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Assessment of the Impact of Disaster on Agricultural Production and Its Influence on Overall Development.

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Abstract:

In Bangladesh, disasters have a negative impact on agricultural production, indicating that the anticipated output from the agricultural area cannot be attained. The goal of the research was to evaluate the effects of disaster on agricultural production and how it affects development in general. Using Composite weighted index method, the formal delineation of areas is carried out taking into account six elements, including the effect of the disaster on agricultural land, main and minor crop production, livestock and fisheries, the market, and family income from agriculture. The study is based on the Retail Gravitation Analysis Method, which identifies the impacted region into three classes. Each district's population, geographic area, and influence area are rated in order to determine the upazilas with the highest and lowest degrees of influence. Coastal areas, such as Shatkhira, Khulna, Bagerhat are extremely vulnerable for a variety of reasons. Because they have greater facilities and chances, Upazillas like Shyamnagar, Koyra, Mongla, Dacope and others have a larger influence area. Because there is less agricultural output in these areas, there is less influence from disasters on agriculture. Since these areas provided job, shelter, and other amenities and opportunities, individuals from other regions such as Dighalia, Rupsha, Phultala, Kachua, and others which are already affected by disasters depended on them. These areas are also severely affected areas in terms of how a disaster affects agricultural output. People from these areas move on to other locations as a result of being severely affected by the calamities and because the quality of life there is so wonderful. As a result, the government and local authorities will be able to take the necessary measures to address the zones that fall short of expectations in terms of opportunities and facilities.

Keyword: Functional Regionalization, Formal regionalization, Disaster, Agriculture, Influence area.

Introduction

Flooding is the most common natural catastrophe in Bangladesh. Typically, 30 to 70 percent of the country floods each year. (Litchfield, 2010). One of the world's most disaster-prone countries, Bangladesh nevertheless experiences a handful of cyclonic storms every year, with the nation's funnel-shaped bay compounding their impact. Bangladesh is one of the coastal locations in the world that is most susceptible to cyclones and storm surges, making it a major victim of climate change and the disasters brought on by it. (S. K. Paul, Paul, & Routray, 2012). Disasters like cyclones and storm surges frequently wreak havoc on people living in Bangladesh's coastal districts. (Ahmed et al., 2016). The low-lying coastal area is regularly devastated by floods and coastal erosion. Flooding causes significant losses for the nation's agriculture sector every year. (Azad et al., 2013).

Bangladesh's environment is perfect for cultivating a variety of crops. The average amount of land utilized for agriculture worldwide is about 0.2 acres per person (SHED, 2012). Crop agriculture is perhaps the sector most vulnerable to climate change. The primary source of income for these individuals is climate-sensitive agriculture (Kartiki, 2011).Climate change poses a serious threat to agriculture and food security as well as a quicker drop in total productivity (Yusuf et al., 2009). Although the Gross National Income (GNI) per capita is USD 1785 overall, floods cause a poor rural household to lose an average of TK 2,400.00 (USD 33.8) annually. (Azad et al., 2013).

Thus, formal regionalization is carried out while taking into account a number of elements in order to accurately estimate the influence on the areas. A region is an area, especially a piece of a country or the entire planet, having distinguishable characteristics but ill-defined borders (Oxford). It may be categorized using physical geography, human geography, environmental geography, and other criteria (Bailey, 1996). The method of functional regionalization involves applying population-based criteria to define geographic areas in accordance with their interdependence. Understanding the development and impact of a certain geographic area is important. An administrative entity affects the area right around it, regardless of its limits.

The most important factors are considered in this situation. Actually, there are a lot of factors that might play a role in defining the areas. Formal delineation is done using these parameters to determine which regions are most affected by disasters and which regions generate fewer agricultural goods as a result of disasters. This research will aid in determining the upazilas that each upazila in the Satkhira, Khulna, and Bagerhat districts has influence on, as well as the areas that still lack services and the reasons why. The objectives of the study are to define the effect zones of the regional centers, investigate the variables that influence ranking changes, and pinpoint functional deficiencies. According to Reilly's Gravitational Theory, the research applies the Retail Gravitation Analysis Method to pinpoint the impacted area. The study is then shown with a map created using a Geographic Information System (GIS).

This study will help to identify the zones which districts are more affected in the agricultural sector because of disaster and the influence of this on the overall development. The influence zone and unserved zone will represent the development of an area. The zones which have more

influence zone must have the potentiality and facilities for which people relying on these zones. So the zones which are below standard on the basis of opportunities and facilities will be known and the government and local authorities may take the appropriate actions to resolve this situation.

Literature Review

According to J Glasson, "a formal region is a geographical area which is homogeneous or homogenous in terms of defined factors such as topography, climate, industrial or agricultural-type." A region is a substantial geographic area, a country, or a portion of the surface of the planet that may be recognized by certain natural features, climatic conditions, a distinctive fauna and flora, or other traits. (Biswas et al., 2014).

A region is defined through the process of regionalization. Furthermore, regionalization the act of establishing different locations on Earth's surface in order to analyze the similarities and patterns of occurrences there and to develop precise hypotheses, models, systems, and structures. The area was designated before the industrial revolution to assess the homogeneity of phenomena. The formal region is a geographical area that satisfies particular criteria, such as terrain, climate, and industrial or agricultural kinds. (Chowdhury, 2011).

In order to more effectively execute the subsidiarity idea, regionalization is the process of transferring authority from the national or federal government to the regions. Functional regionalization is the process of defining geographic areas according to demographic and interdependent considerations. It is advantageous to assess the development and influence of a certain geographic area. An administrative unit has an impact on the area it is in, regardless of its boundaries. (Sabrin, et al., 2018).

Bangladesh has some of the most stunning wetlands and rivers on earth. Recent years have seen an increase in the frequency of natural catastrophes, which cause death, property damage, environmental harm, and loss of agricultural income (Living with Risk, 2000). The world’s dominant hotspot for tropical cyclones is Bangladesh. Between 1877 and 1995, Bangladesh was hit by 154 cyclones, including 68 tropical depressions and 43 powerful cyclonic storms. The nation's coast has been hit by five significant cyclones since 1995. (Susmita Dasgupta et al. 2014).

In the Ganges, Brahmaputra, and Meghna regions, protracted periods of heavy rain are frequently the cause of these floods. Fish aquaculture, food grains (such as rice, potato, tomato, and mustard), animal husbandry, poultry, and other agricultural activities are all hampered by flooding. The time of year when flooding often occurs in the study area is from June to August. However, certain areas become drowned when there is a lot of rain and extra water unexpectedly arrives from Northern Bangladesh. When the soil is overly wet, healthy root respiration is challenging since the soil contains less oxygen (Eni et al., 2011).

On the other side, significant flooding results in significant damage to crops and property, destruction of homes and infrastructure, and even fatalities. They also lead to financial instability, put people's lives in danger, as well as the lives of household animals and plants.

Very catastrophic floods, known as "plabon," which are relatively rare, destroy people's livelihoods and devastate the nation's economy (Ahmed et al., 2004).

Research Methodology

A well formatted method is used in order to conduct the research and fulfill the certain objectives. For conducting the research the whole process was divided into two steps. At First formal regionalization of 64 districts of Bangladesh is done in order to find out which district has more impact on the agricultural production because of disaster. And then a cross check is done by calculating the influence area of the selected zones. A general hypothesis is understandable that the zone with more influence area has more economic activities and people are more depended on these zones.

Formal Regionalization

The regions are defined using the composite weighted index approach. As the delineation is based on the impact of the disaster on agricultural productivity, several factors that are directly connected to agriculture are used.

In this study six different factors are taken which are impacted agricultural land by disaster, the loss in major crops production for the effect of disaster, the loss in minor crops production for disaster, the loss in livestock and fisheries, the impact on market, the impact on the income of the household from agriculture. These six variables are divided into subcategories, such as agricultural land, which includes crops as well as ponds and livestock farms; main crops include jute, rice, paddy, potato, and wheat; minor crops include pulses, fruits, and others. Every year, a considerable number of agricultural areas are destroyed by natural calamities. Which land stays unsuitable for grain cultivation or fish production during and after the disaster? As a result, agricultural productivity suffers a significant loss each year.

Here, the composite weighted index method is used. These six factors are unidirectional and directly connected to disaster-induced agricultural output losses. If the composite weighted value is greater, the region is most affected by the disaster; if the composite value is lower, the region is less affected.

Here the equation of composite weighted index method is,

$$W = \frac{LogX1*W1+LogX2*W2+LogX3*W3+LogX4*W4+LogX5*W5+LogX6*W6}{W1+W2+W3+W4+W5+W6}$$

Here, W= Composite weighted index

Here the value of X which means the value of each factor is collected from the BBS and this equation is used to calculate the composite weight. The statistics of composite weight is right below:

Table 1: The Statistics of Composite Weighted index (Source: Author's Preparation,2022)

N	64
Mean	3.49339006155
Std. Error of Mean	.044807481911
Median	3.52124077919[a]
Mode	2.435514963[b]
Std. Deviation	.358459855285
Skewness	-.470
Std. Error of Skewness	.299
Kurtosis	-.008
Std. Error of Kurtosis	.590
Range	1.659366405
Minimum	2.435514963
Maximum	4.094881368

Three ways must be utilized to assess the disaster's influence on agricultural production, categorize it, and analyze the data using the composite index method. These are:

1. Equal Interval Method
2. Arithmetic Method
3. Mean Standard Deviation Method

Various statistical methods are used to assess data dependability. SPSS is used to compute the composite's mean, standard deviation of error, skewness, and kurtosis value.

Table 2 : Data relativity comparison (Source: Author's Preparation,2022)

	Equal Interval Method	Arithmetic Method	Mean Std method
N	64	64	64
Mean	4.21875000000	5.04687500000	3.50000000000
Std. Error of Mean	.159781519359	.124860413133	.119937152855
Median	4.30303030303[a]	5.19607843137[a]	3.53333333333[a]
Mode	5.000000000	5.000000000	4.000000000
Std. Deviation	1.278252154870	.998883305068	.959497222839
Skewness	-.331	-1.477	-.278
Std. Error of Skewness	.299	.299	.299
Kurtosis	-.681	3.288	-.409
Std. Error of Kurtosis	.590	.590	.590

Among the three possibilities, the Mean Standard Deviation technique is chosen for class interval calculation. Because the histogram in this technique is more symmetrical and resembles a regularly distributed distribution.

1. Mean Standard Deviation Method

The composite score's mean and standard deviation are calculated using the mean-standard-deviation technique. The mean is 3.50, while the standard deviation is 0.96. In this procedure, mean is placed in the center and 1SD, 2SD…., Take the highest number and deduct 1SD, 2SD…., etc. to get the lowest value. To identify the class, the mean and two standard deviations are computed. The diagram shows the class and histogram. The skewness in this case is -0.278, indicating that the distribution is essentially symmetric. Because it is between -0.5 and 0.5. In this case, the kurtosis is -0.409. It asserts that data sets with low kurtosis have narrow tails or fewer outliers. When the kurtosis value is negative, the tails of a distribution are lighter than those of a normal distribution.

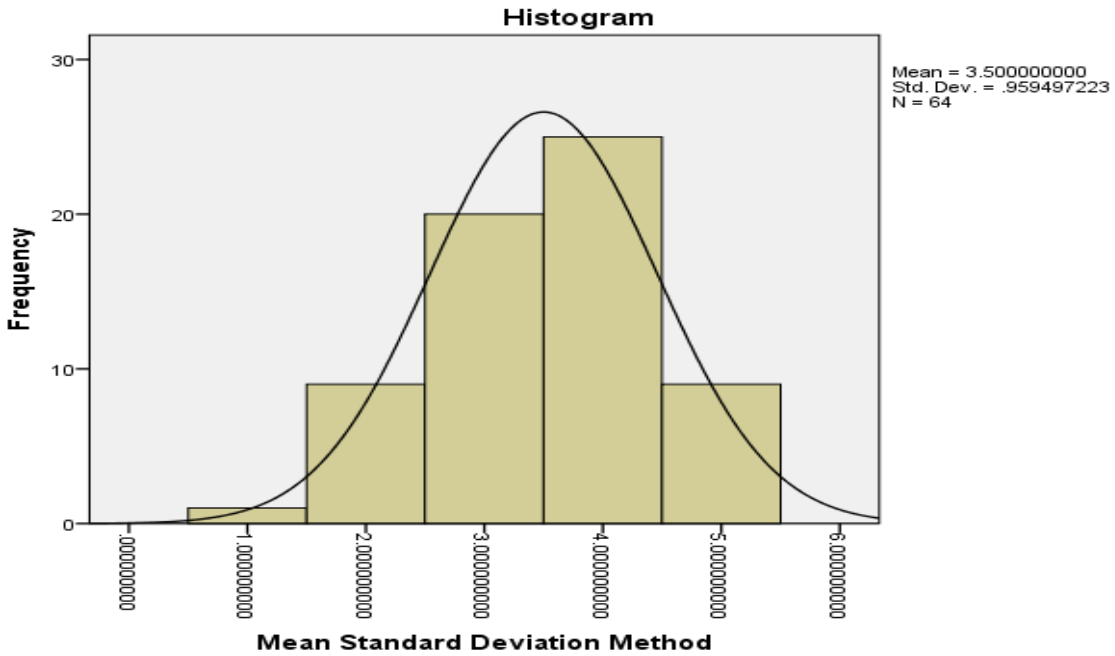

Figure 1 : Mean Standard Deviation (Source: Author's Preparation,2022)

2. Region Delineation

Six variables concerning the impact of catastrophes on agricultural productivity are considered for formal regionalization. To make the map more clearly to everyone, these factors are divided into three categories: highly influenced regions, moderately impacted regions, and low impacted regions.

Table 3: Formal regionalization based on the impact of disaster on agriculture productivity for Bangladesh (Source: Author's Preparation,2022)

Class Interval	Impact	Frequency	%	Name of districts
2.435515 – 3.260389	Low	20	31.25	Panchagarh, Thakurgaon, Chapainababganj, Natore, Meherpur, Kushtia, Rajbari,Narail, Narsingdi, Gazipur, Brahmanbaria, Narayanganj, Munshiganj, Cumilla, Chandpur, Lakshmipur, Feni, Khagrachhari, Rangamati, Bandarban.
3.260390 – 3.689579	Moderate	23	35.93	Nilphamari,Lalmonirhat,Rangpur,Joypurhat, Sherpur, Mymensingh, Kishoreganj, Habiganj,Moulvibazar, Sylhet, Pabna, Manikganj, Dhaka, Magura, Faridpur, Jashore,Gopalganj, Madaripur, Shariatpur, Jhalokati, Noakhali, Chattogram, Coxs bazar.
3.689580 – 4.094881	High	21	32.81	Dinajpur, Kurigram, Gaibandha, Naogaon, Bogura, Jamalpur, Rajshahi, Sirajganj, Tangail, Netrokona, Sunamganj, Chuadanga, Jhenaidah, Satkhira, Khulna, Bagerhat, Pirojpur, Barishal, Barguna, Patuakhali, Bhola.

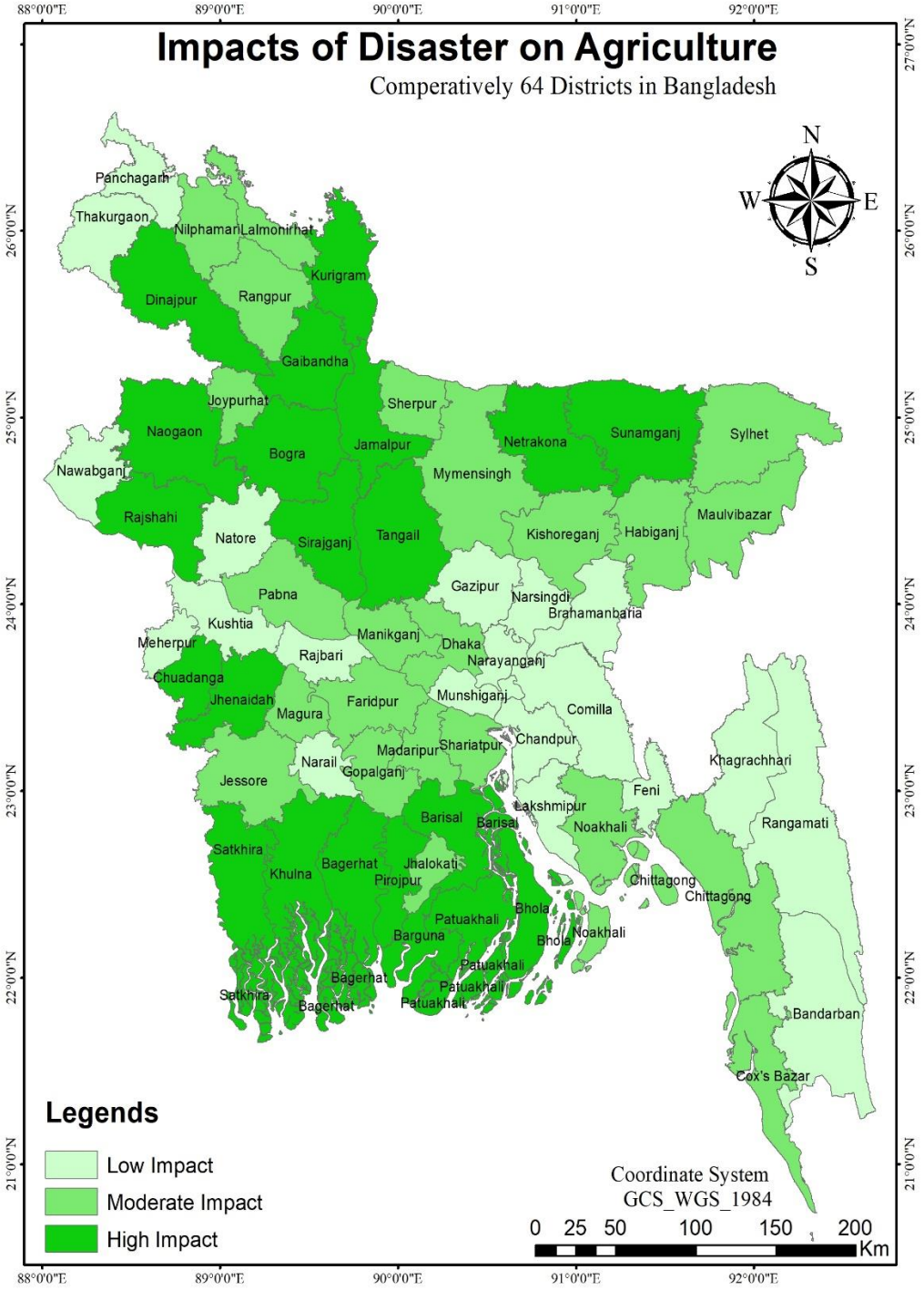

Figure 2: Impacts of Disaster on Agriculture (Source: Author's Preparation,2022)

3. Functional Regionalization

This research defines the regional centers of the upazilas in the districts of Khulna, Satkhira, and Bagerhat. The Bangladesh Bureau of Statistics provided the names of the upazilas and population figures (BBS). Furthermore, data on the location, geographical area, and boundary of the upazila headquarters have been acquired from the BBS shapefile. The map of the existing geographical boundaries was created using a Geographical Information System (GIS). The study was mostly based on Reilly's Retail Gravitational Theory. The following equation is used to determine the breaking point:

$$\text{Miles from outer limit of catchment} = \frac{Distance between A to B}{1 + \sqrt{\frac{Population of A}{Population of B}}}$$

where A and B are adjacent upazilas The breaking point of any upazila was determined by using GIS to compute the distance between two upazila headquarters, and the influence area for each upazila was identified by linking the breaking point for any upazila. The delimited influence region and the unserved area between the polygons were depicted on a GIS map (version 10.5).

Using data from the BBS, the ranking of the geographical region, population impact area, and percentage are determined in Microsoft Excel. The data for the factors is also taken from the BBS, and a bar chart is created in Excel to best illustrate it. Secondary sources were used to cross-check the analysis's result.

4. Region delineation

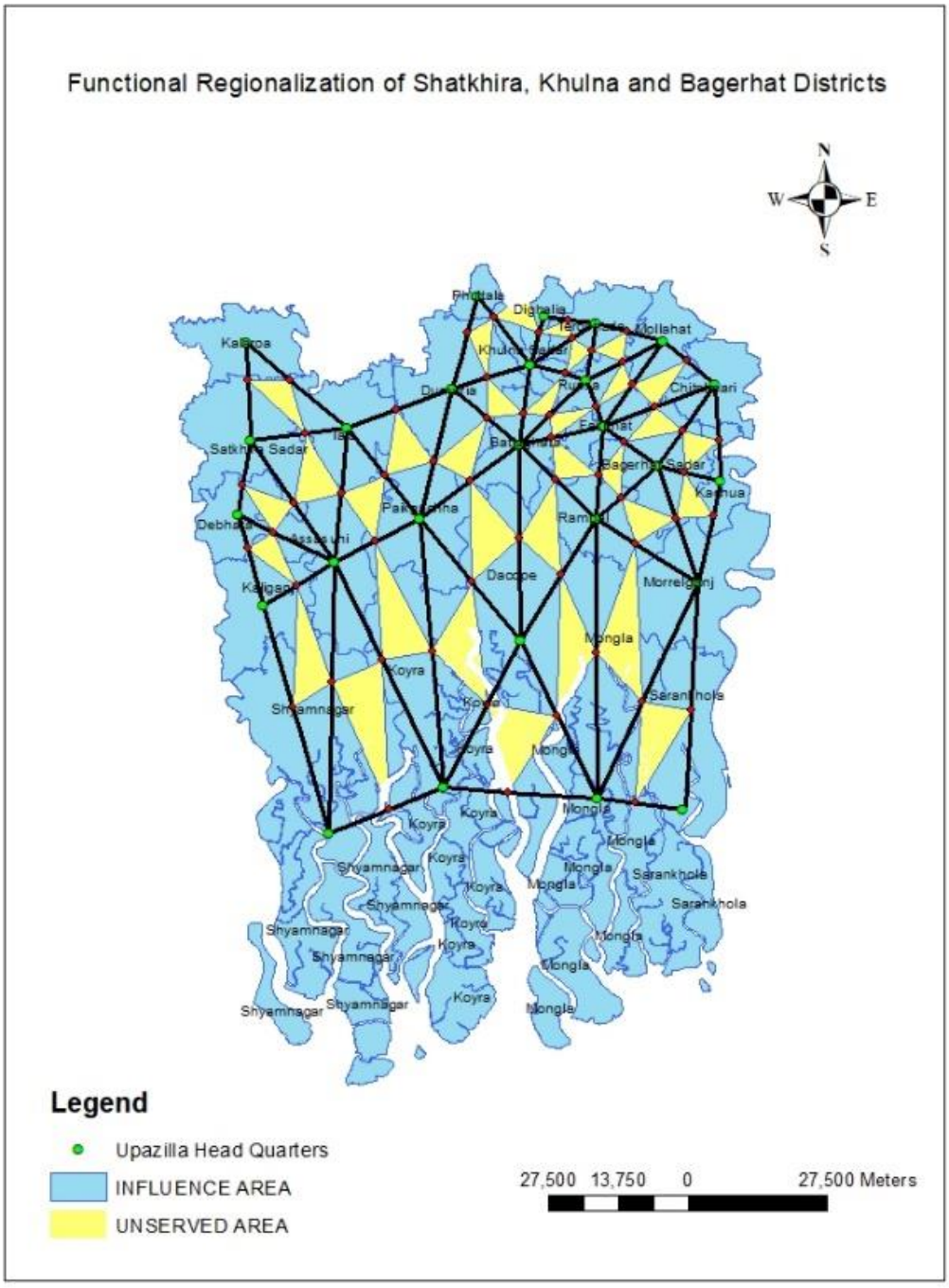

Figure 3: Functional Regionalization of Bagerhat, Khulna, Satkhira Districts (Source: Author's Preparation,2022)

Table 4: The ranking chart among the regional centers (Source: Author's Preparation,2022)

District	Upazila	Population	Ranking	Area	Rank	Influence area	Rank
Shatkhira	Assasuni	268754	8	374.81	10	438.042616	7
	Debhata	125358	21	173.21	20	134.481797	21
	Kalaroa	237992	11	231.4	16	241.226697	15
	Kaliganj	274889	7	333.78	13	361.691165	10
	Satkhira	460892	2	398.57	9	347.930449	11
	Shyamnagar	318254	3	1968.23	1	1240.778471	2
	Tala	299820	5	337.24	11	304.334055	12
Khulna	Batiaghata	172000	14	248.31	15	262.010589	14
	Dacope	152000	16	991.56	4	791.751722	4
	Dighalia	115000	24	77.16	24	57.710518	26
	Dumuria	301000	4	454.23	7	380.665893	9
	Khulna City	751000	1	64.78	25	175.055722	18
	Koyra	194000	12	1775.4	2	1352.029879	1
	Paikgachha	248000	10	411.19	8	422.935458	8
	Phultala	83000	26	56.83	26	82.697171	24
	Rupsa	179000	13	120.15	23	82.629748	25
	Terokhada	117000	23	189.49	18	114.749509	22
Bagerhat	Bagerhat	266000	9	272.73	14	145.72594	19
	Kachua	97000	25	131.63	22	106.695683	23
	Rampal	155000	15	335.45	12	302.503055	13
	Sarankhola	119000	22	756.6	5	562.085408	6
	Chitalmari	139000	17	191.99	17	234.634667	16
	Morrelgonj	295000	6	460.9	6	631.614431	5
	Mongla	137000	19	1461.2	3	989.132072	3
	Mollahat	131000	20	187.8	19	178.44889	17
	Fakirhat	138000	18	160.68	21	139.086857	20

Table 5: Functional gap analysis (Source: Author's Preparation,2022)

District	Area	Influence Area	Unserved Area	% Unserved
Shatkhira	3817.24	3068.48525	748.75475	19.61508184
Khulna	4389.1	3722.236209	666.863791	15.19363403
Bagerhat	3958.98	3289.927003	669.052997	16.89963064

Table 6: Attributes of upazila according to geographic and influence area (Source: Author's Preparation,2022)

Attributes	Upazilas
Influence area increased than geographic area	Assasuni, Kalaroa, Kaliganj, Batiaghata, Khulna, Paikgacha, Phultola, Chitalmari, Morrelganj.
Influence area decreased than geographic area	Debhata, Satkhira, Shyamnagar, Tala, Dacope, Dighalia,Dumiria, Koyra, Rupsa, Terokhada, Bagerhat, Kachua, Rampal, Sarankhola, Mongla, Mollahat, Fakirhat.

Major Findings

The BBS data is evaluated, and the effected and unserved areas are determined using GIS tools. The five criteria chosen will aid in understanding why certain regions are more impacted than others. The BBS is also used to obtain the factor data. The five factors are depicted in the bar chart in upazila order. The study team used this bar chart to highlight the presence of each element in each upazila and why the upazilas have more influence.

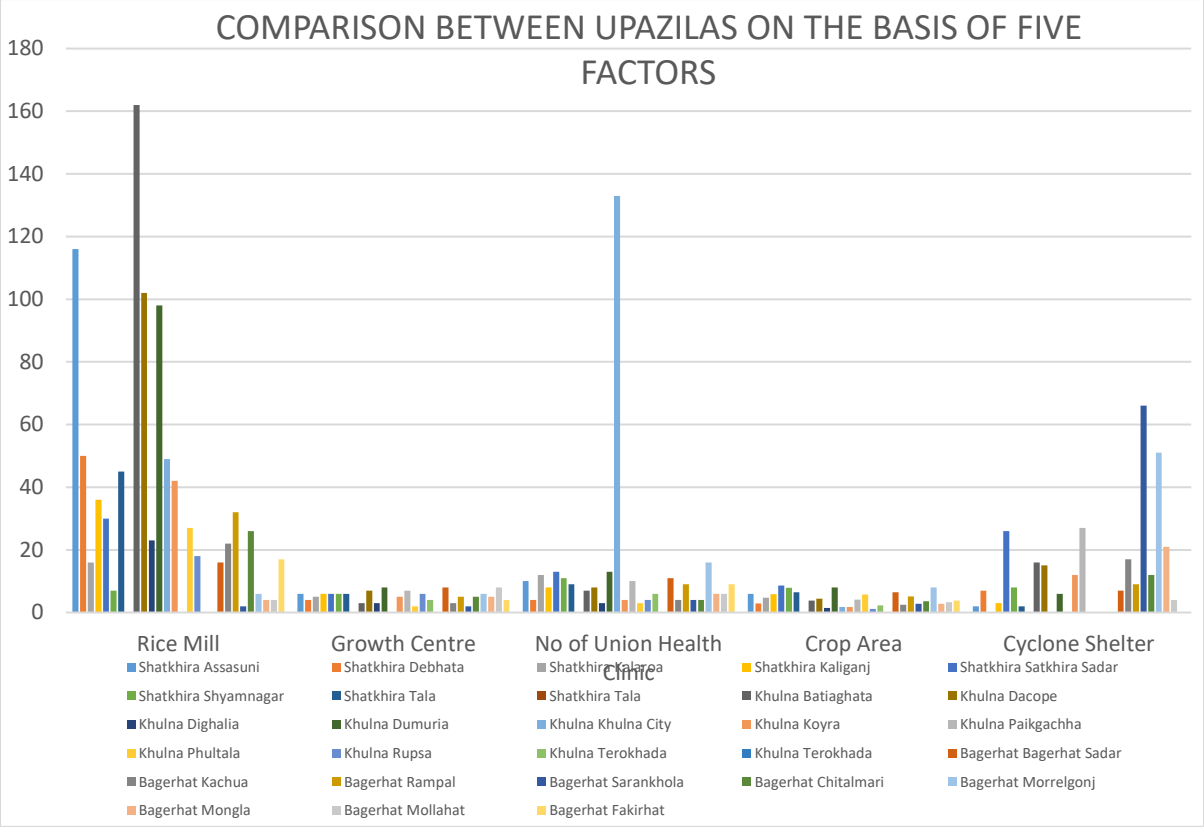

Figure 4 : Comparison Between Upazilas on The Basis of Five Factors (Source: Author's Preparation,2022)

Service Condition at Satkhira District

In this bar chart, a comparison between the factors of Satkhira District's top and lowest effected upazilas is displayed. The comparison will show why Shyamnagar has so much power and Debhata has so little. Shyamnagar features six growth centers, eleven union health clinics, eight cyclone shelters, and a large agriculture area. As a result, it has the greatest effect in the Satkhira district. Because the effect of these elements has previously been outlined, it is clear why Shyamnagar Upazila has such a strong influence.

Debhata upazila, on the other hand, has less impact since it has less growth centers, health facilities, farming lands, and cyclone shelter. There are four Growth Centers, four union health clinics, and seven cyclone shelters. These characteristics are extremely important in situations like these. Because cyclones impact these places practically every year, the location with the most health-related facilities has a greater influence. During the flood, several individuals perished as a result of shelter concerns and other health issues. As a result, it's easy to see why Debhata has less clout.

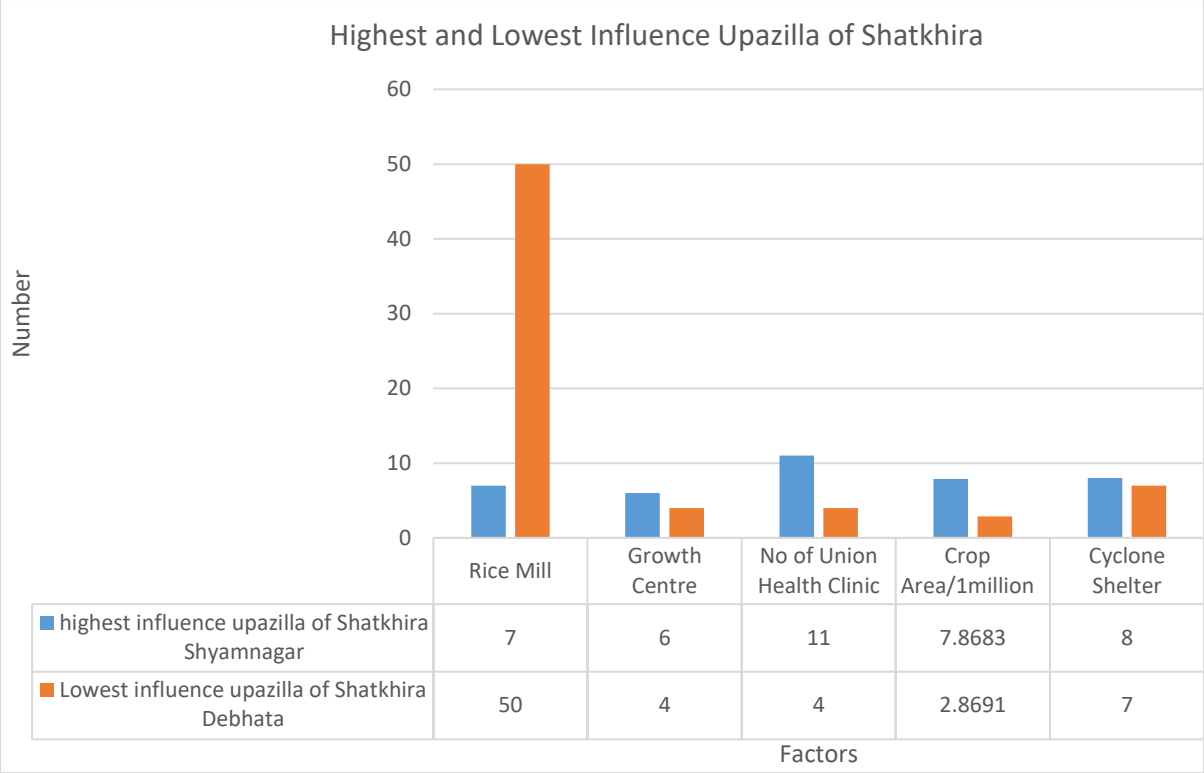

Figure 5 : Highest and Lowest Influence Upazila of Satkhira (Source: Author's Preparation,2022)

Service Condition of Khulna District

The following bar chart compares the components of the most impacted upazila to those of the least influenced upazila. The highest influence zone in Khulna district is Koyra upazila, while the lowest influence zone is Dighalia. There are 42 rice mills, 5 growth centers, 4 union health clinics, and 12 cyclone shelters in Koyra Upazila. As a result, it has the greatest impact in the Koyra district. Because the consequences of these factors have already been explained, it is evident why Koyra Upazila has enormous power.

Dighalia upazila, on the other hand, has a less influence since it has fewer growth centers, medical facilities, agricultural fields, and cyclone shelters. There are just three union health clinics, three growth centers, and no cyclone shelter. These factors are critical in circumstances such as floods and cyclones. Because cyclones hit these areas almost every year, the site with the most health-related facilities will have the most impact. Several deaths occurred during the flood as a result of both housing issues and numerous health-related consequences. People are less interested in this location since there is no cyclone shelter and just three union health clinics. As a result, it is evident why Dighalia is less effective.

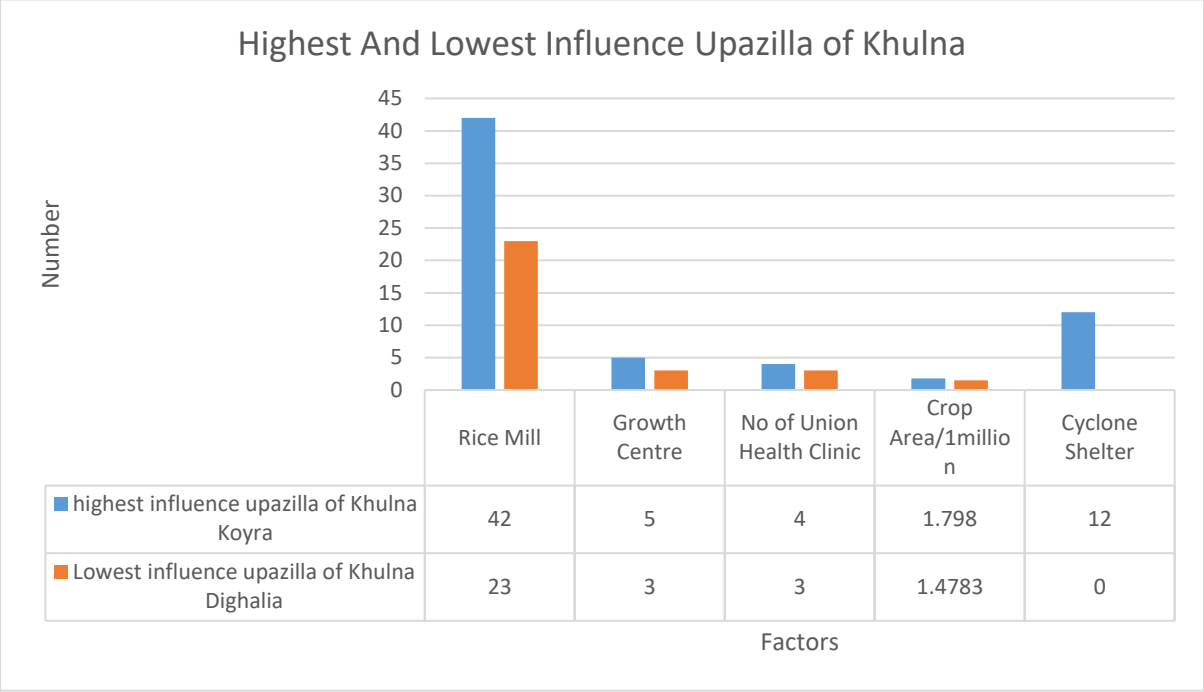

Figure 6 : Highest and Lowest Influence Upazila of Khulna (Source: Author's Preparation,2022)

Service Condition of Bagerhat District

The following bar chart compares the elements that have the most and least effect on Bagerhat district upazilas. In the Khulna district, Kachua has the least influence zone, while Mongla upazila has the most. Mongla Upazila has 5 growth centers, 6 union health clinics, and 21 cyclone shelters. As a result, it has the largest influence in Bagerhat. Given the significance of these elements, it is easy to see why Mongla Upazila has such a large influence. People are drawn to superior amenities such as a health clinic, a cyclone shelter, and a growth center.

Kachua upazila, on the other hand, wields less power since it has fewer growth centers, clinics, farms, and cyclone shelters. There are just three growth centers, four union health clinics, and seventeen cyclone shelters. These elements are critical in situations such as floods and cyclones. Because storms visit these locations on a frequent basis, the region with the most medical facilities and cyclone shelters will bear the brunt of the damage. A number of deaths were caused by housing concerns and other health-related issues during the flood. As a result, it's easy to see why Kachua is less productive.

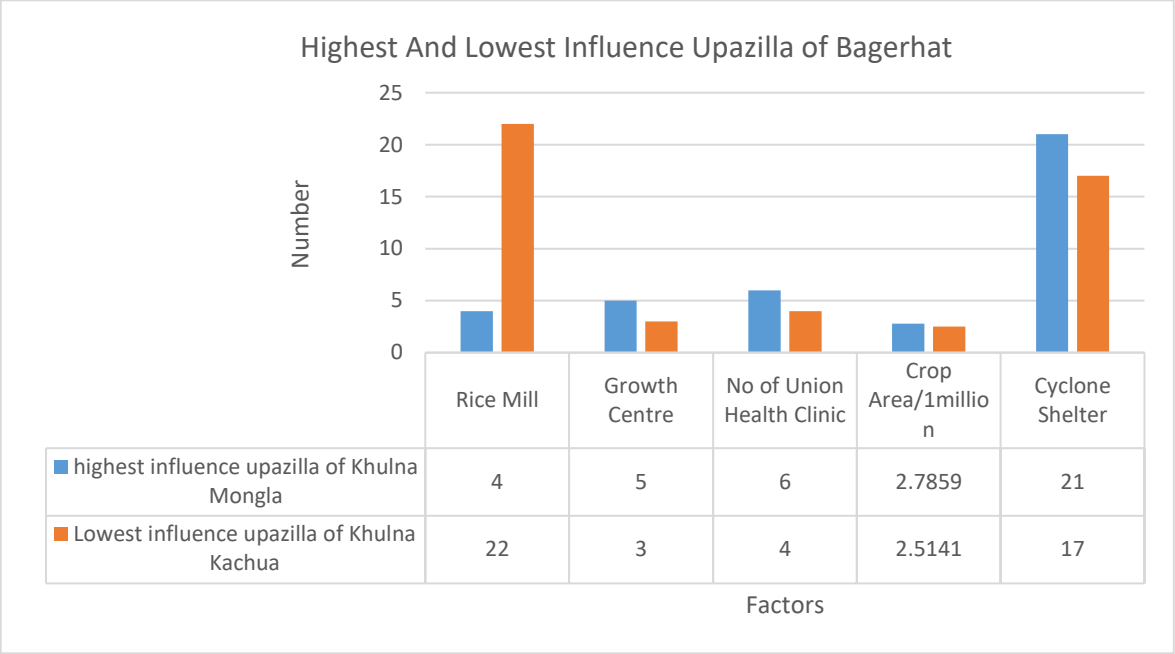

Figure 7: Highest and Lowest Influence Upazila of Bagerhat (Source: Author's Preparation,2022)

Result and Discussion

From the following chart the unserved area from each district which are Shatkhira, Khulna and Bagerhat can be observed. And it is seen that Khulna district has less unserved area than Shatkhira and Bagerhat district as the influence of Khulna district is much more.

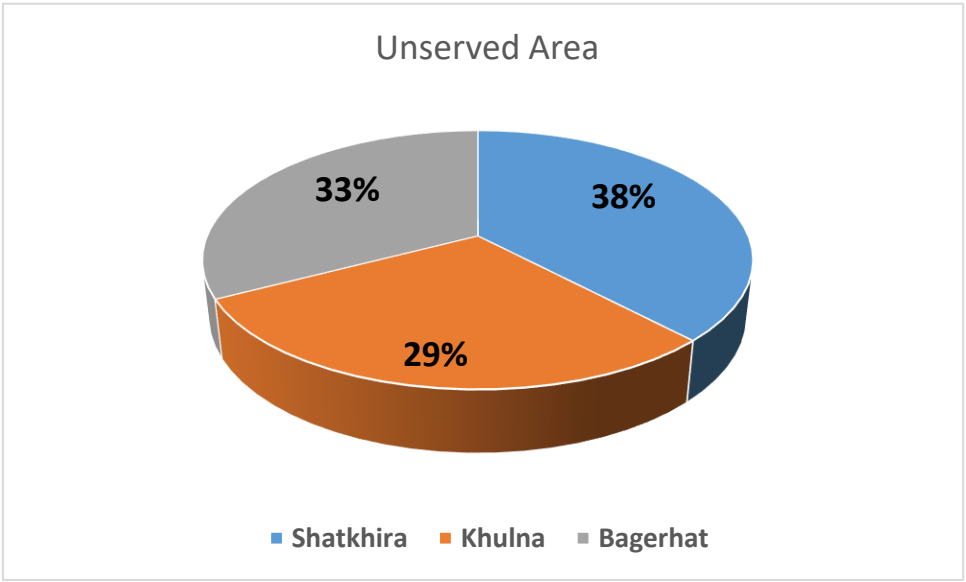

Figure 8 : Percentage of unserved areas of Bagerhat, Khulna, Satkhira Districts (Source: Author's Preparation,2022)

Although all of these districts are highly impacted districts on the basis of the impact of disaster on agriculture. But because of the better accessibility and facility Khulna district has more influence and large number of people depended on this district for education, employment, medical facilities and shelter during the disaster. Many people also migrated from other location during and after the disaster in this district as it has more disaster resilience facilities. Although these three district face a high cost during the disaster in the agriculture sector but the overall agricultural production of these district is so good that the influence of these districts is remarkable.

There is a strong correlation between the agricultural production and influence area. As the agricultural produces hampers a lot because of disaster in these districts people have to move to the area with more opportunity and facilities. Which makes the zone with more facilities more potential to people for employment, shelter and other necessary things. Upazillas such as Shyamnagar, Koyra, Mongla, Dacope and so on has more influence area because of having more facilities and opportunities. In these zone the agricultural production is relatedly less and so the disaster impact on agriculture is less here. As so people from other areas which are already impacted by disaster depended on these zones for employment, shelter and other facilities and opportunities. So disaster impact on agriculture has an inverse relation with the zone with more influence area.

There are also some upazilas such as Dighalia, Rupsha, Phultala, Kachua and so on has less influence area because of having less opportunities and so people migrated from these places to other zones with more opportunities. As well as these zones are highly impacted zones on the basis of disaster impact on agricultural production. So people from these places move forward to other places after being affected by the disasters badly. So, as we know the impact of disaster on agriculture has an inverse relation with the influence zone so it is easily understandable that these zones are zone with less facility and accessibility in respect with other zones.

So, the zone with more influence area is zone where people feel them safe and this zone attracts the people. In these zones the living condition is so good that people from other zones migrated to these zones. On the other hand, people live under the minimum living condition in the zones which have less influence area as so people have to think differently and make them migrated to an area with better facilities.

Conclusion

Bangladesh is a country that frequently experiences natural disasters, therefore almost every district there is affected. It is clear that not all areas are adversely impacted by a disaster, though. The main goal of this study was to evaluate how the disaster affected agricultural output and how it affected overall development. Districts are affected differently depending on their location and other advantages. However, some areas are unaffected while others are too severely affected by the threats. It is well known that areas near rivers and beaches have high agricultural potential. However, because these areas are also categorized as disaster-prone zones, the consequences are considerably more severe there. The three districts chosen for this study, Shatkhira, Khulna, and Bagerhat, are located in coastal regions that flood almost yearly and are severely affected by disasters' effects on agriculture. In this study, influence zones and unserved areas are analyzed, and a variety of factors are looked at to understand why some upazilas have less or more of an impact than others. Because they provide better amenities and have a more welcoming population, places like Mongla, Shyamnagar, Koyra, and others have a stronger impact. Every district has a certain number of unserved areas, and it is these areas that our study is particularly interested in. These underserved regions need to be taken into consideration since they regularly flood, forcing residents to move to locations where they feel safer, have more possibilities, and have more amenities. For instance, growth hubs, cyclone centers, agricultural districts, and health clinics all have a big influence on how attractive a place is to tourists. The primary reason for our regionalization population is also one of the study's flaws or limitations. However, based just on its population, a place cannot be categorized or described. The regionalization process may be influenced by a number of additional variables. This makes it possible to do more study on the subject. The government and local authorities can then take the necessary steps to address this issue by identifying the zones that fall short of expectations in terms of opportunities and amenities.

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