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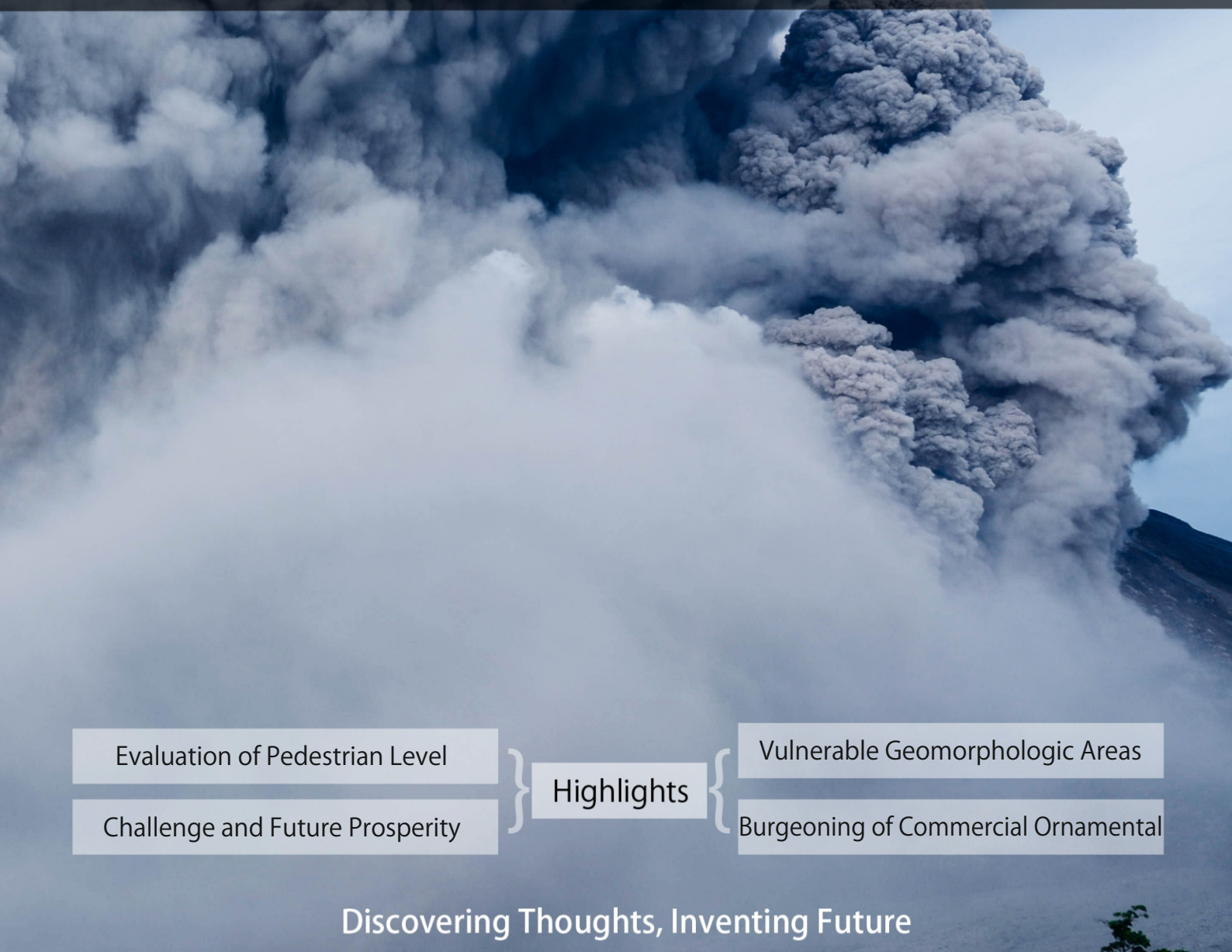

Highlights

- Evaluation of Pedestrian Level
- Challenge and Future Prosperity
- Vulnerable Geomorphologic Areas
- Burgeoning of Commercial Ornamental

Discovering Thoughts, Inventing Future

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Evaluation of Pedestrian Level of Service of Selected Footpath Segments of Dhaka City using Multi-criteria Decision Making Approach

By Md. Musfiqur Rahman Bhuiya, Hossain Mohiuddin, Md. Shahadath Hossain Patwary & Anika Tasneem
The University of Alabama

Abstract- Walking is considered to be the most important mode of travel across the world, particularly for a shortdistance trip. Since 19.6% of the trips are made by the foot in Dhaka, it is necessary to ensure a friendly walking environment in the footpath for the welfare of pedestrians of Dhaka. This study aims to make a comparative analysis of Pedestrian Level of Service (PLOS) of selected footpath segments along Segun Bagicha road, Toynbee Circular Road, Mirpur Road, and Baily road. Pedestrian Level of Service has been determined based on ten factors: path width, pedestrian volume, crossing facilities, availability of buffer, distance from vehicular traffic, surface quality, comfort, walking environment, the existence of street light. The weight of each factor has been determined through the Multi-criteria analysis approach Analytical Hierarchy Process. Path width, Pedestrian volume, and the existence of buffer are the first, second and third most important factors. PLOS has been determined based on the indexed value of factors and weight of factors. All the sections were found to have poor PLOS.

Keywords: pedestrian level of service, accessibility, analytical hierarchical process, connectivity, pedestrian flow rate.

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Evaluation of Pedestrian Level of Service of Selected Footpath Segments of Dhaka City using Multi-criteria Decision Making Approach

Md. Musfiqur Rahman Bhuiya [α], Hossain Mohiuddin [σ], Md. Shahadath Hossain Patwary [ρ] & Anika Tasneem [ω]

Abstract- Walking is considered to be the most important mode of travel across the world, particularly for a short-distance trip. Since 19.6% of the trips are made by the foot in Dhaka, it is necessary to ensure a friendly walking environment in the footpath for the welfare of pedestrians of Dhaka. This study aims to make a comparative analysis of Pedestrian Level of Service (PLOS) of selected footpath segments along Segun Bagicha road, Toynbee Circular Road, Mirpur Road, and Baily road. Pedestrian Level of Service has been determined based on ten factors: path width, pedestrian volume, crossing facilities, availability of buffer, distance from vehicular traffic, surface quality, comfort, walking environment, the existence of street light. The weight of each factor has been determined through the Multi-criteria analysis approach Analytical Hierarchy Process. Path width, Pedestrian volume, and the existence of buffer are the first, second and third most important factors. PLOS has been determined based on the indexed value of factors and weight of factors. All the sections were found to have poor PLOS. The findings of the study will be helpful for transport policymakers to improve the condition of these factors to ensure a better walking condition for pedestrians of selected footpath sections.

Keywords: pedestrian level of service, accessibility, analytical hierarchical process, connectivity, pedestrian flow rate.

I. Introduction

Walking is the most accessible mode of transport. It is considered to be the most sustainable and environment-friendly mode of transport across the globe. A better walking environment can enhance the livability of a city, ensure better access to public transport and helps to combat climate change (Bhuiya, Morshed, and Rahman, 2013; UN, 2016). For this, concerned city authority needs to ensure a better environment for pedestrian movement along the footpath and provide necessary facilities to ease their movement. 19.8% of the total trips of Dhaka are made on feet (DHUTS, 2010). So, the city authority must ensure a vibrant environment and provide the required features for these pedestrians to make the transportation system of Dhaka sustainable. But unfortunately, the footpaths of Dhaka city are not congenial for the movement of pedestrians. Lack of crossing facilities, installation of temporary vendor shops, parking of motorized vehicles, storing of construction material, piling of waste, poor surface condition of footpath and foot overbridges, etc have made movement for the pedestrians difficult and negatively effecting Pedestrian Level of Service (PLOS) (RSTP,2015; Health Bridge Foundation of Canada, n.d). To ameliorate PLOS, firstly, it is necessary to explore the condition of relevant factors influencing the satisfaction of pedestrians and determine the overall condition PLOS. This study is unique because no other studies have been conducted earlier to determine the relative weight of factors influencing PLOS based on the opinion of pedestrians. Then, PLOS of selected segments of the footpaths of Dhaka city will be evaluated based on ten factors using multi-criteria-based decision-making approach Analytical Hierarchy Process. It will further indicate areas to be more focused on future improvement as well as the development of pedestrian facilities in the city.

II. Selected Segments of Footpath

Dhaka city has a huge road network used by pedestrians. For the simplicity and time constraints, this study selected four footpath segments of Dhaka city with potential land uses to generate significant pedestrian flow to carry out the study.

Toyenbi Circular Road, Mirpur Road, Shegun Bagicha Road, and Baily Road. 900-meter long road segments from Mothijeel Junction Bus Stop to Intersection of DIT Avenue Road and Toyenbi Circular Road have been selected for the study. Prominent educational institutions like Notre Dame College and University is in proximity to these segments (Fig 1).

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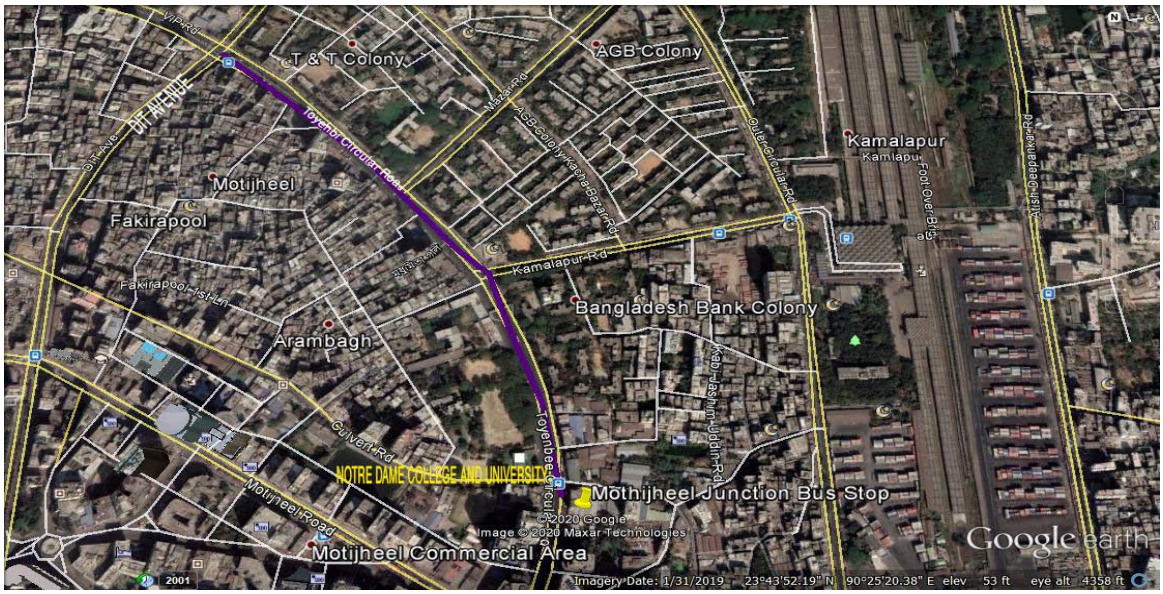

Fig 1: Selected footpath segment of Toyenbi Circular Road (Google Earth, 2019)

An 850-meter footpath along Nilkhet Bus Stop to City College Bus Stop along Mirpur road has been selected as second study pathway segment (Google map, 2018). Many people come to this place to buy clothes and daily necessaries products. The famous Dhaka New Market, Gausia Market and Balaka Cineplex is located close to this segment (Fig 2).

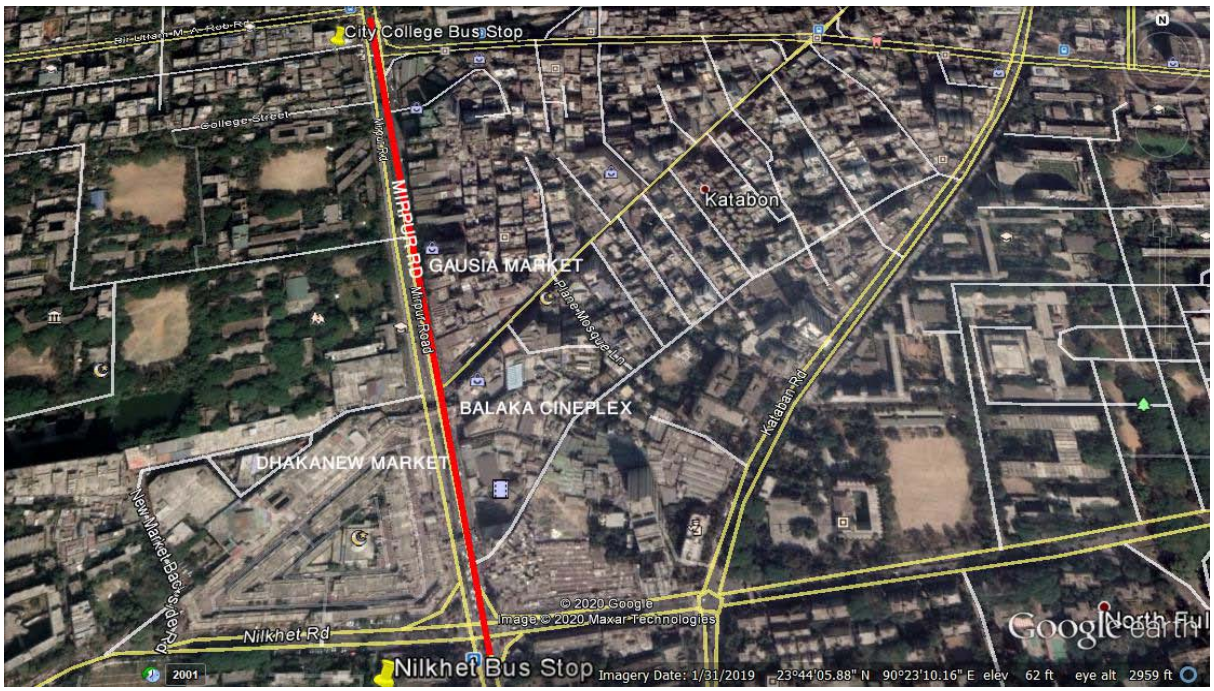

Fig. 2: Selected footpath segment of Mirpur Road

An 850-meter road section between the intersection of Segun bagicha Road and Bir Uttam Samsul Alam Sarak and intersection of Topkhana Road and Segun Bagicha Road is the third footpath under consideration (Google map, 2018). This road gives access to a Shilpakala Academy, Anti-Corruption Commission, Income Tax collection office, Office of Geological Survey of Bangladesh and other public and private offices (Fig 3).

Fourth footpath segment selected for the study is 900-meter long road section along Baily Road which starts from the intersection of Hare Road and Baily Roads and continues to the Baily Fiesta Shopping Mall. This road section has mixed land uses in the surrounding which includes residential, recreational (KFC), commercial (Bailey Fiesta Shopping Mall, Dutch Bangla Bank), Educational Institution (Viqarunnesa Noon School and College) (Fig 4).

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Fig. 3: Selected footpath segment of Segunbagicha Road



Fig. 4: Selected footpath segment of Baily Road

Selected road segments of Toyenbi Circular Road, Mirpur road, Shegun Bagicha, and Baily road have an area of 26240, 5051, 10496 and 20467 Square Feet as a footpath.

III. Methodology

The level of service is one of the key concepts for measuring the performance of transport infrastructures. Pedestrian Level of Service (PLOS) is an approach to quantify the environmental quality of pedestrian space and serve as a yardstick for defining standard for pedestrian facilities in footpath (Parida, Najamuddin and Parida, 2007: 27; Papacostas and Prevedouros, 2006: 136). With more focus across the world on green transport and active transport, it has become a crucial issue to ensure the desired PLOS for developing a sustainable transportation system (Littman, 2003). For this, this study has aimed to explore PLOS of four selected footpath sections of Dhaka and suggest policy measures for the PLOS of those footpath segments.

This study has been conducted based on primary data collected through the physical survey, questionnaire survey and field observation. Initially, a

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reconnaissance survey was conducted to the pedestrians to identify the most important factors influencing PLOS. While carrying out the reconnaissance survey, the concept of PLOS was explained to pedestrians first and they were asked to mention the factors that they consider significant to ensure better PLOS in an open-ended manner. From the findings of the reconnaissance survey, factors mentioned by pedestrians have been tallied based on numbers of pedestrians mentioned a factor. From tallied data, the top ten factors have been identified which pedestrian considers most important for ensuring a better environment for pedestrian movement.

A total number of the pedestrian has been surveyed is 240 with, 60 from each walkway segment to collect information on the relative weight of factors in respect of others. Pedestrians were asked to provide rank about their level of satisfaction about factors on a scale of 1-5.

a) Factors Influencing Pedestrian Level of Service

Path width: With the increase in path width, there will be more space for pedestrian movement avoiding congestion and better accessibility for wheelchair users to maneuver wheelchair (Main Roads Western Australia, 2006: 7; NYC, 2006: 15, Bhuiya, 2018). Path width has been determined through the physical survey. It has been indexed as 0-2, 2-4,4-6,6-8 and 8-10 feet as points 1,2,3,4 and 5 respectively.

Appropriate Placement of Roadside Features: Appropriate Location of roadside features like benches, trees, birdbath, etc on the footpath is necessary so that pedestrians can move on the footpath without receiving hindrances on their way (Mineta Transport Institute, 2012; Old Colony Planning Council, n.d.). Through the questionnaire survey, the value of this factor has been indexed as points 1,2,3,4 and 5 for very poor, poor, moderate, good and very good respectively.

Crossing Opportunity: In this study, availability of crossing opportunity has been referred by the existence of foot over bridge, zebra crossing, median refugees, guard or police control crossing for the pedestrians (Main Roads Western Australia, 2006; Mineta Transport Institute, 2012; National Roads Authority, Ireland, 2001). Point 1,2,3,4 and 5 have been allocated by surveyed pedestrians for the following situations: almost non-existent, some provided but poorly located, some provided and are reasonably well located but more are needed, adequate crossing facilities, reasonably well located and dedicated pedestrian crossing facilities are provided at adequate frequency, respectively.

Surface Quality: A crack-free, well-textured surface without undulation is necessary for the quality walking environment (Parida, Najamuddin and Parida, 2007:28; Banarjee, Maurya and Gammel, 2018: 25, 32). Through the questionnaire survey, the value of this factor has been indexed as points 1,2,3,4 and 5 for very poor, poor, moderate, good and very good, respectively.

Distance from Vehicular Traffic: With the increase in distance from vehicular way, the possibility of a conflict of vehicles with pedestrians will increase and safety is likely to decrease. In this study, distance from the pedestrian way from the curb has been considered as the distance from vehicular traffic (Main Roads Western Australia, 2006; Singh and Jain, 2011). It has been indexed as less than 0.5, 0.5-1, 1-1.5, 1.5-2 and greater than 2 km distance from the curb as points 1,2,3,4 and 5, respectively.

Pedestrian Volume: With the increase in pedestrian volume per unit area, a footpath will get more congested. As a result, the PLOS value will decline (Main Roads Western Australia, 2006; TRB, 2000). While conducting the reconnaissance survey, it has been observed that pedestrian activity remains at a higher level between 8.00 am to 8.00 p.mon weekdays. For this, pedestrian volume survey was conducted between 8 a.m. to 8 p.m over 5 weekdays. The average pedestrian volume of 5 days was divided by area of footpath segments of the road to determine the pedestrian volume over each unit area of the footpath. Pedestrian volume of 1.96-2.14, 1.67-1.95, 1.38-1.66, 1.09-1.37 and 0.80-1.08 person/sqft/day has been indexed as point 1,2,3,4 and 5, respectively.

Comfort: Comfort has been attributed to the existence of different landscaping elements placed on the footpath including benches, drinking fountain etc (Parida, Najamuddin and Parida; Banarjee, Maurya and Gammel, 2018). Through the questionnaire survey, the value of this factor has been indexed as points 1,2,3,4 and 5 for very poor, poor, moderate, good and very good, respectively to know the level of comfort ensured by existing facilities.

Existence of Buffer: Buffer like fences, bollards, trees are used to separate pedestrians from vehicular traffic for their safety (FHWA, n.d; Rahaman, n.d.) According to the opinion of pedestrians, points 1,2,3,4 and 5 have been assigned to buffers providing very poor, poor, moderate, satisfactory and highly satisfactory protection by buffers.

Availability of Street Light: Availability of street light is necessary to ease the movement of pedestrians and ensure safety for them from being mugged or victim of other crimes at night. In this study, the availability of street light has been quantified based on the frequency of street light on the footpath (FWHA, n.d.; NLPIP, 2011). Average distance between two consecutive street lights 25-27.5, 22.5-25, 20-22.5, 17.5-20 and 15-17.5 meter has been provided point 1,2,3,4 and 5, respectively.

Walking Environment: Neat and clean footpath with an aesthetically pleasing look encourages people to use the footpath. Besides, the existence of trees or other

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plants keeps the temperature of the atmosphere of the footpath at a pleasant level. According to the opinion of pedestrians, point 1,2,3,4 and 5, has been assigned to very poor, poor, moderate, satisfactory and highly satisfactory walking environment.

b) Multi-criteria Decision Making Approach and Pedestrian Level of Service

As ten different factors (i.e. criteria) will be required to bring under a single platform to determine the Pedestrian Level of Service, multi-criteria analysis approach has been followed in this study. Analytical Hierarchy Process is a widely used multi criteria approach that is used to determine the relative weight of each factor influencing particular phenomena (Saaty, 2008). Khan (n.d.) used AHP to determine the acuteness of different problems faced by pedestrians while walking along footpath based on weight put to different problems by the pedestrian themselves. In this study, AHP has been applied to determine the relative weight of considered factors to determine PLOS following weights put by the pedestrians. The indexed value of each factor has been multiplied by the respective weight determined through AHP. Thus weighted index value has been calculated and all weighted indexed values have been summed up to determine Combined Weighted Index (C). This combined weighted index value will be the Pedestrian Level of Service.

$$\text{Combined weighted index } C = w1*x1 + w2*x2 + \ldots\ldots\ldots\ldots + wn*xn \quad \ldots\ldots\ldots\ldots (1)$$

In equation (1), w1,w2 defines the weight of the first, second…….n th factor, x1, x2 defines the indexed value of first, second…….n th factor and "n" is the total number of factors considered. PLOS will be classified into four categories based on the combined weighted index. Value of combined weighted index.0-1.25, 1.25-2.5, 2.5-3.75 and 3.75-5 will be regard be as very poor, poor, good and very good respectively.

c) Data Analysis

To conduct AHP, a pair-wise matrix is developed with the help of the judgment values provided by the surveyed pedestrians showing the significance of one factor over another on a scale of 1-9 (Saaty, 2008). Table 1 shows a sample pairwise matrix. To normalize the matrix, judgment values have been summed in each column to determine column total and each entry of the column is divided by the Column Total to determine the normalized score for each entry. The normalized score of each row is summed up to determine Row Total. Priority vector is determined by dividing row total by the number of factors. To obtain the consistency index of the judgments, each column of the pair-wise comparison matrix is multiplied by their corresponding priority vector to determine the consistency measure of each factor. In the next step, a Consistency Ratio (CR) has been determined to evaluate whether the level of consistency of the pairwise comparison matrix is reasonable or not. If CR ≤ 0.1, the level of inconsistency is acceptable and tolerable. Otherwise, the degree of inconsistency is high and the decision-makers might have to re-estimate the elements of comparison matrix for better consistency (Saaty, 2008). Overall priority is measured by determining the geometric mean of the priority vector. Priority vector has been derived for each factor for each of the 240 samples separately. The geometric mean of 240 priority vectors has been determined to calculate the overall weight of each factor influencing PLOS.

Table 1: Detail Calculation AHP Procedure for determining the weight of each factor

Factors	PW	RdFt	Srf	Crs	Buf	WkEn	PV	Com	DsTr	Lig	RT	PV	CM
PW	1	3	5	2	1	2	0.5	2	2	2	1.419	0.142	10.874
RdFt	0.333	1	0.5	0.333	0.5	0.5	0.143	0.5	0.5	0.25	0.34	0.034	10.54
Srf	0.2	1	1	0.5	0.5	1	0.2	0.5	0.5	0.5	0.417	0.042	10.82
Crs	0.5	3	2	1	1	0.5	0.5	2	4	4	1.299	0.13	11.342
Buf	0.5	2	2	1	1	3	0.333	2	1	1	0.939	0.094	10.956
WkEn	0.5	2	1	2	0.33	1	0.25	0.333	0.5	0.5	0.644	0.064	11.01
PV	2	7	5	2	3	4	1	4	3	5	2.537	0.254	10.834
Com	0.5	2	2	0.25	0.5	3	0.25	1	0.333	0.333	0.642	0.064	10.618
DsTr	0.5	2	2	0.25	1	2	0.333	3	1	1	0.862	0.086	10.794
Lig	0.5	4	2	0.25	1	2	0.2	3	1	1	0.901	0.09	10.717
CT	6.533	27	22.5	9.583	9.83	19	3.71	18.333	13.833	15.58			
Factors; PW=Path Width, Rdft= Appropriate Placement of Roadside Features, Srf=Surface Quality, Crs=Crossing Opportunity, WkEn=Walking Environment, DsTr=Distance from Vehicular Traffic, PV=Pedestrian Volume, Com=Comfort, Buf=Existence of Buffer, Light=Availability of Street Light, CT=Column Total, RT=Row Total, PV=Priority Vector, CM=Consistency Measure												n max	10.851
												CI	0.095
CR= CI/RI	CI= Consistency index of pair wise matrix= $(n_{max}-n) / (n-1)$											RI	1.51
$n_{max} = \sum CM/n$	RI= Random consistency of pair wise matrix =1.98x (n–2) / n											CR	0.063

Source: Field Survey, 2017

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Table 2 reveals that path width the most significant factor influencing PLOS. Path width, pedestrian volume, the existence of buffer, availability of crossing opportunity has been identified as second, third, fourth significant factor respectively with a value greater than 0.10.

Table 2: Average Weight and Ranking of the Factors Influencing PLOS

Factor	Overall Weight	Rank
Path Width	0.173	1
Pedestrian Volume	0.151	2
Existence of Buffer	0.144	3
Crossing opportunity	0.131	4
Distance from Vehicular Traffic	0.086	5
Availability of Street Light	0.084	6
Comfort	0.083	7
Walking Environment	0.082	8
Surface Quality	0.043	9
Appropriate Placement of Roadside Features	0.024	10

Source: Field Survey, 2017

d) Evaluation of the Factors Influencing Pedestrian Level of Service

Path Width: Among four selected road sections, Toyenbi Circular Road and Mirpur Road have footpath with a relatively larger width than the other two road sections with a width of 10 feet and 8 feet respectively (Physical Survey, 2017). Section from the Baily Road and Shegun Baghica Road has a footpath width of 4 feet and 2 feet (Fig1).

Pedestrian Volume: It has been identified through pedestrian flow count from field survey that Toyenbi Circular Road, Segun Bagicha Road, Baily Road, and Mirpur Road have an average pedestrian volume of 4800, 2160, 3000 and 5400 pedestrians respectively between 8.00 am-8.00 pm of a day. Pedestrian Volume per square feet of footpath has been found 1.89, 0.85, 1.14 and 2.11person/sqft/day respectively. It implies that Baily Road and Toyenbi Circular Road have been more congested than the other two footpath segments.

Buffer from Road: No buffers were found on the Toyenbi Circular Road, Segun Bagicha Road, Baily Road. A series of steel made bollards were found along the footpath of Mirpur but not across the whole footpath. For this, the buffer of Mirpur road was not able to completely segregate vehicular traffic from pedestrians and ensure better safety for pedestrians.

Crossing Opportunity: In Mirpur Road, zebra crossing and foot over-bridge was found to provide pedestrian crossing facilities. In Tyoenbi Circular Road, there was zebra crossing for the pedestrian to cross the road. But the other two road sections have over-pass or zebra crossing. Pedestrians have to cross the road directly from footpath (Field Survey, 2017). The average value for the existence of crossing facility has been found 2.1, 1.04, 1.09 and 2.9 for Toyenbi Circular Road, Shegun Baghicha Road, Baily Road, and Mirpur Road respectively.

Distance from Vehicular Traffic: All the four considered footpaths were in very close proximity to vehicular way. For the footpath of Segun Bagicha road, the distance from curb to footpath was between 0-0.5 meters. Whereas, the other three pedestrian ways were within 0.5-1 meter. None of the roads have their footway insufficient distance from the vehicular way which makes the experience of walking through these footpaths unpleasant.

Walking Environment: The average value for the existence of walking environment has been found 3.1, 2.87, 3.6 and 1.9 for Toyenbi Circular Road, Shegun Baghicha Road, Baily Road, and Mirpur Road respectively. According tothe opinion of pedestrian, Toyenbi Circular Road, and Baily Road has a better environment for walking.

Availability of Street Light: Availability of street light is necessary to ensure the safety of pedestrian movement at night. The average distance between the street light has been found 24, 20, 16 and 28 meters for footpaths along Toyenbi Circular Road, Segun Bagicha Road, Baily Road, and Mirpur Road respectively. As the average distance between two consecutive street lights is relatively low for Baily Road, it has more street lights than others. More street lights are likely to contribute more to the enhancement of safety as well as PLOS for the pedestrian pathway of Baily Road.

Surface Quality: From the field observation, it has been identified that the footpath of Baily Road was relatively crack free. So, pedestrian feels it less problematic to walk through this footpath. On the other hand, the footpath of Toyenbi Circular Road has too many cracks in it which makes it difficult for the pedestrians to walk through it and decrease its PLOS. The average value for

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surface quality has been found 2.6, 3.4, 3 and 3.04 for Toyenbee Circular Road, Shegun Baghicha Road, Baily Road, and Mirpur Road respectively.

Comfort: Availability of benches, drinking fountains, public toilets, etc are very rare in Dhaka city. Only benches were found along the footpath of Baily road. For this, pedestrians can get better comfort by sitting on these benches. Benches or other kinds of facilities which may provide comfort or Comfort for walking are missing in the footpaths of the other three road sections. The average value for comfort has been found 1.3, 1.9, 3.1 and 1.02 for Toyenbee Circular Road, Shegun Baghicha Road, Baily Road, and Mirpur Road respectively.

Appropriate Placement of Roadside Features: It has been found dustbins and trash receptacles placed in the middle of each footpath segment which is not only creating obstacles in pedestrian movement but also odors from these dustbins and trash receptacle have made the surrounding environment unsuitable for walking. As there is no designated place for vendors and hawkers, they have occupied the place in the middle of footpath and are creating obstacles in pedestrian movement in all the footpath segments under consideration (Field Survey, 2017). The average value for appropriate placement of roadside features has been found 1.1, 1.05, 1.9 and 1.03 for Toyenbi Circular Road, Shegun Baghicha Road, Baily Road, and Mirpur Road respectively.

e) Pedestrian Level of Service

The combined weighted index "C" was calculated first before determining PLOS. It was calculated according to the following equation.

$$C= 0.173* PW+0.151* PdFl+ 0.144* Buf+ 0.131*Crs + 0.086*DsTr+ 0.084* Lig +0.083*Com+0.082*WkEn+0.043*Srf+0.024* RdFt$$

Pedestrian Level of Service for each of the footpaths has been shown in Table 3. None of the footpaths along the considered roads have been found to have a satisfactory PLOS. Each of the footpath segments has been found to have poor PLOS. Among the four footpath segments, the condition of Baily Road is relatively better in terms value of PLOS.

Table 3: Situation Analysis of the Factors and Determining Pedestrian Level of Service

Factors	Toyenbi Circular Road	SegunBagicha Road	Baily Road	Mirpur Road	Weight
Appropriate Placement of Roadside Features	1.1	1.05	1.9	1.03	0.024
Path Width	5	1	2	4	0.173
Pedestrian Volume	2	5	4	1	0.151
Existence of Buffer	0	0	0	2.5	0.144
Crossing Opportunity	2.1	1.4	1.09	2.3	0.131
Distance from Vehicular Traffic	1	2	1	1	0.086
Walking Environment	3.1	2.87	3.6	1.9	0.082
Availability of Street Light	2	4	5	1	0.084
Comfort	1.3	1.9	3.1	1.02	0.083
Surface Quality	2.6	3.4	3	3.05	0.043
Pedestrian Level of Service	2.1964	2.18384	2.3258	2.0706	

IV. Conclusion

Taking appropriate measures to improve the pedestrian level of service is necessary to motivate people to walk more and encourage them to go to the bus stop by walking and reduce dependence on other transport (Bhuiya *et al*, 2013). By providing better environment for pedestrian movement, people can be encouraged to walk instead using motorized vehicles and reduce carbon emission which is very significant for Dhaka in the context temperature rise in recent years and mitigate possible impact of climate change in Dhaka (Mohiuddin, Bhuiya and Mahmud,2014).From the study, it has been found out that all the factors influencing PLOS are not equally important to ensure better walking conditions. It has been found adequacy of path width is the most significant factor influencing PLOS. Pedestrian volume and the existence of buffer are the second and third important factors influencing PLOS. Adequate crossing opportunity and distance from vehicular ways are also important factors. All the pedestrian walkway segments under consideration have unsatisfactory PLOS. But in respect of Dhaka city, this situation is very pitiable as 19.6% of trips of Dhaka City are made by foot. It is a crying need to improve the condition of pedestrian pathways of Dhaka. Due to resource constraints, it may not be possible to

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ameliorate all the factors influencing PLOS. The government can prioritize the factors based on the findings of this study. The concerned authority should take the necessary steps to improve the PLOS for Dhaka. The priority should be given to expanding the footpath as much as possible. The concerned authority should motivate landowners to left lands from their plots to expand footpath which will enhance the capacity of the footpath to accommodate higher pedestrian volume avoiding congestion. Besides, providing adequate crossing opportunities and buffer are also necessary steps to improve PLOS (Rahaman, n.d.).

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Ecological Status, Natural Productivity, Physico-Chemical and Biological Factors Controlling Productivity in the Bow Lake of Bansadaha, Burdwan

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Abstract- The basic understanding of the limnology, productive potentials, and fish productions of beel (water body) is essential for the sustainable development at Bansdahabeel in Burdwan. The area of Bansdahabeel is 26-hectare having depth 1.75 to 5.5m. An investigation was conducted on the ecology of the beels, productivity, plankton and macrophytes. Transparency value was low during summer and the pH was slightly alkaline. The monthly mean values of dissolved oxygen were somewhat lower in this closed beel (water body). The nitrate values were higher in summer and lower during the monsoon period. The soil contains 93% of sand. Among the plankton, community, phytoplankton formed the main portion of the total plankton. Cyanophyceae was the major contributor among the phytoplankton as Chlorophyceae was the second largest group. The monthly mean value of the zooplankton population was 417.22μl^{-1} in Bansdahabeel. The beel harbours mixed population of macrophytes with the dominance of submerged plants throughout the year. Fish production was recorded to 1159.83 kg/ha/yr. However, the production of carps was much higher than the miscellaneous fishes.

Keywords: oxbow lake, wetland, beel, macrophyte, productivity, plankton.

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ECOLOGICALSTATUSNATURALPRODUCTIVITYPHYSICOCHEMICALANDBIOLOGICALFACTORSCONTROLLINGPRODUCTIVITYINTHEBOWLAKEOFBANSADAHABURDWAN

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Ecological Status, Natural Productivity, Physico-Chemical and Biological Factors Controlling Productivity in the Bow Lake of Bansadaha, Burdwan

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Abstract- The basic understanding of the limnology, productive potentials, and fish productions of beel (water body) is essential for the sustainable development at Bansdahabeel in Burdwan. The area of Bansdahabeel is 26-hectare having depth 1.75 to 5.5m. An investigation was conducted on the ecology of the beels, productivity, plankton and macrophytes. Transparency value was low during summer and the pH was slightly alkaline. The monthly mean values of dissolved oxygen were somewhat lower in this closed beel (water body). The nitrate values were higher in summer and lower during the monsoon period. The soil contains 93% of sand. Among the plankton, community, phytoplankton formed the main portion of the total plankton. Cyanophyceae was the major contributor among the phytoplankton as Chlorophyceae was the second largest group. The monthly mean value of the zooplankton population was 417.22μl^{-1} in Bansdahabeel. The beel harbours mixed population of macrophytes with the dominance of submerged plants throughout the year. Fish production was recorded to 1159.83 kg/ha/yr. However, the production of carps was much higher than the miscellaneous fishes. This study may be helpful in optimum utilization and sustainable management of the beel. The management and conservation are essential to ensure a higher fish yield.

Keywords: oxbow lake, wetland, beel, macrophyte, productivity, plankton.

I. Introduction

The availability of protein-rich food has been particularly constrained. Fish is recognized as the most important and easily digestible animal protein and with the available resources, it can play a great role in fulfilling the protein requirement. Apart from promoting aquaculture, the country will have to focus her attention to achieve optimum sustainable yield from wetlands, reservoirs, etc. The oxbow lakes were created in the process when young meandering rivers grew old, straightened their course leaving the erstwhile bend and deepest part separated from the main flowing river course. The separated lotic became stagnant, i.e. lentic water body separated from the river. The oxbow lakes or lakes constitute boundless and varied fisheries resources. These water bodies called oxbow lakes. Oxbow lakes have to be recognized and distinguished from other ecosystems by the ecological characteristics alone for their proper management (Sinha, 1997). The closed beels are water bodies that have lost connections with the main river generally due to strengthening of river embankment. The fishery constituted by miscellaneous fishes (Yadav, 1987). In closed lakes, stocking is the mainstay of management. A production rate up to 1000kg/ha/yr is attainable from floodplain lakes when subjected to scientific management against production to 100 kg/ha/yr. under traditional management (Sinha, 1998, 2001).

The present study has been contemplated from 2017 to 2018 in Bansadaha closed system located in the district of Burdwan, West Bengal to ascertain ecological status, natural productivity, fishery potential, physico-chemical and biological factors controlling productivity.

II. Materials and Methods

The investigation was carried out in closed type beel of Bansadaha during the period from January 2017 to December 2018. The area of Bansadaha beel is 26 hectare lies between latitude 23° 21' to 23° 20'43" N and longitude 88° 17' 45" to 88° 20' E. Fluctuation in water depth on an average ranged in Bansadaha from 1.75 to 5.5m.

a) Physico-Chemical Parameters

The physicochemical parameters studied on water were temperature (Celsius thermometer scale ranging from 0°C to 100°C), water column by rope and scale, Transparency was measured by secchi disc method, pH by field digital pH meter, dissolved oxygen by modified Winkler's method (Strickland and Parsons, 1972), alkalinity by titration method, water nitrate (NO_3-N) was determined by UV spectrophotometer and phosphate by colorimetric procedure. Silicate was determined by the color of the silicomolybdic acid complex by a Beckman spectrophotometer. Primary productivity was determined by measuring the oxygen produced i.e. photosynthesis by light and dark bottle

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technique. Water samples were collected at monthly intervals from the beel throughout the investigation period. The collected soil samples were brought to the laboratory of Environmental Science, The University of Burdwan, for determining the desired parameters. Soil texture was determined by mechanical analysis as per Piper (1966). Soil pH as determined by the electrometric method using a pH meter. The nitrogen was estimated by Kjeldahl's method and available phosphorous was determined by Tong's method.

b) Analysis of Plankton

The plankton samples were collected in the monthly intervals from Bansadaha beel in fixed spots by plankton net made of standard nylon boltting cloth no.25 (mesh size: 0.03-0.04mm). The planktons were preserved in a 3% formaldehyde solution in 10 ml vials and brought to the laboratory of the Zoology Department, Burdwan University. Quantitative and qualitative analyses of collected samples were done in the laboratory by using a Sedgewick-Rafter counting cell. Identification of planktonic organisms was carried out in the Department of Zoology, The University of Burdwan.

c) Macrophytes

The samples for biomass analysis were collected at random using one sq.m. quadrate. Free-floating pant materials were collected along with rooted parts, while the submerged plants were uprooted from the enclosed area. The collected materials were transported into the laboratory and were sorted species-wise. The collected macrophytes were identified in the Department of Botany, The University of Burdwan.

d) Fish fauna

Fish fauna samples were collected every month with the help of local fishermen. Specimen of each species was collected for identification consulting the books of Jayram (1981), Talwar and Jhingran (1991) in the fisheries Laboratory, Department of Zoology, Burdwan University.

III. Results

a) Water Temperature

Variability in water temperature from January to December was not well marked and ranged from 26.2 to 27.5. The temperature being recorded higher during summer and pre-monsoon months (Table 1).

b) pH:

The pH value recorded from 7.8 to 8.9, i.e., no remarkable seasonal variation in the pH values, was observed (Table 1).

c) Dissolved oxygen

The dissolved oxygen content ranges from 4.66 mg L^{-1} to 7.07 mg L^{-1}. The higher values of dissolved oxygen were recorded from June to September, followed by March to May and October to November (Table 1).

d) Alkalinity

Higher values of alkalinity was recorded during the summer period (185.2 mg L^{-1}) and lower values during monsoon and winter months (Table 1).

e) Transparency

Hardly any noticeable fluctuation was observed in the water transparency of the Bansdaha beel during summer and monsoon months ,except during winter months (Table 1).

f) Phosphate

Bansdaha beel exhibited phosphate values between 0.07 mg l^{-1} to .35 mg l^{-1}. The seasonal variation showed the presence of higher value ,i.e., 0.35 mg l^{-1} during summer ,i.e., March to May and lower monsoon (0.17 mg l^{-1}) and winter months (0.07 mg l^{-1} to 0.15 mg l^{-1}) (Table 1).

i. *Silicate*

Hardly any seasonal fluctuations were observed in the silicate values in the Bansdaha closed beel (Table 1).

ii. *Nitrate*

The nitrate value exhibited higher value (0.05 mg l^{-1}) during summer months i.e., March to May and lower (0.02 mg l^{-1}) during the monsoon (0.03 mg l^{-1}) and winter (0.02 mg l^{-1}) months (Table 1).

g) Sediment Characteristics

i. *Soil texture*

The Bansdaha, closed beel contains a very high percentage of sand, which is about 93%, silt3% and clay 4% (Table 2).

ii. *Soil pH*

In Bansdaha, soil pH exhibited hardly any seasonality with minor higher values during the monsoon and lower values during summer and winter (Table 2).

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Table 1: Physico-chemical parameters of surface water in Bansdahabeel

Parameters	December-January	March-May	June- September	October-December
Water Temperature	26.2±	27.3	27.5	26.7
pH	7.83	8.03	7.95	7.8
Dissolved oxygen (mg L^{-1})	4.66	6.31	7.07	6.35
Alkalinity (mg l^{-1})	179.8	185.2	178.1	176.7
Transparency (cm)	1.03	0.72	0.75	0.73
Phosphate (mg l^{-1})	0.15	0.35	0.17	0.07
Silicate (mg l^{-1})	2.41	2.31	2.13	2.32
Nitrate (mg l^{-1})	0.04	0.05	0.03	0.02

h) Phosphorus

The available phosphorus content in the bed sediment was found to be higher in summer months and lower in winter and monsoon months (0.43, 0.23, 0.33 and 0.38 mg/100 gm of soil) (Table 2).

i) Nitrogen

The values of available nitrogen of soil sediment were found to be comparatively higher during summer months (10.16 mg/ 100 gm of soil) and marked lower value during the monsoon season (5.58 mg/100 gm of soil) (Table 2).

j) Phytoplankton

In Bansdaha, closed beel, the highest monthly mean of phytoplankton was observed during June and July. The phytoplankton population was represented primarily Chlorophyceae, and Cyanophyceae. The dominated species of Bansdaha was *Planktosphaeria* and *Closterium*, and Cyanophyceae are dominated by *Anabaena* and *Lyngbya*. (Fig. 1)

k) Zooplankton

The zooplankton population in the Bansdaha closed beel varied from 37 μl^{-1} to 1205 $\mu l^{-1.}$ The beel showed three peaks during February, July and November. The zooplankton is represented by *Cyclops, Diaptomus, Nauplii*, and *Daphnia*. (Fig. 2)

Table 2: Physico-chemical characteristics of soil sediment in Bansdahabeel

Parameters	December- January	March- May	June- September	October- November
Sand (%)	93			
Slit (%)	3			
Clay (%)	4			
Soil pH	6.3	6.16	6.4	6.2
Phosphorus (mg 100^{-1} of soil)	0.38	0.43	0.33	0.23
Nitrogen (mg 100^{-1} of soil)	8.2	10.16	6.25	5.58

l) Macrophytes

The Bansdaha beel harboured mixed population of macrophytes. The numbers somewhat higher during the summer months. The marginal macrophytes were restricted to about 8-10% of water spread and represented by *Ceyratia, Cyperus*species. The rootless floating species like *Salvinia notatus* ,and *Azolla* sp. and rooted free-floating types like *Spirodella polyrhiza, Pistia stratioles*. The rooted submerged macrophytes were represented by *Ceratophyllum demersum*, *Hydrilla verticillata* and *Vallisneria spiralis*. The only rooted floating macrophyte *Nymphaea* sp. was recorded. (Fig.3).

m) Fish production

Fish production is found to be 1159.83 kg/ha/one year. The production value of carp was 853.19 kg/ha/one year. The highest production of fish was recorded during March, April and May. The fish species is represented by *Catla catla, Labeo rohita, Labeo bata, Puntius ticto, Amblypharyngodon mola, Channa sp., Anabas testudineus, Notopterus notopterus, Mystus vittatus, Mastocembelus armatus,* and *Heteropneustes fossilis*. (Fig. 4).

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IV. Discussion

The basic understanding of the limnology, productive potentials, and fish populations of beel is very essential for the sustainable development of beel fisheries (Tamuli et al. 2018). The closed beel is the disconnected remnants of tributaries of riverine networks. Due to topographical feature, the fluctuation in the water column on an average ranged from 1.75 to 5.5m in Bansdaha. According to Mukhopadhyay (1997), the beels of West Bengal are vulnerable to high water level fluctuation. This probably facilitates the growth of rooted aquatic macrophytes that compete for nutrients with phytoplankton. The low transparency has been observed during summer months, which is attributed to the wind action and phytoplankton bloom. Similar seasonal fluctuation in lakes has been reported by Kumar (1985) and Nath (1999). In the present study, the surface water temperature in Bansdaha varied from 26.2 to 27.5. However, the higher temperature was recorded during the summer and monsoon months. Similar sort of temperatures of the water surface was reported by Bhowmik (1988) and Bhattacharya (2010) and Kapil (2010) in beels and bars of west Bengal. In the present observation, the concentration of hydrogen ion was slightly alkaline. The alkaline pH of the water body revealed high productivity and also a conductive environment for bio-community habitation and multiplication. Banerjee (1967) observed that a pH of 8.0 and above had been recorded to be productive. A slightly alkaline water pH was optimum not only for the fishes but also for fish food organisms. Sivlingam et al. (2013) reported that pH is positively correlated with alkalinity, dissolved oxygen, and phosphate. The highest concentration of dissolved oxygen content from June to September in Bansdaha, possibly because of rainfall and alkaline pH, the decomposition of organic matter was less with low consumption of dissolved oxygen. The main supply of phosphorus in the water body comes from leaching of the soil of the catchment area by rain. The values of phosphate of the present study were higher in the summer season, which indicated highly productive. The nitrate concentration was optimal for the growth of plankton. In the present study, the concentration of silicate varied minutely. Silicate content in the water body is of immense significance as a major nutrient for diatoms (Chakrabarti, 1980).

The soil texture contains a high percentage of sand, and a low percentage of silt and clay in Bansdahabeel indicate rich productivity. The soil pH is acidic in nature. Das (1983), working on the bells of West Bengal, has reported a similar acidic pH of soil. In the soil sediment, low phosphate content may be the fact that phosphate ion in soil form soluble compound with iron and aluminum and with calcium under alkaline condition. The plankton population was the major contributor in the Bansdahabeel. The nitrate and phosphate content of water influence the seasonal changes of phytoplankton in the beel (Toner 1981). Highest Cyanophyceae was found to be a major contributor among the phytoplankton in Bansdahabeel. The present study corroborates with the findings of Bhaumik (2001). Zooplankton was found to be inversely correlated with phytoplankton in Bansdahabeel. A similar sort of positive correlation between zooplankton and phytoplankton was reported by McCauley and Kalft (1981).

In the present investigation, the Bansdaha beel harboured mixed population of macrophytes with the dominance of submerged plants. However, deeper parts of the beel were found to be scarcely infested due to depth differences. The rooted submerged macrophytes was found to be more than the other groups. Sharma (1995) also recorded dominance of submerged macrophytes in Kawar Lake in Bihar and opined that this might often result in siltation.

The Bansdahabeel is represented by 12 to 15 dominant species of ichthyo fauna. Bhowmik (1988) and Sugunan et al. (2000) emphasized that the combination of Indian and exotic carps greatly influences fish production in the beels. Fish production in Bansdaha beel was found to be highly correlated with phytoplankton and total plankton.

Therefore, the Bansdaha beel is ideal for practicing culture-based Fisheries as this beel is very rich in nutrient and fish food organisms. The beel also allows the stocking of detritivorous fishes as the energy transfer takes place through the detritus chain. At present, the beel urgently require renovation and proper financial assistance and guidance from the Government sector are essential in this regard. Many species of fishes of Indian origin have become extinct, and many are on the verge of extinction. Bells are suitable places for harboring and culturing such rare species as beels contain several naturally occurring niches. On 11th September 2019, the honorable minister, Sri. Swapan Debnath, Animal Resources Development Ministry, Govt. Of West Bengal, along with the administrators of Panchayet and zilla parishad planted various types of trees on the dike of beel to save greenery as well as to keep the environment viable.

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Legends of the Figures



Fig. 1: Picture of the experimental site, Bansdahabeel.

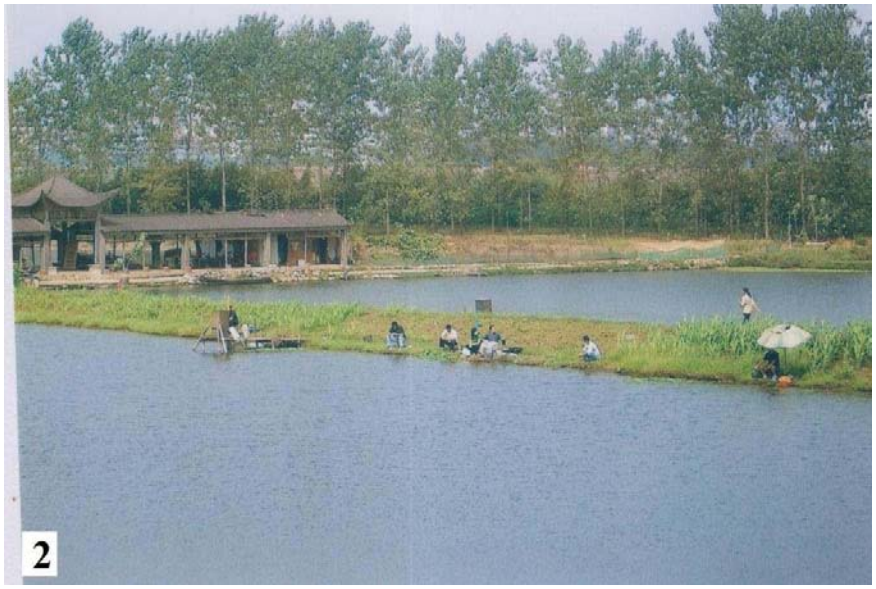

Fig. 2: Estimation of Zooplankton population in the experimental site.



Fig. 3: Distribution of mixed population of marcrophytes in Bansdahabeel.

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Fig. 4: Figure showing the main culture and collection zone for vaious type of fish species.

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Burgeoning of Commercial Ornamental Plant Nurseries in Dar es Salaam City: Challenge and Future Prosperity

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Abstract- Commercial ornamental nurseries are popping up everywhere in the city of Dar es Salaam. However, as the city urbanizes, the commercial ornamental nurseries are confronted by several challenges of which are inadequately explored and documented. This research examines challenges, problems and explains the future prospects of commercial ornamental nurseries in the city of Dar es Salaam. The study adopted the case study design where the method for data collection relied on in-depth interviews and observation. Results revealed that ornamental plant dealers face several challenges such as; unsecured land tenure, which threaten the prosperity of the commercial ornamental nursery practices. Problems encountered are those related to plant pests, diseases management and inaccessibility of water for irrigation. On the other hand, commercial ornamental dealers get little support from the responsible city authorities in access land and management of pest and diseases. The study recommends that success of commercial ornamental nursery industry needs more support from different actors and policies together with capacity building among the commercial ornamental dealers.

Keywords: *commercial ornamental nurseries, challenges, future prosperity.*

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Pastory, S. T [α], Francis, H. S [σ] & Temu, G. S [ρ]

Abstract- Commercial ornamental nurseries are popping up everywhere in the city of Dar es Salaam. However, as the city urbanizes, the commercial ornamental nurseries are confronted by several challenges of which are inadequately explored and documented. This research examines challenges, problems and explains the future prospects of commercial ornamental nurseries in the city of Dar es Salaam. The study adopted the case study design where the method for data collection relied on in-depth interviews and observation. Results revealed that ornamental plant dealers face several challenges such as; unsecured land tenure, which threaten the prosperity of the commercial ornamental nursery practices. Problems encountered are those related to plant pests, diseases management and inaccessibility of water for irrigation. On the other hand, commercial ornamental dealers get little support from the responsible city authorities in access land and management of pest and diseases. The study recommends that success of commercial ornamental nursery industry needs more support from different actors and policies together with capacity building among the commercial ornamental dealers.

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I. Introduction

Commercial ornamental nurseries are one among the informal growing sector in the urban areas of developing countries and it employs the youth who hardly access formal employment. A study by REPOA (2007), reported that more than 50% of the youth in Tanzanian urban are employed in the informal sector. According to Magigi (2013) more than 40% of people in the Dar es Salaam city undertake their activities in the informal sector including urban agriculture. The commercial ornamental nurseries are one of the informal sector activities widely practiced in Tanzanian cities and urban areas including Dar es Salaam City (Liljestrom & Persson, 2014).

Despite commercial ornamental plants nurseries taking being place in the informal sector, they play a vital role in greening the city (Hassan & Mombo, 2016). The dealers of ornamental nurseries provide flowers which are used for aesthetical purposes (Akintoye et al, 2011). Furthermore, those dealers provide fruit trees which have motivated people in the peri-urban areas to grow fruit trees (Hassan & Mombo, 2016 & Lau, 2013). The fruits trees are important for food security and greening and beautifying the city environment (Osawaru et al, 2015).

Commercial ornamental nurseries do not only support the green urban environment and food security but also provide employment opportunities to youth and needy women in the urban areas. Ornamental tree nurseries offer employment opportunity to urban residents around the world and trends forecast show a promising market for this business (Di Vita, 2015). As a considerable number of youths have been employed in this sector, youth unemployment and income generation challenges have somehow been reduced (Abreu et al, 2009 & Bishoge, 2018).

Despite the roles played by commercial ornamental being diverse, problem associated with it have been reported not only in developing countries but also in developed nations. For instance, in the United States of America, management of ornamental plants is less institutionalized compared to the rest of food crop production industry (Daughtrey & Benson, 2005). It is reported that the ornamental plant growers do not enjoy the same governmental subsidies in comparison to non-ornamental plant (Ibid). In Africa, several challenges have been noted. In Nigeria, the study by Adeduntan (2015) show that there is inadequate access to land by ornamental nursery dealers growers. In Kenya, the development activities such as the expansion of roads interfere with the existing nurseries along the major road reserves (Otiso, 2018).

In Tanzania, most of the government officials are not committed to support local ornamental plant nurseries simply because the accrued value of the enterprise cannot easily be expressed in monetary values which have an impact to city or national economy (Mg'ong'o, 2004 & Hassan & Mombo, 2016). In the similar note, Bishoge et al. (2017) noted that there is less recognition of the ornamental plant dealers by the government authority. Such inadequate recognition has hampered ornamental nursery dealers from accessing basic services as well as land. Furthermore, Bishonge and others noted that the ornamental dealers have a limited knowledge in managing the whole activities related to nurseries and growth of ornamental plants.

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However, the argument by Bishonge et al based from scientific research, some of the ornamental nurseries still exist and are rapidly emerging in the cities.

There has been substantial policy development and implementation toward managing urban issues such as; green spaces, human settlements, flooding and other many issues. United Nations in the new urban agenda advocates the nations to integrate policies that support green space in urban areas (United Nations, 2017). The UN Habitat encourages the development of policies that take into consideration the green spaces (Andersson, 2016). These international agencies believe that habitats or settlement without greening is hardly habitable. In 1990s, the Sustainable City Programme (SCP) gained acceptance globally as it encouraged collective efforts of different actors in addressing pertinent urban issues including solid wastes, urban renewal, open spaces mentioning but a few. In Tanzanian context, from SCP the Urban Environment Management (EPM) was established in order to identify, sensitize and work on these issues to enhance environmental sustainability (Kasala, 2015). One the highlighted issues by EPM are the management of open space. However, open space includes the green processes by using plants that are produced in the ornamental nurseries; ornamental nurseries were not given much priority (Hassan & Mombo, 2016). As the result, they emerged everywhere in the city wherever there was a space and the possibility to operate informally.

Dar es Salaam city is one among cities adopted EPM process so as to solve environmental problems in urban areas. Other initiatives adopted and implemented by Tanzania government include the enactment of the National Environmental Act, 2004; National Land Policy of 1995 and the Urban Land Act No.4 of 1999 and The Urban Planning (Urban Farming) Regulations of 2018. In line with these policy and legal frameworks, the Tanzanian government is taking initiative to formalize informal settlements of urban areas and offering informal business card for people engaging in informal activities. However, such initiatives seem to overlook land for commercial ornamental enterprise which provides green materials greening urban environment.

Despite less legal and policy document in Tanzania context, commercial ornamental nurseries are mushrooming everywhere within the CBD and in the peri-urban areas of the city. Yet, there is a limited formal information platform for discussing the future prosperity of these commercial ornamental nurseries. Then, what is the future prosperity of commercial ornamental dealers? Therefore, this paper examines the challenges, problems and future prosperity of ornamental dealers in Dar es Salaam city.

II. Methodology

The study adopted a qualitative research approach in order to unveil the feelings, understanding, thoughts and opinions regarding the challenges and problems encountered by commercial ornamental dealers. Moreover, it employed a case study because five cases were studied including, Mlimani city along Makongo-Juu Road; Temboni along Morogoro Road and Magari Saba along Mbezi to Kibamba Road both in Ubungo Municipality. Others include sites besides Tumaini University College and GMS industrial area along Mwenge to Coca-Cola Road in Kinondoni Municipality.

Thirty ornamental plants dealers were purposively selected particularly those who could provide first-hand information. Moreover, five Mtaa chairpersons, one agrovet dealer, one town planner, one environmental officer and one agricultural officer were interviewed using checklists.

Data were collected from the primary sources through the in-depth interview with ornamental plant dealers, Mtaa chairpersons and the officials. Secondary sources of data, particularly published papers were reviewed firstly to widen the understanding of the researchers on the topic and secondly to cite important information in order to enrich the discussion.

III. Results and Discussion

a) Access to land for commercial ornamental nurseries

Land is the requisite factor for the existence and flourishment of ornamental plant nurseries in the city of Dar es Salaam. Commercial ornamental dealers follow number of steps to acquire land depending on the existing ownership over the land they are interested for their activity. In the visited sites for instance, some of the land is owned by institutions while others by individuals.

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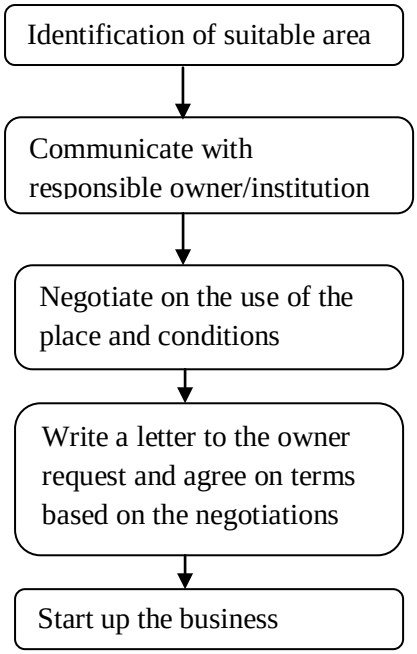

Figure 1: Steps followed to acquire and for ornamental nursery activities.

One of the respondents along Mlimani City nursery declared that places used for ornamental plant nursery are not accessed freely, one has to see the owner or responsible institution in order to request for the permission. However, before establishing the business, they first write a letter which presents their request and send it the owner of the land. Their request can be either accepted or rejected. When it is accepted, they are given conditions which they are obliged to adhere.

In the similar note, one of the respondents quoted saying that:

> *We wrote a letter to the University of Dar es Salaam management requesting a permission to use the two road reserves thinking that the University is the owner, instead the University directed us to the management of Mlimani City Shopping Mall who currently do manage the area, eventually permitted us but with some conditions*".

One among the conditions was to ensure the general cleanness of the site used for such activity. Another condition given was that, they should be ready at any time to vacate the site wherever the area is needed by the management.

Similar conditions were given to Magari Saba ornamental dealers along Mbezi-Kibamba Road; although, this is a different site and owned by Tanzania National Roads Agency (TANROAD) The TANROAD told the ornamental nursery dealers to observe environmental cleanliness while undertaking their activities. The findings reveals that despite, land for ornamental nurseries being owned by different institutions, conditions given to the ornamental plant dealers and procedures to access such land are almost the same.

The most challenge encountered by the ornamental plant nursery dealers is the lack of security of tenure to support their existence in the site. Wherever owners need to use the area for other planned or emerging activities the nursery project ends up instantly. These findings reflect the study by Berry (2014) who points out that access to land by ornamental nursery dealers is not an easy task in rapidly urbanized cities. However frankly, ornamental plants are having more roles to play especially the green of urban environment. In other country like Nigeria also, access to land for ornamental activities is in adequate (Adeduntan, 2015), implying that there is no effort taken by the city authority to designate and allocate land for ornamental nurseries. When the ornamental dealers at Mbezi site were interrupted due to expansion of Ubungo- Kibamba road, they attempted to seek land elsewhere in the city. The squatted on un-built up public land while are keep on searching the land for their ornamental plants.

For instance, ornamental plant dealers located nearby the Tumaini University College along the Mwenge-Coca Cola Road were given a place by the Tanzania Rural and Urban Road Agency (TARURA) but condition that should be ready to vacate whenever the area is in need without any compensation. The condition of instant vacating given is tedious because it is not easy to secure area for short period of time. Some

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gardeners who suffered during the Ubungo-Mbezi road expansion squatted in the public land but three months later their nurseries were destroyed without a pre notice in-favour of government water project.

What happens along Ubungo-Mbezi in Dar es Salaam is not a new story in East Africa context, in Nairobi for example, the expansion of intra city roads involved the evictions of road reserve commercial ornamental dealers without any excuse and compensations (Otiso, 2018). In contrary, Franco et al. (2006) argued that commercial ornamental needs to be recognized in urban land use development projects in order to support the future of ornamental nursery projects. In some countries like Cuba and China, city authorities recognize the importance of ornamental nurseries and landscaping projects hence it area has been included in the design of detailed plan (Zeeuw *et al.,* 2000 & Lau, 2013). However, the city environmental officer acknowledged that in Tanzania little attention has been paid by urban authority to support ornamental nursery because it is thought that it is an enterprise which can operate privately. Despite ornamental nursery being the primary components for greening the city environment, its operation and management is not heartily supported and it seems to be not a city authority priority like health, water services, education and infrastructure development. All these have retarded efforts behind its prosperity.

b) High urban land price

The land value in Dar es Salaam city has increased because of increased population and high demand for residential and commercial plots As a result urban land use with higher economic merits are given priority in land use planning. Access to land by low income groups in urban areas remain uncertain due to high prices which do not reflect low income earners' budget like ornamental commercial dealers.

With this reason, few commercial ornamentals do rely on road reserved land to undertake such activity. Scholars Dearbornet & Kark (2010) argue expensive land price in cities have discouraged majority land owners to put interest to commercial cultivars rather prefer other land uses like residential and commercial activities. Apart from high land price and lack of security of tenure, ornamental plant nursery requires good location free from interferences from other anthropogenic activities. However, this condition did not prevail to the ornamental nursery nearby Mwenge Minibus Stand because of the interferences from petty traders. In the discussion with some of the respondents who formally used area that area reported that because of interference of petty traders, they had to struggle searching for another site which destined them to the road reserve opposite GSM industrial area along Mwenge-Coca Cola Road.

One of the respondents in the discussion had this to say:

> *We had to leave the area because petty traders were not respecting our project they use to step on our seedlings, destroying them and even sometimes stealing them that made us find another place".*

c) Access to water by commercial ornamental nursery dealers

Water is very necessary for the growth of plants as well as in the manufacturing of food via photosynthesis and also in the transportation of minerals and food for the plant. Ornamental plant nursery dealers from the visited sites access water from different sources to supplement rain water during dry season as shown in table 1.

Table 1: Access and sources of water by commercial ornamental nurseries

S/n	Commercial nursery sites	Sources of water
1	Mlimani city	-Waste water discharged from road side drains. -Water discharged from the leakage of city water supply authority (DAWASA).
2	Beside Tumaini University Collage	-Waste water discharged in road side drains from the nearby residences. -Sometimes do buy water from water vendors.
3	Along GMS Industrial area	-Waste water discharged in road side drains from the industrial area and nearby residences.
4	Temboni along Morogoro Road	-Formal connection of water from the city water supply authority. -Water from shallow well dug out in the nearby water streams.
5	Magari-Saba	-Water from shallow well dug out in the nearby water streams.

Source: Field data, 2019.

Like other sites, the Mlimani City use water from different sources including leakage from the Dar es Salaam Water Supply and Sanitation Authority (DAWASA) pipe locate underneath the site. Some are connected to DAWASA as the main supplier of water in the city where those connected do pay monthly bill amounting to 1, 670TZS per cubic meter of water. Other sources include unclean water from road side drains, however commercial ornamental at Tumaini University and GSM site use drain water discharged from the

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nearby industries and waste water from nearby residential areas. Although some commercial ornament dealers use dirty water discharged from the industry and nearby residential houses, none have complained on the negative effects of such water to the garden plants. The use of reclaimed water is however, not a new phenomenon as it is also used in the United States of America for irrigation purposes (Haering *et al.,* 2009); however, it is recommended that such water have to be treated to reduce infections. Again, during dry season most of ornamental dealers do buy water from street vendors at a price of 200TZS per 20 litters bucket. During the dry and drought seasons, only those plants which are less tolerance to drought are irrigated. Barbe *et al.* (2017) observed shortages of water supply for domestic uses in the informal settlement in Dar es Salaam City and such shortage also face ornamental nursery business.



Source: Field survey, 2019.

Plate 1: Water source at Mlimani city shopping-mall nursery

d) Access to seeds and plant material for propagation

Seeds and other propagating materials such as flower and shrubs cuttings and suckers are important for the sustainability of ornamental plant nurseries (Dehnen et al, 2007). Seeds used by gardeners are both exotic and native species collected from various parts of the country. According to the interview, the gardeners collect the ornamental plant seeds and propagating materials within and outside the city and multiplied them through propagation techniques by some experienced gardeners. However, the findings revealed that people who used work as gardeners in foreign embassies and catholic churches located in Dar es Salaam are the ones who brought exotic spices of ornamental materials to nursery dealers. Some seeds of turf grass species like Brazilian are rarely sold in some shops at Kariakoo but most of them are locally collected. In order to ensure the supply of diverse ornamental plant species, some of the commercial ornamental plant garners have established the gardening network with commercial other ornamental dealers from other Tanzanian regions including; Tanga, Iringa, Morogoro, Mbeya and Arusha. However, not all plants from Tanzanian those regions perform better in the hot climate of Dar es Salaam and most of them already contain pest and diseases infestations According to one of the ornamental dealer adjacent Tumaini University argued that their interaction with other dealers outside Dar es Salaam help them share gardening experience, challenges and opportunities though mobile phones and sometime through face to face conversation. This implies that there is no formal arrangement and ways for gardeners to access improved seed for their nurseries (Magigi, 2013).

e) Management of insect pest and disease

Management of insect pest and diseases are essential aspect for the success of commercial ornamental nursery particularly in tropical countries like Tanzania as they have considerable effects in reducing quality and quantity of produce. This normally happen when choosing pest and disease resistant species as a preventive measure. Sometimes ornamental dealers spray pesticides as a control measure for the affected plants, thus, timely availability of inputs is very crucial (Magigi 2013). At Mlimani city nursery, the pests and diseases were not common, however, gardeners reported that, usually use to consult agricultural extension officers wherever they notice signs of insect pest and diseases. One of the agrovet-dealers interviewed said that; normally offer them with pyrethroids pesticide which is not effective for all types of insect pests. The study also revealed that, at Tumaini University College nursery site, the most common pest reported was aphid. Gardeners attempt to control it using Malathion pesticide. Nevertheless, respondents further reported that such pesticide is sold at higher price almost 30,000TZS per 100ml which is less effective for a single application, unless it is applied twice or thrice in a month.

At the GSM site, the nursery is affected by various pests and diseases. However, the gardeners do not know the type of the disease in English; rather describe the symptoms of the disease in Swahili

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language to agrovet dealers. In this incidence, various chemicals and pesticides are used based on the way are directed by agrovet-dealers to pests and diseases. According to one of the respondents around Tumaini University, ornamental dealers manage to name the pesticides in Swahili language as *Digo, Carret, Ninja, Vitashield and Booster*. The respondents further reported that normally booster is used to improve the health of the plant as well as making them greener. However, it is reported that, pest and diseases to plants are serious problem noted during the discussion with youth at Temboni site. Yet, youth undertaking commercial ornament activities are not knowledgeable with pests and diseases, they normally observe changes and physical abnormalities that affect normal plant growth and thereafter take the affected part of the plant to the agrovet dealers to seek for advice and how to deal with such problem. The most common diseases mentioned include fungal and bacterial disease with no specification of a particular disease. The commonly used chemicals and pesticides include Dasfarm, Profecron 720 EC and Farmguard 344SE as shown in plate 2. These findings are in contrary with the study carried out in Nigeria by Akintoye *et al.* (2011) pointed out the common insect pests of ornamental nursery including termites, white flies, stem bore and aphids while the diseases are root rot, powdery mildew, swollen shoot, leaf blight and stem bore.



Source: Respondents interview, 2019.

Plate 2: Pesticides used in ornamental plant nurseries

f) Marketing for ornamental plants

Marketing is a very crucial aspect of any business. Market always sustains any business including production and selling of ornamental plants (Hsieh, 2001). Despite market being important, findings of this study show that commercial ornamental nurseries have no permanent customers of their nursery products, customers are coming from different places of the city. According to one of the respondents at Mlimani city, common buyers are the road passersby, those in car driving, owners of big hotels, commercial buildings and residential houses. Other customers include primary and secondary school as well as university management, who buy and planting them in the outdoor environment within their residences or campuses. Currently, some ornament dealers have started to propagate fruit trees such as mango, guava, pawpaws and citrus, all these are sold to different customers. The fruit trees are highly sold to customers compared to typical ornamental plants because of its possibility to offer double rewards such as food and ornamentation (Bishoge, 2018).

Commercial ornamental dealers generally have no reliable market as may stay for some days or a week or more without selling any plants, but when customers come do compensate those days stayed without making any sell. The gardeners mostly sell the nursery products during rainy season. According to one of the respondents at the Mlimani city the amount earned per month ranges from 600,000TZS to 900,000TZ with an average of 20,000TZS and 30,000TZ a day respectively per person (by 2019, 1USD equates to an average of

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2,280 TZS). One of the respondents along Tumaini University College road reserve argued that the amount he earned is not enough to meet all his needs but he considers himself with better life in comparison to others with no any income generating activity. Another respondent at Temboni site reported to earn 600,000TZS a week. Out of this amount earned per month, he saves one third of the earning as operational costs. The gardeners at this site work as a group while documenting the cost incurred in running the nursery and recording the amount earned as the group per month. The amount earned by garden how it is small; it justifies the finding by Barbe *et al (*2017) who reported that an enterprise has a possibility of reducing income and unemployment challenges.

g) Knowledge acquaintance by commercial ornamental gardeners

Knowledge and experience are among major factors behind success in any project. Likewise, ornamental plant production and management requires people with adequate knowledge obtained from formally recognized institution or practices (Barbe *et al.,* 2017). In this study it was revealed that about 80% (n=30) receive no formal training in the ornamental nursery establishment and management. Most of them learn through practical and experiences. However, 10% (n=30) of the respondents attended a special training on plant propagation at Sokoine University of Agriculture while 10% (n=30) were informally working to individual persons (foreigners) who hired them, coached and instructed them on how to handle ornamental nurseries. As one respondent Mr. Abdala quoted saying that:

> *"When I was working at my boss flower garden, he trained me how to care the ornamental garden plants. After I left the work, I started operating my own small garden at Sinza ward before my friends joined me to establish nursery here at the Mlimani City Shopping Mall".*

Another respondent reported that he was working in Mwanza region and when he arrived in Dar es Salaam he decided to continue with the ornamental commercial activities. Before he started this activity, he visited two different people in different places requesting for offering flower, shrubs and trees trimming service until when he established his own ornamental nursery in 2012. Later on, other youth who were his friends joined the business in 2015. Both of them receive neither financial nor training support from anybody/anywhere.

h) Challenges

Table 2 presents summary of the problems and challenges encountered by commercial ornamental dealers in the studied areas of Dar es Salaam city. Results from the discussion and in-depth interview show that the most pressing problem is lack of security of tenure followed by diseases and pests and lastly almost 5 interviewed persons claimed to have unreliable market.

Table 2: Ranking the challenges confronted by commercial ornamental plant gardeners

S/n	Challenge	Frequency	Percentage (%)
1.	Insecurity to land occupancy right	30	44
2.	Difficulties to access to water sources	9	13
3.	Inadequate assistance (technical/fund)	7	10
4.	Difficulties in marketing ornamental plants	5	7
5.	Diseases and pest management	15	22
6.	Plant materials and seeds inaccessibility	2	3
	Total	68	100

Source: Respondents interview, 2019.

i) Prospects

Despite challenges facing commercial ornamental gardening, still there is hope and confidence of success among dealers (see table 3). In all interviews, respondents were free to mention their possible optimisms with regard to commercial ornamental nurseries; thus, the analysis and discussion of their claims are still vital. Table 3 present participants view and their future prosperity which may become true if some of the problems discussed can be resolved. In particular, the issue access to land for ornamental nurseries which scored 44% in challenge raking table.

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Table 3: Optimism of ornamental nurseries gardeners

S/n.	Prospects	Remarks
1.	Short term lease of vacant public land located close to water sources and road junctions.	Temporally lease utilize idle land, gives gardeners income and can be surrender when need by the owners
2.	Expanding their business	Commercial ornamental gardening provides them a means of earning income.
3.	Diversify their activity	Strive to diversity ornamental garden activities as per wishes of their customers.
4.	Seeking technical/financial support	Visit city office and nation farmers exhibition day (Nane-nane day) for learning more the management practice of their garden and secure fund where wherever there is a possibility of doing that.
5.	Possession of informal business card	The national business card granted for every year by the city authority will make them more recognizable as private business people.
6.	Grow ornamental plants adoptive to local environment	Grow ornamental resistance to drought or pest/disease subject to the advice provided by consulting experts (whenever possible).

Source: Respondents interview, 2019.

The survival and the success of ornamental plants depend on the hopefulness of gardeners from the city authority. Therefore the information from Table 3 provides base information during debating and making decisions of urban land use and supporting ornamental plants nurseries in the cities.

IV. Conclusion

The commercial ornamental nurseries are the main suppliers of ornamental and edible plants in the urban areas. Its values and importance are not restricted to income generation but also in beautifying and greening the urban built-up environment. Apart from these few mentioned values, the enterprise is confronted by number of problem and challenges such as; in-accessibility of land for establishment of nurseries and difficulties in their management practices. The possibility of gardeners to access to land lies within the capacity of city and urban authorities, but the decision in-favour of land for ornamental nurseries establishment seems to be expostulated in land use development decisions; hence, given less attention and priority. The values provided by ornamental nurseries are generalized in some legal and policy documents such as land policy, environmental policy and urban planning act but practically, ornamental gardening practices seem to take place in their absence. Agricultural extension services are mostly confined on food crops production and management; in a very rarely case such services are extended to ornamental plant garners. Moreover, limited source for water for irrigating the ornamental garden has exacerbated garden management problems particularly during the dry seasons. All these challenges and problems hamper the future prosperity of commercial ornamental gardens. Hence, subsequently the enterprise is likely to disappear and the values gained from it will nowhere be found and accommodated in our cities.

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The data of this study was collected from different commercial ornamental dealers in Dar es Salaam city and some selected city officials. Thus, authors would like to thank all participants who agreed to offer their time and provide us with information necessary for study. Authors contributed some amount of money to finance the whole process of conducting the study including field trips and interviews.

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Review of Context Specific and Safe Sanitation Technologies for Vulnerable Geomorphologic Areas in the Bengal Basin

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Abstract- Water and excreta related diseases such as diarrhoea and other respiratory problems remain a major health concern in Bangladesh and people in the Hard-to-Reach (HtR) areas i.e. vulnerable geomorphologic areas and slipping population from all sorts of development activities suffer more. Much effort have already been undertaken to promote decentralized and sustainable context-specific sanitation facilities through increasing the capacity of the vulnerable community and creating their access to services. However, more activities and effort is needed to ensure the appropriate sanitation facilities for all, mainly in the HtR areas. Besides design of proper context-specific sanitation technologies, safe human excreta disposal is also crucial for preventing the spread of infectious diseases as the thickness of surface impermeable clay and depth to groundwater table play vital role to select the distance between pit-latrine- the source of pathogen bacteria, and shallow tubewell. The study was undertaken to evaluate the efficiency of existing sanitation technologies in the geomorphologically variable HtR areas. Five different HtR areas i.e. drought prone, flood prone, char (sand bar), coastal and haor (swamp) areas were selected for the survey.

Keywords: hard to reach area, geomorphology, sanitation technologies, pit latrine, efficiency.

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Review of Context Specific and Safe Sanitation Technologies for Vulnerable Geomorphologic Areas in the Bengal Basin

Anwar Zahid [α], SMA Rashid [σ], M Abdus Salam [ρ], Joseph Halder [ω], M.T. Islam [¥] & M Shahdat Ali [§]

Abstract- Water and excreta related diseases such as diarrhoea and other respiratory problems remain a major health concern in Bangladesh and people in the Hard-to-Reach (HtR) areas i.e. vulnerable geomorphologic areas and slipping population from all sorts of development activities suffer more. Much effort have already been undertaken to promote decentralized and sustainable context-specific sanitation facilities through increasing the capacity of the vulnerable community and creating their access to services. However, more activities and effort is needed to ensure the appropriate sanitation facilities for all, mainly in the HtR areas. Besides design of proper context-specific sanitation technologies, safe human excreta disposal is also crucial for preventing the spread of infectious diseases as the thickness of surface impermeable clay and depth to groundwater table play vital role to select the distance between pit-latrine- the source of pathogen bacteria, and shallow tubewell. The study was undertaken to evaluate the efficiency of existing sanitation technologies in the geomorphologically variable HtR areas. Five different HtR areas i.e. drought prone, flood prone, char (sand bar), coastal and haor (swamp) areas were selected for the survey. The study reveals that context specific technologies and designs are required for the sustainability of sanitation services in the vulnerable areas.

Keywords: hard to reach area, geomorphology, sanitation technologies, pit latrine, efficiency.

I. Introduction

Improved sanitation alone could reduce diarrhoea-related morbidity by more than a third (UNICEF 2006). As not all fecal-oral diseases have a pathway from human excreta, 88% (attribution rate) of diarrheal diseases were assumed to be due to poor management of human excreta (Prüss et al. 2002). Different studies show that for fecal-oral disease, the relative risk reduction of 36-56% for improved sanitation (Waddington et al. 2009; Moraes et al. 2003; Barreto et al. 2010). There is a wide range of technologies for disposing of human excreta, from simple traditional latrines, to complex sewerage systems. The most available solutions for excreta disposal in the rural areas of Bangladesh are pit latrines. Pit latrines reflect a cost effective intervention in all countries (Hutton et al. 2014).

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National sanitation coverage in Bangladesh has improved significantly over the last few years, but there are pockets of areas that have received very little attention due to geomorphologic, socio-cultural and economic situation. In the country safe excreta disposal facilities are still vulnerable in many areas and pit latrines are generally constructed very close to shallow hand tubewells due to space constraint. Therefore, groundwater sources may also sometimes be contaminated by on-site sanitation systems especially when the safe distance between a water point and on-site sanitation is not maintained. Water and excreta related diseases such as diarrhoea, worm infestation and other respiratory diseases remain a major health concern in Bangladesh. In addition to its impact on health and nutrition, improved sanitation generates both social and economic benefits (Ghosh and Cairncross 2014). The geophysical conditions very often affect the availability, quality and accessibility to safe sanitation facilities for the community and the Hard to Reach (HtR) areas are at greater risks. Hard-to-Reach area is defined practically in Bangladesh by taking into account both hard-to-reach in terms of remote geomorphologic locations and slipping population from all sorts of development activities (GoB 2011). Considering indicators and their respective criteria and ranking, from Multi Criteria Analysis, 1144 HtR unions (21%) under 6 different physiographic categories were indentified which spreads over 257 upazilas and 50 districts in Bangladesh. Many Governments agencies, international organizations and NGO's have been working to investigate, survey and mitigate sanitation issues and problems in order to ensure and provide these facilities for all including inhabitants of HtR areas. Department of Public Health Engineering (DPHE) is the principal organization of the Government mainly for water supply and installation of sanitation facilities in rural areas of the country. Many NGO's like NGO Forum for public Health, BRAC, WaterAid etc. have remarkable contribution in this sector.

NGO Forum for Public Health has initiated the project titled 'Promotion of Water Supply, Sanitation and Hygiene in Hard to Reach Areas of Rural Bangladesh (PWASH)' with the financial support of SDC by the end of 2011. The aim of the Project was to promote decentralized and sustainable context-specific water

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supply and sanitation facilities through increasing the capacity of the hard to reach community and creating their access to WATSAN services. Under these physiographic divisions, 47 unions of 15 upazilas and 13 districts are covered. In this study, efficiency of sanitation technologies constructed under PWASH project considering suitability for different geomorphologic areas has been reviewed. Demand-led sanitation program encourage greater participation of users to create, identify and select appropriate sanitation technologies (Cairncross 2004; Kar and Chambers 2008).

Under the PWASH project, sanitation technologies like Plastic Latrine, Single pit ring slab latrine, School latrine, Eco San latrine, Floating latrine, Single Pit ring slab latrine, Twine pit latrine, RCC single Pit Latrine etc. have been installed. The objective of this study is to evaluate the efficiency of installed sanitation Technologies for sustainable use in HtR areas. The specific objectives are,

- Providing information about the efficiency of the existing sanitation technologies in terms of coverage, quantity and quality.
- Measuring the relative effectiveness of context specific sanitation technology for different vulnerable geo-hydrological areas.
- Identification of risk factors of different technologies.

a) Importance of Sanitation in Policies and Plans

Safe human excreta disposal is crucial for preventing the spread of infectious diseases. The economic benefits of improved sanitation include savings in health system costs, fewer days lost at work or at school through illness or through caring for an ill relative, and time savings from increased convenience (Hutton et al. 2007). Bangladesh has already formulated good numbers of policies, implementation plans and strategies in the field of WATSAN and related sectors. Many of the important and essential related issues have been covered by and written in these documents. The main weakness of most of these tools is inadequate implementation and application. Existing laws and regulations do not cover sufficiently in areas such as the rights, powers, and duties of individual users and the government. There is also lack of required research-based education and advocacy campaigns. Scientific and institutional approach analyzing research outputs is yet far behind. However, interest in research uptake and research engagement in the policy formulation process is growing. Researchers, specialists and donors feel a moral and ethical imperative to try to ensure that policy and practice draws on the best research available. Civil society, NGO's and activist groups have been active in calling governments to provide the best options available based on research findings.

The National Policy for Safe Water Supply and Sanitation (NPSWSS), formulated in 1998, is the most significant policy for the WATSAN sector. The goal of the policy is to ensure that all people have access to safe water and sanitation services at an affordable cost and aims to increase the capacity of the sector. The policy emphasizes community sanitation in densely populated poor communities without sufficient space for individual household latrines, the appropriate water supply and sanitation technology options shall be adopted to specific regions, geophysical situations and social groups, research and development activities shall be conducted to improve existing technologies and to develop new technologies.

The primary objective of formulating National Strategy for Water and Sanitation: Hard to Reach Areas of Bangladesh (2011) is to improve safe drinking water and sanitation coverage in hydro-geologically and socio-economically difficult areas where people have services much less than the national standard. The major objectives of the national strategy formulation are to develop criteria for isolating HtR areas based on assessment of present water and sanitation coverage, hydro-geologic conditions represented by water availability, vulnerability to natural disasters, and socio-economic parameters; and to identify challenges and develop strategies for improved WSS services to reach the HtR areas. It is vital to ensure effective enforcement of all of the existing rules and regulation in water and sanitation sector of all of the identified HtR areas of the country. After the implementation of these laws, adequate monitoring and evaluation is also crucial in all of the HtR areas.

II. Study Methodology

Installed sanitation technologies of five Unions under different geomorphologic conditions have been reviewed to assess efficiency and sustainability. Nachole Upazila of Chapai Nawabganj district under Pleistocene uplifted Barind Tract has been selected as drought prone area for this study. Dewanganj upazila of Jamalpur district and Shibalaya upazila of Manikganj district have been representing as Charland and Floodprone areas respectively. Riverine Charland in the North Central region consists of isolated villages surrounded by rivers and goes under water for about six months during monsoon. River erosion and floods affect the Char area. Floodplain in the central part of Bangladesh is characterized by low lying lands susceptible to annual flooding, river erosion and water logging. Haors in the Northeastern region has low-lying elevation where flood water remains for about 6 months and villages become isolated in the rainy season. Dakshin (south) Sunamganj upazila of Sunamganj district has also been surveyed under this study.

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Mixed method has been employed to conduct research and the sample unit was selected by random sampling method. The participatory techniques used in the study process includes,

- Review of available documents (e.g. project proposal, periodical project activities reports, etc), and relevant national policies, plans and strategies.
- Series of field visits were carried out to representative areas under all five physiographic zones and following events were considered,
- Focus Group Discussions (FGD) to evaluate socio-economic conditions of the users, accessibility, affordability and acceptance of the sanitation technologies by them, comments on advantages and limitations of the technologies and their suggestion etc. (Figure 1)
- Key Informant Interview (KII) of drillers, mechanics, staff of partner NGO's and Local Government officials and representatives to gather information on subsurface ithology, seasonal fluctuation of groundwater tables, installation cost of sanitation technologies, gender accessibility, facilities provided by other institutions, major ecological and environmental features, indigenous knowledge and traditional values etc.
- Transect Walks to record the topography, soils, natural vegetation, cultivation, human settlement patterns, local sanitation technology and practices etc.
- Observation of all types of installed sanitation technologies under PWASH project.
- Technology review considering scientific and environmental aspects, hydrogeology, subsurface lithology, groundwater level and flow direction, installation and maintenance cost, acceptability, durability, seasonality, number of users as well as climate change and disaster management strategies etc.



Figure 1: FGD to evaluate socio-economic conditions, accessibility, affordability and acceptance of the sanitation technologies by the users.

III. Geomorphologic Conditions of the Study Area

Bangladesh covers major portion of the Bengal Delta formed by the Ganges-Brahmaputra-Meghna (GBM) river system. About 80% of the land area is flat and low elevated, intersected by numerous rivers and their distributaries. Physiographically, Bangladesh can be divided into seven major divisions (Alam et al. 1991; GWTF 2002) (Figure 2). Study locations lie on five such vulnerable physiographic areas. Previous study (Islam et al. 2016) showed that pit latrines enhance microbial contamination in groundwater of adjacent shallow tubewell based on hydrogeological conditions (i.e. thickness and hydraulic properties of surface clay, depth of groundwater table and groundwater flow direction). Level of bacterial contamination differs in different hydrogeological conditions in both lateral and vertical distances, and where the surface clay is thick and compact, there is less or no contamination.

Sapahar upazila of Naogaon district and Nachole upazila of Chapai Nawabganj district under the project falls within Barind Tract and considered for drought prone characteristics. Nizampur union of Nachole upazila has been surveyed for this study. The Pleistocene Uplifted Terraces cover an area of about 10% of Bangladesh. The Barind Tract is located in the west of the Brahmaputra River. It falls in the central part of north Bangladesh and covers districts under Rajshahi division. The Barind Tract is the product of vertical movements of Pleistocene period and reaches maximum height of 20 m above recent flood plains. Dewanganj upazila of Jamalpur district and Shibalaya upazila of Manikganj district under the project lies on Brahmaputra-Jamuna Flood Plain and are categorized under char land (sand bar) and flood prone areas.

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Chukaibari union of Dewanganj upazila and Teota union of Shibalaya upazila have been selected for this study to represent as Char land and flood prone areas respectively. The flood plains of the Ganges, the Atrai, the Brahmaputra-Jamuna, the Old Brahmaputra, and the Meghna rivers cover approximately 40% of Bangladesh's landform. The elevation of the major part of the flood plain ranges from 3 to 5 meters above the mean sea-level. The flood plain covers the central, north and northeastern part of the country. Elevation of this surface is 29 m in the north and about 6 m in the south. The Ganges flood plain extends from the western border of the country, south of the Barind Tract, as far east where it merges with the Jamuna flood plain. The sand bar areas under the flood plains are home of the poorest and most vulnerable communities on the country where sanitation coverage is far below the standard. These areas are vulnerable to seasonal flood and submerged under water during monsoon and also subjected to river bank erosions that making the sanitation facilities very challenging. In these areas the groundwater table is shallow and the aquifer is predominantly sandy. Contamination of groundwater from open defecation and pit latrines is a problem.

Mongla and Rampal upazilas of Bagerhat district falls under the coastal vicinity. Chila union of Mongla upazila has been considered for this study to represent coastal vicinity. The Delta Complex covers about 32% of Bangladesh. The area south of a line drawn from the Ganges-Padma as far as the lower course of the Feni river in the southeast belongs to the delta of the GBM rivers. The Ganges is the greatest builder of the delta (70-80%). In the southwest, a part of the delta has been classified as the inactive delta but the major part in the south and southeast is very active. The elevation of the delta is about 15 to 20 m from the mean sea level in the northwest and 1 to 2 m in the south. Many swamps (depressions) have developed in the substantial part of the delta. Holocene or Recent sediments from a few hundred to thousands of meters cover the Flood plains and the Delta. The tidal delta covers the southern part of the Delta plain. This area is tide dominated and is considered as the active part of the delta. The landforms are characterized by tidal low land with weakly developed natural levees distributed in an irregular pattern. Numerous rivers, channels, tidal creeks have criss-crossed the area. Swamps and depressions are also present in the area. Estuarine deposits of silt, silty clay dominates in this area. The coastal belt is one of major HtR areas, where people are frequently exposed to natural disasters like cyclone, storm surge and tidal floods as well as to seawater encroachment.

The project areas of Dakskhin Sunamganj upazila of Sunamganj district falls under Sylhet Depression. Shimulbak union of Dakskhin Sunamganj upazila has been surveyed for this study. The Sylhet Depression is a tectonic basin subsiding at a very fast rate and is bounded by the hills of frontier strip of Sylhet and Netrokona districts in the north and the northeastern and Sylhet Hills in the east. Numerous lakes (beels) and large swamps (haors) cover the saucer shaped area of about 7,250 sq. km. The elevation of the central part of the depression is about 3 m above the sea level. The inland marshes are found scattered all over the country. The haor and wetlands remain inundated for about 6 to 8 months, therefore, crop cultivation is limited to a certain period of the time in the year. The sanitation situation in the area is appalling, with little coverage of hygienic latrines and widespread open defecation.

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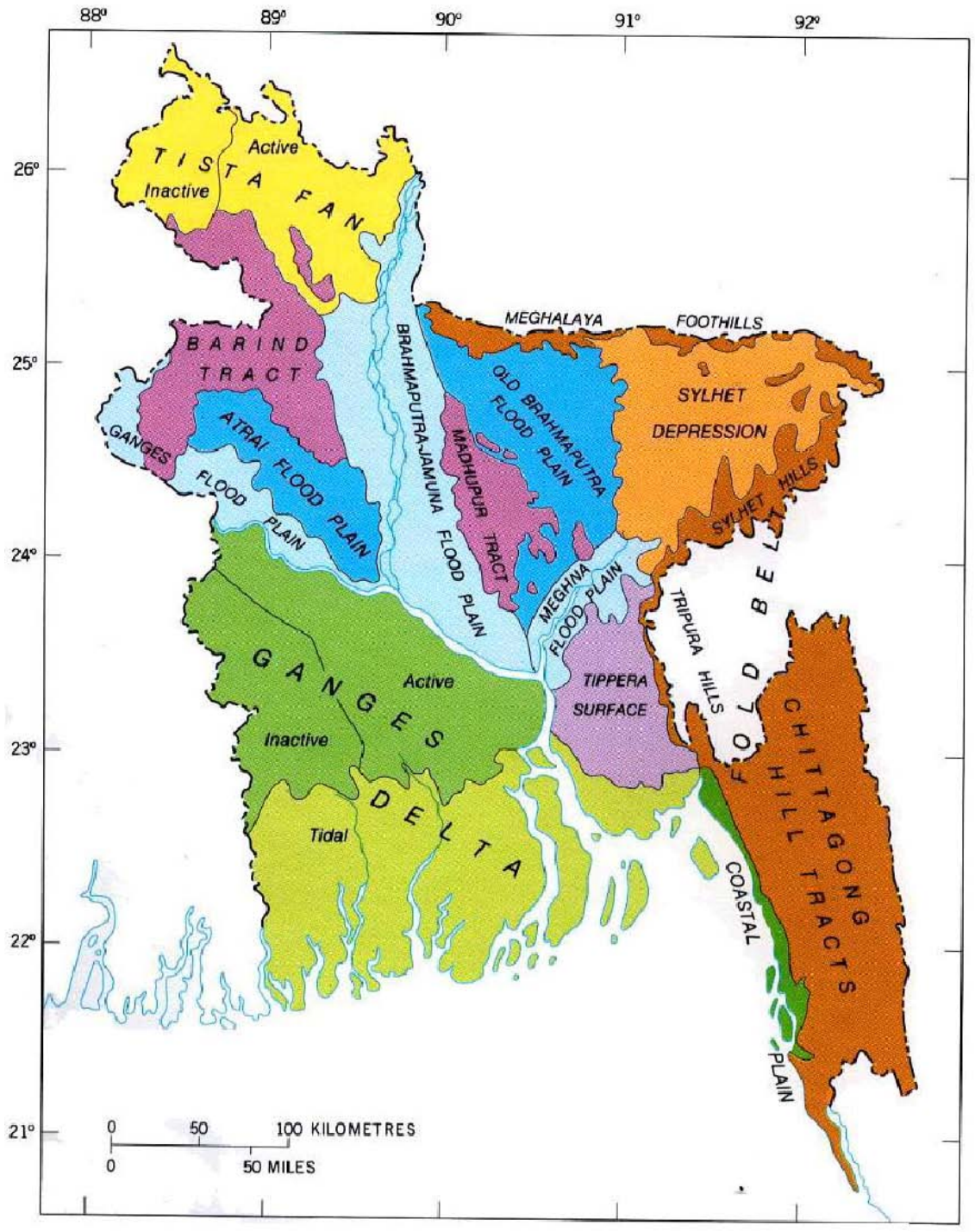

Figure 2: Physiographic map of Bangladesh (Alam et. Al., 1991) showing studied upazilas.

IV. Selection of Context-Specific Technologies

Bangladesh Centre for Advance Studies (BCAS) and NGO Forum (BCAS-NGOF 2012a) had conducted a feasibility study to promote decentralized and sustainable context-specific water supply and sanitation facilities through increasing the capacity of the HtR community and creating their access to WATSAN services. The socio-economic condition of the study area implies that most of the households belong to poor-category. Overall, 73.6% of households are below the upper poverty line (UPL). In terms of awareness on safe water, hygienic latrine and natural disasters, the percent of respondents is found significant. Overall, 53.0%, 46.6% and 35.0% of respondents are aware on safe water, hygienic latrine and natural disaster respectively.

The main types of latrine used in the survey area are ring-slab/offset latrine with water seal, ring-

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slab/offset latrine without water seal, hanging latrine, pit covered latrine, septic latrine etc. Only 35.8% of total households have the access to improved sanitation options (septic latrine, pit covered latrine and ring-slab/offset latrine). However, the access to improved sanitation options dramatically drops to almost half from non-poor to poor when only sanitation technology is considered. The practice of using hanging/open latrine becomes double (19.1%-38.0%) during disaster period. The types of latrine used in the study areas fluctuate based on eco-zone. Ring-slab/offset latrine with water seal is found the most common type of latrine practiced in flood-prone area followed by coastal area, as reported by 33.3% and 30.3% household respectively. Again, ring-slab/ offset latrine without water seal is mostly used in coastal area, according to the argument of 31.2% household. Hanging latrine is mainly used by the respondent in haor area (25.8%). On the other hand, pit covered latrine is mainly practiced by households (about 10%) in flood prone area and pit-uncovered latrine is practiced by households (8.3%) in haor area. It is found that overall, 35.8% of surveyed households have the accessibility to improved sanitation options.

The BCAS-NGO Forum need assessment study for PWASH has been designed for the poor and most deserving communities living in the geo-physically HtR areas in Bangladesh including coastal area, drought-prone area, char area, haor area and flood-prone area (BCAS-NGOF 2012b). Initial need assessment identifies that the local contexts, risks and vulnerability of the community in relation to their sanitation, health and family well-being, particularly for the vulnerable people. To ensure access of the poor and vulnerable people during promotion of feasible technologies, more emphasis has been given to the selection of appropriate sites by involving community people. The objectives of the need assessment were to identify the number of climate change context specific technologies for the HtR people in the selected climate vulnerable eco-zones in relation to sanitation as well as to identify the current coping and adaptation needs of the local community to initiate local activism towards establishing and promoting climate resilient sanitation technology for the vulnerable communities.

A significant numbers of single pit and ring slab (without water seal) have been calculated as the main needed resilient water technology in drought-prone area. The second major option is single pit and ring slab (with water seal), while other technologies like ventilated improve, community latrine, twin pit offset and plastic latrine are also needed with a considerable numbers. In drought prone area different sanitation technologies are demanded by the local people. Most of them asked for a low water consuming sanitation technology. In drought prone area water for sanitation and hygiene practice is very limited. In Chapai Nawabgonj, only single pit ring slab toilet is wanted by the local people, because this is low cost and easy to install. In Panchagahr district, community toilet/pacca toilet is also wanted by the local people because they are ready to use community toilets. But in Naogaon, local people want different technologies due to topographic variation. In Sapahar upazila of Naogaon district, unions are situated in undulated topography, for that reason their demand for sanitation technologies are also different. They want Single Pit Ring Slab, Tinpit Offset, Community toilet/ Pacca toilet and plastic toilet. Due to geographical variation of the study sites local people's need is also different. Local people want plastic toilet because it is light to carry in hard to reach area and re-useable. That's why people want different technologies in drought prone area. The study also revealed that Single Pit Ring Slab highest desired technology among all technologies and the values are modification 44.80%, new installation 55.20%.

In case of need assessment, a significant number of single pit and ring slab (with water seal) have been calculated for the main needed resilient sanitation technology in char area. The second major option is single pit and ring slab (without water seal), while other technologies on community latrine and hygiene latrine are also found as technology needed for a considerable number of people. Considering peoples' demand in flood-prone area, a significant number of single pit and ring slab (without water seal) have been calculated as the main needed climate resilient sanitation technology, while a single pit and ring slab (with water seal) is found as the climate resilient main technologies based on rationality criteria. In Manikgonj people want single pit and twinpit offset toilet in their area. Singles pit is mostly popular in that area with twin pit offset. Single pit is low cost and twin pit offset is relatively safe because the waste is stored in a distant place form the defecation site. In case of Sanitation technology, a significant number of single pit and ring slab (without water seal) have been calculated as the main demand of the people in coastal area. The second major option is single pit and ring slab (with water seal), while technology on community latrine is also needed in the area. According to the peoples' demand, a significant numbers of single pit and ring slab (both water sealed and without water sealed) have been identified as the main needed resilient sanitation technology in haor area. However, the technology of twin pit offset is considered as the major identified need, based on rationality with current resilient sanitation technologies in this zone. Haor area is prone to different types of flood and water logging. The villages are also situated in a elevated piece of land which looks like an island during monsoon. Water wave is also affected the villages of the haor area. For that reason, people have to build the sanitation technologies inside the elevated land of village. BCAS also conducted action research for NGO Forum on Context Specific,

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User-friendly Sanitation Technologies and Hygiene Practices in Selected HtR Areas.

Based on the study findings sanitation technologies have been installed in the selected HtR areas under PWASH project. Survey showed that the economic returns may not positive for all technologies, however, pit latrines always remain a feasible, affordable and efficient sanitation option and reuse options have economic returns of at least two times (Hutton et al. 2014). For most sanitation technologies, health benefits and time savings accounted for the majority of the overall benefits.

V. Result and Discussion

a) Review of Installed Sanitation Technologies

There is a wide range of technologies for disposing of human excreta, from simple traditional latrines, to complex sewerage systems. The most available solution for excreta disposal in the rural areas are pit latrines. The most common systems are, basic improved traditional latrine, ventilated improved pit latrine, double-vault compost latrine etc. Considering the physiographic conditions of the country many other area specific sanitation systems have also been introduced like raised pit latrines, sand-enveloped pit latrines, sealed pits or tanks, eco-sanitation or composting latrines, floating latrines, latrines for disable people etc. Climate, topography, availability of water, availability of technical skills, cultural beliefs demand etc. are influencing factors for determining the type and size of the sanitation systems. A decline in efficiency over time was observed, which was found to be caused by households not sustaining improved behaviors either because of force of habit and lack of conviction, or because the technology itself had stopped functioning (Hutton et al. 2014). Under PWASH project, the following major sanitation technologies have been installed and reviewed for the study.

i. *Traditional pit latrine*

Traditional latrines usually consist of a single pit covered by a slab with a drop hole and a superstructure (Figure 3). The slab is made reinforced concrete. Concrete made rings are generally used to cover the drop hole walls. The superstructure provides shelter and privacy for the user. Basic improvements include, a hygienic self-draining floor made of smooth, durable material and with raised foot rests, a floor raised at least 0.15 m above ground level, to prevent flooding, an adequate foundation, to prevent damage of the slab and superstructure etc. Ventilated Improved Pit (VIP) latrines are designed and constructed to reduce bad odors and insect proliferation. A VIP latrine differs from a traditional latrine by having a vent pipe that is covered with a fly screen. Wind blowing across the top of the vent pipe creates a flow of air which draws out odors from the pit. As a result, fresh air is drawn into the pit through the drop hole and the superstructure is kept free of smells. Pit latrines have been constructed in all unions under PWASH project. These are easy to install and low cost technology. However, very shallow groundwater table limits excavation to avoid bacterial contamination. Disposal of wet excreta from the full pit is a problem and uncontrolled discharge may also cause spreading of dieses like dihorrea. Chair commodes of different sizes and heights are installed with pit to provide support to disable peoples (Figure 3).

ii. *Raised pit latrine*

In flood prone areas normal pit latrines may be submerged under water and damaged during flood. Therefore, most common solution for excreta disposal in flood prone areas and in areas of high groundwater table is to build raised pit latrines. These are simple pit latrines and VIP latrines in which the pit is built upwards above ground level using bricks, blocks, concrete rings etc. To prevent contamination of groundwater, the bottom of the pit was considered sufficiently above the maximum groundwater table. Raised pit-latrines are provided in the flood prone areas of Teota and Chukaibari of Shibalaya and Dewanganj upazilla respectively, disaster prone Chila and Chadpai unions of Mongla upazila and water logged haor areas of Shimulbak union at south Sunamganj upazila.

iii. *Sealed pit*

Groundwater contamination can also be prevented if the disposal pit or tank is fully lined and sealed, so that the contents are unable to infiltrate into the surrounding ground. This can be done using locally available materials such as concrete, cement blocks, bricks, plastic tanks, and concrete or metal culvert rings. The construction of fully lined pits is expensive and time-consuming, however, useful for family use.

iv. *School/Madrasa latrine*

The school latrine is conventional sanitation technology (Figure 3). Under the PWASH project this technology has been constructed with slight modification of conventional latrine. In the structure of the latrine there is a separate urinal section for male students. School latrines are constructed in all unions under the project.

v. *Floating latrines*

Floating latrines are useful in flood prone and water logged areas and generally usable during flooding. The base of the latrine superstructure is commonly made from timber/bamboo so that it floats like a raft. A number of large buckets/containers or barrels with squatting slabs of some sort over the top was used so people can defecate in them (Figure 3). A safe system of bucket collection and final disposal of excreta is essential to have minimal negative impacts. Floating latrines have been provided at Teota, Chukaibari and Chadpai unions of Shibalaya, Dewanganj and Mongla upazillas respectively.

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Figure 3: Installed pit latrines for vulnerable areas and people under PWASH project.

vi. *Eco-san and twin-pit latrines*

Eco-san (ecological sanitation) latrines are used in areas of shallow groundwater table and water scarcity areas. These normally consist of two chambers and are raised above the ground to facilitate easy emptying (Figure 3). One chamber is used until it is full, at which point it is sealed and the second chamber is used. If the contents of the first are left to stand for 1-2 years the waste will be relatively safe to handle and the pit can be emptied. Once both pits are full the first can then be emptied and used again. The concept of eco-san is built on the idea that human excrement is not a waste, but can be a valuable fertilizer if it is properly treated and composted. These latrines are useful for improvement of health by minimizing the introduction of pathogens from human excreta into the water cycle and also improve agricultural productivity by preserving soil fertility. Eco-san toilets have sealed chambers so the risk of human waste contaminating water supplies and wells is decreased when compared to traditional latrines. Because double pits are used alternately, their life is virtually unlimited. Urine-diverting eco-san latrines are

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constructed at water scarce Barind union of Nizampur under Nachole upazila that is also feasible for other areas where seasonal flood does not inundate the land area to use the composted dry excreta as fertilizer.

b) *Thickness of surface clay and depth to groundwater table*

From the cross-section of lithologic logs (sediment/soil type) of Nachole upazila (Figure 4) it is observed that the first aquifer is extended from 10 to 55 m depth below surface dominated by brown very fine, fine and medium sand and overlain by A 10 to 20 m thick brown sticky and almost impermeable clay layer that is a barrier for bacterial movement from pit latrine to groundwater. This layer also acts as a barrier for any sorts of surface contaminant. In the western part of the upazila, the surface aquitard extends till investigated depth of 95 m. The maximum and minimum water table in Nachole upazilla, measured in BWDB observation wells are recorded between 10.0 and 30.0 m and 7 and 22.0 m respectively with the seasonal fluctuation of about 3-10 m. Thick upper clay with variable thickness is present in most of the area and suitable to construct simple pit-latrine. However, eco-san latrine can save significant quantity of fresh water in water scarce Barind area.

Under Dewanganj upazila area the upper shallow or the first aquifer is encountered from surface down to the depth of about 85 m and dominated by fine sand followed by medium sand at deeper part. The first aquifer is open to the surface i.e. no aquitard is encountered in many areas, mainly in the vicinity of char areas, and vulnerable to surface contamination. At some places 3 to 12 m thick aquitard i.e. clay layers are encountered above the upper aquifer. The maximum and minimum groundwater table under Dewanganj upazilla area measured in BWDB observation wells are between 6.5 and 9.0 m and 0 and 0.5 m respectively with the maximum fluctuation of about 6.0 m.

The upper or the first aquifer is encountered between 20 and 85 m depths overlain and underlain by clay and silty clay aquitards at Shibalaya upazila. The thickness of surface aquitard varies between 5 and 20 m. The aquifer sediment consists of fine and medium sand. The upper 5 m thick aquitard may not be thick enough to prevent surface contaminants i.e. pit of latrine to reach to groundwater table in the upper aquifer. The maximum and minimum groundwater table in Nachole upazilla area, measured in BWDB observation wells are recorded between 7.0 and 8.5 m and 0.5 and 1.0 m respectively with the seasonal fluctuation of about 6.5 to 7.0 m.

The upper aquifer under Mongla upazila area is encountered from 25 m till investigated depth of 90 m and consists of very fine and fine sand. This aquifer is overlain by a 25 to 35 m thick silty clay aquitard. The maximum and minimum groundwater table in Mongla upazilla area, measured in BWDB observation wells are between 0.5 and 1.5 m and about 0 to 0.5 m respectively with the fluctuation of about 0 to 0.5 m.

Under Sunamganj area the upper or the first aquifer is encountered between 40 and 150 m, consists of fine sand and inter-bedded by thick clay aquitards. At many locations the upper aquifer is not encountered till this depth. The thickness of the surface aquitrad varies between 40 and 150 m. Therefore, though the available upper aquifers of the area are safe from any surface contamination. The maximum and minimum groundwater table under Sunamganj upazilla area measured in BWDB observation wells are recorded between 4.0 and 6.5 m and 3.0 and 3.5 m respectively with the maximum fluctuation of about 1.0 m.

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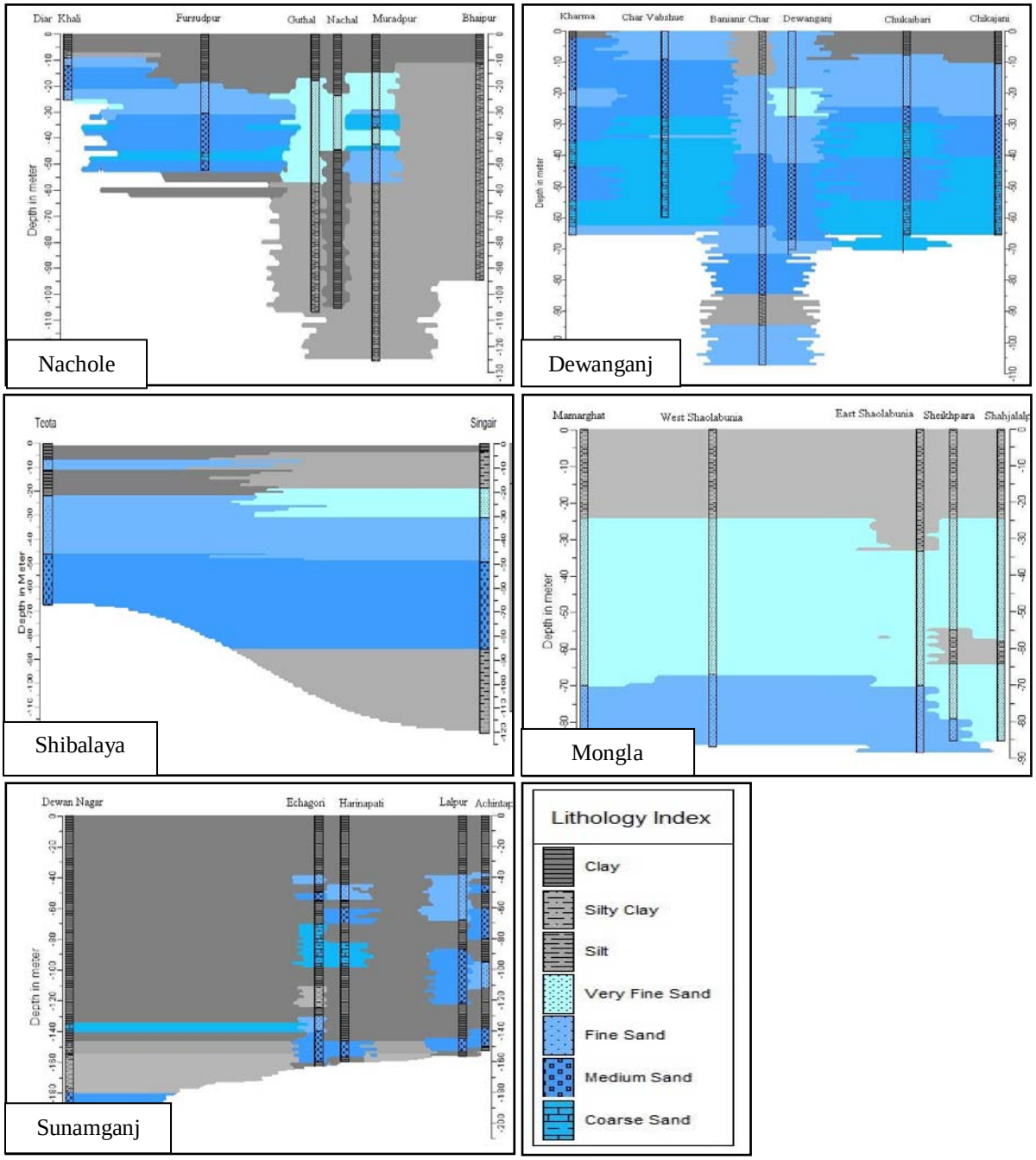

Figure 4: Extension of shallow groundwater aquifer and maximum depth to groundwater table (m) in dry season under Sunamganj upazila of Haor area.

c) *Efficiencies of installed Sanitation Technologies*

Nizampur union of Nachole upazilla lies at Chapai Nawabganj district which is a part of the Barind Tract. Considering water scarcity at Nizampur area and lowered groundwater table (upto 35 m below surface) below suction limit, simple pit-latrines, school latrines and eco-san latrines have been constructed for sanitation facilities. The thick compact clay in the sub-surface protects groundwater from any surface contamination including pathogen bacteria sourced from pit-latrines. Besides improved pit-latrines, at Jhenaipukur village eco-san latrines have been provided. Construction cost of eco-san latrine is higher compare to traditional pit-latrines. But, considering saving of water in such an water scarce zone and use of composted excreta for increased crop/vegetable production, eco-san latrine should be the first priority in water scarced areas like Barind. This technology is well accepted by the vallagers. Villagers have already started to use the dry composted excrement as valuable

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fertilizer. People in the area who do not have eco-san latrines, want to have it and many are interested to install the technology by themselves. Community based eco-san latrines like school latrine can be constructed for better benefits and cost effectiveness.

Regular seasonal flood and riverbank erosion are major problems for the Chukaibari union of Dewanganj upazila, Jamalpur district lies on Brahmaputra river plain. Installed sanitation facilities under the project are pit latrines, raised platform latrines, raised platform double chamber school latrines, plastic latrines, floating latrines and disable latrines. Depth of conventional pit latrines was restricted above the groundwater table to avoid groundwater contamination as the surface clay in the area is soft and leaky and where the thickness of surface clay is less. Raised latrines with stable concrete platforms are the best option in flood prone areas. Raised platform school latrines are suitable not only for school/madrasa students but also for the villagers during flood. Plastic latrines and floating latrines are very useful during flood and also in the areas vulnerable to river bank erosion. Due to regular vulnerability to flood, eco-san latrine is not a feasible option in flood-prone char areas.

Seasonal flood and arsenic contamination in shallow groundwater are the major problems towards sanitation services for the population of Teota union of Shibalaya upazila, Manikganj district, lies on Brahmaputra river plain. Installed sanitation facilities are pit latrines, raised platform latrines, school latrines, and disable latrines. Raised latrines are stable option in flood prone areas. Raised platform school latrines are suitable not only for school/madrasa students but also for the villagers during flood. Depth of conventional pit latrine should be limited to avoid bacterial contamination of shallow groundwater where the thickness of surface clay is less. Plastic latrines and floating latrines are very useful during flood and also in the areas vulnerable to river bank erosion.

Natural calamities like cyclones, storm surges, seawater encroachment in the coastal eco-system and saline water intrusion in groundwater are the most common phenomena (disasters) in the coastal areas of Bangladesh. In addition, coastal areas are also vulnerable to the anticipated impacts of climate changes like sea-level rises. Chila and Chandpai unions of Mongla upazila and Perikhali union of Rampal upazila of Bagerhat district lies on the coastal plain and have been suffering from disasters mentioned above. Single pit-latrines, raised pit latrines, disable latrines, plastic latrines, floating latrines and school latrines have been constructed for sanitation. For sanitation, single pit latrine with raised and stable concrete platform is the most effective and suitable option in disaster prone coastal areas.

Haor areas are characterized by numerous lakes (beels) and large swamps (haors) and water logging for 6-8 months is a major challenge. Clay and silty clay dominates the aquifer system in the area. The deep aquifer is encountered at about 180 m depth below ground. Twin-pit latrines have been constructed in order to use the dry and composted human excreta as fertilizer and villagers are motivated to use it for getting more crops and vegetables. Pit latrine with raised platform in water logged areas is the cheapest technology for sanitation services at haor area. Eco-san latrine can be provided in highland areas.

VI. Summary

As Shallow Hand Tubewell (STW) is the most popular because of shallow groundwater in the recently formed Char areas. The safe distance of STW from nearby pit latrine needs to be considered to protect bacterial contamination as the surface clay is not thick enough and leaky permeable. Installed low-cost Raised Pit Latrines are stable option in flood prone Char areas. Raised platform school latrines are suitable not only for school/madrasa students but also for the villagers during flood.

Installed Raised Pit Latrines are stable option in flood prone areas. Raised platform School Latrines are suitable not only for school/madrasa students but also for the villagers during flood. Depth of conventional pit latrine should be limited to avoid groundwater contamination as the surface clay in the area is soft and leaky permeable and where the thickness of surface clay is less. Plastic Latrines and Floating Latrines are very useful during flood and also in the areas vulnerable to river bank erosion.

In the water scarce zone like Barind, installed Eco-san Latrines are the best option for sanitation. Eco-san may be introduced to School Latrines too and resultant composted excreta can be used as fertilizer for increased crop and vegetable production. Installed Improved Pit Latrines and School Latrines are providing better sanitation services. Single Pit Latrine with raised and stable platform is the most effective and suitable option in disaster prone coastal area for individual households.

Pit latrine with raised platform in water logged areas is the cheapest technology of sanitation for haor area. Eco-san latrine can be provided in highland areas to use the excreta as fertilizer. Twin-pit latrines have been constructed in order to use the dry and composted human excreta as fertilizer and villagers are motivated to use it for getting more crops and vegetables.

More activities and effort is needed to ensure the sanitation facilities for all, mainly in the hard to reach areas. Still it is required to expand and improve the sanitation services in order to satisfy the basic needs in these areas. The need is greater for under privileged groups and vulnerable regions. Proper maintenance and

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monitoring of existing technologies are also important for long-term sustainable use. To capture the full benefits of sanitation services, further attention is needed to improve technology design and implementation. There is a significant drop in efficiency and benefits actually received by households and the communities, because the wrong technology is chosen. For the sustainability, sanitation programs need to be more people-centered and demand driven.

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5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

Policy on Plagiarism

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.



Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for writing a good quality Social Science Research Paper

Techniques for writing a good quality homan social science research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of homan social science then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.
Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

19. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

20. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

21. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

22. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

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Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.



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Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



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Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."



Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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