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Anthropogenic Delta in a Floodplain: GIS and Remote Sensing Approach

Bibi Hafsa[1]

Abstract: Delta is the Earth's surface most recently formed landform. The deltaic plains of Bangladesh are likewise well known, but the idea of an anthropogenic delta is new. An infrequent Anthropogenic delta emerged in the middle of the nation. According to the study, an antropogenic delta developed in the Markas Beel area of the Kaliakair Upazila in the Gazipur District. Gazipur district is one of the most prominent industrial districts in Bangladesh where waste management practice is not doing in an effective way.

Industrial wastewaters flow into the *khal* which are deposited in the Markas Beel, where they continue over time and form a delta. As the deposits are not natural, rather they are products of industrial manufactures and processes, it can be regarded as an anthropogenic formation. Total area of the delta is approximately 70 acres (2022). The morphology of *Markas* delta is waste dominated delta and bird's foot type delta whose shape is elongated. Both primary and secondary data have been used in the study. Data was gathered by observation and Google Earth Pro; timeseries data was obtained from Google Earth Pro. QGIS software was used to process the data using Georeferencing and Digitization procedures.

Key Words: Anthropogenic delta, Industrial wastewater, Birds foot type delta, Google Earth Pro.

1. Introduction

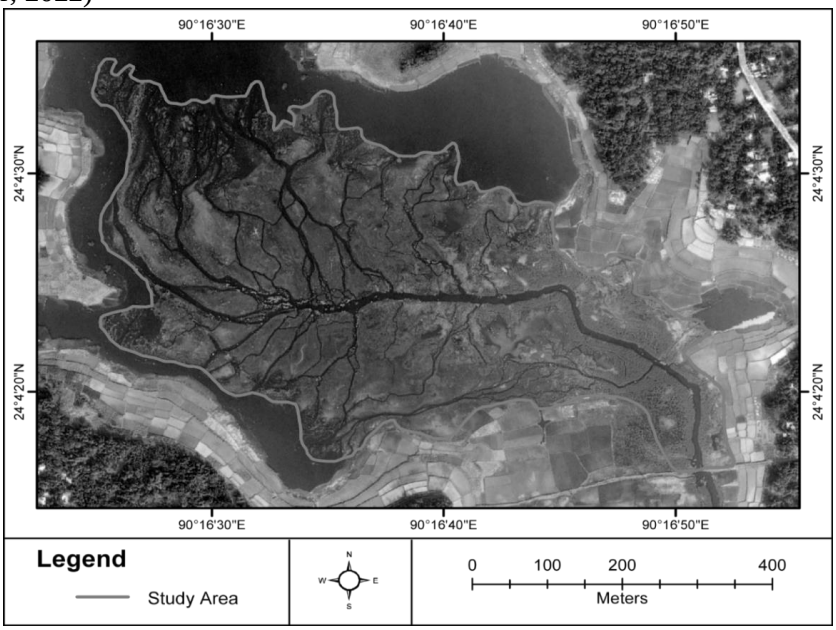
Delta is one of the major depositional plainland in Bangladesh. Generally, a delta is formed by sediment deposition carried by the river. Most often the sediment deposition occurs at the boundary of the river mouth and a standing water body (most cases an ocean and sometimes a lake (Seybold et al. 2007). According to Coleman (1975), morphology of a delta regulates by "the discharge regime, the sediment load of the river, and the relative magnitudes of tides, waves, and currents". Besides, water depth at the delta forming site and grain size of sediment plays a significant role in shaping a delta and its depositional patterns.

In this study, a delta formed inside the Markas Beel at the mouth of a river that discharged into the Beel. The river flow is dominated by the huge influx of industrial effluent. The sediment source of the river is agricultural land along the bank of the river. The flow regime of the river is highly dominated by anthropogenic activity. The Markas Beel supports the requirement of a standing water body. The Markas Beel is situated in Kaliakair Upazila under the Gazipur district. Gazipur district in Bangladesh is known as

[1] Associate professor, Department of Geography and Environment, Jahangirnagar university, Savar, Dhaka, Bangladesh. Email: hafsa@geography.juniv.edu.bd

an industrial zone where allocated 1773 industries in this district and 153 industries are allocated in Kaliakair Upazila of this district. The industrial segment like readymade garment sectors, pharmaceutical, polymer and plastic industries have been boomed in recent years. The rapid expansion of the industry has not followed the proper guideline for industrial effluent (Azad. 2018). The fast growth of industrialization disquiets the natural environment through improper disposal of industrial effluents and other toxic wastes which are the major environmental issues (Islam,2012). The study has been conducted based on primary and secondary survey, secondary survey like Google Earth pro is prominent to detect the boundary line of Delta over the years. QGIS 3.16.14 software has been used for georeferencing, digitization and mapping purpose. The main goal of this study is to conceptualize the anthropogenic delta and delineate the boundary line over the years. Figure 1 below represents a Googler Earth view of the study area at the mouth of the Markas Beel.

Figure 1: Anthropogenic Delta Formed at the mouth of Markas Beel (Source: Compiled by Author, 2022)



2. Aim and Objectives

The broad aim of this research work is to explore the anthropogenic delta. However, to achieve this broad aim, two specific objectives have been taken as below:

i. To conceptualize the anthropogenic delta
ii. To trace and delineate the anthropogenic delta using Geographic Information System (GIS) and Remote Sensing (RS) techniques.

3. Study Area

Markas Beel at Kaliakair Upazila of Gazipur district was selected as the study area. This water body was famous for its enriched biodiversity. But in the last decade it is being used as a waste dump area for a nearby industrial zone and as a result it started to demise

its biodiversity. Nowadays, one position of this water body is fully exploited with these waste materials.

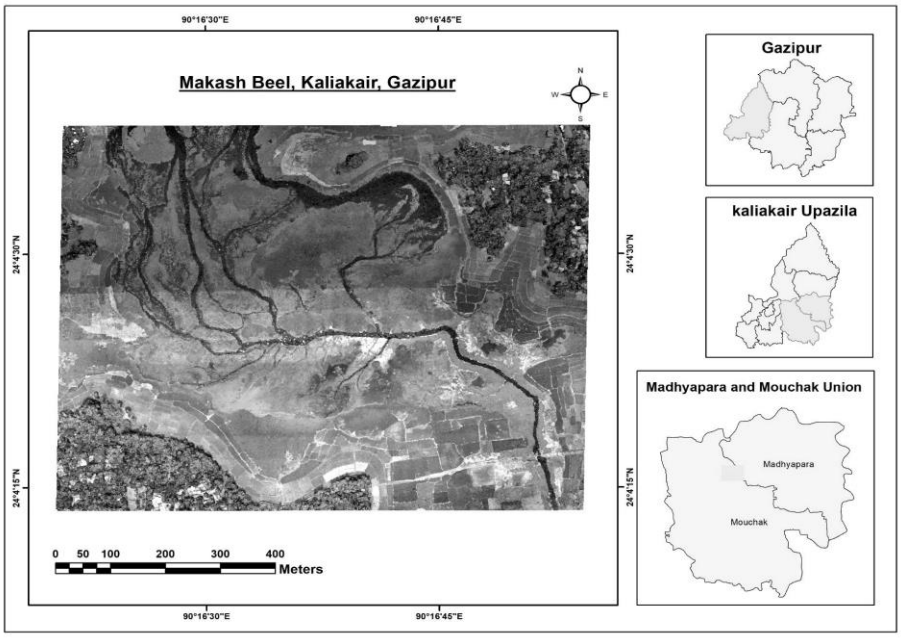


Figure 2: Location of Study area (Source: Compiled by Author, 2022)

The longitude of the study area is 90°16'13.30''E to 90°17'03.39''E and the latitude of the study area is 24°04'07.45''N to 24°04'45.46''N. This area is situated on the boundary of two unions, name- *Madhyapara* and *Mouchak* in Kaliakair Upazila of Gazipur district (Figure2).

4. Methodology

Primary data is the key to this research work. Satellite image from the Google Earth Imagery used to identify the physical boundary of the anthropogenic delta. Primary field visit also conducted to investigate the formation process of the delta. Figure 3 reflects the methodological chart of this research.

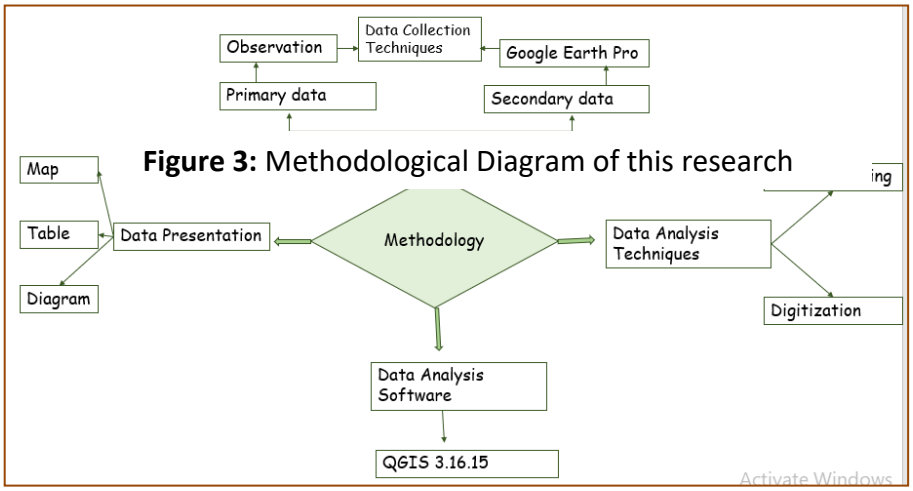


Figure 3: Methodological Diagram of this research

In present study, delta area delineation is based on the use of remote sensing and GIS technique. Data collected from field survey through observation and Google Earth images worked as secondary data. Google Earth Pro is a useful software that combines various satellite image and information and present it as 3D globe. This software is used to collect image data and it is also used for image interpretation and choosing the appropriate area for the study. QGIS 3.16.15 is a GIS software used to make maps and spatial analysis for this study. Georeferencing and Digitization of the study are done using the QGIS software. Geo-referencing is important GIS techniques to make aerial and satellite imagery, usually raster images, effective for mapping (Fig 4). Digitization is the process of transferring geographic data into digital form. During this process, spatial data on images are traced as point, line or polygon. This technique is useful tool in GIS for displaying geographic data, produce map layer, store data etc. Remote sensing and Geographic Information Systems (GIS) have been familiarity as an effective tool for drainage study (Mahala, A., 2020). For the creating of several theme layers for time-series, remote sensing is used as a dependable source. The study has been used Google Earth to for interpret time-series data (2012-2022) of the study area. The study has been inserted below step-by-step methodological process. Figure 4 represents the Georeferencing and Digitization process of this study shows in Figure 5.

Figure 4: Georeferencing of the Study area

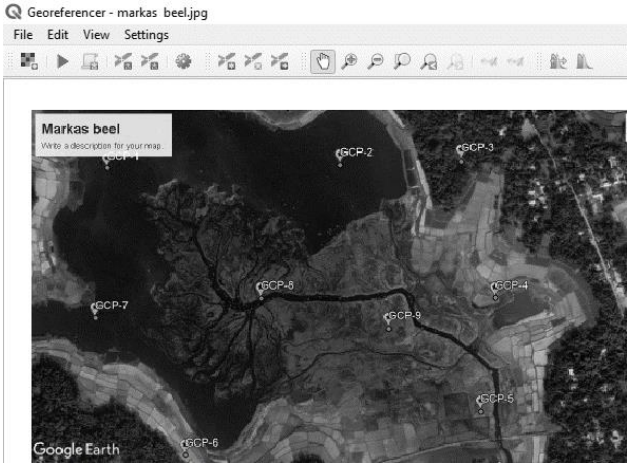
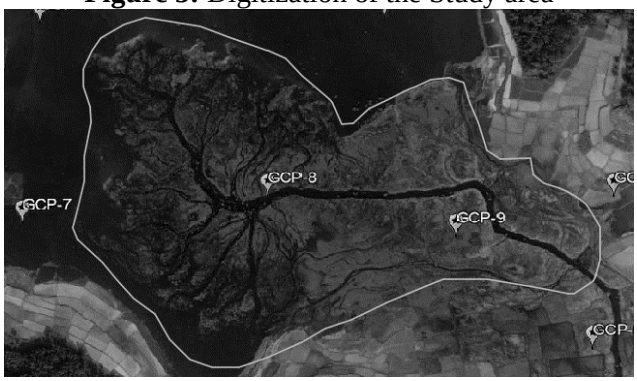


Figure 5: Digitization of the Study area



5. Concept of Anthropogenic Delta

Gazipur is an industrial zone in Bangladesh. Several industries are run throughout the district. These industries generate a huge number of wastes. Though they have waste management system, they are not properly followed. As a result, a huge amount of waste is deposited openly into surrounding waterbodies (Khandker and Hossain, 2017). Markas *beel* is a large waterbody located in Kaliakair of Gazipur with great history of its own. But in recent years this waterbody is getting filled with industrial wastes coming from the industries on its bank.

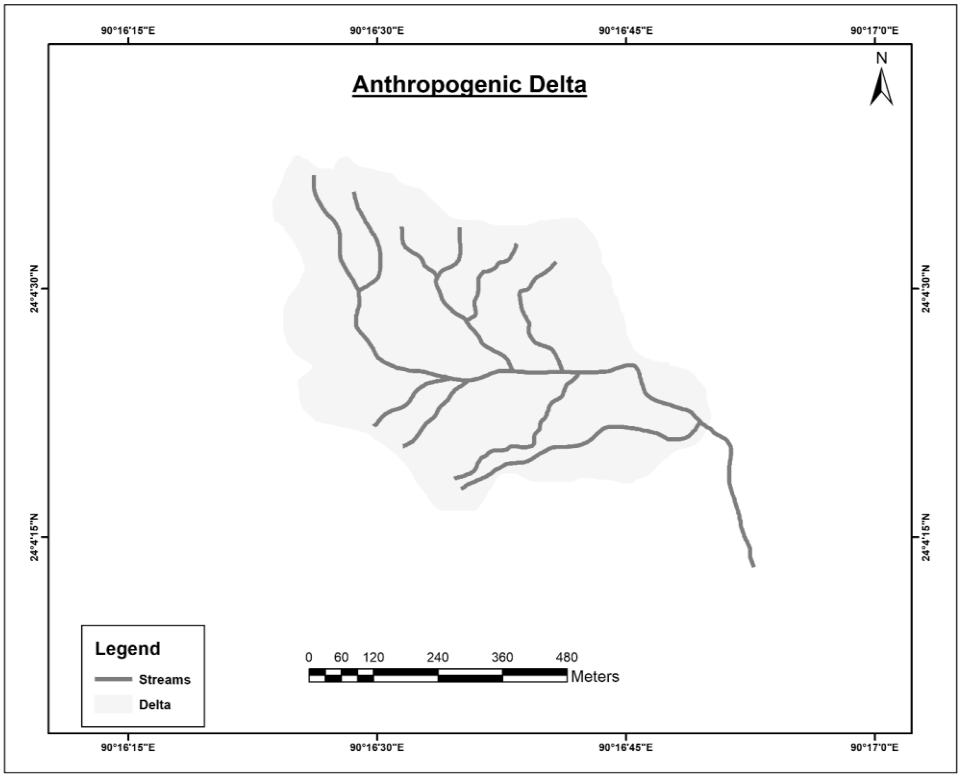
The wastewater is continuously deposited into the Beel through different channels and drainage. The waste deposits are making layers and spreading at an alarming rate. This continuous deposition of wastes is creats a delta formation. As the deposits are not natural, rather they are products of industrial manufactures and processes, it can be regarded as an anthropogenic formation.

Unlike other Delta landforms affected by water current, a delta is not mainly created because of the deposition of the land surface caused by the force of wind and water. As the river channel flows over the ground and contacts soil, it carries with it sediments like gravel, sand, silt and clay (Bralower, 2005). When a river channel encounters another body of water, it loses it speed and deposits such sediments onto a flat area. Markas beel is a still waterbody. Various channels and drainages are cut by the industries exposed to the waterbody. Wastes flow through these channels and fall into the mouth of the waterbody. Then waterflow carries these wastes as sediments and flows through it. Markas beel flows towards Turag River. It deposits the sediments on its course. This is a continuous process. Sediments are continuously deposited and this process has been occurring almost for 15 years. This continuous deposition is forms layers of waste sediments and gradually its expanding and deepening.

Typically, a delta becomes a main channel that divides substantial land masses into various streams called distributaries. These distributaries appear like a maze of water channels. From the Figure 6 below it is evident that the landform is working as a main body creating subsidiary streams while being the divider. So, this formation can be recognized as a delta.

The Markas Delta formation started in 2012 which is noticeable from the Google Earth Software. The extension of Markas Delta formation is increase year by year which visible from Google Earth. The study digitize the Anthropogenic delta area, streams from Google Earth and show it in Figure 6 (below).

Figure 6: Area of Anthropogenic delta of study area (Source: Compiled by Author, 2022)



Direct or indirect human interventions affect processes that shape Earth's surface on a large scale, e.g., sedimentation, erosion and soil formation. This sedimentation in the study area is not natural, rather its completely human induced. The wastes are produced through human activities like industrial manufacturing and processes. Apparently, this delta is formed with sediments created through human activities. Industrial wastes are products of human activities. So, this delta can be conceptualized as an anthropogenic delta which is human induced.

The landform of Anthropogenic Delta is technically different from the Delta use normally in a sense that Delta normally develops with natural components driven by a natural force. But here in this study, a delta which is developed driven by a natural force but not with natural components. It is totally built with human induced waste materials from nearby industrial areas. The area of the anthropogenic delta is about 75 acres and the total area of the Markas Beel is about 450 acres.

6. Formation of Anthropogenic Delta

Markas Beel is a long-standing waterbody. Waste deposition did not start long ago. From Google Earth Image it is evident that this delta formation has been occurring for almost 12 years. Previous image data are collected to determine the progression of the delta. The formation of delta progression annual rate of 6 acre. But the delta progressed mostly in last 5 years (2018-2022). Almost 67% formation progressed in these years. Table 2

shows the pattern of anthropogenic delta and figure 7 also represent the area of anthropogenic delta based on acre and percentage. Area of delta from Google Earth and Drone image calculated and presented in figure 8-figure 12:

Table 2: Area of Anthropogenic Delta (2012-2022) (Source: Compiled by Author, 2022)

Year	Area of Delta (Acre)
2012	16.5
2015	17
2018	23
2021	50
2022	70

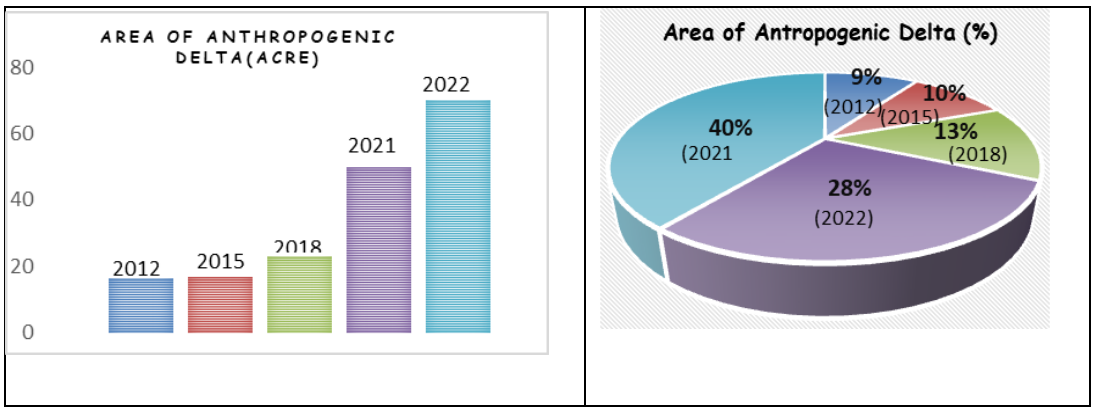


Figure 7: Area of Anthropogenic Delta (Acre and %) (Source: Compiled by Author, 2022)

Figure 8: Delta in Markas Beel in 2012 (Source: Google Earth, 2012)

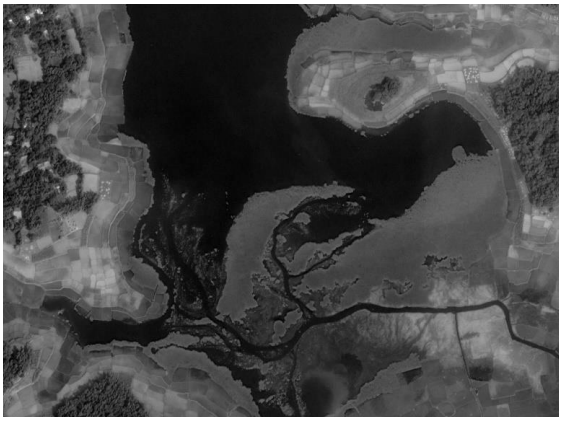


Figure 9: Delta in Markas Beel in 2015 (Source: Google Earth, 2015)

Figure 10: Delta in Markas Beel in 2018 (Source: Google Earth, 2018)

Figure 11: Delta in Markas Beel in 2021 (Source: Google Earth, 2021)

Figure 12: Delta in Markas Beel in 2022 (Source: Google Earth, 2022)

7. Morphology of Delta

The study explored two morphological elements appear in this anthropogenic delta such as; Delta plain and Delta front. This anthropogenic delta is sediment input based and shape elongated which looks like bird-foot delta. Sediment input of Markas Delta. Globally, it is widely accepted that there are three morphologies of deltas that reflect the relative influence of wave energy, tidal energy and sediment input (Hori and Saito, 2003). Deltas that are primarily the result of high rates of sediment input tend to be elongated because of their rapid outbuilding associated with high rates of deposition into the receiving basin. These three types represent one apex of the plot and all deltas fall somewhere on this plot.

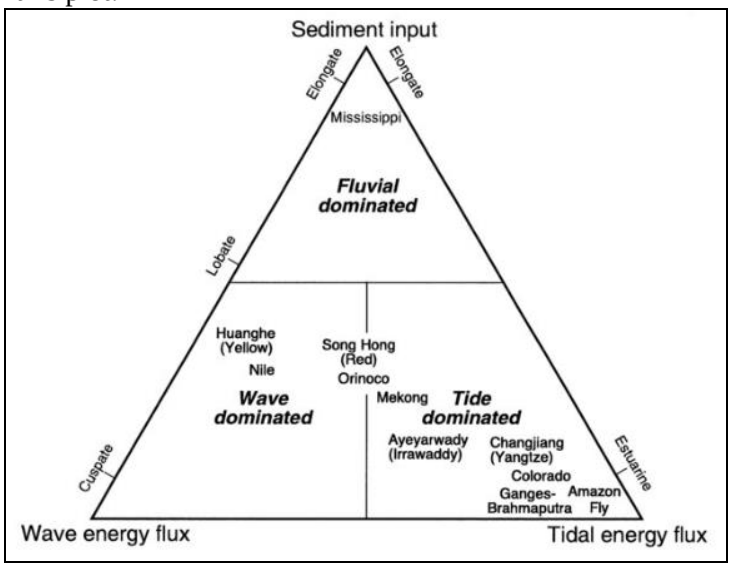


Figure 13: Delta types based on formation (Source: Hori and Saito,2013)

The morphology of anthropogenic (Markas) delta shown in figure 14 where shows it is elongated shape, birds foot type delta and sediment dominated (wastewater) delta. Figure

13 reflects the delta type, delta shape and dominating formation geomorphic agent. Morphologically, a delta has three parts: delta plain, delta front and prodelta (Hori and Saito, 2013). The research unearths the anthropogenic delta shape, type, dominating geomorphic agent and also explore the morphologically two parts of delta; delta plain, delta front visible in this study.

Name: Anthropogenic Markas delta
Delta type: Birds foot delta
Input: sediment(wastewater) dominated
Shape: Elongated

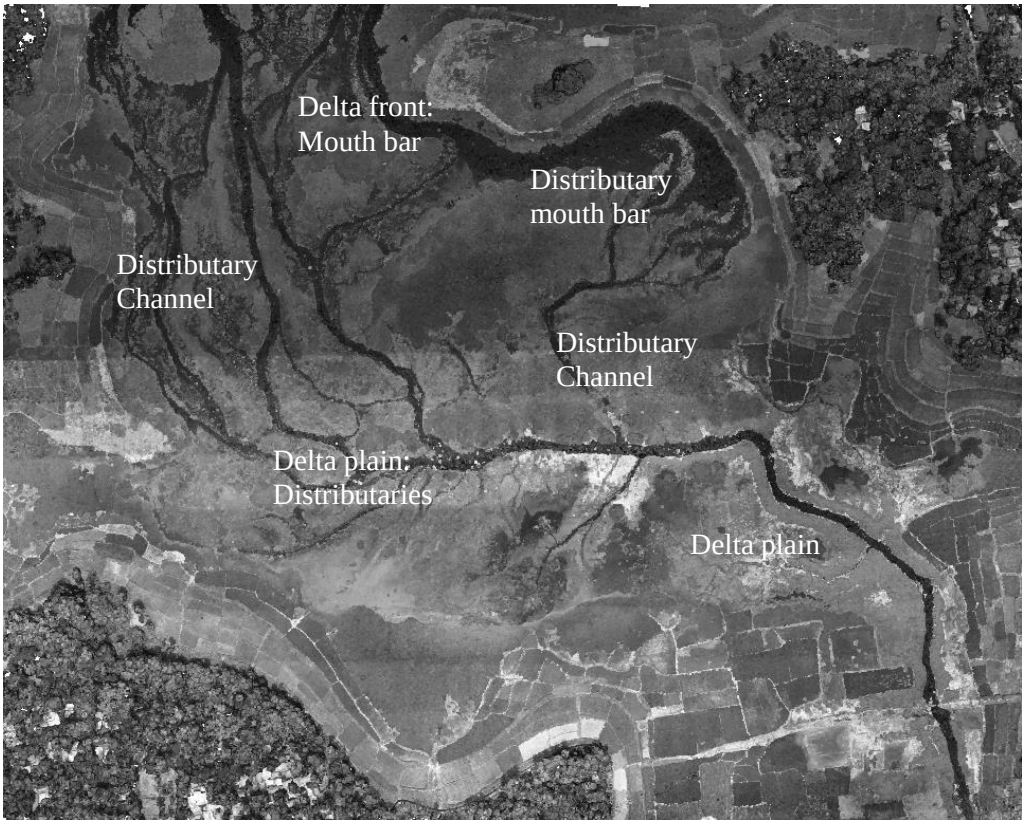


Figure 14: Morphology of Anthropogenic Markas delta (Source: Compiled by author, 2022)

8. Findings

The findings of the research are noted below:

1. A number of industrial wastes is found in the study area including plastic, polythene, garments' remaining, various chemicals etc.
2. Deposits of a delta is not necessarily natural. The industrial waste sediments dominated human produced anthropogenic materials.

3. The progression rate of is 6 acres per year.
4. The landform is a recently formed delta that has been progressing for around 12 years.
5. Total area of the delta is approximately 70 acres (2022)
6. In recent years (2018-2022) progression rate of the delta is approximately 67%.
7. Morphologically, two types of elements observed in study area; delta plain and delta front.
8. The Markas delta sediment dominated delta and birds foot type delta which shape elongated.
9. The research revealed that formation of anthropogenic delta is possible.

9. Conclusion

Although Delta is very common in this part of the world, and Bangladesh have a share of about 60% of the Bengal delta (shared with the West Bengal of India), but anthropogenic delta at the center of the floodplain is very much unusual in Bangladesh. This research identifies the morphological characteristics of this special type of anthropogenic Markas delta. The study revealed how anthropogenic delta formed in the center of flood plain and forming progression. The study also unearthed that anthropogenic delta formation is possible.

References

Bhattacharya JP, Walker RG Walker RG , James N (1992) in Facies Models, Response to Sea-Level Change, eds Walker RG , James N (St. Johns, Geol Assoc Canada), pp 157–177.

Bralower, T. (team leader, 2005), Delta morphologies and driving processes. https://www.e-education.psu.edu/earth107/node/1023.

Coleman J (1975) Deltas: Processes of Deposition and Models for Exploration (Continuing Education, Champaign, IL).

Hori, K. and Saito, Y., (2003), Morphology and Sediments of Large River Deltas, Journal of Geography 112(3) 337-3592003

https://www.researchgate.net/publication/237497050_Morphology_and_Sediments_of_Large_River_Deltas/figures?lo=1

Hudson, P.F., (2005), Deltas, Department of Geography and the Environment, University of Texas at Austin, Austin, Texas, U.S.A. https://www.researchgate.net/publication/275640337_Deltas/figures?lo=1

Islam, M.S.et.all., (Nov. - Dec. 2012), Investigation of soil quality and heavy metal concentrations from a waste dumping site of Konabari industrial area at Gazipur in Bangladesh, IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) ISSN: 2319-2402, ISBN: 2319-2399. Volume 2, Issue 1), PP 01-07 www.Iosrjournals.Org www.iosrjournals.org

https://www.researchgate.net/publication/325115654_Investigation_of_soil_quality_and_heavy_metal_concentrations_from_a_waste_dumping_site_of_Konabari_industrial_area_at_Gazipur_in_Bangladesh/figures?lo=1

Khandker, P.S. and Hossain, L., (21 December 2017), Solid Waste: Emerging Threat to Gazipur City Dwellers**,** The daily Sun**.**

https://www.daily-sun.com/printversion/details/276596/Solid-Waste:-Emerging-Threatto-Gazipur-City-Dwellers

Nyanga, BC., Obegi, B.N. and Bich, L.T.T., (2021), Antropogenic activities as a source of stress on species diversity in the Mekong River Delta, DOI: 10.5772/intechopen. 101172. https://www.intechopen.com/online-first/79645

Seybold, H., Andrade, J. S. and Herrmann, H. J., (2007). Modeling river delta formation. Proceedings of the National Academy of Sciences Oct 2007, 104 (43) 16804-16809; DOI: 10.1073/pnas.0705265104

Strahler, A. N., 1964, Quantitative geomorphology of basins and channel networks. In: Chow VT (ed) Handbook of applied hydrology. McGraw Hill Book Company, New York.

Magesh, N. S., Chandrasekar, N., Soundranayagam, J. P., (2011), Morphometric evaluation of Papanasam and Manimuthar watersheds, parts of Western Ghats, Tirunelveli district, Tamil Nadu, India: a GIS approach. Environ Earth Sci 64(2):373–381

Vittala, S. S., Govindaiah, S. and Gowda, H. H., (2004), Morphometric analysis of sub-watersheds in the Pavagada area of Tumkur District, South India using remote sensing and GIS techniques. J Ind Soc Remote Sens 32(4):351–362