Evaluation of Water Chemistry along the Coastal and Lagoon Segments of Kavaratti Tropical Island, South West of India

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ABSTRACT

The extent of anthropogenic inputs into the lagoon and coastal waters and the variation of physico-chemical parameters assume greater significance in the case of highly populated coral island of Kavaratti. Observation at 7 stations for 3 seasons were carried out between 9^0 58'16" and$10^0$34'22" N and between $72^0$37'28" and $76^0$14'43" E onboard ORV Sagar Manjusha during 2013. The best fit relationship for temperature versus nitrite, nitrate and phosphate was inverse linear and for silicate it was fractional. A non-linear relationship was observed between nutrients and salinity. The deviations from these inverse linear and fractional relationships years will provide an insight into the nature of anthropogenic inputs into the lagoon and marine eco-system. The results showed that the pH was higher for lagoon waters (8.10-8.35) as compared with coastal waters (7.89-8.24) and salinity conversely ranged from 26.45-32.91 PSU and 30.07PSU-33.97PSU for lagoon and coastal waters. A detailed study on nutrient flux in the coastal and lagoon waters showed that the concentration of nitrite ranged from 0.09-0.53 µmol/L and 0.09-0.69 µmol/L; nitrate from 3.96-18.15 µmol/L and 4.41-18.68 µmol/L; ammonia from 0.29-2.56 µmol/L and 0.14-2.48 µmol/L; inorganic phosphate from 0.36-1.22 µmol/L and 0.10-1.24 µmol/L and silicate from 1.63-6.93 µmol/L and 1.14-11.12 µmol/L respectively. The nutrient flux indicates that the values are higher than the standard limits and is structured as a combination of hydrodynamics and bio-geochemical factors.

Keywords: Kavaratti, Nutrients, Physico-chemical parameters.

1. INTRODUCTION

Kavaratti Island coast and the lagoon region are major hotspots in terms of pollution in Lakshadweep Sea. The nutrients especially nitrite, nitrate, phosphate etc. are highlighted as indicators of pollution in lagoon and coastal waters. There have been many studies on the distribution, cycling and inter-relationship of the nutrients in the Lakshadweep sea Ryther et al, 1966 ., Viswanathan and Ganguly, 1968 ., Sankaranarayanan, 1973, 1983 ., Deuser et al, 1978., and

De and Singbal, 1986. However recent records on the nutrient distribution in coastal waters of Kavaratti Island are very scanty. This paper provides recent information on the chemistry of lagoon and sea waters adjacent to Kavaratti Island. The study examines the pattern of distribution of nutrients such as ammonia, nitrite, nitrate, phosphate & silicate in relation to temperature, p^H, Dissolved Oxygen (DO), alkalinity & salinity. Temperature, p^H and DO of the water samples have been measured *in situ* by using certified thermometer and Eutech (PCD 650) water quality analyser. Salinity has been measured *in situ* by using Eutech (PCD 650) water quality analyser and it has also been estimated by Mohr-Kundsen method (Muller, 1998). The analysis of dissolved forms of nutrients (nitrates, nitrites, ammonia, phosphate and silicates) has been done by Spectrophotometric procedure (APHA, 1998). Total nitrogen and total phosphorus have also been analysed spectrophotometrically (Grasshoff, 1999).

2. MATERIALS AND METHODS

2.1 Study area

The lagoon and pelagic waters of Kavaratti, Lakshadweep is a major hotspot in terms of pollution. The water chemistry here has been studied based on samples from seven stations distributed in lagoon and coastal waters. These are 0.5 km off the shore in the lagoon and 0.5 km, 2 km, 5km off the Helipad and Light house in the open sea lies between 9^0 58’16” and $10^0$34’22” N and between $72^0$37’28” and $76^0$14’43”E respectively shown in Fig.1.

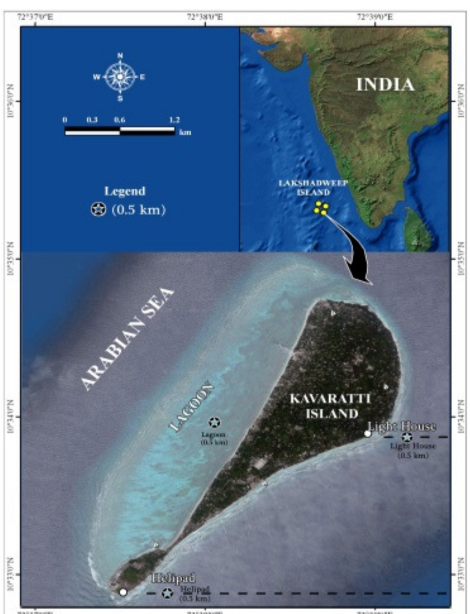

Fig.1 Study Area

2.2 Sampling

Samples have been collected using Mechanized Vessel for lagoon and ORV Sagar Manjusha equipped with GPS and Fathometer for the Sea. Samplings have been carried out at an interval of 3 hours for a whole day (6:00, 9:00, 12:00, 15:00, 18:00, 21:00, 24:00 & 3:00 hrs). Water samples have been collected using 5L Teflon coated Niskin sampler. The prioritized individual sub samplings have been done (i) For pH (ii) For nutrients and physical parameters. All the samples have been preserved at low temperature (4^0C) condition to avoid the change in nutrient concentration due to the biological activity of microorganisms present in the sea water. Samples have been collected in triplicate from each station and average value for each parameter has been reported.

2.3 Chemical Analysis

The analysis of dissolved forms of nutrients (ammonia, nitrites, nitrates, phosphate and silicates) has been carried out spectrophotometrically. In this survey, a Varian spectrophotometer-Carry Bio-50 has been used. Ammonia has been estimated by phenate method using 1cm cell at 630nm against ammonia free MQ water as reference. Nitrite and Nitrate have been determined using 1cm cell at 540nm. Phosphate has been estimated using 1cm cell at 880nm. Concentration of silicate has been estimated using 1cm cell at 810nm. All the estimations have been done against MQ water as reference (APHA, 1998). The concentrations of nutrients were reported in µmol/L.

Total nitrogen and total phosphorus have also been analysed by spectrophotometric procedure (Grasshoff, 1999). Total nitrogen has been estimated by oxidation followed by reduction using column reductor and absorbance is measured using 1cm cell at 540nm and Total phosphorus has been estimated by oxidation method and absorbance is measured using 1cm cell at 880nm. Both against MQ water as reference. The concentrations were reported in µmol/L.

3. RESULTS AND CONCLUSIONS

Seasonal variation of physico-chemical characteristics in Kavaratti hotspot is plotted in (Figs.2a to 6b). The atmospheric temperature ranged from 23.3^0C (post monsoon) to 31.8^0C (pre-monsoon) in lagoon. In coastal region the values ranged from 29^0C (summer) to 33.4^0C (pre-monsoon). Water temperature ranged from 26.7^0C (post-monsoon) to 30^0C (post-monsoon) in lagoon and 27.9^0C (post-monsoon) to 31^0C (summer) in coastal. The factors controlling the seawater temperature in the Kavaratti coast is dominated by warm water inflow and air-sea heat flux. Water Flowing towards the shore of Kavaratti warmer by 2^0 C mainly due to direct air-sea heat flux.

Dissolved Oxygen ranged from 2.90mg/L to 7.16mg/L (averaged 5.2) in lagoon and from 4.06mg/L to 7.14mg/L (average 5.7) in coastal waters. The oxygen saturation concentration depends on temperature and salinity (Weiss, 1970). In addition, the DO concentration depends on the photosynthetic rate and also on nutrient concentrations. High temperature and salinity cause the oxygen to be relatively low (Badran, 2001): the higher the temperature, the lower the solubility of oxygen in seawater. The DO levels have been found towards an optimal range which indicates the health of the water and its suitability as fish habitat. Most of the tropical fish ponds culture systems Indicates DO around 8 mg/L.

Alkalinity ranged from 103.07mg/L to 178.96mg/L and 112.44mg/L to 189.25mg/L in lagoon and coastal waters respectively, It indicates the buffering capacity of the water and concentrations of the dissolved carbonate ions and in turn the stability of the recirculating system and suitability for certain reproduction requirements. Generally water having alkalinity above 100 mg/L is known to be conducive for fish habitation. Alkalinity and pH are directly influenced by both respiration and nitrification. P^H values (Fig.3a&3b) ranged from 7.89 (summer) to 8.24 (pre-monsoon) and 8.10 (summer) to 8.35 (Pre-monsoon) in lagoon and coastal waters respectively. P^H values recorded in this study are well within the desirable range of 6.5 to 9.0 recommended for optimal fish production (Boyd and Lichktopller, 1979). Salinity values (Fig.4) ranged from 26.45PSU (post-monsoon) to 32.91PSU (summer) and 30.07PSU (pre-monsoon) to 33.97PSU (summer) in lagoon and coastal waters respectively.

The concentrations of nutrients are given in (Figs.7a&7b). The concentration of nitrite ranged from 0.09 (summer) to 3.53 (post-monsoon) and 0.09 (summer) to 0.69 (post-monsoon) in lagoon and coastal waters respectively. The values of nitrates ranged from 3.96 (summer) to 18.15 (post-monsoon) for lagoon water and 4.41 (summer) to 18.68 (post-monsoon) for coastal waters. In the case of ammonia, the range is between 0.29 (summer) and 2.56 (post-monsoon) for lagoon and 0.14 (pre-monsoon) to 2.48 (post-monsoon) for coastal water. Inorganic phosphate values ranged from 0.36 (pre-monsoon) to 1.22 (summer) in lagoon and 0.10 (pre-monsoon) to 1.24 (summer) in coastal waters. Silicate concentration ranged from 1.63 (summer) to 6.93 (pre-monsoon) in lagoon and in coastal the values ranged from 1.14 (summer) to 11.12 (pre-monsoon. The total nitrogen concentration ranged from 14.47 (pre-monsoon) to 44.07 (summer) and 12.06 (post-monsoon) to 32.10 (summer) in lagoon and coastal waters respectively. The values of total phosphorus ranged from 0.93 (pre-monsoon) to 4.21 (summer) in lagoon and in coastal region the values ranged from 0.54 (pre-monsoon) to 4.78 (summer).

Stratification conditions are reflected in the concentrations of nutrients (Figs.7a&7b) including nitrate, phosphate and silicate (Klinker et al. 1978, Badran 2001, Castro et al. 2002, Al-Qutob et al. 2002). Temperature may also influence nutrient concentrations in summer by affecting the photosynthesis rate (Tait 1981, Pliński & Jożwiak 1999) in addition to affecting the mixing of the water column. Light intensity can also indirectly affect nutrient concentrations during summer.

4. ACKNOWLEDGEMENT

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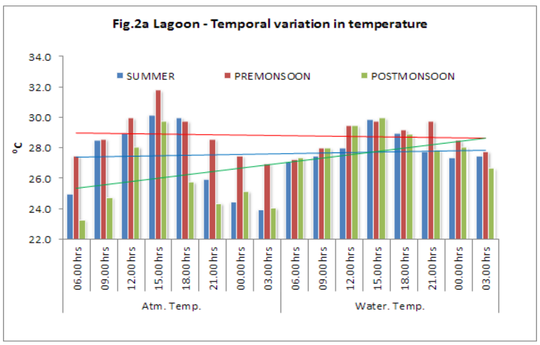


Fig.2a Lagoon - Temporal variation in temperature

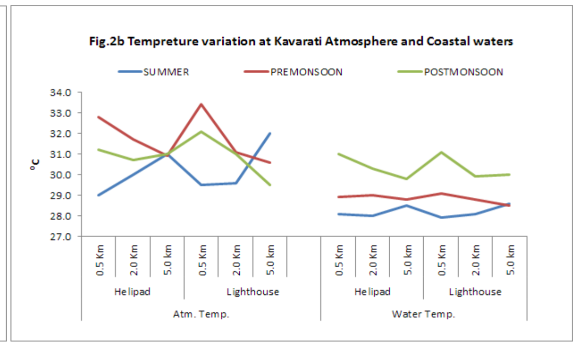


Fig.2b Tempreture variation at Kavarati Atmosphere and Coastal waters

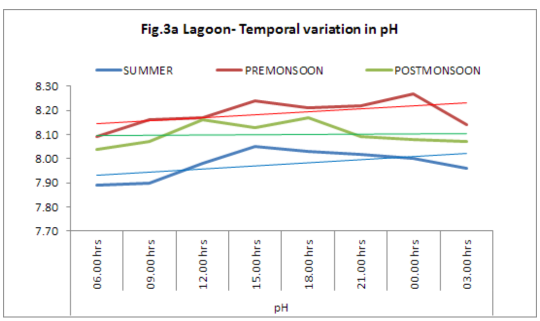


Fig.3a Lagoon- Temporal variation in pH

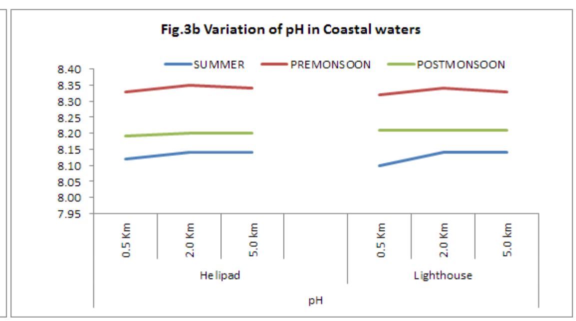


Fig.3b Variation of pH in Coastal waters

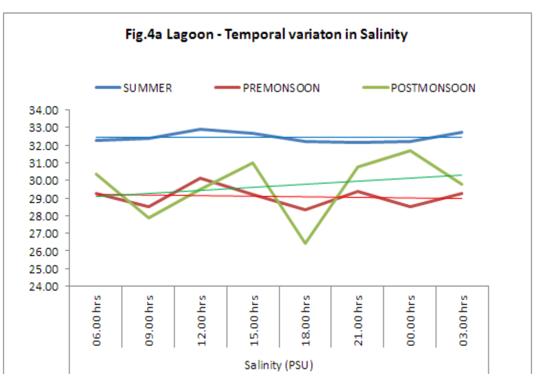


Fig.4a Lagoon - Temporal variaton in Salinity

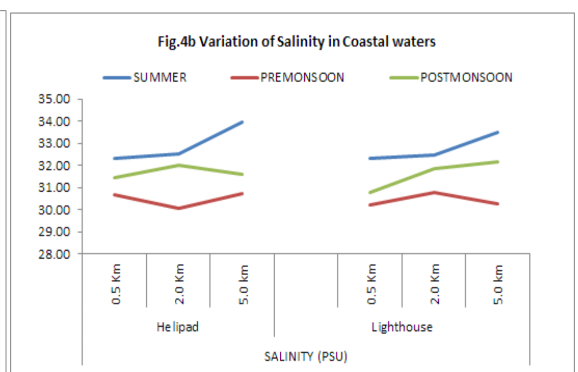


Fig.4b Variation of Salinity in Coastal waters

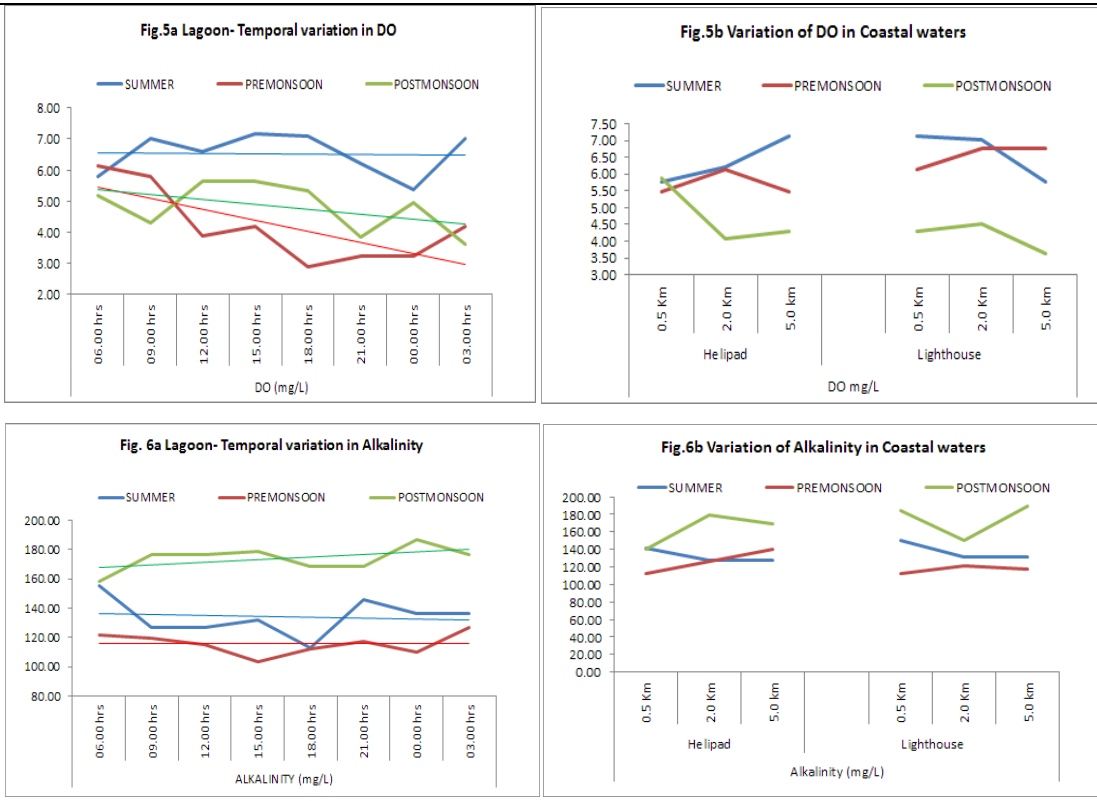
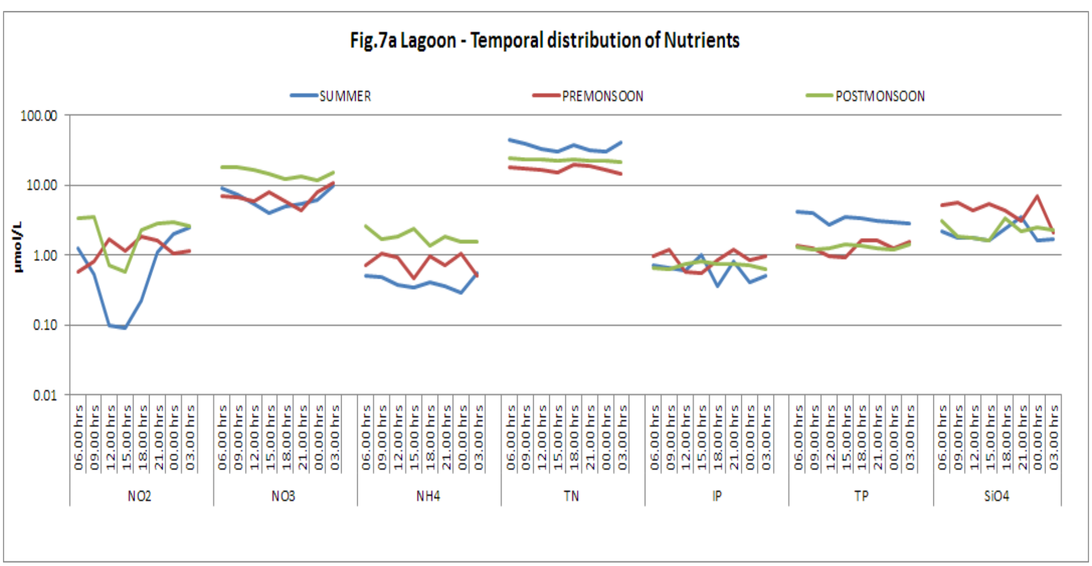


Fig. 2a-6b Temporal variation of Physico-chemical Parameters in Kavaratti



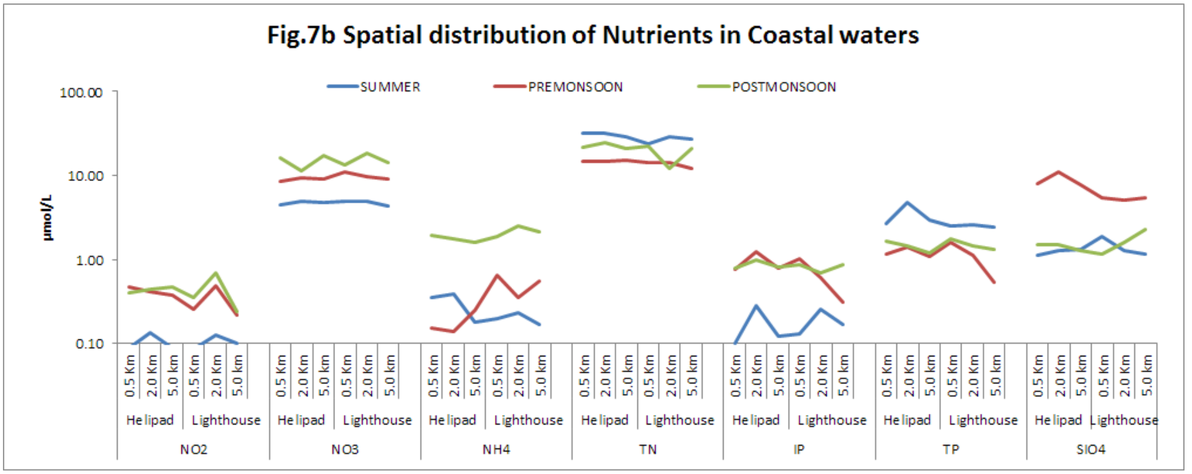


Fig. 7 Temporal distribution of Nutrients in Kavaratti

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Role of Environmental Factors in Urban Malaria and Dengue Prevalence

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ABSTRACT

Vector borne disease situation particularly of Malaria and Dengue in urban areas of the world is deteriorating. Today approximately 40% of the world's population is at risk of malaria. In tropical and subtropical countries it causes more than 300 million acute illnesses and at least one million deaths annually. Dengue fever causes 50-100 million cases and 500,000 cases of Dengue Hemorrhagic Fever annually in the world. Environmental and Socio economic factors contribute to the rise of vector borne diseases. These factors include: (i) Rapid Urbanization leading to shortage/lack of civic facilities for huge population leading to the rise of communicable diseases. (ii) immigration particularly workers from disease endemic areas settle in urban slums with highly receptive and vulnerable surroundings suitable for local transmission of vector borne diseases, (iii) immigration of population introduces new and drug resistant strains in new urban environment; and (iv) climate change which causes altered temperature and rainfall pattern and floods that in turn results in enhanced vector breeding grounds and adult mosquito survival rate (v) shortage of potable water in urban areas forces people to store water leading to enhanced vector breeding grounds (vi) inadequate solid waste disposal facility especially provide suitable breeding site for mosquitoes. Literature supports the rising trend of malaria and dengue in the urban areas of the world. Anopheles stephensi the vector of malaria that breeds in a variety of containers in urban areas has completely adapted itself to the urban environment. Similarly for Dengue, Aedes aegypti the primary vector of dengue fevers has a global distribution and it is invading areas under urbanization. To control rising urban Malaria and Dengue a multi dimensional approach involving different stakeholders like, civic agencies, community, media, and Health & education departments is recommended.

Keywords: urbanization, environmental management, modernization, globalization

1. BACKGROUND

Vector borne disease situation particularly of Malaria and Dengue in urban areas of the world is deteriorating. Today approximately 40% of the world's population is at risk of malaria. In tropical and subtropical countries it causes more than 300 million acute illnesses and at least one million deaths annually. Dengue fever causes 50-100 million cases and 500,000 cases of Dengue

Hemorrhagic Fever annually in the world. Urbanization is of utmost importance in the development of the society and human yet poses a serious environmental challenge to the society. Environmental and Socio-economic factors that contribute to the rise of vector borne diseases include; Rapid Urbanization, immigration of people from disease endemic areas; climate change causing altered temperature and rainfall pattern; shortage of potable water in urban areas; inadequate solid waste disposal facility.

Overall the epidemiology of malaria and Dengue depends mainly on two major forces: Environmental, climatic and social features that establish ecological conditions conducive or restrictive to the disease transmission, and the scaling-up of vector borne control interventions. Both forces alter the disease transmission and infection, as well as associated morbidity and mortality [1, 2, and 6]. The present paper attempts to analyze role of environmental factors in urban malaria and dengue prevalence.

2. URBAN MALARIA AND DENGUE SCENARIO

Urban malaria and dengue epidemiology will pose different challenges to the urban areas [2]. One concern is that urban agriculture which is promoted to increase food security and alleviate poverty [4] might, especially when irrigated; increase the urban malaria and Dengue risk by creating breeding sites for the *Anopheles and* Aedes aegypti vector. Several environmental studies have recorded breeding of *Anopheles* in urban areas like in the urban slums due to unplanned settlement, construction and irrigation sites.

3. ENVIRONMENTAL FACTORS

The importance of environment in malaria and dengue transmission in the urban areas and society at large cannot be over looked because a positive or negative environment will determine the situation and the transmission rate of the diseases causing species of mosquitoes.

3.1 RAPID URBANIZATION

Globalization and modernization is one main factor promoting rapid urbanization in the world at large. The rising speed of urbanization is leading to shortage/lack of civic facilities for huge population in the cities resulting to the rise and spread of communicable diseases; studies have shown that there is less space availability in urban areas, and most of the housing facilities tend to be very expensive for some classes of people which are not able to afford payment of house rent thus resort to under breach, road side and urban slum dwellers. This compromises the environmental sanitation and drainage system leading to favorable breeding ground for the species of mosquitoes which spread the malaria and dengue disease. The geographic spread and expansion into peri-urban areas of the mosquito Aedes albopictus, exquisitely adapted for breeding in discarded plastic containers and used automobile tires, is a good example of how a potential vector of viral diseases has taken advantage of environmental change.

3.2 IMMIGRATION PARTICULARLY WORKERS FROM DISEASE ENDEMIC AREAS

Many studies also attribute malaria to migration that is imported malaria and other strains of vector born disease. The most affected demographic groups in these studies were males and all cases had a recent travel history to malaria-endemic areas with the main purpose for travel being overseas labor. The cases were mainly acquired from African countries. Plasmodium falciparum was the most common species. The increase in malaria and dengue cases imported from other countries was associated with the growth of investment to Africa from Asia and the increasing number of exported laborers to Africa from Asia [3, 11, and 13]. Security force personnel engaged in UN missions in malaria-endemic countries like Haiti and Sri Lankans who travel to other countries in search of jobs [16] also transport the diseases. Pilgrimage tours to India, which are popular among locals, pose yet another challenge increasing the risk of parasite carriage in to the country.

Immigration of people from disease endemic areas to urban slums with highly receptive and vulnerable surroundings suitable for local transmission of vector borne diseases add to the diseases burden.

3.3 CLIMATE CHANGE

Climate change represents a potential environmental factor affecting disease emergence. Shifts in the geographic ranges of hosts and vector, the effect of increasing temperature on reproductive, development and mortality rates on hosts, vectors, and pathogens, and the effects of increased climate variability on flooding and droughts all have the potential to affect disease incidence and emergence positively or negatively. Climate change causes altered temperature and rainfall pattern and floods that in turn results in enhanced vector breeding grounds and adult mosquito survival rate. The mosquitoes most likely survive in hot temperature water logged area.

Rainfall was associated with malaria cases in both hot and cold weather. However, a dominant theme emerging from research on the ecology of infectious disease is that accelerated and abrupt environmental change, whether natural or caused by humans, may provide conditions conducive to pathogen emergence: pathogen adaptation, host switching, and active or passive or dispersal. The disease range was longer in hot weather countries compared to cold weather countries. Relative humidity was correlated with malaria cases at early and late lags in hot weather countries. Minimum temperature had a longer lag range and larger correlation coefficients for hot weather countries compared to cold weather counties [14].

3.4 INTRODUCTION DRUG RESISTANT STRAINS IN NEW URBAN ENVIRONMENT

The disease has re-emerged in several Central Asian countries and in Southeast Asia partly because of relenting malaria control efforts and the emergence of parasite resistance to the most commonly used anti-malarial drugs [2]. In many regions the vectors have become resistant to the main insecticides and cases of artemisinin resistance have been reported from the Greater Mekong sub region. Resistance to chloroquine and sulphadoxine/pyrimethamine (S/P) has been reported from Bangladesh [1] but until now there is no evidence that artemisinin resistance has spread westwards to Bangladesh, which traditionally forms a gateway to the Indian Subcontinent [7].

3.5 INADEQUATE WATER SUPPLY

Shortage of potable water in urban areas forces people to store water leading to enhanced vector breeding grounds especially when storage containers have no lids.

3.6 INADEQUATE SOLID WASTE DISPOSAL FACILITY

With the increasing incidence of indiscriminate solid waste disposal especially at the storage site before they are finally disposed of provide suitable breeding site for mosquitoes in the containers and around the surrounding with other rodent which unsafe activities are very harmful to human's health as in the case of laser fever [2,3,5].

4. CONCLUSION

In all, the role of environment impact in the transmission of vector borne diseases is so significant that if the environment is properly managed then majority of the vector borne diseases will be roll out from the surface of the earth. Thus environmental management is the watch word for overcoming vector borne diseases.

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