

RESEARCH PAPER

# Healthcare Services for Disaster Risk Reduction Using the Geographical Information System (GIS): A case study on the management of health services in Satkhira, Bangladesh

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## ARTICLE HISTORY

Received: May 10, 2020

Revised : June 14, 2020

Accepted: July 20, 2020

Published: August 31, 2020

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## ABSTRACT

This study illustrated the health care service for reducing disaster risk. The coastal area of Bangladesh is vulnerable to unpredictable climate conditions. This paper focus on the health care problems of Satkhira district. Applying GIS as geoprocessing buffer tool and focus group discussion in the community level for performing analysis and hypothesis about the health care services. The relationship between distance and death rate is established as a secondary data study and also proposes to bring together governmental and non-governmental organization to help and build a resilient community. The results of this study ensure standard health care services in the Satkhira Coastal District for disaster risk reduction.

Key words: Disaster Risk Reduction, GIS, Health Care Services, Hospital Management

## Introduction

Bangladesh is a hotspot for disaster risk; it ranks fifth among the top 15 highest-risk countries (Roy 2019). The Coastal People of Bangladesh are fighting against with multiple disasters. In every three years the coastal area of Bangladesh faces a severe cyclone. Over a period of 100 years, 508 cyclones were already affected Bengal Bay, 17 percent of which generated landfall in Bangladesh (Kabir and Khan 2017). The coastal region of Bangladesh covers about 20 percent of total land area and over 30 percent of cultivable lands of the country (Minar et al. 2013). Climate change is shattering both the environment and people live. Dr. Tedros Adhanom Ghebreyesus, the Director-General of WHO (World Health Organization) said, "Every Year, more than 170 million people will be impacted by war and another 190 million by disasters; but the full effect on human health is much greater than this."

As a developing country every sector is progressing on a daily basis; but some rural locations are still depleted of these facilities. Bangladesh's health system has a double burden of illness, low facilities and lack of adequate financial risk security mechanism (Joarder et al. 2019). Coastal residents are marginalized group are largely deprived of healthcare services. Again, the Government of Bangladesh has a statutory obligation to "supply the basic medical needs for all segment of the people in the society" and the "improvement of the nutritional and the public health status of the people". Some Upazila are situated at critical zone in terms of frequent costal floods, salinity, cyclone and

waves, thousands of people have lost their living standards (Shaibur *et al.* 2017). There are a range of challenges facing Satkhira district's people such as financial hardship, distance from healthcare facilities.

The after math of the disaster or any outbreak would be significant. This work focused on the issues facing coastal area individuals and the possible solution. This proposed remedy will assist the community people to create a resilient society and cover the objectives of Universal Health Coverage (UHC) as well as minimize the mortality rate. The core objectives of this study are to find out the quality of health care services in Satkhira District; and to put forward recommendations for an effective health services as well as health management to reduce disaster risk reduction.

## Materials and Methods

### Study Area

Satkhira district, which is the south western district of Bangladesh and part of Khulna division. It lies between 21°36' and 22°54' north latitudes and between 88°54' and 89°20' east longitudes. The total area of Satkhira district is 3817.29 sq. km. of which 1534.88 km is under reserve forest. The district consists of 7 Upazilas, 79 unions, 1440 villages (Fig.1). The Upazilla are Satkhira Sadar, Assasuni, Debhata, Kalaroa, Kaliganj, Shyamnagar and Tala (Bangladesh Bureau of Statistics 2013).

Out of seven Upazila's Shyamnagar is extremely vulnerable depending on the disaster record of Satkhira. Most of the people use local dispensary. Upazila health complex is run out of adequate facilities. Even the people

of Shyamnagar is also deprived from medical treatment from Upazila health complex. Most of the health compare lack of X-ray machine, MRI machine and ECG machine (Debnath 2019). Here is a population chart of Satkhira district. Second most populated area

is Shyamnagar Upazila after Sadar Upazila (Figure 2). We prioritized every Upazila of Costal district Satkhira. Based on the earlier devastation record in all Upazila we emphasized Shyamnagar Upazila as well as all other Upazila to ensure standard health service.

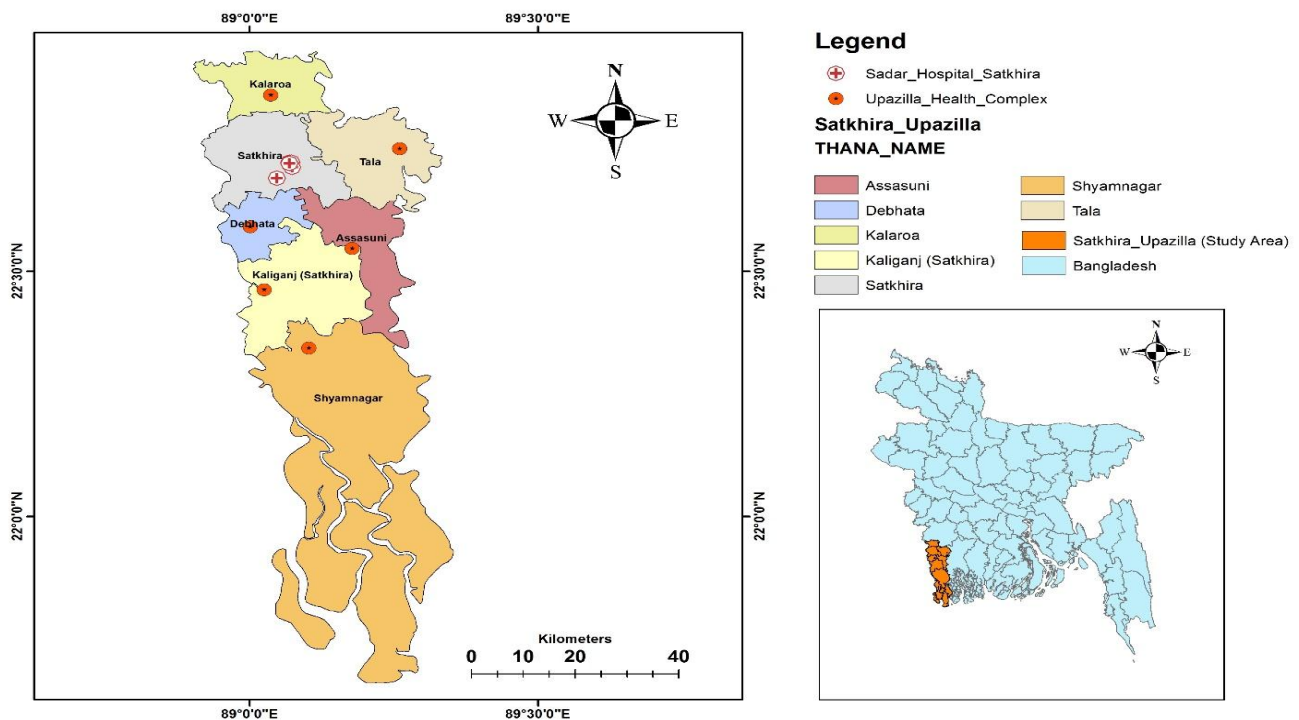


Figure 1. Study area map (Satkhira Upazilla)

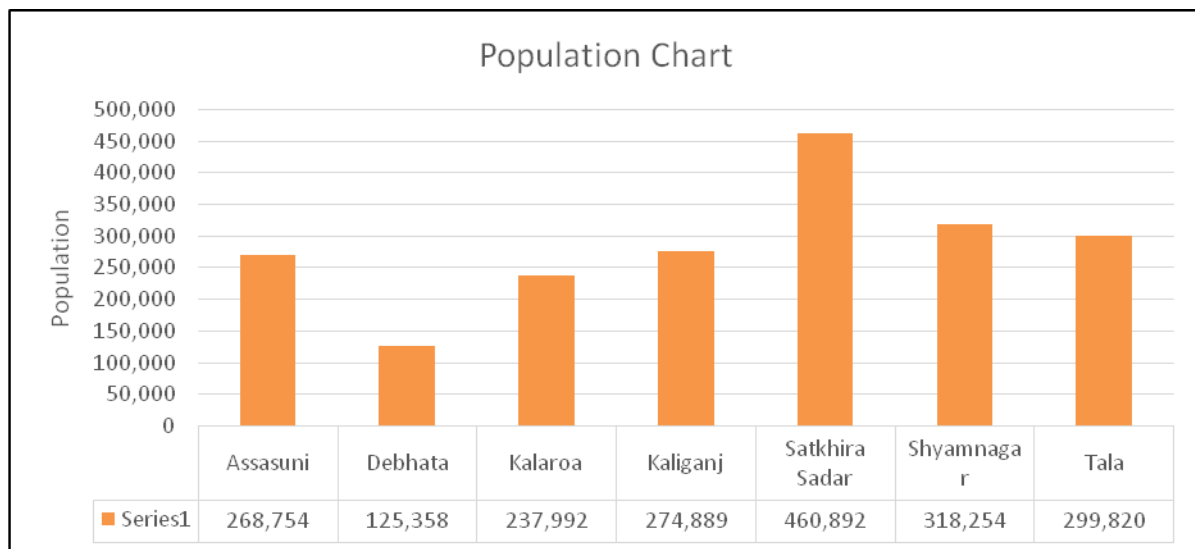


Figure 2. Population chart of Satkhira district (Source: Local Health Bulletin, 2016)

### Data Collection and Analysis

All the collected data and information gathered through survey were analyzed by operating Excel and ArcMap 10.2 software. We had done Focus Group Discussion to understand the scenario of current hospital facilities. The occupation of farming, housewife, business, shop owner and also the variation of ages were participants on the discussion. All the data were collected on the month of October 2019. After understanding the scenario, we utilized ArcMap 10.2 buffer Geoprocessing tools and the

Open Street Map for road networking data. Results from the analysis were shown by map.

We acquired verbal consent from the participants in this study for ethical approval. Participants were advised that it is voluntary to participate in the discussion, and voluntarily provided us with their data for our analysis.

### Results and Discussions

Health Care services ensures the system where safe, accessible, high quality, people-centered, and integrated institution that provides supports in the critical time.

Hospital supports the health services in the crucial time to the community people. And also provides care from prevention to diagnostic disease, rehabilitation and palliative care (WHO 2020). In order to make our analysis convenient we had classified the health services into two categories: Class A and Class B. (Table 1, Table 2).

Class A type indicates the governmental and private health care services like Sadar hospitals, private clinics very well equipped and maintained. On the other hand,

Class B type also indicates the Upazila health complexes which are not adequately equipped and not maintained. Health facilities have updated in Bangladesh undoubtedly. But most of facilities are highly centralized (Ahmed *et al.* 2015). Every Upazila has an Upazila health complex which is lack of equipment and human resource also (Debnath 2019).

These are class A type health services are exceptionally easy to access for the Sadar residence and the nearest Upazilas from Sadar.

Table 1. Class type A health services

No	Location	Hospital Name (Class-A)
1	Satkhiria Town	Satkhiria Sadar Hospital
2	Satkhiria -Kaliganj Highway	Satkhiria Medical College & Hospital
3	Khulna - Satkhira Road, Satkhira	Bushra Hospital, Satkhira
3	Khulna - Satkhira Road, Satkhira	Chain Bangla Hospital, Satkhira
4	Satkhiria - Kaliganj Highway	Sangram Medical Hospital
5	Paka Pull, Paka Pull Rd, Satkhira	Nowab Memorial Diagnostic & Consultant Center, Khan Market, Pakapole, Satkhira
6	Satkhiria - Kaliganj Highway	Care Diagnostic Centre & Clinic

Table 2. Class type B health services

No	Location	Name of Hospital (Class-B)
1	Assasuni	Assasuni Upazila Health Complex
2	Debhata	Debhata Upazila Health Complex
3	Kaliganj	Kaliganj Upazila Health Complex
4	Kalaroa	Kalaroa Upazila Health Complex
5	Shyamnagar	Shyamnagar Upazila Health Complex
6	Tala	Tala Upazila Health Complex
7	Paka Pull Rd, Satkhira	Satkhiria Maternity Hospital
8	Jessore - Satkhira Highway	Satkhiria Children's Hospital

We figured out the distance from every Upazila's health complex to class A hospitals utilizing geodesic line measurement tools of GIS. To make a comparison with the people who live alongside to the facilitated hospitals. In this study our core focus on the pregnant women. Those who live near the hospitals, 72% birth in hospital (Hanson *et al.* 2015).

Over here we have displayed the figure of the distance of Upazila health complex to class A hospital.

Consequently, we surveyed on Gabura union of Shyamnagar Upazila. It is the last portion of Satkhira and only available transport route is by road. Most of the people of Gabura union earn their livelihood by fishing, crab cultivation or doing some seasonal business. Most of the people having a great problem because of no medical facilities. The community clinic was also a dead lock. There are some NGO who provide doctor for the people of Shyamnagar. But that service was also expensive for the people. Most vulnerable were the pregnant women. The roads had not good enough to transport a pregnant woman to class A hospitals. We took a focus group discussion (FGD) to find out more details.

Their prime need now the medical services. Seven people died in January to July 2019 due to obvious lack of medical facilities and four of them died on delivery.

They died in normal weather. In severe weather conditions transportation is more challenging.

As per our survey, the Gabura union has faced cyclone "Aila". The people of Gabura is still trying to recover their village. They built mini dam in order to safe from water and storm surges. But that dam is eroding because of the water of Kholpetua River. The people of Gabura union have to cross the river every day for their daily basis.

The participant told a name "Shahrin khatun", who was dead because of complication in delivery. And she did not manage any well medical services.

Rabeya (32), who lost her child in 2018. She could not afford to go to a hospital. She informed us, "Most of the women of Gabura go to midwife for maternal suggestions and sometimes, NGO comes to support them and suggest them what they should do in their pregnancy period. Presently she has two children and delivered by midwife.

Khaleda Begom (28), who also lost her child in 2019. She notified us, "At least one woman will face pregnancy related problem in Gabura Union every year." She told us a boy had a head injury, but because of a vast distance of hospitals that kid could not survive."

Akbar Ali (50) a shop owner, we discussed him at the river bank on Munshiganj Bazar. He and her wife

### Assasuni Health Complex to Class-A Hospital Distance(km)

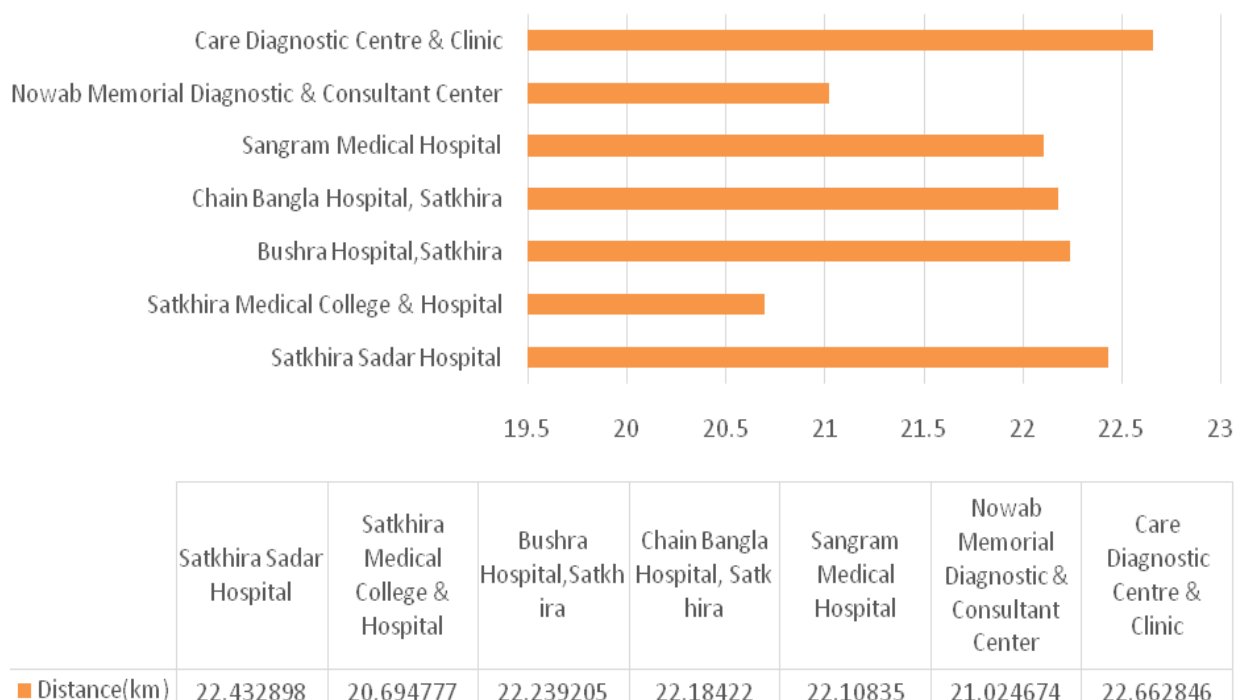


Figure 3. Assasuni Health Complex to Class-A Hospital Distance(km)

### Debhata Health Complex to Class-A Hospital Distance(km)

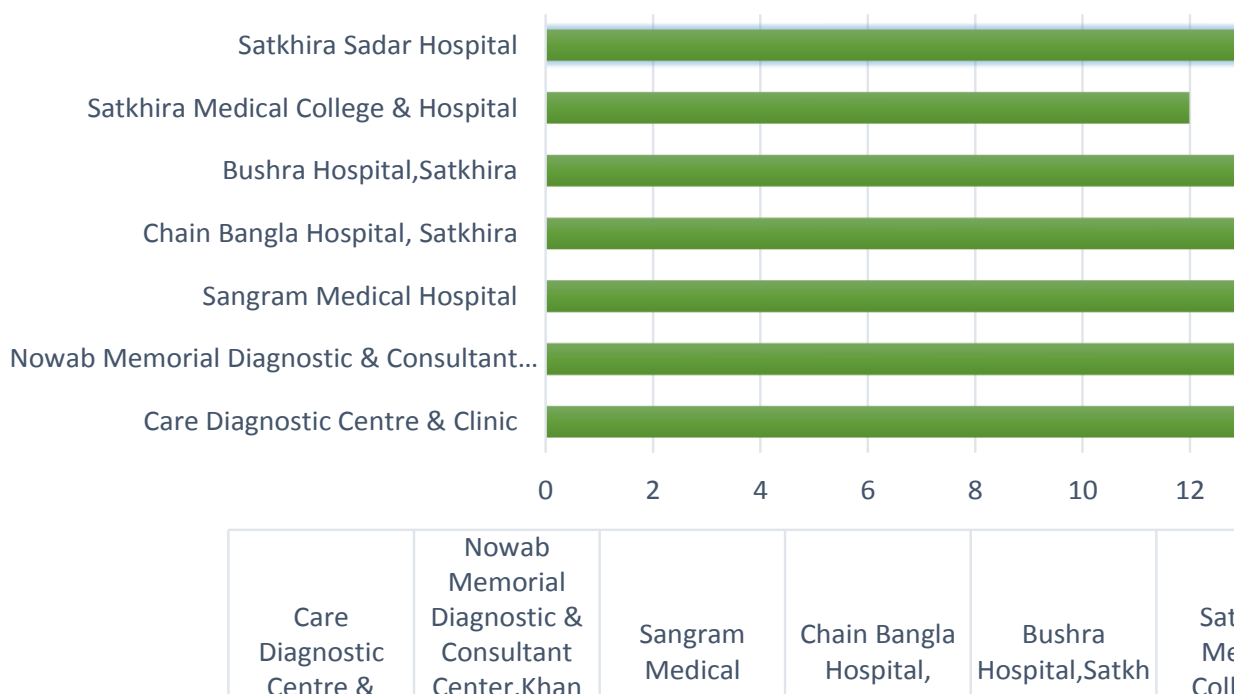


Figure 4. Debhata Health Complex to Class-A Hospital Distance(km)

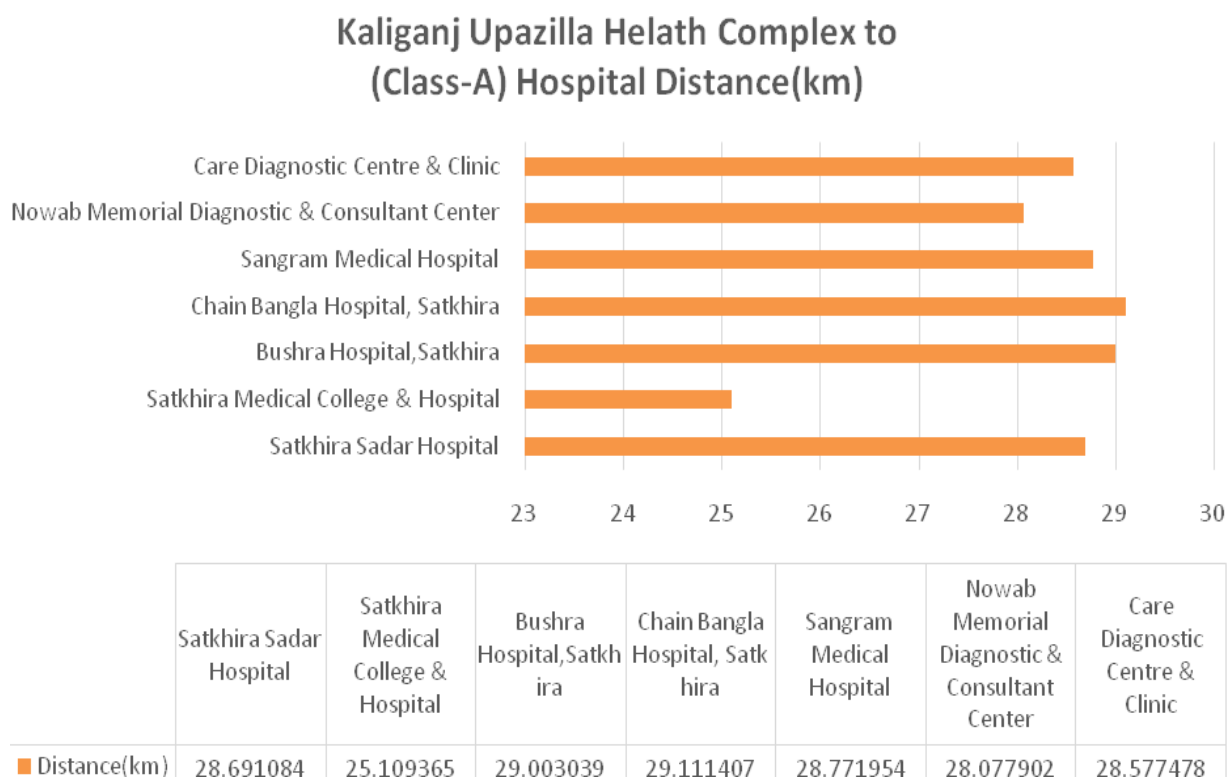


Figure 5. Kaliganj Upazilla Helath Complex to (Class-A) Hospital Distance(km)

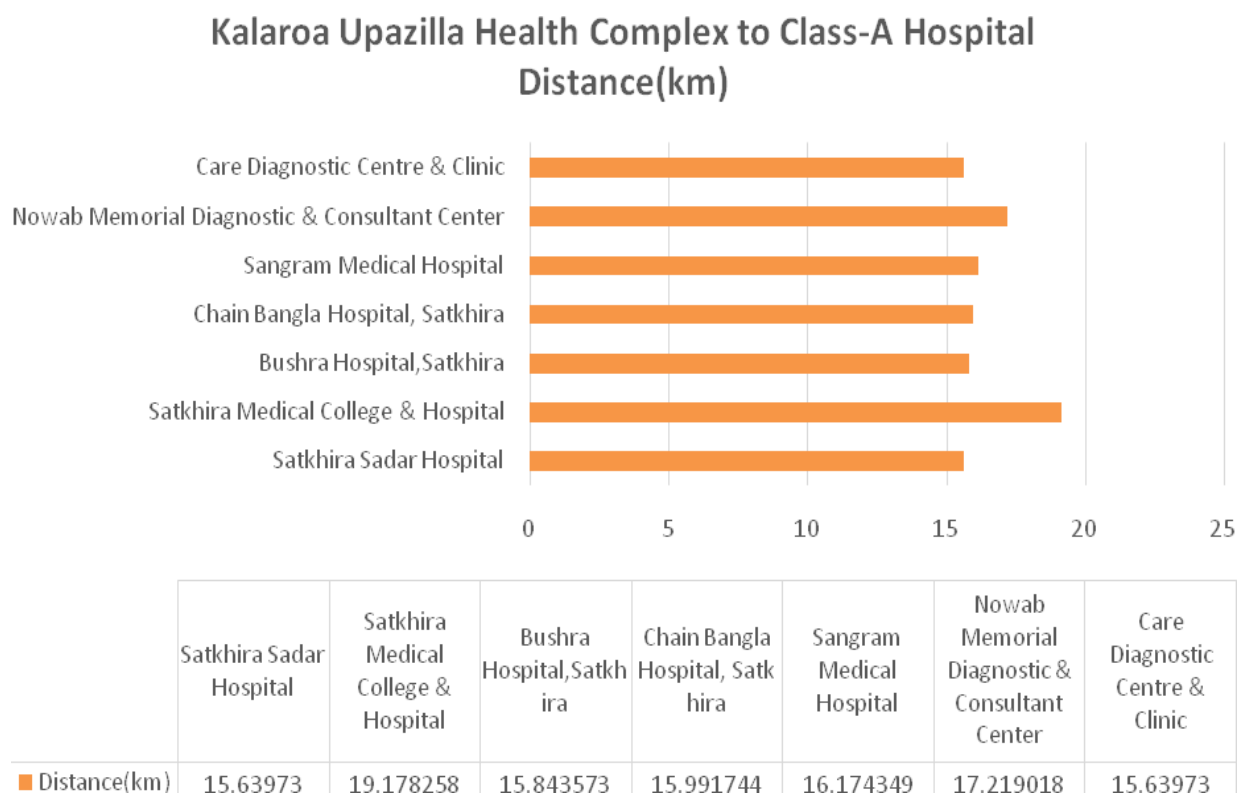


Figure 6. Kalaroa Upazilla Health Complex to Class-A Hospital Distance(km)

### Shyamnagar Upazilla Health Complex to (Class-A) Hospital Distance(km)

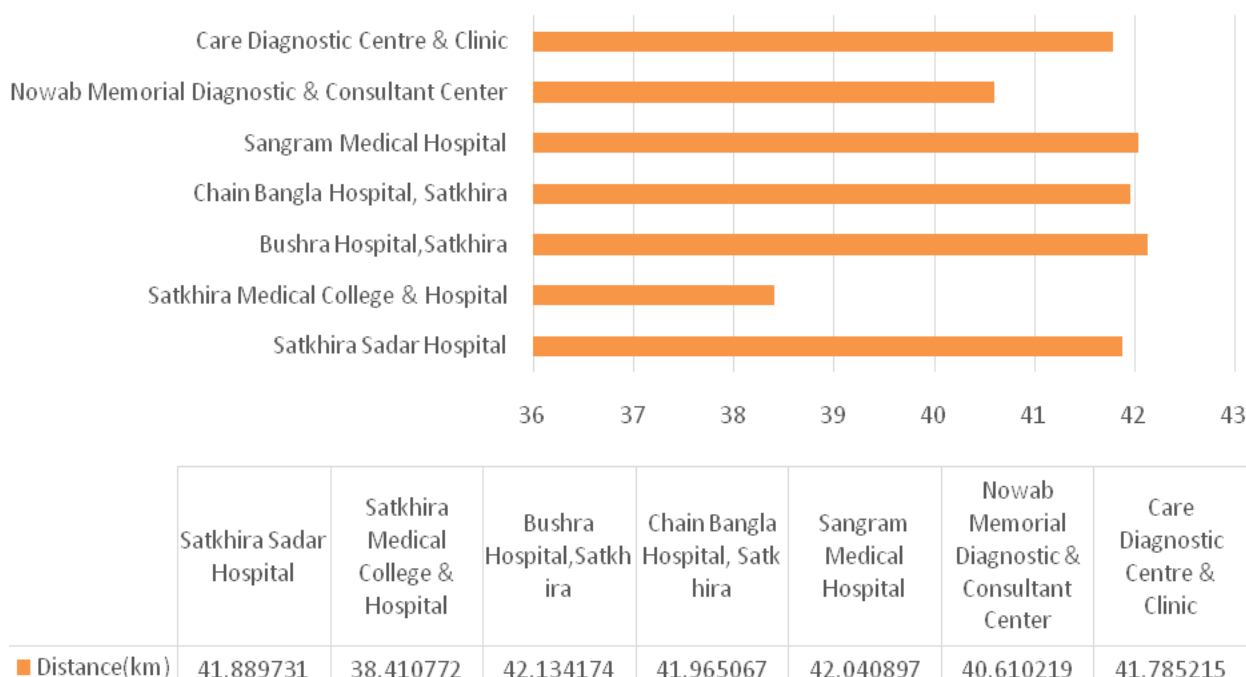


Figure 7. Shyamnagar Upazilla Health Complex to (Class-A) Hospital Distance(km)

### Tala Upazilla Health Complex to (Class-A) Hospital Distance(km)

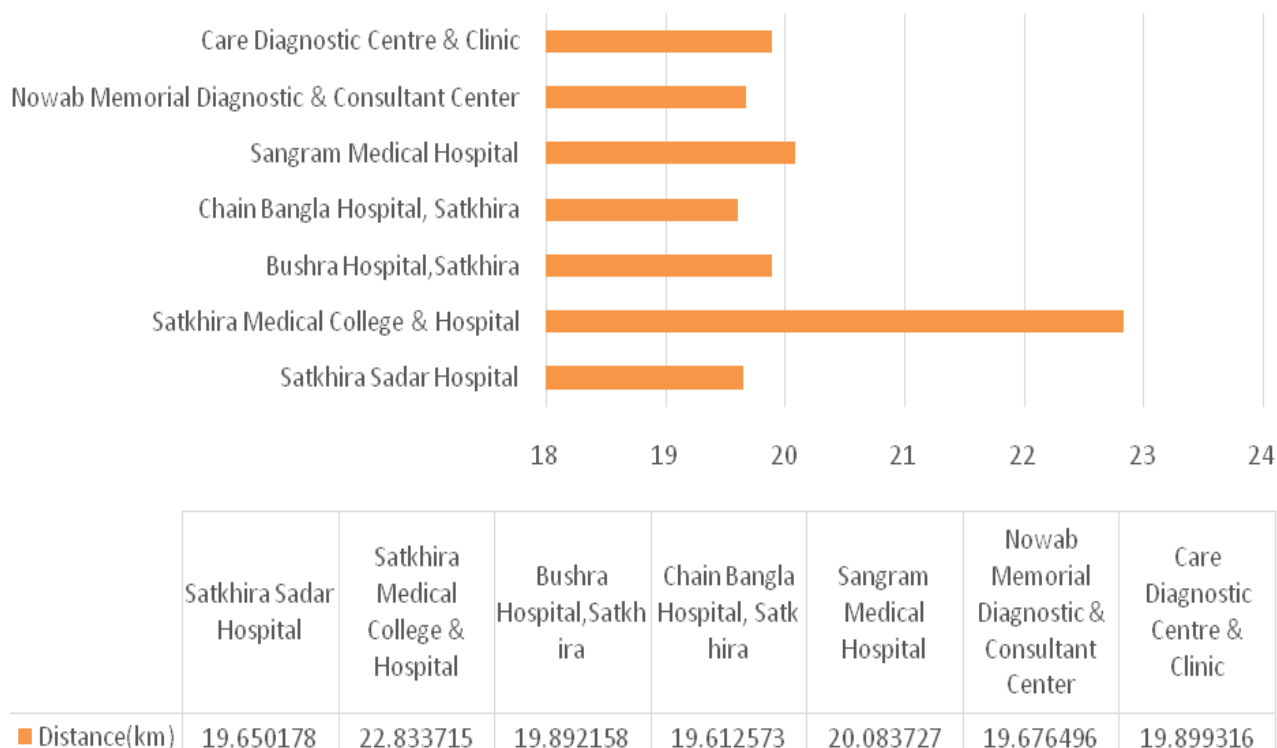


Figure 8. Tala Upazilla Health Complex to (Class-A) Hospital Distance(km)



operate a grocery store. He has a problem in his liver, so he cannot everything alone. Her wife informed us, “I have to take him in the diagnostic center thrice in this month. He requires an operation. Hence, we are collecting money.” Akbar Ali said, “Sometimes, I can feel so much pain. Every week a doctor come from Dhaka and sometimes I visited there. But that too costly to bare.” After questionnaire survey we generated a report on the medical facility of that area. And the graph of that report is given below (Figure 9).

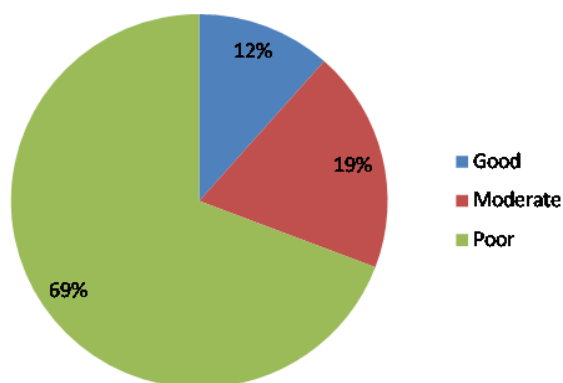


Figure 9- Medical Facility (Based on FGD discussion)

Most of the people of that area were unsatisfied with the facility and most of them suffering a massive problem with it. Again, the Upazila health complex condition was extremely bad. Most of the people of that area live in a marginal line, so they cannot provide a costly doctor which is facilitated by the NGO named “Friendship”.

The similar case we have found on rural southern Tanzania. The people of rural southern Tanzania had faced the similar problem like the people of Shyamnagar Upazila. In that case study Pregnancy-related mortality was significant at 712 deaths per 100 000 livebirths, with hemorrhage being the leading cause of death (Hanson *et al.* 2015).

After MDG Worldwide, maternal deaths have declined by 45% per year since 1990, with the estimated number in 2013 being 289 000. But, in sub-Saharan Africa alone, 179 000 women die each year during pregnancy and childbirth (Hanson *et al.* 2015). A case study shows that the common impression regarding the spatial effect of health is as considerable distance between residents and health care providers' increases, utilization of health care decreases and vice versa. In some cases, a significant role plays a hospital or clinic near home for hypertension and diabetes patients (Biswas and Kabir, 2017).

Another article shows that the influence of distance on such major health outcomes as vaccination status, morbidity and mortality among the children under 5 years. They studied that by 2007, the study area was served by one district hospital equipped with nearly 100 beds. There are no ambulance services. Habitants transported by bike or donkey and most of the habitants walk. The authors estimated the time in minutes. In dry season it is 105 minutes and in rainy season it is 135 minutes. They figured out by a comparison survival curve with the log rank test showed that survival

increased with decreasing travel time. The study mainly demonstrates that the travel distance to the closest health facility is a leading risk factor for infant (Schoeps *et al.* 2011).

In rural southern Tanzanian people also confront that problem. They published a paper on between distance and mortality. Direct causes of maternal deaths are highly related to distance. In that paper they have showed that the mortality rate increasing from 111 per 100 000 livebirths among women who lived within 5 km to 422 deaths per 100 000 livebirths among those who lived more than 35 km from a hospital (Hanson *et al.* 2015).

In this figure (Figure 10) they precisely calculated the ratio pregnancy related mortality to livebirths in their study period. And these statistics are categorized by the distance of the health care facility centers. They showed the Childbirth in hospitals are more common for women who living within 5 km of a medical facility is 72% than those living within 5–10 km is 34%, living within 25 km of a medical facility is 60% than those living within 5–10 km is 34%. Again, the women who lived more than 35 km from a hospital 21% had a delivery in a hospital (Hanson *et al.* 2015).

We can say 25 km as a contrast between Tanzania and Shyamnagar is the ideal place to set up a Class-A hospital. As we described the earlier incident, hospital between this 25 km would assist to minimize the mortality rate as well as accident, death.

In the present circumstances we have to visualize between 25 km there is not exist Class-A Hospital. Accordingly, we have to find out a suitable location that will reduce the risk of death and ensure proper health management. Hither we will use GIS based map for finding out location. GIS tools like buffer have the potential to find out lacking in local public health administration and decision-making (M. Taylor *et al.* 2012). “Buffer” is an area of specified width drawn around one or more map elements (Masoodi and Rahimzadeh 2015).

#### Logic: 1:

We know that Satkhira Sadar have many Hospital that facilities highly Sadar people as well as less facilities Shyamnagar and nearby Upazila. Over here we find out the center point of Satkhira Sadar. Geodesic measurement helps to capture center point and here creates a buffer of 25km. On the contrary Shyamnagar Upazila have highly density populated Upazila. This Upazila is extremely vulnerable for disaster.

We visualize the human settlement of Shyamnagar Upazila on our map. Ensuring highest facilities, we marked ending point of the human settlement. Downward of the ending point there have no human settlement that's why we capture this point and make a buffer of 25 km.

Conclusively, we follow our logic: 1 map there we have no intersected zone where we can establish Class-A category hospital.

#### Logic: 2

We hitherto mentioned Satkhira Sadar had highly hospital services. Logic:1 we create buffer from center point. This time we capture a point which hospital is

mostly nearby from Shyamnagar Upazila. Because

emergency takes people nearby hospital.

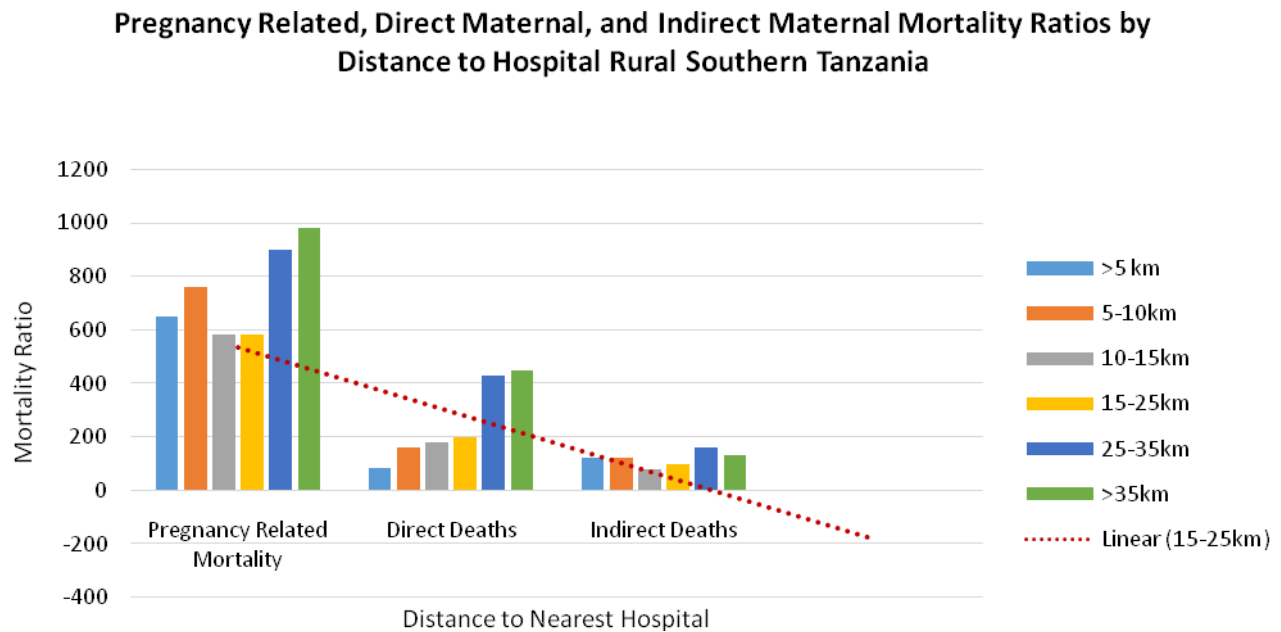
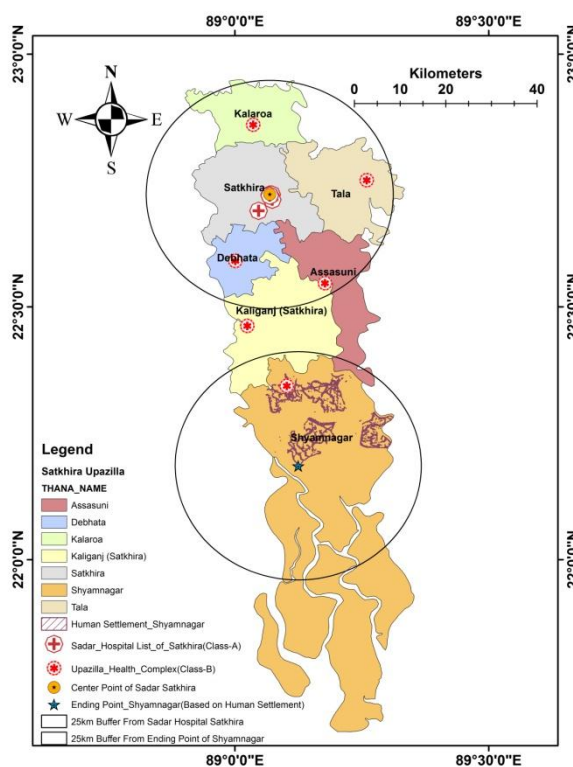
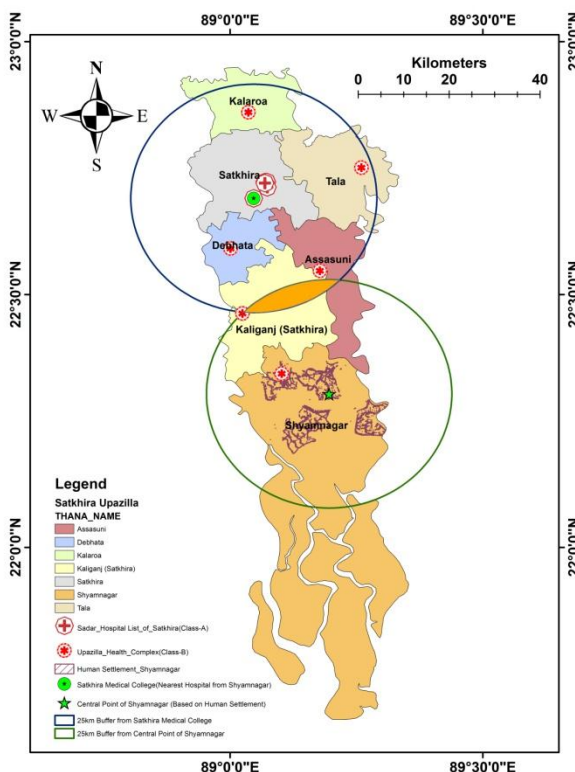


Figure 10. Relation between death and distance: A case study of Tanzania Source: (Hanson *et al.* 2015)



Satkhira Medical College Hospital, which is nearby to the Shyamnagar Upazila where capture point and create a buffer of 20km. On the contrary Logic-1 on Shyamnagar Upazila we capture point where the human settlements are ended. Ending point cannot be a wise decision. Because Southern part of ending point consist of no human settlement. If we manage a center point of human settlement that ensures all peoples health services. Hence, this time we marked the center point



based on human settlement. (Arc Map have geodesic measurement tools to find out center point). Logic: 2 tells us that two buffers have an intersection region. These intersecting zones are ideal for hospital establishment that ensures proper health management. As of now, in the intersecting zone we have to find out local road network. Most of the specific area in our intersect zone are Kaliganj and few areas in common are Assasuni.



Project related to geographic information system like Pavement Management System project in Ulaanbaatar they use local road network for storing, retrieving, analyzing and reporting information for decision making (Mužik and Sitányiová 2013). Traffic Movement in Guwahati city, India they digitized road network of the concerned city and converted them to ArcGIS, Geographic Information System (GIS) software for creating, analyzing and compiling maps for obtaining information (Das *et al.* 2019).

OSM (Open Street Map) provides street level mapping which is combination of many nodes with updateable data. OSM route data we instantly convert in ArcGIS and make the road classification. Route mapping on OSM, they standardized Road Classification as USA road classification except their have country-based route classification on OSM wiki.

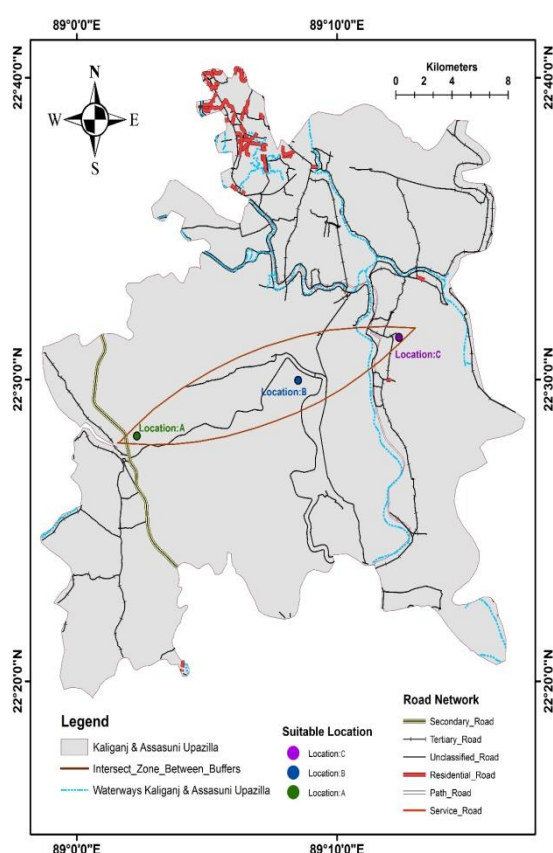


Figure 11. Suitable Location for Hospital

Based on Bangladesh we can divide road on nine categories. These are displayed below in details-

#### Primary Road:

Primary roads are generally divided, limited-access highways within the interstate highway system. These highways are accessible by ramps and may include some toll highways. (US Census Bureau; Department of Commerce, 2015)

#### Secondary Road:

These are representing a type of road connected with the capital to capital or two lanes roads with heavy transportation. (Source- OpenStreetMap Wiki- 2019)

#### Tertiary Road:

These are representing connected two or more Zilla of the country. These roads have been connecting more minor settlements and within large settlements for roads connecting local centers. (Source- OpenStreetMap Wiki- 2019).

#### Unclassified Road:

These are representing municipal roads typically at the lowest level of the interconnecting grid network. These are not represented residential area. Public transport is available and heavy weight transportation are restricted. (Source- Open Street Map Wiki- 2019)

#### Residential Road:

These are representing roads accessing or around residential areas but which are normally unused as through direct routes as well as there are restricted public transport. (Source- Open Street Map Wiki- 2019)

#### Track Road:

These roads are representing for primarily agricultural use, forest tracks etc. (Source- Open Street Map Wiki- 2019)

#### Path Road:

These roads are representing walking and hiking trails, bike trails and paths, horse and stock trails, mountain bike trails. (Source- Open Street Map Wiki- 2019)

#### Service Road:

These roads are representing inside road of the market that serves peoples. (Source- Open Street Map Wiki- 2019)

#### Pedestrian Road:

These roads are representing road or an area mainly or exclusively for pedestrians in which some vehicle traffic may be authorized. (Source- Open Street Map Wiki- 2019)

Figure-11 Kaliganj and Assasuni Upazila have six types of roads out of mentioned nine categories road classification. Following intersect zone there selected (Location: A, Location: B, Location: C) three individual location based on their facilities.

#### Location: A

Location A is adjacent to the secondary and unclassified road. Primary roads are 3km from the location and unclassified road are 18 meters from the unclassified road that is a water free zone. It ensures here that it is flood free and also there have enough open spaces to establish a hospital.

#### Location: B

Location B is adjacent to the unclassified road. These roads are one-way road. Based on geodesic measurement secondary roads are 12km from the location and tertiary roads are 6km from the location that is long distance. There have no water sources as well as a flood free zone. Based on our survey there have enough open spaces.

#### Location: C

Location C is adjacent to the tertiary road. These are two ways roads. Road networks are strength enough compare

to location. But nearby to the location there have water sources that can causes flood based on our survey. There have enough open spaces to establish the hospital.

Finally Considering road network, flood free zone, open spaces location: A is more suitable than Location B and then Location C. (Location A > Location B > Location C) Location B is equally good enough compare to Location C. Location B has no risk to flood where Location C have flood risk. On the contrary Location B has long distance compared to Location A, C and Location C is adjacent to two ways road.

We typically prefer location A here to establish hospital. In case of operational problems, we can follow Location B > Location C.

This study typically illustrated on the comprehensive health service of Satkhira District. The local people of Shyamnagar is experiencing trouble because of the distinct lack of medical facilities. This study utilized GIS software to provide a suitable place for a public hospital. As a result, the people of Shyamnagar can also secure their medical facilities from that hospital. As a topmost vulnerable place, people get their sustainable medical treatment that will ensure equity in access to health services and people will be protected against financial risk. According to WHO, based on achieving three points that ensures universal health care service for the community.

Points are given in the overview of our findings: -

1. This hospital will remarkably reduce the mortality rate of local people caused by numerous diseases as well as ensures the standard quality of health care services.
2. During disaster period they can easily reach at the hospitals and get all needy facilities for their health care. Consequently, the people can manage the minimum range of medical services that ensures the disaster risk reduction to the community people.
3. Again, the Upazila's around Shyamnagar like Assasuni and Kaliganj will be equally benefited as well as ensures Universal Health Coverage (UHC) health care services in coastal district Satkhira.

The people of the Shyamnagar region continuously got support from the Non-Government Organization (NGO) and the GO. Hither the hospital strengthens their community capacity as well as ensure the proper hospital management overall Satkhira District.

## Conclusion

The suitable place for the hospital is around the middle of the Kaliganj Upazila as per our GIS analysis. As, people from Shyamnagar also had to go to Sadar hospital after passing a long distance because there isn't any hospital there. So, if a hospital placed in a suitable place, it can play a big role in the health sector of the Satkhira

district. People can also reach to hospital easily in case of any emergencies and get all required facilities from the hospital. Good health and wellbeing is one of the sustainable development's goal (SDG), which is directly interrelated to health sector. One of its aim is improve access to the health (Alam 2019). On the other hand, Universal Health Coverage (UHC) also has some objectives as 'Equity in access to health services - everyone who needs services should get them' (WHO 2019). Which all will be applicable in the Satkhira district, when all the people will get equal facilities. Here, the suitable location of hospital of Satkhira will accelerate the process of implementing those goals as well as the policies. Besides, it can also play a vital role during any disasters or emergencies by providing the service to victims and also reducing the mortality rate. And this also the number one target of Sendai framework.

## Acknowledgement

Several people played an important role in the accomplishing of this paper. And we would like to acknowledge them here. First, we would like to thank Mir Safayet Hossain, Urban mobilizer of Islamic Relief worldwide, Bangladesh for guiding us and help us to find out the respondents. We are extremely grateful to Md. Tahsin Aziz, Project officer of Islamic Relief worldwide, Bangladesh for helping us by providing valuable information.

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