Journal of Engineering Science 10(2), 2019, 49-60

JES
an international Journal

APPLICATION OF "DPSIR" FRAMEWORK TO ASSESS THE STATUS AND ROLE OF BLUE ECOSYSTEM SERVICES (BES) IN KHULNA CITY

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Received: 25 August 2018 Accepted: 28 October 2019

ABSTRACT

City dwellers are getting increasingly dependent on the ecosystem servicers for security, conform, and livability which exacerbate the ecosystem degradation process. There is hardly any study that has examined this in a systematic way in Khulna city. The objective of the research is to identify the blue ecosystem services (BES) in south west part of Khulna city and to formulate an analytical framework to identify the whole process of BES. A three-stage procedure is followed for the study. At first, all the blue ecosystem components were mapped out in Geographic Information System (GIS) environment with showing the existing condition in 2018. At the second stage the types of ecosystem services, their gradual change, status of utilization and other attributes are assessed empirically by using DPSIR (driving forces, pressures, states, impacts and response) framework. Then the Habitat Suitability Index (HSI) is developed for informed conservation planning of Blue Ecosystem Services (BES). Finally, it provides some policy suggestions in line with the study findings like free cost of maintenance of BES, the increase of public- private partnership, fixation of non-market value etc. to better address the degradation of blue ecosystem service in Khulna city. The results show that a wide range of factors like farming, water quality, lack of social relationship etc. contribute to degradation of BES in the entire south-west part of the city. The key drivers are economic pressure, climate change, poverty, unplanned urban expansion and weak urban environmental governance. Again, among the 11 BES selected for the research there are hardly any area which can be said that it is in good position because of the poor maintenance system.

Key words: *Blue Ecosystem Services (BES); Built Environment; Coastal Bangladesh; DPSIR Framework; HSI*

1. INTRODUCTION

The ecosystem in a water environment is known as an aquatic ecosystem. Aquatic ecosystems can be classified as freshwater ecosystem and marine ecosystem (Alexander and Fairbridge, 1999). Aquatic ecosystem performs numerous functions and offers varieties of services. The services obtained from aquatic ecosystem are known a blue ecosystem service. Sustained flow of blue ecosystem services is essential for ecosystem components including the aquatic organisms (Maes *et al.,* 2018). However, the quality of blue ecosystem services is often affected by various external forces and the user's behaviors apart from the characteristics of the blue ecosystem itself. For instance, a free flowing blue ecosystem is more productive than a closed/static blue ecosystem. Similarly, the size and depth of blue ecosystem also affect the productivity of ecosystem services. Therefore, understanding the ecosystem characteristics and the forces affecting the ecosystem quality is an integral part of any conservation planning of blue ecosystems.

Any conservation planning effort requires linking the nature with the population. The blue ecosystem services help linking the population with the nature. In an urban context the more the linkages between the natural and socio-economic systems are established the more sustainable conservation and management of blue ecosystem services could be ensured (Guerry *et al.,* 2015). Although there are studies that address various issues of ecosystem services, but they have some common limitations.

For instances, the first group of studies explored the role of ecosystem services (Saroar *et al.,* 2019; Akber *et al.,* 2018; Navrud and Mungatana, 1994; Maes *et al.,* 2018). The second group of studies (Dearling and Hossain, 2018; Haque *et al.,* 2018; Kashem *et al.,* 2017; Fisher and Turner, 2008) explored the factors that affects the quality of ecosystem services. A very overwhelming majority of these studies addresses the ecosystem issues from regional scale often in rural setting. Moreover, some of them put higher emphasis on the impact of climate change on the ecosystem services, a bit intuitive in nature with limited empirical insight. Very scanty attempts are seen to address the changes of blue ecosystem services in a temporal scale especially in urban context. This research fills these gaps in numerous ways taking Khulna metropolis in coastal Bangladesh as a case.

Khulna city is situated in a special zone which can be particularly said the coastal zone of Bangladesh and remarks in the south-west part of the country. It encompasses several ecosystem types, including wetlands, mangroves, floodplains and natural canals, which are exposed to both climatic and non-climatic factors (Saroar *et al.,* 2019). Again, Khulna city has a lot of water bodies which are indicated as blue part of ecosystem and many rivers are gone through beside the city (KCC, 2018). These types of ecosystem services can incorporate

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ISSN 2075-4914 (print); ISSN 2706-6835 (online)

the daily life of local people. The composition of population as well as their social and economic structure is changing rapidly in Khulna city. With increasing population, some resources are getting over extracted and some are not being utilized in a proper manner (Mondal *et al.,* 2018). Improving the understanding and management of rivers and ponds can help to provide excellent wildlife havens, right in the middle of the landscapes where they are most needed (Rashid *et al.,* 2017). Degradation of the blue ecosystem services are one of the most significant environmental problems of Khulna city. As a result, different types of river and water body ecosystem services also decreases which hampers the environment and the living standard of general people (Saroar *et al.,* 2019). For understanding the current status about the blue ecosystem services in macro perspective DPSIR (Driving Forces, Pressures, State, Impacts, and Responses) framework is used. On the other hand, Habitat Suitability Index (HSI) is introduced to identify the very deep issues in micro sense. If the blue ecosystem services are totally extinct in recent time the future generation will be in great threat. If the possible loopholes and the impediments lying behind the worse situation of the existing blue ecosystem services are identified, then there is a chance to solve the problem. The objective of the research is to locate the blue ecosystem services and to know the current status of the ecosystem through DPSIR framework and HSI for ensuring the substantial flow.

The paper is structured as follows. At first, all the candidate water bodies are mapped and identified in GIS environment. Then the information of current scenarios as well as needful data is collected from the stakeholders especially from the local people. Here, the most important factors will be the governance system of the ecosystem which is mapped through DPSIR framework and the process is described in methodology portion. The second part shows the results of analysis in the form of a realistic approach for assessing and valuing ecosystem services relevant for water resource like Habitat Suitability Index. The third part works for finding the challenges in valuing ecosystem services as well as integrating biophysical and economic assessments. On the basis of findings some policy suggestions are also enclosed in the research.

2. MATERIALS AND METHODS

To carry out the research we followed the following sequence of work. First designing the research framework and then, developing the tools and protocol of data collection and for using the framework for analysis.

2.1 Developing Research Framework

This research framework is heavily centered on two contemporary issues: one is DPSIR framework and another is HSI. Here following paragraph contains the information about the DPSIR framework

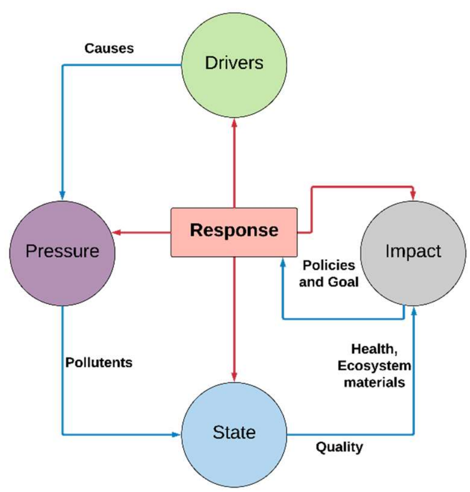

Figure 1: DPSIR Framework (Author, 2018)

2.2 DPSIR Framework

Multipart environmental issues are formed and communicated by a very valuable tool which is also mentioned as a system named DPSIR framework. According to (Environmental indicators: Typology and Overview, 1999) it is found that the first coin of DPSIR Framework was launched by the European Environmental Agency and it has been used by the United Nations. Furthermore, the framework has been adopted by the US Environmental Protection Agency (EPA) in the Sustainable Puerto Rico initiative (Kristensen, 2004). The DPSIR framework is a tool by which the cause-effect relationship between social, economic and environmental issues can be joined to perform their functions (Omann *et al.,* 2009). The DPSIR framework has been used for many environmental resource applications, including management of agricultural systems (Omann *et al.,* 2009), water resources (Laura *et al.,* 2009). The DPSIR framework also can be used to give one common platform in integration of social, cultural, and economic aspects of environmental and human health. In recent years DPSIR has most commonly been used for ensuring environmental management (Figure 2) to connect ecological and socioeconomic factors (Yee *et al.,* 2015) for taking decision on environmental issues (Gari *et al.,* 2015). Here the DPSIR framework is used for as a holistic approach and looking at from the macro perspective of the blue ecosystem situation. Again, DPSIR captures the external forces as well as internal situation but in a macro perspective. But for the detail analysis of selected blue ecosystem components (water bodies) habitat suitability index is used, and it is addressed below.

2.3 Habitat Suitability Index (HSI)

US Fish and Wildlife Service are known as the introducer of HSI scoring systems as a means of evaluating habitat quality and quantity. The value of HSI lies between 0 and 1 as it is a numerical index, where 0 stands for unsuitable habitat, optimal habitat is represented by 1. HSI evaluates (water body) habitat quality (Oldham, 2000; Biggs *et al.,* 2014). The existing condition of the water bodies for the living organisms is easily examined by this index. Though Oldham and Biggs used ten criterions to measure the index but, in this research, only seven are used. Since all the criterions were not found in the context of Bangladesh, some similar criteria were carefully chosen by expert opinion survey and literature review. Each factor was evaluated, and different values were assigned. Result showed that the variation of the candidate water bodies occurred for different variables.
The HSI is a geometric mean of seven suitability indices:

$$HSI = (SI_1 \times SI_2 \times SI_3 \times SI_4 \times SI_5 \times SI_6 \times SI_7)^{1/7}$$

- The seven Suitability Indices are scored for a Water body, in the field and from map work.
- The seven field scores are then converted to SI scores, on a scale from 0.01 to 1 (0.01 is used as the bottom end of the range instead of 0, because multiplying by 0 reduces all other SI scores to 0).
- The seven SI scores are then multiplied together.
- The seventh root of the desired result is calculated as $(X)^{1/7}$. The range of the calculated HSI for a Water body should be between 0 and 1.

Table 1: HSI Indicator

HSI	Water body suitability
<0.5	Poor
0.5- 0.59	Below average
0.6- 0.69	Average
0.7- 0.79	Good
>0.8	Excellent

Suitable Criteria:

- Geographic Location (SI_1)

Field score	SI	Criteria
Well Accessible	1	if it is connected with the surrounding road network that the atmosphere may quite good
Accessible	0.8	If it is not fully connected with the surrounding road network and some impediments exists to ensure a healthy habitat.
Moderate Accessible	0.5	If it is beside along only one road that no open space is available there.
Discrete	0.1	If there is no scope of natural habitat situation.

- Water body Drying (SI_2)

Never	1	Never dries
Sometimes	0.9	Dries no more than two years in ten or only in drought
Rarely	0.5	Dries between three years in ten to most years
Annually	0.1	Dries annually

- Water body Area (SI_3)

Well enough	0.9	Area (487-581) Acres
Moderate	1	Area (289-484) Acres
Rarely Tolerable	0.5	Area (1- 287) Acres

- Water Quality (SI_4)

Good	1.0	Abundant & diverse communities Netting, diverse inverts including may fly larvae & water shrimps
Moderate	0.67	Moderate invert diversity
Poor	0.33	Low invert diversity (e.g. Species such as midge and mosquito larvae), few

		submerged plants
Bad	0.1	Clearly polluted, only pollution tolerant species (rat-tailed maggots), no submerged plants
• Water Depth (SI_5)		
Good	1.0	More depth (more than 3 m)
Moderate	0.67	Moderate depth (2-3 m)
Poor	0.33	Low depth (about 1 m)
• Waste dumping (SI_6)		
Far Distance	1	about 10m distance
Adjacent	0.67	about 5m distance
Very close	0.33	about 1m distance
• Adjacent ground cover (SI_7)		
Moderate	0.50	Rarely cultivated
Worse	0.1	Very poor condition for any living being.

In this research trend analysis is also used to draw the situational change of the blue ecosystem services.

2.4 Trend Analysis

The gradual changing of different parameters is easily identified by this method. The degree of changing and the factors affecting the parameters are listed in a tabular format. The reason behind the changes, the future work and the temporal diversification is the main idea of trend analysis (Saplıoğlu, 2015). Spatial analysis can easily be done here. Although trend analysis is often used to forecast future events, it could be used to guess undefined events in the past, such as how many incidents occurred between two dates in covering the low land, based on data such as the average years which other known thumb ruled (Saplıoğlu, 2015). That's why this technique is used to locate the changing phenomena of blue ecosystem services.

Sl No.	Target	Parameter	Methods
01	To formulate an analytical framework to identify the whole process of BES	Using DPSIR framework	The framework stands for • D- Driving forces • P- Pressures • S- State • I- Impact • R- Response Source: (Environmental indicators: Typology and Overview, 1999)
		Trend Analysis	The observation of the decadal change more specifically for a certain duration. Here it is about 5 years from 2003 to 2018. The scale of influence is fixed through the multiplication of two with the seven criteria's selected for HSI. So influence is measured on (7×2= 14) where 14 is the highest value.
02	To locate the water bodies (blue ecosystem services) in the zone and mapping in a GIS environment.	Geographic coordinate (Latitude, Longitude) Area of the water bodies.	Using GPS to identify the location of the water bodies. Then the water bodies are selected based on the criteria that area >1 Acre. For mapping these blue ecosystem services, the coordinates are in GIS and formulate a map showing the water bodies.
		By using HSI	Seven factors are considered to measure the HSI value which is ranged from 0 to 1. • Geographical location • Area of water bodies • Drying condition • Water quality • Depth of water bodies • Location of waste dumping zone • Adjacent ground cover

Source: (Oldham, 2000)

2.5 Overall Analytical Matrix

After choosing the potential location for the research a questionnaire survey was done. Map preparation helped to collect data of specific water bodies. Then, the computation of HSI identified the status of ecosystem services while DPSIR framework judges the whole process of the BES. Here, the sample size of questionnaire survey was 96 which were conducted in the whole study area.

DPSIR framework indicates the complete relationship of a particular system. It shows the interaction between the different phases with the policy to manage the problems in a sound manner (Kristensen, 2004). By integrating five important features DPSIR framework can be formulated. One of them is Driving force that means the Driving Forces are the factors that motivate human activities and fulfill basic human needs. Then, pressure exerted to the nature including the state lying behind the whole system. At last the responses against each feature are addressed to give some policy-based information about the BES.

Trend analysis is the sequential analysis of a hypothetical problem and can present the actual situation of the candidate area. The changes may occur for natural or man-made reasons. It may help to understand the whole scenario that can help to choose the appropriate decision. Here the interval of the problem statement is almost five years to detect the change. Field survey and some literature-based information were used to formulate such kind of tabular format.

For selecting the water bodies, the operation is done in GIS environment by applying query builder where the command was 'only the water bodies > 1 acre' then the candidate BES are in map. It is assured after the field survey that those selected water bodies can represent the wards. The geographical conditions as well as local people perceptions are considered to nominate the water bodies. To draw a conclusion about the ecosystem services of the particular wards these 11 water bodies can be used. The procedure of calculating HSI is already discussed before. The scale of measurement is flexible.

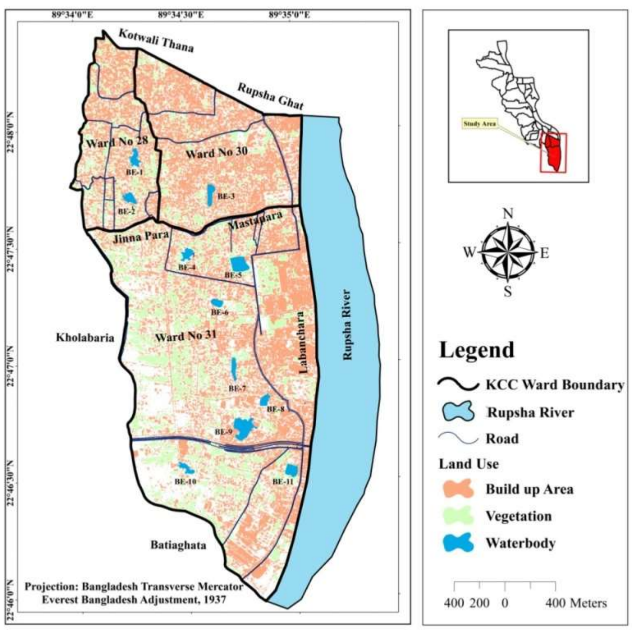

Figure 2: Study Area, Author 2018

2.6 Study Area

The three study areas are selected based on near distance in Khulna City Corporation (KCC) so that it can be defined as a zone. This candidate area also shows the high presence of water bodies under serious threat due to quick expansion of the city. Ward No 30 and Ward No 31 are selected because of the existence of Rupsha river flows beside the wards. On the other hand, in ward 31 eight water bodies are available to measure the ecosystem value. Ward 28 is selected to create a zone for measuring the influence of the blue ecosystems and identify the most significant water body in the area. The study area is located between 22'46"0W and 89'35"0E. All the blue ecosystems are identified in this map for better understanding and further analysis.

3. RESULTS AND DISCUSSION

Identification and valuation of blue ecosystem services in the research area as well as in overall Khulna city is the primary function of the analysis and findings chapter. The provision of ecosystem services in the Khulna city has undergone many changes in recent years. The increasing rate of built environment and urbanization can be highlighted in these changing phenomena.

3.1 Respondent Profile Analysis

About 62.5% family belonged 2-5 members, where 20.8% family having more than 5 members. Most of the respondents were in the range of 45-59 age groups. Maximum people were found that they only completed secondary education (Field survey, 2018). There were also a large number of people was illiterate. Most of the surveyed people were businessmen where 1% people were found unemployed. Peoples were very close to the river (<1) km was calculated 36.5%. 37.5% respondents have reported an income level of > 5000 taka, 14.6% people earned more than 20,000 taka per month. 75% people had their own houses. This basic data is needed because of examining the status of blue ecosystem services through HSI. One of the crucial parts of scoring the value is general people perceptions in calculating the index. It may also clarify the perception of the study area including the stakeholders, especially local people's profile.

3.2 Trend Analysis

Here the table 2 shows that how the condition of the selected problem could change over five-year intervals.

Table 2: Change in Blue Ecosystem Services (BES)

Year	Tourism Facilities	Community participation in preservation	Pollution and Management	Influence[1]
2003	Only local people enjoyed services	• People seriously deprived of BES • Accessibility problem	• Adjacent environment was seriously polluted • Lack of proper maintenance of BES	••••••••••••••
2008	Changing the Value to monetary forms	• Percentage of commercial use was increasing • People were not willing pay for services	• Some development was initiated • Diseases was spreading from the BES	••••••••
2013	Attracted people from outside	• High demand for residential use • Moderately accessible to any portion of candidate area	• Become Lowering the rate of Pollution • Some positive change took place in transparency of Authority	•••••
2018	The Capacity and System in enhancing the economic growth	• Dense settlement prevails there • Some Community based organization developed to protect the BES	• Less water related diseases occur • But the BES is decreasing at an Alarming rate	••••

(Source: Field survey, 2018)

The research can describe the facts that, the influence was so high for serving the ecosystem services in 2003 but now the rate is quite deteriorating of overall condition of water body. The lack of waste dumping station near the water bodies may cause harm like health diseases and so on which also change on the passage of time. From theexplorative point of view, biodiversity often plays a different role in the different time it first played a role as little bit habitual in 2003, it changed in the middle of the period but now it is declining again. If the participation of community people was analyzed, the results showed that initially common people did not take part in the preservation of Blue Ecosystem services (Table 2). Nowadays at 2018, some community-based organization is willingly taking initiatives to preserve the BES (Table 2). Another main branch of blue ecosystem service is tourism facilities which put its significance in national economy. At the beginning of 2003,

[1] Here, the indicators of influence were taken on the basis of indicators taken in HSI for BES. Seven criteria are selected for measuring HSI then the scale of influence is taken by multiplying two with the number of criteria. Which makes the range of influence are 14 and the measurement is based on this value.

only local people can have the accessibility to yield the facilities like fish catching, cultivation. But over time the situation was changed. Now at 2018, economic growth can easily be increased with the proper management of BES. So, it can be declared as a golden opportunity to yield the economic growth. The area of the water bodies is decreasing day by day, even in some cases the water bodies are converted into residential land.

The influence of blue part is decreasing (Figure 3) due to some geographical and manmade reason from 2003 to 2018. People are now interested to develop the low land to build high rise buildings without considering the negative sides. Again (Figure 3) the possible reason of decreasing the influence of BES is lack of awareness of stakeholders especially the community people. Four ecosystem services are common in nature. In this connection, two water bodies are available to serve as provisioning and regulating services in ward 28. Some provisions like direct source of food are generated from one then other water body may serve as the purifier of water, air or other elements of the environment. There is only one provisioning service available in ward 30. But there are a huge number of water bodies observed in ward 31. Most of the BES is providing the supporting services. Again, the soil formation helps to formulate the productivity to the adjacent area. Here only one cultural service is seen to support the community bonding and enhance the ability to prevent the natural calamity. There are also some regulating services to regulate the behavior of human being as well as environment.

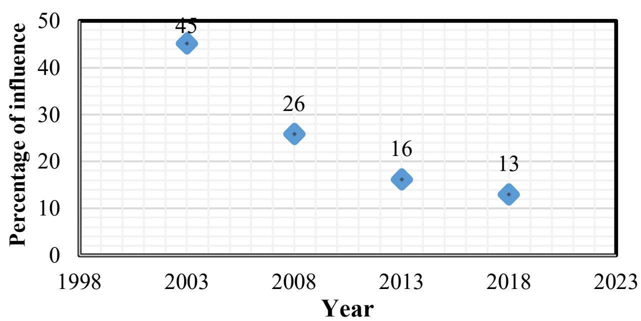

Figure 3: Changing Influence of BES, Authors calculation, 2018

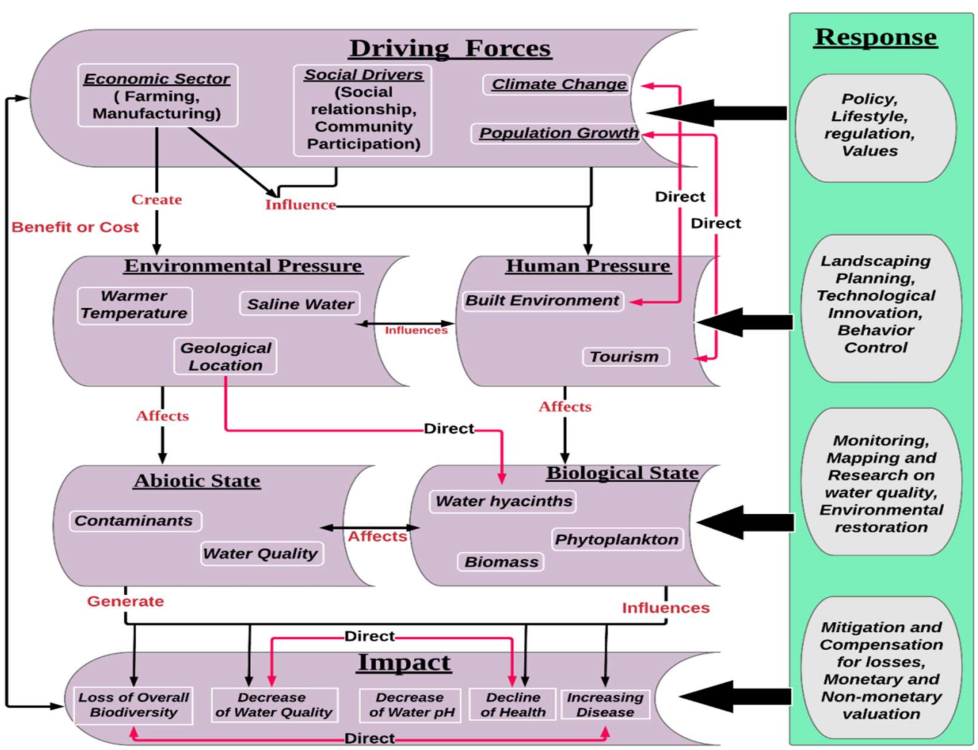

Figure 4: DPSIR framework for BES, Author 2018

Table 3: Type and idea within BES (DPSIR)

Type	Idea
Driving Forces	
Economic Sectors	
Farming	Agriculture, aquaculture, fisheries, forestry
Manufacturing	Manufacturing and trade, transportation, backing and insurance industries, utilities, practical services
Social Drivers	
Social Relationship	Religious associations, social groups, marriage, or family dynamics
Community Participation	Education for all, availability of health care centers, access to jobs
Climate Change	Water level rising, melting of ice
Population Growth	Urbanization increasing, opportunity cost
Pressure	
Environmental Pressure	
Warmer Temperature	Natural calamity, inducing hazards
Saline Water	Lack of proper ingredients, source of diseases
Geological Location	Disaster prone area, low elevated zone
Human Pressure	
Built Environment	Buildings, roadways, furnishings, landfills
Tourism	Waste disposal, misuse of resources
State	
Abiotic State	
Contaminants	Fire, nutrients, pH, atmospheric CO_2 levels
Water Quality	Transparent, taste, color
Biological State	
Water Hyacinths	Water cleaning capacity, living place for organisms
Phytoplankton	Food providing services for fishes, food producing services
Impact	
Loss of Overall Biodiversity	Soil stabilization, wave energy attenuation, recreational value and ecotourism
Decrease of Water Quality	Water quality parameter, temperature regulation, erosion regulation, water refining, pest regulation, pollination, natural hazard regulation
Decrease of Water pH	water resources, acidity increasing
Decline of Health	Educational or knowledge value
Increasing Disease	Malnutrition, waterborne diseases
Response	
Driving Force -Based	
Policy	Health, Cultural, Transportation, education policies
Lifestyle	Equity, security, decision making policies
Regulation	Law enforcement, political pressure on government
Values	Community bonding, believes
Pressure-Based	
Landscaping Planning	Land use supervision, building permits, coast re-nourishment, nominated confined areas
Technological Innovation	Improved technology, alternate energy sources
Behavior Control	Punishment on smoking, diet adaptation, opting for community transportation
State-Based	
Monitoring, Mapping and Research	Setting nominated uses, hunting licenses, fishing licenses, boating licenses, designated protected areas
Environmental Restoration	Community planning, eco-friendly environment
Impact-Based	
Mitigation and Compensation	Compensatory mitigation, mitigation banking
Monetary Valuation	Methods to quantify and monitor well-being
Non-Monetary Valuation	Non-market valuation, multi-attributed utility theory

(Source: Author's Design, 2018)

Status of Blue Ecosystem Service from Macro Perspective (Use of DPSIR Framework) DPSIR is the analytical framework for determining the relationship between various types of ecosystem services components. The environment is composed of different elements and the use of the DPSIR framework gives the idea from an external point of view about the status of ecosystem services. It can also describe the factors regarding driving forces and actors as well as consequence's immediate or long-term impact. The relationship holds the sole identity to show the actual scenario regarding the status of ecosystem services in the candidate area through DPSIR framework. Then, the decision can be finalized to upgrade the worse condition of the community with the concern of idea. This type of relationship can help to judge the current scenario which may assist to make decision about the suitability condition.

The Figure 4 is showing the ins and outs of the ecosystem services with the level of significance in governing procedure. Red arrows showed the direct relationship among the factors, black arrows indicate the regular meaning. This type of analysis (Figure 4) can help to identify the actual status of the locality and the response measures the steps and the logic to cope up the problems. The prime consideration of this framework is to find the whole governance system of ecosystem service in a particular area. Direct effect might be considered seriously rather than indirect one. For better understanding the diagram can be illustrated in the following manner where all the steps are clearly mentioned with the explanation. All the factors regarding or associated with the candidate BES are mentioned here and at last the responses or the possible solutions are mentioned.

Table 3 stands for elaborating the concept of DPSIR framework and establishing the relationship between the factors. DPSIR framework indicates the complete relationship of a particular system. According to Kristensen, (2004), DPSIR framework shows the interaction between the different phases with the policy to manage the problems. From the expertise point of view, it can be said that, the driving forces worked behind the ecosystem as well as the pressure created in the environment can be clearly identified from the explanation. The composition of driving forces (Figure 4) is economic sector and social drivers which is already sated in the table. Then, pressures come on the ecosystem as environment and human based action. Again, the state of different elements like biotic and abiotic is noticed in a confined way. The impact of the ecosystem services largely depended on Loss of Overall Biodiversity, Decrease of Water Quality, Decrease of Water pH etc. At last, the remedy or response to the negative impact on the ecosystem should be removed by setting policies on the four elements of the framework like driving force based, pressure based, state based and impact based response. Table 3 establishes the linking between the crucial factors of any ecosystem services.

3.3 Status of Blue Ecosystem Service from Micro Perspective (Use of HSI)

Basically, the measurement of HSI is done based on some specified steps (Table 4). The score of the index stands for declaring the current status of living organism. The value of each criterion is given with the availability of particular provisions which is mentioned.

Seven suitable criteria are carefully chosen to justify the result to the standard value which may help to take the decision. Each score was given based on field survey and finally the values were used to calculate the HSI. The values were taken based on expert opinion survey. The criteria were classified at a fixed interval. The calculation procedure was previously discussed and based on the given formula. The candidate water bodies were given different values on a scale of 0 to 1. The actual scenario is very close to the output of the HSI. From the eleven water bodies (Table 5), only two stands for average status which may serve the minimum service to the environment and they are BES-8 & BES-10.

Table 4: Suitable criteria's for HSI

Source: Expert opinion survey and (Oldham, 2000)

Suitable Criteria	BES										
	1	2	3	4	5	6	7	8	9	10	11
Geographic Location (SI - 1)	0.1	0.5	0.1	0.1	0.5	0.1	0.5	0.8	1	1	0.1
Water body Area (SI - 2)	0.5	0.5	0.5	0.1	0.5	0.5	0.1	0.1	0.5	0.1	0.1
Water body Drying (SI - 3)	0.1	0.5	0.1	1	0.1	0.5	0.5	0.9	0.1	0.9	0.1
Waste dumping (SI - 4)	0.1	0.67	0.67	1	0.33	1	1	1	1	1	0.1
Water Quality (SI - 5)	0.1	0.67	1	1	0.67	0.67	0.67	1	0.67	0.67	0.33
Adjacent ground cover (SI - 6)	0.1	0.5	0.1	1	0.5	0.1	0.1	0.5	0.5	0.5	0.1
Water Depth (SI-7)	0.67	0.67	0.67	1	1	0.67	0.67	1	0.67	1	0.33

The ecosystem services are very urgent for the area, but the existing situation is not so satisfactory. Local people may greatly deprive of the needs. Most of the BES is poor in the influence sector and they cause great harm to the environment. BES-1, 2, 5, 6, 7 & 11 all the water bodies are marked as poor status (Figure 6). Three water bodies marked as just below average condition that may stand for the limited opportunities. Not worse as poorly conditioned water bodies but not so good condition as the best situation. The current status of the existing BES is not satisfactory and if the deterioration of the water bodies is continuing future generation may have the adverse situation.

Table 5: Score of BES on the basis of HSI

Name	Local Name	Value	Suitability
BES - 1	N/A	0.17	poor
BES - 2	N/A	0.57	Below Average
BES -3	N/A	0.41	Poor
BES - 4	N/A	0.52	Below Average
BES - 5	Rafiq's Water body	0.43	Poor
BES - 6	N/A	0.38	Poor
BES - 7	N/A	0.38	Poor
BES - 8	Graveyard Water body	0.62	Average
BES - 9	Gher	0.53	Below Average
BES -10	Mizan contractors Water body	0.60	Average
BES- 11	N/A	0.14	Poor

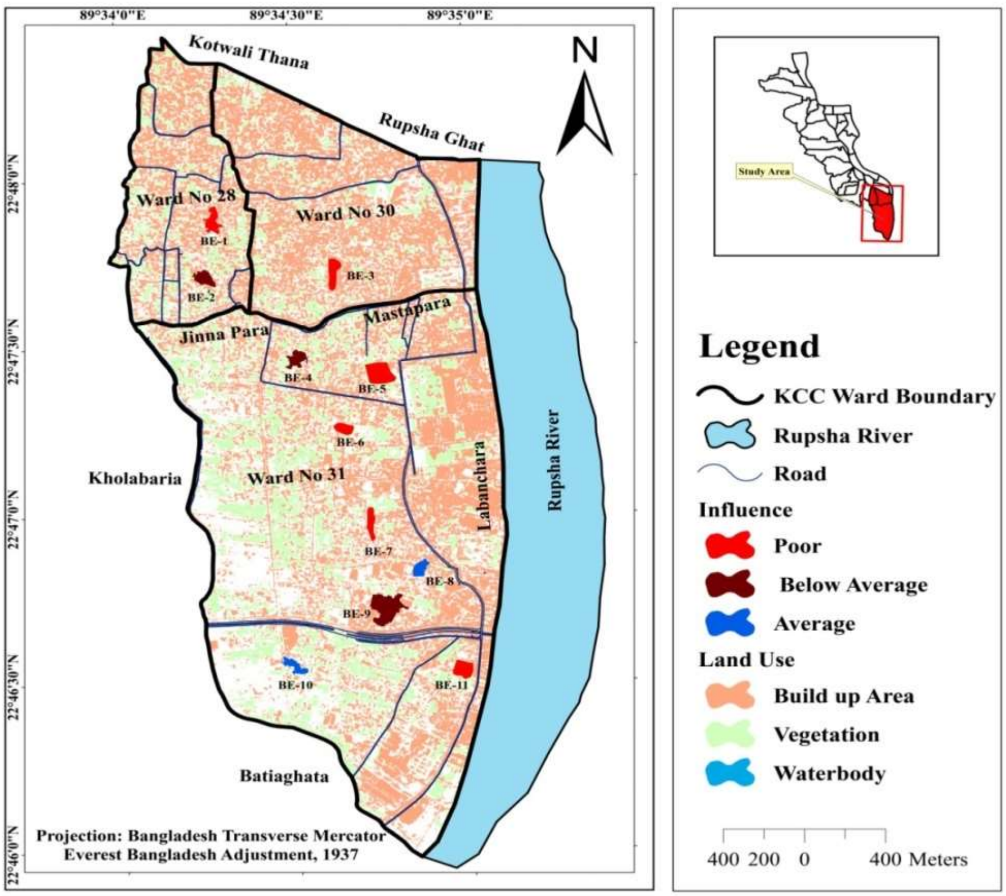

Figure 5: Visual representation of BES status, Author 2018

4. CONCLUSIONS

European and international state governments and organizations have recognized that economic value can be gained by including ecosystem service assessment in policies and decision making (Fisher *et al.,* 2008). Long term resilience policies can help to avoid significant costs and risks in environmental planning and ecological system also. It can also help to increase the public consciousness about the policies of natural system which can help to minimize the risk to the nature. Major limitations of this research are the blue ecosystems (water body) having the area greater than 1 acre only considered for the research, for calculating Habitat Suitability Index only 7 variables were taken. Existing canals and river are ignored. The data size for different services is not same.

Here, the DPSIR framework indicates the overall procedure of the blue ecosystem services with some policy measure. The standard format of blue ecosystem services is not maintained properly by existing driving forces. Impacts are the most vital indicators to judge the status of BES. There is a need for an effective set of responses to ensure sustainable ecosystems such as institutional and governmental changes, incentives such as free maintenance costs, social and behavioral factors, integration in agriculture, finance, trade and health services to achieve specific goals. Public- Private Partnership increased the transparency and accountability in ecosystem management by introducing new technology for the promotion of increased crop yields without harmful environmental impacts. All values should not incorporate in market factors some should be in non-market value fixation. There is hardly any provision for available parks which should be provided adequately. Again, most of the open fields are dirty that should be cleared in a regular interval. For ensuring normal run off drainage condition should be improved that means it should be open rather than covered.

Again, the prevention should be maintained in nursing the blue part of the ecosystem. In this research the Habitat Suitability Index is mainly used to judge the actual scenario and defined the condition of the water bodies. Among the 11 BES selected for the research there are hardly any area which can be said that it is in good position because of the poor maintenance system. So that, it is high time to take initiative which is already discussed to lead a sound life.

REFERENCE

Akber, M. A., Khan M. W., Islam M. A., Rahman M., and Rahman R., 2018. Impact of land use change on ecosystem services of southwest coastal Bangladesh, *Journal of Land Use Science*, 13(3) , 238-250.

Alexander, D. E., and Fairbridge R. W. (Eds.), 1999. *Encyclopedia of Environmental Science*, London, United Kingdom: Chapman and Hall.

Assessment, M. E., 2005. Ecosystems and Human Well-being: Synthesis, Island Press, Washington, DC.

Biggs, J., Ewald N., Valentini A., Gaboriaud C., Griffiths R.A., Foster J., Wilkinson J., Arnett A., Williams P. and Dunn F., 2015. Using eDNA to develop a national citizen science-based monitoring programme for the great crested newt (Triturus cristatus), *Biological Conservation*, 183, 19-28.

Dearing J.A., Hossain M.S., 2018. Recent Trends in Ecosystem Services in Coastal Bangladesh, In: Nicholls R., Hutton C., Adger W., Hanson S., Rahman M., Salehin M. (eds) Ecosystem Services for Well-Being in Deltas, Palgrave Macmillan, Cham.

Environmental indicators: Typology and Overview, 1999. DK-1050 Copenhagen K Denmark: European Environment Agency.

Fisher, B., Turner R. K. and Morling P., 2008. Ecosystem services: Classification for valuation, *Biological Conservation*, 141, 1167-1169.

Gari, S. R., Newton A. and Icely J. D., 2015. A review of the application and evolution of the DPSIR framework with an emphasis on coastal social-ecological systems, *Ocean & Coastal Management*, 103, 63-77.

Guerry, A. D., Polasky S., Lubchenco J., Chaplin-Kramer R., Daily G. C., Griffin R., et al., 2015. Natural capital and ecosystem services informing decisions, *Proceedings of the National Academy of Sciences of the United States od America,* USA: PNAS.

Haque, M. N., Mamun M. A. and Saroar M. M., 2018. Mapping and valuation of blue ecosystem service in an urban area: a case study on ward 30 in Khulna city, Bangladesh, *Proceedings of the 4th International Conference on Civil Engineering for Sustainable Development (ICCESD 2018)*, Khulna: Department of Civil Engineering, KUET.

Jain, S., 2005. Ecosystems and their Structure. In C. O. India, Basics of Ecology and Life Support Systems (pp. 35-36). India: Centre of Excellence in Environmental Education (CEE).

Kashem, M. A., Siddiqui A. A. and Rahman M. M., 2017. Coastal zone of Khulna district in Bangladesh: Fisheries land use and its potentials, *International Journal of Fisheries and Aquatic Studies*, 5 (2), 599-608.

Khulna City Coorporation (KCC), 2018. Retrieved from http://www.khulnacity.org/index.php?page=Home

Kristensen, P., 2004. The DPSIR Framework. A comprehensive / detailed assessment of the vulnerability of water resources to environmental change in Africa using river basin approach. Kenya: UNEP Headquarters, Nairobi..

Laura, M., Spangenberg J. H. and O'Connor M., 2009. An analysis of risks for biodiversity under the DPSIR framework, *Ecological Economics*, 69, 12-23.

Loomis, J., Kent P., Strange L., Fausch K. and Covich A., 2000. Measuring the total economic value of restoring ecosystem ervices in an impaired river basin: results from a contingent valuation survey, *Ecological Economics,* 33, 103-117.

Maes, J., Burkhard B. and Geneletti D., 2018. Ecosystem services are inclusive and deliver multiple values: A comment on the concept of nature's contributions to people, *One Ecosystem* 3: e24720 .

Mondal, S., Moniruzzaman S. M. and Islam M. S., 2018. Study on emptying of faecal sludge at selected areas in Khulna City, *Journal of Engineering Science*, 09 (1), 77-84.
Navrud, S., and Mungatana E., 1994. Environmental valuation in developing countries: The recreational value of wildlife viewing, *Ecological Economics*, 11(2), 135-151.
O'Higgins, T. G., Ferraro S. P., Dantin D. D., Jordan S. J., and Chintala M. M., 2010. Habitat Scale Mapping of Fisheries Ecosystem Service Values in Estuaries, *Ecology and Society*, 15 (4), 7.
Oldham, R., Keeble J., Swan M. J., and Jeffcote M., 2000. Evaluating the suitability of habitat for the Great Crested Newt (Triturus cristatus), *Herpetological Journal*, 10 (4), 143-155.
Omann, I., Stocke A., and Jager J., 2009. Climate change as a threat to biodiversity: An application of the DPSIR approach, *Ecological Economics*, 69 (1), 24-31.
Rashid, M. H., Shirazy B. J., Ibrahim M. and Shahidullah S. M., 2017. Cropping Systems and their Diversity in Khulna Region, *Bangladesh Rice J.*, 21 (2) , 203-215.
Saplıoğlu, K., 2015. A new methodology for trend analysis: A case study in Burdur and Isparta, Turkey, *Fresenius Environmental Bulletin,* PSP 24,10a.
Saroar, M. M., Rahman M. M., Bahauddin K. M., and Rahaman M. A., 2019. Ecosystem-Based Adaptation: Opportunities and Challenges in Coastal Bangladesh. In S. H. al., Confronting Climate Change in Bangladesh (pp. 51-63). Springer Nature Switzerland AG .
Yee, S., and Bradley P., 2015. Using the DPSIR Framework to Develop a Conceptual Model: Technical Support Document. US Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division.