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Effect of Sodium Concentration of Inland Water Bodies Related to Paddy Cultivated Land in South Eastern Region

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Abstract: The chemical stuff containing domestic and industrial waste effluents are principal sources to degrade the quality of agricultural land through water supplying practices from its related inland water bodies. The contribution of domestic and other improper waste disposal to the inland water bodies were monitored over a period of six months for three of different water bodies at South Eastern Region. The significant level of sodium, dissolved oxygen (DO), pH, temperature, salinity, Total dissolved solid (Tds) and specific conductivity (SC) were measured.

Impact of the inorganic matters on these water bodies were studied based on the specific conductivity values and the influence of this parameter was studied with other parameters. Absorption of the nutrients was disturbed by the increasing level Sodium Absorption Ratio (SAR). Mainly calcium and magnesium intake ability of the crop massively disturbed by this sodium containing wastewater and as a result of long term improper maintenance of wastewater practices significantly affect the paddy cultivation in this region.

Keywords: Water bodies, Dissolved Oxygen, Salinity, Total dissolved solid, Specific conductivity and Sodium Absorption Ration.

Introduction

The water is a sustainable source for the future generation therefore naturally occurring water sources should be protected in a good condition. Inland water systems may be natural, as well as human-altered such as canals, ponds, and reservoirs (Cole 1994). Ponds and lakes are diverse in form and function and are typically distinguished by size and depth with ponds typically smaller than lakes (Summerfelt 1993, U.S. EPA 2010). Both systems lack notable flow and may be found at any elevation. The origin of ponds and lakes may be natural or human-made.

2010s people especially individual household thought the water is used for both activities such as personal hygiene and the transportation of household waste to the distant inland water bodies. Disposal of faecal materials, urine and cloth washing are the personal hygiene while general household water use includes washing, cooking utensils, floors, cleaning and preparing food and flushing unwanted materials away in the wastewater sink. Environmental characteristics of inland water bodies are also toughly influenced by chemical stuff, elevation, precipitation, topography, soils and vegetation (Heinz Center 2008), and human alterations-both direct and indirect. The consumption of chemicals is an essential element of domestic wastewater, which is to assist the washing action of clean water such as laundry detergents, soap, bleaches and bactericides. Similarly other chemicals used on the body (toothpaste, make-up, powders) and in kitchen (tea leaves, oils, detergents and greases). These chemicals are partly decompose its neighboring water bodies to release nitrates, phosphate, sodium and a complex array of the other chemicals, alter the pH of the same.

The open disposal of the wastewater from the household, factories, municipal and market is the problem to the soil. The use of a conventional water

bodies offering primary treatment to all wastewater and disposal of the effluent to subsoil disposal. These activities are to increased sodium concentration, a quality of the paddy land imparting through the use of sodium rich chemicals in house. The purpose of this study was to evaluate and study the effect of sodium on paddy field related to its nearby water sink through the individual household activities.

Material and Methods

Study area

The location A, which is 1Km offshore from the Kalmunai shoreline and completely closed to the paddy field, was having an open water column depth of 2.5m. Aerial view of this location was illustrated in the figure 1.

The satellite image of the location B was shown at figure 2, with water column depth of 1.5 m which was 0.1 Km from the paddy field of Ninthavur and the location C was widely open to agricultural land and it was located around 12 Km from the Karaitivu offshore having the water column depth of 2 m and the aerial view of this location was illustrated at figure 3.

The water samples were collected once a month from June to November in 2011 between 09:00 am to 12:00 noon. These were transferred into sterile plastic containers and transported to the laboratory using insulated containers. The physical and chemical parameters were measured on the following day of the water sampling.

The work focused on sodium concentration and other related parameters in the locations A, B, & C. Further pH, DO, Tds, salinity, SC and temperature (T) were determined *in situ* using portable meters. The concentration of sodium was analyzed using Systronics Flame Photometer 128 with series of standard solution.

The following satellite images were taken at May 2013

Figure 1: Satellite image of the location A Figure 2: Satellite image of the location B
Figure 3: Satellite image of the location C

Standard Preparations

A sodium chloride standard solution was prepared and the following approximate concentrations were made: 20, 40, 60, 80 and 100 mg/ml as Sodium by using this stock solution. The deionized water was used to clean the glassware and for the dilution. These standards were prepared in clean/ dry volumetric flasks and transfer the solutions to plastic bottles.

Results and Discussion

The locations were received different types of inorganic stuff including sodium and other organic waste. The wastewater were collected from three locations namely location A, B & C.

Table 1:
Sodium concentration and physico-chemical parameters of the location A

Variables	Mean ± SE	Range	Co.Var. (%)
pH	5.51 ± 0.05	5.17 - 5.82	5.63
Salinity (‰)	0.27 ± 0.01	0.17 - 0.40	29.63
Tds mg/l	394.37 ± 15.01	112.60 - 795.00	6.24
DO mg/l	2.06 ± 0.17	0.86 - 3.35	49.51
SC (µS/cm)	792.67 ± 90.05	444.07 - 1232.40	68.16
Sodium (Na)	7.28 ± 0.53	3.34 - 10.68	43.77

SE = Standard error, upper and lower ranges equivalent to 95% confidence interval, Co. Var = Coefficient of Variation.

The variations in physico-chemical properties of the location A (Table 1), Increases in sodium ranged from 3.34 to 10.68 mg/l, at the beginning of this study shown low sodium while it has increased during before ending period and it may happen because of analyzing period is monsoon.

The location B has higher concentration of sodium rather than other locations due to getting huge level of laundry detergents directly from the edge of the channel of the location. Inclusion of organic waste such as leaves, grass clippings, dead plant (algae and water based plants) sewage and animal dropping are also significantly higher at this location.

Table 2:
Sodium concentration and physico-chemical parameters of the location B

Variables	Mean ± SE	Range	Co.Var. (%)
pH	7.92 ± 0.82	5.68 – 8.01	2.02
Salinity (‰)	0.36 ± 0.05	0.10 – 0.80	80.56
Tds mg/l	604.55 ± 15.96	104.91 – 1000.20	14.90
DO mg/l	3.38 ± 0.15	2.13 – 4.79	27.22
SC (µS/cm)	864.32 ± 52.34	254.73 –1590.00	36.33
Sodium (Na)	17.24 ± 1.36	8.83 – 26.80	44.50

SE = Standard error, upper and lower ranges equivalent to 95% confidence interval, Co. Var = Coefficient of Variation.

Then this organic matter gets decomposed by bacteria and these bacteria may have consumed the dissolved oxygen. Depending on the organic waste more bacteria may grow and they can use more oxygen, as a result DO concentrations can drop. Higher levels of Tds, salinity and SC were observed during the study and which were summarized in the Table 2. It may be due to the remaining enormous number of anions, cations and other ionic compounds through the evaporation of huge amount of water from this location.

The range of sodium 8.83 – 26.80 mg/l was observed during this study period, while it has higher value at the end of middle period such as fourth month. This period was obviously used by the huge number of laundry activities on the edge of the channel of the location. As a results salinity and specific conductivities also increases during this period. The location C has number of waste effluents, especially domestic, hospital and other effluents. However, it was located far from the household activities.

Table 3:
Sodium concentration and physico-chemical parameters of the location C

Variables	Mean ± SE	Range	Co.Var. (%)
pH	5.46 ± 0.06	5.21 – 6.06	6.96
Salinity (‰)	0.24 ± 0.01	0.13 – 0.33	33.33
Tds mg/l	219.88 ± 11.96	127.67 – 314.57	32.64
DO mg/l	1.53 ± 0.01	0.67 – 2.74	5.23
SC (µS/cm)	508.20 ± 26.21	323.70 – 692.33	30.95
Sodium (Na)	7.26 ± 0.53	2.54 – 10.31	48.25

SE = Standard error, upper and lower ranges equivalent to 95% confidence interval, Co. Var = Coefficient of Variation.

The location C have been receiving comparatively low level of above types of waster effluent than the other location because, it was located geographically far away from household, hospital and other waste effluent. However the above said waste effluents were attained to this location by passing long distance.

The range of sodium, from 2.54 – 10.31 mg /l, was very significant and it was shown that the Table 3. Higher level of sodium concentration exhibits, for the sample collected at the ending period of this study. Due to the excess waste effluent attained to this location with having huge level of sodium containing wastewater.

DO concentrations significantly vary within the locations and the low level of DO concentration was observed at location C (Table 4) to other locations. The DO level of the location A significantly varies from the location B with but not in the case of the location C. Because of the location B have huge level of DO and it was cleared that this effect can be occurred by the vast level of laundry activities.

Significantly low level of Tds record at location B and its level investigated before and after contamination of the household, laundry and other wastewater activities. Significantly a higher level of Tds was observed from the location C compared to the other two locations A and B.

Sodium concentration of the location B has huge values 17.24 mg/l rather than the other locations and it was clearly exhibited that the location highly contaminated by the sodium containing waste effluent such as laundry detergents and other household practices. However, the location A and C has approximately equal level of sodium but both are different in nature as well as the connection between the type of waste sources and the distance to the locations.

The method has been authenticated from the square values of Pearson product moment correlation coefficients (positive correlation) with r2 = 0.8694 of the correlation of sodium concentration Vs pH. It has clearly exhibited, that the location heavily contaminated by the salt active waste effluent. As a result of these salt active substances the location was led to basic nature.

Table 4:
Sodium concentration and physico-chemical properties for the locations

Location	T (°C) Mean ± SD	pH Mean ± SD	STY (‰) Mean ± SD	DO (mg/l) Mean ± SD	Tds (mg/l) Mean ± SD	Na (mg/l) Mean ± SD	SC (µS/cm) Mean± SD
A	29.46 ± 0.50	5.51 ± 0.31	0.27 ± 0.08	2.06 ± 1.02	394.37± 4.60	7.28 ± 3.18	792.67 ± 0.31
B	29.88± 0.49	7.92 ± 0.16	0.36 ± 0.29	3.38 ± 0.92	219.88 ± 1.77	17.24 ± 9.31	864.32 ± 94.02
C	30.14 ± 1.22	5.46 ± 0.38	0.24 ± 0.08	1.53 ± 0.08	604.55 ± 0.08	7.26 ± 3.06	508.02 ± 57.24

Physical parameters and the concentration of sodium in the water sink and its variation within the locations are summarized in Table 4. During the study period, the temperature of the locations doesn't exhibit any critical changes on its surrounding; however the values were changed within 29.88 to 30.14 °C. The freshwater ecosystem processes like development, productivity, food web relationship, and interrupt integral decomposition rates (IPCC AR4 2007). On the other hand, the pH was changed 5.46 ± 0.38 for location C and 7.92 ± 0.16 for location B.

Similarly, the positive correlation among the concentration of sodium and pH with higher (r2 = 0.7817 and r2 = 0.8193) r2 values were observed for location A and the location C respectively It has clearly described in the figure 4. But salinity, DO, SC and the sodium concentration values of this location such as 0.36 ± 0.29‰, 3.38 ± 0.92 mg/l, 864.32 ± 94.02 mg/l and 17.24 ± 9.31 mg/l also increase rather than the other locations.

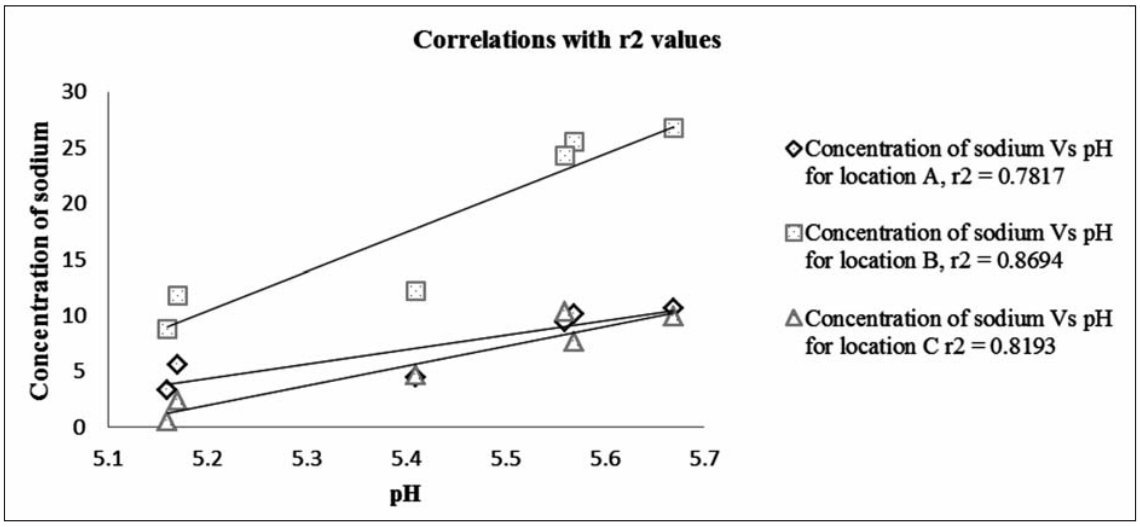

Figure 4:
The correlations between the concentration of sodium and the pH with square values of Pearson product moment correlation coefficients for all locations.

All the locations were dynamically involved to receiving the household wastewater, market and hospital effluent. The household activities such as laundry detergents, soap, bleaches and bactericides, similarly other chemicals used on the body (toothpaste, make-up, powders) and in kitchen (tea leaves, oils, detergents and greases) were significantly contributed to increase the sodium concentration to this locations.

The locations were situated sink like water body and which were opened to the paddy field, when which filled by the waste water. From the nature of the locations, the study was concluded that the locations significantly contributed to increase the SAR in the paddy field.

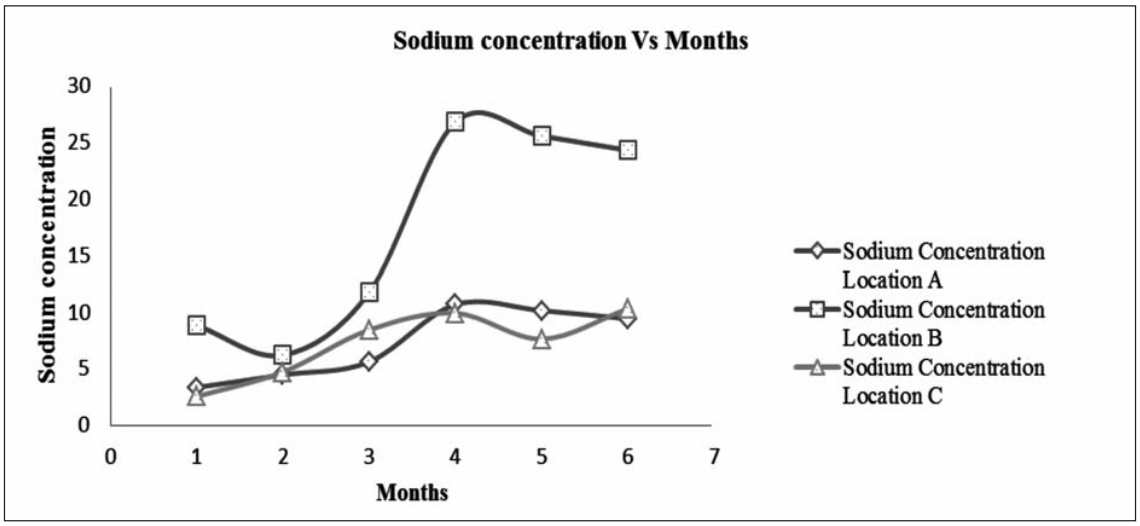

Figure 5:
The variation of sodium concentration with months for locations

Location A may have huge possibilities to receiving the householder effluent than the other locations. Nevertheless, among the locations, location B has shown that the detergents and the chemicals massively contributed to the sodium effect and this effect clearly described with all locations in the figure 5. Highly contaminated chemicals including laundry detergents and other household detergents were subjected to this effect.

Calcium and Magnesium intake ability of the crop massively disturbed by this sodium containing wastewater through ion exchange properties and which was don as a function of each component (Ca, Mg and Na) in soil samples. SAR and ionic concentration should also be affecting the diffusion type such as pore diffusion and mass transfer diffusion of the soil. As a result of long term wastewater practices to the locations significantly affect the yield of paddy cultivation.

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