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# Water quality assessment of a shrimp farm: A study in a salinity prone area of Bangladesh

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**Abstract**
The study was conducted in a shrimp farm to assess the water quality status of the farm. Standard methods were used to analyze the collected samples. The water temperature was found to vary between 18 $^0$C and 32 $^0$C in the farm at different months of the study period. The pH value of the water was found slightly alkaline (7.4 to 7.9) during the study period. The values of alkalinity, free carbon dioxide, dissolved oxygen, transparency, salinity, and hardness were found to vary between 154.6 to 167.2 mg/l, 4.1 to 5.7 mg/l, 5.6 mg/l to 6.8 mg/l, 24.4 cm to 42.2 cm, 15.2 ppt to 18.3 ppt and 89.01 mg/l to 117.83 mg/l respectively. There was no significant variation in two parameters such as water salinity and pH in the farm. However alkalinities, hardness, acidity, DO fluctuated significantly in the farm. Air temperature showed seasonal trends in fluctuation during the study period. The air temperature was recorded low during winter and high during summer. During the study period the lowest evaporation, sunshine hour and rainfall was recorded in rainy season and the highest was recorded in summer. But there was no significant variation found in relative humidity during this study period. Air pressure was recorded throughout the year. During the study period the lowest air pressure was recorded 996.4 mb in January and the highest was recorded as 1150.12 mb in April. The overall behavior and nature of an environment was largely governed by the interaction of the respected meteorological, physical, chemical and biological parameters.

**Keywords:** Water quality, shrimp farming, physical parameter, chemical parameter, fisheries.

## 1. Introduction

Bangladesh is fortunate enough having an extensive and huge water resources scattered all over the country in the form of small ponds, beels (natural depressions), lakes, canals, haors, baors, small and large rivers and estuaries covering an area of about 4.34 million ha. Fisheries sector of Bangladesh, thus, becomes highly diversified in resource types and species. There are about 735 species of fish and 48 species of shrimp available in the fresh and marine waters of Bangladesh (DoF, 2003) [15]. Fisheries sector have been playing a very significant role and deserve potential for future development in the agrarian economy of Bangladesh. This sector contributes 4.39% to the national GDP and almost one-fourth (22.76%) to the agricultural GDP (Bangladesh Economic Review 2012). In recent years, this sector performs the highest GDP growth rate in comparison to other agricultural sectors (crop, livestock and forestry). The growth rate of this sector over the last 10 years is almost steady and encouraging, varying from 4.76 to 7.32 percent with an average (FRSS April, 2013) [18] 5.61 percent. Whereas last four years average growth rate of this sector is 6.22 percent. The country's export earnings from this sector is 2.46% in 2011-12. The sector's contribution to the national economy is much higher than its 4.39% share in GDP, as it provides about 60% of the animal protein intake and more than 11% of the total population of the country is directly or indirectly involved in this sector for their livelihoods (FRSS April, 2013) [18].

Aquaculture is one among the fastest growing food sectors in the world. Amongst the various branches of aquaculture, shrimp culture has expanded rapidly across the world because of faster growth rate of shrimps, short culture period, high export value and demand in the market. In developing countries of east and south-east Asia, shrimp culture has become an important industry and contributes for the majority of the export both in terms of quantity and value. Currently more than 70% of global shrimp production is coming from these countries and most is exported to developed countries. China is the leading producer of farmed shrimp in the world. Bangladesh has vast potential in terms of species diversity and total marine and

brackish water culture environment. Although shrimp aquaculture has significant contribution in the export earning still there is a room for improvement in the total production through lateral expansion and better management practices. In this regard, the division of Khulna has the vast coast line in Bangladesh and that can be suitable for the expansion of shrimp aquaculture.

Water quality plays an important role in increasing the productivity of shrimp farm. It provides nutritionally balanced and healthy environment to cultured animals. Water quality has a significant role in increasing the total production of pond. Water quality management is important in aquaculture. The pH in water and sediments determine the healthy survival and growth of aquatic animals. The physico-chemical parameters like temperature, salinity, dissolve oxygen, free CO2, alkalinity, hardness and transparency influence the water quality directly or indirectly, which ultimately govern the healthy survival of organisms in aquatic ecosystems. Salinity plays an important role on the physiological functions of culture organisms. The balance of salt and water in a tissue is very essential for maintaining the coordination in its physiological functions. Salinity is a major concern in the southwestern part of Bangladesh, especially in coastal region. Salinity intrusion in fresh water results the eventual degradation of both the land and water resources (Haque, 2003) [21]. Salinity is increasing day by day in the study area due to tidal action, shrimp cultivation as well as tidal surge at the time of cyclones. Salinity is also increasing by subsurface penetration of saline seawater and leaching of salts due to the rise of sea level, faulty management of sluice gates, regular saline tidal water flooding in unpoldered area, capillary upward movement of soluble salts due to presence of high saline ground water table at shallow depth (SRDI, 2003) [47]. The water salinity range in Dacope was 12-20 ppt in 2010 but in 2007 it was 5-10 ppt. (SRDI, 2010) [46]. The salinity affects the nutrient availability by modifying the retention, fixation, and transformation of the nutrients in soils and water (Chhabra, *et al.*, 1986) [9]. Many natural ponds and water bodies are found contaminated with high salinity due to the subsurface leaching of salinity in the study area. The study on changes of physico-chemical parameters of surface and shrimp farm (gher) water was carried out in shrimp cultivation areas to determine the comparative changes of different physico-chemical parameters of water in the shrimp farm under the coastal sub-region Dacope of Khulna.

## 2. Materials and Methods

### 2.1. Study Area

The study area was selected in a semi intensive shrimp farm (named S and M shrimp culture Ltd.) at Dacope in Khulna. This farm is situated at Kata Khal in Dacope beside the Possur River and just opposite of the Mongla port. The study was carried out in this shrimp farm during January-June 2013. The study area is also located near to the Sundarbans mangrove forest. The area under the present study [between $22^0 24'$N and $22^0 36'$N, and $89^0 24'$E and $89^0 36'$E] is located at Dacope in Khulna district, the most South-Western part of Bangladesh.

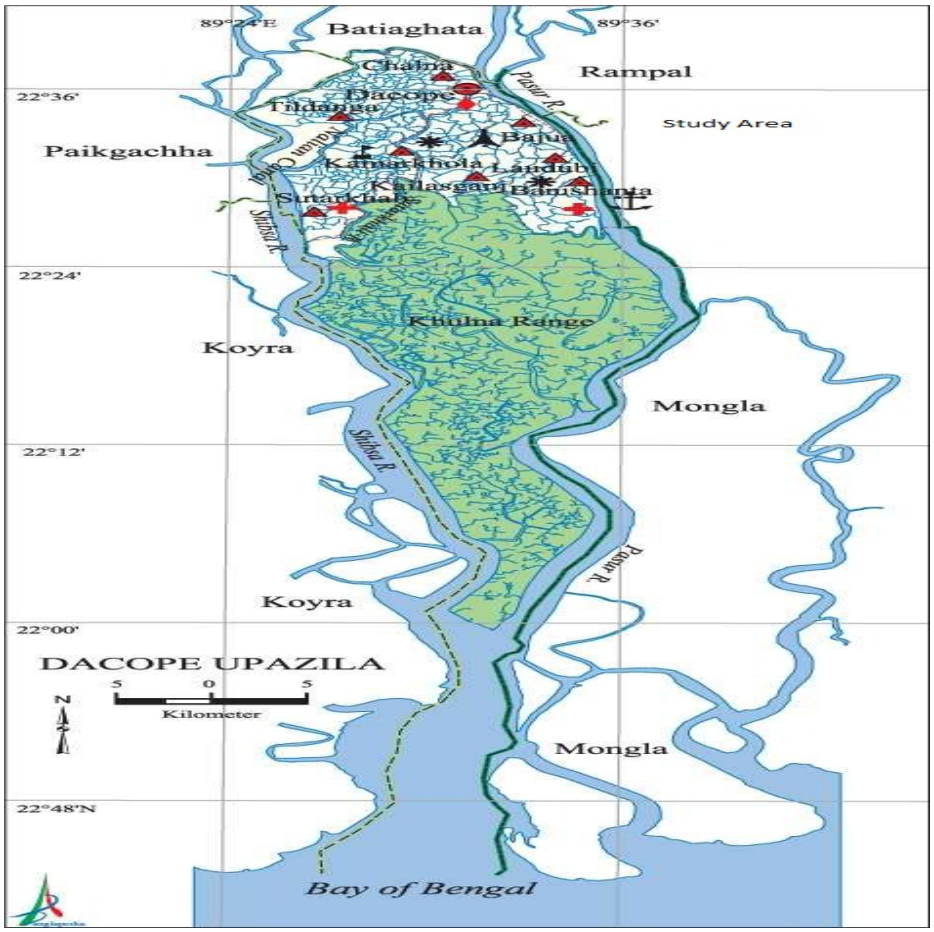


**Fig 1:** Map of the study area (source: Banglapedia)

### 2.2. Collection and preservation of samples
Water samples were collected twice a month from January 2013 to June 2013. For the determination of dissolve oxygen, water samples were collected in different DO bottles, each has 300 ml capacity. In case of the other parameters one liter capacity clean plastic bottle was used for collecting the water samples.

All the collected samples were placed into a plastic box and transported to the workshop of the farm immediately for further analysis.

The preservation procedure varies depending of the test to be performed. The samples for DO, after collection, should not be allowed to remain in contact with air or be agitated because either condition causes a change in its gaseous content. The DO was "fixed" with some prescribed reagents (such as Manganese sulphate, $MnSO_4.H_2O$ and Alkahli Iodide Azid) at the pot as soon as the sample has been collected.

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### 2.4. Method of Analysis
#### 2.4.1. Temperature
Water temperature was measured with a mercury-filled Celsius thermometer ranging $0^0$ to $50^0$C. To measure temperature the thermometer was dipped in to the water for one minute and the reading from the thermometer was recorded in the paper.

#### 2.4.2. Salinity
Water salinity of the collected samples was measured using a digital salinity meter (Model No- 211. HANNA instruments). One drop of sample water was taken on the main prism of the meter. Before inserting the water sample, the prism of the meter was rinsed with distilled water and adjusted the meter scale to 0 ppt.

#### 2.4.3. Water pH
Water $p^H$ of the collected samples was measured using a digital $p^H$ meter (Model No- pHeP HI 98107. HANNA instruments) nearest to 0.01. Before using the instrument it was calibrated with $p^H$ 7 and $p^H$ 10 buffer solutions. The pH meter was immersed in the water samples to be tested without exceeding the maximum immersion level. Then the sample was Stired gently and waited for the reading to stabilize and the reading from the pH meter was recorded in the paper.

#### 2.4.4. Dissolve Oxygen (DO)
Dissolve oxygen (DO) of collected water samples was measured using a digital DO meter (Model No- YK 22DO. LTLUTRON instruments). The probe plug was connected into the probe input socket and the power button was pushed. Then the CLA button was pushed and waited for the reading. The reading form the DO meter was recorded in the paper.

#### 2.4.5. Free carbon dioxide
Free carbon dioxide of water was measured using titration method following (APHA, 1992). Burette was clamped and filled with 0.1N NaOH solution up to the mark 250 ml sample was taken in to the conical flask and added 5 drops indicators phenolphthalein solution. Titrate was made with 0.02N NaOH solution until a permanent pink color appeared. Free carbon dioxide in the sample water was calculated by the equation as bellow:

$$\text{mg } CO_2/L = \frac{A \times N \times 44{,}000}{ml\ of\ sample}$$

Where, A = ml titrant and N = Normality of NaOH

#### 2.4.6. Alkalinity
Alkalinity of the water was measured using titration method following (APHA, 1992). The burette was first rinsed with distilled water and then rinsed with 0.1N $H_2SO_4$ was standardized by $Na_2CO_3$ solution. 10 ml sample was taken in a 250 ml conical flask and added 5 drops of the phenolphthalein indicator solution into it. 5 drops methyl orange indicator was added to the sample and titrated with 0.1N $H_2SO_4$ to a light pink color and the volume of titrate was recorded. Alkalinity of the sample was determined with following formula.

$$\text{Alkalinity, mg } CaCO_3/L = \frac{A \times N \times 50{,}000}{ml\ of\ sample}$$

Where, A = ml standard acid used and N = Normality of standard acid.

#### 2.4.7. Hardness
Hardness of water was measured using ethylenediaminetetraacetic acid (EDTA) titration method. 0.800M ethylenediaminetetraacetic acid (EDTA) titration cartage was set into the selected place of the titrator. By moving the knob of the titrator the liquid was taken at the end of the delivery tube. Then the reading was taken of the titrator at 0.10 ml sample water was taken and 90 ml mineral water was taken into the 250 ml orlimere flask. 2 ml buffer solution was taken (Hardness-1) into the sample water. Titration was done with 0.800M ethylenediaminetetraacetic acid (EDTA) until the color change from red to blue. Titration was carefully done at the end point and the temperature was kept under $20^0$C. Total hardness was calculated with the following formula:

$$\text{Hardness (EDAT) as mg } CaCO_3/L = \frac{A \times B \times 1000}{ml\ of\ sample}$$

Where, A = ml titration for sample and B= mg $CaCO_3$ equivalent to 1.00 ml EDAT titrant.

#### 2.4.8. Transparency
Water transparency was measured using a white Sacci disk. The instrument was placed into the water until the disk was visiable. The visiable and invisiable length of the stick which was sank into the water was measured by cm scale. The arithmatic mean of visiable and invisiable length was recorded.

### 2.5. Meteorological Data
During this investigation all the metrological data were collected twice a month from January 2013 to June 2013 from 'Regional Information Center, Khulna.

## 3. Results

### 3.1Physico-chemical parameters

A total of eight different water quality parameters were recorded and analyzed two times a month from the selected farm during the field observation.

### 3.1.1 Water temperature

The temperature was found to vary in different months of the study period between 18 $^0$C to 32 $^0$C in this farm. The maximum surface water temperature was recorded at 32$^0$C in the summer. A wide difference about 14$^0$C water temperature was recorded between summer and winter season. The temperature fluctuation during the study period is presented in Fig. 2.

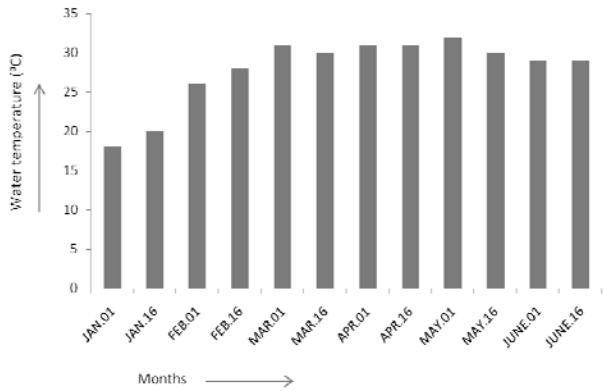


**Fig 2:** The changes of water temperature during the study period

### 3.1.2 Water pH

The average pH value was found to vary from 7.4 to 7.9 in different month (Fig. 3). The highest pH of water recorded in the farm was 7.9 in June as well as lowest pH of water as recorded in January. The average value of pH is 7.64 $\pm$ 0.01.

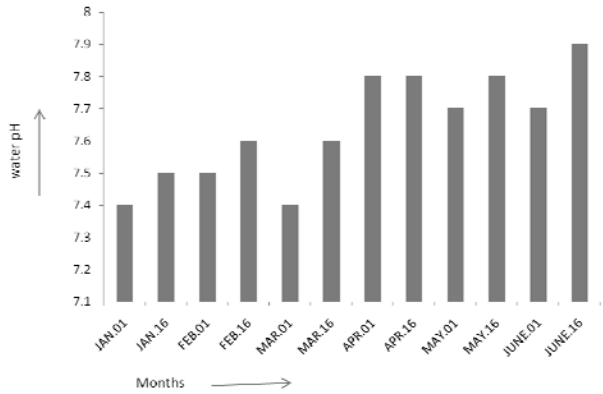


**Fig 3:** The changes of water pH during the study period

### 3.1.3. Dissolve oxygen

The values of dissolved oxygen content of water under study station all the time period are presented in Fig. 4. The dissolved oxygen content of water ranged 5.6 mg/l to 6.8 mg/l. The highest dissolved oxygen content was recorded 6.8 mg/l in January. The lowest dissolved oxygen content (mg/l) was recorded 5.6 mg/l in June.

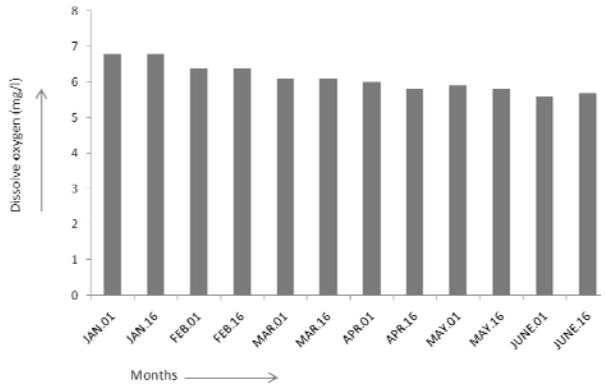


**Fig 4:** The fluctuation of Dissolve oxygen during the study period

### 3.1.4 Salinity

During the study period the range of salinity of the farm were found between 15.2 to 18.3 ppt that is shown in Fig. 5. The highest and lowest salinity was recorded in April and January respectively.

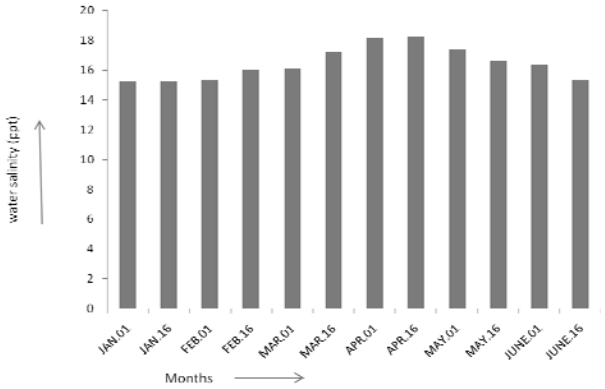


**Fig 5:** The fluctuation of water salinity during the study period

### 3.1.5 Alkalinity

Total Alkalinity in the study area was found to vary from 154.6 mg/l to 167.2 mg/l in the station that is shown in Fig.6. The highest value of total alkalinity was recorded (167.2 mg/l) in April and the lowest 154.6 mg/l) in June.

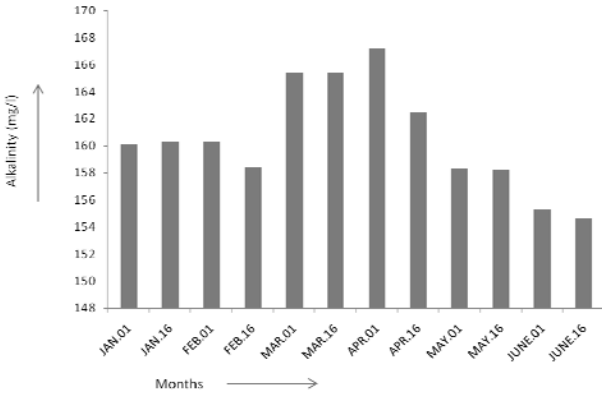


**Fig 6:** The fluctuation of alkalinity during the study period

### 3.1.6 Free carbon dioxide

The range of free carbon dioxide value found to vary from 4.1 mg/l to 5.7 mg/l. The changes in free carbon dioxide are presented in Fig. 7. The highest value of free carbon dioxide

was recorded (5.7mg/l) in January and the lowest value was found 4.1 mg/l in June.

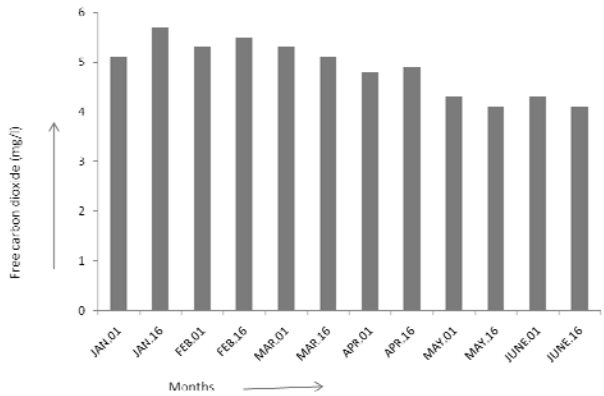


**Fig 7:** The fluctuation of free carbon dioxide during the study period

### 3.1.7 Hardness

The value of hardness content of water from the farm in study period is presented in Fig. 8. The hardness content of water in the study areas was found to vary from 89.01 mg/l to 117.83 mg/l in the farm. The highest value of hardness content was recorded 117.83 mg/1 and the lowest value was found 89.01 mg/l.

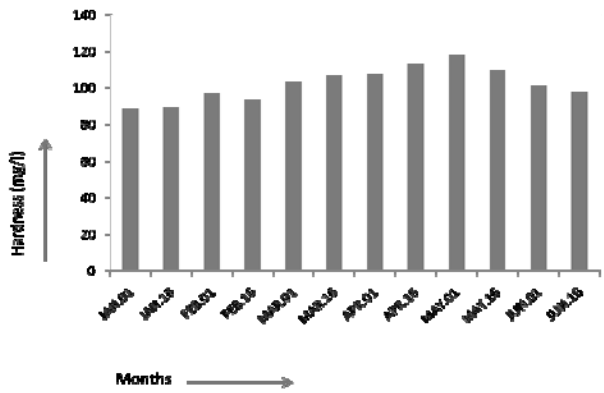


**Fig 8:** The changes of Hardness during the study period

### 3.1.8 Transparency

The range of transparency value found to the study farm is presented in Fig. 9. The highest value of transparency was recorded (42.2 cm) in January and the lowest value was found (24.5 cm) in June.

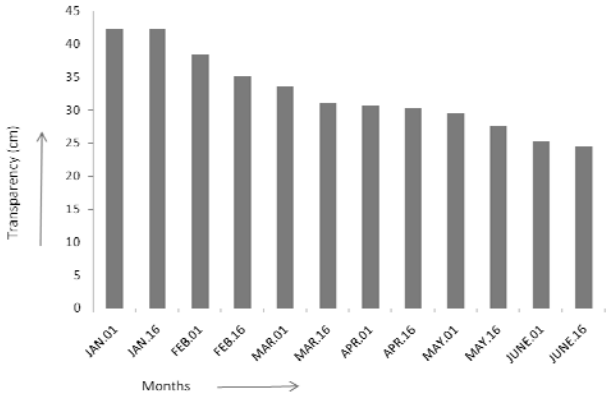


**Fig 9:** The changes of water transparency during the study period

### 3.2 Meteorological data

During the investigation period meteorological data were collected from Regional Information Center khulna. The meteorological data of Khulna city during the study period was as followings.

### 3.2.1 Air temperature

The data regarding air temperature at the farm area from January 2013 to June 2013 was recorded. It was observed that air temperature varied considerably throughout the study period and range of temperature was found to vary from 15.1 $^0$C to 35.9 $^0$C during the study period. The maximum air temperature was recorded as 35.9 $^0$C. In April 2013 and the minimum value was recorded as 15.1 $^0$C in January 2013. Fig. 10 shows the monthly fluctuation of air temperature value.

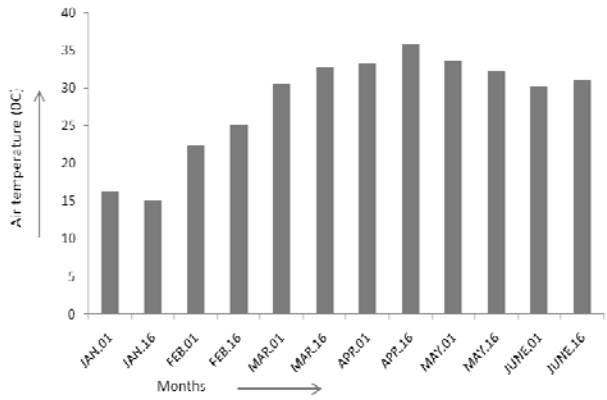


**Fig 10:** The changes of air temperature during the study period

### 3.2.2 Evaporation

During the study period the lowest evaporation was recorded 3.6 mm in June and highest was recorded as 4.8 mm in April. The study period average evaporation was found 4.15 mm. Fig. 11 shows the ranges of evaporation.

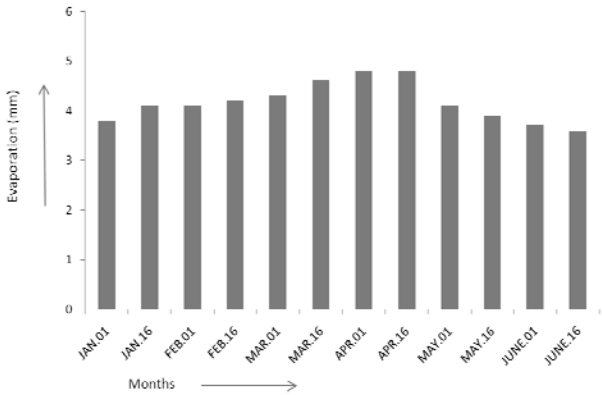


**Fig 11:** The changes of evaporation during the study period

### 3.2.3 Sunshine hours

Sunshine hour was recorded throughout the study period. During the study period the lowest sunshine hour was recorded 5.045 hours in June and the highest was recorded as 9.5 hours in April. The average sunshine hour was found 7.87 hours. Fig. 12 shows the range of sunshine hour value.

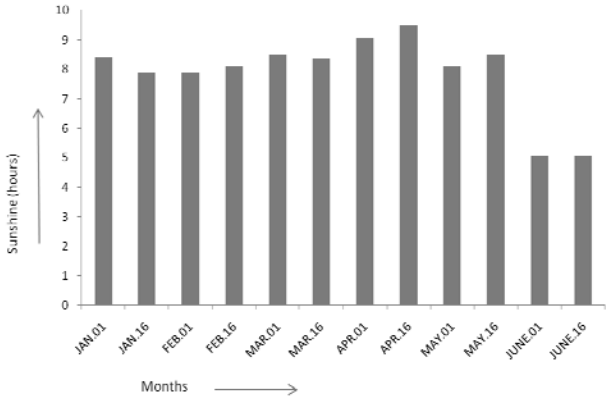


**Fig 12:** The fluctuation of Sunshine hours during the study period

### 3.2.4 Rainfall

The rainfall during the study period shows a distinct seasonal trend in fluctuation. The maximum rainfall was recorded as 16.7 mm in June 2013 and the minimum rainfall was recorded as 0 mm in January - March. The average rainfall was calculated as 4.53 mm. Fig. 13 shows the range of rainfall value recorded during the study period.

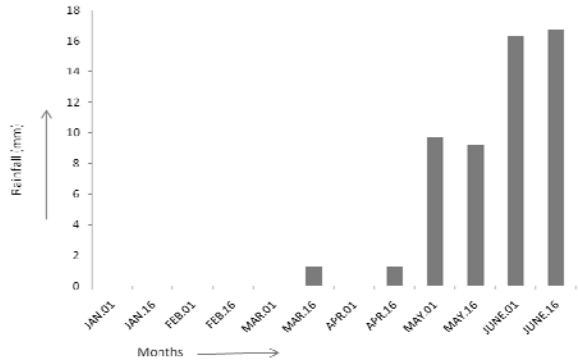


**Fig 13:** The fluctuation of Rainfall during the study period

### 3.2.5 Relative humidity

During the study period the lowest humidity was recorded on 71.9% in March 2013 and the highest was recorded as 87.1% in June 2013. Mean of humidity was found 76.89%. Fig. 14 shows the changes of humidity value.

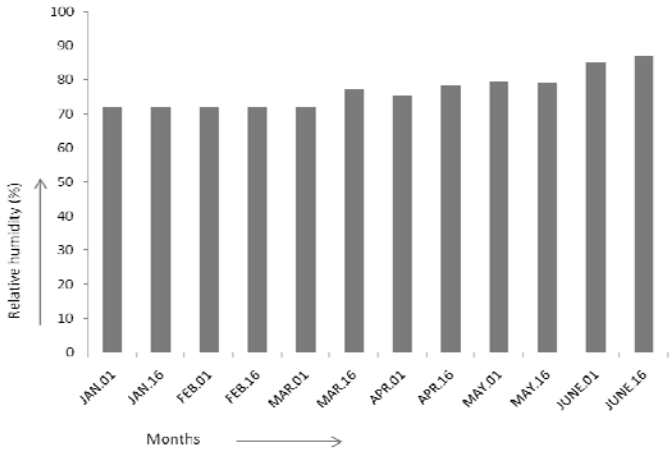


**Fig 14:** The fluctuation of relative humidity during the study period

### 3.2.6 Air pressure

Air pressure was recorded throughout the study period. During the study period the lowest air pressure was recorded 996.4 mb in January and the highest was recorded as 1150.12 mb in April. Fig. 15 shows the changes of air pressure value.

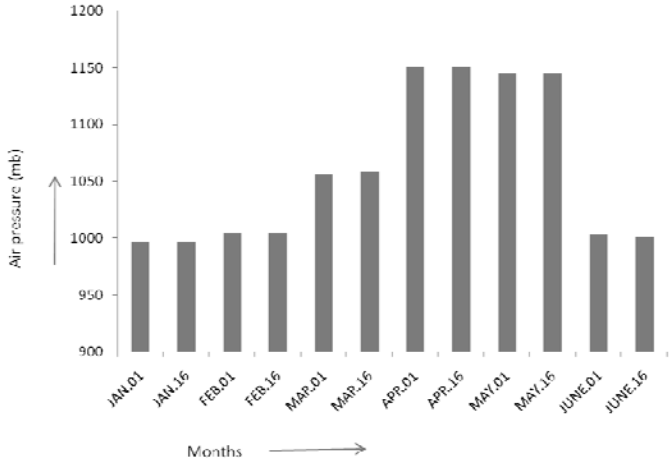


**Fig 15:** The fluctuation of air pressure during the study period

## 4. Discussion

### 4.1. Physicochemical parameters

#### 4.1.1. Water temperature

Temperature has the most outstanding and biological influence on the activities of the flora and fauna of the aquatic farm. This phenomenon of aquatic environment was found in the relationship between water and air temperature as expressed by seasonal variations. A rise in temperature of the water leads to the speeding up of the chemical reactions in water reduces the solubility of gases and amplifies the taste and odors as well as the biological activities of aquatic organisms. The variation in water temperature (18 $^0$C to 32 $^0$C) during the study period may be attributed to the position of the sun and day length. Temperature may not be that important factor because of the wide range of temperature tolerance of aquatic biota in non-polluted environment, but in the polluted water, rapid temperature changes may cause over shoots in the metabolism of the aquatic organisms and it may have a profound effect on dissolve oxygen which subsequently effects the aquatic biota particularly to the fishes of an ecosystem. Hence its measurement is very important. The raise in temperature in the river water could be correlated with increases in free carbon dioxide levels (Tailling, 1957) [30]. The rainfall and air temperature had the direct influence on the variation of water temperature (Michael, 1968) [33]. The rainfall and water temperature also varied directly, which was observed by Miah *et al*., (1981) [32]. This was possibly due to the heavy influx of water during monsoon which increased the light illumination. The heavy rainfall reduced the plankton turbidity and therefore sunlight entered in to deeper water thus the temperature of water was increased. Optimum temperature for fish growth ranges from 28 $^0$C to 32 $^0$C. This direct relationship between air water temperatures was also reported by Islam *et al*., (1976) [25]; Miah *et al*., (1981) [32]; Ismail *et al*., (1984) [27]; and Begum *et al*., (1989) [4, 6]; in Bangladesh. Similar results were reported by Zafar (1974) [55], Munawar (1978), Islam *et al*., (1983) [26]; Chowdhury and Mojumder (1981) [11], and Miah *et al*., (1981) [32]. The changes in the temperature were mainly induced by variations in the atmospheric temperature. Qusim and Gopinath (1969) and Dehadrai (1970) [14] had also reported similar finding in vellar estuary Cochin backwaters and Mormugao Bay respectively. Raman *et al*., (1976) [41]; also observed seasonal fluctuation in temperature in Cochin back waters. The maximum summer month was reported by Ganapati (1940) [19] in Roshanara tank and Naini Lake, Vyas and Kumar (1968) [51] in Tekanpur reservoir and Mathew (1975) [30] in Gobindgarh Lake in India. The maximum temperature in June to August in a pond, London was also reported by Young (1975) [54]. The low water temperature during the study period was found in winter month which also supported by Das and Bhuyan (1974) [13], Islam *et al*., (1976) [25]; Oppenheimer *et al*., (1989); in Bangladesh. The maximum temperature in May and August was reported by Chowdhury and Mojumder (1981) [11] in Bangladesh who worked in Kaptai Lake. The low water temperature during winter months was also found several authors in India notable George (1964) [20], Verma (1969) [50] and in England by Young (1975) [54]. The rainfall and air temperature had the direct influences on the variation of water temperature (Michael, 1968) [33]. The rainfall and water also related to the productivity of the farm. It is more or less similar to the findings of Chakrabarti (1984) [10], who found maximum concentration of macro benthic fauna in high temperature. Similar results were also recorded by Dewan (1973) [16].

#### 4.1.2. Water pH

The pH of a solution refers to its hydrogen ion activity and is expressed as the reciprocal of the hydrogen in activity at a given temperature. Water with pH ranging from 6.0 to 9.0 is generally regarded as suitable for organism's growth (Ellis, 1997) [17]. The growth is retarded if pH falls below 5.0. The lower pH of water was recorded in late winter, because lower phytoplankton primary productivity at low light intensity. The pH of the farm was found to be alkaline. According to Roy (1955) [44] the pH of the river Hoogly to be more or less stable within the range of 8.3 to 8.4 which is an example of high buffering capacity and pH value of 6.7 was reported from the river (Dewan, 1973) [16]. Lower pH in different water station receive sewages has been reported by chakrabarti (1984) [10], Raman, *et al*., (1976) [41]. The pH values between 6.5 to 8.5 were required to maintain the productivity of water and normal physiology of aquatic life (Jhingran, 1985). The pH range of Mouri river fall within the range between 6.1 to 7.7 and also to maintain the productivity of water and normal physiology of aquatic life.

The alkaline nature of river water was reported by Islam and Mendes (1976) [25] and Ali *et al*., (1980) [3]; Ali and Islam (1983) [26], Patra and Azadi (1987) [38], Ali *et al*., (1989) [4]; in Bangladesh. Ganapati (1940) [19], George (1964) [20], Joyangodour (1964) [28], Arora (1966) [5], Vyas and kumar (1968) [51], Michael (1968) [33], Verma (1969) [50], Sreenivasan (1966) [48], and Mathew (1975) [30], in India. Maximum pH value were recorded in October (1997), March (1997), July (1977) and December (1966), which was also noted by George (1964) [20] in India. Chakrabarti *et al*., (1984) [10]; also observed the maximum pH value in March to June and November to December in Allahbad. A direct relationship with free carbon dioxide was observed by Islam and Mendes (1976) [25], Oppenhemer *et al*., (1978) [37]; Ali *et al.,* (1982) [2]; Miah *et al*., (1981) [32]; patra and Azadi (1987) [38], and Begum *et al*., (1994) [7]; in Bangladesh, Zafar (1964) in India. A direct relationship between pH value and DO was observed during the present investigation agreeing with Oppenhemer *et al*., (1978) [37]; Ali *et al*., (1982) [2]; and Begum *et al*., (1989) [4, 6]; in Bangladesh. The pH value in alkaline condition in the river water was supposed to be helpful for proper growth and development of fishes and aquatic organisms Nikolsky (1963) [36]. Rice (1983) [43] observed an annual variation of pH in the river. Thames, where pH attain a value of 8.5 in spring at time phytoplankton maximum and was relatively low in summer fall and winter.

#### 4.1.3. Dissolve Oxygen

The highest dissolve Oxygen content (mg/l) was recorded 6.8 mg/l from the farm in January. The lowest dissolved Oxygen content (mg/l) was recorded 5.6 mg/l in June. Optimums DO level for the survival of organisms range from 4.5 mg/l to 8 mg/l (Meybeck, 1989) [31]. Lower DO value was recorded in summer season because of low production of oxygen by phytoplankton in absence of light and overnight respiration of zooplankton and other nekton living in the farm. The low dissolve oxygen during early summer season due to the high temperature which enhanced the high production of free carbon-dioxide, because the dissolve oxygen consumption is almost doubled of rise of 10$^0$C temperature (Welch 1952) [52]. DO content of water of river Mouri indicates the low productive range. Dissolve oxygen in the farm water comes from two source. Most of it comes as a by-product of photosynthesis. The other source is affected by many factors

particularly water temperature, respiration and the level of organic matter.

Chakrabarti (1984) [10] found maximum concentration of macro benthic fauna ranged from 6.2 to 8.2 mg/l of the dissolved oxygen content. On the other hand Bhuyan (1974) [8] reported that the dissolved oxygen content of water ranging from 5 to 6 mg/1 was within the good production range. Mathew (1975) [30] found that the dissolved oxygen content of water should be higher than 1 mg/l to maintain positive benthos production. The station was found maximum during January which agree with chowdhury and Mojumder (1981) [11] and Khan *et al*., (1990); in Bangladesh, George (1964) [20], Zafar (1964), and Vyas and kumar (1968) [51], in India. The lowest dissolved oxygen content of the station was found minimum during summer season which agree with verma (1969) [50], in India. Islam *et al*., (1974) and Patra and Azadi (1987) [38], in Bangladesh.

The dissolved oxygen shows reverse relationship with free carbon dioxide which conform with the result of Michael (1968) [33], verma (1969) [50], Mathew (1975) [30] Ali *et al*., (1983); Miah *et al*., (1981) [32]; and Ismail *et al*., (1984) [27]. DO showed positive relationship with alkalinity. DO also showed negative relationship with free carbon dioxide agreeing with Michael (1968) [33], Verma (1969) [50], Mathew (1975) [30], Ali *et al*., (1983); Miah (1981) [32], and Ismail *et al*., (1984) [27]. The values of DO varied seasonally. Similar observation also noticed by Islam (1983) [26] in karnafully river and Dehadri (1970) [14] in the Mandovis and zuari estuaries and Rajendran (1974) in vellar estuary and stated that in general the Do values were higher during the monsoon and pre-monsoon season. The present work coincides with the above authors.

### 4.1.4. Salinity

During summer season water salinity increased. But in rainy season this salinity decreased. Salinity plays an important role in the growth of culture organisms through osmoregulations of body minerals from that of the surrounding water. For eg. the optimum range of salinity for black tiger shrimp is between 10 and 25 ppt, although the shrimp will accept salinity between 5 and 38 ppt. since its eurihaline character. The early life stages of both shrimp and prawn require standard seawater salinities but while growing they can with stand to brackish water or even to freshwater. However, for better survival and growth optimum range of salinity should be maintained in the shrimp farm.

### 4.1.5. Alkalinity

Alkalinity measures the buffering capacity of the water against changes in pH. Water that has a high Alkalinity can accept doses of acid or bases without altering the pH significantly. Water with low Alkalinity, such as rainwater or distilled water can experiences a drop in the pH with only a minor addition of an acid or base. Alkalinity in polluted river water of Andra prades was found 171.2 mg/l to 2.35 mg/l during 1961 to 1985 (Hossain, 2004) [22]. The Alkalinity above 40 mg/l is considered to be hard water characteristic (Mathew 1975) [30] which help to maintain the pH value alkaline condition. Hutchinson (1957) [24], station that bicarbonates the chief source of alkalinity at a pH range of 7.0 to 9.0.

Welch (1952) [52], and Yaron (1964) [53], held that alkalinity of an aquatic habitat partly depends on the amount of water present in it. The dilution of bicarbonate concentration may occur during the rains in comparatively shallow bodies of water. Future Welch (1952) [52], and Hutchinson (1957) [24], held that a decrease in alkalinity May probably be caused by the breakdown of carbonate due to the photosynthetic activity of plants. Moreover turbulence of water during the rainy months may drive free carbon dioxide to escape to nature, consequently causing a fluctuation in the bicarbonate alkalinity values. Pearsall (1930) [39], Raymond (1937) [42], Zafar (1964), observed that waters rich in bicarbonates are also rich in calcium.

Evaporation of water causes a gradual increase in alkalinity (Michael, 1968) [33], due to low volume of water and low pH. The high bicarbonate alkalinity during winter was possible due to the low free carbon dioxide, low temperature and rainfall. In the study station the low alkalinity was recorded during summer which is supported by George (1964) [20]. The bicarbonate alkalinity during summer was possibly due to the heavy rainfall which diluted the alkalinity future more production of free carbon dioxide enhanced by high temperature agreeing with Michael (1968) [33], and Verma (1969) [50].

### 4.1.6. Free carbon dioxide

Free carbon dioxide in the study area was found to vary in study period. The highest value of free carbon dioxide was recorded (5.7 mg/l) in January and the lowest (4.1 mg/l) in June. Here free carbon dioxide is totally absent in June due to photosynthetic activities of phytoplankton and algae. Vyas and Kumar (1968) [51] noted same observation in India. Islam and Mendes (1976) [25], Miah *et al*., (1981) [32]; Ismail *et al*., (1984) [27]; and patra and Azadi (1987) [38], also observed similar results in Bangladesh. Low photosynthetic activity which consumed carbon dioxide, low precipitation of free carbon dioxide which agrees with Miah *el al*., (1981) [32], Ali and Islam (1983) [26], and chowdhury and Mazumder (1981) [11]. Optimum free carbon dioxide level for the survival of organisms is less than 5 mg/l (Huq, 2002) [23].

### 4.1.7. Hardness

Hardness was found to fluctuate during the period in study areas. The highest value of hardness content was recorded 117.83 mg/l in May and the lowest value was found 89.01 mg/l in January. The variation of hardness might be due to variation of photosynthetic activates of phytoplankton. Which utilize free carbon dioxide and increased the calcium carbonate level (singh, 1994) [46].

Clark (1954) [12] found more carbonate, when free carbon dioxide was taken up from water by photosynthesis. Optimum hardness level for fish growth and reproduction is 50 mg/l to 100 mg/l (Huq, 2002) [23].

### 4.1.8. Transparency

Analytically, Transparency refers to the penetration of light through water (the lesser the penetration, the greater the turbidity), formally to imply concentration (weight of solids per weight of water). Suspended solids make water cloudy or opaque; they include chemical precipitates, flocculated organic matter, living and dead planktonic organisms, and sediment stirred up from the bottom on a pond, stream, or raceway. Dissolved solids may color the water, but leave it clear and transparent; they include anything in true solution. The range of transparency value found to vary from 24.5 cm to 42.2 cm. which is suitable for shrimp farming.

### 4.2. Meteorological data
The overall behavior and nature of an environment is largely governed by the interaction of the meteorological, physical, chemical and biological parameters. Again a factor is not always independent. There remains a close relationship between the factors. A litter variation may influence the other. Similar type of interaction was observed in the present study. But some meteorological data show a little adverse relation with the physico-chemical parameters.

#### 4.2.1. Air temperature
Air temperature shows seasonal trends in fluctuation during the study period. The air temperature was recorded low during winter and high during summer. The direct relationship between air and water temperature was also reported by Islam *et al*., (1976) [25]; Miah *et al*., (1981) [32]; Ismail *et al*., (1984) [27]; and Begum *et al*., (1989) [4, 6]; in Bangladesh. The air temperature had the direct influence on the variation of water temperature (Michael, 1968) [33]. This was possibly due to the heavy influx of water during monsoon which increased the light illumination. Air temperature is directly and closely related with temperature but sometime exception may occur when water temperature may be slightly higher than air temperature.

#### 4.2.2. Evaporation
The monthly and seasonal fluctuation evaporation largely depends on the sunshine hour. Evaporation of water cause of a gradual increase in alkalinity (Michael, 1968) [33], low volume of water and low pH.

#### 4.2.3. Sunshine hours
Sunshine hour showed seasonal trends in fluctuation during study period. During the study period the lowest sunshine hour was recorded 5.045 hours in rainy season and the highest was recorded as 9.5 hours in summer. The evaporation largely depends on the sunshine hour.

#### 4.2.4. Rainfall
Rainfall had a cooling effect on air temperature, the hot summer wind took a moderate trend variation when frequent rainfall begun to take place in the month of May and continued till October. This is supported by a similar observation made by Islam and Mends (1976) [25]. The rainfall had the direct influence on the variation of water temperature (Micheal, 1968). The rainfall also varied directly, which was observed by Miah *et al*., (1981) [32]. This was possibly due to the heavy influx of water during monsoon which increased the light illumination. The heavy rainfall reduced the plankton turbidity and therefore sunlight entered in to deeper water and thus the temperature of water was increased.

Heavy rainfall enhanced the oxidation of organic matters by the consumption of dissolve oxygen and high production of free carbon dioxide so heavy rainfall has the advance relation with dissolve oxygen. Besides the cloudy day restrict the photosynthetic activities of phytoplankton as a result dissolve oxygen decreases. Low rainfall caused low decomposition of organic matter and addition of carbon dioxide high photosynthesis which consumed high precipitation of carbon dioxide thus low free carbon dioxide occurred. Which agreed with Michael (1968) [33], in India and patra and Azad (1987) [38], in Bangladesh. Due to the low free carbon dioxide, low temperature and rainfall the high bicarbonate alkalinity during winter occurred. Heavy rainfall diluted the alkalinity further more production of free carbon dioxide enhanced by high temperature during summer season so the low alkalinity occurred which agree with Michael (1968) [33], and Verma (1969) [50].

#### 4.2.5. Relative humidity
The monthly and seasonal fluctuation of atmospheric humidity was found to be in conformity with the extent of rainfall. This is supported by a similar observation made by Islam and Mendes (1976) [25]. During the study period the lowest humidity was recorded on 71.9% in March 2013 and the highest was recorded as 87.1% in June 2013.

#### 4.2.6. Air pressure
Air pressure showed seasonal trends in very small fluctuation during the study period except in April, because AILA crossed the northern region of this month.

## 5. Conclusion
Water samples were collected from the study farm to analyze seasonal variation in water quality parameters. During the study it was found that there was no significant variation in three parameters such as water salinity, DO and pH in the farm. These parameters are maintained by using various substances. In summer season salinity increases due to evaporation of surface water and in rainy season salinity decreases. Then the reservoir water is used to maintain salinity level. To maintain the DO level, electrical paddle wheel is used in the farm. Three types of lime such as dolo lime ($CaMgO_3$), $CaCO_3$, and CaO are used to maintain the pH level of water in the farm. However alkalinities, hardness, temperature and transparency fluctuate significantly in the farm. Air temperature showed seasonal trends in fluctuation during the study period. A great care was taken to determine the physico-chemical parameters of water during study period.

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