

**STUDY ON THE CURRENT STATUS OF THE WATER
QUALITY IN THE POSSUR, RUPSHA AND VHAIRAB
RIVER CHANNEL**



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STUDY ON THE CURRENT STATUS OF THE WATER QUALITY IN THE POSSUR, RUPSHA AND VHAIRAB RIVER CHANNEL

A project work

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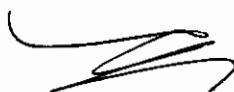


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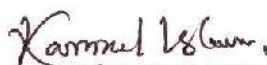
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Declaration

**Study on the Current Status of the Water Quality in the Possur,
Rupsha and Vhairab River Channel**

**The results presented in the project thesis with the above mentioned title are
entirely of the candidate's own investigations and no part of the results has been
accepted for any degree nor is it being concurrently submitted for any degree.**



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DEDICATED TO

MY BELOVED PARENTS

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Abstract

This project thesis deals with the study of current status of water quality of the three rivers Vhairab, Rupsha and Possur in the South-west costal reign of Bangladesh. This describes the condition of pH, Temperature, DO (Dissolved Oxygen) TDS (Total Dissolved Solid), EC (Electrical Conductivity), Salinity, Chloride, BOD (Bio-chemical Oxygen Demand), and Hardness. Water temperature was found to fluctuate from 25°C to 30°C. The highest and lowest pH values of the river Vhairab, Rupsha and Possur were 7.2 to 8.9, 7.40 to 9.6 and 7.34 to 9.5 respectively. TDS value of the river Possur, Rupsha and Vhairab were in the range of 0.070 to 0.089 gm/L, 0.078 to 0.099 mg/L and 0.074 to 0.089 gm/L respectively. The Electrical Conductivity of Vhairab river was more than the other two rivers and it attained 96 ms/cm and lowest EC was in the Possur river and that was 31 ms/cm. Average salinity in the Vhairab, Rupsha and Possur river was 21 ppm, 18 ppm and 19ppm respectively. Average alkalinity was found 250mg/L, 200mg/L and 250 mg/L in the river Vhairab, Rupsha and Possur respectively.

Average bio-chemical Oxygen Demand (BOD) in the river Vhairab, Rupsha and Possur was 2.25 mg/L, 3.75 mg/L and 3.75 mg/L respectively. Average Dissolved Oxygen (DO) was found in these three rivers 4.75 mg/L, 5.87 mg/L and 5.625 mg/L respectively. Hardness of these rivers did not fluctuate significantly. The highest and lowest hardness of these three rivers were 5.99 mg/L and 4.2 mg/L respectively. All the physico-chemical parameters were well below the permitted levels recommended for aquatic organism.



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CHAPTER ONE

INTRODUCTION

Chapter-1

INTRODUCTION

1.1. Introduction:

Bangladesh is an agro-based riverine country. There are a lot of rivers criss-crossed through out the country. More or less 80% of our people depend on agriculture for their occupation and fisheries is one of the sub-sectors which plays an important rôle in the socio-economic development of Bangladesh. Inland open water of this country mainly included the network of rivers and canals, flood plains (3-6 months inundated low lying areas), haors (large deeply flooded depression), beels (depression often with permanent area of water), and ponds. This environment is dependent on chemical status as well as water chemistry which lead the aquaculture more productive.

Chemistry of water is generally refers to component of water, which is to be present at the optimum level suitable for growth of plants and animals. Various factors like water temperature, turbidity, hardness, alkalinity, Dissolved oxygen (DO) play an important role for the growth of plants and animals in the water. Each factor has a specific role on aquatic ecosystem. Fish influence water quality through processes like nitrogen metabolism and respiration. Knowledge of testing procedures and interpretation of results are important to the fish farmer. Some water quality factors are more likely to be involved with fish losses such as dissolved oxygen, temperature, and ammonia. Others, such as pH, alkalinity, hardness and clarity affect fish, but usually are not directly toxic. Each water quality factor interacts with and influences other parameters, sometimes in complex ways. What may be toxic and cause mortalities in one situation can be harmless in another. Initially the water supplied for fish ponds are usually of good quality. Metabolism cause pronounced diurnal fluctuations in dissolved oxygen concentrations, dissolved carbon dioxide concentrations, and pH. Such fluctuations cause stress in fish resulting in reduced fish growth rates. There are chemical and biological factors that influence the beneficial use of water. There are many water quality variables in water. Coastal regions are the most productive ecosystems in the world, exemplified by the fact that coastal and estuarine habitats provide feeding and reproduction ground for approximately 90% of the world's marine fish catch. Some parameter are discussed in this thesis.

Total Dissolved Solid (TDS)

TDS (Total Dissolved Solid) in water mainly consist of ammonia, nitrite, nitrate phosphate, alkalis, some acids, sulphates, metallic ions etc. TDS in the river were due to the discharge of effluents and waste (Moore *et al.*, 1960) The TDS of the river Poshur, Rupsha and Vhoirab are given in the table summarized in the appendices.

Electrical Conductivity (EC)

It is usually used for indicating the total concentration of the ionized constituents of water. It is closely related to the sum of the cat-ions or an-ions as determined chemically, and it usually correlates closely with TDS (Rouse, 1979). A sharp fall of EC values in wet season might be due to huge dilution of the river water by the monsoon rainfall. Prescott (1962) described that a rich algal flora, particularly if it is the Myxophycean type is a visible index of an abundance of electrolytes.

Total alkalinity

Generally the water shows alkalinity due to the presence of carbonates and bi-carbonates. Both carbonates and bi-carbonates are of importance because of their tendency to combine with and precipitate the divalent cat-ions Ca and Mg. Value of total alkalinity influences the production of plankton and then fish production (Rouse, 1979). Doudroff and Katz (1950) reported that more of the strong alkalis were shown to be lethal to fully developed fish and other biota. When their concentrations were not enough to raise the pH of the water above nine.

Alkalinity of Natural water

The total alkalinity of waters ranges from less than 5 mg/L to over 500 mg/L as CaCO_3 and is determined by the geology of the aquifer or, water shed. Bicarbonate and carbonate are derived primarily from the dissolution of basic minerals. Dissolution of limestone is the source of alkalinity in many waters. Limestone has low solubility in pure water but the rate of dissolution and amount of bicarbonate in solution are greatly increased in the presence of dissolved CO_2 which act as an acid. The range of total alkalinity values in inland surface water is similar to that for ground waters but surface waters usually have lower total alkalinity than ground waters in the same vicinity because surface waters usually have lower CO_2 level than ground waters. The total alkalinity of seawater is about 120 mg/L as CaCO_3

Chloride

As chloride is frequently associated with sewage, it is often incorporated into assessment as an indication of possible faecal contamination or as a measure of the extent of the dispersion of sewage discharges in water bodies.

The effect of chloride in an aquatic environment does not seem to have received much attention. However, it is certain that high concentration of any ion is bound to affect overall biota drastically. This is particularly applicable to chloride as this ion is known to have far reaching physiological significance in maintaining the permeability constant of biological membrane (Bhouyan, 1979).

Dissolved Oxygen (DO)

Dissolved Oxygen is essential to all forms of aquatic life including those organisms responsible for the self purification processes in natural waters (Chapman, 1992). Without free DO, the river, streams and lake become uninhabitable to gill breathing of aquatic organisms (Vesilind *et al.*, 1990). Low DO concentrations might be associated with the higher microbial activities in decomposing organic waste released from the surrounding environment. Chapman (1992) reported that a high waste discharge of organic matter and nutrients can lead to decrease in DO concentrations as a result of the increased microbial activity (respiration) occurring during the degradation of the organic matter. DO concentrations were generally higher in dry season and lower in wet season. As temperature increases in the summer months, the metabolic activity of aerobic aquatic species increases thus demanding more oxygen resulted in depletion of DO in the river waters (Vesilind *et al.*, 1990). Apart from this, surface run-off for monsoon rainfall increased the turbidity, which caused less light penetration and consequent decrease in photosynthetic activity responsible for lower DO level in wet season. Over all pattern of DO level showed negative correlation with temperature and positive correlation with the value of transparency. DO concentrations during monsoon months presumably associated with the warming of water, death and decay of planktonic and other organic matter and related photosynthetic activity due to reduction in the sunlight caused by cloudy weather condition. DO if the water body is free from any other polluting agents.

Dissolved Oxygen in Natural Waters

Most ground waters contain little or no dissolved oxygen because biological processes occurring in the aquifer recharge zone remove oxygen as water percolates through the

ground. However, ground waters from aquifers with large joints or fissures may recharge so rapidly that some dissolved oxygen of atmospheric origin remains in the water. Also, ground waters in limestone (karat) regions may flow through caverns where exposure to the atmosphere replenishes dissolved oxygen

In streams and rivers unpolluted by oxygen-demanding waters, dissolved oxygen concentrations are usually near saturation because the water is aerated by turbulent mixing. However, dissolved oxygen concentrations may be low in rivers down stream from organic waste outfalls or below dams where water is discharged from the bottom of the reservoir. Dissolved oxygen concentrations are near saturation in the surface waters of most ponds, lakes, and reservoirs. If phytoplankton or aquatic plants are abundant, dissolved oxygen concentrations may vary during the day, being highest in late afternoon and lowest at sunrise. Some lakes and reservoirs thermally and chemically stratify during the warmer months of the year. The bottom waters are not mixed with oxygen-containing surface waters and insufficient light is present for photosynthetic oxygen production. These waters are thus deprived of reparation and may become oxygen deficient as biological activity consumes oxygen faster than it can diffuse from the overlying water. The availability of dissolved oxygen frequently limits the activities and growth of aquatic animals. Water saturated with oxygen contains 20-40 times less oxygen by volume than air and the energetic costs of breathing water are greater than for air because water is much denser and more viscous. The oxygen content in aquatic environments also varies much more than in air because the availability of oxygen is limited to begin with (oxygen is a sparingly soluble gas in water), so small differences in the metabolism of the aquatic community can dramatically change dissolved oxygen concentrations. If dissolved oxygen concentrations are consistently low, aquatic animals will not eat or grow well and will be susceptible to infectious diseases. If concentrations fall to very low levels, the animal may die.

Biochemical oxygen demand (BOD)

The rate of oxygen used by used by organisms in the aquatic systems while stabilizing decomposable organic matter is commonly referred to as BOD. It is important to understand that BOD is not a measure of some specific pollutant but it is very important phenomena for limnological studies (Vesilind *et al.*, 1990).

BOD values were higher in the wet season in relation to the dry season This might be due to the warmer temperature in wet season enhanced microbial activities, consuming

more oxygen for the decomposition of industrial and municipal effluents and domestic wastes which are drained out into the river by monsoon a rain and surface run-off. Moreover, an inversely proportional relationship between

Water Temperature :

Water temperature is perhaps the most important variable affecting aquaculture production. Water temperature affects the natural productivity of aquatic ecosystems and directly or indirectly affects all other water quality variables. In aquaculture, it is seldom cost-effective to cool or heat large volumes of water, so the water temperature prevailing at a particular site determines which species can be cultured and the potential growth, health, and reproductive success of that species. For example, in Australia, there was an attempt to grow Marron (*Cherax tenuimanus*), a cool-water crustacean, in warm-water ponds in Queensland. There was limited success. Attempts to grow Marron in the southern United States also have failed because of high water temperatures in summer. In the southern United States, there is widespread interest in producing penaeid shrimp in ponds. Water temperatures are high enough for optimum growth of most species for only a few months each year. Therefore, only one crop can be produced, and shrimp farming in the United States probably cannot be as profitable as in the tropics, where two or more crops can be produced annually.

Factors Affecting Water Temperature :

The temperature of surface water supplies is established by local temperature and solar radiation, except of course when the body of water is subject to the inflow of water of a different temperature. The temperature of surface waters therefore varies through the year with seasonal changes in air temperature, day length, and solar radiation. Obviously, surface water temperatures in subtropical and tropical regions vary less than waters in temperate regions. Also, the magnitude of annual variation in water temperatures and the rate at which temperatures change are less in deep lakes and large rivers than in small streams and ponds in the same region because the larger volume of water provides a "buffer" against changes in temperature. For the same reason, shallow coastal plain estuaries have greater annual water temperature variation than deeper bays or offshore waters.



For a given body of water, the average maximum and minimum water temperatures are fairly consistent year to year, and climatological data on air temperature or solar radiation can be used to model pond-water temperatures (Klemetson and Rogers, 1985). The predictor equations developed by Wax and Pote (1990) for estimating the surface water temperature in ponds at dawn and mid-afternoon .

Temperature and Growth of Aquatic Animals :

Fish and crustaceans are poikilothermic or cold-blooded. This means that their body temperature is roughly the same as the temperature of the water surrounding them, and because water temperature changes daily and seasonally, the body temperature of fish and crustaceans also changes frequently. The rates of all biochemical processes are temperature dependent. Within the temperature range that normally occurs in the natural habitat of a particular species, the rate of biochemical processes roughly doubles for every 10°C increase in temperature. Each aquatic species has a characteristic range of upper and lower lethal temperature limits and a range of temperatures considered optimum for growth and health. Rowland (1986) pointed out that many species suitable for aquaculture will survive over a wide temperature range, but the temperature range for maximum growth is narrower. For example, a species might tolerate temperatures of 5°C - 36°C , but the range for maximum growth might be from 25°C to 30°C . Generally, tropical and subtropical species will not grow well when water temperatures fall below about 25°C and water temperatures below 10°C or 15°C may kill them. Warm-water species which are native to temperate climates grow best at temperatures between 20°C and 28°C , but they can survive at temperatures near 0°C . Cold-water species grow best at temperatures below 20°C , and they may die when temperatures exceed 25°C . Some workers use the term cool water for species that grow well between 15°C and 25°C and use the term cold water for species that grow best at or below about 15°C .

Survival at or near the extremes of thermal tolerance depends strongly on the rate of temperature change and acclimation temperature. When temperatures change slowly (no more than about $2^{\circ}\text{C}/\text{day}$), physiological changes occur that allow aquatic animals to adapt and survive at the new temperature. Acclimation involves biochemical changes in enzyme systems and cell membrane structure that allow metabolic reactions to proceed more efficiently at the new temperature. Animals are stressed when temperatures change rapidly because there is not enough time for physiological adaptation. Very rapid

temperature changes (more than about $0.5^{\circ}\text{C}/\text{min}$ for changes of more than about 5°C) may cause thermal shock and possibly death. If animals must be transferred quickly between waters, they should be tempered by gradually changing the temperature during transfer. A temperature change of $0.2^{\circ}\text{C}/\text{min}$ usually can be tolerated, provided the total change in temperature does not exceed more than about 5°C . Fish and crustaceans for stocking in ponds often are transported in plastic bags filled with water. The bags can be floated in a pond while the temperature of the water in the bag equilibrates with that of the pond. Then, the animals in the bag can be safely transferred. If animal are transported in tanks, the water in the tank can be slowly diluted with pond water until the temperature of the water in the tank matches that in the pond.

Thermal stress of aquatic animals often causes impairment of osmoregulation. Thermal tolerance therefore interacts with other aspects of water quality that affect osmoregulation. Two important modulators of thermal tolerance are salinity and environmental calcium concentration. The ability to withstand sudden changes in temperature and the ability to survive at extremes of water temperature are greatest when animals are living in water near the optimum salinity for the species in question. Calcium is also important because it affects the permeability of gill membranes to ions and water. The effect is species-specific and incompletely documented but, as an example, the lower lethal temperature of red drum (*Sciaenops ocellatus*) may be reduced by as much as 5°C as environmental calcium concentrations increase from less than 10 to over $100\text{mg Ca}^{2+}/\text{L}$ (Procarione, 1986).

Salinity:

Salinity refers to the total concentrations of all ions in water. It is not, as some people think, the concentration of sodium chloride in water. The major ions contributing to salinity are calcium, magnesium, sodium, potassium, bicarbonate, chloride, and sulfate. The absolute and relative concentrations of these ions vary greatly among different waters. Salinity may be reported in milligrams per liter (or its equivalent, parts per million or ppm), but when waters have high salinity, it is more common to report salinity in grams of solute per kilogram of solution, which is equivalent to parts per thousand (ppt).

Each species of aquatic animal has an optimum range of salinity for reproduction and growth; outside that range, performance is diminished and survival may be poor. Fortunately, the salinity tolerance of most aquaculture species is rather wide and only large differences in salinity or sudden changes are likely to be important. Salinity also interacts with other water quality variables because the ionic strength of a solution affects equilibrium constants for all chemical reactions, and increasing the salt concentration of a solution decreases the solubility of dissolved gases through the O salting out effect of practical importance, as the salinity of increases, the solubility of dissolved oxygen decreases and the percentage of total ammonia present as toxic un-ionized ammonia decreases. The salinity in estuaries depends on the relative amounts of fresh river water and seawater that are mixed together, salinity thus varies with both time and location within the estuary. In areas with pronounced wet and dry seasons, salinity will vary dramatically through the year because high river discharge rates during the wet season cause salinities to decline . On a shorter term, salinity at a given point in the estuary decreases during ebb tide as saline waters are flushed downstream. Strong winds can also influence the salinity of an estuary by opposing or adding to the flow of rivers or tides. The salinity in the lower reaches of an estuary, near the sea, is also influenced by river inflow, tides, and wind; however, the magnitude of the effect is reduced due to the greater water volume. Seawater has a relatively constant salinity of about 35

Salinity Requirements of Aquatic Animals

A solvent will pass through a membrane from a dilute solution to a more concentrated solution. A simple way to view this phenomenon is to realize that the membrane is being bombarded continuously on both sides by molecules of both solvent and solute. On the side of the membrane facing the dilute solution, more molecules of the solvent will strike the membrane surface than on the side of the membrane facing the concentrated solution because there are more solvent molecules per unit volume in the dilute solution than in the concentrated solution. Therefore, there will be a net movement of solvent molecules from the dilute solution to the concentrated solution until equilibrium (equal concentration) is attained between the two sides.

For fish and crustaceans, we can think of the body fluids as one solution, the surrounding water solution as the other solution, and the part of the animal that separates the two solutions as the membrane. Freshwater fish and crustaceans have body fluids more concentrated in ions than the surrounding water; they are hypersaline or hypertonic with

respect to their environment. Saltwater species have body fluids more dilute than the surrounding water. They are hyposaline or hypotonic to their environment. Osmoregulation in freshwater fish involves the uptake of ions from the environment and restriction of ion loss. The freshwater fish tends to accumulate water because it is hypertonic to the environment, so it must excrete water and retain ions. On the other hand, osmoregulation for marine fish requires the constant intake of water and excretion of ions. Because the marine fish is hypotonic to the environment, it loses water. To replace this water, the fish takes in salt water; but to prevent the accumulation of excess salt, it must excrete salt. Each species has an optimum salinity range. Outside of this range, the animal must expend considerable energy for osmoregulation at the expense of other processes, such as growth. A good example is provided by Wang *et al.* (1997) who grew common carp, *Cyprinus carpio*, at various salinities and determined the proportion of the energy contained in the feed that was consumed that was eventually recovered in fish growth:

Table 1: Percentage of total food energy recovered as fish growth in different salinity

Salinity	Percentage of total food energy recovered as fish growth
0.5 ppt	33.4%
2.5 ppt	31.8%
4.5 ppt	22.2%
6.5 ppt	20.1%
8.5 ppt	10.4%
10.5 ppt	-1.0%

Note that fish growth in this study was most efficient at salinities less than 2.5 ppt and that fish lost weight when grown at a salinity of 10.5 ppt. Of course, if salinity deviates too much from optimum, the animal will die because it cannot maintain homeostasis.

The blood of freshwater fishes has an osmotic pressure approximately equal to the osmotic pressure of a 7-ppt sodium chloride solution (McKee and Wolf, 1963). Many freshwater fish can live in waters with salinities up to 7 ppt, but they may not grow well at this salinity. Most freshwater fish of importance in aquaculture reproduce and grow well at salinities up to at least 4-5 ppt. Many species can tolerate salinities at least twice

that high, but growth and reproduction may be adversely affected. Some species of *Oreochromis*, a genus usually considered to be adapted to fresh water, can grow and reproduce in waters ranging from nearly 0 to over 35 ppt salinity. Likewise, most anadromous fish and species normally inhabiting estuaries are remarkably euryhaline and can be cultured in waters over a wide range of salinities. Note, however, that different life stages of fish may require waters of different salinities and that fish species and life stages vary in their ability to tolerate sudden changes in salinity.

Some species of freshwater fish are extremely tolerant of high salinity and can be cultured in fresh water or in brackish water or seawater. The rainbow trout (*Oncorhynchus mykiss*) is a good example. In Australia and in Northern Europe, rainbow trout fingerlings are produced in fresh water, acclimated to salt water, and grown out to marketable size in sea cages. Even though rainbow trout can tolerate full-strength seawater, their survival and growth decreases at salinities above 20 ppt (McKay and Gjerde, 1985) and cages should be placed in estuaries

Stickney (1986) reviewed the salinity tolerance of tilapias. He concluded that the optimum salinity range for growth of *Oreochromis aureus* and *Oreochromis niloticus* has not been established, but that good growth has been obtained in salinities of near 0 ppt to 10 ppt. A few workers have grown *Oreochromis aureus* at salinities of 23-40 ppt, but lesions have been noted on fish and reproduction has been adversely affected. A greater salinity tolerance was reported for *Oreochromis mossambicus*; it grows and reproduces in fresh water and in full-strength seawater. However, some studies suggest that it does better in brackish water of 10-20 ppt salinity than in fresh water or full-strength seawater. The red hybrid tilapia, produced by crossing combinations of *O. mossambicus*, *O. aureus*, and *O. niloticus*, is suitable for culture in salinities up to 17.5 ppt. Studies by Watanabe and Kuo (1985) showed that reproduction and survival of *O. niloticus* fry was greatest at 10-15 ppt salinity.

The marron, a freshwater crustacean of Australia, will tolerate salinities up to about 17 ppt (Morrissey, 1978), but most marron farms are in regions with salinities of 0.1-7 ppt (Morrissey, 1988). Mills and Geddes (1980) found that the Australian yabbie (*Cherax destructor*) gradually lost the ability to maintain osmotic homeostasis as salinity increased from 6 to 16 ppt. The red swamp crawfish, *Procambarus clarkii*, is widely cultured in the United States. This animal will survive in salinities up to 20 ppt for

several weeks, but they are seldom found in natural waters with salinities above 8 ppt (Huner and Barr, 1981).

Lee and Fielder (1981) showed that the Australian freshwater prawn (*Macrobrachium australiense*) did not undergo metamorphosis at salinities above 15 ppt. Salinities of near 0 to 15 ppt did not affect survival up to the postlarval stages. The larvae of freshwater prawns *Macrobrachium rosenbergii* (Tansakul, 1983) and *M. amazonicum* (Guest and Durocher, 1979) require salinities of 11-15 ppt, but postlarvae and adults grow best at salinities less than 8 ppt.

Species of fish and crustaceans that occur in brackish water or in the sea have specific ranges of salinity tolerance. For example, Wu and Woo (1983) exposed 13 species of adult marine fish to low salinities (3, 5, and 10 ppt) for 2 weeks. Twelve species survived at 10 ppt, six species at 5 ppt, and three species at 3 ppt. Effects of longer-term exposure on the fish were not measured. Nevertheless, the results suggest that many species of marine fish could potentially be cultivated in estuaries.

Two species of shrimp *Penaeus merguensis* (bahana prawn) and *P. monodon* (tiger prawn), are widely cultured in Asia. Best survival and growth of *P. merguensis* in ponds is achieved at salinities above 15 ppt (Ruttanagostigit and Musig, 1982), but *P. monodon* will survive and grow well at lower salinity (Boyd, 1987). Chakraborti *et al.* (1986) found no difference in growth rates of *P. monodon* over the salinity range of 5-31 ppt. Tiger prawn can tolerate freshwater for about 1 month. In South and Central America, *P. vannamei* commonly is cultured. Salinities of 15-25 ppt are considered ideal, but *P. vannamei* can be cultured successfully at lower and higher salinities (Boyd, 1989). *P. vannamei* can be cultured successfully at lower and higher salinities (Boyd, 1989). In Ecuador, many farmers claim that this species can be grown in fresh water. Although *P. vannamei* can tolerate fresh water for several weeks, practical experience indicates that a salinity of at least 0.5-1.0 ppt is necessary for growth and survival. Rosas *et al.* (1997) determined the optimum salinities for *P. setiferus* and *P. schmitti* postlarvae by measuring rates of oxygen consumption for animals held at various salinities and then determining the salinity at which minimum metabolic energy was used for osmoregulation. Based on this approach, the optimum salinity for *P. setiferus* postlarvae was between 5 and 15 ppt, and the optimum for *P. schmitti* postlarvae was about 25 ppt. Shrimp farming has typically been conducted in places where salinity fluctuates considerably between the wet and dry seasons. Hence, only species that can tolerate

these salinity changes are suitable. Parado-Esteva *et al.* (1987) pointed out that fluctuations in salinity were especially critical when shrimp molted.

When the salinity of water is changed by more than 10% in a few minutes or hours, fish and crustaceans may be unable to compensate and will be severely stressed or may die from osmoregulatory failure. Fish and crustaceans can acclimate to much lower or higher salinities within their range of tolerance if the change is made gradually. For example, shrimp larvae are produced or captured from the wild in waters with salinities of 28-35 ppt, but they often are stocked in ponds with much lower salinity. When shrimp postlarvae are stocked into ponds, they should not be acclimated at a rate exceeding 1 or 2 ppt change in salinity per hour. For example, Tangko and Wardoyo (1985) transferred *P. monodon* from 33 ppt to 3 ppt salinity at rates of 2.5, 5, 7.5, and 10 ppt salinity change per hour. Survival decreased from 82.2% when salinity was lowered at 2.5 ppt/h to 56.7% when salinity was changed at 10.0 ppt/h.

The ability to tolerate sudden decreases or increases in salinity can be improved in some animals if adequate environmental calcium is present. This was clearly demonstrated in two separate studies using two different species of fish. In the first study, Crocker *et al.* (1982) transferred juvenile red drum abruptly from water at 28 ppt salinity to water of less than 1 ppt salinity. The stress response associated with the sudden decrease in salinity was much reduced when the calcium concentration of the low-salinity water was increased from 84 to 150 mg Ca^{2+} /L. In the second study, Grizzle and Mauldin (1995) transferred larval or newly transformed striped bass (*Morone saxatilis*) abruptly from fresh water to waters with various concentrations of NaCl. The LC_{50} for NaCl increased from 1.4 ppt to 18.2 ppt as the environmental calcium concentration increased from 3 to 100 mg Ca^{2+} /L, showing that calcium dramatically improved the tolerance to sudden increases in salinity in this species.

pH

The pH value expresses the intensity of the acidic or basic character of water. It is defined as the negative logarithm of the hydrogen ion activity which, in fresh water, is essentially equal to the hydrogen ion concentration. The pH scale is usually represented as ranging from 0 to 14, but the pH can extend past those values. Conditions become more acid as pH values decrease and more basic as pH increases. At 25°C, pH 7.0 is the

neutral point and the activities of hydrogen and hydroxyl ions are equal (each at 10^{-7} mol/L).

Exposure of aquatic animals to extremes of pH can be stressful or lethal, but the indirect effects of pH and interactions of pH with other variables are usually more important in aquaculture than the direct toxic effects. Important interactions include the effects of pH on certain aqueous equilibria involving ammonia, hydrogen sulfide, chlorine, and metals. The fertility of aquatic ecosystems is also strongly influenced by environmental pH.

pH of Natural Waters :

Most groundwaters contain dissolved carbon dioxide, bicarbonate, and carbonate and have pH values between 5 and 9. In general, ground waters in contact with silicate minerals have low concentrations of bicarbonate, a relatively high carbon dioxide content, and, consequently, a lower pH than waters from carbonate rock deposits. High pH values (>8.5) are usually associated with ground waters that have a high sodium carbonate content. Dissolved carbon dioxide cannot make water more acid than about a pH of 4.5. So, pH values less than 4.5 are due to the presence of strong mineral acids. Strong acids may occur in water draining from some mines (so-called acid mine waters) as a result of the oxidation of mineral sulfides. Low pH values also may occur in thermal waters which contain H₂S, HCl, or other volatile acids of volcanic origin.

Most surface waters also are buffered by the bicarbonate-carbonate system and typically have pH values between 5 and 9. Very high pH values (>9) are common in lakes in arid regions, where the water has a high sodium carbonate content. Low pH values (<4) are caused by the presence of mineral acids, especially sulfuric acid, and are typical of streams and lakes in volcanic regions or in areas receiving acid mine drainage. Sulfuric acid also causes low pH in waters in contact with certain soils developed from marine sediments. These soils, called acid-sulfate soils or cat's clays, contain large amounts of sulfide produced under anaerobic conditions during soil genesis. When the soils are drained and exposed to oxygen, sulfide is oxidized to sulfuric acid. Water in ponds built on acid-sulfate soils may have a pH of less than 4. Low pH values also are found in waters, such as Sphagnum bogs, that are rich in organic acids produced by decaying vegetation. Poorly buffered waters, such as those occurring in the mountainous regions of eastern North America, may have low pH values as a result of acid precipitation. Precipitation is naturally acidic because it contains carbon dioxide, but in areas where the

atmosphere is polluted by industrial emissions, the pH of rain or snowfall is further decreased by the presence in the atmosphere of sulfur dioxide or nitrogen oxides. These oxides form strong acids in the atmosphere, and acid precipitation can have a pH of less than 5.

Seawater is buffered by the bicarbonate-borate system and, indirectly, by the formation of magnesium carbonate ion pairs. It has a relatively stable pH between 8.0 and 8.5. High rates of biological activity in nutrient-rich marine waters may result in higher or lower pH values, but the pH is seldom lower than 7.5 or greater than 9.0.

The pH of most surface waters varies diurnally as photosynthesis and respiration cause changes in dissolved carbon dioxide concentrations. During daylight, aquatic plants remove carbon dioxide from water for use in photosynthesis. Both plants and animals continually release carbon dioxide into the water by respiration. However, during daylight, aquatic plants usually remove carbon dioxide from the water faster than it can be replaced by respiration, and pH increases. During the night, carbon dioxide accumulates and pH declines. The magnitude of the daily fluctuation in pH depends on the buffering capacity (total alkalinity) of the water and the rates of photosynthesis and respiration. In some highly eutrophic, poorly buffered waters, the pH can cycle between nearly pH 6 at dawn to over pH 11 in mid-afternoon.

Effects of pH on Aquatic Animals

The optimum pH for growth and health of most freshwater aquatic animals is in the range 6.5-9.0. The acid and alkaline death points are approximately pH 4 and pH 11, respectively. Marine fish evolved in the highly buffered seawater environment which is not subject to a wide variation in pH. Consequently, most marine animals typically cannot tolerate as wide a range of environmental pH as freshwater animals, and the optimum pH is usually between pH 7.5 and 8.5. Fish and crustaceans living in brackish water are often exposed to a wide range of pH values as the relative amounts of fresh water and seawater change with variations in river discharge and tidal flow. As such, brackish water inhabitants are rather tolerant of extremes of pH. For instance, Tsai (1990) considers that the acid and alkaline death points for most penaeid shrimp are roughly 4.8 and 10.6, and that the optimum pH range is 5.5-8.5. Allan and Maguire (1992) showed that the minimum lethal pH to *Penaeus monodon* in water of 32 ppt salinity is about 3.7 and the minimum acceptable pH is 5.9. Another brackish water



inhabitant, the flatfish *Paralichthys orbignyanus*, tolerates pH values as low as 5.2 and the 96-h LC₅₀ is pH 4.4 (Wasieliesky *et al.*, 1997).

The gills of aquatic animals are the primary target of elevated hydrogen ion concentrations in the environment, which is not surprising considering the structural delicacy of gills and their intimate contact with the external environment. For freshwater fish, it appears that there are seven major effects of low pH on gill structure or function.

pH 6 to acutely toxic levels around pH 4 (1) inhibition of sodium and chloride uptake mechanisms (2) increased ion permeability and diffusional ion efflux (3) increased hydrogen ion influx across the gills (4) increased mucus production (5) mucus coagulation and precipitation (6) inhibition of gas exchange across the gills (7) damage to gill epithelial layers.

These effects are reviewed in detail by McDonald (1983). Overall, it appears that maintaining internal ion balance is the major problem facing animals living in low pH environments. Increased mucus production and gill structural damage at low pH also impairs respiratory efficiency. Respiration is further compromised by blood acidosis, which decreases the affinity of oxygen-binding blood pigments (such as hemoglobin) for oxygen. Under mild acid stress, animals must expend extra metabolic energy for maintenance of gill function (active ion transport, production of mucus, turnover of gill epithelial cells, and so on) at the expense of other processes such as growth and immune function. Under extreme acid stress, the animal is not capable of maintaining homeostasis and dies.

Acid stress is uncommon except in bodies of water affected in some way by the activities of man. Long-term acidification of lakes because of acid precipitation is having disastrous effects on natural fish populations in certain areas of Europe and North America (Meamish *et al.*, 1975). although this is of little concern in most form of aquaculture. The most common problem with low pH in aquaculture is the production of sulfuric acid when ponds are constructed on potential acid-sulfate soils.

The gills of fish and crustaceans also are highly sensitive to alkaline solutions (high pH). In brook trout (*Salvelinus fontinalis*) under mild alkali stress, mucus cells at the base of the gill filaments become hypertrophic and the gill epithelium separates from the pillar cells (Daye and Garside, 1976). Damage to the lens and cornea also occurred. One also would expect gill damage to result in problems with osmoregulation, respiration, and

blood acid-base balance. High environmental pH also hinders excretion of waste nitrogen because at a high water pH, a large fraction of the ammonia immediately outside the gill will be in the form of un-ionized ammonia, thereby reducing the diffusive gradient for passive excretion of ammonia. In fact, fish endemic to environments with consistently high pH must rely on alternate routes for excreting waste nitrogen. For example, in the alkaline Lake Magadi, Kenya, the environmental pH is consistently above 10 and the native tilapia, *Oreochromis alcalicus* excretes all waste nitrogen in the form of urea (Wood *et al.*, 1989).

As mentioned above, the pH in ponds changes during the day in response to photosynthesis. In poorly buffered waters, the pH may fall to 6 in the early morning and increase to 9 or more in the afternoon. Nevertheless, good aquaculture production usually can be achieved in low alkalinity waters even though pH values are high during periods of intense photosynthesis. In waters with high alkalinity and low hardness, afternoon pH values may rise above 10 during periods of intense photosynthesis (Mandal and Boyd, 1980). It is widely suspected that the high afternoon pH in such waters may kill fish fry and zooplankton. Fry of certain species, such as channel catfish and hybrid striped bass, may be particularly susceptible because they feed or reside in surface waters where photosynthesis is most intense and pH values are highest. In arid climates, surface waters of some closed-basin lakes may contain high concentrations of sodium and carbonate (so-called alkali waters) and have pH values too high for fish production.

Tolerance to extremes of pH can be influenced by other environmental factors. Obviously, any factor that affects osmoregulation is likely to affect pH tolerance. For example, fish and crustaceans will tolerate a lower pH when the salinity of the external medium is near optimum for the species in question. Calcium is a particularly important modulator of pH toxicity because calcium affects the permeability and stability of biological membranes (Reid and McDonald, 1991). The presence of high concentrations of waterborne calcium improves the survival of aquatic animals in acidified waters because it makes gill epithelial membranes less leaky thereby reducing the rate of passive loss of plasma electrolytes (McWilliams, 1982).

Most waters used for aquaculture have pH values within the range considered desirable for fish production, and direct toxic effects from extremes of pH are seldom encountered.

The two exceptions to this generality-acid produced from acid-sulfate soils and transient high pH in surface waters due to intense photosynthesis-have already been mentioned. More commonly, it is the indirect effects of pH and the interactions of pH with other environmental variables that are important in aquaculture. For example, the proportion of total ammonia ($\text{NH}_4^+ + \text{NH}_3$) existing in the toxic, un-ionized form (NH_3) increases as the pH increases.

Total Hardness

Total hardness is the sum of the concentrations of calcium (Ca^{2+}) and magnesium (Mg^{2+}) in water, expressed as mg/L equivalent CaCO_3 . Other divalent cations contribute to hardness, but their concentrations in natural waters are usually low. Total hardness is an aggregate property and cannot be precisely interpreted in relation to aquatic animal health or culture system management unless the concentrations of substances contributing to total hardness are known. In general, calcium is of greater importance than magnesium in the management waters for aquaculture.

Hardness of Natural Waters

The total hardness of natural waters ranges from less than 5 to over 10,000 mg/L as CaCO_3 . The geology of the aquifer or watershed determines the total hardness and the relative concentrations of calcium and magnesium in fresh waters. The common origin of ions contributing to alkalinity and hardness results in total alkalinity and total hardness values being of similar magnitude in many fresh waters. This is by no means universally true, however, as various reactions (especially precipitation and ion exchange) may alter the relative magnitudes of alkalinity and hardness. Also, hardness may be contributed by dissolution of non-carbonate minerals (such as gypsum, CaSO_4) that do not contribute to alkalinity.

The total hardness of most ground waters usually ranges from less than 20 to over 400 mg/L as CaCO_3 . High total hardness values (some over 1000 mg/L as CaCO_3) are found in ground waters in contact with gypsum formations or in aquifers subject to seawater intrusion; those waters typically have total hardness values in great excess of total alkalinity. Aquifers composed of limestones yield waters of moderate to high total hardness, and total hardness and total alkalinity values are usually about equal. Groundwaters of high total alkalinity and very low total hardness are common in many

coastal-plain areas where groundwater containing bicarbonate and calcium and magnesium derived from dissolution of limestones comes into contact with sodium-rich silts and clays of marine origin. The calcium and magnesium in the water are exchanged for sodium adsorbed onto solids in the process known as natural softening. Aquifers in regions rich in crystalline igneous and metamorphic silicate minerals (basalt, granite, and others) usually yield waters of low total hardness (and low total alkalinity) because of the relatively low solubility of those minerals.

Most inland surface waters have total hardness values ranging from less than 5 to 200 mg/L as CaCO_3 . Values far exceeding 200 mg/L are common, however, in arid regions where deposits of relatively soluble chloride and sulfate salts of calcium and magnesium are present. Rivers and lakes in limestone terrain usually have moderate hardness values. Surface waters in regions with crystalline silicate rocks typically have low total hardness. Seawater has a total hardness of about 6500 mg/L as CaCO_3 with a calcium hardness of about 1000 mg/L as CaCO_3 and a magnesium hardness of about 5500 mg/L as CaCO_3 . The total hardness of estuarine water depends on the river inflow and degree of mixing with sea water.

1.2. Objectives of the present study:

Bangladesh is covered with many rivers. These water bodies are full natural resources, mainly fish and fisheries. Among the total water area the South-west coastal area is high productive than other parts of Bangladesh in the fisheries sector. If the fisheries sectors develop in the South-west part of Bangladesh many people will be beneficated on depending fisheries. For the development of fisheries sector it needs more and more research on water quality. By knowing the water quality parameter it can ensure the good quality fisheries products. Water quality parameters are temperature, Dissolved Oxygen

(DO), Bio-chemical Oxygen Demand (BOD), Hardness, Salinity, Alkalinity, Total Dissolved Solid (TDS), Electrical Conductivity (EC), pH etc.

Khulna is the third largest industrial as well as largest river point of Bangladesh and Sundarban is the largest contiguous mangrove forest ecosystem in the world. There are about 950 large, medium and small industries inside the Khulna city corporation area and these industries directly or indirectly dump their effluents in the Vhairab-Rupsha-Possur waterways which in turn surrounds the Sundarban mangrove forest as the major supplier of the inland freshwater flux.

So, the primary objective of the present study was to characterize the aquatic system in terms of physico-chemical properties. In the light of the views discussed so far in this dissertation, the specific objectives of the study and its functional mode were set as:

Measurement of different water parameters in high tide and low tide in the surface layer of the Vhairab, Rupsha and Possur river.

Assessment of pollution status of the Vhairab-Rupsha-Possur river system and comparison with other published data.

CHAPTER TWO

MATERIALS AND METHODS

Chapter-2

MATERIALS AND METHODS

2.1. Study Area and Period

The study was conducted on three rivers such as Vhairab, Rupsha and Possur river and it was carried out during the period of 13 June to 16 July, 2007.

2.2. Sample collection

The water samples were collected in BOD bottle and 1 litre screw cap plastic bottles which were previously soaked with a mixture of distilled water. On the next day the bottles were scrupulously washed several times with distilled water, rinsed with double distilled water and dried in an oven. The bottles were then ready for sample collection. All the water samples that needed were preserved into Khulna University laboratory and tested them with appropriate strength and opportunity.

2.3. Measurement of Water quality parameter

Water quality parameters such as temperature, dissolved oxygen (DO), pH, alkalinity, hardness, chloride were recorded after 7 days interval. Before starting the experimental works, some of the important analytical methods in some cases with some modification were setup in the water Chemistry Research Laboratory of Fisheries and Marine Resources Technology Discipline.

2.3.1. Temperature

Water temperature was measured on site by using a mercury thermometer (0-50⁰C) by dipping the thermometer bulb 3-4 cm in water.

2.3.2. Salinity

Salinity was measured with the Salinity meter.

2.3.3. pH

pH was measured on site with a Hanna Instrument Model ISO 9001 pH meter. Calibration of the instrument was done immediately before measurement by using standard buffer of pH 4.0 and 7.0 or 4.0 and 10.0

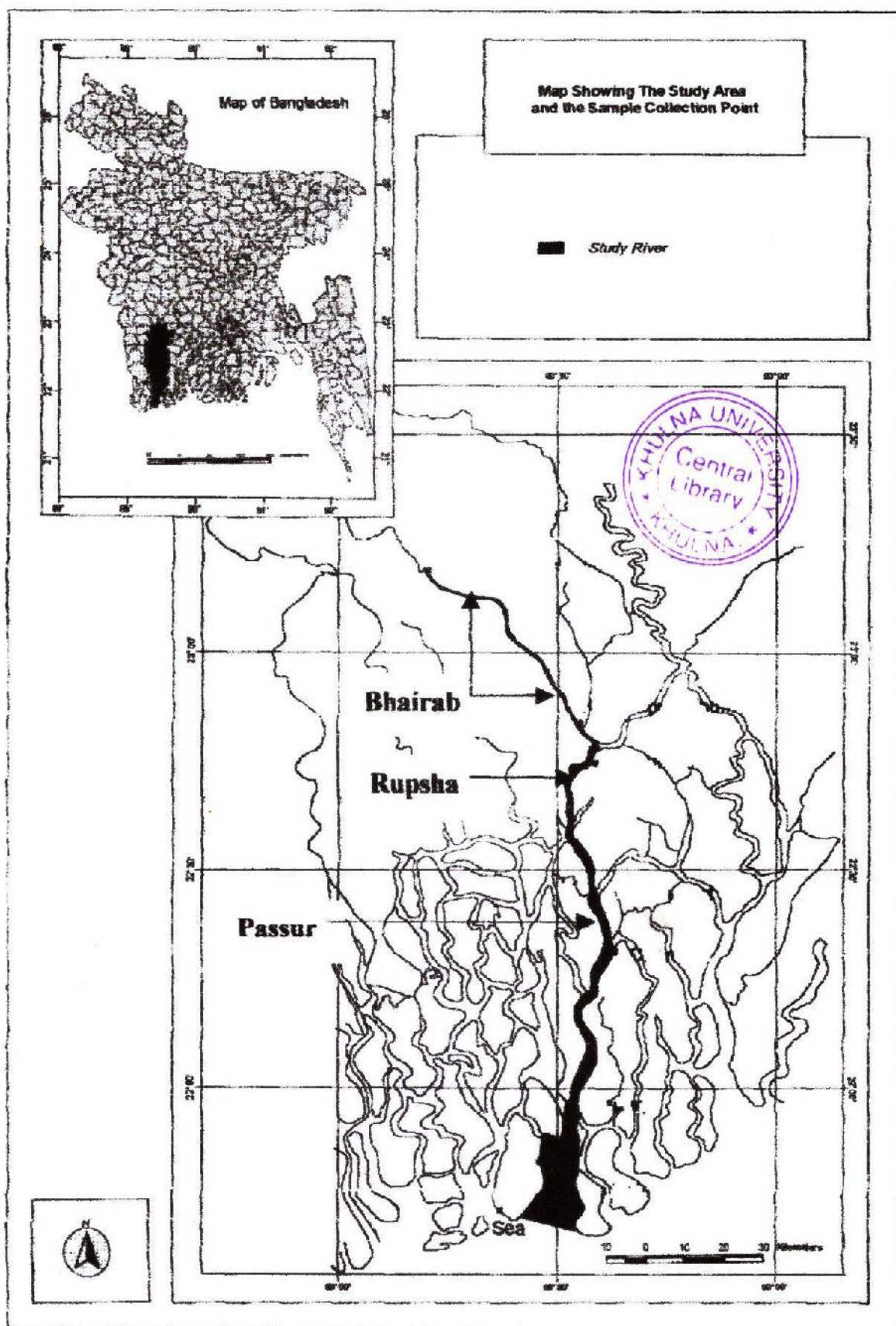


Fig.1: Location map of the study area

2.3.4 Dissolved Oxygen (DO)

Dissolved oxygen was measured on site using the azide modification of Winkler method.

Principles:

Manganous (Mn^{2+}) ions form manganous hydroxide $Mn(OH)_2$ under highly alkaline condition. This $Mn(OH)_2$ reacts with DO of water and an equivalent amount of Mn^{+2} is oxidized to higher valency states. On acidification, in presence of iodide, the oxidized manganous again reverts to divalent Mn^{+2} and iodide is liberated in equivalent amount of DO. This I_2 estimated by titration with sodium thiosulphate ($Na_2S_2O_3$) indicates the amount of DO in water sample.

Materials:

- Manganous sulfate ($MnSO_4 \cdot 4H_2O$).
- KOH, KI and NaN_3
- Starch and
- Sodium thiosulfate. ($Na_2S_2O_3$)

Procedures:

Laboratory Preparation:

- Manganous sulfate solution: 120 gm $MnSO_4 \cdot 4H_2O$ (or 100 gm $MnSO_4$ ($2H_2O$ or 91 gm $MnSO_4 \cdot H_2O$ 91gm) was dissolved in distilled water and diluted to 250ml.
- Alkali- iodide- acid reagent: For a saturated or less than saturated sample; 700 gm KOH and 150 gm KI were dissolved in distilled water and diluted to IL. 10gm NaN_3 was added into it dissolved in 40 ml distilled water.
- Starch solution: 2gm laboratory grade soluble starch and 0.2 gm salicylic acid were dissolved as a preservative, in 100 ml hot distilled water.
- Standard sodium thiosulfate titrant: 6.20 gm $Na_2S_2O_3 \cdot 5H_2O$ was dissolved in distilled water and 0.4 gm NaOH was added and diluted to 100ml.

Field Works:

- 1 ml $MnSO_4$ solution was added followed by 1 ml alkali-iodide- azide reagent to the sample collected in a 250 to 300 ml BOD bottle.
- The bottle was stoppered carefully to exclude air bubbles and mixed by inverting bottle a few times.

- When precipitate had settled sufficiently to leave clear supernatant above the manganese hydroxide floc, 1.0 ml conc. H_2SO_4 was added.
- The bottle was restoppered and mixed by inverting several times until dissolution was completed.
- The sample (10 ml) was titrated with 0.025 $\text{Na}_2\text{S}_2\text{O}_3$ solutions to pale straw color by adding a few drops of starch solution and continued titration to first disappearance of blue color.

Calculation:

$\text{DO in mg / L} = (y \times 200) / x$

Here Y = ml of the titrant and x = ml of the sample.

2.3.5. Alkalinity

Alkalinity of the water samples were measured in the laboratory by titration method.

Principles:

Water samples containing measurable OH^- and or CO_3^{2-} ions turn pink to phenolphthalein indicator. This water becomes colorless at pH below 8.4, when titrated with acid to convert these ions to HCO_3^- form. Again, water sample with only HCO_3^- can be titrated to the critical pH level of 5.3 with acid by using yellow to faint orange color change of methyl orange indicator. Both of the indicators are used for determining total alkalinity, expressed as ppm of calcium carbonate (CaCO_3) and also the concentrations of OH^- , CO_3^{2-} and HCO_3^- ions in water samples.

Materials:

- Burette (25 ml),
- Pipette (10 ml)
- Funnel,
- Conical flask (250),
- Measuring flask (100 ml),
- Beaker (250 ml),
- Spatula, Burette stands etc.

Reagents:

- H_2SO_4
- Na_2CO_3 .
- Phenolphthalein indicator,
- Methyl orange indicator.

Reagent Preparation:

- 0.1N H_2SO_4 Solution: 2.8 ml H_2SO_4 (95- 98%, sp gravity = 1.84) was taken into 1 litter volumetric flask and diluted it to 1000 ml mark of the flask.
- 0.1N Na_2CO_3 solution: 2.65 gm Na_2CO_3 was taken into 500 ml volumetric flask and diluted it to the mark of the flask.
- Phenolphthalein indicator solution: 2.5 gm Phenolphthalein was dissolved into 250 ml 95% ethyl alcohol and added 250 ml of distilled water.
- Methyl orange indicator solution: 500 gm methyl orange free acid powder was dissolved in distilled water and diluted it to 1 liter.

procedures:

- The burette was rinsed with distilled water and then rinsed with 0.1N H_2SO_4 by pipette.
- The burette was clamped and filled with 0.1N H_2SO_4 solution up to mark.
- The H_2SO_4 was standardized by Na_2CO_3 solution.
- The sample (10 ml) was taken into 250 ml of conical flask and added 5 drops of methyl orange indicator solution into it and titrated with 0.1N H_2SO_4 to a light pink (P^{H} 4.5) color as required by the sample composition.

Calculation:

$$\text{Alkalinity, mgCaCO}_3/\text{L} = \frac{A \times N \times 5000}{\text{mlSample}}$$

A = ml standard acid used and N = normality of standard acid.

2.3.6. Hardness

Hardness of the water samples were measured by complexometric(EDTA) titration.

For determining hardness of waters, concentration of Ca and Mg in water are first determined. The values are then converted to respective equivalents of CaCO_3 and added to get total hardness to water.

Materials:

Glassware, volumetric flask, burette, pipette, conical flask etc.

Reagents:

0.01N calcium solution, ammonium purpurate (mureside) indicator, erichrome black T indicator, 4N sodium hydroxide, ammonium chloride, 0.01N EDTA solution.

Procedures:

(a) Standardization of EDTA solution:

- 5ml 0.01N Ca solution was taken in a 100 ml conical flask and diluted it to about 25 ml with distilled water.
- Then 5 ml 4N NaOH solution was added and about 25 mg of murexide indicator was also added.
- The content was mixed well to get a orange red coloration.
- Then it was titrated with 0.01N EDTA solution against a white background until the color changes to purple.
- The color changes were not very distinct and hence the titration during end point was carried out cautiously.
- The strength of EDTA solution was determined by using the following relationship.

$$\text{Strength factor} = S/V$$

Where, V = volume of EDTA solution.

Titration:

- 10 ml of water sample was taken in a 100 ml conical flask.
- Then 1ml of NH_4Cl - NH_4OH buffer solution and 1 drop of eriochrome black T indicator was added to get a wine red color.
- It was then titrated against 0.01N EDTA solution until the color change to blue.

Calculation:

Hardness = $(A \times B \times 1000) / \text{ml sample}$.

Where, A = ml of titrant for sample and B = 1.0 ml EDTA titrant.

2.3.7. Chloride (Cl⁻)

Chloride (Cl⁻) was measured by Mohr Titration method (Argentoetric Method).

Principle: The Mohr method employs a solution of silver nitrate as the titrant and potassium chromate as the indicator. In a neutral or slightly alkaline solution, potassium chromate can indicate the end point of the silver titration of chloride. In the titration the chloride ion is precipitated as white silver chloride.



The end point can not be detected visually unless an indicator capable of demonstrating the presence of excess Ag⁺ is present. As the concentration of chloride ions approaches extinction, the silver concentration increases to begin to form a reddish brown precipitate.



Since an excess of Ag⁺ is needed to produce a visible amount of Ag₂CrO₄, the indicator error or blank must be determined and subtracted from all the titration.

Apparatus:

- Erlenmeyer flask
- 250 ml Burette,
- Pipette
- Beaker etc.

Chemicals:

Potassium Chromate (K₂CrO₄),

Silver nitrates (AgNO₃).

Reagent Preparation:

Potassium chromate (K₂CrO₄) indicator solution: 12.50gm K₂CrO₄ was dissolved in one liter distilled water. AgNO₃ solution was added until a definite red precipitate was formed.

Standard silver nitrate titrant 0.0141M(0.0141N) : 2.39 gm AgNO₃ was dissolved in water and was diluted to 1000 ml. Here 1.00ml = 0.5gm Cl⁻.

Procedures:

- 10ml of the sample was taken into 250ml conical flask.
- 1.0ml K_2CrO_4 indicator solution was added.
- The sample water was titrated with standard silver nitrate titrant to a pinkish yellow end point.

Calculation:

$$Cl^- \text{ mg/L} = A \times N \times 35450 / (\text{ml sample})$$

2.4. Data Analysis

Graphs were plotted to explain the recorded data by using Microsoft Office Excel.



CHAPTER THREE

RESULTS & DISCUSSION

Chapter-3

RESULT AND DISCUSSION

3.1. Temperature

The optimum water temperature is for aquatic species between 25°C to 30°C. If this temperature is over and below of the optimum temperature the natural growth of aquatic species hamper. Our finding water was between 23°C to 31°C. So, this temperature was not harmful to the species. Because, the temperature controls the reproduction and other biological activities of fish and other aquatic organisms. For 1°C rise of water temperature metabolic rate of fish increase 10%. So, for 10°C rise of water temperature metabolic rate becomes high. In very low temperature, fish growth stops and extremely high temperature fish will die (Rahman, 1992). The comparative variation (weekly) of water temperature are shown in the figure 2.

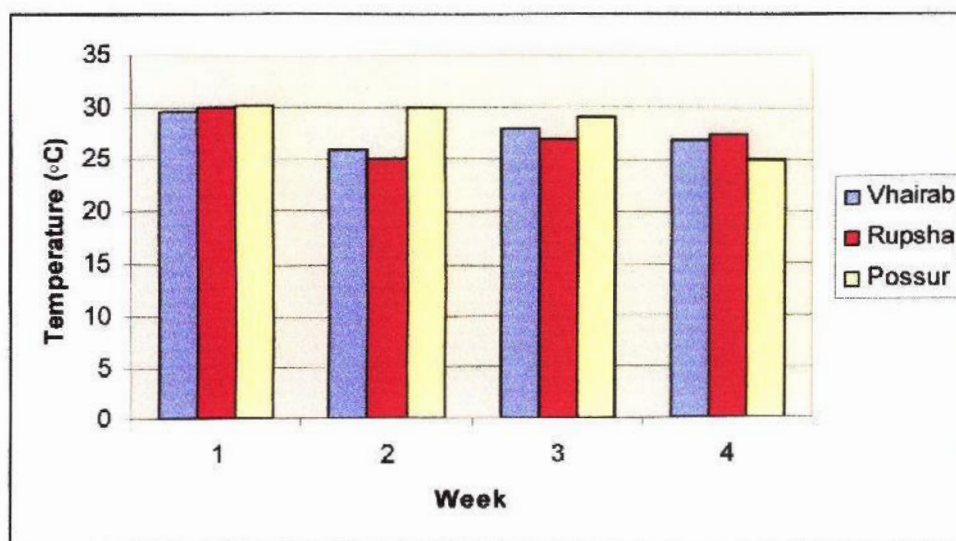


Fig.2: Weekly variation of temperature in three rivers system.

3.2. Dissolved Oxygen (DO)

Dissolved oxygen is a critical factor. The rate of respiration of the aquatic organisms depends on the availability of DO (Azam *et al.*, 2002). In the study DO of the three rivers varied from 3 to 8 mg/L during high tide. The highest DO (8 mg/L) was in the Rupsha and Vhairab river and the lowest DO (3 mg/L) was in the Possur river and in the low tide DO ranged from 4 to 7 mg/L. DO concentration is the greatest at 0°C and decrease with the increasing temperature (Boyd, 1992). The maximum concentration (8mg/L) of DO was observed in the Rupsha river. DO level in natural water body depends on the physical, chemical and bio-chemical activities in water body (Green berg, 1992 and Faruque, 1992). The lowest values DO in Possur river was due to the increase of salinity. DO level (weekly) are seen in the figure 3.

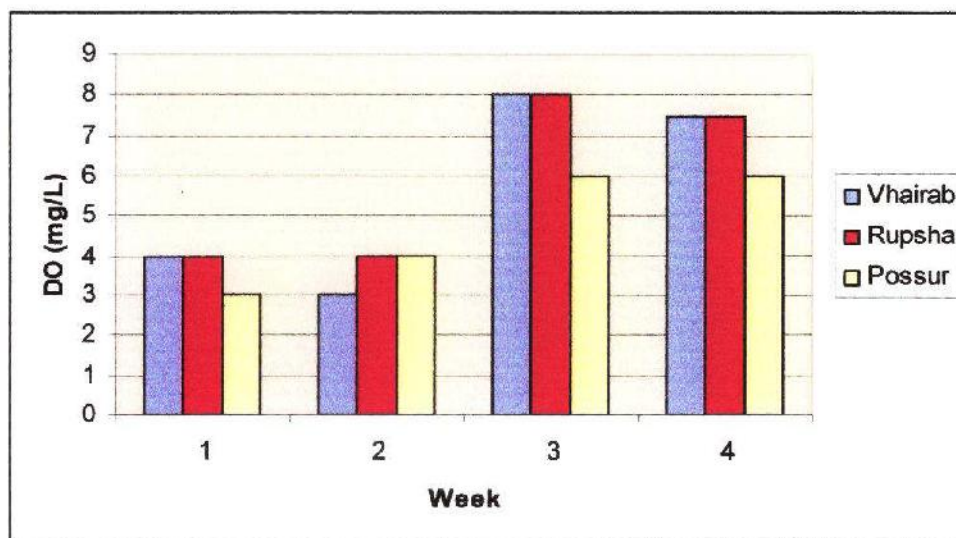


Fig.3: Weekly variation in DO levels in three rivers system.

According to EQS (1991), the standard values of DO of the costal waters of Bangladesh is 6 ml/L. So, it can be said that the values of DO obtained in the present study is comparatively lower than the EQS value. If the DO is high, the water become acidic that is harmful for aquatic organisms. In the same way, lower DO is also harmful for the aquatic organisms. Because aquatic organisms take oxygen from water (Dissolved in water). Our present study showed that the DO level is not too much lower. So, it is not more harmful to the aquatic organisms.

3.3. Total Dissolved Solid (TDS)

During high tide the TDS at the three rivers ranged from 0.071 to 0.099 mg/L and for low tide the TDS varied from 0.074 to 0.091 mg/L. TDS values during high and low tide were not more varied. TDS values increased with rainfall and up stream from down stream. Azam *et al.* (2002) studied that the TDS values seasonally varied from 0.043 to 0.044 mg/L.

Rahman *et al.* (2003) studied that the TDS of the Possur - Sibsa river systems varied from 0.089 to 0.0422 mg/L. It is uncertain what effect high TDS values may have on fish but any increase in free ion concentrations in the external environment as well as concentration of other stressors would lead to osmoregulation imbalances. TDS change (weekly) of three rivers is shown in the figure 4.

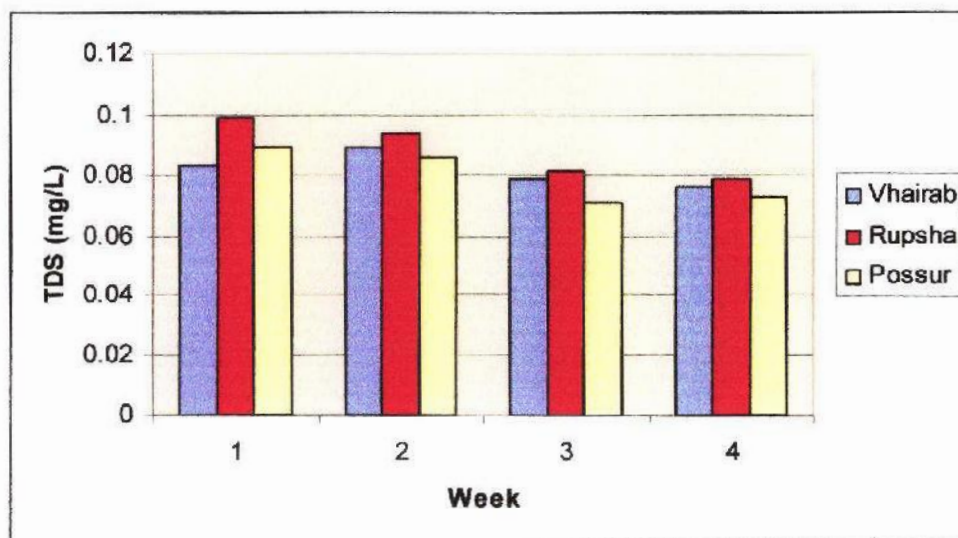


Fig.4: Weekly TDS variation in three rivers system.

The values of TDS in the Vhairab river were in the range of 0.03 to 0.05 mg/L (Rahman, 1997). The present study agrees with the above investigations. So, this indicates the osmoregulation imbalances. However, should the concentration of the ions increased in the plasmas, then adverse effect on the heart rate and nerve excitability will occur.

3.4. pH

During the high tide the values of pH at the three rivers were in range from 9.6 to 7.20. The highest pH (9.6) was in the Rupsha river and lowest pH (7.20) was in Possur river and for low tide the water pH ranged from 9.5 to 7.40. In this case the higher pH (9.5) was also in Rupsha river. In this study it was found that tidal variation was almost the same and the highest pH values and lowest pH value was almost same. pH variations (in week) are found in the figure 5.

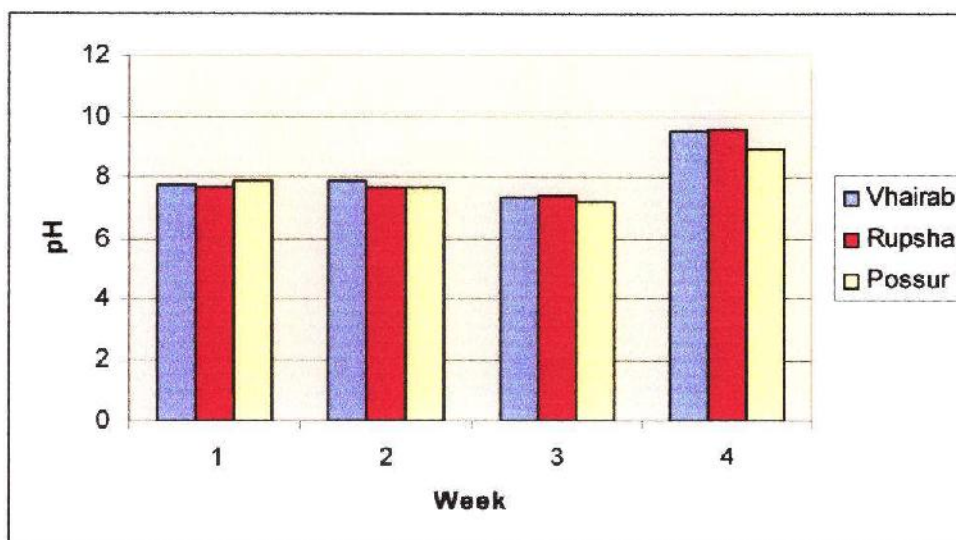


Fig.5: Weekly variation of pH of the three rivers

According to EQS (1991), the standard value of pH of the coastal waters of Bangladesh is 6 to 9. In the study of the three rivers, the pH values were relatively covered the range. So, the pH values are not harmful to the aquatic organisms. Because, it is said to be neutral and has a pH of 7. Greater than 7 is more basic and less than 7 is more acid.

3.5. Salinity

During high tide the salinity varied from 18 to 21.78 ppt and during low tide salinity varied from 18.29 to 21.60 ppt. During high tide the highest salinity (21.78 ppt) found in Possur river and lowest salinity (18 ppt) found in Rupsha river. Comparative study (weekly) is shown in the figure 6.

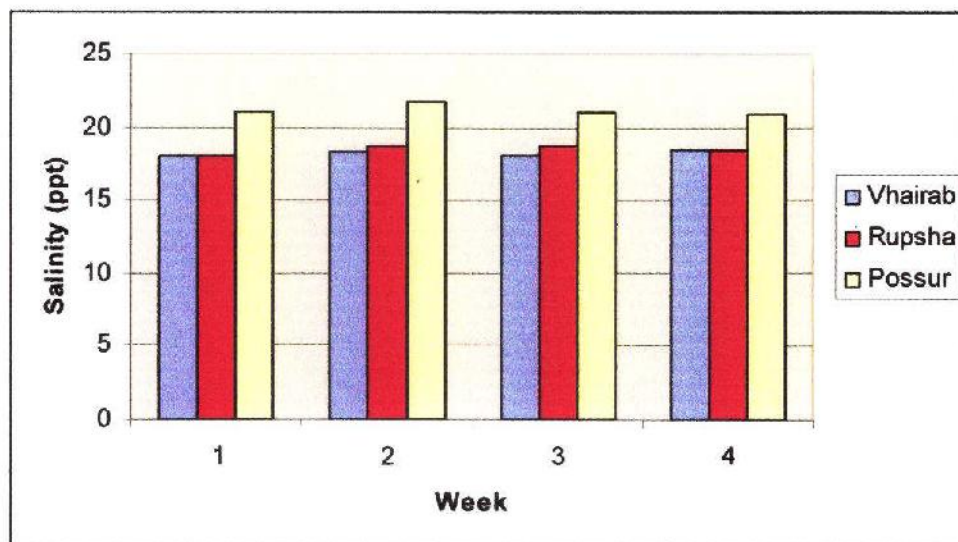


Fig.6: Weekly variation of salinity in three rivers system

Fish can tolerate a high range of salinity. It ranges from 0 to 35 ppt. Many fresh water fish can live with salinities up to 7ppt, but they may not grow at this salinity. Many carp fishes can tolerate full strength sea water and their survival and growth decrease at salinities above 20ppt, but good growth has been obtained in salinities of near 0 to 10 ppt (McKay and Gjerde, 1985). In the present study the salinities were between 18 to 21.78 ppt which are not beneficial to the aquatic organisms.

3.6. Electrical Conductivity (EC)

During the high tide the EC at the three river varied from 31 to 94 ms/m and for low tide it varied from 70 to 96 ms/m. In the high tide highest EC found in the Vhairab river and lowest in the Possur. And during low tide the highest EC found in the Vhairab river and lowest in Rupsha. So, it increased from downstream to upstream.river. Highest and lowest EC (weekly) are seen in the figure 7.

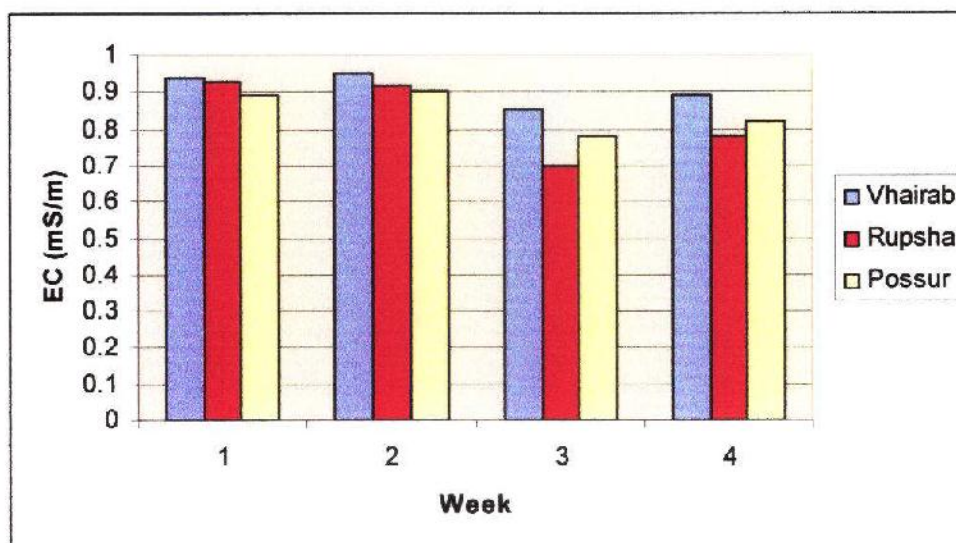


Fig.7: Weekly variation of EC in three rivers system.

Electrical Conductivity (EC) depends on the presence of ions, on their total concentration mobility and on the temperature (Greenberg, 1992). In the present study the EC were remain relatively constant of the three rivers because temperature did not more fluctuated. Younus *et al.* (2003) studied that the EC seasonally varied from 0.084 to 0.0885 ms/m. Faruque(1999) studied the industrial waste discharge into the river Vhairab and Rupsha, Bangladesh and found that the EC seasonally varied from 0.0210 to .0305 ms/m. The present study concurs well in the findings of the above studies. So, the results were not harmful to the aquatic organisms.

3.7. Hardness

During high tide Hardness varied from 4.9 to 5.8 mg/L and in low tide hardness varied from 4.2 to 5.94 mg/L. for high tide highest hardness was found in Possur river and lowest in the Vhairab and Rupsha river. On the other hand for low tide the highest hardness was found in the Possur river and lowest in the Vhairab and Rupsha river. The comparative study (weekly) is shown in the figure 8.

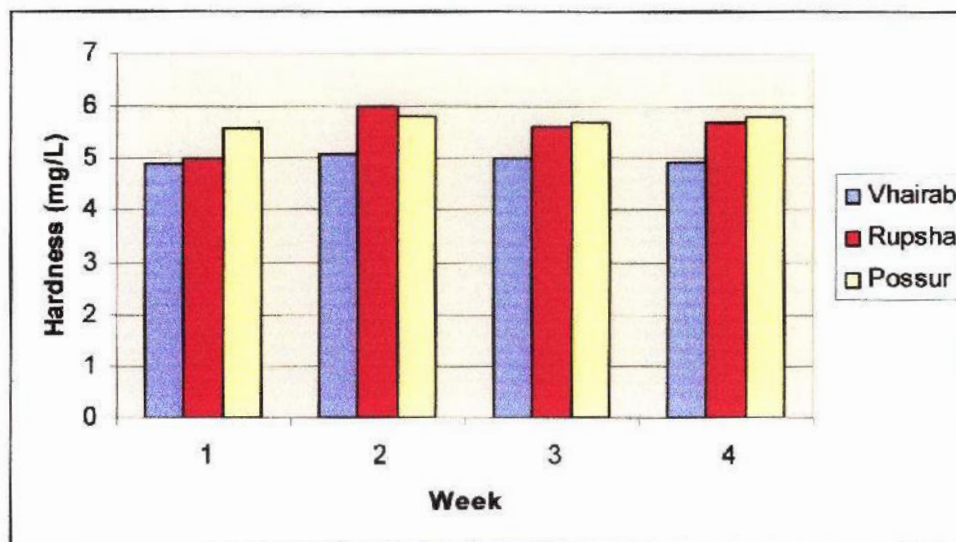


Fig.8: Weekly variation of Hardness in three rivers system.

Boyd (1987) found that most inland surface waters have total hardness values ranging from less than 5 mg/L to 200 mg/L as CaCO_3 . In the present study hardness of the three rivers system was within the optimum range. So it is not harmful to aquatic organisms.

3.8. Bio-chemical Oxygen Demand (BOD)

During high tide the BOD values varied from 2 to 4 mg/L and low tide it varied from 2 to 4 mg/L. Highest BOD (4 mg/L) was found in the river Rupsha and Vhairab and lowest (2 mg/L) in the Possur river in both high tide and low tide.

BOD increase in the lightened water and decrease in the dirty water. Rupsha and Vhairab rivers water were clearer than the water of Possur. So, the DOD in the river Rupsha and Vhairab were more than the water of Possur. BOD variations (in week) are shown in the figure 9.

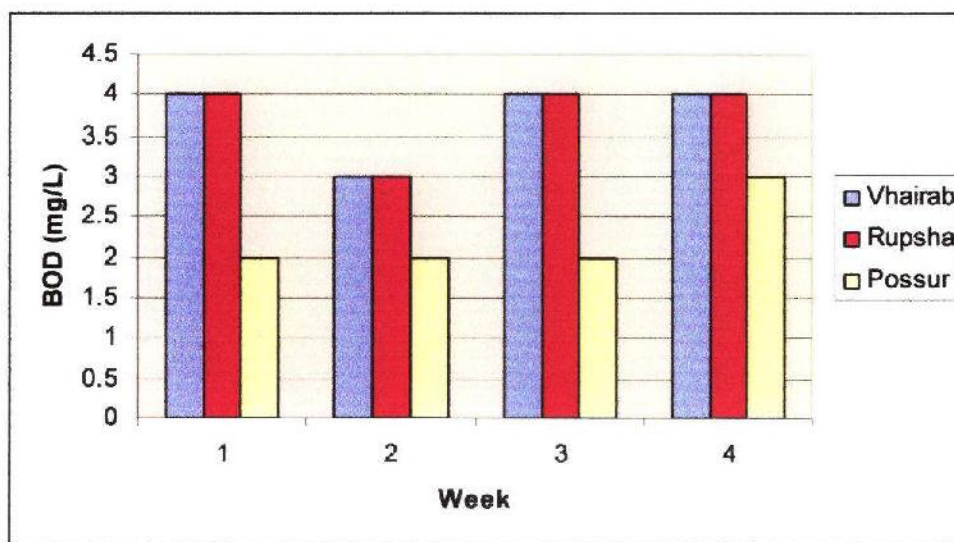


Fig.9: Weekly variation of BOD in three rivers system.

An inversely proportional relationship between BOD and DO. Bhouyan (1979) studied on the effluents of industries discharge and found BOD values were higher in waste disposal area than the control area. In the study BOD values of Vhairab river and Rupsha river were higher because of industrial effluents and municipal discharge which was not harmful to the aquatic organisms.

3.9. Alkalinity

During high tide total alkalinity varied from 150 to 250 mg/L and during low tide it varied from 145 to 250 mg/L. For high tide highest alkalinity was found in Possur river and Vhairab river and lowest alkalinity was found in the Rupsha river.

During low tide highest 250 mg/L alkalinity was found in the Possur and Rupsha river and lowest (145 mg/L) found in the Vhairab river. So by increasing alkalinity the production of plankton increase. Acidity decrease with increasing alkalinity. Comparative study (weekly) are seen in the figure 10.

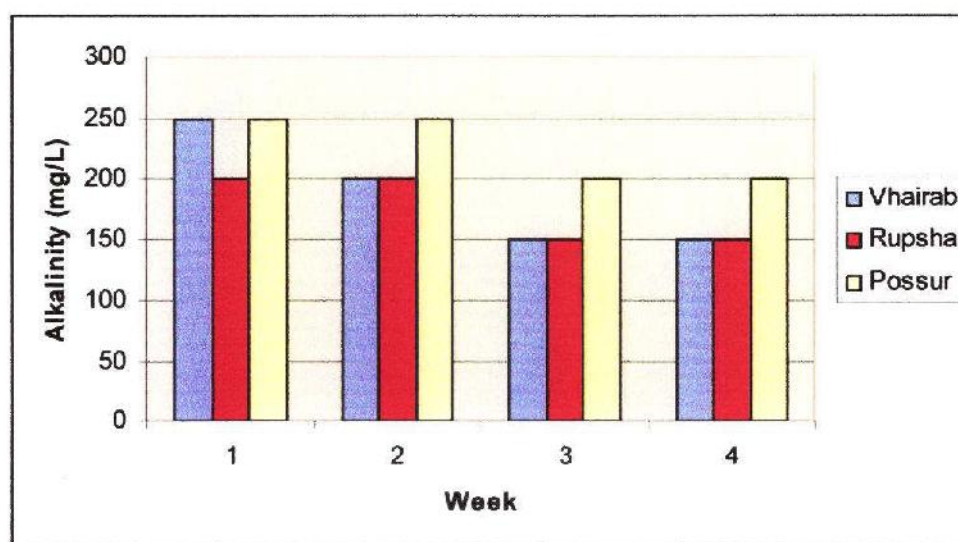


Fig.10: Weekly variation of alkalinity in three rivers system.

Alikunhi(1957) reported that the highly productive water bodies should have more than 100 mg /L alkalinity. Chisty and Rahman (1999) stated that total alkalinity of 100 mg/L to 175mg/L indicates good water quality. In the three rivers alkalinities were more than the optimum level. Present finding did not indicate the good quality of water. Alkalinity was not much fluctuated. It was relatively stable. This result refers the harmful quality of the water to the aquatic organisms.

3.10. Chloride

Variation of Chloride (Cl^-) during high tide was 5.317 ppt to 10.36 ppt. The highest and lowest chloride was found in the Possur and Rhupsha river respectively.

During the low tide the highest chloride (10.30ppt) and lowest chloride (5.216 ppt) was found in the Possur and Vhairab river respectively. Increase of NaCl , the increase of Cl^- . In the river Possur the salinity was more than other two river. So, the chloride was always higher in the Possur river than of the two rivers. Chloride variation (weekly) is graphically shown in the figure 11.

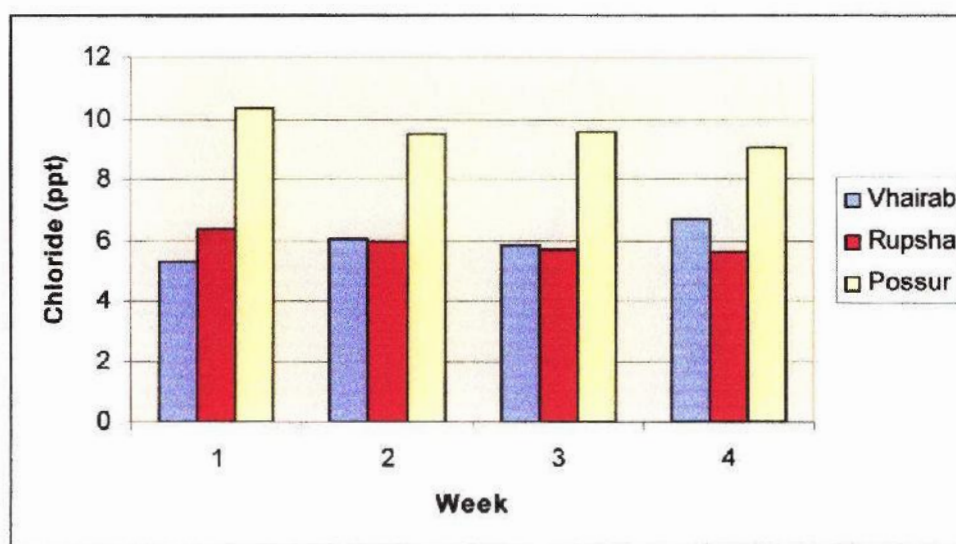


Fig.11: Weekly Chloride variation in three rivers system.

Industrial effluents, Municipal sewage sludge and salt water intrusion from the Bay of Bengal into the three rivers were higher than the optimum level of inland fresh water. In the present study the chloride concentration found in the three rivers affect the overall biota drastically.

CHAPTER FOUR

CONCLUSION & RECOMMENDATION

Chapter-4

CONCLUSION AND RECOMMENDATION

The developed, developing and third world countries are facing global environmental problems especially related to water pollution, which have appeared in last three decades. The abnormal change in the environment as well as water qualities are mostly due to the ignorance and negligence by human beings. The domestic sewage and industrial effluent are the major source of aquatic pollution. Human consciousness has yet not developed that need long time projects and lot of awareness to get rid of this water pollution.

In this study, the temperature, DO, pH, were nearly to the standard levels, but the other parameters were not in the optimum range. In spite of some constraints most of the hydrographical parameters defining the quality of the surface water in the Vhairab-Rupsha-Possur river system were found to be within acceptable range except one or two. It was observed that hardness, alkalinity, chloride and salinity in the water gradually increased upstream to downstream.

CHAPTER FIVE

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Chapter-5

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APPENDIX

APPENDICES

Table -1: TDS reading (mg/L) of three rivers during high tide.

Week/River	Possur	Rupsha	Vhairab
01	0.089	0.099	0.083
02	0.086	0.094	0.089
03	0.071	0.081	0.079
04	0.073	0.079	0.076

Table-2: TDS reading (mg/L) of three rivers during low tide.

Week/River	Possur	Rupsha	Vhairab
01	0.086	0.094	0.083
02	0.083	0.091	0.089
03	0.074	0.084	0.074
04	0.070	0.078	0.075

Table-3: Dissolved Oxygen (DO) reading (mg/L) of three rivers during high tide

Week/River	Possur	Rupsha	Vhairab
01	3	4	4
02	4	4	3
03	6	8	8
04	6	7.5	7.5

Table-4: Dissolved Oxygen (DO) reading (mg/L) of three rivers during low tide

Week/River	Possur	Rupsha	Vhairab
01	3	4	4
02	4	3.6	3
03	5	8	7.2
04	6	7.5	7.5

Table-5: Salinity (ppt) reading of three rivers during high tide

Week/River	Possur	Rupsha	Vhairab
01	21	18	18
02	21.72	18.74	18.24
03	21	18.72	18.00
04	20.89	18.39	18.40

Table-6: Salinity (ppt) reading of three rivers during low tide

Week/River	Possur	Rupsha	Vhairab
01	21.2	18	19.2
02	21.60	18.29	18.80
03	215	18.32	18.40
04	20.34	18.40	18.74

Table-7: Electrical Conductivity (in ms/m) reading of three rivers during high tide

Week/River	Possur	Rupsha	Vhairab
01	0.89	0.93	0.94
02	0.90	0.92	0.95
03	0.78	0.70	0.85
04	0.82	0.78	0.89

Table-8: Electrical Conductivity (in ms/m) reading of three rivers during low tide

Week/River	Possur	Rupsha	Vhairab
01	0.79	0.94	0.96
02	0.81	0.91	0.94
03	0.73	0.74	0.74
04	0.89	0.68	0.75

Table-9: Chloride (ppt) reading of three rivers during high tide

Week/River	Possur	Rupsha	Vhairab
01	10.36	6.38	5.317
02	9.49	5.98	6.012
03	9.56	5.69	5.85
04	9.02	5.61	6.7

Table-10: Chloride (ppt) reading of three rivers during low tide

Week/River	Possur	Rupsha	Vhairab
01	10.0	6.35	5.14
02	8.50	5.91	6.32
03	7.96	5.98	5.95
04	8.61	6.12	5.96

Table-11: Alkalinity (mg/L) reading of three rivers during high tide

Week/River	Possur	Rupsha	Vhairab
01	250	200	250
02	250	200	200
03	200	150	150
04	200	150	150

Table-12: Alkalinity (mg/L) reading of three rivers during low tide

Week/River	Possur	Rupsha	Vhairab
01	250	200	250
02	240	200	220
03	200	150	150
04	200	150	145

Table-13: pH reading of three rivers during high tide

Week/River	Possur	Rupsha	Vhairab
01	7.85	7.67	7.71
02	7.65	7.69	7.89
03	7.20	7.40	7.34
04	8.9	9.6	9.50

Table-14: pH reading of three rivers during low tide

Week/River	Possur	Rupsha	Vhairab
01	7.75	7.59	7.69
02	7.80	7.62	7.2
03	7.50	7.40	7.10
04	8.7	9.5	9.40

Table-15: Hardness (gm/L) reading of three rivers during high tide

Week/River	Possur	Rupsha	Vhairab
01	5.6	5.0	4.9
02	5.8	5.99	5.1
03	5.7	5.63	5.0
04	5.8	5.7	4.92

Table-16: Hardness (gm/L) reading of three rivers during low tide

Week/River	Possur	Rupsha	Vhairab
01	5.61	5.2	4.2
02	5.78	5.62	5.0
03	5.62	5.58	5.42
04	5.94	5.94	4.69

Table-17: BOD (gm/L) reading of three rivers during high tide

Week/River	Possur	Rupsha	Vhairab
01	2	4	4
02	2	3	3
03	2	4	4
04	3	4	4

Table-18: BOD (gm/L) reading of three rivers during low tide

Week/River	Possur	Rupsha	Vhairab
01	2	3	4
02	2	3	4
03	3	4	3
04	3	4	3

Table-19: Temperature ($^{\circ}\text{C}$) reading of three rivers during high tide

Week/River	Possur	Rupsha	Vhairab
01	30.2	30.1	29.6
02	30.1	25	26
03	29	27	28
04	25	27.6	27

Table-20: Temperature ($^{\circ}\text{C}$) reading of three rivers during low tide

Week/River	Possur	Rupsha	Vhairab
01	28.6	29.8	29.
02	30	30	25
03	29	27	28
04	26	27.4	26

PHOTO GALLERY



Photo-1: Collection of sample

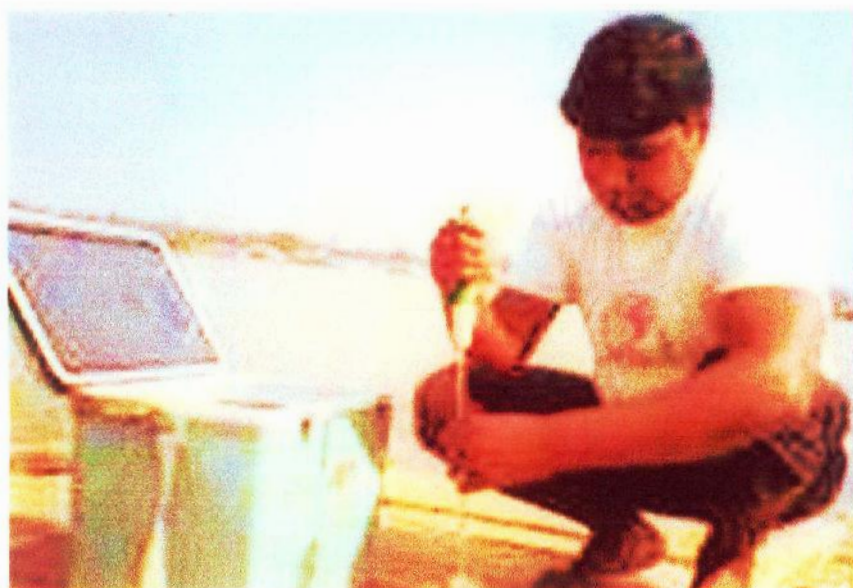


Photo-2: Mixing of Alkaline Iodide in sample

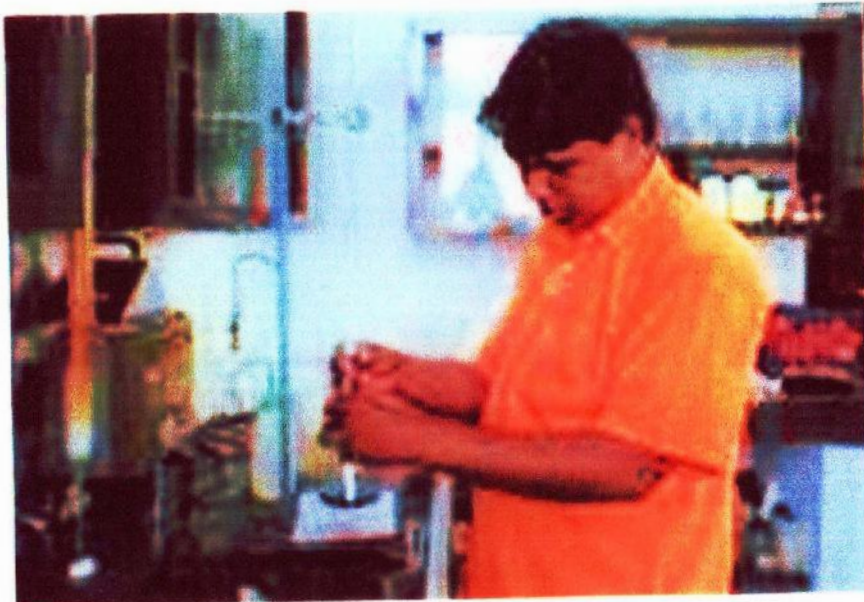


Photo-3: Titration of sample in the Laboratory

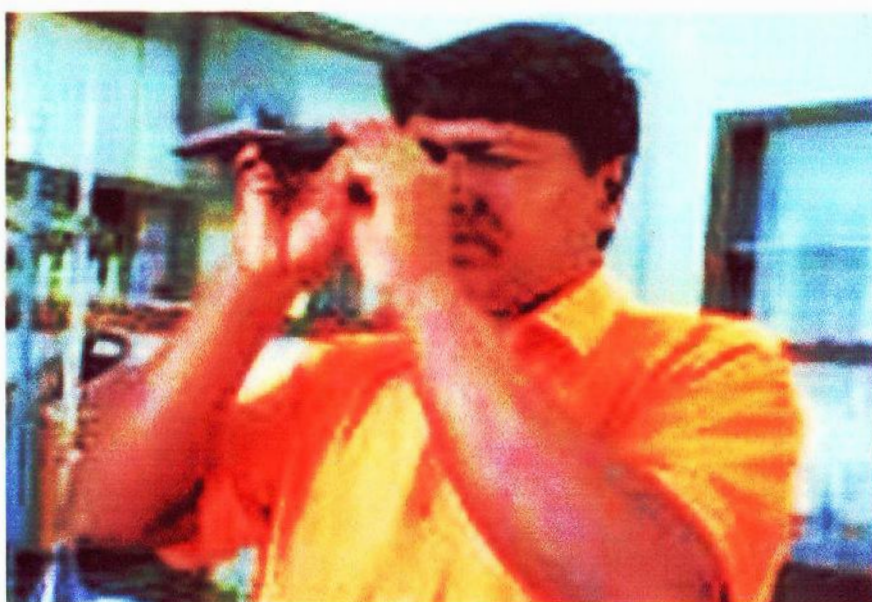


Photo-4: Measurement of salinity of sample