SALINITY

It is the amount of dissolved salt in water in parts per thousand i.e. amount of salt dissolve in one litre of water. Fresh water has little salt (<0.05% of salt in one litre), marine = 20-37%, brackish = 5-20%. All these are divided into hyposaline, mesosaline, and hypersaline.

Salinity affect productivity with certain range especially which PO^{4-} ,NO^{3-}, CO_3^{2-} concerned.

Excess salt = pollution = depth of organism = increase in production

Therefore fertilizer applied will increase the concentration of NO_3 and PO_4. Increase in salinity affect organism distribution, only low salinity lovers restrict into freshwater. While saline lovers stay in marine (Due to osmosis and Exosmosis) e.g. Clarias die at salinity >12.5‰. Very few organism can cope with fluctuation in salinity, therefore marine fishes has higher population than freshwater, while the lowest population is found in brackish water environment.

Salinity affects biology of organism in water. Increase salinity will increase the growth of fish.

In fresh water, organisms spend more energy to control Osmoregulation (water entering its tissue). This energy would have added to its growth. Tilapia tolerate change in salinity hence cultured in brackish and saline water of Israel, Philippine (grow and produce but may not breed in saline water)

Seasonal variation - during rain, aquatic body is diluted resulting in low salinity. During the dry season, water evaporated leaving salt at the bottom of the water thereby increasing salinity.

Spatial variation - salinity is low in areas with lot of rain e.g. Tropics. Salinity is high in place with little or no rain e.g. desert like Dead Sea (Arabia country), Red sea (between Arabia and Sahara). Many lakes in east Africa are greatly saline e.g. Eutopia. Also saline in standing water bodies such as lakes and ponds is greater than that of flowing river. Salinity depend on geochemistry of the bed rock. If substratum has lot of lime and NO_3^-, Po_4^- there is high salinity. If water run over insoluble materials e.g. granite it gives a freshwater wih no salt.

FACTORS AFFECTING SALINITY

Temperature: increase in temperature results in high evaporation therefore increase in salinity.

Rainfall: increase in rainfall will decrease salinity and when rainfall is decrease, salinity is increased.

Organism: certain mollusks and fishes absorb salt to make their body shell i.e. decrease in water salt content.

Decaying organisms: the decaying organisms in water breakdown into ions which increase salinity.

Man: man as ecological factor use fertilizer, pesticides, which increase salinity. Also, man use water bodies for refuse disposal of factories, poultry, abattoirs, and domestic waste all increase salinity.

MEASUREMENT OF SALINITY

1. measurement of salt whose water has been evaporated at temperature of 60-80^{o}C (not use in fresh water)
2. measure amount of chlorine using salt meter
3. Using titration method -titrate $AgNO_3$ + saline water using $K_2Cr_2O_7$ (chromate indicator) will give yellow.

SALT CONCENTRATION

It is determined by electrical conductivity based on number of charge. The more the dissolved salt content, the greater the charges and the conductivity. Using two electrodes and measure with conductivity meter to measure current in mho/cm or ohm^{-1}/cm. since intensity depends on temperature, therefore in tropics 25^{o}C, temperature 20^{o}C. ohm^{-1}/cm replaced with siemens S cm^{-1} at 25^{o}C. Measure inorganic charges

$H_2O + CO_2 \rightleftharpoons H_2CO_3$ at 25^{o}C = pH 5.68

HYDROGEN ION CONCENTRATION (pH)

This is the degree of acidity or alkalinity of water. It ranges from 1-14 (1-6.9 is acidic, 7.0 is neutral, 7.1-14 is alkaline). pH also reflects presence of salts in water, clean pure water is neutral, rain water contains CO_2 which form carbonic acid and makes the water more acidic i.e. low pH. Urban water contain sulphur compounds which form H_2SO_4 with water which is acidic; urban water also contain heavy metals, divalent elements e.g. Ca, Mg, which is alkali.

Diurnal variation:- in the daytime, phytoplankton plus other aquatic plants absorb CO_2 for photosynthesis thus leaving the water very high in pH. At night, a lot of CO_2 is released into water via respiration of aquatic organisms. This increased water acidity, hence low pH.

Bed rock- clay soil substratum gives acidic water

Productivity- at pH 6.5 - 9.0 there is maximum productivity. Below 6.5 there is low growth, at pH 5 fishes refuse to reproduce and at pH 4 fishes die. At higher pH (alkali) fish lives for short periods but at pH>11 fish dies. Reason why we add lime to water is to regulate pH.

MEASUREMENT

1. Using pH meter- deep electrode into fresh sample at room temperature to measure pH directly.
2. pH solutions e.g. methyl red will give colour which is compared on the scale
3. pH paper with which chemical have been impregnated. Dip in water compared on pH scale.
4. Litmus paper dips in water and compares this on scale.

CARBONDIOXIDE (CO_2)

Concentration of carbondioxide depends on photosynthetic activities of phytoplankton and other plants and by their respiratory activities. During day time, the light present pick up CO_2 to photosynthesis, hence depleting the aquatic CO_2 result in alkali water (CO_2 being acidic) i.e. high pH. When phytoplankton dies off or during thermal stratification

and cloudy weather, there is low light penetration which reduces photosynthesis hence high concentration of CO_2 and acidic water. High level of CO_2 can be tolerated by fish though avoid low CO_2 5mg/l, most survive CO_2 concentration of 60mg/l.

$H_2O + CO_2 \longrightarrow H_2CO_3$

Rain water is greatly acidic because it contains CO_2 which form carbonic acid with water. Also water from urban areas containing sulphur reacts with water to give H_2SO_4. CO_2 can also react with bases in rocks and soils (bedrock) to form HCO_3^-.

$CaCO_3 + H_2O \rightleftharpoons CO_2$ increases $+ Ca^{2+} + 2HCO_3$

$CaMg(CO_3)_2 + 2CO_2 + H_2O \rightleftharpoons Ca^{2+}$

Both calcite and dolomite gives low solubility but solubility of $Mg^{2+} + 4HCO_3$ is enhance by CO_2. Therefore HCO_3 can act as acid and base.

Carbondioxide get into water via release from animal and plant excess CO_2 removed by $Ca(OH)_2$.

Carbondioxide and alkalinity

Bicarbonate and alkalinity which reflect with carbonate contents of the bed rock/bottom muds. CO_3^{2-} alkalinity cause strong hardness in water gives more production than soft water as essential element like phosphorus increase, alkalinity enriching the water.

PHOSPHORUS

Phosphorus is a key metabolic nutrient, its presence regulates phytoplankton and plant product, hence increase fish production. Presence of H_3PO_4 ionisable organic phosphates from effluents increases soluble organic phosphorus.

SOURCE; found in aerobic mud of high CaCO3 with precipitate tricalcium phosphates $Ca(PO_4)_2$, therefore less Phosphorus should be added to water with muddy bottom as

aquatic plankton plus fish and other rooted plants get it from mud. This Phosphorus is only available to organism during overturning and decline in oxygenate environment of pH 5.5-6.

NITROGEN

Source: The sources of nitrogen include biological source, meteorological source and industrial source. Most Nitrogen in organic matter exist as a acids in CHON which are deaminated to give NH_3. Nitrogen undergoes ammonification to release NH_3 into environment by a heterotrophic process i.e. aerobic/anaerobic release NH_4^+ used by aquatic plants.

$NH^{3+} \longrightarrow NO_3$ (chemo autotrophic bacteria) i.e $NH_4^+ + 1^1/_2O_2 \longrightarrow NO^{2-} + 2H^- +$ H_2O (by nitrosomonas which use NH_4 as energy source)

$NO^{2-} + {}^1/_2O_2 \longrightarrow NO_3^-$ (nitrobacter which use NO_2 as energy source)

At pH 7-8, temperature 25-30^oC nitrification is rapid by free living bacteria and blue green algae. NO2-, NH3, NO3-. Inorganic forms of Nitrogen in H_2O. NO_2 present only decrease DO.

High concentration of NH_3 and NO^{3-} found in newly fertilized ponds or following plankton die off. When Nitrogen is used in fertilizing the pond, the concentration declines quickly

1. Must have been absorbed by plants which release it to bottom mud when dead.
2. Denitrified in hypolimnion plus mud.
3. Absorb by mud.
4. Loss through volatilization of NH_3 during high pH in the afternoon.

SULPHUR

Sulphur occurs as SO_4^{2-}, concentration varies with geological material and hydrological condition of water. It is greater in water of high salinity (acidic water) and greater in ponds receiving acid mine drainage.

H_2S-: it is available in anaerobic water when heterotrophic bacterial use SO_4^{2-} and excrete H_2S as waste in hypolimnion zone.

$SO_4^{2-} + 8H^+ \longrightarrow S^{2-} + 4H_2O$, $H_2S \rightleftharpoons HS^- + H^+$, $HS \longrightarrow S^{2-} + H^-$

Manganese and iron forms Ferrichydioxide, low in water when manganese is lower. Both found in hypolimnion region and mostly in wells.

SILICON

Silicon is found as undissolved silica acid 1-50mg/l HSi.O3.K, Na, Cl.

Sodium and chlorine are higher in coaster water with higher rainfall (1-100mg/l) and ponds in arid zone with fertile soil (not in sandy soil).

Zn, B and Cu- zinc and boron micro but important for plant growth, copper is important because fish farmers use it as herbicides. In form of $CuSO_4$ as fertilizer, dissociate to give Cu^{2+} which form complex with a polypeptide to preserve it.

Cl- Inform of molecular $Cl_2/Ca(OCl)_2$ (calciumoxichloride) use to disinfect water. Free chlorine form hypochloric and hypochlorus acids.

$Cl_2 + H_2O \longrightarrow HOCl + H^+ + Cl^-$ pH 6-Disinfectant.

Chlorine and hypochlorite react with NH3 Chloroamines (toxic to fish).

Excess chlorine can be removed using Nathiosulphate $2Na_2S_2O_3$.