrative Building 1st Floor	RFQ

Package No	Description of procurement packages Goods/Works/Services	Procurement method and Type
WR3	Procurement of renovation work of SPARRSO Administrative Building 2nd Floor	RFQ
WR4	Construction and Renovation of Laboratory and Toilet of SPARRSO	RFQ
WR5	Procurement of Internet Service from ISP at SPARRSO	RFQ
SR1	Development of an Office Management Software for SPARRSO	QCBS
SR2	Appoint of 1 (one) Research Associate for ongoing Project “Mapping Changes in the Mangrove Forest Ecosystem using Satellite Sensor Data”	3 CV

CHAPTER 5

Library and User Services

5.2 User Services

Delivery of Satellite Data Product

SPARRSO Photographic Division provides different types of remote sensing data products to different government, non-government organizations and universities for conducting their study and project works. The image products of different aspect supplied to the different organization in the financial year of 2021-2022 are mentioned below:

Product Description	Date	Supplied to the concerning Authority
TM Satellite Image	01-09-2021	Md. Sahidul Islam Lecturer Rangpur Cadet College.
Sentinel2 Satellite Image	17-02-2022	Survey Corporation (PVT.) Limited.

5.3 Library and Documentation

Bangladesh Space Research and Remote Sensing Organization (SPARRSO) has a rich library that contains valuable books, journals, periodicals, pamphlets, newsletters, bulletins, reports and proceedings of workshop, symposia and conference etc. covering different thematic areas of space science and remote sensing. It is an automated library which has self-developed library management software, namely Microsoft Access Database that supports circulation control, reference service, and readers' guidance service, literature search facility by author, title, publisher, subject, accession number, ISBN number and issuing reminder letters to the users for retuning the library materials. The library database management system avoids duplication of the work by introducing computerized library management system and it helps to improve the existing services.

At present, there are about 16,173 books, journals and reports covering a large number of fields such as remote sensing, space science, agriculture, biology, cartography, chemistry, computer science, ecology and environmental science, electronics and instrumentation,

engineering sciences, fisheries, forestry, geography, geology, GIS, hydrology, mathematics, meteorology, oceanography, photogrammetry, photography, physics etc. in the library. The library has books on the Liberation War and the autobiography of the Father of the Nation Bangabandhu Sheikh Mujibur Rahman. Besides, the library has religious and other reference books, government and non-government publications and other departmental collections.

During the reporting period of July 2021 to June 2022 the following books were procured. The category-wise numbers are listed below:

Table 4: List of procured books

Sl. No.	Description	Number
1	Scientific Related Books	63
2	Accounting Related Books	5
3	Nature Related Books	5
	Total	**73**

Readers/Users

All the employees of SPARRSO are entitled to use the library. Besides, students and teachers of different educational institutions and scientists, engineers, research workers and policymakers of government and non-government organizations can use the library with the permission of the authority of SPARRSO. Scientists, engineers, other officials and research students of SPARRSO use the library for their study and research purpose in every working day.

Library Hours

SPARRSO library remains open from 9:00 am to 5:00 pm in all working days (Sunday to Thursday) and it remains closed on all government holidays.

Contact Numbers: +88-02-9113957, Cell Phone: +88-01773526707

Address: Bangladesh Space Research and Remote Sensing Organization (SPARRSO), Agargaon, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh.

Email: juelrana2930@gmail.com

CHAPTER 6

INTERNATIONAL EVENTS

6.1 Asia-Pacific Space Cooperation Organization (APSCO)

Asia-Pacific Space Cooperation Organization (APSCO) is an inter-governmental organization with full international juridical nature. The institution has been working for the peaceful exploitation of space technology in order to promote sustainable economic and social development among the member states and regional countries in the Asia-Pacific region. APSCO started its formal operation in December 2008 and has been granted the permanent observer status to the Committee on Peaceful Uses of Outer Space of United Nations since 2009. Currently, APSCO has eight Member States namely Bangladesh, China, Iran, Mongolia, Pakistan, Peru, Thailand and Turkey and one Signatory State namely Indonesia which is under respective domestic procedures of its ratification on APSCO Convention.

Photograph 7. APSCO Headquarters in Beijing (Source: www.apsco.int)

Bangladesh joined the Asia-Pacific Space Cooperation Organization (APSCO) to accelerate peaceful exploitation of space technology in order to promote sustainable economic and social development. Bangladesh signed APSCO Convention on 28th October 2005 and the Convention was ratified on 1st August 2006. Since then, Bangladesh has been actively participating different programs and events organized by APSCO.

6.2 The 2nd APSCO Development Plan Committee Meeting

The 2nd APSCO Development Plan Committee Meeting was organized through a teleconference during 5-9 and 12th and 15th July 2021 via teleconference. The APSCO Development Plan Committee Members and experts from all Member States participated in the meeting. Mr. A Z Md, Zahedul Islam, Member (Technology-2), SPARRSO and Dr. Md. Abdus Salam, Chief Scientific Officer, SPARRSO from Bangladesh attended in the meeting.

The detailed project proposals listed in the current 10-Year development plan, as well as new projects proposals were presented by project initiators from Member States, in the domains of Space Technology Development, Space Science, Space Technology Application, DSSP Application and Space Education Development. After presentation and Q&A session, the projects evaluation and scoring were conducted by the Development Plan Committee. The projects were selected and listed in the draft Project Implementation Plan (2021-2025) with timeframe and their budget requirements. Two draft documents, namely, "APSCO Project Implementation Plan (2021-2025)" and "Amendment of Rules on Cooperative Activities of APSCO" were consolidated.

Photograph 8. Participants of the 2nd APSCO Development Plan Committee Meeting.

6.3 Short Training Course on "Lunar Data Analysis"

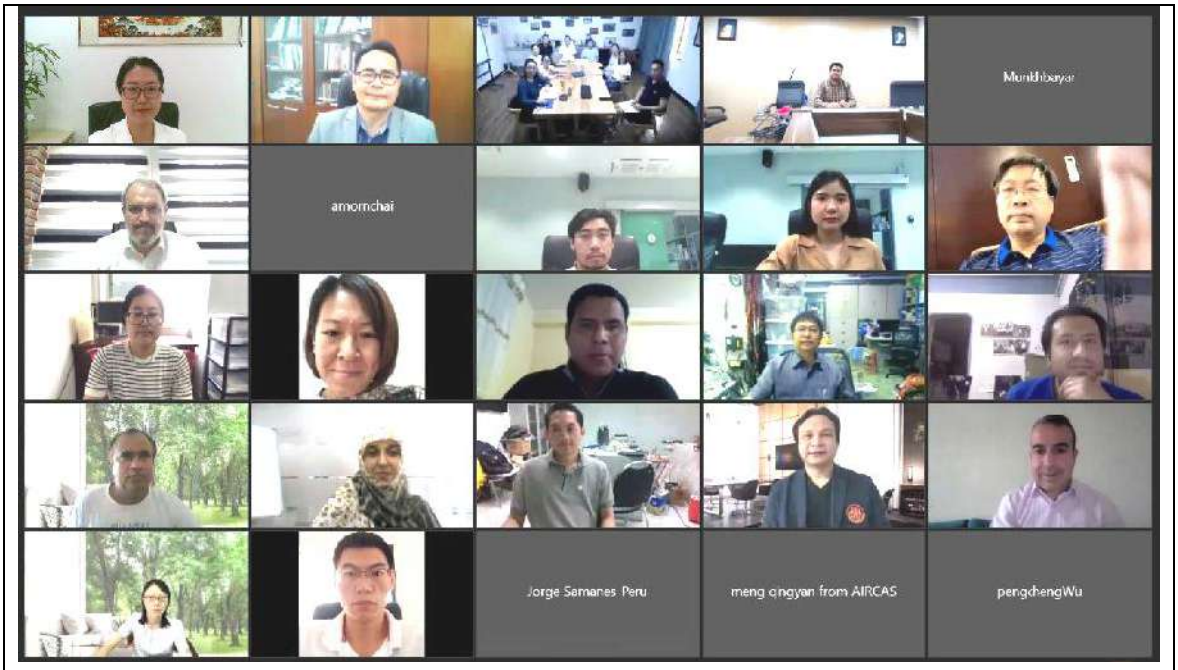
A Short Training Course on "Lunar Data Analysis" was jointly organized by APSCO and Lunar Exploration and Space Engineering Center (LESEC), China during 5-9 July and 12-16 July 2021 through teleconference. The course was well designed, addressing the subjects that include: Lunar Mapping, Lunar Geology, Chinese lunar ground-penetrating radar exploration, Chang'E laser altimetry and its data processing, Imaging Radar Remote Sensing of the Moon: A Review, Data Usage, and Scientific Applications, Lunar gravity field development and its application, and Impact cratering and crater chronology. In total, 30 lecture-hours were given by the lecturer team, consisting of 7 outstanding researchers and professors working in the frontier fields. Md. Nur Hossain Sharifee, Chief Scientific Officer and Ms. Farhana Tazneen, Senior Scientific attended in this training.

Photograph 9. Participants of the online short training course on "Lunar Data Analysis".

6.4 Test Readiness Review Meeting and Training on the APSCO Earthquake Research Project Phase II Integrating Satellite and Ground Observations for Earthquake Signatures and Precursors

Bangladesh Delegate attended Test Readiness Review Meeting and Training on the APSCO Earthquake Research Project Phase-II Integrating Satellite and Ground Observations for Earthquake Signatures and Precursors organized virtually by APSCO. The Test Readiness Review Meeting and Training on the APSCO Earthquake Research Project Phase II Integrating Satellite and Ground Observations for Earthquake Signatures and Precursors during 30th August – 1st September 2021 were organized through videoconference. Project Management Board (PMB) members, delegates from all Member States (M.S.) of APSCO performed in the meeting, including Bangladesh, China, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey. During this videoconference, the overall progress of the project was reviewed and discussed on Site-Hosting Agreements and Site Survey for magnetometer installation. Experts from all Member States attended the training and shown their appreciation to the Institute of Crustal Dynamics, China Earthquake Administration (ICD, CEA). The Project Management Board and all delegates from the Member State agreed that the project has completed the milestone and it is ready to transit into its next stage. Dr. Md.

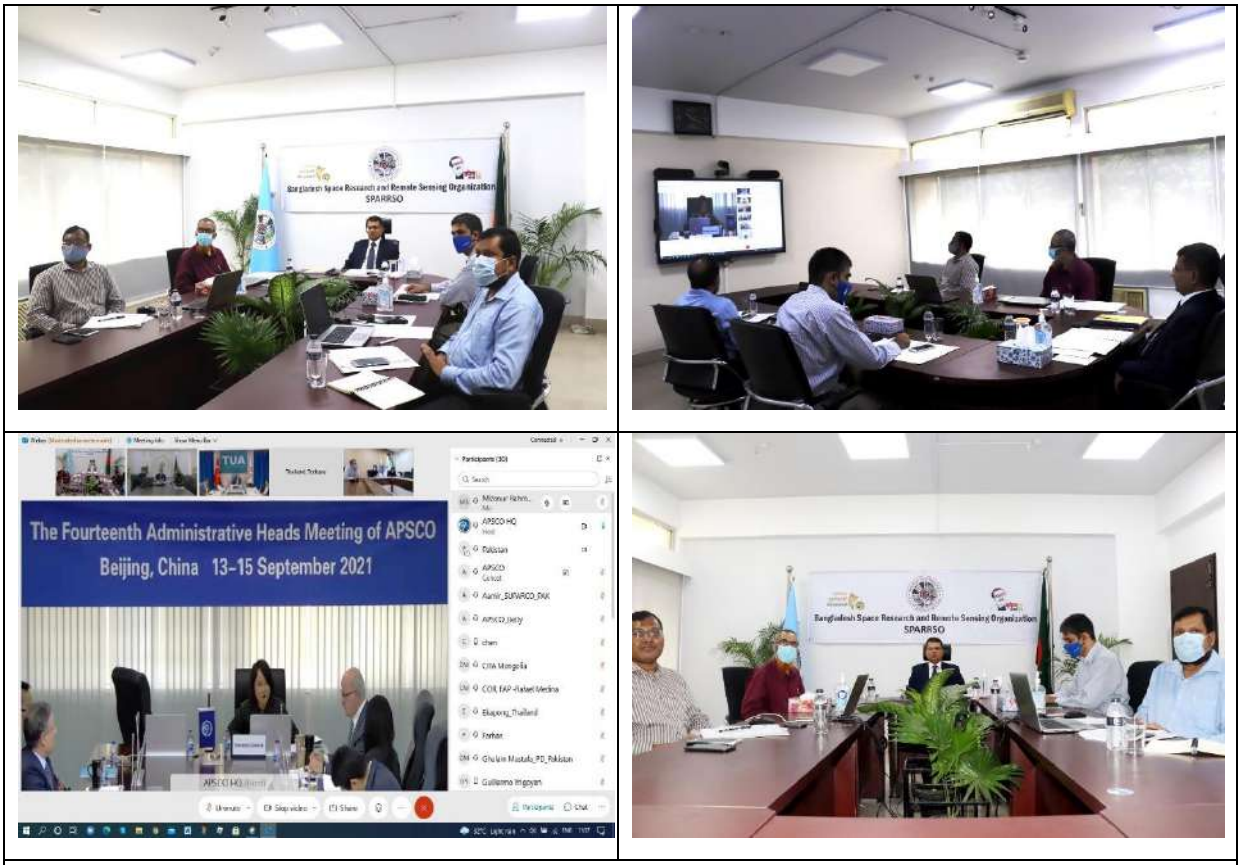
Mahmudur Rahman, Chief Scientific Officer and Ms. Farhana Tazneen, Senior Scientific Officer, attended in the meeting as an expert from SPARRSO.



Photograph 10. Participants of the online Test Readiness Review Meeting and Training on the APSCO Earthquake Research Project Phase II.

6.5 14th Administrative Heads Meeting of APSCO

The 14th Administrative Heads Meeting of APSCO was held from 13 to 15 September 2021 in Beijing, China through Virtual Platform. After the APSCO Council, it is the second highest decision-making forum of APSCO. Administrative Heads and accompanied delegates from Member States: Bangladesh, China, Iran, Mongolia, Pakistan, Peru, Thailand and Turkey, attended in the Meeting. Mr. Mizanur Rahman Chairman SPARRSO (Additional Secretary) led the Bangladesh Delegation. He also chaired the 1st session of the meeting. Mr. Md. Zafar Ullah Khan, Member (Application) (Joint Secretary), Mr. M. Mahmud Ali, Member (Technology-1) (Joint Secretary), Dr. Md. Abdus Salam Chief Scientific Officer & Focal Point of APSCO from Bangladesh and Mr. Mohammed Nur Hossain Sharifee Chief Scientific Officer of SPARRSO also attended in the meeting. The Administrative Heads and the delegates from Member States made detailed deliberations and discussions on each agenda item.



Photograph 11. Bangladesh delegates of 14th Administrative Heads online meeting of Asia Pacific Space Cooperation Organization (APSCO).

Photograph 12. Member States delegates of 14th Administrative Heads online meeting

The Administrative Heads finalized the recommendation on each agenda item for the confirmation/approval of the APSCO 15th Council Meeting, which is scheduled to be held in November 2021 in Beijing.

6.6 Participation in the Global Space Science Forum in Rabat, Morocco.

Mr. Mizanur Rahman (Additional Secretary to the Government), Chairman of Bangladesh Space Research and Remote Sensing Organization (SPARRSO) participated in the forum titled 'Exploring the Space Science Future-Together' which was held on 01-03 November 2021 in the Islamic World Education, Scientific and Cultural Organization (ICESCO), Rabat, Morocco. He gave a presentation on "Future of Space Science and Bangladesh" at this global forum.

Photograph 13. Heads of the Space Agencies and Representatives attended the Global Space Science Forum

As a side line event a bilateral meeting was held between Mr. Mizanur Rahman (Additional Secretary to the Government), Chairman, Bangladesh Space Research and Remote Sensing Organization (SPARRSO) and the Director General of ICESCO, Dr. Salim bin Muhammad Al Malik on 2nd November 2021. In order to enhance cooperation in the field of space research and technology, these two organizations reached in a fruitful end of discussion.

Photograph 14. Chairman SPARRSO and Director General, ICESCO were in a discussion meeting

6.7 Bangladesh Delegate attended in the 15th Council Meeting of APSCO

The 15th Council Meeting of APSCO was held from 9-11 November 2021, virtually. APSCO Council is the highest decision-making forum of APSCO. Council Members/Representatives and accompanied delegates from the Member States: Bangladesh, China, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey, attended the Meeting.

Photograph 15. Mr. Md. Masud Karim, Additional Secretary, Ministry of Defence (MoD)Mr. Mizanur Rahman, Chairman (Right Side) along with Dr. Md. Abdus Salam, Chief Scientific Officer & Focal Point of APSCO during the Virtual Meeting on 9-11 November 2021.

Mr. Md. Masud Karim, Additional Secretary, Ministry of Defence (MoD) led the Bangladesh Delegation as Representative of Council Member from Bangladesh Mr. Dr. Md. Abu Hena Mostofa Kamal, ndc, Secretary, Ministry of Defence. Dr. Md. Abdus Salam, Chief Scientific Officer & Focal Point of APSCO from Bangladesh also attended the meeting.

Photograph 16. Member States delegates of 15th Council Meeting of APSCO online.

The Council Members/Representatives and the delegates from the Member States made discussions on the reports and proposals of APSCO cooperative activities as presented by APSCO Secretariat in different agenda items. The Council reviewed/ revised /confirmed /approved the recommendations on different agenda items earlier recommended in the 14th Administrative Heads Meeting of APSCO.

6.8 The Kick-off Meeting of the First Batch of DSSP Application Projects led by Bangladesh and Mongolia

The Kick-off Meeting of the First Batch of DSSP Application Projects led by Bangladesh and Mongolia was successfully held on 12th January, 2022, through a teleconference. Delegates from Bangladesh, China, Iran, Mongolia, Pakistan, Peru, Thailand and Turkey participated in the meeting; all eight projects under the first batch have been kicked-off. Dr. Md. Mahmudur Rahman and Dr. Md. Abdus Salam, Chief Scientific Officer, SPARRSO from Bangladesh attended in the meeting. The main objective of the meeting is to review and discuss the Project Implementation and Management Plan (PMP) of two DSSP application projects led by Bangladesh and Mongolia.

Photograph 17. Participants of the Kick-off Meeting of the First Batch of DSSP Application Projects led by Bangladesh and Mongolia online.

During the meeting, Dr. Md. Abdus Salam, the project manager from SPARRSO, Bangladesh, gave a presentation on the PMP of the "Investigation on the Applicability of Microwave and Optical Satellite Images for Assessment of Major Crop Acreages at Early Stage of Crop Life Cycle" Project and replied to the answers from the participants on the output, work breakdown and data requirement aspects.

Photograph 18. Presentation made by Bangladesh

Photograph 19. Presentation made by Mongolia

Dr. Byambakhuu Gantumur, the project manager from National University of Mongolia, gave a presentation on their PMP of the "Wildfire monitoring of natural disaster and its risk assessment using remote sensing methods in Mongolia" Project and replied to the answers

from the participants on the data requirement and risk management aspects. With the strong support provided by all the Member States and the consistent endeavor made by all the Project Leads, the meeting was successfully concluded and the two DSSP application projects were officially kicked-off.

6.9 Competition on Discovering Historical Cultural Heritage with Eye in Space

A 'Competition on Discovering Historical Cultural Heritage with Eye in Space was held in Beijing of China during 8-10 January and 21 January 2022 organized by Asia Pacific Space Cooperation (APSCO). Mr. M. Mahmud Ali, Member (Research) attended Expert Committee Meetings in virtually.

Photograph 20. Online Participants of Competition on Discovering Historical Cultural Heritage with Eye in Space Related Expert Committee Meetings.

6.10 The 3rd APSCO Development Plan Committee Meeting

The 3rd APSCO Development Plan Committee Meeting was organized during 7-9 March 2022, via a teleconference. The APSCO Development Plan Committee members and experts from all Member States of APSCO participated in the meeting. Mr. M Mahmud Ali, Member (Technology-1), SPARRSO and Dr. Md. Abdus Salam, Chief Scientific Officer, SPARRSO from Bangladesh attended the meeting. The meeting started with Exchange of Views on Cutting-Edge Space Technology. From both APSCO Secretariat and Member States exchanged presentations, including APSCO Cooperation on Lunar and Deep Space Exploration; Briefing on China's White Paper "China's Space Program: A 2021 Perspective"; Mechanism on Emergency Response Services of APSCO; Construction and Application of the Natural Resources Satellite Remote Sensing Cloud Service Platform; and International Lunar Research Station (ILRS).

Photograph 21. Participants of the 3rd APSCO Development Plan Committee Meeting online.

The agenda was followed by the reports on APSCO progresses on Space Law and Space Policy Activities Implementation, Education and Training Projects/Activities Implementation, DSSP Application Projects, and Cooperative Projects Implementation presented by the Director-General of respective departments. On the review and evaluation of new project/activity proposals, there were 9 proposals proposed to the 3rd Development Pan Committee Meeting, in domains of Space Technology Application, Space Science, Space

Technology Development, Education and Training, and International Cooperation Activity based on the evaluation result, two projects under the domain of Education Development Program were selected to include into the Project Implementation Plan (2021-2025).

6.11 Participation in the ISNET's Outstanding Award Program on Implementing SDGS through Space Science and Technology

Sustainable Development Goals 2030 are the latest guidelines covering all areas of socioeconomic development. ISNET is cognizant of the significant role space technology & applications can play in achieving the SDGs. Foregoing in view, ISNET Secretariat had made an announcement for "Outstanding Award Program on Implementing SDGs through Space Science & Technology" to its member states. This award program identified and has given rewards for outstanding practices/ initiatives/ case studies in ISNET member counties with high potential for achieving SDGs through space science, technology and applications. The program was focused on actions that not only enhance existing knowledge, but also brings about positive transformation to the context of the subject to some extent. The conclusions and results of this type of action/initiative have led to improvement of the studied context and the betterment of society as a whole. The awards were given to the initiative that holds the greatest promise for improving our understanding of harnessing space-based technology & applications for achieving the SDGs.

Dr. Md. Abdus Salam Chief Scientific Officer of SPARRSO had participated to this Outstanding Award Program through a submission on the topic "Boro and Aman Crop Acreage Estimation Using Remote Sensing (RS) for Supporting the Food Security Planning in Bangladesh" which enhanced to the data support for SDG 2-Zero Hunger which is one of the important goals of SDGs. His submission has been shortlisted among the top six proposals of the ISNET's Outstanding Award Program.


Photographs and certificate 22-23. ISNET's Outstanding Award Program on Implementing SDGS through Space Science and Technology

The top six proposals have been presented via recorded video presentation during ICS 2022 on 28th March 2022. The recorded video presentation was followed by Q & A session with the Judges Panels composed of UNESCAP, SESRIC and GEO. Dr. Md. Abdus Salam actively interacted with the Judges Panels after his presentation during the Q & A session. Finally, he has been given a "CERTIFICATE OF ACHIEVEMENT" for being shortlisted for the final evaluation round of the Award Program.

6.12 Expert Group Meeting (EGM) on the Feasibility Study of the Aerosol Monitoring CubeSat Project

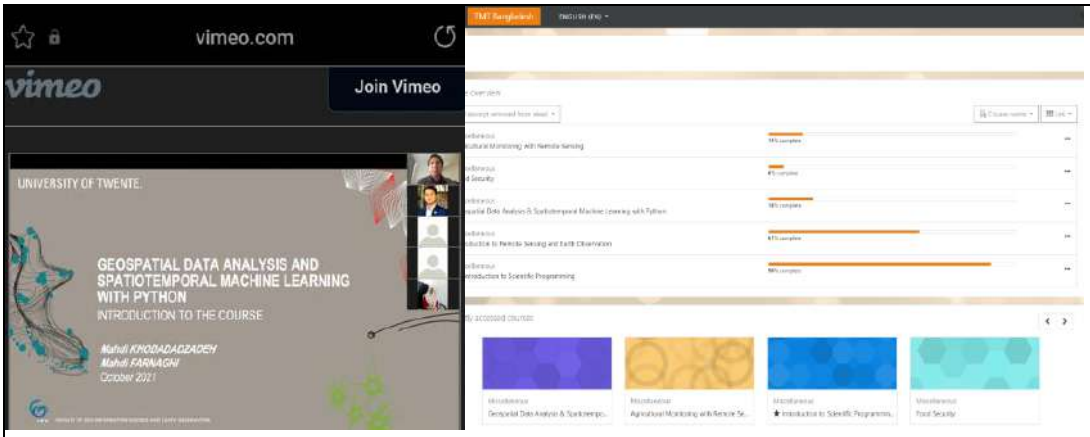
In order to implement the APSCO Project Implementation Plan (2021-2025) approved by APSCO Council Meeting, APSCO has started Feasibility Study of the Aerosol Monitoring CubeSat Project. The Expert Group Meeting (EGM) on the Feasibility Study of the Aerosol Monitoring CubeSat Project is organized on 21-23 June 2022, through teleconference (Webex). In this meeting, the Feasibility Study Report (FSR) of the project is reviewed, and the EGM Review Report on the FSR is consolidated. Dr. Mohammad Shohidul Islam, Principal Scientific Officer and Mr. Md. Naim Islam Talukder, Scientific Officer, SPARRSO have participated on the meeting.

Photograph 24. Participants of the online Expert Group Meeting (EGM) on the Feasibility Study of the Aerosol Monitoring CubeSat Project.

6.13 Open-Source Scientific Computing for Agrogeospatial Big Data Analysis: An Orange Knowledge Programme Tailormade Training Plus Project (Phase II)

Ms. Nasrin Sultana, Senior Scientific Officer participated in the Open-Source Scientific Computing for Agrogeospatial Big Data Analysis: An Orange Knowledge Programme Tailormade Training Plus Project (Phase II)

Three online courses on "Geospatial Data Analysis & Spatiotemporal Machine Learning with Python, Agricultural Monitoring with Remote Sensing and Food Security'' run from Oct 2021 to Dec 2021. Courses follow the principles of Massively Open Online Courses



Photograph 25. Participants of the online Open-Source Scientific Computing for Agrogeospatial Big Data Analysis: An Orange Knowledge Programme Tailormade Training Plus Project (Phase II).

(MOOCs) where trainees follow a series of live and recorded lectures, tutorials and interact with trainers through forums on MoodleCloud for troubleshooting and Q & A sessions. Staff from the University of the Twenty (ITC) led the teaching, and staff from the International Maize and Wheat Improvement Center Bangladesh (CIMMYT) assisted for local troubleshooting and teaching.

These courses cover various Python-based analytical solutions to organize and explore spatio-temporal data. They present the use of Jupyter Notebooks to create interactive analytical environments. They also present various go-computational approaches that help to improve our understanding of geographic processes and/or to extract actionable geo-information from spatio-temporal data. Special attention is paid to data mining and machine learning methods.

6.14 Twenty Fifth Session of the Intergovernmental Consultative Committee (ICC) Meeting

The 25th session of the Intergovernmental Consultative Committee (ICC) on the Regional Space Applications Programme for Sustainable Development in Asia and the Pacific (RESAP) was held on 24-27 August 2021 at the United Nations Conference Centre in Bangkok, Thailand. The meeting was organized by the Economic and Social Commission for Asia and the Pacific (ESCAP) of the United Nations on a virtual platform. Bangladesh Delegation led by the Chairman of Bangladesh Space Research and Remote Sensing Organization (SPARRSO); Mr. Mizanur Rahman, Chairman(SPARRSO) attended the meeting. Dr. Md. Mahmudur Rahman, Chief Scientific Officer of SPARRSO also participated in the meeting.

Photograph 26. Participants of the online Twenty Fifth Session of the Intergovernmental Consultative Committee (ICC) Meeting.

The meeting was attended by delegations from the following ESCAP member and associate member States: Armenia, Australia, Bangladesh, Bhutan, Cambodia, China, Hong Kong, China, India, Indonesia, Iran (Islamic Republic of), Japan, Mongolia, Myanmar, Nepal, Pakistan, Papua New Guinea, the Philippines, the Republic of Korea, the Russian Federation, Singapore, Sri Lanka, Tajikistan, Thailand, Uzbekistan and Viet Nam.

Dr. Md. Mahmudur Rahman, Chief Scientific Officer of SPARRSO made a presentation on the progress of the SPARRSO in contributing to the Plan of Action in three thematic areas: disaster risk reduction and resilience, natural resource management and social development. The present activities and future plan of SPARRSO were highlighted in the presentation.

6.15 3rd International Conference on Space (ICS-2022), Islamabad, Pakistan

The Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), Asia Pacific Space Cooperation Organization (APSCO), Islamic World Scientific, Educational and Cultural Organization (ICESCO) and Inter-Islamic Network on Space Sciences and Technology (ISNET) jointly organized the 3rd International Conference on Space (ICS-2022) in Islamabad, Pakistan, from 28 to 30 March 2022.

Photograph 27. Participants of the 3rd International Conference on Space (ICS-2022), Islamabad, Pakistan.

The theme of ICS-22 was the role of space technology and applications for the welfare of human living, sustainable development and uplift of economy. International Conference on Space (ICS) brought together space sector professionals, scientists, decision makers, academicians, researchers, educators as well as students on a single platform to showcase achievements, share ideas and latest developments, and voice opinions on areas of space science, technology and applications.

The conference was started with the plenary session. There were several technical sessions on space application, space science, space technology and space education, law & policy. In the conference, there were four workshops: (i) Big Data Analysis and Cloud Computing, (ii) Microgravity and Space Farming, (iii) Application of Remote Sensing Data and Hazard Modeling and (iv) Navigation Error Analysis Tool. There were poster sessions covering all the topics as it was presented in the technical sessions.

Dr. Md. Mahmudur Rahman, Chief Scientific Officer of SPARRSO presented a paper entitled ‘Monitoring Mangrove Afforestation Using Landsat-8 and Worldview Satellite

Imagery' which was presented on 29th March 2022 under technical session space application.

6.16 Short Training Course on "Analysis and Interpretation of data from China's Lunar Missions"

APSCO Short Training Course on "Analysis and Interpretation of data from China's Lunar Missions" was held in Beijing, China through teleconference. All member states of APSCO including SPARRSO participated in the teleconference. Main objectives of the event were to inform activities of China's Lunar Missions based on contemporary topics such as: Geology Mapping of the Moon, Compositions of the Moon derived from hyperspectral Remote Sensing, Lunar Gravity Field development and its applications and application of Ground Penetrating Radar in China's lunar exploration. Organized by APSCO from 16 to 20 May 2022. Ms. Nasrin Sultana, Senior Scientific Officer, Ms. Farhana Tazneen, Senior Scientific Officer, Mr. Mohammad Mahdi Hasan, Scientific Officer, Mr. Muhammad Sharif, Assistant Engineer, Mr. Md. Abdur Rahman Al-Mamun, Scientific Officer, Mr. Md. Shamim Reza Saimun, Scientific Officer, Mr. Md. Farid Uddin, Scientific Officer, Mr. Milan Kumar Shiuli, Scientific Officer, and Mr. Naim Islam Talukder, Scientific Officer, attended this training.

Photograph 28. Participants of the online Short Training Course on "Analysis and Interpretation of data from China's Lunar Missions".

CHAPTER 7

IN-HOUSE AND LOCAL EVENTS

7.1.1 SPARRSO Visit of Defence Secretary

Honourable Senior Secretary of Ministry of Defence, Golam Md Hashibul Alam visited SPARRSO on 01 March 2022. Mr. Md. Zafar Ullah Khan, Chairman, SPARRSO warmly welcomed him and showed him SPARRSO Premises, Research Labs and Bangabandhu corner. In the discussion meeting, SPARRSO Chairman vowed to continue research activities of SPARRSO in quest of fulfilling SDG in Bangladesh. The brief activities of SPARRSO were presented by Dr. Md. Mahmudur Rahman, CSO; where the past, present and future plan of SPARRSO had been exposed. He praised SPARRSO's different research activities in order to meet the Sustainable Development Goals (SDG) and also advised SPARRSO to expand the area of research activities and make collaboration with other organizations in order to boost Country's development in space science and technology. During this visit, Defence Secretary also observed SPARRSO Gallery and planted a sapling in remembrance of the visit.

Photograph 29. Warm reception to the Secretary of Ministry of Defence, Golam Md Hashibul Alam by Mr. Md. Zafar Ullah Khan, Chairman, SPARRSO

Photograph 30. Visit of SPARRSO premises by Defence Secretary with SPARRSO officials

Photograph 31. Honourable Secretary of Ministry of Defence attended in a discussion meeting in SPARRSO conference room

7.1.2 RRSC (Regional Remote Sensing Centre) of SPARRSO visit of Defence Secretary

Honourable Senior Secretary of Ministry of Defence, Golam Md Hashibul Alam visited RRSC (Regional Remote Sensing Centre) of SPARRSO located at Savar, Dhaka on 16th March 2022. Mr. Md. Zafar Ullah Khan, Chairman, SPARRSO along with other senior officials from Ministry and SPARRSO also went there. During his visit, he mentioned some important instructions to make the centre functional.

Photograph 32. RRSC (Regional Remote Sensing Centre) of SPARRSO visit of Defence Secretary.

7.2 In-house Training

7.2.1 Training on "Electronic Government Procurement (E-GP)"

SPARRSO organized a 5 (five) days training course on "Electronic Government Procurement (E-GP)" for the officers and staffs from 19-23 September 2021 as per the decision of the 27th meeting of the SPARRSO Ethics Committee.

Photograph 33. e-GP training at SPARRSO

7.2.2 Training on "Basic Photography Course for Research Work"

SPARRSO Officials and Staffs participated in a training course named "Basic Photography Course for Research Work" under Annual Performance Agreement (APA) on 29th & 30th September & 3rd October 2021.

Photograph 34. Basic Photography Course for Research Work

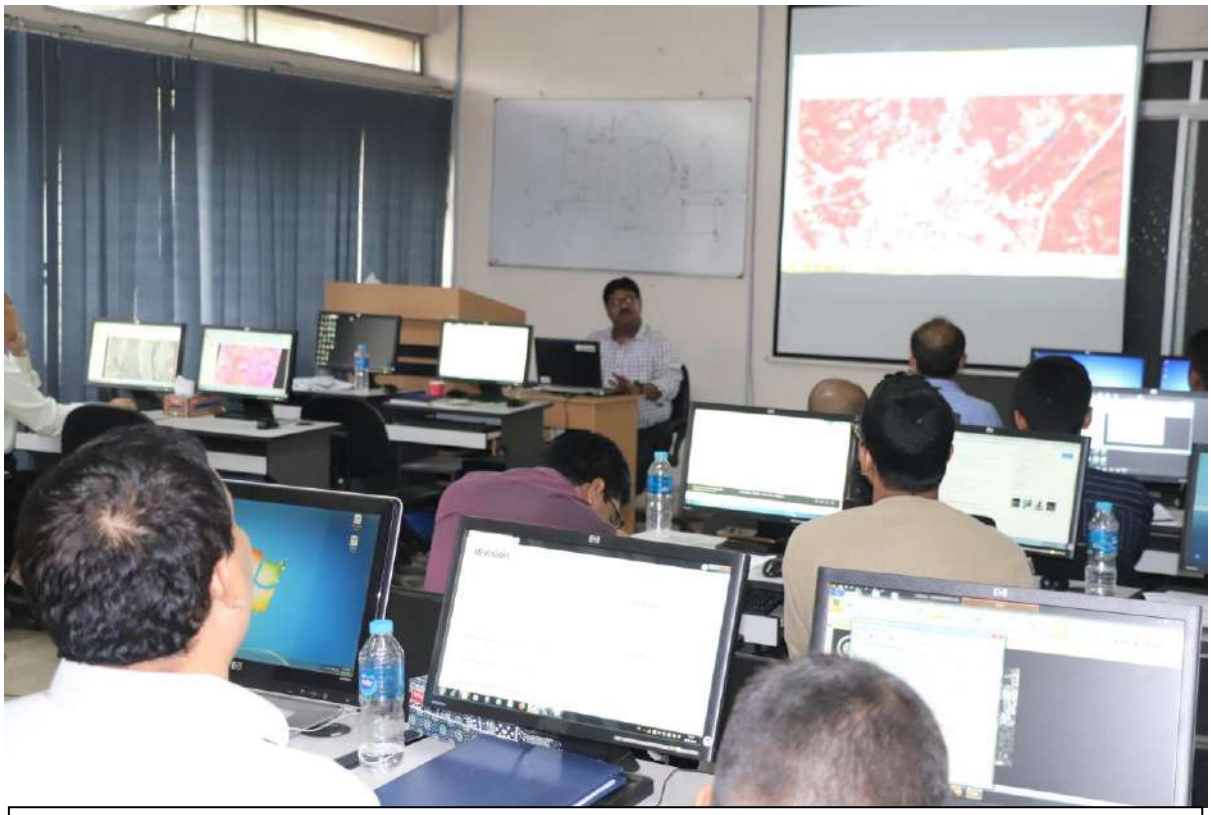
7.2.3 Training on “Electronic file (e-nothi)”

For the betterment of working system, SPARRSO arranged a long day In-House Training Course on “e-nothi” held on 22th March 2022. A number of Officers and staffs of SPARRSO participated in the course**.**


Photograph 35. Participants of E-file training

7.2.4 Training on ArcGIS Pro Software and ERDAS Imagine software for users of SPARRSO

For better understanding the application procedure with technical guideline, SPARRSO organized training on ArcGIS Pro Software and ERDAS imagine software for all the officers and scientific assistant from 12-16 June 2022 and 19-23 June 2022. Different techniques like Georeferencing, maintaining data quality, data creating, editing and modification, image processing etc. were included in this training. Those training were very helpful for Remote Sensing Application.



Photograph 36-38. Arc GIS Pro and ERDAS Imagine software training for officials

7.3 In-house events

7.3.1 Dissemination Seminar on Selected Research Works (2020-21) of SPARRSO

A seminar was organized on 21st March 2022 at Bangladesh Space Research and Remote Sensing Organization (SPARRSO) to inform the results of two research activities in the financial year 2020-2021. Defence Secretary Mr. Golam Md Hashibul Alam was present as the Chief Guest at the seminar and Mr. Md. Zafar Ullah Khan, Chairman of SPARRSO presiding over the Seminar. Two research activities named Investigation on the Applicability of Microwave and Optical Satellite Images for Assessment of Rice Crop Area at Early Stage of Crop Life Cycle and Remote Sensing Based Water Quality Assessment for Inland Fisheries were presented by Dr. Md. Abdus Salam, Chief Scientific Officer and Mr. Mohammad Imrul Islam, senior Scientific Officer.Dr. Md. Abdus Salam mentioned that for the last two decades, SPARRSO has been regularly using satellite remote sensing data to determine the cultivable area of Boro and Aman paddy and provide this information before harvesting. The research is being conducted in response to requests from stakeholders and policy makers to provide more information. Research has shown that the lead time for providing information can be further enhanced, which will play a helpful role in food security planning in Bangladesh. In research of Remote Sensing Based Water Quality Assessment for Inland Fisheries, Mr. Mohammad Imrul Islam expressed that this study uses data from Sentinel-2 and Landsat-8 satellites to detect chlorophyll (Chl-a) and suspended particulate matter (SPM) in some waterbodies at Gazipur district in Bangladesh. This study shows that the Sentinel-2 satellite sensor is more effective for detecting chlorophyll (Chl-a) whereas the Landsat-8 satellite sensor is more effective for detecting suspended particulate matter (SPM). Different national organizations officials attended the seminar and took part in the discussion focusing on current and future research of SPARRSO.

Defence Secretary Mr. Golam Md Hashibul Alam emphasized on coordination among the institutions under the Ministry of Defence in the use of space research and remote sensing technology for the development of the country and the nation.

He requested SPARRSO to conduct research based on the needs of the stakeholders and to contribute to the socio-economic development of the people. Mr. Md. Zafar Ullah Khan, Chairman of SPARRSO, mentioned the encouraging results of the two studies presented and sought the cooperation of all concerned people and organization in these two large-scale studies.

Photograph 39-42. Dissemination Seminar on Selected Research Works (2020-21) of SPARRSO

7.3.2 Consultation Seminar on the Selected Research Work of SPARRSO

(Mapping Tidal Mudflats in the Coastal Regions of Bangladesh)

A seminar was organized on 26th April 2022 at Bangladesh Space Research and Remote Sensing Organization (SPARRSO) to make a consultation on the results of recent research activities. Additional Secretary of Ministry of Defence Mr. Md. Khairul Alam was present as the guest of honor at the seminar and Mr. Md. Zafar Ullah Khan, Chairman of SPARRSO presiding over the Seminar. The research activity entitled Mapping Tidal Mudflats in the Coastal Regions of Bangladesh was presented by Dr. Md. Mahmudur Rahman, Chief Scientific Officer.

Dr. Rahman has mentioned that the coastal regions of Bangladesh are undergoing continuous changes. Many areas are eroded and disappeared in the river and sea due to erosion. Similarly, new lands are formed by the sediment transported by the Padma, the Meghna and Jamuna rivers and their tributaries from the hinterland. Therefore, mapping and continuous monitoring of tidal mudflats are important. Mudflats are those lands that emerge from the coast during high-tide and disappear during the low tide.

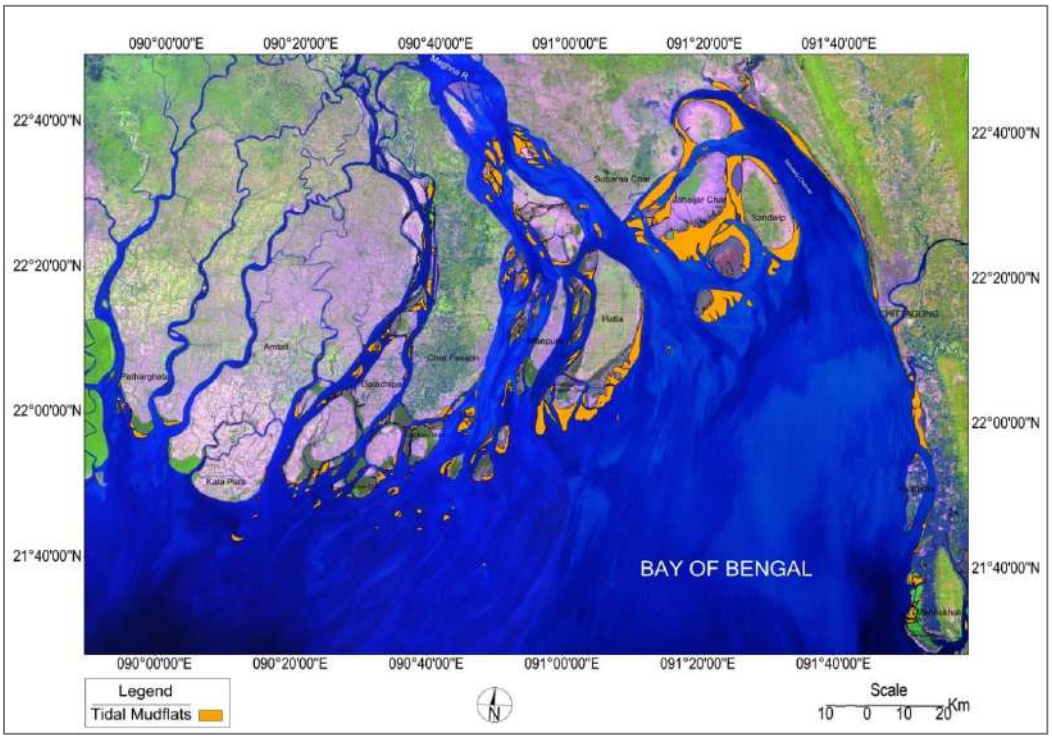


Figure 37. Tidal mudflat map in the coastal region of Bangladesh

Tidal mudflats in the coastal regions of Bangladesh have been prepared using Landsat-8 and Sentinel-2 satellite images (Figure 1). The mudflat map was validated on the ground. It is revealed from the map that the total amount of land of the mudflats is more than 900 square kilometer. The formation and the dynamics of tidal mudflats in the coastal region of Bangladesh have been discussed in the seminar. The prepared mudflat map overlaid on the satellite images of 2022 has also been demonstrated.

The tidal mudflat map will play an important role for the planning and the implementation of coastal development. It will also be helpful for mangrove afforestation, land reclamation from the sea, implementation of Delta Plan 2100 etc.

High official of the Ministry of defence along with the representative of different organizations such as Bangladesh Forest Department, Bangladesh Coast Guard, Bangladesh Navy, Department of Disaster Management and the teachers of different universities were present at the seminar.

Photograph 43. Seminar on Mapping Tidal Mudflats in the Coastal Regions of Bangladesh

7.3.3 Workshop on Establishment of Integrated Research Center at Savar

A workshop was organized on 22th may 2022 by Bangladesh Space Research and Remote Sensing Organization (SPARRSO) based on Establishment of Integrated Research Center for Bangladesh Space Research and Remote Sensing Organization (SPARRSO), Bangladesh Meteorological Department (BMD), and Survey of Bangladesh (SOB). Mr. Golam Md Hasibul Alam, Senior Secretary, Ministry of Defence was the chief guest of the workshop. The group activity was the important part of the workshop. To achieve the goal of the workshop and to reach the finding of the two specific objectives of the event, all participants were divided into 04 (four) groups. Each group has worked on a topic (thematic area or concept) to achieve findings against two specific objectives. From 04 group discussions, it found that there are many common research areas such as agriculture, disaster risk reduction, data sharing, location specific AWS, sea level rise, climate change, early warning for storm surge inundation, flood and flash flood, health sector, energy sector, urban drainage management, urban heat island, development of sector specific climate service, potential fishing zone identification, in where BMD, SOB and SPARRSO can work together. Most of the groups mentioned that the implementation of the collaboration research among SPARRSO, BMD and SOB, data sharing is very essential so these three organizations can establish a Data sharing platform. They suggested that SOB can share aerial photo, topographic map, geodetic control data, contour map, thematic map, GNSS CORS data, DEM, DSM, DTM data with other two organizations. Similarly, BMD can share meteorological surface data, upper air data, radar data, seismic data & ship observation data, while SPARRSO can share flood data, river network data, agricultural data, forest data, coastline & island data, land use land cover data, mudflat data, wetland data & water quality data with other two partners. These three organizations can also share their existing technology & equipment as well. SoB can share aerial triangulation workstation, photogrammetric workstation, stereo plotting software, DEM and contour map preparation related hardware and software, RTK and static survey equipment, optical drone, LIDAR drone and UAV and LIDAR data processing software and BMD can share observation network (stations), data Processing system and SPARRSO can share satellite data server & satellite data processing software training in this platform. The groups suggested that to implement the concepts for the research hub, it is essential to set up a new central hub or server, create a national data center and establish an effective NSDI network.

The main challenges and difficulties to implement these activities for the Research Hub are lack of coordination among three organizations, lack of a proper framework for the coordination and collaboration, common areas identification and target specific planning & implementation and institutional capacity building & skilled human resources.

And in order to overcome these difficulties they have to ensure common projection system, data management module, provision to set up a base map, institutional framework, availability of technological facilities, policy & fund, high configuration computer & internet facilities, instrument maintenance & calibration, recruiting and so on.

Photograph 44. Workshop on Establishment of Integrated Research Center Inaugurated by Mr. Golam Md Hasibul Alam, Senior Secretary, Ministry of Defence

Photograph 44-45. Participants on Workshop on Establishment of Integrated Research Center

7.4 Integrity Award in the Financial Year of 2021-2022

Mr. Rubel Kanti Dey, Information Officer, Mr. Md. Mostufa Kamal, Accountant and Mr. Md. Zakirul Islam, Library attendant of SPARRSO have been awarded Integrity Award in the Financial Year of 2021-2022. They have received one-month basic salary and a certificate which was handed over by SPARRSO Chairman.

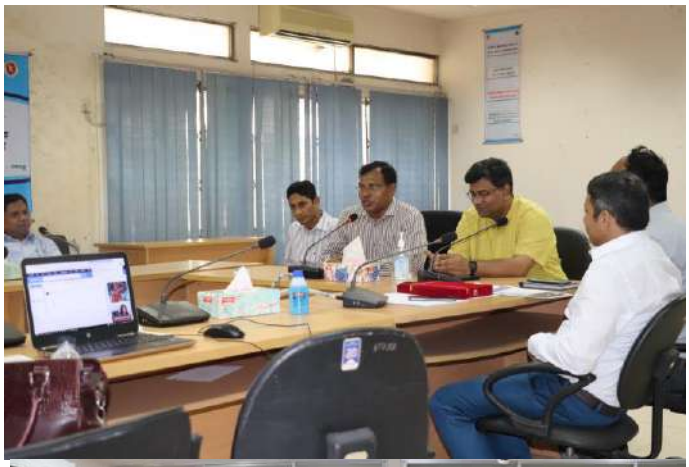
7.5 Visitors to SPARRSO

During the ongoing pandemic situation, the number of visitors was restricted by maintaining governmental procedure. However, a limited number of visitors came to visit to SPARRSO by maintaining proper hygienic measures and COVID distance protocol. The list of following officers from different organizations visited SPARRSO during reporting period are below:

Sl. No.	Organizations	Number of Visitors	Date
01	Fighter Controller Unit of BAF	07	28 February 2022
02	No 70 Basic ADWC Course, FCTU BAF	07	23 May 2022
03	"Eighteenth Training Course on Oceanography: Principles and Applications of NOAMI"	35	29 May 2022
04	Bangladesh Institute of Maritime Research and Development (BIMRAD)	05	02 June 2022
05	Bangabandhu Sheikh Mujibur Rahman Aviation and Aerospace University	15	07 June 2022
06	Ministry of Defence and a2i	10	18 June 2022
07	Institute of Forestry and Environmental Science, University of Chittagong	36	28 June 2022
08	Ministry of Environment, Forest and Climate Change	10	29 June 2022

Photograph 46-47. SPARRSO Visit by the officers of Fighter Controller Unit of BAF

Photograph 48-49. SPARRSO Visit by Bangabandhu Sheikh Mujibur Rahman Aviation and



Photograph 50-53. "Eighteenth Training Course on Oceanography: Principles and Applications of NOAMI" team Visited SPARRSO

Photograph 54. Bangladesh Institute of Maritime Research and Development (BIMRAD) visited SPARRSO on 02 June 2022

Photograph 55-56. Students and Teachers of University of Chittagong visited SPARRSO on 28

Photograph 57-58. Delegates from Ministry of Environment, Forest and Climate Change Visited SPARRSO on 29 June 2022.

Photograph 59. Delegates from Ministry of Defence and a2i along with Defence Secretary Visited SPARRSO on 18th June 2022

7.7 Local Participation

7.7.1 Participation at the "Career Festival & Research Fair 2022"

Career Festival & Research Fair 2022 was held on 17 May 2022 at Teacher-Student Center (TSC), University of Dhaka (DU) which was organized by the Faculty of Earth and Environmental Sciences (FEES). Bangladesh Space Research and Remote Sensing Organization (SPARRSO) participated in the event. A team from SPARRSO led by Chief Scientific Officer Dr. Md. Mahmudur Rahman attended in the program. The team described the participants about the ongoing research works as well as the contribution of SPARRSO at the national level. Students from the faculty of Earth and Environmental Science were very keen to know about the research and job opportunity at SPARRSO. This program has also opened some opportunity to conduct collaborative research work between DU and SPARRSO.

Photographs 60-61. SPARRSO Stall at Career Festival & Research Fair 2022 organized by the University of Dhaka

CHAPTER 8

PUBLICATIONS

The scientists and engineers of SPARRSO made some publications both in national and international journals on remote sensing and GIS technology-based research work of SPARRSO. They also presented papers on specific topics in national and international seminars and symposia. Some of them are mentioned below:

Ahammad, Tofayel. 2022. "Effect of Chlorophyll Content & Solar Irradiance on Spectral Reflectance of Vegetation Canopies Acquired by Spectro-Radiometer." *International Journal of Environment and Geoinformatics* 9 (1): 170-178. doi:10.30897/ijegeo.958100.

Ali, Md. Shahjahan, and Md. Abdus Salam. 2021. "Assessment of Land Use and Land Cover Changes in Savar Upazila under Dhaka District in Bangladesh: A Remote Sensing (RS) – Geographic Information System (GIS) Approach." *International Journal of Scientific and Research Publications* 11 (12): 399-406. doi:10.29322/IJSRP.11.12.2021.p12057.

Islam, Mohammad Shohidul, SM Injamamul Haque Masum, Md. Aftab Uddin, and Sultana Easmin Siddika. 2022. "Sea State Determination using Power Waveforms of Beidou GEO Satellite." *DEW-DROP* (Bangladesh Meteorological Department) 8 (1): 122-127.

Sultana, Nasrin, Md. Abdus Salam, Tofayel Ahammad, and S. M. Abdullah Zahir. 2022. "Remote Sensing Based Assessment of Crop Water Requirement of Boro Rice Using SEBAL Model." *DEW-DROP* (Bangladesh Meteorological Department) 8 (1).

Tazneen, Farhana, A. Z. Md. Zahedul Islam, Md. Abdus Salam, Mohammad Rajib, Md. Masud Karim, and Md. Fahad Hossain. 2022. "Analysis of Heavy Minerals Existence using Multispectral Satellite Imagery in Teknaf Upazila of Bangladesh." *DEW-DROP* (Bangladesh Meteorological Department) 8 (1).

CHAPTER 9

OBSERVATION OF NATIONAL EVENTS

9.1. Discussion meeting and Doa Mahfil on the 46th Martyrdom Anniversary and National Mourning Day of the Father of the Nation held in SPARRSO

On the occasion of 46th Martyrdom Anniversary and National Mourning Day of Father of the Nation Bangabandhu Sheikh Mujibur Rahman, the Great Architect of Independence; several programs like holding the national flag at half-mast, wearing a black badge, laying a wreath at the portrait of the Father of the Nation, showing a documentary (Oshmapto Mohakabbo) on the life of Bangabandhu, discussion meeting and prayer Mahfil were held at Bangladesh Space Research and Remote Sensing Organization (SPARRSO) on 15 August 2021. These programs and discussion meetings with prayer were held in separate rooms on virtual platforms in compliance with proper hygiene rules while maintaining a safe distance.

Mr. Mizanur Rahman (Additional Secretary to the government), Chairman of SPARRSO, presided over the discussion meeting. The keynote address was delivered by Mr. Md. Zafar Ullah Khan (Joint Secretary to the Government), Member (Application) of SPARRSO. In his article on "Mourning August and Breaking the Dreams of Bengalis", he gave a detailed account of the dreams cherished in the formation of Nation by Bangabandhu. Mr. Mizanur Rahman, Chairman of SPARRSO and President of the discussion meeting, paid deep respect to Bangabandhu Sheikh Mujibur Rahman, Bangamata Sheikh Fazilatunnesa Mujib and other family members on the 46th martyred anniversary of the Father of the Nation Bangabandhu and prayed for the forgiveness of their souls.

Photograph 62-67. Different activities held on the occasion of 46th Martyrdom Anniversary and National Mourning Day of Father of the Nation Bangabandhu Sheikh Mujibur Rahman.

9.2. Discussion meeting and prayer gathering on the occasion of Sheikh Russel Day at SPARRSO

A discussion meeting and prayer mahfil was held on the occasion of Sheikh Russel Day on 18 October 2021 at SPARRSO from 11:00 AM to 1:00 PM. A special documentary film "Sheikh Russel is the name of a dream" produced by the Department of Film and Publications was screened considering the significance of Sheikh Russel's 58th birthday. Mr. M. Mahmud Ali (Joint Secretary to the Government), Member (Technology-1) of SPARRSO was the keynote speaker on the occasion to realize the importance and significance of this national day. In his main article titled "Sheikh Russel is the name of our emotions, feelings and self-confidence", he discussed various informations about Sheikh Russel's birth, up-bringing, childhood and life memories before and after the independence. Mr. Mizanur Rahman (Additional Secretary to the Government), Chairman of SPARRSO, who was the chief guest at the discussion, highlighted the theme of the day "Sheikh Russel Dipta Joylas, Indomitable Confidence" and called on everyone for inculcating the patriotism, compassion and humanity respectively. Besides, he paid deep respect to Father of the Nation Bangabandhu Sheikh Mujibur Rahman and his family members, especially Sheikh Russel on this day. He called upon all to fulfill the responsibilities entrusted to them with honesty and sincerity, so that every child may grow up in affectionate love and develop future leadership qualities. He called upon the officials / employees of SPARRSO to commit them for building a happy, prosperous and developed country with a view to implementing the Vision 2041 announced by the Hon'ble Prime Minister Sheikh Hasina. Mr. Md. Zafar Ullah Khan, Member (Application) (Joint Secretary) along with the Chief Scientific Officers of SPARRSO also participated in the discussion. All the officers / employees working at SPARRSO were present at the discussion meeting. The event was organized in compliance with hygiene and social distance to prevent corona infection.

Photograph 68-71. Discussion Meeting and Doa Mahfil held at SPARRSO of Sheikh Russell Day on 18 October 2021.

9.3 Discussion meeting on the occasion of Victory Day Celebration at SPARRSO.

On the occasion of the great victory day of 16 December 2021, the golden jubilee of independence; a discussion meeting was held at Bangladesh Space Research and Remote Sensing Organization (SPARRSO) from 10:00 AM to 12.30 PM on 15 December 2021. Mr. Md. Nur Hossain Sharifee, Chief Scientific Officer was the keynote speaker in the meeting. He discussed extensively on the article titled "Bangabandhu, Bangladesh and the Golden Jubilee of Independence: The Use of Space Technology in Building a Better Bangladesh". Mr. Mizanur Rahman, Chairman of SPARRSO commemorated the sacrifices made by Father of the Nation Bangabandhu Sheikh Mujibur Rahman and his family and 3 million martyrs of the Liberation War in this meeting. He called upon all to develop the ideals and consciousness of the war of liberation and Bangabandhu from generation to generation by carrying out various programs announced by the government on the occasion of the golden

jubilee of independence. He called upon all to make concerted efforts to build a developed and prosperous Bangladesh through the implementation of Vision 2041of Hon'ble Prime Minister Sheikh Hasina, daughter of Bangabandhu. On this golden jubilee of victory, He also urged all to work hard for building up the SPARRSO as a Center of Excellence. In celebration of the Great Victory Day, SPARRSO has illuminated and displaying informational images on the main gates and display boards, and decorated with banners and festoons bearing the Father of the Nation's message for the last one week. Officers/employees of SPARRSO were present at the discussion. The meeting was organized in accordance with hygiene and social distance to prevent corona infection. After all, the discussion meeting ended with a prayer mahfil seeking the prosperity of the country, all the family members of the father of the nation, the freedom fighters and the souls of the martyrs killed in the war of independence

Photograph 72-75. A Discussion Meeting held at SPARRSO on the occasion of Victory Day 2021.

9.4. SPARRSO pay tribute on the portrait of Bangabandhu and organized discussion meeting on the day of Bangabandhu's Homecoming Day

On the occasion of Father of the Nation Bangabandhu Sheikh Mujibur Rahman's Homecoming Day on 10 January 2022, Bangladesh Space Research and Remote Sensing Organization (SPARRSO) paid homage to Father of the Nation Bangabandhu Sheikh Mujibur Rahman by laying a wreath at the Bangabandhu Corner at SPARRSO with the presence of SPARRSO Chairman Mr. Mizanur Rahman (Additional Secretary to the Government) and other officials at all levels. For remembering the Bangabandhu's return to the newly-independent Bangladesh in 1972, SPARRSO showed video documentary on Bangabandu's biography and hold a discussion meeting from 3:00 PM to 4:30 PM. Chief Scientific Officer Dr. Md. Abdus Salam was the keynote speaker at this the meeting. He discussed extensively on the role of Father of the Nation Bangabandhu Sheikh Mujibur Rahman in shaping and building up the country and nation. Mr. Mizanur Rahman, chairman of the discussion meeting, commemorated the sacrifices made by Father of the Nation Bangabandhu Sheikh Mujibur Rahman and his family and 3 million martyrs of the Liberation War on the occasion of Homecoming Day. All Officers / employees of SPARRSO were present at the discussion. The event was organized in accordance with hygiene and social distance to prevent corona infection. Above all, the discussion meeting ended up with a prayer mahfil seeking the prosperity of the country, Father of the Nation Bangabandhu Sheikh Mujibur Rahman and all members of his family, all freedom fighters and the souls of the martyrs killed in the war of independence.





Photograph 76-80. SPARRSO organized discussion meeting on the day of Bangabandhu' Homecoming Day on 10 January 2022

9.5 SPARRSO pay tribute and organized discussion meeting on the day of International Mother Language Day on 21 February 2022.

In order to celebrate Martyr's Day and International Mother Language Day 2022 various day-long programs were organized by Bangladesh Space Research and Remote Sensing Organization (SPARRSO) on Monday 21st February 2022. The Day's program began with the hoisting of the national flag at half-mast at the time of sunrise. Then at 10:00 am, a discussion meeting on Martyr's Day and International Mother Language Day 2022 was help at the auditorium of SPARRSO. The discussion was presided over by Mr. Md. Zafar Ullah Khan, honorable chairman of SPARRSO. The program began with the recitation of the Holy Quran. SPARRSO members then delivered welcome speeches. Mr. M. Mahmud Ali Member (Technology-1) was the keynote speaker. Also Mohammad Sanaul Huq, Economic adviser (Deputy Secretary), and SPARRSO officials addressed the nation on nation February 21, 1952 in honor of the self-sacrificing language martyr's. Finally, Mr. Md. Zafar Ullah Khan, chairman of SPARRSO, paid tribute to those who gave their live for the Bengali Language, called upon all to protect the dignity of the Bengali Language and concluded the program with prayers.

Photograph 81-84. Discussion Meeting held at SPARRSO on the occasion of Martyr's Day and International Mother Language Day 2022.

9.6. Bangladesh Space Research and Remote Sensing Organization (SPARRSO) celebrated "Historical 7th March" 2022.

A discussion meeting was held at Bangladesh Space Research and Remote Sensing Organization (SPARRSO), from 10:00 AM-1:00 PM to the mark of the day of the historical March 7 speech of the Father of the nation, Bangabandhu Sheikh Mujibur Rahman. Mr. Md. Zafar Ullah Khan, honorable chairman of SPARRSO, inaugurated the day by laying a wreath at the portrait of Bangabandhu. A documentary on the historical 7th March was screened at the conference. Mr. M. Mahmud Ali Member (Technology-1) was the keynote speaker on the occasion. He highlighted the importance and significance of the speech of the Father of the nation, Bangabandhu Sheikh Mujibur Rahman. Also Mohammad Sanaul Huq, Economic adviser (Deputy Secretary), and SPARRSO officials addressed on the historical March 7 speech of the Father of the nation. Mr. Md. Zafar Ullah Khan, chairman of SPARRSO, discussed about Bangabandhu Sheikh Mujibur Rahman, Bangamata Sheikh Fazilatunnesa Mujib, and 3 million martyrs of Liberation war and remembered them with deep respect. He called upon people to develop the ideology of liberation war and Bangabandhu from generation to generation by celebrating various programs announced by the government of the occasion of Golden Jubilee of Independence and Mujib Year. Honorable Prime Minister Sheikh Hasina, daughter of Bangabandhu, called upon all to take concerted efforts to build a developed and prosperous Bangladesh by implementing the Vision 2041.He strived to make SPARRSO a center of excellence in the future. He requested all to work hard accordingly. Adhere to hygiene and social distance to prevent corona infection, the event is organized.

Photograph 85-86. Historical 7th March 2022 Celebration at SPARRSO.

9.7 Discussion Meeting held at SPARRSO on the occasion of Women's Day on 8 March 2022.

A discussion meeting was held at Bangladesh Space Research and Remote Sensing organization (SPARRSO), from 10:00 am-12:00 pm to the mark of the Women's Day on 8 March 2022. Mr. Md. Zafar Ullah Khan, honorable chairman of SPARRSO, was the chief guest of the program. He discussed about the importance of the Women's Day and discussed frankly with all of the female officer and employees of SPARRSO and shared their problems and feelings that they faced in their job sector. Md. Mahmud Ali Member (Technology-1), Mohammad Sanaul Huq, Economic adviser (Deputy Secretary) and also Jalal Uddin Ahmed, Director of SPARRSO was present on the program.


Photograph 87-88. Women's Day celebration at SPARRSO

9.8. Discussion Meeting and Prize Giving Ceremony on the occasion of 102nd birth anniversary and children's day of father of the nation Bangabandhu Sheikh Mujibur Rahaman".

On the occasion of 102nd birth anniversary and children's day of father of the nation Bangabandhu Sheikh Mujibur Rahaman, quiz and poetry recitation competition and meeting discussion and prize distribution and other programs were held at Bangladesh Space Research and Remote Sensing organization (SPARRSO). Mr. Md. Zafar Ullah Khan, honorable chairman of SPARRSO, presided over the program. He inaugurated the program by hoisting the National Flag at sunrise and laying a wreath at the portrait of Bangabandhu at 10:30am. Registration for the quiz and poetry recitation competition begins at 10:30am.Then the invited guests take their seats. The program began with the recitation of the Holy Quran.

SPARRSO members then delivered welcome speeches. A documentary on Bangabandhu's life philosophy and building a prosperous Bangladesh was screened at the discussion. Mr. Md. Zafar Ullah Khan, discussed the importance and significance of 102nd birth anniversary of father of the nation Bangabandhu Sheikh Mujibur Rahaman. He gave a detailed outline of Bangabandhu's contribution to build independent Bangladesh starting from his childhood. He called upon people to develop the ideology of liberation war and Bangabandhu from generation to generation by celebrating various programs announced by the government of the occasion of Golden Jubilee of Independence and Mujib Year. Besides, Prime Minister Sheikh Hasina, daughter of Bangabandhu, called upon all to take concerted efforts to build a developed and prosperous Bangladesh by implementing the Vision 2041.Officers/ employees of SPARRSO were present at the discussion. The program was concluded with prayers for the souls of Father of the Nation, Bangabandhu Sheikh Mujibur Rahaman and the martyred members of his family and distribution of prize among the winners of quiz and recitation competitions.

Photograph 89-91. 102nd Birth Anniversary of father of the nation Bangabandhu Sheikh Mujibur Rahaman and Children's Day celebration at SPARRSO.

9.9. Voluntary blood donation program at SPARRSO on the mark of 25 March "Genocide Day"

On 24 March 2022, a voluntary blood donation program was held at Bangladesh Space Research and Remote Sensing organization (SPARRSO), to mark the day of Mujib and the golden jubilee of independence. Mr. Md. Zafar Ullah Khan, honorable chairman of SPARRSO, inaugurated the program at 11:00am. At the outset of the program, he strongly condemned the infernal massacre carried by the Pakistani aggressors on March 25, 1971. At the same time, he prayed for the forgiveness of the 3 million martyrs of our great liberation war and the souls of the father of the Nation and his family. He said that, on the night of March 25, the barbaric Pakistani forces attacked the innocent Bengalis and carried out the most heinous genocide in history which on the one hand very painful but also glorious. Because, on March 25, through the resistance of the Bengali nation, the greatest Bengali of all time, the great hero of the Bangladesh, the Father of the nation, Bangabandhu Sheikh Mujibur Rahman declared the independence of Bangladesh. The chairman commended the officers/ employee of SPARRSO for this great initiative of voluntary blood donation. He mentions through this noble initiative like blood donation. In the blood donation program conducted with the join support fo Bangladesh Red Crescent Society. SPARRSO highly appreciated this noble initiative.

Photograph 92-93. Blood Donation Program at SPARRSO on 25 March 2022.

9.10. Discussion Meeting on the occasion of "Independence and National Day 2022 on March 26."

A discussion meeting was held at Bangladesh Space Research and Remote Sensing Organization (SPARRSO) from 10:00 am to 1:30pm to mark the great Independence and National Day 2022 on March 26. The discussion was presided over by Mr. Md. Zafar Ullah Khan, honorable chairman of SPARRSO. All the officers/employees of SPARRSO actively participated in the event. On the historic 26th March, the SPARRSO officials/staffs spoke on the significance of the great Independence and National Day. Mr. Zafar Ullah Khan, chairman of SPARRSO, pays deep respect to Bangabandhu Sheikh Mujibur Rahman, of the Father of the nation, his family and 3 million martyrs of Liberation war. He also called upon all officers and employees to their respective duties and maintains the continuity of real independence and development of the country by being punctual. Mohammad Sanaul Huq, Economic Adviser (Deputy Secretary, Jalal Uddin Ahmed, Director, Md. Abdus Salam, Chief Scientific Officer and Honorary Member and many more participated. The event is organized in compliance with hygiene and social norms to prevent corona infection

Photograph 94-95. Discussion Meeting on the occasion of "Independence and National Day 2022 on March 26."

ABBREVIATION AND ACRONYMS

Short Form	Full Form
ADWC	Air Defence Weapon Controller
AI	Artificial Intelligence
AIT	Assembly, Integration and Test
APHRODITE	Asian Precipitation - Highly-Resolved Observational Data Integration Towards Evaluation of Water Resources
APSCO	Asia Pacific Space Cooperation Organization
APP	Annual Procurement Plan
BAF	Bangladesh Air Force
BBS	Bangladesh Bureau of Statistics
BDT	Bangladesh Taka
BE	Blue Economy
BMD	Bangladesh Meteorological Department
BIMRAD	Bangladesh Institute of Maritime Research and Development
BUET	Bangladesh University of Engineering and Technology
DDM	Department of Disaster Management
DoF	Department of Fisheries
DOM	Document Object Model
DSSP	Data Sharing Service Platform
DU	Dhaka University
FEES	Faculty of Earth and Environmental Sciences
ERDAS	Earth Resource Data Analysis System
ERD	Economic Relations Division
EGM	Expert Group Meeting
E-GP	Electronic Government Procurement
EMRD	Energy and Mineral Resources Division
ERTS	Bangladesh Earth Resource Technology Satellite
ESA	European Space Agency
ESCAP	Economic and Social Commission for Asia and the Pacific
EVI	Enhanced Vegetation Index
GEE	Google Earth Engine
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
HE	Harvest End
HTML	HyperText Markup Language
GRD	Ground Range Detected
ICC	Intergovernmental Consultative Committee
ICS	International Conference on Space
ICESCO	Islamic World Educational, Scientific and Cultural Organization
ISBN	International Standard Book Number
ILRS	International Lunar Research Station
LESEC	Lunar Exploration and Space Engineering Center
LMM	Local Maximum & Minimum

LST	Land Surface Temperature
LPS	Low Pressure System
LSWI	Land Surface Water Index
LULC	Land Use and Land Cover
MIT	Massachusetts Institute of Technology
MoD	Ministry of Defence
MoWCA	Ministry of Women and Child Affairs
MODIS	Moderate Resolution Imaging Spectroradiometer
NAT	Network Address Translation
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NDBI	Normalized Difference Built-up Index
NMS	Network Management Station
NOAMI	National Oceanography and Maritime Institute
NSDI	National Spatial Database Infrastructure
OBIA	Object Based Image Analysis
OTM	Open Tendering Method
OOP	Object-Oriented Programming
PHP	Hypertext Preprocessor
PFZ	Potential Fishing Zone
PMP	Project Implementation and Management Plan
PRL	Post Retirement Leave
PPA	Public Procurement Act
PPR	Public Procurement Rules
QCBS	Quality and Cost-Based Selection
RFQ	Request for Quotation
RS	Remote Sensing
RRSC	Regional Remote Sensing Centre
SA	Settlement Area
SAR	Synthetic Aperture Radar
SARC	Space and Atmospheric Research Centre
SAARC	South Asian Association for Regional Cooperation
SoB	Survey of Bangladesh
SDG	Sustainable Development Goal
SOCC	Satellite Operations Command Centre
SPARRSO	Bangladesh Space Research and Remote Sensing Organization
S2I	Sentinel-2 indexes
SST	Sea Surface Temperature
TM	Thematic Mapper
TS	Transplant Start
TSC	Teacher-Student Center
TTC	Telemetry, Tracking & Command
VPN	Virtual Private Network

****The End*****