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Sensitivity-Based Modeling

Achieving Effective Vegetation

Highlights

A Study on Eco-Physiology

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Discovering Thoughts, Inventing Future

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Achieving Effective Vegetation Cover in Katsina Urban Area, Katsina State Nigeria

By Suleiman Iguda Ladan
Hassan Usman Katsina Polytechnic, Nigeria

Abstract- Urban areas in many countries of the world in both developed and developing nations have today realized the relevance of achieving effective vegetation cover towards improving the built environment. This paper focuses on one of the urban areas in northern Nigeria located at the fringes of the Sahara desert. Data for the study were generated through field visits to the different areas and interview with the relevant officials. The results identified seven major forms of vegetation in the urban area many of which are not in good condition. This area due to some factors hindering achieving effective vegetation cover in the urban area. These factors include high demand for fuel wood, poorly enforced laws, the semi-arid climate of Katsina, uncontrolled urbanization, lack of awareness and misguided government action. It therefore recommended adequate measures should be adopted towards achieving effective vegetation cover in the urban area.

Keywords: *achieving, effective, vegetation cover, urban area.*

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Achieving Effective Vegetation Cover in Katsina Urban Area, Katsina State Nigeria

Suleiman Iguda Ladan

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Keywords: achieving, effective, vegetation cover, urban area.

I. Introduction

Vegetation is the general term for the plant life of a region. It refers to the ground cover provided by plants and is by far the most biotic element of the biosphere (Science Daily, 2014). Vegetation is the plant cover of the earth consisting of assemblages of plants such as trees, shrubs, herbs and grasses which constitutes the most observable element of the landscape (Online Nigeria, 2014). Vegetation performs vital functions and services which make the planet earth lively and habitable by playing a key role in the efforts to fight climate change, releasing oxygen into the atmosphere while storing carbon dioxide (UNEP, 2011). Vegetation is essential for water supply, creating and maintaining soil fertility, and assisting to reduce the devastating impacts of storms, floods and fires. Vegetation provide home to a wide variety of terrestrial species of animals, plants and insects. Vegetation also provides source of fuel, job security and cultural relevance for vegetation dependent populations (UNEP, 2011).

Effective vegetation cover is adequate vegetation cover that provides sufficient services to the people in form of providing shade from the sun, break the force of wind, cover bare soil from erosion, absorb carbon emissions, combating desertification and performing other ecological functions.

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Vegetation in Nigeria is influenced by physical and human factors. Among the physical factors, climate is the most important factor influencing vegetation as the different types of vegetation grow in response to the amount and seasonal distribution of rainfall (Dingba and Adamu, 2007). In terms of human factors natural vegetation is influenced and modified by the activities of man for example through clearing for agriculture, lumbering, cattle rearing, fuel wood extraction and construction projects.

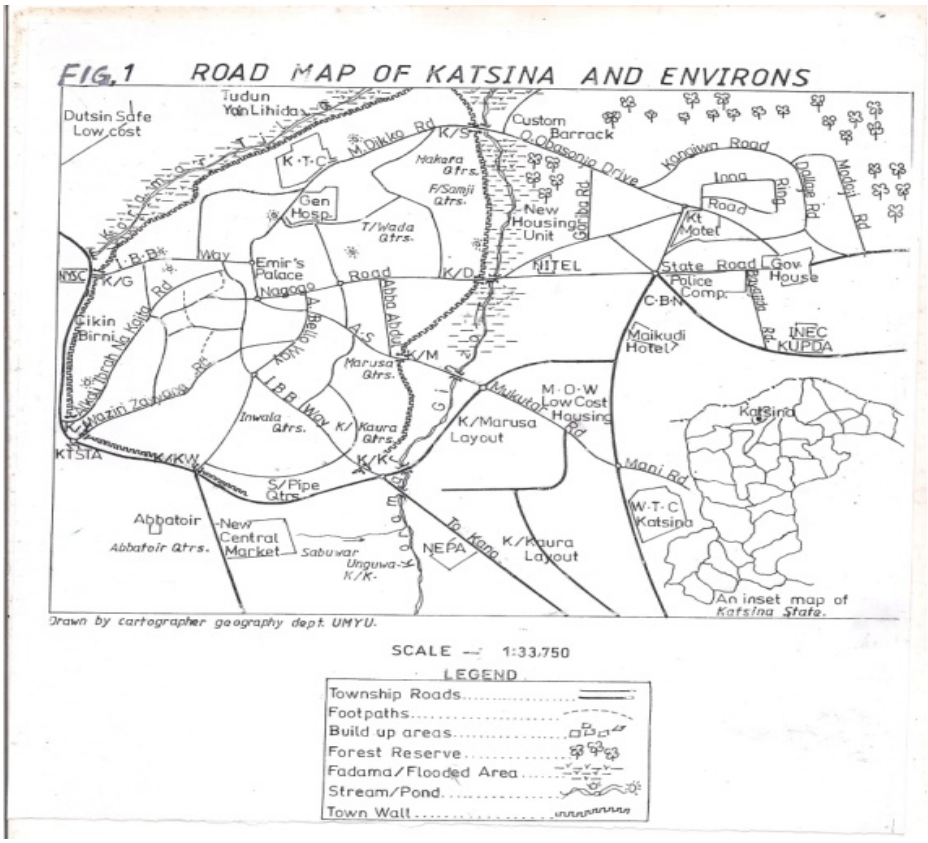
The main types of vegetation in Nigeria are mangrove swamps, fresh water swamps, high forest, guinea savanna, Sudan savannah and Sahel savannah. Katsina urban area falls within the Sudan savannah vegetation belt. The climate of Katsina is Tropical Continental type that is hot and dry for most of the year. Maximum day temperatures of about 38^0C in the months of March, April and May are common and the minimum temperature is about 22^0C in the month of December and January. Annual rainfall average is about 780mm (Rumah and Sheikh, 2010).

Urban areas in both developed and developing countries consists not only of built environment which man uses for shelter but also biotic components that contribute to human wellbeing. Thus urban built environment also consist of different types of vegetation that transforms urban streets, dwelling places, schools, institutions and open spaces into attractive landscapes (Akpan, 2007).This paper is therefore on urban vegetation or urban greenery, a field of study that have not been given proper attention it deserves among scholars in the developing countries.

II. The Study Area

The study area Katsina urban is located at the extreme margin of northern Nigeria that lies on geographic coordinates of $11^0$08'N and $13^0$22'N and longitudes $6^0$52'E and $9^0$20'E. Katsina urban area covers a total land area of about 3,370km2 (Rumah and Sheikh, 2010). Katsina is one of the oldest urban centers of Nigeria believed to have been established in 1100AD as citadel and political capital in the pre and post Danfodio's Jihad, of the 19th century. It has its roots stretching back considerably before the advent of British colonizers and has served as entre port to the Saharan and trans-Saharan trade (Isah, 2011). Katsina

city is surrounded by an ancient wall that is presently in ruins of about 21km in length and the walled city enclosed an area of about 8 sq km that exited through eight major gates (See fig.1).



Katsina is a local government headquarters and the capital of Katsina state created in 1987. Since 1987 Katsina has witnessed rapid urbanization manifested in the extensive qualitative and quantitative land use transformations (Danjuma, 2012). The population of the urban area has increased since then and has further been increasing as a result of migration of people from the troubled north eastern Nigeria due to insecurity. Katsina is the center of an agricultural region that produces food and cash crops such as guinea corn, millet, groundnut, beans, cotton and hides (Ladan, 2014).

Katsina's location at the extreme margin of northern Nigeria at the fringes of the Sahara desert makes it necessary to thrive towards achieving effective vegetation cover to combat desertification and halt desert encroachment among others.

III. The Objectives of the Study

The objectives of this paper are to identify the major types of vegetation cover in Katsina urban area, examine the conditions of the vegetation cover, find out the factors hindering achieving effective vegetation cover, and identify the recent developments towards achieving effective vegetation cover and offer recommendations for achieving effective vegetation cover in the urban area.

IV. Methodology

The method used to collect data for the study include field work which involved visits to the eight major roads to observe and examine the road side planting, to six secondary schools to observe school plantations/compound planting, to five private, commercial and institutional gardens to observe the garden plants, to areas outside the city wall to see the Green Belt Area, the forest reserve, and Children's Park at Government Residential Area (GRA).

The field visits to the study sites were accompanied with interview and those interviewed include officials of Katsina State Afforestation Project Unit (KTAPU), Forestry Department Ministry of Agriculture, Principals of Secondary Schools, and garden owners, officials of Katsina State Urban and Regional Planning Board, and staff of Maryam Babangida Children's Park. The interview question are on the condition of the plants, problems encountered, recent developments and recommendations for achieving effective vegetation cover in the urban area.

The data collected were complemented with secondary sources of data such as journal articles, conference papers, textbooks and internet sourced materials. The data was then edited, analyzed and presented using descriptive analysis in forms of tabulations, averages, percentages etc.

V. Review of Related Literatures

According to Cunningham and Cunningham (2006), urban sustainability in the developed world has brought about maintaining green belts in and around cities which provide recreational space and promote efficient land use as well as help ameliorate air and water pollution. Historically the main benefits of urban trees and forests relates to health, aesthetics and recreational benefits in industrialized cities such as New York and Paris where parks and other green areas are found even at the city centre or the central business district.

Chaudhry et al (2011) examined urban greenery status of some Indian cities and the results of the study indicate that urban greenery/forestry is one of the ways to bridge the gap between people and nature. According to the study most of the Indian cities are far behind inequality as well as quantity of urban forests than their counterparts in Europe and North America. High population density they noted is one of the reasons for underdevelopment of urban greenery sector in India.

In another study on Chandigarh, northern India Chaudhry et at (2013) observed that urban parks/gardens, wetlands, rivers and good landscaped environment provide intangible benefits that contribute to the quality of urban life. Also the enhancement of urban vegetation is one of the ways which has the potential to mitigate the adverse effects of urbanisation mainly pollution in a sustained manner. The study reported that Chandigarh, the beautiful city is one of India's planned cities where trees, plants and other green areas are as much as part of the construction plans as the buildings and the roads.

Akpan (2007),undertook a study on enhancing the value of trees in the urban environment of Akwa Ibom State south eastern Nigeria and concluded that majority of Nigerian cities fall short of enjoying the unquantifiable benefits trees provide urban environment such as beautification, micro-climate regulation, purify-cation of rain, protection from rain and wind erosion and conservation of biodiversity.

Umar and Kanu (2007) reported that in Nigeria's Federal Capital territory Abuja parks and gardens are created as part of Abuja Master Plan and they were established to make people to go there to relax at their leisure time as people need to refresh their minds after work, to recreate for the next day. It is based on this that today there are several parks such as Millennium Park, Abuja Zoological Park and gardens such as Abuja gardens, Apo Legislative Gardens which not only serves as places for recreation but improve the landscape of the Abuja environment.

Daramola and Ibem (2010) noted that in many urban areas of Nigeria the absence of updated master plans, lack of enforcing urban planning regulations, rapidly growing urban population and uncoordinated spatial urban growth have led to depletion of green areas and open spaces resulting in the loss of biodiversity with detrimental effects to the urban environment.

Alabi (2012) noted that in many towns that attained the status of State capital such as Lokoja, Jalingo, Gombe etc in 1991 to date there was an increase quest for land for urban development and consequently clearing of land for housing and road construction which consequently led to the clearing of natural landscape, the destruction of ornamental plants and trees which were left to rot due to negligence and lack of maintenance and a resultant increase in bare surfaces as a consequence areas that were once parks were taken over by buildings.

Enete et al (2013) examined the air pollution tolerance indices of tree species around Enugu urban area and reported that that the species provide good shade and high air pollution tolerance for the benefit of the residents of the city located in south eastern Nigeria. The results of the study can be handy for future planning and as well as providing tolerant species for landsc-aping and urban heat island mitigation.

One of the few vegetation studies in northern Katsina State was undertaken by Tukur et al (2013) who examined indigenous trees and their multipurpose uses in Dutsin ma area of Katsina State. The study found out that indigenous trees in the area play vital roles on the socio-economic development of the people and has made it possible for the people to undergo various trading activities of some useful parts of the trees.

Ene (2014) observed that in Nigeria in order to ensure a healthier urban environment for sustainable development there is need to create aesthetic values and beautify our cities using effective vegetation. Ene (2014) further observed that good landscaping is a powerful tool to achieve a pleasant environment. Landscaping contribute to visual satisfaction which could have a profound effects on the psychological nature of man (Ene, 2014).

VI. Results and Discussion

a) The vegetation covers in Katsina urban area and their present condition

A total number of seven (07) different types of vegetation cover were identified in Katsina urban area. These are road side planting, secondary schools planti-ng, gardens, green belt area, forest reserve, recreational parks and home planting. These were highlighted below:-

i. *Road side planting*

These are trees planted along the major roads from the city center through the city gates to roads outside the city (See fig.1). Road side planting has a long history dating back to the colonial period around 1910 when the then Emir of Katsina directed for the

planting of tree seedlings mainly neem (Azadirachta indica) along the major roads of the city. Today these trees mainly neem have grown big providing shade and place of business for petty traders and a resting place for people who sit in the day time. The table below shows the road side planting along the major roads.

Table 1 : Road side planting along major roads in Katsina city

S/N	Name of road	Dominant tree specie	Present conditions
1	IBB Way (A) (Kofar Kaura Road)	Neem trees (*Azadirachta indica*) India Almond trees (*Terminalia catappa*)	Trees in good condition but widely spaced in between
2	Nagogo Road (Kofar Durbi Road)	Neem tree (*Azadirachta indica*) Few other species	Some tree were cut due to road dualization project
3	Ahmadu Bello Way (Kofar Kwaya Road)	Neem Trees (*Azadirachta indica*) Other species planted by people	Trees in good condition but found mainly on one side of the road
4	Waziri Zayyana Road (Rafindadi Road)	Neem Trees (*Azadirachta indica*) Other species	Trees in good condition and the road has the dense collection of trees
5	Alkali Ibrahim Na Kaita Road (Kofar Yandaka Road)	Neem Trees (*Azadirachta indica*) Few other tree species	Trees in good condition but few and far in between. Need for more trees
6	IBB Way (B) (Kofar Guda Road)	Neem trees (*Azadirachta indica*) Few other tree species	Trees in good condition but few, others cut due to development
7	Muhammad Dikko Road (Kofar Sauri Road)	Neem trees (*Azadirachta indica*) Few other tree species	Trees in good condition but more trees need to be planted especially behind general hospital
8	Abdullahi Sarki Mukhtar Road (Mofar Marusa Road)	Neem trees (*Azadirachta indica*) Few other tree species	Trees in good condition Road narrow thus few trees near gate

Source : Field work, 2014

From table 1 could be observed that the trees are in good condition in about 80% of the roads. Most dense trees found along Waziri Zayyana Road where in some section of the road the trees form a canopy. But more trees need to be planted especially Alkali Ibrahim Na Kaita Road and Abdullahi Sarki Mukhtar Road this is because few trees where found along these roads as the roads were narrow along many sections. It was observed that some trees were cut as a result of the road dualization project of Nagogo road that leads to the Government Residential Area (GRA).There is the need for tree seedlings be replanted to replace those that were cut particularly fast growing tree species such as Incense tree (Eucalyptus sp.) that will grow within a short time and provide the services needed along the dual carriage road when completed.

ii. *Secondary schools planting programme*

The secondary schools planting programme is an initiative of Katsina Arid Zone Programme (KAZP) when it was funded by European Economic Community (EEC) now European Union (EU) and the Federal Government of Nigeria in 1990. The school's planting programme was carried out by Young Foresters Club which consists of students interested in forestry who were given tree seedlings to plant either in a school plantation or within the school compound (Ladan, 2004).The programme is aimed at making the youth to imbibe the culture of tree planting at a young age which will in the long run benefit the community and environment in general. The secondary schools planting programme can be seen on table 2 below:

Table 2 : Secondary schools planting programme in Katsina urban area

S/N	Name of school	Name of planting	Condition of planting
1	Government College Katsina	School compound planting	Big trees in a depression Trees intact and in good condition
2	Katsina College Katsina	School compound planting	Few trees could be seen in the school premises
3	Government Girls' College Katsina	School plantation	Plantation intact and in good condition. Another tree planting programme outside the school
4	Sir Usman Nagogo College of Arabic & Islamic Studies Katsina	School compound planting	Trees planted within compound intact, school also maintains a small garden.
5	Government Day Secondary School Kofar Yandaka, Katsina	School plantation	Plantation of trees intact, plans to revive school's garden
6	Government Pilot Secondary School K/Sauri Katsina.	School compound planting	Trees planted in compound have grown well and they are in good condition
7	Government Pilot Secondary School Kambarawa, Katsina	School plantation	Plantation intact and even fenced to avoid encroachment

Source : Field Work, 2014

The school compound planting involved planting of species of trees mainly neem (*Azadirachta indica*) within the compounds of the schools in different locations particularly along roads and paths. In the schools visited such as Government College Katsina and Government Pilot Secondary School Kofar Sauri the trees have grown well forming a canopy providing shade. The school's plantation involved planting of neem (*Azadirachta indica*) trees on a piece of land of about 2 hectares forming a plantation as the trees grow close to one another. In one of the schools visited Government Day Secondary School Kofar Yandaka, the plantation consist of 16 trees planted in 12 rows totaling 192 stands of trees. The school's Young Forester Club is very active as they have recently won a quiz competition on forestry organized by KAZP and the school's old students have planned a paper presentation titled the " The Significance of trees and Forests in Semi-arid Environment of Katsina State" coming up on 5th June, 2014.

iii. *Gardens*

These are planned cultivated pieces of land having fruit trees, ornamental trees specifically flowers or vegetable crops (Bellamy, 2007). In Katsina urban area three types of gardens are found. These are personal/private gardens, commercial/market garden and institutional gardens. One of the prominent private gardens in the urban area is Lambun Khadija owned by the former General Manager of KAZP. The plants found in the garden are mainly fruit trees such as mango (mangifera indica), guava (psidium guajava), orange (citrus sinensis) and other ornamental plants. Private gardens are significant habitats that improve connectivity by functioning as corridors and patches and thus enhance the overall network size of urban green spaces (Singh et at 2010). The commercial/market gardens are found outside the city wall at Kofar Marusa, Kofar Durbi and Kofar Sauri. Crops planted and cultivated for sale to the urban market include lettuce, onions, cucumber, carrots, green beans, peas, maize etc. KTAPU garden is one of the institutional gardens visited for the study. Tree species found in the garden include mango (mangifera indica), cashew (Anarcadium occidentale), gum Arabic (Acacia nilotica), lemon (citrus lemon), incense tree (Eucalyptus sp.), guava (psidium guajava), orange (citrus aurantium) etc. The trees in the garden have attracted different bird species that made nets on the trees and sings in the garden. The gardens with the dominant plant species can be seen of table 3 below.

Table 3 : Some selected gardens in Katsina urban area

S/N	Name of garden	Dominant plants	Present conditions
1	Lambun Khadija	Fruit trees and ornamental plants	Garden in good condition
2	Kofar Marusa gardens	Market garden crops	Crops in good condition but part of garden land converted to Filling Station
3	Kofar Durbi Gardens	Market garden crops	Garden plants in good condition, well catered for and watered
4	Kofar Sauri Gardens	Market garden crops and food crops	Garden plants in good conditions, well catered for and watered
5	KTAPU garden	Fruit trees and few others	Fruits trees show signs of physiological stress due to lack of water

Source : Field work, 2014

From the table it could be observed that the plants in both personal and commercial gardens are in good condition, though there is a reduction in the land area used for gardens at Kofar Marusa as part of the land previously used for gardening has been converted to Filling Station. The plants in institutional gardens are drying due to lack of adequate water supply as was seen clearly during field visit to the garden. The plants most of which are not drought resistant show symptoms of physiological stress due to moisture deficiency (Kawo et al., 2010). It was observed that over the last few decades there was a drastic reduction in the number of gardens in the urban area especially at Rafukka a residential area synonymous with gardens as the once green gardens have been converted to residential houses.

iv. *Green Belt Area*

This is a belt around a city where construction work and any form of land development is totally banned and the area is maintained by grasses, shrubs, forests or agricultural land, garden and open space which in some cases control the further expansion of the urban area (Lodha, 2007). A study by Ladan (1989), show that buffer zone or green belt area demarcated for undisturbed plant growth outside the northern part of the city and near Polo ground accounted for 3 per cent of the township land. According to KTAPU officials all the eight (08) city gates used to have a city wall as part of the green belt area. But as of today (April, 2014) only two city gates namely Kofar Durbi and Kofar Sauri have a plantation of plantation of Dum Palm (Hyphaeme thabaica) representing approximately 25 per cent of the former green belt area (see fig.2).

A Pilot project consisting of several stands of date palm (phoenix dectelifera) incorporated with community based irrigation scheme in an area 3.84 hectres outside Kofar Durbi – Kofar Sauri has become part of the remnant of the green belt area (see fig.3).

The situation of the green belt area in Katsina urban area is similar to what is obtained in many cities of Nigeria even Abuja where areas earmarked for green belts were being taken over corner shops and other structures (Aliyu, 2010).

v. *Recreational Parks*

The Maryam Babangida Children's Park established in 1989 is the only park in Katsina urban area serving as a place for children's recreation. The park is presently under Department of Girl Child Education and Child Development. The park comprises metal installations for children's play and variety of plants planted in different parts of the park. Some of the trees in the park include mango (mangifera indica), cashew (anacardium occidentale), guava (psidium guajava), lemon (citrus limon), orange (citrus sinensis), rubber tree (hevea brasiliensis), incense tree (Eucalyptus sp.) etc. A close observation on some of these trees have shown that they are drying due to lack of water examples include lemon and orange trees. Some of the trees were affected by various pests and diseases which affects their normal growth and reproduction.

Interview with staff of the park have reveal that there is lack of watering materials for the watering of the plants even though the park has many taps and overhead tank for that purpose. Also some of the trees were cut under the slight pretext of been affected by diseases and the wood used as firewood in homes.

The park is clearly in need of care particularly the various varieties of trees and shrubs planted which have to be well taken care of if they were to grow well and blossom.

vi. *Forest Reserves*

These are areas where trees were planted and allowed to grow well forming a forest and then declared a reserve where the trees cannot be cut for any purpose or land area used for any development. As Katsina is located at the fringes of the Sahara desert several areas were set aside as forest reserves. In 2003 one of the forest reserves at Goriba Road was degazetted, the trees cut and land used for the construction of Goriba Road Housing Units.

Today the only forest reserve located within Katsina urban area is the Modoji forest reserve (see fig.1). The reserve was created in 1950, located at an area of land outside Kofar Sauri to GRA extension and the dominant tree species is the neem tree (Ladan, 2013). It was observed during field visit to the reserve that only about 40 percent of the reserve remains as the remaining 60 per cent of the trees have been cleared and the land is used for extension of GRA, Katsina city ring road development project and the new Katsina State Government House. Furthermore it was also noted that some people have gradually started cutting of the trees in the reserve for use as fuel wood.

vii. *Home Planting*

This is the planting of different species of plants in people's homes to provide shade, good landscape and beautify the homes. Trees, shrubs and grasses used are the exotic or ornamental types that beautify the homes and their surroundings. Examples include Dodonia viscoser, Bouganvellia, Calyptus,Fan Palm, Rose flower, carpet grass, casuarinas, olive plant etc. Also planted are fruit trees such as mango- (mangalifera indica), guava (psidium guajava), cashew (Anacadium occidentalle), lemon (Citrus limon), paw-paw (Carica papaya), banana (Musa sapientum), ficus tree (Ficus sp.) etc. These are mainly planted in spacious bungalows, flats and mansions in GRA, Kofar Kaura residential layout, Goriba Road and Barhin housing units. They are also planted in the homes of well to do and VIPs found within the city wall. The plants are well maintained and catered for to serve the purpose of planting them.

b) Factors Hindering Achieving Effective Vegetation Cover in Katsina Urban Area

From the foregoing discussion on the condition of the plants in the seven vegetation types it is obvious that majority of the types are not in good condition and as such could not provide effective vegetation cover in the urban area. This arises due to the following factors:

i. *High demand for fuel wood*

There is high demand of fuel wood as a source of domestic energy for cooking. This is so as majority of the people of the urban area uses fuel wood and thus any tree that shows symptoms of ailment is quickly cut for fuel wood instead of been treated. People even encroach into forest reserves to obtain fuel wood and the situation is further aggravated by lack of cheap alternative such as kerosene or biogas.

ii. *Poorly enforced laws*

There are several laws enacted towards protecting trees planting on the road side and those in the forest reserves. These laws are ineffective as they are not fully enforced to punish offenders and serve as a deterrent to other people. The result is that people cut trees planted along the roads or even encroach into forest reserves without been apprehended by the law enforcement agents.

iii. *Uncontrolled Urbanization*

Katsina urban area has in the last few decades witnessed uncontrolled urbanization. Residential developments have taken place in environmentally sensitive areas such as fadamas/flooded area, wetlands, green belt areas, gardens and once proposed green areas. Also many areas that were once occupied by farm crops have been converted to residential use (Ruma and Sheikh, 2010). This uncontrolled and unguided urban expansion has drastically led to the reduction of areas covered by trees, shrubs and grasses

iv. *Lack of awareness on the relevance of vegetation*

There is lack of awareness from the people on the relevance of vegetation particularly forests in combating climate change. Many people in the urban area are not aware of the relevance of trees in assisting to reduce some of the environmental challenges facing the urban centre such as flooding, windstorms, hailstorms and heat waves. Furthermore, due to lack of awareness many local people see trees in their fuel value instead of their environmental relevance.

v. *Semi-arid climate of Katsina*

Katsina has a semi-arid climate which means that rainfall is seasonal falling mainly with four month and the annual rainfall average is about 780mm which are not sufficient for proper growth of plants. The result is that many trees shed their leaves thus unable to provide shade and other services needed. Also some of the trees in institutional gardens such as lemon, orange, tangerine and flowers face physiological stress and thus their growth and reproductive rates fall (Kawo et al., 2006).

vi. *State Government Negligence*

The Katsina state government has shown clear negligence towards protecting trees, forest reserves and green belt areas. This is demonstrated by failure to enforce laws to punish those who cut trees or encroach into forest reserves. The government has not attached importance to forest and forest protection by recently de-gazetted the Kabakawa forest reserve and using the land for the building of Peoples Democratic Party (PDP) secretariat and other commercial uses. The government has also failed to ensure the sale of Kerosene in Filling Stations at the official rate of N50 per liter to reduce the use of wood for domestic cooking which is very important as Katsina State in general is a state prone to desertification.

c) *Recent Developments towards Achieving Effective Vegetation Cover In Katsina Urban Area*

There are some recent developments that have occurred which are steps forward towards ensuring effective vegetation cover in Katsina urban area. These are outlined below:

1. Katsina State government has created the office of the Special Adviser Department of forestry. Budgetary allocations have been made to the department which allows it to purchase new Toyota hilux vehicles for field activities, motorcycles and bicycles for woodlot patrol guards. Canter vehicle for seedling distribution and water tanker for watering of seedlings. Tree planting by the department now include protection and employment of forest guard.
2. KTAPU presently placed under the department has its office at GRA Katsina fully renovated to boost the morale of staff to carry out their assigned duties and they have already started establishing new plantations across the State that comprise 250 fuel wood plantations and 150 industrial plantations. This besides about 250 hectares of land to be planted with tree seedlings across the length and breadth of the State.
3. The regular sale of kerosene at filling stations within the urban area has been observed which if it continues can reduce the high demand for fuel wood, thus saving the remaining trees and pockets of forests. However some Filling Stations sell at the rate of N110 per litre instead of the official rate of N50 which discourage many people from buying the product.
4. There were plans by the Department of Girl Child Education and Child Development to establish a new recreational park along Mani road complete with different varieties of plant species. The park when established will improve the vegetation cover of that part of the urban area.

VII. Recommendations

The following recommendations were made towards ensuring effective vegetation cover in Katsina urban area.

The state government should make a bold move towards providing an alternative source of fuel for cooking such as biogas and kerosene sold at official rate in all Filling Stations in the urban area. This is necessary in order to reduce the high demand for fuel wood to save the remaining trees within the urban area.

The State government should enforce strictly the relevant laws that were made to protect trees, forest areas and forest reserves. The enforcement of laws concerning the cutting of trees have proved effective in drastically reducing tree cutting in some developing countries such as India and thus can be applied to desert prone states of Nigeria. There should be the creation of improved awareness on the print and electronic media about the relevance of trees and forest in our environment towards reducing hazards such as floods, hailstorm, windstorms etc.

Environmentalists and environmental groups in the State should regularly organize paper presentations, workshops and symposia to further enlighten the general public on the relevance of trees, forests and forest reserves in our environment that is frown to desertification.

The State Regional and Urban Planning Board should henceforth be very strict to ensure that all residential developments are carried out in accordance to the Katsina city master plan recognized the position of green belt area and controlled open spaces. New areas of land should be demarcated and green belt area where tree seedlings, shrubs and grasses will be planted and protected.

The State government should give top priority to matters concerning vegetation in view of their importance towards improving our environment. Appropriate laws and legislations enacted and enforced, budgetary allocation and recognition should be given to the planting and protection of trees and shrubs in the environment.

VIII. Conclusion

Urban areas all over the world are today facing serious challenges as a result of increasing population, increase in their spatial growth and climate change. These challenges called for the need to protect the urban environment from degradation by improving the vegetation cover or the greenery of the urban areas. Katsina urban area is located at the fringes of the Sahara desert which necessitates the conservation and improve-ment of the vegetation to halt desertification among others. However, the various forms of vegetation are either reducing or not in good condition. It is necessary for the people and the government to stand up and improve the vegetation cover of the urban area to improve the environment for people to enjoy the benefits vegetation provides especially in urban areas. More trees, shrubs and grasses need to be planted to achieve effective vegetation cover in the urban area. In areas that need quick intervention such as along the road sides, incense tree (Eucalyptus sp.) should be planted as it is fast growing specie while in other areas such as in the forest reserve neem tree (Azadirachta indica) should be planted as it has been effective in the control of erosion and desert encroachment.

References References References

1. Alabi,M.O.(2012)-"Urban Landscape Planning and Soil Variations in Nigeria: Lokoja as a case Study" Canadian Social Science Journal 8 (5) 99-104.DOI:10.3968/J.CSS.1923669720120805l090.
2. Akpan,S.J.(2007)-"Enhancing the Value of Trees in the Urban Environment" International Journal of Environmental Studies 5 (1&2) 257-262.
3. Aliyu, A. A. (2010) – Nigeria: The Path to National Rebirth, Aboki Publishers, Makurdi, Nigeria.
4. Bellamy, P. (2007) – Academic's Dictionary of Environment, New Delhi, India.
5. Chaudhry, P., Sharma, M.P., Singh, G. & Bansal, A.(2013)."Valuation of urban Environmental Amenities in Developing Countries: A Case Study of Chandigarh, India" Global Journal of Science Frontier Research: Environment and Earth Sciences 1-13 URL:www.journalofscience.org<....>chaudhr
6. Cunningham,W.P.&Cunningham,M.A.(2006 Environmental Science:Inquiry and Applications McGraw Hill Boston, USA.
7. Danjuma, K. (2012) – "Urbanization and Urban Agriculture: The Case of Metropolitan Katsina and Implications for Sustainable Development in Nigeria" Biological and Environmental Sciences Journal for the Tropics 9 (2) 56-58.
8. Daramola, A. & Ibem, E.O. (2010)."Urban Environmental Problems in Nigeria: Implications for Sustainable Development". Journal of Sustainable Development in Africa 12 (1).124-145. URL: convenantuniversity.edu.ng/…/urban
9. Dingba, A. A. & Adamu, A. S. (2007) – Regional Geography of Nigeria in Eziashi, A. C. eds. Readings in Geography Vol. 1 Joyce Graphic Printers and Publishers, Kaduna, Nigeria.
10. Ene,R.N.(2014)."Environmental Hygiene in the Nigerian Urban Cities (A Case Study of Enugu Urban)".International Journal of Environmental Science and Development 5(4)336-339. DOI:107763/IJESD.2014.V5.504.
11. Enete,I.C.,Ogbonna C.E.& Oficha,M.C. (2012)." Using Trees as Urban Heat Island Reduction Tool in Enugu City Nigeria Based on their Air Pollution Tolerance Index" Ethiopian Journal of Environmental Studies and management 5 (4) 484-488 URL:http://dx.doi.org/10.314/ejesm.v5i4.57.
12. Isah, A. F. (2011) – "Applications of Geomatics Technology in the Analysis of Spatial Growth of Katsina Metropolis (1977 – 2007)" 28-31 Proceedings of First International Geomatics Symposium in Saudi Arabia,URL:http://geomaticsksa.com/GTC/proceedings.
13. Kawo, A. H., Aliyu, B. S., Mukhtar, M. D. & Bishir, H. (2006) – Ecology at a Glance Benchmark Publishers Limited, Kano, Nigeria.
14. Ladan, S. I. (1989).Changing Land Values in Katsina Township. Unpublished B.A. Geography Dissertation submitted to Ahmadu Bello University, Zaria.
15. Ladan, S. I. (2004). "Towards Efficient Environmental Conservation in Katsina State: Floral Conservation" Environmental Watch, 1(1).241-250.
16. Ladan, S. I. (2013). "An Appraisal of the Status and Consequences of Encroaching into Forest Reserves in Katsina Urban Environment, Katsina State" Danmarna International Journal of Multi-disciplinary Studies 5(1).91-101.
17. Ladan, S. I. (2014). "Composting as a sustainable waste management method in Katsina metropolis, northern Nigeria" International Journal of Bioscience, Biochemistry and Bioinformatics 4(1) 11-13 DOI:10.7763/IJBBB.2014.V4.301.
18. Lodha, R. M. (2007) – Academic's Dictionary of Geography, Academic India Publishers, New Delhi.
19. Online Nigeria (2014)–Vegetation.URL: http://www.onlinenigeria.com/links/ad.asp(Acessessed 2/04/2014).
20. Rumah, M. M. & Sheikh, A. U. (2010) – "Reuse of waste water in urban farming and urban planning implications in Katsina metropolis, Nigeria" African Journal of Environmental Science and Technology.

4 (1)028-033 URL:http://www.academicjournal.org/AJEST.

21. Singh,V.S., Pandey,D.N. & Chaudhry,P. (2010)- "Urban Forests and Open Green Spaces: Lessons from Jaipur, Rajastan India" Occasion Paper No.1/2010.URL: www.rpcb.nic.in
22. Sciencedaily (2014) – Vegetation.URL: http://www.sciencedaily.com/articles/v/vegetation(Assessed 3/04/2014
23. Tukur,R., Adamu, G.K., Abdulrashid,I. & Rabiu,M. (2013). "Indigenous Trees Inventory and Their Multipurpose Uses in Dutsin ma Area of Katsina State" European Scientific Journal 9 (11) 288-300 URL:eujournal.org/index.php/articles/viewfile/981/981/1053.
24. Umar, A. & Kanu ,N.(2007).Parks and Recreational Centres in Abuja Daily Trust.1st August,2007.
25. United Nations Environmental Programme (UNEP) (2011) – World Environment Day – Forests: Nature at your service 05 June.URL: http://www.unep.org/wed/theme.(Assessed 2/04/2014).

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Microbial and Spectrocopic Assessment of Elemental Composition of Edible Clams (*Mercenaria Mercenaria*) in Bahrain

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Abstract- The study aimed to determine the Microbial and Spectroscopic Elemental Composition of Edible Clams (Mercenaria mercenaria) in Bahrain. Specifically, it determined the elemental composition and their concentrations was compared with the normal composition of daily serving of clams. The determination on the presence of microbes was also done and microbes present were identified.

Clams samples were collected along the seashore of Tubli in the Kingdom of Bahrain where they are abundantly found. The collected clams were transported to the Biochemistry laboratory of the College of Medicine of AMA – International University of Bahrain for analysis. The spectrophotometer was used to determine the elemental composition which were limited to the analysis of calcium, chlorides, magnesium, sodium, iron and zinc.

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A Research Proposal Presented to AMA International University Kingdom of Bahrain

Pura B. Andeng

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Results show that the elemental composition of the clam on calcium, magnesium, sodium and chloride were found to contain higher composition as compared to the normal elements found on daily serving of clams which may be due to the nature of substrate found in the area where the edible clams were collected while the composition of potassium, copper and iron was found to be lower than the normal elemental component of daily serving of clams which means that these elements are not that much in the area where the clam samples were collected considering that clams are considered scavengers. Lastly, the analysis on zinc was found to have same concentration when compared to the normal elemental composition on clams. This indicates that chlorides in the area where the samples were collected are minimal knowing that chloride is one of the major inorganic anions present in water and sewage which is responsible on the salty taste produced by chloride concentration and depends upon the chemical composition of water.

The microbial test results show that the collected clams were contaminated with fecal coliforms and cocci coliforms so proper handling and cooking it properly is one of the remedies in patronizing the clams.

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I. The Problem and its Background

a) Introduction

The sea is home to a diverse array of seashells in which one of them are bivalves such as clams making up many of the most often found seashells. The actual shells are just half of the existing shells because they exist as bivalves containing two parts. They usually attach themselves on hard surfaces along seashores and others burrow themselves on sand so others may allow growing more and attached at the sand surface.

The terms given to short-bodied animals that live in shells, usually beside the seashores are clams. It is normally found along the seashores and across the coastal banks of the Atlantic and Pacific Ocean. The binomial name for Clams is maxima and it fits to the Bivalvia class in the family Veneridae. The word clam is frequently used to discuss to fresh water mussels and other freshwater bivalves as well as marine bivalves. However most of the species of Bivalvia are thought out to be palatable, some of them are too small and not all of them are considered edible. The shell of a clam can be connected by axis joint and can be divided into equal valves. It is beneficial and good for human health since it is a rich source of many important nutrients like phosphorous, calcium, potassium, protein, iron and other vitamins needed by the body. As regards to the nutritive health benefits value of consuming clams, it results for a sensible healthy decision as they contain negligible fat and are omega-3 fatty acids rich. Comparing the protein level with red meat clam is very much lower with very few calories.

Clams act as a beneficial source of phosphorus for the body which is the nutritional value needed for bones and teeth development and supports the body in consumption of vitamins. It is also a good source of iron for the body as some researchers claim that clam is much higher in iron as compared to other sources like beef. It is then good for persons who are suffering from iron deficiency.

The presence of potassium in clam supports the body in sustaining blood pressure and normalizing heart movement, besides with other body progressions.

Vitamin A is also loaded in clams which are needed by the body to preserve strong, fit and healthy skin and also stimulates foresight, developmen good for the health needed to preserve healthy blood dietary fat in the human body.

Clams can be classified as scavengers since they make use of their taps siphons to wrench in and then sieve tiny units of organic matter and some inorganic materials from the nearby water source which shared to almost all clams in attaining their food; they are filter feeders. It is therefore necessary to assess the elemental composition of these edible clams for the safety of the consuming public.

Since clams are collected from coastal banks the possibility to be infected with wastes on organic and elemental pollutants present in the seawater is likely to happen, hence this experimental study has been conceived. It is for this reason that the researcher seeks to experiment on the microbial load and assess elemental composition of clams if it is safe to consume.

The hard clam (Mercenaria mercenaria) is the one utilized in the study which is known to be named as quahog or quahaug. It is a round clam or hard-shelled clam which is a marine bivalve mollusk. History says that this was first eaten by natives of the eastern shores of North America to the Yucatán Peninsula. It is one of many unrelated edible bivalves which in the United States are frequently referred to simply as clams, as in the expression "clam digging". Older literature sources may use the systematic name Venus mercenaria; this species is indeed in the family Veneridae, the venus clams. (Wikepedia 2012).

This study aimed to determine the presence of microbes and assess the macro-elemental composition of edible clams collected at Tubli area in the Kingdom of Bahrain. Specifically, it sought to answer the following questions :

1. *What are the elemental compositions of the edible clams in the Kingdom of Bahrain?*
2. *What are the concentrations of the assessed macro-elemental composition of the clams under study?*
3. *Are the concentration of the assessed elemental composition of the edible clams Under study comparable to the standard elemental composition of clams?*
4. *Are the edible clams under study positive with microbes?*
5. *What pathogenic and coliform organisms through bacteriological parameters are found/present in the edible clams?*

i. *Significance of the Study*

Clams are collected along the Atlantic, Gulf and Pacific shorelines providing slightly diverse varieties of basic clam varieties. These clams may be soft-shelled or hard-shelled. Soft-shelled clams have a long, elastic andchewy sap that extends beyond the edge of their shells but hard- shell are of opposite. The palatable parts of the clams are the tap in which the clam absorbs water while its footis use to push itself over the sand and the muscle is the one responsible in opening and closing the shell. Irrespective of size, the flesh is sweet, being somewhat chewy and elastic and rich source of vitamin A, minerals and omega-3 fatty acid.

Wikipedia 2007 says that hard clam has many alternative common names such as Quahog clam, round clam or chowder clam. These clams were taken from the marine floor at the north coast of Iceland. It was lately confirmed that they can tribe up to 405 years which are now accepted as the longest living animal in the world.

These hard clams have different names according to marketspecialists in which are usually based on their sizes. The smallest legally harvestable clams are called count-necks followed with the next size aslittle-necks, then top-necks followed by cherrystones, and the largest size are called quahogs or chowder clams.(Wikipedia 2012).

It is firmly believed that nature offers considerable possibilities as vast source of food supply with all the healthy nutrients but the quality must be taken into consideration. Since clams can just be collected for free in the country, it is high time to determine the presence of microbes in it and to assess its elemental composition so as for people to become aware whether it is safe to consume or not. This research has been conceived based from the personal experience of the researcher on serious stomach problems may have been due to consumption of the clams. Testimonies from other friends were also taken who experienced the same; thus, this research was conducted.

This research would benefit the following entities

Future researchers: This could serve as guide for related studies in determining which month of the year will clams be free from microbes because this may not be observed on whole year round.

Health workers: The result of this research would warn the consuming public due to its contamination withsome microbes which can affect the health of the populace though the nutritive value are of significance.

Local populace: This study could provide idea on the nutritive value other than its contamination which may not be observed in all year round. This study can provide information on the nutritive value which is an

alternative to the costly foodstuff packed with macro-elements found in these clams.

This study would also help proper authorities, health workers, vendors from wet markets, farmers, housewives and the consuming public to become aware of the macro- elemental composition and the nutritional value of clams and to warn the public if it is not safe to consume or not. As often said, prevention is better than cure. Furthermore, it would help housewives to choose cheap alternative and safe source of minerals, vitamins and other macro-elemental composition from clams needed for human growth.

ii. *Scope and Delimitation*

This study was limited in assessing the macro-elemental composition like calcium, potassium, magnesium, copper, iron, sodium, zinc and chlorides of edible clams in the Kingdom of Bahrain and compare the result with the standard nutritional value contained in a normal clam. The determination on the presence of microbes was also done on the clam sample. The assessed elemental composition was only limited to the compositions above because other nutritive components of clams cannot be analyzed by the spectrophotometer available in Biochemistry laboratory of the University. Clams were collected along seashores in Tubli, Kingdom of Bahrain which was done first week of June 2013. The collected clams were brought to the Biochemistry laboratory at the College of Medicine of AMA University for analysis.

b) Research Paradigm

The following paradigm was conceptualized this way for better illustration of the study.

Input	Process	Output
Collected clams	Experimented and Analyzed in the laboratory	Safe edible clams Information on the elemental composition

II. Review of Related Literature

Clams is of the kingdom animalia, subkingdom metazoa of phylum mollusca, class bivalvia, subclass heretodonta of order veneroida of family mactridae and of species M. mercenaria.

Clams are either soft-shelled or hard-shelled and there are about 15,000 different species of clams worldwide in which a hard clam Mercenaria *mercenariais* one of them. Practically, clam meat is soft white but their shells range in many colors with shades of cream, yellow, brown and red-brown. The shells are attached by a muscular axis which the clam uses to close its shells firmly when exposed and threatened. Clams burrow into the sand through their foot, and a double-tubed siphon that functions rather like a tube, one tube taking in water from which they extract oxygen and filter small organic particles which serve as their food while the other tube serves to expel water and other excretory waste products. The siphon or tubes ventures from the end parallel the foot and may be joint in a single column referred to as the neck.

The hard-shelled and edible clam (Mercenaria mercenaria), is known to have different local names. Others call it quahog orquahaug which is a marine bivalve mollusk. This shell was first eaten by natives of the eastern shores of North America to the Yucatán Peninsula because of its nutritional value setting aside the macro-elemental, minerals and vitamins packed in this naturally available marine resource. This hard clam is found elsewhere over the pacific marine water and along Gulf coastal shorelines which can live up to 400 years. It is one of many unrelated edible bivalves which in the United States are frequently referred to simply as clams. (Roger, et.al.1975).

Hard clams are quite ordinary and this class of shell has also been introduced and farmed on the Pacific coast of North America, Great Britain and continental Europe. It reproduces sexually by females and males shedding gametes into the water.

According to Kraeuter, J. N. and M. Castagna (2001), this hard clam can be found in restaurants known as raw bars or clam bars specialized in serving littlenecks and topnecks raw on an opened half-shell, usually with a cocktail sauce with horseradish, and often with lemon. The meat of these different sizes of hard clam can be made into different menus like the littlenecks are steamed and dipped in butter. Littlenecks are often found in-the-shell in sauces, soups, stews, clams casino or substituted for European varieties such as the cockle in southern European seafood dishes. The largest clams, quahogs or chowders and cherrystones having the hardest meat, are used as clam chowder, clam cakes and stuffed clamsor they can be minced and mixed into other dishes.

Edible clams (Mercenaria mercenaria) are smooth and have unclearly heart-shape, comes in three sizes and somewhat salty flesh. It is rough and frequently used for attraction or “bait” and cooked in broth (chowder) which got its popular name as chowder clam. (Wikipedia).

Though greatest of the varieties of Bivalvia are considered edible, some of them are too small and not all of them are considered edible. The meat of a clam is highly nutritious and a powerful storehouse of many essential nutrients required by the body, especially phosphorus, potassium, protein, vitamin A and iron. It is low in fat, thus conveying it suitable for fitness conscious people. But the amount of accrued metals and other components must be taken into consideration.

Manley et al., (1984) said that heavy metals restrain evolution in a variety of mollusks species. Sericano et al. (1995) also said that bivalvemollusks collect many pollutants within their tissue and shell has

led to their use as bio-monitor of hydrocarbons and heavy metals in which same findings were observed by Bourgoin (1990) and Phillips & Rainbow (1993) who mentioned that in marine and estuaries water same method of pollution may take place. In contrast it is known that the accumulated heavy metals and hydrocarbons on tissues of pearl oysters that upon exposure on these compounds can cause toxic effects on other bivalve mollusks which was confirmed on a study conducted by Kennedy et.al. in 1996.

A research conducted by Rutgers on bivalve at the Haskin Shellfish Research Laboratory in Tuckerton, New Jersey said that clams can live to roughly seven years and they make use of their sap to wrench in and sieve the tiny small particles of organic substances from the immediate water source which is their usual activity to gather food for survival. They can therefore be regarded as filter feeders. As such it is then crucial to the consuming public to just consume such clams considering their nature of obtaining their food. It is for this reason that that the researcher is interested to determine the microbial load of the edible clams available in the Kingdom considering the activities in the nearby shorelines like the metal processing undertaken by the Aluminum Industry where toxic metals like lead, chromium, zinc and mercury can be one of their waste materials. Other than this is the extraction of petroleum products in which we know well that drilling and refining is done in all neighboring Gulf countries and toxic metals can also be one of the wastes generated.

The meat of clams (Mercenaria mercenaria) have sweet flavor that makes it possible to turn to strips possible for broth, sushi and others which can be coat and rolled with bread cramps and served as clam strips similar to the one promoted and commercialized by the Howard Johnson's franchise.

According to Natalie Stein (2011), the nutritional value of clams can have protein, negligible amount of fat, omega- 3 fatty acids, carbohydrates and omega-6 fatty acids, vitamins A, B6, B12, C, E, K, folate, niacin, thiamin, and some minerals.

Clams being minimal in fat and high in omega-3 fatty acids make up an admirable heart-healthy food and operates also as decent source of phosphorous which is required by the body for appropriate formation of teeth and bones for which the consumption of vitamins are supported. But since clams are gathered along coastlines its possibility to be contaminated with chemical impurities prevailing in the aquatic marine and also in fresh water is feasible. Hence, this study was conducted to assess the microbial load and elemental composition of clams.

III. Research Methodology

This chapter presents the discussion of the procedures used in determining the presence of microbes and in assessing the macro-elemental composition of edible clams (Mercenaria mercenaria) in the Kingdom of Bahrain.

a) Materials Equipment and Glass Wares

The materials used were two receptacles, bucket, prewashed bottle, hot plate, beakers (45-80mL), watch glass, atomic absorption spectrophotometer, petri dishes, micro-pipets of different volumes, 0.1mL (units) graduated cylinder, 6 oz. (160 ml) dilution bottles, glass slides, sterile swabs, inoculating loop, rubber stoppers or plastic screw caps, petri dish containers, Bunsen burner, refrigerator, water bath, incubator, auto-clave, dilution blanks and microscope.

The following regents used in the study were: deionized water, reagent blanks and standard reagents of calcium, potassium, magnesium, cupper, iron, sodium, zinc and chloride. Nutrient agar and Staining reagents like crystal violet, saffranin, 80 % ethyl alcohol and gram iodine were also included.

i. *Experimental Design*

This study made use of descriptive design which is limited on the presence of macro-elemental composition and determining the presence of microbes on edible clams in the Kingdom of Bahrain.

ii. *Extraction and Chemical Analysis*

a. Gathering of Samples

Fresh clams were gathered along the seashore of Tubli in the Kingdom of Bahrain where they are found abundantly. The freshly collected clams were washed with sea water from where they were collected to be sure that the present characteristics of the clams are maintained and to remove some unwanted component of the clams. These were brought to the Biochemistry laboratory at the College of Medicine – AMA International University of Bahrain for analysis. The meat of the clams were the subject utilized in the study.

b. Elemental Determination of Clam Meat

Thirty grams of the clam meat were removed from their shells and homogenized in a blender. The supernatant liquid from the clam meat mixture was the one utilized for the elemental determination with the use of the spectrophotometer available in the Biochemistry laboratory. The following were the macro-elements analyzed.

Determination of Calcium

Three cuvettes were labeled 1, 2 and 3, respectively. To each cuvette 0.5 ml each of calcium base reagents was added. To cuvette one (1) 0.01 ml of the calcium standard solution was added while same volume of the homogenized clam meat was added to cuvette two (2). Nothing was added to cuvette 3 which served as control. The cuvettes with content were incubated at 370C for 1 minute in the spectrophotometer then the results on the absorbance of the standard reagent and clam sample against the reagent blank at

550 nm wavelength within sixty minutes was recorded. The collection of data was done in three trials and the average was computed and recorded.

Determination of Potassium

Three cuvettes were again taken and labeled 1, 2 and 3, respectively. 0ne ml of potassium blank reagent was measured and was placed in the three separate cuvettes. To cuvette 1, 0.1 ml of potassium standard reagent was added and same volume of the homogenized clam meat was added in cuvette 2 while cuvette number three was added with same volume of distilledwater which served as blank or control. The cuvettes and content were incubated at 300Cfor five minutes in the spectrophotometer. Results on the absorbance of the standard reagent and clam meat sample against the reagent blank at 580 nm wavelength within sixty minutes was recorded. The collection of data was again done in three trials and the average was also computed and recorded.

Determination of Magnesium

Three cuvettes were again taken and labeled 1, 2 and 3, respectively. 0ne ml of magnesium blank reagent was again measured and was placed in the three separate cuvettes. To cuvette 1, 0.1 ml of magnesium standard reagent was added and same volume of the homogenized clam meat was added in cuvette 2 while nothing was added in cuvette number three which served as blank or control. The cuvettes and content were incubated at 37oCfor three minutes in the spectrophotometer. Results on the absorbance of the standard reagent and clam meat sample against the reagent blank at 520 nm wavelength within 180 minutes and data was recorded same as above.

Determination of Copper

Three cuvettes were again taken and labeled 1, 2 and 3, respectively. 0ne ml of copper blank reagent was measured and was placed in the three separate cuvettes. To cuvette 1, 0.1 ml of copperstandard reagent was added and same volume of the homogenized clam meat was added in cuvette 2 while nothing was added in cuvette number three which served as blank or control. The cuvettes and content were incubated at 37oC for five minutes in the spectrophotometer. Results on the absorbance of the standard reagent and clam sample against the reagent blank at 520 nm wavelength within 30 minutes was observed in 3 trials and recorded.

Determination of Iron

Three cuvettes were again taken and labeled 1, 2 and 3, respectively. 0ne ml of iron blank reagent was again measured and was placed in the three separate cuvettes. To cuvette 1, 0.1 ml of iron standard reagent was added and same volume of the homogenized clam meat was added in cuvette 2 while nothing was added in cuvette number three which served as blank or control. The cuvettes and content were incubated at 370Cfor three minutes in the spectrophotometer. Results on the absorbance of the standard reagent and clam meat sample against the reagent blank at 520 nm wavelength within 180 minutes .was observed in 3 trials and recorded.

Determination of Sodium

Three cuvettes were again taken and labeled 1, 2 and 3, respectively. 2.5 ml of sodium blank reagent was measured and was placed in the three separate cuvettes. To cuvette1, 0.5ml sodium standard reagent was added and same volume of the homogenized clam meat was added in cuvette 2 while cuvette number three was diluted with same volume of distilled water which served as blank or control. The cuvettes and content were again incubated at 300C for ten minutes in the spectrophotometer. Results on the absorbance of the standard reagent and clam meat sample against the reagent blank at 420 nm wavelength within thirty minutes was observed and recorded.

Determination of Zinc

Three cuvettes were again taken and labeled 1, 2 and 3, respectively. 0ne ml of zinc blank reagent was measured and was placed in the three separate cuvettes. To cuvette 1, 0.1 ml of zinc standard reagent was added and same volume of the homogenized clam meat was added in cuvette 2 while nothing was added in cuvette number three which served as blank or control. The cuvettes and content were incubated at 370C for five minutes in the spectrophotometer. Results on the absorbance of the standard reagent and clam sample against the reagent blank at 520 nm wavelength within 30 minutes was observed and recorded.

Determination of Chlorides

Three cuvettes were again taken and labeled 1, 2 and 3, respectively. 0ne ml of chloride blank reagent was measured and was placed in the three separate cuvettes. To cuvette 1, 0.01ml chloride standard reagent was added and same volume of the homogenized clam meat was added in cuvette 2 while nothing was added on cuvette number three which served as blank or control. The cuvettes and content were incubated at 300C for five minutes in the spectrophotometer. Results on the absorbance of the standard reagent and clam meat sample against the reagent blank at 500 nm wavelength within thirty minutes was observed and recorded.

iii. *Microbial Determination*

a. *Sterile Techniques*

All the glass wares needed in the experiment were sterilized using the autoclave which were done at the Biochemistry room at the College of Medicine.

b. *Growth Media*

The YED standard (Yeast Extract and Dextrose) were used as the normal development medium. It is called a "complex" medium because it is prepared from

regular elements (yeast) and its correct chemical structure is not identified. Two grams of the extract from yeast was mixed with four grams of anhydrous dextrose and four grams of agar-agar. The mixture was dissolved in 200 milliliter of purified water. The mixture was heated and brought to boiling to dissolve the yeast, anhydrous dextrose and agar-agar and was poured in a three sterilized petri dishes and were kept in the incubator.

c. *Growth Temperature and Development Rates*

The media were incubated about 30°C to have best possible progress for the strains. Temperatures above 30°C should be avoided. The incubated cultures were kept in the dark area to reduce light viability of the cells to obtain ideal development for the red pigment to progress. The plates were covered with plastic bags with small opening to allow enough oxygen to maintain aerobic respiration to materialize.

d. *Spreading Cells*

Quantifiable pour plating technique was use in the study. There were 1 to 10 dilution sequences of yeast cell suspensions. From these suspensions 0.1 ml was measured carefully with the use of a pipet which was poured to a sterilized tube containing 0.9 ml of sterile water. The tubes were swirled to allow the cells to be suspended and entire contents of the tube was poured onto the surface of the agar medium which was tilted and rotated to the plate to distribute the suspension evenly over the surface of the agar ready for isolation of the colonies.

e. *Isolating Single Colonies*

Short and single streak of cells (about 2 cm long) were done near the edge of the agar in a petri dish prepared with the use of sterile swabs and these were overlapped with a subsequent streak at an angle of roughly 15 degrees. The cells from the first streak were loitered onto the fresh agar and this was repeated by numerous and parallel streaks with the same toothpick. Another new sterile swab was taken and the process was repeated starting from the end of the last streak. The sequence was repeated until the entire plate has been covered. The population of the duplicated cells is those that are generated from a single parent cell taken from yeast.

f. *Estimating the Number of Yeast Cells in a Culture*

The estimation on the number of colonies from yeast cells in a culture was done and viewed in an electronic microscope and the electronic counter chambers was also used. The data gathered were observed and recorded.

g. *Microscopic Examination of Yeast*

The plates were viewed using an electronic microscope. The low-powered objectives (10x) was used because high powered objective ones get too close to the agar and can cause mist to get through the lens of the microscope. Observation was done and recorded.

IV. Presentation, Analysis and Interpretation of Data

This chapter presents the data gathered on the macro-elemental assessment and microbial analysis of edible clams in the Kingdom of Bahrain.

Clams samples included in the study were collected along the seashore of Tubli in the Kingdom of Bahrain where they are abundantly found. These were kept in plastic container previously washed with the sea water in the area to be sure not to alter the present characteristics of the clams. The collected clams were transported to the Biochemistry laboratory of the College of Medicine of AMA –International University of Bahrain for analysis. The spectrophotometer was used to determine the elemental composition of the clams which were limited to the analysis of calcium, chlorides, magnesium, sodium, iron and zinc which are the only elements that can be done with the use of the spectrophotometer available in the laboratory. The microbial test was also done following the standard procedure in microbial analysis.

Thirty grams of fresh clam meat was homogenized in a blender and the supernatant liquid of the mixture was the one used in the elemental analysis of calcium, chlorides, potassium, magnesium, sodium, iron and zinc with the use of the spectrophotometer. The homogenized clam meat were then added with the different reagent blanks and reagent standards of the different elements tested then absorbance of the edible clam against the absorbance of the standard reagents were observed, computed and recorded.

The microbial test was also conducted in the biochemistry laboratory and results were again analyzed and recorded.

a) Elemental Composition of the Clams

Determination of the elemental composition of clams was found to be present and the computed concentrations are shown in table 1.

Table 1 : Elemental Composition (mg) compared to the Normal Composition of Edible Clam based from Health Benefits of Eating clams.

Element Detected from clam meat	Trial 1 on Elemental Composition (mg)	Trial 2 on Elemental Composition (mg)	Trial 3 on Elemental Composition (mg)	Average Elemental Composition (mg)	Normal Elemental Composition of Clams (mg)
Calcium	111.27	97.64	106.72	105.21	104
Potassium	70.62	69.71	70.17	70.17	71.3
Magnesium	21.53	21.31	21.53	21.46	20.4
Copper	0.75	0.73	0.80	0.76	0.8
Iron	31.7	32.15	29.89	31.25	31.7
Sodium	149.49	147.0	144.95	147.15	127
Zinc	3.1	3.1	3.1	3.1	3.1
Chloride	12	12.73	12.73	12.89	5.0

The analysis on the elemental composition which was based from the thirty gram clam meat used reveals that they vary in concentration as compared from the results computed on daily serving of 227 grams of clams. (Health Benefits of Eating Clams, 2010)

Calcium is one of the many minerals in the body which can be found in a number of food sources like clams and other dietary supplements necessary for bodily functions like muscle contraction, blood vessel expansion and contraction, secretion of hormones and enzymes and instinct transmission.

The result of the spectroscopic analysis showed that calcium was present and computed to contain an average of 105.21 milligram or 1.16% higher as compared to 104 milligram normal calcium content.

Potassium was also analyzed and found to be present from the edible clams and computed to have an average composition of 70.17 milligram which is 1.58 % lower than the normal composition which is 71.3milligram of potassium.

Potassium is an essential nutrient in the body which functions as a mineral and the world's seventh most abundant metal. It is an essential nutrient in the human body and functions in many bodily systems and uses an estimated 20 to 40 percent of resting energy just to move potassium through cells. This much energy expenditure requires a readily available and nutrient rich in which clam is one of them to sustain life.

Magnesium and Copper were also detected to be present on the clam which was computed to have an average of 21.46 milligram against 0.80 milligram on daily serving of clams for magnesium while copper was found to contain an average of0.76 milligram which is almost same as the normal component of copper which is 0.80 milligram.

Magnesium plays an important role in energy production and management in human body. Severe and prolonged magnesium deficiency can lead to delirium and hallucination. Cupper which is a trace element is also an essential for human body for the proper functioning of organs and metabolic processes. Clams being a good source of magnesium and copper should be considered but its handling and cooking preparation should be done properly.

The elemental composition on Iron, sodium and zinc was also done which was computed to have an average composition of 31.25, 147.15 and 3.1 milligrams respectively against the normal composition of clam based on normal composition of clam which is 31.7, 127.0 and 3.1 milligram separately.

Iron is one of the most abundant metals in the earth's crust. Iron is an essential element in human nutrition. Estimates of minimum daily requirement for iron depend on age, sex, physiological status and iron bioavailability and range from about 10 to 50 mg/day (Philippine National Standards for Drinking Waters, 1993).

Sodium is an equally important electrolyte that helps maintain the balance of fluid in a person's body. It normalizes the amount of water in and around the body cells and helps regulate blood pressure.

Zinc is also an equally important trace element because it is found in every tissue in the body and is directly involved in cell division. It is a powerful antioxidant, helping to prevent cancer and directly involved in proper endocrine function and the maintenance of ideal hormone levels.

Lastly, analysis on chloride was done and computed to have 12.89 milligram on average composition against 5.0 milligram composition on normal clam.

The chloride ion is formed when the element chlorine gains an electron to form an anion (negatively charged ion) Cl^-. The chloride ion and its salts such as chloride are very soluble in water. It is an important electrolyte found in all body liquids accountable for sustaining acid/base stability, transferring nerve impulses and controlling fluid in and out of cells. Knowing clams to be a good source of sodium and chloride, this naturally available food source can be considered but again its handling and cooking preparation should be done properly (Nutritional Value of Clams).

b) Bacteriological Analysis

Clams and other bivalves require greater attention because these may contain pathogenic microorganisms and toxins from the water where they were collected which are harmful when eaten raw or partially cooked.

Results can be seen from figure 2 that bacilli of rod shape appearance are indication that the collected clams were positive of fecal coliforms. Rod or stick-shaped bacteria are called bacilli which include E. coli and Salmonella which are cholera causing bacteria. Fecal coliforms are groups of coliform bacteria that are present in sewage disposals. The presence of fecal coliform bacteria indicates that a pathway exists from waste sources such as animal feedlot run-off, septic tank or spool leakage.

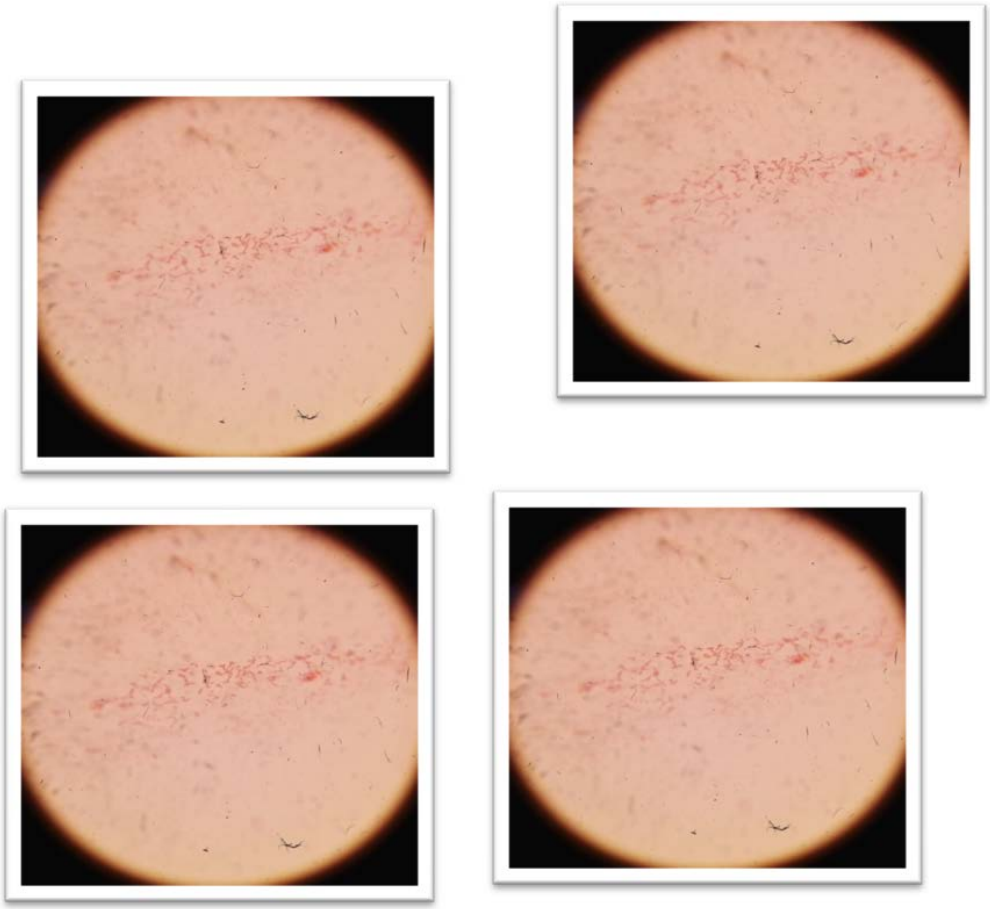

Figure 2 : Identified Rod Shape Bacilli from Edible Clam

Cocci was also observed on the clams as seen by the morphological description identified thru the help of one of the medical doctors in the College of Medicine as shown in the figure 3.

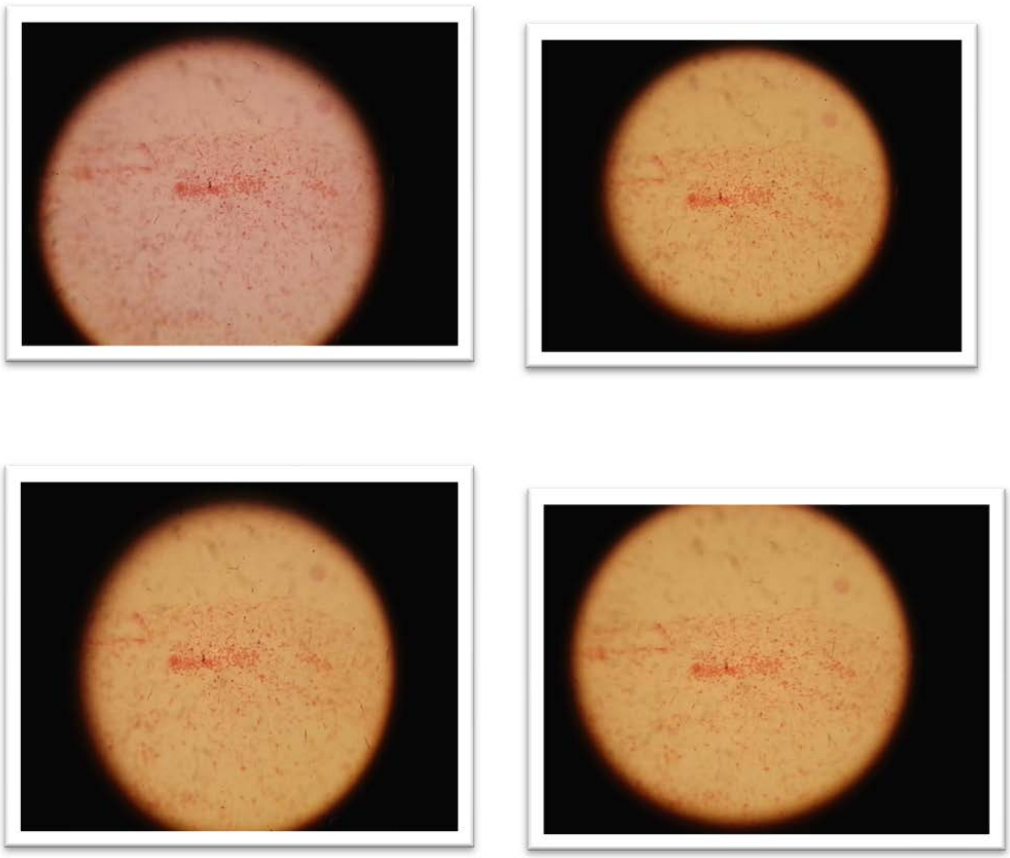

Figure 3 : Identified Cocci Microbes from Edible Clam

These spherical bacteria causes various infections in animals which includes gram-positive cocci Staphyloco-ccus aureus, Streptococcus pyogenes and Streptoco-ccus pneumonia while Gram negative cocci includes Neisiseria gonorrhea and N. meningitidis. These genera of bacteria are not related to one another though they share common ecology as human parasites. Though cocci were observed from the clam meat it is not conclusive as to what gram positive or gram negative was identified.

IV. Findings, Conclusions and Recommendations

a) *Summary of Findings*

The purpose of this study was to determine the elemental composition of edible clam and to determine the microbes present on it. The clams were collected along the seashore of Tubli in the Kingdom of Bahrain. Post-harvest procedures for marine bivalves like clams are designed to maintain the quality of these bivalves which requires proper handling and greater vigilance because these products can concentrate pathogenic microorganisms and/or toxins from the water where they are collected which to harmful to the consuming public.

The analysis on the elemental composition and bacterial determination were done during the second to third week of June 2013 in the Biochemistry laboratory of the College of Medicine at AMA International University.

The study made use of the supernatant liquid of the homogenized 30 grams of clam meat while the microbial determination made use of the swabbing technique in determining the presence of microbes.

The elemental composition was analyzed using the spectrophotometer available in the Biochemistry laboratory. It was observed that calcium; potassium, magnesium, sodium, iron, zinc and chloride were found on the clam meat.

The elemental composition of the clam meat was also compared with the normal elemental composition based on daily serving of clam and found out that Calcium Magnesium, sodium and chloride were found to contain higher elemental composition as compared to the normal elements found on daily serving of clams which may be due to the nature of substrate found in the area where the edible clams were collected.

The analysis on the elemental composition of potassium, copper and iron was found to be lower than the normal elemental component of daily serving of clams which means that these elements are not that much in the area where the clam samples were collected considering that clams are considered scavengers.

Lastly, the analysis of zinc was done and found out that same concentration was analyzed when compared to the normal elemental composition on clams. This indicates that chlorides in the area where the samples were collected are minimal knowing that chloride is one of the major inorganic anions present in water and sewage which is responsible on the salty taste produced by chloride concentration and depends upon the chemical composition of water.

Microbial test was also carried out in the analysis revealing that the collected clams were found to be contaminated with fecal coliforms and positive with cocci pathogens. The identification of the cocci present on the clam samples were not undertaken.

b) Conclusions

The following conclusions were derived from the findings:

1. That the edible clams contain calcium, potassium, magnesium, cupper, Iron, Sodium, Zinc and Chlorides.
2. That the average elemental composition on calcium, magnesium, sodium and chlorides are higher in concentration while potassium, iron and zinc was found to have lower concentration as compared to daily composition of clams per serving. Zinc was found to have same concentration which is comparable to the normal chloride composition in a normal clam.
3. The collected clams were found to be contaminated with fecal coliforms and cocci coliforms so proper handling and cooking it properly is one of the remedies in patronizing the clams.

c) Recommendations

The following recommendations are given based on the findings and conclusions of the study:

1. Collection of the clams in other sites should also done and subject to same analysis.
2. Other nutritional value of the clams gathered on same site should also be analyzed and compare it with the standard nutritional value based on daily serving of clams.
3. Microbial test on the water samples used in washing the collected clam samples should be done which may be the cause of fecal contamination.
4. Continuous monitoring on the microbial test is done on clams where they are abundantly found since fecal contamination may not be present in the area for the whole year round.

References Références Referencias

a) Books

1. Waldbusser, G.G., E.N. Powell, and R. Mann (2013). Ecosystem effects of shell and behavior of the hard clam Mercenaria mercenaria.
2. Kingsley, David H. (2012). Food Environ Virol. Published online 2012 November 20. PMCID: PMC3590410.
3. Natalie Stein (2011), Nutritional Value of Steamed Clams, Demand Media.
4. Stern Bonnie R. et al. (2007). "Copper and Human Health: Biochemistry, Genetics, And Strategies For Modeling Dose-Response Relationships.
5. Journal of Toxicology and Environmental Health. Part B 10: 157–222.
6. Encyclopedia Americana. Americana corporation, Volume 28 and 29, 1993."Vadopalas, B. & J. P. Davis. 2004. Optimal chemical triploid induction ingeoduckclams, Panopeaabrupta, by 6-dimethyl-aminopurine.Aquaculture 230:29–40.
7. Kraeuter, J.N. and M. Castagna (eds)., 2001. The Biology of the Hard Clam. Elsevier Science, Amsterdam. 772 pp. ISBN 0-444-81908-8Google Books.

b) Journals

1. Journal of Microbiologican Methods. 2013; 93(3):161-167.
2. International Journal of Environmental Research and Public Health. 2013; 10(4):1586-1597.
3. Journal of Toxicology and Environmental Health.2012; Part B 10: 157–222.
4. Journal of Shellfish Research. 2012. 30(3):761-769. 2011.
5. Journal of experimental Biology. 2012. doi: 10.1242/jeb.082909.
6. Journal of Toxicology and Environmental Health. Part B 10: 157–222.
7. SRAC Publication No. 4902.May 2010.Shellfish Handling Practices –Shrimp and Molluscs.

c) Electronic sources

1. http://info1.cfsan.fda.gov/shellfish/sh/shellfis.cfm - Certified shellfish shippers
2. http://www.floridaaquaculture.com/processing/handleintro.htm
3. http://www.floridaaquaculture.com/publications/VVriskreduction.pdf
4. http://www.livestrong.com/article/457637-side-effects-of-intraveneous-sodium-chloride/
5. www.textbookofbacteriology.net
6. www.LabMedica.com

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Sensitivity-Based Modeling of Evaluating Surface Runoff and Sediment Load Using Digital and Analog Mechanisms

By Olotu Yahaya, Bada Olatunbosun. O, Rodiya. A.A & Omotayo F.S
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Abstract- Analyses of runoff- sediment measurement and evaluation using automated and convectional runoff-meters was carried out at Meteorological and Hydrological Station of Auchi Polytechnic, Auchi using two runoff plots (ABCDa and EFGHm) of area 2m2 each, depth 0.26 m and driven into the soil to the depth of 0.13m. Runoff depths and intensities were measured from each of the positioned runoff plot. Automated runoff-meter has a measuring accuracy of ±0.001l/±0.025 mm and rainfall depth-intensity was measured using tipping-bucket rainguage during the period of 14-month of experimentation. Minimum and maximum rainfall depths of 1.2 and 190.3 mm correspond to measured runoff depths (MRo) of 0.0 mm for both measurement approaches and 60.4 mm and 48.9 mm respectively. Automated runoff-meter provides precise, accurate and instantaneous result over the convectional measurement of surface runoff. Runoff measuring accuracy for automated runoff-meter from the plot (ABCDa) produces R2 = 0.99; while R2 = 0.96 for manual evaluation in plot (EFGHm). WEPP and SWAT models were used to simulate the obtained hydrological variables from the applied measurement mechanisms. The outputs of sensitivity simulation analysis indicate that data from automated measuring systems gives a better modelling index and such could be used for running robust runoff-sediment predictive modelling technique under different reservoir sedimentation and water management scenarios.

Keywords: *runoff, sediment, intensities, modelling, rainfall, variables, runoff-meter.*

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Strictly as per the compliance and regulations of :

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Olotu Yahaya [α], Bada Olatunbosun. O [σ], Rodiya. A.A [ρ] & Omotayo F.S [ω]

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Keywords: runoff, sediment, intensities, modelling, rainfall, variables, runoff-meter.

I. Introduction

The rates of soil erosion and land degradation in Nigeria are high. Nigeria loses about 3.4 billion metric tons of fertile soil every year and the degradation of land through soil erosion is increasing (Olotu et al., 2009). Soil erosion, downstream flooding and siltation pose a major challenge to watershed managers, particularly in the humid tropics with their high rates of deforestation and intense rainfall. Knowledge of the volume and rates of runoff generated in response to rainfall is very important, if not quintessential, to predicting soil losses. Although runoff may be generated in a number of ways (Ward, 1984; Brammer and McDonnell, 1996), 'Hortonian' infiltration-excess overland flow may well be the dominant mechanism on bare, degraded soils (Kirkby, 1978; Hudson, 1995). Researches have shown that an estimated 35% of the highland area is affected with large volumes of soil eroded annually.

The subject of sediment yield modelling has attracted the attention of many scientists but lack of resources and compelling methods to predict sediment yields are some of the bottlenecks towards this direction (Silva et al., 2007; Ndomba & Neveen, 2004; Ndomba et al., 2005, 2007a, b). Other workers such as Wasson (2002) have noted the transferability problem of plot or micro scale studies results to larger catchments. Others have also cautioned that long term sediment monitoring of suspended sediment loads does not necessarily give better results (Summer et al., 1992). A basin sediment yield refers to the amount of sediment exported by a basin over a period of time, which is also the amount, which will enter a reservoir located at the downstream limit of the basin (Morris & Fan, 1998).

Reliable predictions of the quantity and rate of runoff and sediment transport from land surface into streams, rivers, and water bodies are very useful in determining and measuring sediment load and transport over period of time. By using sediment and runoff models, delivery ratios can be determined for several basins in any region for use in developing prediction equations. A key limitation of earlier studies is that runoff rates were not measured and sediment yields were aggregated values from one or more storms. Another problem is that the sediment traps used to measure sediment production generally underestimate the amount of silts and clays being eroded from the road surface (Sampson, 1999). More detailed measurements and a process-based understanding are needed to predict runoff and sediment yields more accurately at farm site and paved surfaces. More physically based models may be better able to predict runoff and erosion rates from extreme events and be useful for a wider range of conditions. Developing a calibrated surface runoff and sediment parameters that will be useful in running hydrological-based models and making accurate and precise predictions of runoff and sediment in response to rainfall depth and intensity; therefore, the research study is focused on comparing the accuracy obtained in measuring runoff and sediment variables

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using automated and manual runoff-meters in response to derived approach.

II. Materials and Methods

a) Rainfall

Rainfall rate was measured using a custom-built tipping bucket-logger system which recorded the time of each tip to the nearest second and rainfall depth was measured to the nearest millilitres (mm). Three tipping-bucket rainguages were used for the measurement and the data obtained in each of the instrument was compared and averaged. The measurement was carried out between 19 February 2013 and 20 November 2014, while daily rainfall totals continued to be measured afterwards. Due to occasional malfunction of automated rainguage, convectional/ standard rainguages were also installed to capture the volume of rainfall in a given area which was later converted to rainfall depth in (mm) as follows:

$$\mathrm{Rd} = \frac{V(m^3)}{A(m^2)} \quad (1)$$

Where Rd = Rainfall depth (mm);
V = Rainfall volume (m3);
A = Catchment area (m2). Rd is converted to the nearest (mm) by the value of 1000.

b) Surface runoff

Surface runoff from the metal sheet runoff plots $ABCD_a$ and $EFGH_m$ of area 2m2 each, 0.26m depth and driven into the mineral soil to the depth of 0.13 m between 19 February 2012 and 20 November 2013. Runoff from the $EFGH_m$ was collected in calibrated bucket of 100 litres capacity placed below a gutter extending along the downslope end of the plot; the volume was measured using a standard calibrated cylinder. The runoff volume was converted to runoff depth as follows:

$$\mathrm{Rod} = \frac{RV(m)^3}{2(m^2)} \quad (2)$$

Where;
Rod = Runoff depth (mm); and
RV = Runoff volume (m3).

In addition, runoff volume, depth and rates were measured during selected periods in plot $ABCD_a$ using an automatic and electro-mechanical runoff-meter (Olotu, 2006). A pressure transducer-logger and sensitive tipping micro-switch designed to break and open operational system were developed at the Department of Agricultural Engineering, Federal University of Technology, Akure, Nigeria. The system measures runoff volume, depth and intensity at pre-set time intervals with accuracy typically better than ±0.001l/±0.025 mm. Data were collected at 3 or 10-minute intervals in the collecting plot of $ABCD_a$. The 3 and 10 min precipitation and runoff intensities were measured by a tipping-bucket rain-gauge located about 30 cm apart within the two runoff plots $ABCD_a$ and $EFGH_m$.This gauge had a resolution of 0.25 mm and data were collected from 19 February 2012 and 20 November 2013.

c) Sediment yield measurement

Measured runoff was recovered from the storage compartment of the instrument after each simulation attempt. Dissolved coagulating agent, $AlS0_{4(aq)}$ was added to the recovered water sample, and after the sediment had settled, the water was carefully decanted and the remaining water was passed through paper filter placed within a vacuum filtration funnel (Olotu et al.,2009). Deposited sediment retained by the filter paper was oven dried at 1050C for 24- hour and then weighed to the nearest 0.1 g. Suspended sediment obtained was oven dried to 105oC for 24-hour and weighed. Summation of suspended and dissolved sediment resulted to the total sediment loss.

III. Sediment-Runoff Model

A sediment yield model requiring runoff input was attached to runoff models to predict daily, monthly, and annual sediment yield (Williams and Berndt, 1976). The MUSLE (Williams, 1975c), the sediment yield model, is expressed as

$$Y = 11.8(Q * qp)0.99^{0.56} \quad KCPLS \quad (3)$$

where *Y* is the sediment yield from an individual storm [in tonnes] ; *Q* is the storm runoff volume [in m^3] ; qp is the peak runoff rate [in m^3/s] ; K is the soil-erodibility factor; LS is the slope length and gradient factor; C is the crop management factor; and P is the erosion control-practice factor. Procedures for determining area-weighted values of the K, C, P, and LS factors for basins were described previously (Williams and Berndt, 1976). Sediment yield would be evaluated using MUSLE approach based on the assumption that sediment deposition depends upon settling velocities of the sediment particles, length of travel time, and the amount of sediment in suspension. These assumptions are expressed by the sediment routing equation as follows:

$$RY = \sum_{i=1}^{n} Yiexp(-\beta\,\mathrm{Ti}\sqrt{\mathrm{d1}}) \quad (4)$$

where *RY* is the sediment yield from an individual storm for the entire basin*; Yj* is the sediment yield from runoff plot, i predicted with equation (3); |3 is the routing coefficient; 1\ is the travel time from sub-basin i to the basin outlet; dj is the median particle diameter of sediment for sub-basin i; and n is the number of sub-basins. *F/* can be predicted fairly accurately with equation (3) because the sub-basins are delineated so that K, C, P, and LS are as uniformly distributed as possible over each runoff plots. RY can be

predicted fairly accurately with equation (3) if K, C, P, LS, and di are uniformly distributed over the entire plots. To determine j3 for an individual storm on a particular plot, uniform distributions of AT, C, P, LS, and d-; are assumed. Thus, Y computed in equation (3) is equal to RY computed with equation (4). Setting the right-hand sides of equations (3) and (4) equal yields the equation as follows:

$$(Qqp)^{0.56} = \sum_{i=1}^{x} (\text{Qiqpi}) 0.99^{0.56} \exp\left(-\beta Ti\sqrt{di}\right) \quad (5)$$

IV. Results and Discussion

The results of the experiments carried out between February, 2012 and November, 2013 at Meteorological and Hydrological Station of Auchi Polytechnic, Auchi, Nigeria using both automated and conventional runoff-meter to measure surface runoff and evaluate sediment load. The output for the automated ($ABCD_m$) and conventional ($EFGH_m$) measurements is shown in Table 1 and 2. Model output varies for two measurement approaches. SWAT model was used to simulate sediment load from the measured sediment load. Table 3 shows the results of sensitivity simulation and mathematically-based iteration.

Table 1 : Hydrological measurement in runoff plot $ABCD_a$.

	N/S	RF(mm)	MRo(mm)	Ri (mm/min)	Roi(mm/min)	SL(ton/hac)	SLR (ton/min)
1	3.5	0.0	0.0	0.0	0.0	0.0	0.0
2	3.2	0.0	0.0	0.0	0.0	0.0	0.0
3	1.2	0.0	0.0	0.0	0.0	0.0	0.0
4	8.5	3.4	2.8	1.7	0.3	0.1	
5	40.8	15.6	4.1	1.3	0.8	0.08	
6	64.2	22.7	6.4	2.3	1.4	0.14	
7	89.4	29.6	8.9	3.0	1.6	0.16	
8	109.7	35.9	11.0	3.6	1.9	0.19	
9	180.1	45.8	18.1	4.6	2.4	0.24	
10	171.6	43.6	17.2	4.4	2.2	0.2	
11	190.3	60.4	19.0	5.9	3.6	0.4	
12	150.4	42.6	14.8	3.9	1.9	0.2	
13	7.5	2.6	0.73	0.21	0.24	0.02	
14	3.4	1.1	0.3	0.11	0.2	0.02	

Table. 2: Hydrological measurement in runoff plot $EFGH_m$

	N/S	RF(mm)	MRo(mm)	Ri (mm/min)	Roi(mm/min)	SL(ton/hac)	SLR (ton/min)
1	3.5	0.0	0.0	0.0	0.0	0.0	0.0
2	3.2	0.0	0.0	0.0	0.0	0.0	0.0
3	1.2	0.0	0.0	0.0	0.0	0.0	0.0
4	8.5	3.7	2.5	1.3	0.2	0.07	
5	40.8	13.6	3.5	0.9	0.6	0.05	
6	64.2	19.7	4.4	1.9	1.0	0.11	
7	89.4	24.6	6.9	2.0	1.2	0.13	
8	109.7	30.9	9.5	3.1	1.4	0.15	
9	180.1	38.8	17.1	3.9	2.0	0.18	
10	171.6	35.6	15.2	3.4	1.6	0.14	
11	190.3	48.9	18.3	4.3	2.6	0.3	
12	150.4	30.6	11.8	2.7	1.1	0.12	
13	7.5	2.2	0.63	0.12	0.19	0.01	
14	3.4	0.0	0.0	0.0	0.0	0.0	

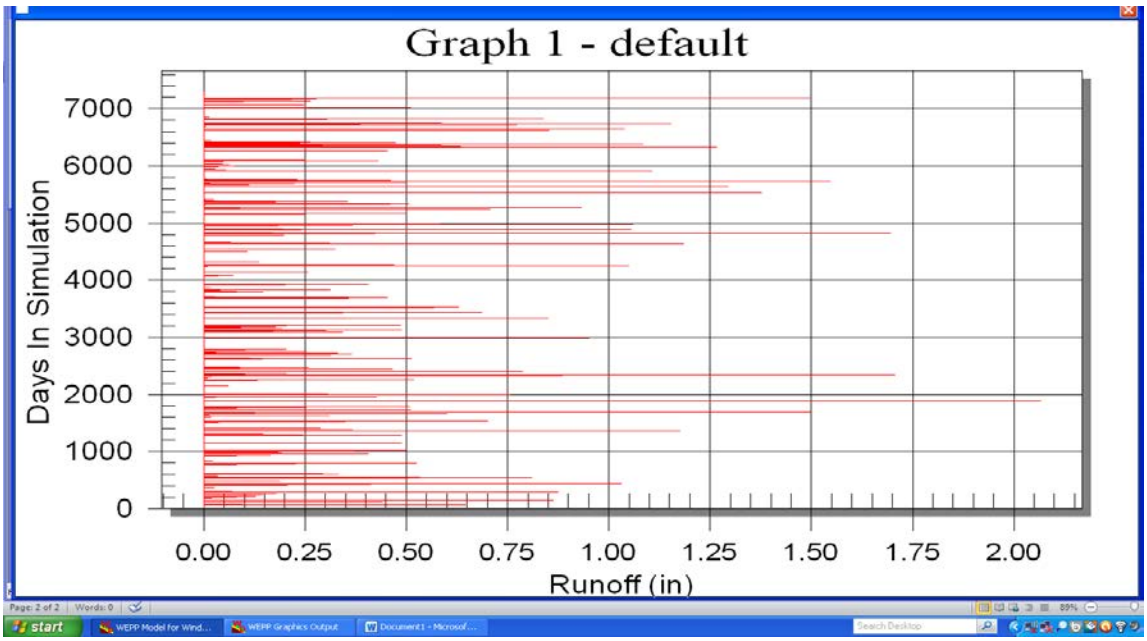
RF= Rainfall(mm); Runoff (mm); Roi= Runoff intensity (mm/min); SL = Sediment loss (ton/hac); Sediment loss rate (ton/min)

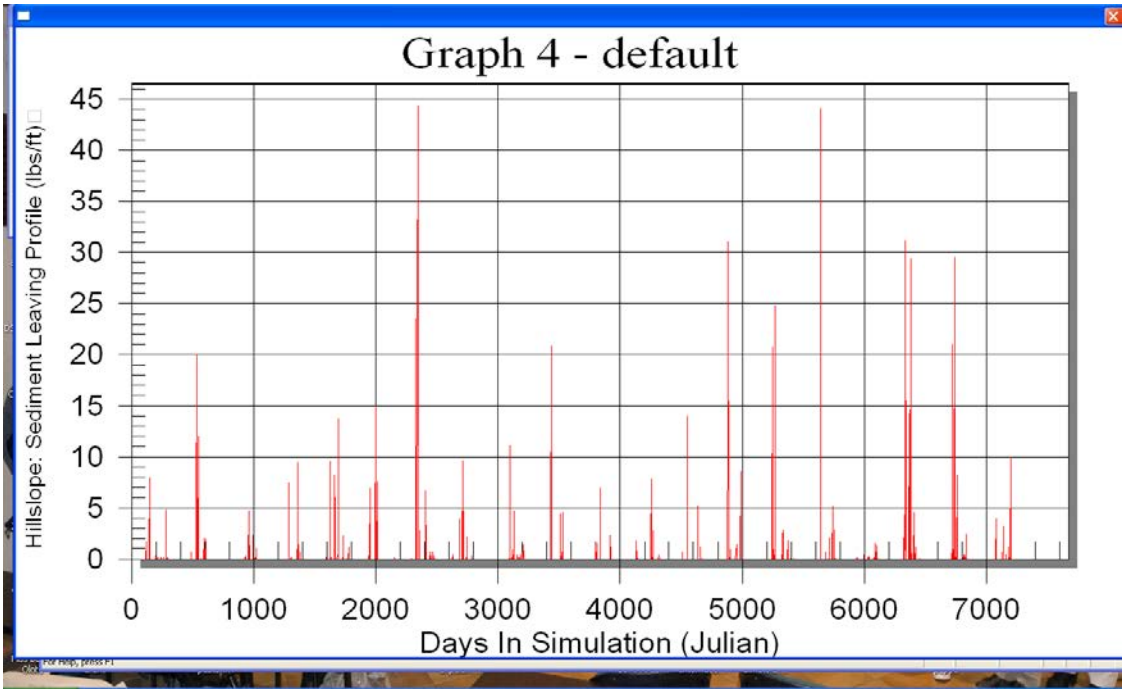
Table 3 : Simulation and computed hydrological variables

	Surface plot(ABCD)$_a$				Surface plot(EGFH)$_m$			
N/S	SRo	MSL	SSL	CSL	SRo	MSL	SSL	CSL
1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
2	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
3	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
4	3.4	0.3	0.25	0.27	3.5	0.2	0.23	0.25
5	14.6	0.8	0.7	0.75	14.2	0.6	0.65	0.7
6	20.9	1.4	1.2	1.3	20.5	1.0	1.1	1.2
7	27.8	1.6	1.5	1.54	25.4	1.2	1.3	1.4
8	33.9	1.9	1.7	1.8	31.6	1.4	1.5	1.6
9	44.2	2.4	2.2	2.3	40.0	2.0	2.2	2.4
10	40.4	2.2	2.0	2.1	37.4	1.6	1.7	1.9
11	58.4	3.6	3.5	3.7	50.2	2.6	2.8	2.9
12	40.3	1.9	2.0	2.1	32.4	1.1	1.2	1.3
13	1.5	0.24	0.2	0.23	2.5	0.19	0.2	0.21
14	0.9	0.2	0.1	0.15	0.3	0.0	0.0	0.0

SRo = Simulated runoff (mm); MSL = Measured sediment loss(ton/hac); Simulated sediment loss (ton/hac); Computed sediment loss (ton/hac)

Runoff and sediment rates can be difficult to measure accurately, because they are highly variable spatially and influenced by many factors such as rainfall intensities. Modelling is, therefore, a very useful tool for extrapolating available measurements and predicting sediment under different conditions of rainfall intensities, soil formation and gradient.





WEPP simulation outputs for runoff and sediment load for both measurement approaches is shown in graph 1 and 4 respectively. Physics-based expressions could be established from the sensitivity simulation to formulate deterministic predictive structured model that could be used to solve the problem of soil erosion and land degradation.

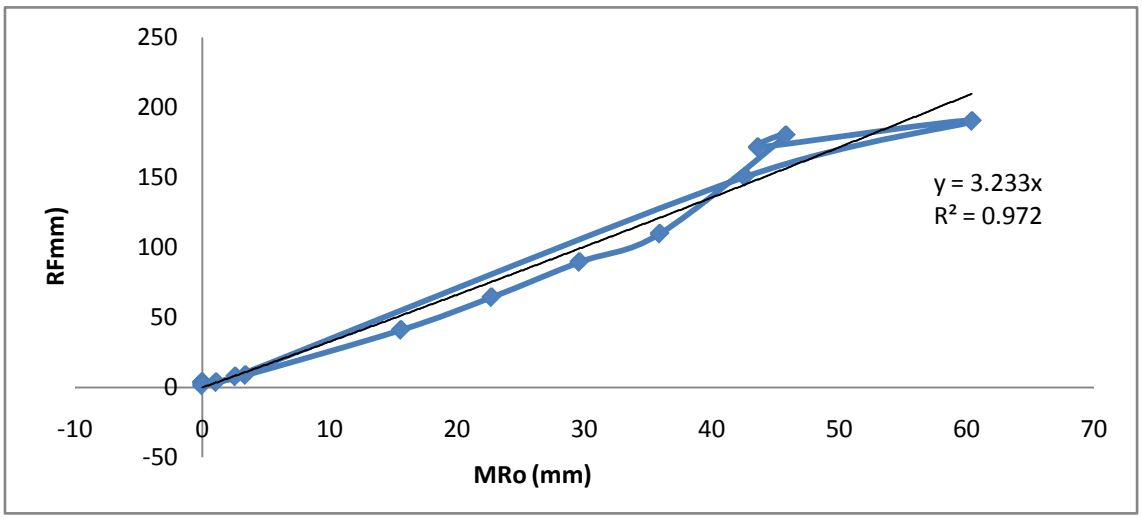


Figure 1 : Calibration curve for runoff measurement in plot ABCDa

The increment in surface runoff resulted to increase in sediment loss, this is a function of rainfall intensities, and the soil gradient and soil type (Olotu et al., 2009). Logarithm modelling between rainfall and measured runoff for the automated and convectional measuring approaches shown that a strong relationship exist between the two hydrological parameters with ABCDa and EGHFm having coefficient of determination (R2) = 0.9721 and 0.9627 respectively. The slight improvement on the R2 value for the ABCDa shows that the automated instrument gives a better and precise value of the conventional method. The calibration and simulation of the hydrological parameters using data obtained from automated and convectional measurement approaches. The outputs of the simulation analysis is shown in the calibration curves in the Fig.1, 2,3,4 and 5 respectively. The summary of the sensitivity analysis is shown in Table.4

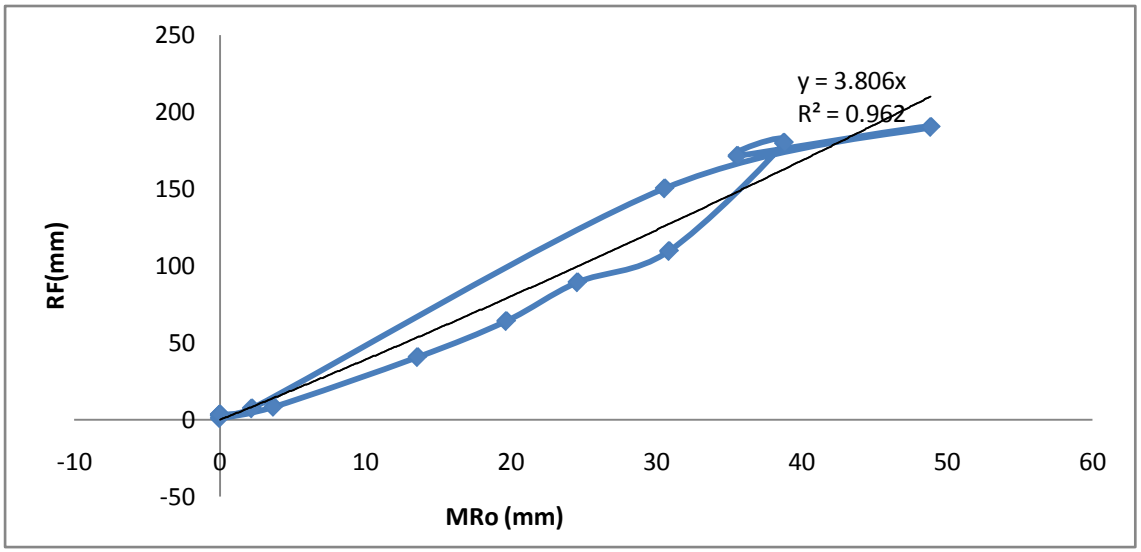


Figure 2 : Calibration curve for runoff measurement in plot EGFHm

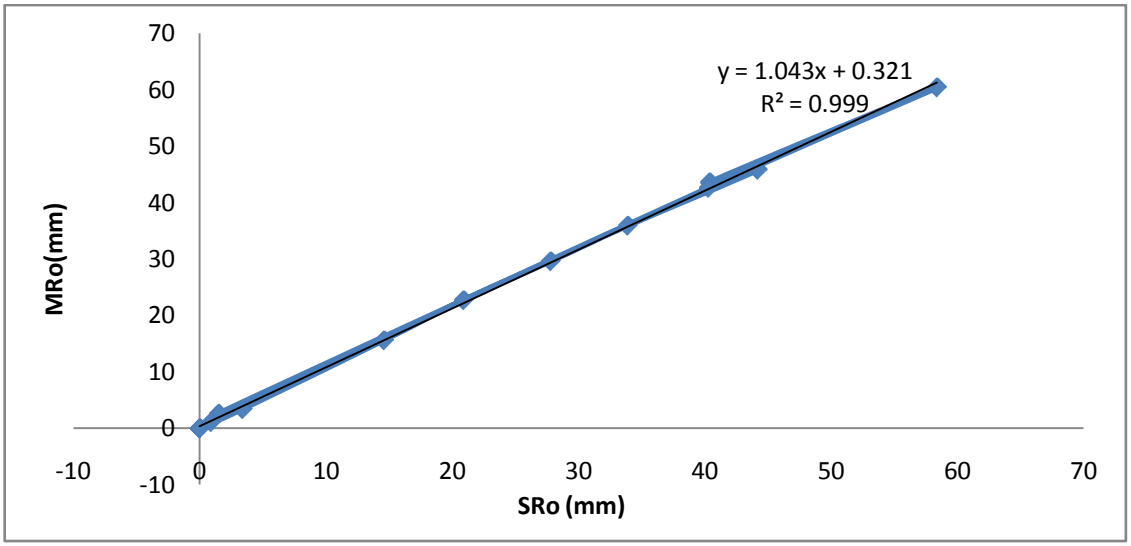


Figure 3 : Simulation curve of observed-measured runoff in plot ABCDa

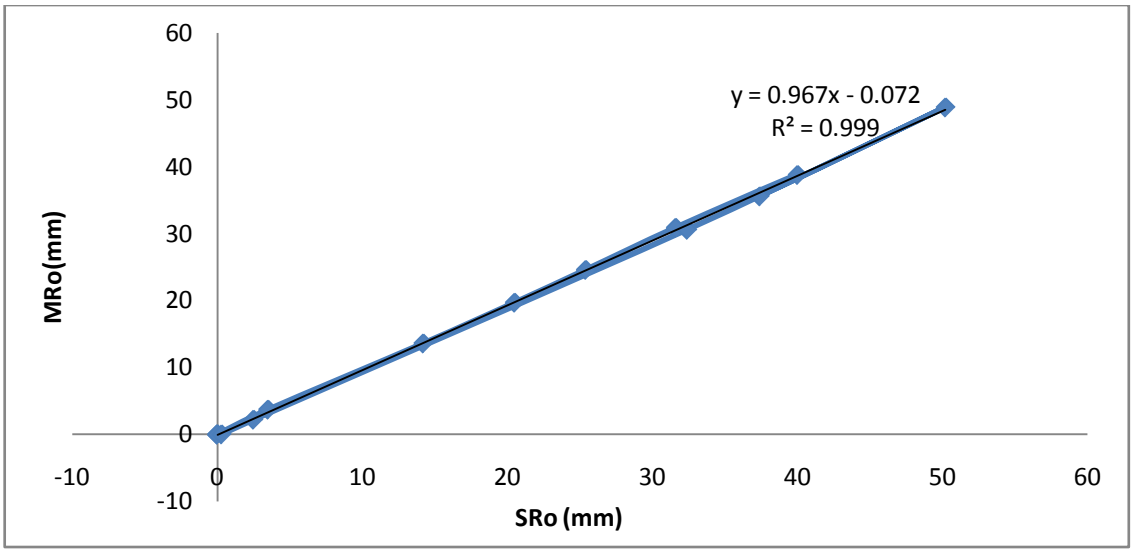


Figure 3 : Simulation curve for observed-measured runoff in plot EGFHm

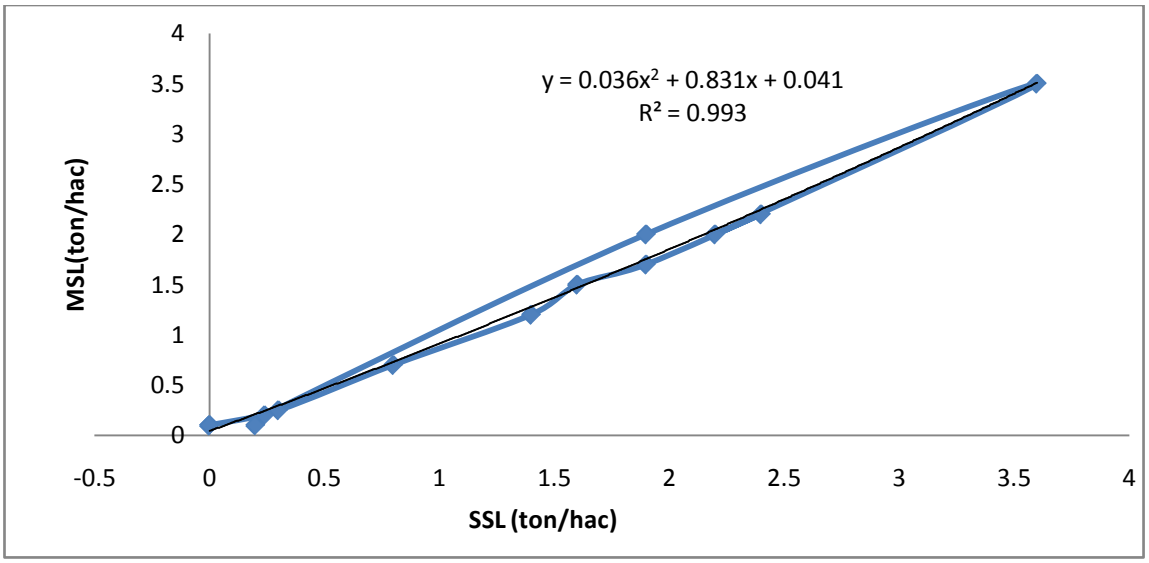
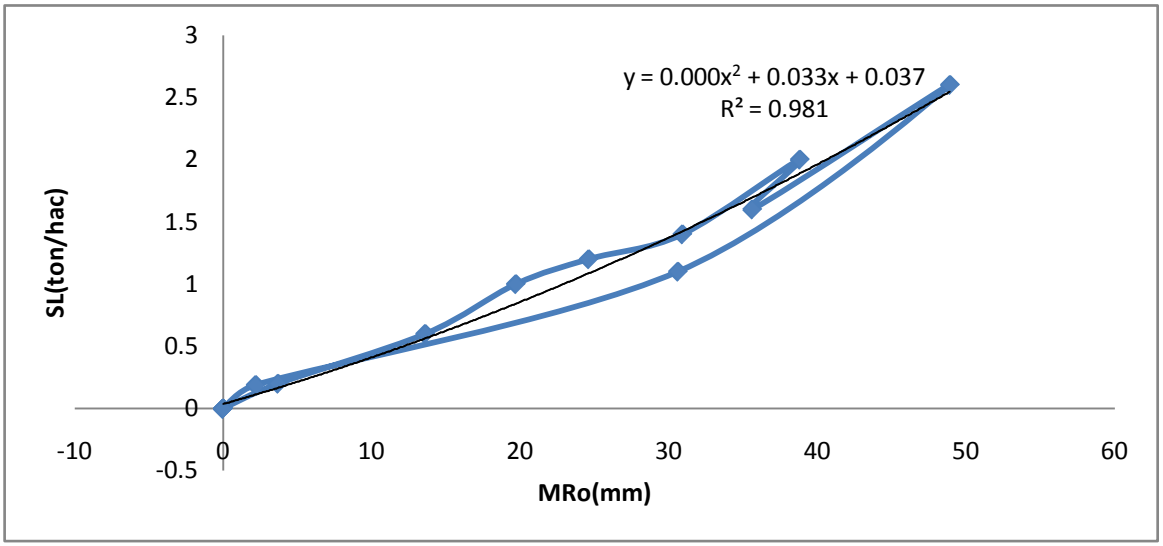


Figure 4 : Simulation curve for measured-simulated sediment loss



Fiigure 5 : Sediment-Runoff calibration curve

Table 4 : Summary of sensitivity simulation and statistical analysis

N/S	Models	Overall statistical outputs			
		R^2	Equations	SE	Sig. level
1	Polynomial ($EGFH_m$)	0.96	$0.01x^2+3.8065x$	0.133	0.01
2	Polynomial (ABCDa)	0.97	$0.004x^2+3.2339x$	0.121	0.01
3	Linear (Runoff Simulation)	0.99	0.9675x -0.0726	0.111	0.01
4	Polynomial (sediment simulation)	0.99	$0.0365x^2+0.0412$	0.10	0.01
5	Polynomial (sediment -runoff)	0.98	$0.0004x^2 + 0.0376$	0.12	0.01

V. Conclusion

Application of automated runoff-meter for measuring surface runoff shows a better accuracy over convectional measurement. It provides precise, accurate and instantaneous result. Thus, this improves the evaluation of sediment load and sediment load rates. 14-month of surface runoff flow and sediment yield data was used to calibrate and validate the WEPP model. The average measured sediment yield varied from 0.3 ton/hac to 3.6 ton/hac in plot ($ABCD_a$ and 0.2 ton/hac to 2.6 ton/hac in the plot (EGFH)m. The average simulated sediment yield for plot (ABCD)a was 0.1 and 3.5 tones /ha, while 0.1 and 2.8 tons/hac in the plot(EGFH)m for calibration and validation period, respectively. The correlation between the runoff and sediment yield has shown that the amount and intensity of rainfall plays an

important role for the sediment yield and runoff generation. The calibrated model can be used for further analysis of different management scenarios on soil degradation, conservation and water management system. The research study output can be applied to derive physics-mathematical based water and soil erosion simulating models.

References Références Referencias

1. Brammer E.W., and V.A. McDonnel (1996). "Density of Sediments Deposited in Reservoirs," in a Study of Methods Used in Measurenzent and Analysis of Sedirnent Loads in Streams, Report no. 9, Interagency Committee on Water Resources.
2. Hudson., R.W. (1995). Precipitation-Runoff Modelling System-User's Manual, USGS Water Resources Investigations Report 83-4238.
3. Kirkby, U.C. (1978). "Sediment Yield Estimation Using Gls," Hydrological Sciences Journal, vol. 42, no. 6, pp. 833-843.
4. Ndomba, E.W., and V.A. Neveen (2004). "Density of Sediments Deposited in Reservoirs," in A Study of Methods Used in Measurement and Analysis of Sedirnent Loads in Streams, Report no. 9, Interagency Committee on Water Resources.
5. Moris, L.A., and L.D. Fan (1998). "Small Amount of Surface Runoff Reduces Soil Erosion and Runoff Velocity," Transactions of the America Society of Agriculture Engineers, vol. 12, pp. 638-648.
6. Sampson RW. 1999. Road runoff and erosion at the plot and road segment scales on St. John, US Virgin Islands. MS thesis, Department of Earth Resources, Colorado State University, Fort Collins, CO.
7. Williams, J.M., and M.R. Berndt (1976). "Revision of the Procedure to Compute Sediment Distribution in Large Reservoirs," U.S. Bureau of Reclamation, Denver, Colorado.
8. Ward, E.W. (1984). "The Importance of Fluvial Morphology in Hydraulic Engineering," Journal of' the Hydraulic Division, Proceedings, American Society c? f Civil Engineers, vol. 81, paper 745, pp. 1-17.

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A Study on Eco-Physiology of *Spirulina* in Relation to some Environmental Parameters

By Sunita Verma, Divya Tiwari & Ajay Verma
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GJSFR-H Classification : *FOR Code: 760299p*

Strictly as per the compliance and regulations of :

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Abstract- Physico-chemical characteristics of Surajkund water body in Varanasi (UP) were monitored. High levels of nitrogen (N), phosphorus (P), calcium (Ca), potassium (K) and sodium (Na) indicated that pond was eutrophic. However, contrast to nitrate, ammonia-nitrogen was high in summer and low in winter. The high concentrations of sodium in summer stimulated uptake and transport of CO_2 and HCO_3 at high pH. Highly significant correlation was observed among studied traits. NO_3 exhibited significant negative relation with all traits, though the magnitude varied from NO_2 to NH_4. More over positive correlation observed among traits only exception was NO_3. Calcium, Potassium, Sodium etc showed significant positive correlation with other traits except NO_3. Positive correlation maintained by NO_2 with other traits where negative value with NO_3. Surajkund Microcystisaeruginosa was dominant plankton in the month of December January and February. Spirulina sp. was found along with the population of Oscillatoria and Chlamydomonas in April, May and June. After 15 days of growth, protein, dry weight, carbohydrate, chlorophyll and carotenoids were estimated for Spirulina platensis.

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I. Introduction

The blue green alga *Spirulina* has attracted worldwide interest as photosynthetic *planktonic* organism suitable for mass cultivation[1,3,6]. Efforts are underway to evolve a simple rural technology for producing *Spirulina* biomass and to utilize it as a feed supplement for cattle and poultry. *Spirulina* has a higher protein content, higher growth rate and easy digestibility [14,9,16]. Malnutrition in developing countries has catalyzed several efforts to intensify the production of protein both from conventional agriculture and from unconventional sources. *Spirulina* because of its many favourable properties has considerable future potential in improving the protein supply to mankind [7,10,12]. In India millions of hectares of available land annually rendered unfit for farming because of increasing salinity or alkalinity. The saline alkaline lands occupy an area of about 65 lakh hectares in the country. These lands are characterized by impermeability, silty texture and loose aggregation of soil particles. These saline-alkaline lands are locally known as Usar Land. Due to canal irrigation, the area of user land increasing year after year. User lands show high pH from 8.3 – 10 or even 11. These lands also contain high levels of sodium. Due to high alkalinity and salinity usar land unfit for growth for most of the crops. The problem of soil alkalinity and salinity is due to the salt formation of Na^+, K^+, $Ca^{++}$and Mg^{++} ions with Cl^- and SO_4 mainly, sometimes with NO_3 and CO_3 and to a small extent with HCO_3 which may be nutrients for *Spirulina. Spirulina* can grow at high alkalinity up to pH 8 to 11 and prefers high salt content for growth (14,s15,18,19,20)

II. Materials and Methods

a) Collection, isolation and purification

Water and soil samples were collected from certain alkaline sites and were analysed as per standard procedure of *APHA (1989).*

i. *Growth Measurement*

The growth experiments for isolated strains were conducted in 100 ml flasks. Exponential grown cultures were centrifuged washed with sterile double distilled water and re-centrifuged. The inoculum of filamentous strains was prepared by cyclo-mixing. The following methods were used for growth estimation.

a. *Protein estimation*

Protein content of algal samples was determined by following the method of Lowery et al as modified by Herbert at al.

b. *Pigment extraction*

Estimation of Chlorophyll a- Chlorophyll a and caroteniods were extracted in methanol and estimated as per the methodology of Mackinney. Chlorophyll a and carotenoids were recorded for absorbance of 663 and 480 nm.

c. *Carbohydrate estimation*

Total sugar was estimated by Phenol-sulfuric acid method using the absorbance of 480 nm, using glucose as standard.

d. *Dry weight*

For the measurement of dry weight, algal cultures of known volume were filtered on Whatman Nol filters and dried in a hot air vacuum even at 45 C for 24 hours. Ammonia was determined as per the method of Solarzano. Dissolved Oxygen in the water sample was estimated by *Winkler's method*. Nitrate in water sample was estimated by *Brucinesulphuric* acid method.

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III. Results and Discussion

Different water bodies in Varanasi such as *Durgakund, Surajkund, Laxmikund, and Laatbhairo* were extensively surveyed for high alkalinity *(Table-3).* User soil and water samples *(Table-2, Figure-1)* [Varanasi] were also collected for isolation of *Cyanobacteria.* All strains were made axenic using standard microbiological techniques and identified with the help of *Desikachary (1959).* All these strains were maintained in air conditioned culture room at 26+3 in presence of 75μ E light m $^{-2}$ Sec $^{-1}$ with 18 hr and 6hr light dark periods. Cultures were transferred to fresh agar slants at an intervals of 16 days. Following strains were isolated from saline-alkaline habitats and their pH limits were recorded *(Table 2).* In Suraj Kund, a dense surface bloom of *Microsytisaeruginosa* was observed during the month of December, January and February. In the months of April, May and June *Oscillatoria amphibia* dominated in Suraj Kund. *Spirulinasp* and *Chlamydomonassp* were found along with the population of *Oscillatoria* in the months of May, June and July. The physico-chemical characteristics of the pond water recorded in different months are given in Table 3. The pH values varied hourly and monthly also, pH was lowest in December and January and highest during May and June. Figure indicate that pH of water varied greatly from morning to evening; it was highest at 2:30 PM, followed by 6:30 PM, 10:30 PM and 6:30AM. The temperature varied greatly from 19 to 42 C. Similar to pH, temperature was also highest at 2:30 PM followed by evening and morning on the same day. It was highest in May and June and lowest in December and January. Marked increase in dissolved oxygen content of water occurred during day time at 2:30 PM in all the months and followed the same trend like pH and temperature. Hardness, alkalinity and total alkalinity increases considerably from December to June being highest in May, June and lowest in December. The ammoniacal nitrogen was highest in May, June and lowest in December, January. In contrast to this, nitrate nitrogen was minimum in May, June and maximum in December and January. Sodium, Potassium and calcium concentrations in water samples followed similar trends, being highest in May, June and lowest in December and January. After 15 days growth, protein, dry weight, carbohydrate, chlorophyll and carotenoids were 400, 780(mg/l), 125, 6.5 and 4.92 (μg/ml) respectively for *Spirulina platensis*. The specific growth rate and generation times were 0.026 and 38.7 (h) *(Table-1).* Correlation analysis measures the closeness of the linear relationship between chosen variables *(Table-4).* Moreover the value of correlation coefficient nearer to +1 or –1,shows the probability of linear relationship between the variables x and y. Highly Significant correlation observed among studied traits.NO_3exhibited significant negative relation with all traits, though the magnitude varies from NO_2 to NH4. More over positive correlation observed among traits only exception is NO_3.Calcium, Potassium, sodium etc showed significant positive correlation with other traits except NO_3.Positive correlation maintained by NO_2 with other traits where negative value with NO_3 *(Table-4)*

Table 1 : Growth, biomass, chemical composition of *S.platensis* attained at 15 days of growth

Parameters	*S platensis*
Final growth 0.0 (665m)	1.52
Specific growth rate (generation h_	0.026
Generation time (h)	38.70
Dry weight (mg/l)	780.00
Carbohydrate (μg/ml)	125.00
Protein (μg/ml)	400.00
Chlorophyll(μg/ml)	6.50
Cartenoids(μg/ml)	4.92

Table 2 : Collection site, characteristics of Cynobacteria isolated from different water bodies

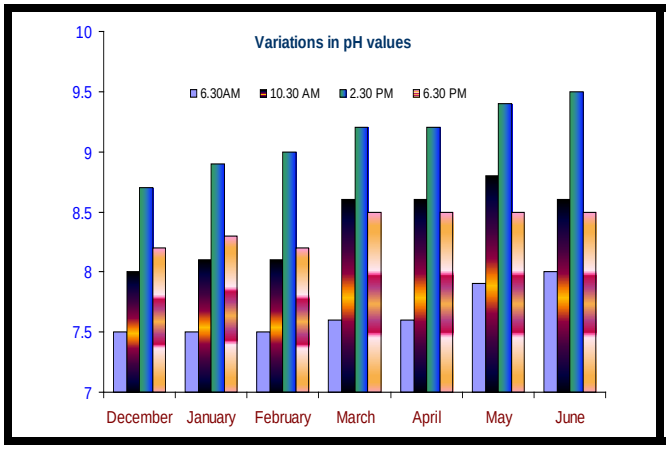
Cyanobacterial	*Medium*	*Collection site*	*Characteristics*	*pH for growth*
Microcystisaeruginosa	Jaworski medium	Suraj Kund, Laxmi Kund, Laat Bhairo	Unicellular, bloom forming	9-11
Oscillatoriaamphibia	CHU-10	Suraj Kund	Non-heterocystous filamentous	8-9.5
Nostoccalcicola	Allen Arnon	Usar Soil, Bhadooi, Varanasi	He terocystous filamentous	8
Nostoc sp.	Allen Arnon	-do-	-do-	8
Anabaena sp.	Allen Arnon	-do-	-do-	8.2
Spirulina sp.	Zarrouk's medium	Suraj Kund, Laat Bhairo	Non-heterocystous filamentous	9

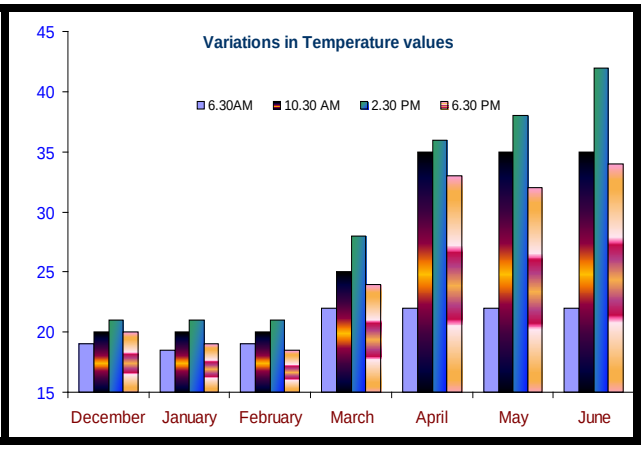
Table 3 : Physico-chemical characteristics of Suraj Kund water in different months

	December	*January*	*February*	*March*	*April*	*May*	*June*
Hardness (mg/l)	18.6	22.4	21	23.8	24.6	26	28
Alkalinity(mg/l)	20	21	21	38	39	42	42
Total Alkalinity(mg/l)	169	165	164	189	190	199	225
NO_3(mg/l)	9.4	9.3	9.2	8.4	7.8	5.25	3.75
NH_4(mg/l)	0.14	0.21	0.4	0.9	1.7	3.92	4.4
NO_2(mg/l)	0.46	1.6	2.9	3	3.2	3.6	3.7
Na (ppm)	110	117	119	130	135	139	140
K(ppm)	78	89	90	110	124	125	130
Ca(ppm)	23	23.4	24.3	26	28.5	29	29.2

Table 4 : Correlation matrix for physio-chemical traits of Suraj Kund

	Hardness (mg/l)	Alkalinity (mg/l)	Total Alkalinity (mg/l)	NO_3 (mg/l)	NH_4 (mg/l)	NO_2 (mg/l)	Na (ppm)	K (ppm)	Ca (ppm)
Hardness (mg/l)	1.0000	0.8921	0.8993	-0.8920	0.8891	0.8552	0.9531	0.9481	0.9116
Alkalinity(mg/l)		1.0000	0.8867	-0.8054	0.8264	0.8133	0.9680	0.9682	0.9503
Total Alkalinity(mg/l)			1.0000	-0.9458	0.9200	0.7037	0.8799	0.8881	0.8845
NO_3(mg/l)				1.0000	-0.9914	-0.7102	-0.8528	-0.8452	-0.8695
NH_4(mg/l)					1.0000	0.7342	0.8763	0.8665	0.8999
NO_2(mg/l)						1.0000	0.9088	0.8780	0.8590
Na (ppm)							1.0000	0.9943	0.9801
K(ppm)								1.0000	0.9866
Ca(ppm)									1.0000





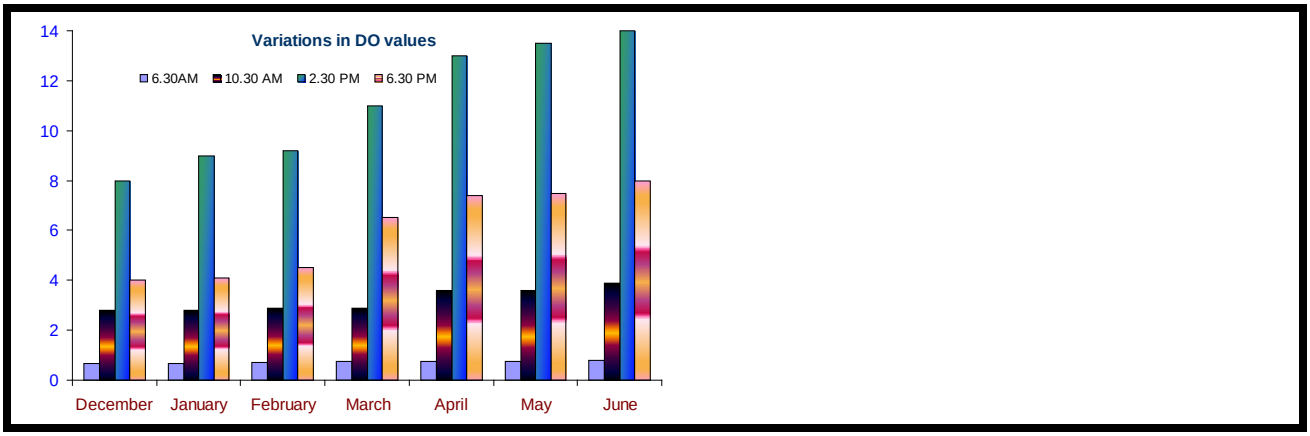


Figure 1 : Monthly variations in pH, temperature and DO values

IV. Acknowledgement

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References Références Referencias

1. Fox, R.D. 1985. Spirulina, the alga that can end malnutrition. *The Futurist*, 19: 30-35.
2. Gabby, A.R., Tel, O.E. and Gresshoff, P.M. 1993, Mechanisms of salt tolerance in cyanobacteria. Plant Sources to the Environment. *Current Topics in Plant Molecular Biology* pp. 123-132.
3. Li, D.M. 1995. Spirulina as a health food. In *Spirulina*, pp, 2128, Beijing, China, Chinese Agro technology Publication.
4. Shimamatsu,H. 2004. Mass production of Spirulina, an edible microalga, *Hydrobiol.,* 512: 39-44.
5. IECFA (FAO/WHO Expert Committee on Food Additives). 2002. Evaluation of certain food additives. Fifty ninth report of the joint FAO/WHO Expert Committee on Food Additives. Genova, World Health Organization.
6. Muthukumar, C Muralitharan, G., Vijayakumar, R., Panneerselvam, A. and Thajuddin, N. 2007. Cyanobacterial biodiversity from different freshwater ponds of Thanjavur, Tamilnadu India *Acta Botanica Malacitana*, 32: 1-9.
7. Anuradha, V. and Vidhya, D. 2001. Impact of administration of Spirulina on the blood glucose levels of selected diabetic patients *Indian J.Nutri.* & *Dietetics,* 38: 40-44.
8. Ayachi, S., El-Abed, A,,Medhioub, A., Brouers, M. and Marzouk, B, 2004. Influence of temperature and light intensity on fatty acid composition during the development of spirulina, Arthrospira platensis, Rivista Italiana delle Sostanze Grasse, 81: 185-190.
9. Belay, A., Yoshimichi, O., Miyakawa, K. and Shimamatsu, H. 1993. Current knowledge on potential health benefits of Spirulina. *J. Appl. Phycol.,* 5: 235-241.
10. Bhattacharya, S. and Shivaprakash, M.K. 2005. Evaluation of three Spirulina species grown under similar conditions for their growth and biochemicals. *J. Sci. Food Agric,* 85: 333-336.
11. Costa, J.A.V, Colla, L.M. and Filho, P.F.D. 2004.Improving Spirulrna platensis biomass yield using a fed-batch process. *Bioresource Technol.,* 92: 237 241.
12. Laliberte, G., Olguin, E.J. and de la Noue, J. 1997. Mass cultivation and wastewater treatment using Spirulina.in A.Vonshak, ed. Spirulina platesis (Arthrospira platensis) *Physiology, Cell Biology and Biotechnology,* pp, 159-174. Basingstoke, Hants, London, Taylor and Francis.
13. Pareek, A. and Srivastava, P. 2001.Optimum photoperiod for the growth of Spirulina platensis, *J. Phytol.* Res., 14:219-220.
14. Vonshak, A, (ed). 1997. Spirulina platensis (Arthrospira). In *Physiology,* Cell Biology and *Biotechnology*. Basingstoke, Hants, London, UK, Taylor and Francis.
15. Abdulqader G, Barsanti L and Tredici MR 2000. Harvest of Arthrospira platensis from Lake Kossorom (Chad) and its household usage among the Kanembu. Journal of Applied Phycology, 12:493-498.
16. Anaga A and Abu GO 1996. A laboratory-scale cultivation of Chlorella and spirulina using waste effluent from fertilizer Company in Nigeria. Biores Technol, 58:93-95.
17. Banerjee M and Deb M. 1996. Potential of fly ash and spirulina combination as a slow release fertilizer for rice yield. Cientifica jaboticabal, 24:55-62.Ciferri O. 1983. Spirulina, the edible organism. Microbiol rev.47:551-578.
18. Lodi A, Binagli L, Solisio C, Converti A and Del Borghi M. 2003. Nitrate and phosphate removal by Spirulina plantensis. J of Ind Microb and Biotech 30:656-666.

19. Zeng WL, Cai ZL and Ouyang F. 2001. Growth characteristics and dynamic model of Spirulina platensis. Chinese J Appl Environ Biol, 7:360-364.

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Groundwater Quality in Nigerian Urban Areas: A Review

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Abstract- The status of the quality of groundwater in urban areas of Nigeria is reviewed in this paper. This is done against the backdrop of its current status, trend and identification of factors influencing the quality of urban groundwater and possible remedial measures in Nigeria. Studies have shown that Nigeria urban groundwater quality is influenced by the geology and geochemistry of the environment, rate of urbanization, industrialization, landfill/dumpsite leachates, heavy metals, bacteriological pollution, and effect of seasons. Remedial measures suggested include protection of water sources, proper handling of wastes and construction of sanitary landfills, control of all land use polluting activities, and treatment of water before is used for consumption. Continuous monitoring of groundwater quality is necessary to forestall any unpleasant consequences.

Keywords: *groundwater, quality, pollution, concentrations, hand dug wells, boreholes.*

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Groundwater Quality in Nigerian Urban Areas: A Review

Ocheri, M.I [α], L.A.Odoma [σ] & Umar.N.D [ρ]

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I. Introduction

In Nigeria, the rate of urbanization characterized by high population concentration ,increasing industrial and agricultural activities coupled with environmental pollution/degradation and indiscriminate disposal of all kinds of wastes are perceived to pose serious pollution threats with all its concomitant health hazards on groundwater quality especially in urban areas (Kehinde, 1998; Adelana et al, 2003., Adelana et al,2004; Adelana et al, 2005; Ajala,2005; Ocheri, 2006, Adelana et al, 2008; Eni et al,2011). This concern has attracted overwhelming attention of researchers in different parts of Nigeria urban areas. This borders on the fact that the public or municipal water supply is inaccessible to a large proportion of urban dwellers, and even where is available the supply is highly inadequate, unreliable and irregular. Consequently, there is high dependency on untreated groundwater abstracted through hand dug wells and borehole systems (Ocheri, 2006; Ocheri, 2010). According to Forster et al (1998) urbanization affects the quality and quantity of underlying sub-surface water by radically changing the pattern and rate of recharge, initiating new abstraction regimes and adversely affecting the quality. In this paper, attempt is made to bring together studies carried out on Nigeria urban groundwater quality with the view to ascertaining the current status, trend and possible protection and remedial practice. It is hoped that it will be of interest to researchers, water managers, policy makers and the genera public since water is used by all.

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II. Geology and Groundwater Pollution

Fundamental to the study of groundwater in any place is the geology of the environment. Geology is the main controlling factor in groundwater hydrology. The nature and the properties of the rock, aquifer specific yield and retention, the chemistry of water are governed by the geology of the environment (Brassington, 1988; MacDonald et al,2005).According to Sajad et al(1998) the quality of groundwater is a function of natural processes as well as anthropogenic activities, and that the type, extent and duration of anthropogenic activities on groundwater quality are controlled by the geochemical and physical processes and the hydrological condition present (Matthess,1976). Since groundwater is a product of geological formations, some studies examined groundwater quality in relation to influence of geology in an urban environment.

Du preez and Barber (1965) pioneered a hydrogeochemical investigation across geological formation of the northern part of Nigeria. They found that water from basement complex contains calcium or sodium bicarbonate, nitrate in high concentration of health implication. Water samples from cretaceous sediments of upper and lower Benue have elevated concentrations of iron especially in Binia-Yola sand and Yolde formation and also total dissolved solids, sulphate and salinity. Water samples from Jos plateau were found to be of good quality while that of Biu plateau has problem of hardness, alkalinity and salinity. In a similar study,Ezeigbo(1988)examined the influence of geology and hydrogeology on Nigeria environment and noted the following:

(i) high iron concentration was characteristic of groundwater in significant proportions practically in all states of Nigeria.
(ii) excessive concentration of manganese occur in significant proportions in parts of Rivers, Anambra and Imo States
(iii) low pH or acidic water was noted in calcareous rocks of Mamu, Nsukka, Ogwuasi-Asaba and Benin formations.
(iv) mining and processing of metallic ore and coal were noted to have affected both the surface and

groundwater sources with high iron, aluminum and sulphate in Enugu coal mine and lead-zinc mining area of the Benue Trough

(v) water hardness linked with limestone or calcareous rock formation as noted in Asu-group, Odukpani, Ezeaku shale, Awgu-Ndeabo group and Ewekero and Kalamina formation

(vi) salt intrusion in coastal areas as well as inland evaporates deposit in Uburu and Okposi in Imo State.

A comprehensive review of the status of groundwater chemistry of Nigeria by Edet etal (2011) covering the four major groundwater sedimentary basins of Benin, Benue, Niger Delta and Sokoto and crystalline basement complexes reveal the following: In general, on the average, total dissolved solids for groundwater for different basins was less than 250mg/L compared to saline groundwater as high as 15700mg/L. The high salinity was attributed to salts and seawater intrusion. Nitrate concentration on the average was noted to be high especially in Sokoto basin indicating anthropogenic pollution. Results of multivariate analysis and cross plot indicated that the major geologic controls on groundwater chemistry are chloride, dissolution, weathering (silicate and carbonate) and ionic exchange. The distribution of ions in groundwater of sedimentary and basement complex areas (excluding the saline water) indicate comparable concentrations with EC, Na, K, Mg and Cl higher in sedimentary areas relative to the basement complex. No geographical bias to the distribution was observed except on local basis and water tends to reflect the lithology. The distribution of ions in the sedimentary areas is as follows: Na>Ca>K>Mg/L and HCO_3>Cl>SO_4 and for basement is Ca>Na>Mg>K and HCO_3>SO_4>Cl. With respect to agriculture and irrigation purposes, beside saline groundwater from Benue basin and coastal aquifer, the groundwater are considered to be excellent.

The local geology of noticeable stratigraphic variation influences natural attenuation of contaminants, their pattern of transfer and subsequent breakthrough into groundwater. The existing hydrogeological setting of Lagos metropolis favours adsorption and retention of contaminants in the pore spaces, thereby making the pattern of leacheate dispersion very irregular and difficult to predict. As much as some of the contaminants are found in groundwater at concentrations higher than the background groundwater chemistry of aquifer in Lagos, there is therefore the tendency to suspect that landfill as one of the sources of groundwater contamination in Lagos (Longe et al, 1987). Adebo and Adetoyinbo (2009) assessed the groundwater quality in an unconsolidated coastal aquifer of Lagos, noted that of the parameters analysed, chloride concentration exceeded WHO guide limit for drinking water. This is traced to saltwater intrusion. Water type delineated include iron-calcium-magnesium-sulphate (Fe-Ca-Mg-SO_4), iron-chloride-bicarbonate (Fe-Cl-HCO_3), magnesium-chloride type (Mg-Cl). They concluded that the peculiar geologic and hydrogeologic condition that prevail in Delta area of Nigeria is what obtains here. Groundwater contamination and their flow characteristics in Ibadan was studied by Ajibade et al (2010). Major ions identified in order of abundance are Na> Ca> K> Mg> Al> P> Fe, trace elements So> Mn> Zn> Ni> C0> pb> Cu> Cr> Sb, anions HCO_3> Cl> NO_3> SO_4> br> PO_4> Fe. The calculated anthropogenic factor for the element shows lead, chromium, and strontium pose very high contamination factors. Water in the area is of two types: earth-alkaline water and earth alkaline with alkali compound.

Hydrochemical faecis of Delta Plain of Warri was delineated against the backdrop of the factor controlling groundwater quality of the area. Water samples were analysed for pH, TDS, K, Na, Mg, Cl, HCO_3 and SO_4 and the result subjected to R-mode factor analysis. Three factors were extracted by Olobaniyi and Owoyemi (2006).Factor 1 include K, Na, Cl and EC reflects the signature of saline water intrusion resulting from seepages into the aquifer of water from tide influenced River Warri. Factor II has high loading on Mg, Ca, HCO_3 and pH represent the processes of natural recharge and water and soil rock interaction. Factor III include SO_4 related to dissolution of sulphides from interstratified peat within the geological formation, heavy vehicular activity and the petroleum refining process in the town. Also in Warri town, Akunobi and Chibuzor (2012) assessed the quality of groundwater and found water to be acidic to slightly acidic. Heavy metal such as Cu, Cr,Zn,Cd and Pb were found in traces. Water type delineated are Ca-Mg-HCO_3, Na-HCO3;Na-Cl.The predominance of alkali and alkali earth metallic ion and chloride are a major attribute of seawater intrusion, while heavy metal reflect the increasing impact of anthropogenic activities. Also within the Niger Delta area, Nwankwoala and Udom (2011) found to the eastern part, groundwater to be acidic, high chloride concentration linked to saltwater intrusion, and high iron content in the wells. Groundwater is classified into three types: type 1 Ca-Mg-Cl-SO_4 and Na-K-Cl-SO_4, type II water influenced by No3 area mainly made up of mainly of mixture of earth alkaline and alkaline metal predominantly Cl-So4.Chloride is the dominant anion followed by sulphate. Amadi et al (1989) earlier found some parts groundwater to be enriched with Na, Ca, Cl, HCO_3 and So4, salinity, TDS and total hardness. General increase in Cl and decrease in HCO_3 content towards the coast is associated with saltwater intrusion. Five groundwater types were identified: (i) sodium-calcium-bicarbonate (ii) Na-Ca-Mg-HCO_3.In Yenegoa town within the region, Amangabara and Ejienna(2012) noted from the analyses of the physico-chemical concentrations in wells to be a reflection of the hydrochemical faecis of

groundwater of the area. The ionic trend of the area is $Ca>HCO_3>Na>K>Mg>Cl>SO_4$.Na $>K>Cl$. The elevated occurrence of $Ca>HCO_3>Mg$ ions in the groundwater beyond the WHO prescribed limit reflect the process of natural rainwater recharge and water-soil/rock interaction. Nwankwoala and Udom(2011) assessed the hydrogeochemistry of groundwater using 18 representative wells in Port Harcourt town. Physico-chemical parameters analysed include pH, EC, Ca, Na, K, Cl, HCO_3 and So_4.Ionic order identified is $Ca>Mg>K>=HCO_3>Cl>SO4>NO_3$. Ca-Mg-$HCO_3$ and Ca-Mg-SO_4 were found to be the dominant hydrochemical faecis. Ion exchange process of carbon and silicate weathering is responsible for groundwater chemistry of the area. Hydrochemical indices Mg/Ca, Cl/HCO_3 and cation exchange values generally indicate low salt inland with minimal marine influence. Okoye et al (2010) investigated physico-chemical quality of groundwater of Calabar and its environs, noted water to be acidic, trace elements such as iron, magnesium, aluminium and nickel to be less in concentration in the wells. The ionic relative abundance are $Ca>Na>L>Mg>$and $Cl>So_4>HCO_3$ .Groundwater type is Ca-Mg-Cl-So_4 and Ca-Mg-Na-Cl.In Aba town,Alichi et al(2010) noted groundwater to be very acidic, high total dissolved solids were recorded around dumpsites and high sulphate concentration around NNPC depot. Ionic order of abundance for cations are $Na>Ca>Mg$ and anions $No_3>Cl>SO_4$.Five water samples were identified, Na-Cl-NO_3; Na-Ca-Cl-SO_4; Na-Cl;Na-Ca-NO_3 and Na-Ca-SO_4-No_3-Cl.Departure of the concentration levels of the parameters from the background suggest impact of urbanization.

Groundwater quality from basement complex of Abeokuta and Kano towns in the southwest and northcentral Nigeria were assessed by Ufoegbune et al (2009) and Adamu et al (2013) respectively. Results show that zinc, iron and lead had elevated concentrations above WHO prescribed limit in Abeokuta, while pH, conductivity, alkalinity, total dissolved solids were found to be lower in quartzite area than those of granite, schist and gneiss areas of Kano town. The pattern of pH, Co_2 portray similar trend in the four rock types. In a hydrochemical and isotopic characteristics of groundwater in Central Abuja,Dan-Hassan et al(2010) found water to acidic in some areas,low total dissolved solids and Disolved Oxygen.The predominant hydrochemical faecis delineated are Ca-HCO_3 and Na-HCO_3.Chemical mixture and ionic exchange are probably responsible for chemical evolution of groundwater from Ca-HCO_3 to Na-HCO_3 type.In a hydrochemical assessment of groundwater in Dadin-Kowa area of Bauchi, Anudu et al(2010) identify groundwater to be slightly acidic to slightly alkaline, hard to very hard, and concentration of ions range are Ca, Mg,Na,K,Fe, HCO_3,SO_4 ,Cl. Concentrations of Fe, Cu, and Pb were above the prescribed limit for drinking water. Groundwater type delineated are Mg-Ca (Na)-HCO3; Ca-Mg-(Na) HCO_3; Mg-Ca(Na)-HCO_3-(So_4);Mg-Ca-HCO_3:Mg-Ca $HCO_3(SO_4)$ and Ca-Mg-HCO_3-(SO_4). Water is alkaline.

III. Urbanization and Groundwater Pollution

African cities have a long history of water supply from surface and groundwater sources. However, due to deteriorating quality and quantity of surface water through increased urbanization and industrialization and high cost of developing new dams urban groundwater is viewed as a better option (Adelana et al, 2008).This advantage notwithstanding, urbanization has important overall implications for freshwater use and waste management, and specifically for the development, protection and management of sub-surface water in an urban environment (Eni et al, 2011).

In a comprehensive study by Adelana et al(2003,2004,2005) of groundwater quality of the southeastern parts of Lagos from 1999-2001on the impact of urbanization, found that of the water samples analysed, concentrations of sulphate, nitrate and chloride at objectionable proportion were noted in all the wells. Nitrate particularly was noted to be very high and is linked with anthropogenic activities. Groundwater in Lagos is particularly vulnerable to contamination due to shallow depth and the unconsolidated permeable sand and gravel aquifer. In a similar study, Eni et al (2011) assessed the impact of urbanization on the sub-surface water of Calabar town noted water to be acidic, nitrate and faecal coliform to have very high concentration in the wells. Results of multiple regression show faecal coliform,pH, and chlorine have positive relationship with urbanization. High faecal coliform is often associated with the sanitary condition of the environment of the wells. Amadi et al (2010) examined the effect of urbanization on groundwater quality of Makurdi metropolis. Results of analyses show water samples collected within the vicinity of dumpsite have low pH, higher concentration of iron, manganese, calcium and total dissolved solids and total coliform when compared to those far away from the dumpsite suggesting leachate influence. Presence of coliform is traced to sanitary condition of the well. Groundwater type is Ca-SO_4. In a related study, Tse and Adamu (2012) in the chemical and bacteriological analyses of hand dug wells in Makurdi town noted water to be slightly acidic, moderately hard, low total dissolved solids. Heavy metal such as iron, zinc, copper, lead and cadmium occur in traces, while high concentration of coliform is noted in all the wells.

IV. Groundwater Quality Status Studies

Of primary concern is the quality of groundwater exploited for drinking as well as other domestic uses. This is because consumption of water that is polluted has serious health implication as such World Health Organization has to set safe standards for drinking water. This concern has attracted overwhelming studies on the quality status of groundwater abstracted from shallow wells (hand dug wells) and deep wells (boreholes) for human consumption in urban areas of Nigeria.

In a baseline study on the inorganic and microbial contaminants of health importance in water from boreholes and open wells in Benin City, Erah et al(2002)found that all of them were contaminated with abnormal levels of lead, chromium, zinc and faecal coliform. They concluded that consumption of water from these wells will have serious implications. In related studies, Alexander(2008) Efe et al(2008)Al-Hassan and Ujo(2011) found groundwater to be slightly acidic, and calcium, magnesium, chloride and sodium concentrations were within WHO guide limit in Mubi town; hand dug wells located close to dumpsites in Onitsha have higher levels of turbidity, total suspended solids, calcium bicarbonate, electrical conductivity, salinity, acidity, lead. iron and bacteria loads; and for Masaka, water from all the wells analysed were polluted with chemical and bacteria, turbidity, dissolved oxygen, nitrates, chromium, total bacteria count, and concluded that water was not safe for drinking. Jatau et al(2006) in a preliminary investigation of the quality of surface and groundwater in parts of Kaduna Metropolis, noted groundwater to be slightly acidic, high iron , nitrate, faecal coliform concentrations. This is traced to leachates from wastes and dumpsites. Earlier, Egbulum (2003) used faecal coliform and faecal streptococcus indicator to assess the microbial quality of groundwater from hand dug wells in Mando and Kawo area of Kaduna,found that the wells were all contaminated, and that bacterial loadings increases from dry season to rainy season between 1998-2002.

In Gwagwalada area of Abuja Metropolitan City,Ishaya and Abaje(2009) found that groundwater from the boreholes analysed has turbidity, total dissolved solids,magnesium, total hardness concentrations above the WHO prescribed limit for drinking water in some of the wells. Nitrate was however within WHO guide limit for drinking water. Studies carried out by Yerima et al (2008) Danmo et al(2013) in Bama and Konduga towns in Bornu State in sudano-sahelian ecological zone, noted that nitrate, manganese, faecal coliform concentrations in both hand dug wells and boreholes were above the WHO permissible limit for drinking water. Idris-Nda et al (2011) appraised the chemical quality of groundwater quality of Minna metropolis and found heavy metals with high concentrations are magnesium, copper, arsenic and lead. Cation with highest concentration are manganese, sodium and dominant anions HCO_3,CO_2 and NO_3.The groundwater was generally found to be of good quality. In Jemeta area of Yola town, Ishaku and Ezeigbo (2010) analysed the quality of groundwater and found concentrations of chloride, nitrate, total dissolved solids and coliform to far exceed the WHO allowable limit for drinking water and were higher in the wet season. This is traced to anthropogenic activities as household wastes, waste-water find their way into water sources. Relationship show positive correlation for chloride,total dissolved solids, nitrate, sulphate, nitrate and total dissolved solids and sulphate for dry season, while nitrate and sulphate, total dissolved solids and sulphate, chloride and sulphate and chloride and nitrate.

In Ibadan Metropolis, Ayantobo et al(2012) assessed the quality of water from hand dug wells and noted nitrate, faecal coliform and total coliform at objectionable levels and are pronounced in wells located close to domestic wastes, abattoir, pit latrine and stagnant water and drainage. According to Omotoyinbo (2007) the pollution of groundwater by organic wastes in Ado-Ekiti is attributed to location of wells in terms of distance to toilet and refuse dumpes. Atarhe and Egbuna (2013) assessed the quality of water from hand dug well in Akure town noted groundwater to be acidic, with electrical conductivity to exceed WHO prescribed limit for drinking water. Hydrochemical facies delineated are calcium-sodium and bicarbonate-chloride-sulphate water types. Geology of the area is concluded to influence the quality of groundwater of the area.

Onwuka et al (2004) assessed the potability of shallow groundwater using parameters of waste derivable chemical such as nitrate, chloride, sulphate and indicator micro-organism of faecal coliform. Result show 22% of the wells have nitrate above WHO limit, and 8 out of 10 show evidence of faecal coliform derived from sewage contamination. In related a study, Omono et al(2013) used principal component analysis(PCA) to identify factors controlling groundwater in Achara, Abakpa and Emene residential areas of Enugu town.PCA was able to extract 77.7%,88.1% and 83.13% of the explained variables for the residential areas. PC 1 reflect weathering of the host rock minerals and constitutes the dominant controlling process of the areas. PC II and PC III of Achara and Abakpa is traced to both weathering/leaching of feldpatic minerals of host rocks giving rise to alkaline in groundwater and anthropogenic activities. Discriminant analysis of the groundwater quality of the area reveal total dissolved solids, sodium, manganese and chloride as dominant elements. Groundwater in the area is controlled both by geologic and anthropogenic activities.

Aiyegbusi et al (2010) analysed the quality of groundwater from shallow wells in Ilesa town in Osun State. They noted groundwater to be dominantly Ca-Mg(alkaline) and classified the water into Ca-Mg-Cl- SO_4 type; Ca-Mg-Na-K-HCO_3; Ca-Mg-Na-K-Cl-SO_4-HCO_3; Na-K-HCO_3.Heavy metals such as copper, lead, iron, chromium, arsenic, nickel in both surface and groundwater exceeded the WHO guide limit for drinking water. The presence of coliform in most of the water samples is linked to sanitary condition of the wells. In Ede town, Adediji and Ajibade (2005) assessed the quality of water from hand dug wells and found concentration of potassium to most abundant. All cations such as calcium, manganese, sodium, potassium were within WHO limit for drinking water. Jegede and Alade (2010) in their assessment of water quality from hand dug wells in Ijebu-Ijesa of the parameters analysed found lead, iron and cadmium levels to exceed WHO prescribed limit.

Ocheri and Odoma (2013) in a baseline study analysed the quality of water from boreholes in Lokoja town and noted concentrations of total coliform and lead to be above the Nigerian drinking water standards. Correlation was noted between coliform and nitrate, total dissolved solids and calcium, calcium and lead and geology. Ocheri and Ode(2012) assessed the quality of water from hand dug well in Oju town, Benue State, found the concentrations of iron, nitrate, and coliform above the WHO prescribed limit for drinking water. They attributed this to the shallow depth of the wells, distance to latrine/soakaway, improper well construction as well as landuse.

V. Groundwater Pollution from Landfill, Dumpsite and Abattoir Wastes

Proper management and protection of urban groundwater quality has been a major problem in Nigerian cities .Waste dumpsites are not properly designed nor constructed as landfill sites. Consequently, wastes dumped at dumpsites over the years are expected to have biodegenerated and generate leachates which could become point source of pollution into soil and groundwater (Bayode et al, 2012). The rate and characteristics of leachate production depends on a number of factors such as solid waste composition, particle size, degree of compaction, hydrology of the sites, age of the landfill, mixture and temperature of the condition and availability of oxygen (Ogundiran and Afolabi, 2008).

Ikem et al (2002) evaluated groundwater quality characteristics near two waste sites in Ibadan and Lagos found the concentrations of nitrate, ammonia, chemical Oxygen Demand, aluminium, cadmium, chromium iron lead nickel and total coliform to exceed WHO prescribed limit for drinking. The elevated concentration of these elements in groundwater is traced to leachates from the dumpsites. Longe and Enekwechi (2007) investigated potential impact and influence of local hydrogeology on natural attenuation of leachate at municipal landfill and groundwater of Lagos City and noted elevated nitrate, chloride, sulphate in groundwater and heavy metal chromium, calcium were detected at measurable level in groundwater down the gradient of the landfill location without any particular attenuation pattern of the well studied. Babatunde et al(2009) and Odukoya and Abimbola (2010) assessed the impact of leachate from dumpsites on groundwater quality in Isolo, Ojota and FESTAC areas of Lagos Metropolis and found elevated concentrations of iron, magnesium, nitrate, phosphate, sulphate and coliform above the prescribed limit for drinking water. They noted the concentrations of these elements were higher in water samples collected close to dumpsite than those far away thus suggesting the influence of leachate generated from dumpsites. In Ilupeju and Agbara industrial area Odukoya et al (2010) effluents discharged were noted to pollute the groundwater sources of the area. High concentrations of elements above WHO allowable limit in drinking water were observed in cadmium, antimony, barium, tellurium, tungsten, copper, lead and nickel linked to industrial effluent.

In Ibadan, Adeyemo and Temowo(2010) in a hydrogeological investigation of waste dumps noted the concentration levels of electrical conductivity, total dissolved solids, sodium, potassium, magnesium, nitrate and chloride were higher in water samples collected near the dumpsite than those far away. This is traced to leachate from dumpsite. Oladunjoye et al(2011) used geoelectrical imaging to measure the impact of waste dump of groundwater quality of Ibadan and concluded that high concentration of leachate towards lower elevation means the adjoining stream is prone to pollution from leachate from dumpsite. The environmental implication of municipal solid waste dumpsite leachate on contiguous hand dug wells in Ogbomosho was investigated by Ojoawo and Seriboh (2007). High concentration levels of turbidity, hardness, alkalinity, pH, calcium, nitrate, magnesium, zinc, phosphate and coliform were noted in the well close to dumpsite and evidence of leachate contamination.

Bayode et al (2012) assessed the impact of some waste dumpsite on the groundwater quality in some parts of Akure metropolis and of the parameters analysed, pH, electrical conductivity, total dissolved solids, calcium, and nitrate concentrated exceeded WHO prescribed limit for drinking water. This especially true of water samples collected within the vicinity of the dumpsite implying leachates may have contributed to the concentration level. According to Bayode(2010) pollution of groundwater from dumpsites in the basement complex of Southwestern Nigeria have been

documented by Olayinka and Olayiwola(2001) Tijani et al(2002) Abimbola et al(2002) Abimbola et al(2005) Ayolabi and Daniel(2005) Obase et al(2009).

Omofonwman and Esigbe (2009) and Imoisi et al(2012) examined the impact of municipal wastes on the quality of groundwater in Benin City and found concentration levels of physico-chemical and bacterio-logical loading higher in wells close to dumpsite than those far away. Studies carried by Adeyemo et al (2002) Chukwu(2008) in Ibadan and Minna metropolis confirmed the pollution of hand dug wells from abattoir wastes. This is evident in high faecal coliform and nitrate concentrations in the wells located close to abattoir. In a related study, Ahmed (2003) investigated the effect of sanitation on groundwater in Kaduna, noted high peak values of sanitation pollution indicators such as coliform and nitrate. Hand dug wells located close to pit latrine and soakaway have higher concentration of these pollution bacteria.

VI. Groundwater Pollution from Heavy Metals, Nitrate, Iron

a) Heavy Metals

Heavy metals are individual metals and metal compounds that can impact human health. Common heavy metals of toxic effects are arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. They are naturally occurring substances which are often present in the environment at low level but augmented by anthropogenic activities. Generally, humans are exposed to these metals by ingestation (drinking and eating)or inhalation(breathing)(Martin and Griswold,2009).These metals may come from natural sources, leached from rocks and soils according to their geochemical mobility or come from anthropogenic sources, as a result of human land occupation and industrial operation. The increase in industrial activities has intensified environmental pollution problems and the deterioration of several aquatic ecosystems with the accumulation of metals in biota and flora. These trace metals are dangerous because they tend to bio-accumulate resulting in heavy metal poisioning(Abolude et al,2009).Because of the harmful effect of heavy metal in drinking water researches have been carried in these areas.

Oyeku and Eludoyin (2010) assessed heavy metal pollution of groundwater resources in Ojota area of Lagos metropolis, noted that hand dug wells and boreholes near Olusosun landfill were contaminated with heavy metals. The uncontrolled disposal of lead and batteries, spent petroleum products probably caused the relatively high level of lead, copper and iron in groundwater. The spatial and seasonal variation in the concentration level suggest point sources pollution. In a related study, Yaya and Ahmed(2010) found high concentration of heavy metals in water sources of Abuja FCT, Nigeria .Arsenic, lead, iron and zinc concentrations were particularly noted to be high in both surface and groundwater sources. At Ibadan metropolis, Laniyan et al (2010) in a geochemical investigation note quartzite rocks to have the highest arsenic concentration. They concluded that water sources in Ibadan are prone to arsenic contamination from both leaching of weathered bedrock and indiscriminate discharge of wastes and industrial effluent. Trace metals in surface and sub-surface area of Kaduna south industrial area was examined by Jatau et al (2008). Of the parameters studied, vanadium, chromium, iron, cobalt, nickel, gallium, arsenic, selenium, lead, stronium, zirconium, and Molybdenum accounting for 73.68% of the well have concentrations above the WHO guide limit for drinking water. Nwankwoala et al(2011) investigated heavy metal pollution of groundwater of Yenegoa town, and found the concentrations of iron, manganese, nickel, chromium, lead, arsenic, cadmium, mercury and copper to be above the WHO allowable limit for drinking water. They attributed this to industrial discharges and subsurface injection of chemicals being an oil producing area. Mile et al (2013) assessed heavy metal pollution in groundwater sources of Makurdi and sub-urban, noted high concentrations of chromium, cadmium, iron and copper above the WHO prescribed limit for drinking water. They attributed this to soil mineralogy, use of chemical fertilizers and agro-chemicals and other landuses. Of the heavy metal studied, lead because of its abundance due to industrial activity and its toxicity have been suspected in water sources.

Sridhar et al (1998) pioneered a study on lead contamination levels in indoor and outdoor environment of the populous city of Lagos and Ibadan. Lead pollution level in surface and groundwater beside soils, dust and foods were investigated. The results of analyses of lead level in various water sources indicate that majority of the waters showed lead level above the WHO prescribed limit. Water from low density areas in Ibadan recorded relatively higher lead levels. However, the groundwater from high areas in both cities showed significantly higher lead levels.

Musa et al (2004) determined lead level in wells and boreholes in Zaria City and found that 91% of the wells sampled had lead concentrations above the WHO permissible limit for drinking water. Higher lead level was noted in well near motor mechanic and industrial areas of the city.

Iron level at objectionable proportion in boreholes across various formation of Benin town was noted by Ohaji and Akujieze(1989).The source of iron in these boreholes according to them could be traced to geology of the ferrugised formation, drilling method, size of submersible pumps and quality of pipes used in the distribution.

VII. Seasonal Effect on Groundwater Pollution

Season is believed to influence the concentration level of the physico-chemical and bacterialogical loading in water sources.

Agbaire and Oyibo (2009) investigated seasonal variability of physico-chemical elements in boreholes in Abraka town. The result show total dissolved solids were lower in the dry season. Ocheri et al(2010) assessed seasonal variation in nitrate level in Makurdi metropolis and found 80% of the wells had nitrate concentrations above the WHO allowable limit for drinking water for wet season. Other parameters whose concentrations were higher in the wet season are pH, turbidity, electrical conductivity, chloride, iron, calcium, chromium, biochemical oxygen demand and faecal coliform bacteria. Nwafor et al(2013) anlysed the seasonal influence on the physico-chemical concentrations in hand dug wells in Akure town noted, of the parameters studied, pH, total dissolved solids, total alkalinity, potassium, iron, sulphate have higher concentrations in the wet season. Whereas, temperature, turbidity, total hardness, chloride, magnesium, electrical conductivity, sodium, nitrate have higher concentrations in the dry season.

VIII. Groundwater Pollution Mitigation Measures in Nigeria

Groundwater pollution in Nigerian urban emanates mainly from two sources; physical processes and anthropogenic activities. It is generally believed that once groundwater is polluted is difficult to remedy or very expensive to treat. Preventive measures are often recommended. Suggestions put forward in this respect are as follows:

There is the need for continuous monitoring of Nigerian urban groundwater to determine its quality status. This will serve as a guide to the public and water managers on action plans to be taken.

All landuse activities capable of polluting water sources both surface and underground should be properly regulated to safe guide their quality.

There should be protection of water sources and water points. Indiscriminate dumping of wastes into water sources should be prevented and hand dug well should have protective covers and sanitary environment kept free of stagnant waters and animal/human defecation.

Industrial effluents to be properly treated before they are discharged to avoid polluting water sources Sanitary landfills and waste disposal sites to be properly designed and constructed. Wastes generated should be promptly removed and disposed of.

Groundwater exploitation systems such as boreholes and hand dug wells should only be sited after proper sanitary inspection and approved recommendation.

Appropriate measures should be taken to treat the water by way of disinfection, filtration and boiling to safe guide drinking water quality.

There should be strong legislation on pollution of water sources. Perhaps polluter pay principle and good practice should be adopted.

IX. Conclusion

Studies have shown that Nigerian urban groundwater quality is under pollution threats from geology and the geochemistry of the environment, rate of urbanization, landfill/dumpsite leachates, heavy metals, organic matters and influence of seasons. This portends a danger of health hazard of utilizing groundwater for drinking water without any form of treatment. This calls for appropriate measures to protect and remedy polluted groundwater for safety purposes.

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References Références Referencias

1. Abimbola, A.F., T.A. Laniyan, O.W. Okunola., A.A.Odewale.,M.Ajibade, and T. Kolawole. 2005. Water quality test of areas surrounding selected refuse dumpsite in Ibadan southwestern Nigeria. Journal of Water Resources, Vol.16.pp.39-48.
2. Abimbola, A.F., A.M. Odukoya, and A.S Olatunji. 2002. Influence of the bedrock on the hydrogeochemistry characteristics of groundwater in northern parts of Ibadan metropolis, Southwestern Nigeria. Journal of Water Resources, Vol.13.pp.1-6.
3. Abolude, D.S., O.A. Davis, and A.M. Chia. 2009. Distribution and concentration of trace elements in Kubani Reservior in Northern Nigeria. Research Journal of Environment and Earth Sciences, Vol.1, No.2, pp.39-44.
4. Adamu, G.K., R. Tukur, and A.I. Kankara. 2013.Groundwater assessment in the basement complex of Kano state, Nigeri., American Journal of Engineering Research, Vol.2,Issue 7,pp.171-175.
5. Adebo, B.A., and A.A. Adetoyinbo. 2009. Assessment of groundwater quality in unconsolidated sedimentary coasted aquifer of Lagos. Scientific Research and Essay, Vol.4 (4), pp.314-319.
6. Adedeji, A.A., and L.T. Ajibade 2005.Quality of water in Ede area, southwestern Nigeria. Journal of Human Ecology, Vol.17, No. 3 pp., 222-225.

7. Adelana, S.M.A., R.B. Bale., and M.Wu. 2003. Quality of assessment of pollution vulnerability of groundwater in Lagos metropolis, SW Nigeria in: proceedings of the aquifer vulnerability Risk Conference AURO3 Salamenia Mexico, 2, pp.1-17.
8. Adelana, S.M.A., R.B Bale., and M. Wu 2004. Water quality in a growing urban centre along the coast of South western Nigeria In: Seilder, K, P.W and XI, R (eds). Research Basic and Hydrological planning, Balkama, The Netherlands, pp.83-92.
9. Adelana, S.M.A., Bale, R.B., Olasehinde, P. I. and M.Wu.2005.The impact of anthropogenic activities over groundwater quality of coastal aquifer in Southwestern Nigeria. Proceedings on Aquifer vulnerability and Risks.2nd International Workshop and 4th Congress on the Protection and Management of Groundwater. Raggia di Colorno-parma.
10. Adelana, S.M.A., T. A. Abiye., D.C.W. Nkhuwa., C. Tindinugaya., and M.S. Oga. 2008. Urban groundwater management and protection in Sub-Saharan Africa in: Adelana, S. M. A and MacDonald, A.M Applied groundwater studies in Africa, International Association of Hydrogeologists, selected papers, pp.222-259.
11. Adeyemi, G.O and O.O.Temowo.2010. Hydrogeological investigation of waste dump environment near Ibadan, Southwestern Nigeria. Proceedings, Annual conference of Nigerian Association of Hydrogeologists on Water Resources Development and Climate Change.12.
12. Adeyemo, O.K., I.O. Ayodeji., and C.O. Aiki-Raji. 2002.The water quality and sanitary conditions in a major abattoir, Bodija Ibadan, Nigeria. African Journal of Biomedical Research, Vol.5, No.1-2,pp.51-55.
13. Agbaire, P.O. and Oyibo, P.2007.Seasonal variation of some physic-chemical properties of boreholes in Abraka, Nigeria. African Journal of Pure and Applied Chemistry.Vol.3 (6), pp.116-118.
14. Ahmed.H.2003.Effect of sanitation on groundwater quality. International conference on Towards the Millennium Development Goal, pp.183-185.
15. Aiyegbusi, M.S., A.U. Alichi., O. Ugwuja., and A.I.Oteri.2010.Assessment of shallow groundwater in Ilesha and Environ. Journal of Water Resources, Vol.20 (2), pp.15-28.
16. Ajibade, O.M., Omosanya, K.O and G.O.Odunsi. 2010. Groundwater contamination and flow direction of urban aquifer, Ibadan,Southwestern Nigeria. Proceedings, Annual Conference of the Nigerian Association of Hydrogeologists on Water Resources Development and Climate Change.p10.
17. Ajala, O.2005.Environmental impact of urbanization, culture and the Nigeria in: Fadare et al(eds) Globalisation, Culture and Nigerian built Environment, Faculty of Environmental Design and Management, OAU,pp.192-199.
18. Akunobi,B.E.B., and N. Chibuzor. 2012. Hydrochemical evaluation of water sources in Warri metropolis, Delta State, Nigeria. Journal of Basic Physical Research, Vol.3, pp.64-72.
19. Alexander, P.2008.Evaluation of groundwater quality of Mubi town in Adamawa State, Nigeria. African Journal of Biotechnology, Vol.7 (11), pp.1712-1715.
20. Al-Hassan, M.A and Ujo.2011. An assessment of groundwater quality of drinking water from hand dug wells in Masaka. Bayero University Journal of Social and Environmental Studies, Vol. 14 (1), 79-95.
21. Alichi, A.U., Asana, I.O., Aghomishe, M.A., Ozoade, V.U and .S.Aiyegbusi. 2010. Hydrogeochemical characteristics and groundwater quality assessment in Aba Metropolis, Southeastern Nigeria. Proceedings, Annual Conference of the Nigerian Association of Hydrogeologists on Water Resources Development and Climate Change.p30.
22. Amadi, P.A., C.V. Ofoegbu., andT. Morrision. 1989. Hydrochemical assessment of groundwater quality in parts of Niger Delta. Environmental geology, Vol.14, No.3, pp.195-202.
23. Amadi, A.N., Ameh, M.I and P.I.Olasehinde.2010. Effect of urbanization on groundwater quality within Makurdi Metropolis, Benue State. Proceedings, Annual Conference of the Nigerian Association of Hydrogeologists on Water Resources Development and Climate Change.p49.
24. Amangabara, G.T., and E. Ejienna. 2012. Groundwater quality assessment of Yenegoa between2010-2011. Scientific and Academic Publishing, Vol.2 (2), pp.20-29.
25. Anudu, G.K., Adekeye, J.I.D., Essien, B.I and S.E.Obrike.2010. Hydrochemical assessment of groundwater in Dadin-Kowa and environs, Bauchi State, Northcentral Nigeria. Proceedings, Annual Conference of the Nigerian Association of Hydrogeologists on Water Resources Development and Climate Change.p37.
26. Atarche, D.O., and I.C. Egbuna .2013. Physico-chemical assessment of groundwater in Akure, southwestern Nigeria. Journal of Civil Engineering and Urbanism, Issue 1, pp.25-28.
27. Ayantobo, O.O., G.O. Oluwasanya., O.A. Idowu., and A.O. Eruola. 2012. Water quality from hand dug wells in Ibadan. Proceeding, Nigerian Hydrological Sciences conference on Hydrology for disaster management, Federal University of Agriculture, Abeokuta.
28. Ayodele, J.I., R.U. Mommoh., and M.Amin.1996. Determination of heavy metals in Sharada industrial effluents in water quality monitoring and environmental status in Nigeria. Proceeding, National Seminar on water quality in Nigeria, FEPA. pp. 158-166.

29. Ayolabi, E.A., and Y.P. Daniel. 2005. Hydrochemical and electrical resistivity assessment of the impact of solid waste on groundwater at Oke-Alfa refuse dumpsite Lagos, Nigeria. Environmental Science and Engineering Technology, Vo.12, No.1, pp.5936-5946.
30. Babatunde, A.L., M. Okolue., O.T. Oyelola., and A.K. Odunlade. 2009. Pollution of groundwater through surface input from domestic, agriculture and industrial sources in FESTAC town Lagos, Nigeria. International Journal of Applied science, Vol.3 (2), pp.19-59.
31. Bayode, S 2010.Geoelectrical investigation of the area around some old dumpsites in Akure metropolis. Unpublished Ph. D Thesis, Federal University of Technology Akure, p.233.
32. Bayode, S., M.O lurunfemi., and J.S.Ojo. 2012. Assessment of impact of some waste dumpsite on groundwater quality in some parts of Akure metropolis southwestern Nigeria. Pacific Journal of Technology, Vol.13, No.2, pp.528-536.
33. Brassington, N.1988. Field Hydrogeology. Geological Society of London, John Wiley.
34. Chukwu, O.2008. Analysis of groundwater pollution from abattoir in Minna, Nigeria. Research Journal of Dairy Sciences, Vol.2, pp.74-77.
35. Dan-Hassan, M.A. and P.I.Olasehinde.2010. Seasonal variations in physic-chemical properties of groundwater from central part of the Federal Capital Territory, Abuja, Nigeria. Proceedings, Annual Conference of the Nigerian Association of Hydrogeologists on Water Resources Development and Climate Change.p10.
36. Danmo, M.N., J.M. Deborah., I.A. Yusufu and Sangodoyin 2013.Evaluation of groundwater quality of Konduga town, Nigeria, European Journal of Science and Technology, Vol.2, No.5, pp.13-17.
37. Du preez, J.W. and W. Barber.1965.The distribution and chemical quality of groundwater in Northern Nigeria, Geological Bulletin, pp.1-82.
38. Edet, A.E., T.N. Nganje., A.J. Ukpong., and A.S. Ekwere. 2011. Groundwater chemistry and quality of Nigeria: A status review. African Journal of Environmental Science and Technology, Vol. 5(13), pp.1152-1169.
39. Efe, S.I. 2008. Quality of water from hand dug wells in Onitsha metropolitan Area. Journal of Environment, Vol.125, pp.5-12.
40. Egbulem, B.N.2003.Shallow groundwater monitorring. 29th WEDC International conference, pp.133-134.
41. Eni, D.V., J.Obiefuna., C. Oko., and I. Ekwok. 2011. Impact of urbanization on sub-surface water quality in Calabar municipalty, Nigeria. International Journal of Humanities and Social Sciences, Vol.1, Issue 10, pp.167-172.
42. Erah, P.O., C.N. Akujieze., and G.E.Oteze.2002. The quality of groundwater in Benin City: Baseline study on inorganic chemical and microbial contaminants of health implication in boreholes and open wells, Tropical Journal of Pharmaceutical Research, Vol.1, No.2, pp.75-82.
43. Ezeigbo, H.I.1988.Geological and hydrogeological influence on the Nigerian environment. Journal of water resources, Vol.2, pp.36-44.
44. Forster, D., A.R. Lawrence., and B.B.Morris.1998. Groundwater in urban development. World Bank Technical Paper No.390, Washington D.C, 121.
45. Forster, S.S.D., A.R. Lawrence. and B.L.Morris.1996. Groundwater resources beneath rapidly urbanizing cities-Implication and priorities for water supply and management in: Report of Habitat in 1950 Urbanisation, Economic Development and Policy in Developing countries, Habitat International Vol.14.pp.3-42.
46. Idris-Nda, A., A.G. Isah., N.M. Waziri. and A.I.Sadiq.2011.Appraisal of the composition of groundwater in Minna metropolis, Central Nigeria. Proceeding of the Nigerian Association of Hydrogeologists conference on Sustainable Water Resources and Mineral Development Challenges, Lafia. p12.
47. Ikem, A., O. Osibanjo. M.K.C.Sridhar., and A.Sobande.2002. Evaluation of groundwater quality characteristics near two wastes sites in Ibadan and Lagos, Nigeria. Journal of Water, Air and Soil pollution, Vol.140, No.1-4, pp.307-333.
48. Imoisi, O.B., Ayesanmi, A.F. and E.G.Uwumarongie-Ilori.2012.Assessment of groundwater quality in a typical urban settlement or residents close to three dumpsites in Southsouth, Nigeria. Journal of Environmental Science and Water Resources. Vol.1 (1), pp12-17.
49. Ishaku, J.M., and Ezeigbo, H.I.2010. Groundwater quality monitoring in Jemeta-Yola Area of northeastern Nigeria. Journal of Water resources, Vol.20 (2), 1-14.
50. Ishaya,S., and I.B.Abaje.2009.Assessment of borehole water quality in Gwagwalada town, Abuja FCT. Journal of Ecology and Natural Environment, Vol.1(2), 32-36.
51. Jatau, B.S., C.I. Abengowe., and R.O. jodo.2006. Preliminary geo-environmental evaluation of some parts of Kaduna North metropolis, Kaduna, Proceedings Nigerian Association of Hydrogeologists.
52. Jatau, B.S., I. Bajah., and S.Innocent.2008.Trace metal in surface and sub-surface water of Kaduna south industrial area of North Central Nigeria. Research Journal of Applied Sciences, Vol.3(1),pp. 81-87.
53. Jegede, O.O and O.S. Alade.2010. Groundwater investigation of Ijesbu-Ijesha, Osun State. Inter-

national Journal of Environmental Science.Vol.No.3, pp 79-85.
54. Kehinde, M.O.1998.The impact of industrial growth on groundwater quality and availability in: Osuntokun, A(eds) Current Issues in Nigerian Environment, Ibadan Danidan Press.
55. Laniyan, T.A.2010.Arsenic and heavy metals in waters: A case study from Ibadan, South Western, Nigeria. Proceedings, Nigerian Association of Hydrogeologists on Water Resources Development and Climate. p47.
56. Longe, E.O., and L.O.Enekwechi.2007.Investigation on potential groundwater impacts and influence of local hydrogeology on natural attenuation of leachates at municipal landfill. International Journal of Environmental Science and Technology, Vol.4, No.1, pp.133-140.
57. Longe, E.O., S.Malamo., and M.A. Olurunmiro. 1987. Hydrogeology of Lagos metropolis. Journal of African Earth Science, Vol.6 (3), pp.163-174.
58. Mackey, R.1990.Groundwater quality In: Thanah, N.C and Biswas, A.K (eds) Environmentally Sound Water Management, Oxford University Press, pp. 220-225.
59. MacDonald, A., Davis, J., Calow and J.Chilton.2005.Developing groundwater: A guide to rural water supply, ITDGS Publishing. U.K.
60. Martin, S and W. Griswold. 2009. Human health effects of heavy metal. Environmental Science and Technology briefs for citizen, Kansas State University Centre for hazardous substances Reseach, www.engg.ksu.ed/CHSRT
61. Matthes, G .1976.Effect of man's activities on groundwater quality. Hydrological Science ITDGS Publishing, U.K.
62. Mile, I.I., J.I. Amonum., and N.N.Sambe.2013.Heavy metals in groundwater in urban and sub-urban Makurdi, Nigeria. Pakidtan Journal of Chemistry, Vol.3. Issue 2, pp.87-90.
63. Musa, H., I.A. Yakasai., and H.H. Musa.2004. Determination of lead concentration in well and boreholes in Zaria, Nigeria. Chemical Class Journal, Vol. pp.14-18.
64. Nwafor, E.K; C.J.Okoye., and O.C. Akinbile. 2013. Seasonal assessment of groundwater quality for domestic use in Akure Metropolis, Ondo State, Nigeria. Proceeding, Nigerian Association of Hydrological Sciences conference on Water Resources and National Development in: Mbajiorg, C.C; Obeta,M.C and Anyanwu, C(eds),pp.38-42.
65. Nwankwoala, H.O., and G.J. Udom .2011. Hydrochemical evaluation of groundwater in parts of eastern Niger Delta, Nigeria, Journal of Academic and Applied Sciences, Vol.1,No.2,pp.33-58.
66. Nwankwoala, H.O., G.T. Udom., and S.A.Ugwu.2011.Some heavy metal investigation in groundwater resources in Yenegoa, Bayelsa State, Nigeria. Journal of Applied Technology in Environmental Sanitary, Vol.1, No.2, pp.163-170.
67. Obase, K., M.O. Olurunfemi., and Akintonwa.2009. Geophysical and Hydrochemical investigation of the area around a waste dumpsite in Ile-Ife, Southwestern Nigeria. Global Journal of Geological Science, Vol. 7(1), pp.47-54.
68. Ocheri, M.I. 2006. Analysis of water consumption pattern in Makurdi metropolis. Journal of Geography and Development, Vol.1, No.1, 71-83.
69. Ocheri, M.I and I.I. Mile.2010. Spatial and temporal variation in groundwater quality of Makurdi sedimentary formation. Journal of Geography, Environment and Planning, Vol.6, No.1, pp. 141-146.
70. Ocheri,M.I., and O.O. Ode.2012. Water quality from hand dug wells in Oju town, Benue State, Nigeria. Nigerian Journal of Hydrological Sciences,Vol.1, pp.57-66.
71. Ocheri, M.I., I.I. Mile., and M.C. Obeta. 2010. Seasonal variation in nitrate levels in hand dug wells in Makurdi metropolis. Pakistan Journal of Nutrition, Vol.9, pp.539-542.
72. Ocheri, M.I., and L.A. Odoma.2013. Baseline investigation of groundwater quality of Lokoja, Nigeria. Proceedings, Nigerian Association of Hydrological Sciences conference on Water Resources and National Development C.C. Mbajiogu, M.C Obeta and Anyanwu, C (eds) held at University of Nigeria, Nsukka, pp.65-71.
73. Odukoya A.M. and A.F. Abimbola.2010. Contamination assessment of surface and groundater within and around two dumpsites. International Journal of Environmental Science and Technology. Vol. 2(2).pp367-376.
74. Ogundiran, O.O., and T.A.Afolabi.2008.Assessment of physic-chemical parameters and heavy metal toxicity of leachates from municipal solid waste dumpsite, International Journal of Environmental Science and Technology, Vol.5,No.2,pp 243-250.
75. Ohaji, S.M.O., and N. Aknjeize, N.1989. Iron in borehole water sources in Bendel State, Nigeria. Journal of Water Resources, Vol.2, pp.4-9.
76. Ojoawo,S.O and O. Seriboh 2007.Environmental implication of municipal solid on waste dumpsite leachates on contiguous well in Ogbomosho town. Journal of Environmental Issues, Vol.5, pp.169-179.
77. Okoye, G.E., Aiyegbusi, M.S.,Aghomishie, M.A., Mbachu,C.C and C.N. Akujieze.2010. Physicochemical quality of water resources in Calabar and its environs, South-South Nigeria. Proceedings Annual Conference of Nigerian Association of Hydrogeologists on Water Resources Development and Climate Change.p6.
78. Oladunjoye, M.A., A.I. Olayinka., and Amidu. 2011. Geoelectrical imaging at an abandoned waste dumpsite in Ibadan, Southwestern Nigeria. Journal of Applied Sciences, Vol.11., pp.3755-3764.

79. Olayinka, A., and M.A.Olayiwola.2001. Integrated use of geoelectrical imaging and hydrochemical method in delineating limit of polluted surface and groundwater at a landfill site in Ibadan area southwestern Nigeria. Journal of Mining and Geology, Vol.37, No.1, pp.53-68.
80. Olobaniyi, S.O.B., and F.B. Owoyemi. 2006. Characterisation by factor analysis the chemical facies of groundwater in the Deltaic plain sand aquifer of Warri, western Niger Delta. African Journal of Science and Technology, Vol.7, pp.73-81.
81. Omofonmwan, S.I., and J.O. Esigbe 2009.Effect of solid waste on the quality of groundwater in Benin metropolis, Nigeria. Journal of Human Ecology, Vol.26 (2), pp.99-105.
82. Omono, O.V., O.S. Onwuka., and C.O. Okogbue.. 2013. Characterisation of groundwater in three settlement areas of Enugu metropolis, southern Nigeria. Environmental Monitoring and Assessment, www.ncbi.nih.gov/pubmed/24037228.
83. Omotoyinbo, O.2007. Determination of contamination of underground water (hand dug well) by organic waste: A case study of Ado-Ekiti, Nigeria. Ethiopian Journal of Education and Science, Vol.3, pp.43-50.
84. Onwuka, O.S., K.O. Uma., and H.I.Ezeigbo.2004. Potability of shallow groundwater in Enugu town, southeastern Nigeria. Global Journal of Environmental Science, Vol.3 (2), pp.33-39.
85. Oyeku,O.T., and A.O. Eludoyin. 2010. Heavy metal contamination of groundwater resources in a Nigeria urban settlement, African Journal of Environmental Science and Technology,Vol(2), pp.367-376.
86. Sajad, M.M., S.Rahim., and T.Tahir .1998.Chemistry of groundwater of Rawalpinli/Isalama,24th Conference, Islamba.
87. Sridhar, M.K.C., J.F.Olawuyi., L.A.Adogame., I.R.O kekearu., C.O.Osajie and L.Aborka 1998.Lead in the Nigerian environment: problems and prospects. Department of Environmental Health College, College of Medicine, University of Ibadan.
88. Tijani, M.N., S.O.Onibalusi., and A.S.Olatunje. 2002. Hydrochemical and environmental impact assessment of Orita Aperin waste dumpsite, Ibadan, southwestern Nigeria. Journal of Water Resources, Vol.13, pp.28-84.
89. Tse, A.C and C.I.Adamu 2012.Assessment of anthropogenic influence of groundwater in hand dug wells in Makurdi Metropolis in Northcentral Nigeria. Ife Journal of Science, Vol.14, No.1, pp.
90. Ufoegbune, G.C., K.I.Lamidi., J.A.Awomeso., A.O.Eruola., O.A.Idowu., and C.O.Adeotun 2009. Hydrochemical characteristics and groundwater assessment of some selected communities in Abeokuta southwestern, Nigeria. Journal of Environmental chemistry and Exotoxicology, Vol.1,No.1, pp.10-22.
91. Yaya, O.O.and S.D.Ahmed, 2010.Investigation of heavy metals in groundwater and surface water in the Federal Capital City of Abuja. Proceedings Annual Conference of the Nigerian Association of Hydrogeologists on Water Resources Development and Climate Change.p8.
92. Yerima, F.A.K., M.M.Dawa., and B.A. Gambo 2008.Assessment of groundwater quality in Bama town, Nigeria. Journal of Sustainable Development in Agriculture and Environment, Vol.3 (2), pp.128-137.

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Estimation of Redox Reactions of Deep Groundwaters in Japan

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Abstract- pH and oxidation reduction potential (ORP) values of waters in original positions (in-situ) were estimated using analytical data on deep groundwaters and hot spring waters at 67 points in Japan. A predominant redox reaction at each point was thermodynamically analysed on the basis of the Gibbs reaction energy. The results showed that a redox reaction of iron sulphide / sulphate ion was estimated to be predominant at many points, and that in a pH-ORP diagram, most of the in-situ pH and ORP estimates were on an equilibrium curve between pyrite and sulphate ion. It is suggested that the in-situ groundwaters in the Tertiary sedimentary rocks in Japan could be governed with the redox reaction of the iron sulphide / sulphate ion.

Keywords: *groundwaters, hot spring waters, redox reactions, in-situ pH, in-situ ORP.*

GJSFR-H Classification : *FOR Code: 26050, 040699*

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Keywords: groundwaters, hot spring waters, redox reactions, in-situ pH, in-situ ORP.

I. Introduction

Geochemical characteristics of deep groundwater are essential information for safety assessments for the geological disposal of radioactive wastes (Nuclear Waste Management Organization of Japan (NUMO), 2004), and the sequestration of carbon dioxide (Xue and Matsuoka, 2008), one of the known green house gases, because groundwater chemistry could affect migration of the species included in disposal wastes. In order to facilitate the smooth advance of the above disposal projects, it is necessary to investigate the geochemical characteristics economically across a wide area extending over several kilometres.

Existing investigations of groundwater chemistry so far have involved drilling a borehole, purging the drilling mud, pumping up the groundwater, sampling it at the surface and conducting analyses in the laboratory. At potential disposal locations (hereinafter referred to as in-situ), the groundwater is generally under high pressure to dissolve gases i.e. carbon dioxide, and is in a reduced condition. When pumped up to the surface, it could be degassed with depressurization to increase its pH and it could beoxidised by contact with the atmosphere to increase its oxidation redox potential (ORP) (Gascoyne, 1997, 2004; Grenthe *et al*., 1992; Iwatsuki et al., 2009).

In order to procure quality data on the pH and ORP of the deep groundwater, it is recommended to measure them in-situ (Furue *et al*., 2005; Ii *et al*., 1997), and some apparatus has been developed for in-situ groundwater measurement and sampling. One problem is that since in-situ measurement takes longer and is more expensive, it is difficult to set up a network of measurements consisting of many test intervals in boreholes. A realistic solution is considered as follows: (1) perform not only in-situ measurements, but also the existing ones; (2) develop a method for estimating the in-situ pH and ORP using existing data in comparison with in-situ data; (3) estimate the in-situ values of test intervals where in-situ measurements are not conducted; (4) economically obtain data on the in-situ pH and ORP across a wide area. Hokari *et al*. (2014) presented a means of estimating the in-situ pH and ORP on the basis of existing groundwater data and chemical equilibrium analysis, which was applied to a geochemical pumping test measuring the in-situ pH and ORP for validation. It was performed by the Japan Atomic Energy Agency (JAEA) in the deepest borehole drilled in the course of the Horonobe Underground Research Laboratory Project (Horonobe URL project). Figure 1 illustrates a location and geology of the Horonobe site.

Existing pumping tests were also conducted in several boreholes at the Horonobe site (Kunimaru *et al*., 2007). Hokari and Kunimaru (2008) applied this estimation method to those pumping tests in order to estimate distributions of the in-situ pH and ORP at the site (Figure 2). Figure 2 includes pH and ORP values measured in-situ in the geochemical pumping test, values measured with flow-through cell sensors at the surface in the existing pumping tests, and values estimated from the groundwater analysis data. ORP_SHE represents an ORP relative to the standard hydrogen electrode.

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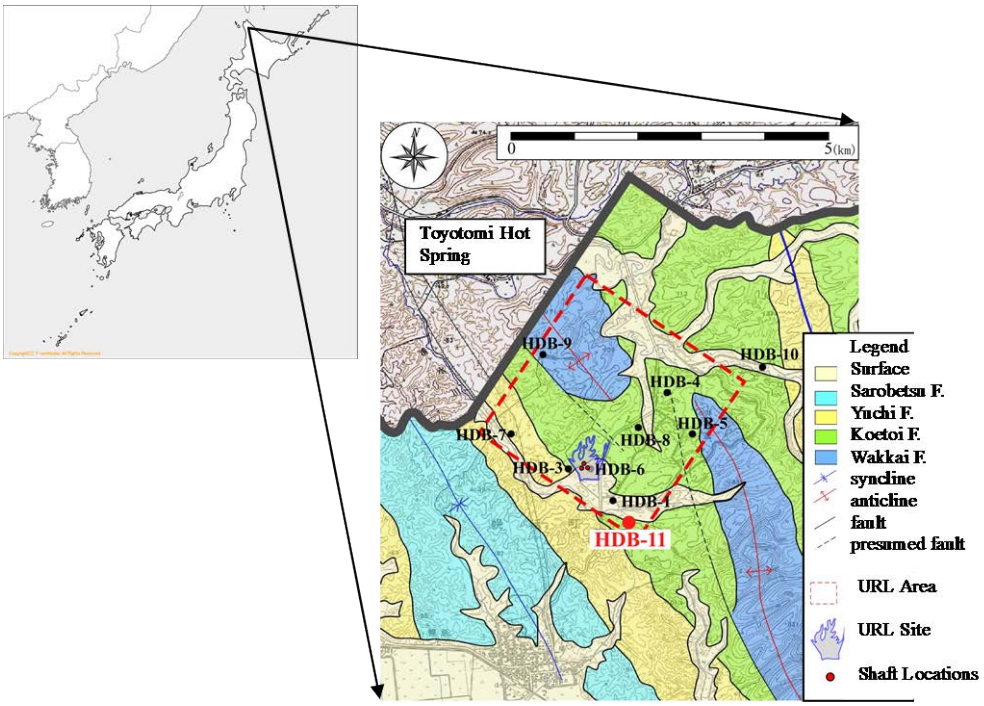

Figure 1 : Location and geology of the Horonobe Underground Rock Laboratory (URL) Project site

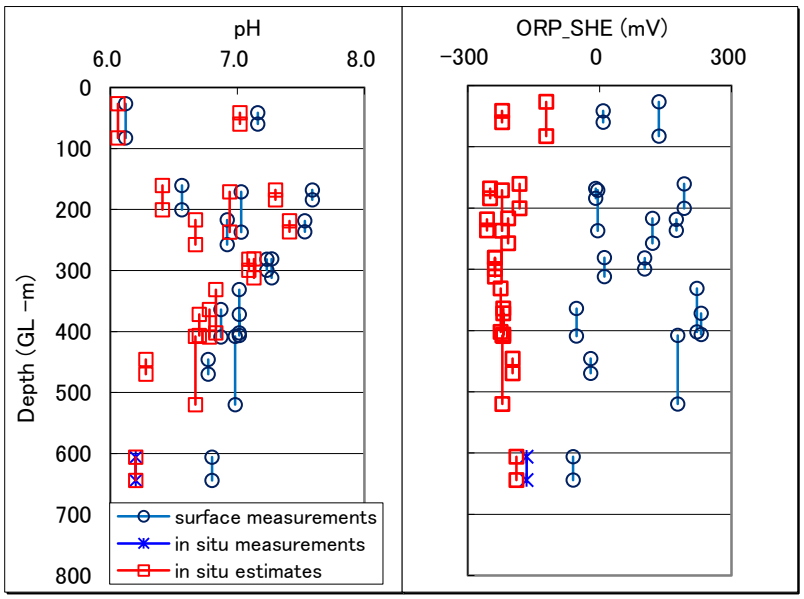

Figure 2 : Depth distributions of the in-situ pH and ORP estimates at the Horonobe site

It is confirmed that the in-situ pH and ORP estimates are in good agreement with the in-situ measurements at depths of approximately 600 m, which shows that the estimation method is valid. The in-situ pH estimates are more acidic than the surface measurements and have a tendency towards acidity to approximately 6.2 with depth. It is coincident with the pumping test results that more CO_2 gas was released from the deeper groundwater pumped up to the surface. The in-situ ORP estimates represent a greatly more reduced condition than the surface measurements, and show stable reduction of approximately -200 mV at depths of below some 200 m. It is estimated that the underground environment is reductive and stable.

Figure 3 is a pH-ORP diagram for the system Sulphur-Oxygen-Hydrogen, showing the pH and ORP measurements in the pumping tests and the in-situ pH and ORP estimates. Since the in-situ estimates are on the equilibrium curves of sulphate and sulphide ions, the in-situ groundwaters at the Horonobe site could be governed by a redox couple of sulphate and sulphide ions.

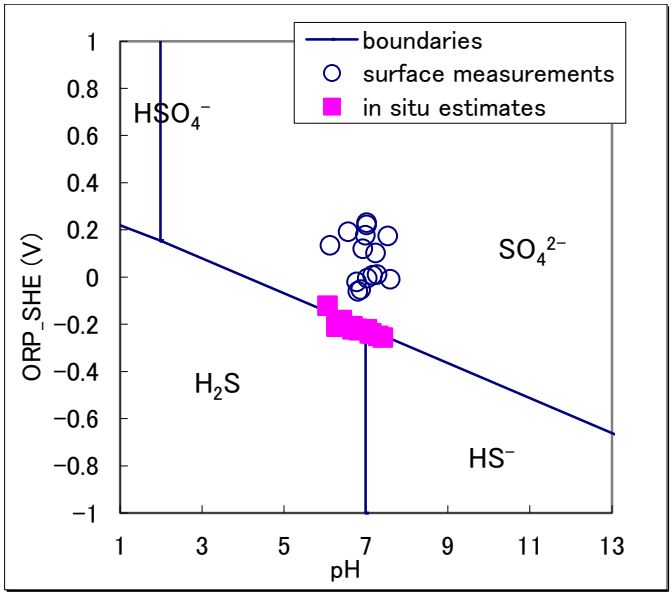

Figure 3 : pH-ORP diagram for the system S-O-H with the pumping test measurements and the in-situ estimates at the Horonobe site

Seki *et al.* (2004), after conducting measurement and analysis of deep hot spring waters at the eastern Kanto District in Japan, addressed that ORP measurements for the waters with very low content of dissolved oxygen (DO) were in good agreement with values calculated from a redox couple of sulphide and solid sulphur (S^0 rhombic) as shown in Figure 4. It gives the pH and ORP measurements for the water samples with approximately zero DO at the eastern Kanto District, which are found to be on equilibrium curves for solid sulphur and aqueous hydrogen sulphide at different total sulphur content. Solid and broken curves are for 25°C and 50°C, respectively. Plots with h are for more than 40°C. Eh in Figure 4 represents an ORP relative to the standard Hydrogen electrode, which is used especially when it is calculated thermodynamically. Seki *et al*. (2004) argued that ORP for deep groundwaters could be actually buffered with sulphide ions and solid sulphur in the assumption that the pH and ORP values, which were measured at the surface, should be the same as those in-situ.

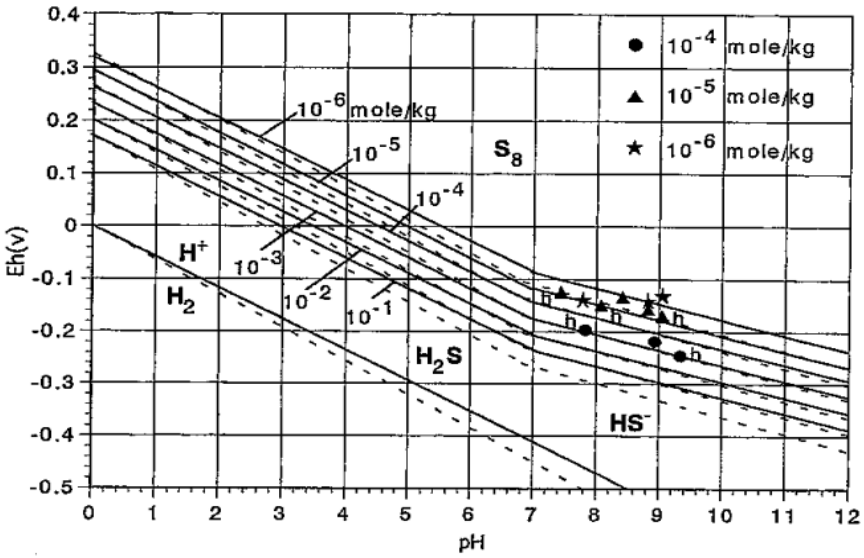

Figure 4 : pH-ORP diagram for the system S-H, showing the pH and ORP measurements for the water samples with approximately zero dissolved oxygen at the eastern Kanto District

All of the groundwaters at the Horonobe site were sampled in mud stone formations of the Neogene Period. An approximately half of the water samples at the eastern Kanto District came from sedimentary rocks (sand stone, mud stone, and tuff) of the Neogene Period, and the rest of them came from granite and gneiss of the Cretaceous Period and sedimentary rocks (sand stone and shale) of the Jurassic Period.

The groundwaters in the different two regions are found to be governed with redox couples of sulphur. This characteristic could generally prevail in some geological environment which is common in the two regions, for example, groundwaters in sedimentary rocks of the Neogene Period. In order to assess the safety for radioactive waste disposal or CO_2 sequestration, the characteristic could be very useful information on underground geochemical properties in a stage of preliminary investigations such as literature researches, which precedes site investigations.

This paper, using a groundwater database, estimated the in-situ pH and ORP of the following groundwaters: the Dohoku area including the Horonobe site, the Kanto District and the other hot springs, and studied whether those groundwaters should be governed with redox couples of sulphur or not, and whether there should be common redox reactions governing the groundwaters or not.

II. Estimation of pH and ORP for In-Situ Groundwaters

a) Groundwaters

In order to study possibility that groundwaters in some region of Japan should be governed with redox couples of sulphur, in-situ groundwater pH and ORP were estimated in use of groundwater analysis data of the region compiled up in the groundwater database (Asamori *et al*., 2003) on the basis of a method proposed by Hokari *et al*. (2014). Of redox reactions, which were assumed to be possible to occur under the ground, the most predominant reaction was identified thermodynamically. A relationship between the predominant reaction and the in-situ pH and ORP estimates was studied graphically with a pH-ORP diagram. This groundwater database has collected and sorted out chemical analysis data on groundwaters and hot springs in Japan, and studied and added sampling location data (latitudes, longitudes and elevations) as possible.

Figure 3 shows that the groundwater samples in the pumping tests conducted at the Horonobe URL Project could be governed with the redox couple of sulphide and sulphate ions in-situ. In order to investigate if this tendency should be contributed to limited local characteristics at the Horonobe site, in-situ predominant reactions surrounding the Horonobe site were studied by collecting existing groundwater condition data of existing boreholes surrounding the site and estimating the in-situ pH and ORP values.

Figure 4 shows that the groundwater samples of Seki *et al.* (2004) at the eastern Kanto District could be governed with the redox couple of sulphide and solid sulphur. Since the data of Seki *et al.* (2004) were measured at the surface, whatever low contents of DO for the groundwaters were, in-situ predominat reactions were studied by estimating the in-situ pH and ORP. And in order to investigate if the above tendency should be contributed to limited local characteristics at the eastern Kanto District, in-situ predominant reactions surrounding the eastern Kanto District were studied by collecting existing groundwater condition data of existing boreholes surrounding the District and estimating the in-situ pH and ORP values.

As the other groundwaters than those in the above site, District and surroundings, another groundwaters were studied which fall in the following four types of hot springs in Japan, which Matsubaya *et al.* (1973) classified on the basis of their hydrogen and oxygen isotopic ratios and major element chemistry in terms of their origins: green tuff type (3 samples), ocean coastal type (4 samples), volcanic type (4 samples) and Arima type (2 samples). The green tuff type waters are in the green tuff formation of the Tertiary Period, and are of neutral sodium chloride sulphate type chemistry with a chloride content of less than 3 g/L.δD and δ^{18}O values of the groundwaters are in agreement with those of local meteoric waters, and δ^{34}S and δ^{18}O values of the sulphate in the groundwaters are similar to those of the sulphate in the sea water. It is deduced that the green tuff type waters are simply recycled meteoric waters. The ocean coastal type waters show intermediate δD and δ^{18}O values between the standard mean ocean water (SMOW) and local meteoric waters as a result of mixing of sea water and the meteoric waters. Na-Ca-Cl type waters of low Mg^{2+} and SO_4^{2-} concentrations are typically produced by chemical reactions between fresh or diluted sea water and wall-rock minerals. δ 34S values of SO_4^{2-} are similar to those of the fresh sea water sulphate, because SO_4^{2-} is removed by anhydrate precipitation. The volcanic type waters are found in close affiliation with Quaternary volcanism. Although the waters essentially occur as a mixing of sea water and local meteoric waters, they iδndicate varying degrees of isotopic shifts that Dδ and δ^{18}O values of the waters are shifted towards heavier values from the meteoric water line on a δD and δ^{18}O diagram. Those isotopic shifts are assumed to be attributed to an isotope effect in evaporation near the surface and an O-isotopic exchange between the meteoric waters and geothermal rocks in Japan. The Arima type waters are found in the Cretaceous granitic rocks and metamorphic rocks around Arima region. The waters show highly salinity and isotopic shifts towards heavier values than the meteoric waters. Those waters are not mixtures of the meteoric waters and sea water, but occur by mixing of the meteoric waters and the possible fossil magmatic, metamorphic or geothermal fluids.

The groundwaters and hot springs studied here are as follows:

1. Pumping test samples at the Horonobe URL site (Kunimaru *et al*, 2007): 11 samples

2. Petroleum well and hot spring samples surrounding the Horonobe site (Asamori et al., 2003): 14 samples
3. Deep hot spring samples at the eastern Kanto District (Seki *et al*., 2004): 16 samples
4. Naturak gas well, hot spring, observation well and coal mine samples surrounding the District (Asamori *et al*, 2003): 13 samples
5. Samples supposed to fall in typical hot springs in Japan (Asamori et al., 2003): 13 samples

The studied groundwaters should include the following analysis data:

- cation contents: Na^+, K^+, Ca^{2+}, Mg^{2+} and anion contents: Cl^-, HCO_3^- or / and CO_3^{2-}, SO_4^{2-};
- pH and temperatures when the waters were sampled;
- sampling depths for boreholes;
- released gas

Figure 5 illustrates locations of the groundwaters studied here in Japan. The above groundwater data (1) and (2) correspond to Dohoku in Figure 5, the data (3) corresponds to Seki et al. (2004), and the data (4) and (5) correspond to Others, respectively.

Although the above groundwater data are not necessarily enough to represent all groundwaters in Japan, rock types in which the groundwaters were sampled widely vary as follows:

Sedimentary rocks: mudstone, shale, siltstone, sandstone, green tuff, tuffaceous conglomerate, welded tuff Igneous rocks: granite, granodiorite, rhyolite, andesite Metamorphic rocks: gneiss Rock types of more than half of the pumping intervals in boreholes are unknown and there are no records on geology.

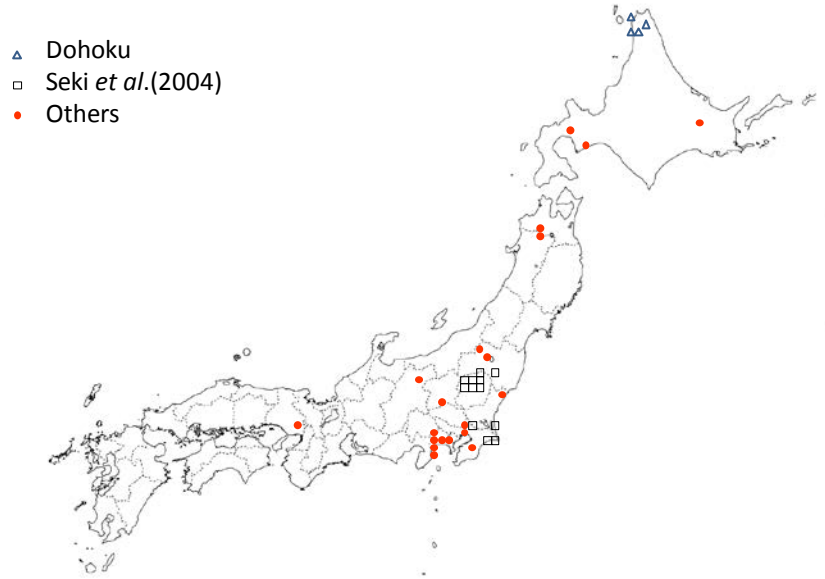

Figure 5 : Map showing localities of the 67 groundwaters studied here in Japan

b) Estimation method of the in-situ pH and ORP

At this section, the estimation method of the in-situ pH and ORP proposed by Hokari *et al.* (2014) is briefly presented. It estimates the in-situ pH and ORP of groundwaters by using data of existing pumping tests, as are seen in the groundwater database, on the basis of geochemical equilibrium simulations and the in-situ mineral-water interactions.

In order to understand the evolution mechanism of groundwater chemistry, it is convenient to calculate speciation of elements in some environments with a thermodynamic code for geochemical modelling. The geochemical code enables calculations of species activities, concentrations and saturation indices in water on the basis of the mass balance law and the mass action law with a thermodynamic database that includes mass action constants. This paper employs one of the open codes, called PHREEQC (Parkhurst and Appelo, 1999), developed by the U.S. Geological Survey to estimate the in-situ pH and ORP. There are several codes for geochemical modelling other than PHREEQC, which are detailed in the following websites (Geotechnical & geoenvironmental software directory, 2008).

Since the details of PHREEQC were presented by Parkhurst and Appelo (1999), only a summary of PHREEQC is given here. It is designed to perform a wide variety of low-temperature aqueous geochemical calculations on the basis of an ion-association aqueous model. In ordet to estimate the in-situ water conditions on the basis of the existing surface data, of the many geochemical calculation capabilities of PHREEQC, speciation and batch reactions with gas at equilibrium are focused on here. It uses the mole balance Equation

(1), the mass action Equations (2), (3), and the activity coefficient expression including the Davies Equation (4) or the extended Debye-Huckel Equation (5) (Truesdell and Jones, 1974) to calculate the activities, concentrations and saturation indices of the species in solution.

The mole balance equation of an element *m* is expressed:

$$\sum_{i}^{N_{aq}} b_{m,i} n_i + \sum_{g}^{N_g} b_{m,g} n_g = const. \quad (1)$$

where N_{aq} is the number of aqueous species, N_g is the number of gas-phase components. The moles of each entity in the system are represented by n_i for aqueous species and n_g for gas components. The moles of element m per mole of each entity are represented by $b_{m,\ i}$ for aqueous species and $b_{m,\ g}$ for gas components.

The mass action equations can lead to the total moles of an aqueous species *i* and a gas component g:

$$n_i = \frac{K_i W_{aq}}{\gamma_i} \prod_{m}^{M_{aq}} a_m^{c_{m,i}} \quad (2)$$

$$n_g = \frac{N_{gas}}{P_{total}\ K_g} \prod_{m}^{M_{aq}} a_m^{c_{m,g}} \quad (3)$$

where n is the moles, K is the mass action constant, a_m is the activity of master species m, M_{aq} is the total number of aqueous master species, c_m is the stoichiometric coefficient of master species m, W_{aq} is the mass of solvent water in an aqueous solution, γ is the activity coefficient, N_{gas} is the total moles of gas, P_{total} is the total pressure, subscript $_{i,\ g}$ represents a solutions species and a gas component, respectively.

Activity coefficient γ of aqueous species i is defined with the Davies Equation (4) or the extended Debye-Huckel Equation (5):

$$\log \gamma_i = -A\, z_i^2 \left(\frac{\sqrt{\mu}}{1+\sqrt{\mu}} - 0.3\,\mu \right) \quad (4)$$

$$\log \gamma_i = -\frac{A\, z_i^2 \sqrt{\mu}}{1 + B\, a_i^0 \sqrt{\mu}} + b_i \mu \quad (5)$$

where z_i is the ionic charge of aqueous species i, μ is the ionic strength of solution, A and B are constants dependent only on temperature, a_i^0 and b_i are ion-specific parameters fitted from mean-salt activity-coefficient data.

The initial input to PHREEQC was the following analysis data on the groundwater pumped up to the surface: the temperature, pressure (1 atm), pH, ORP, main species concentrations, if there were found free gases, the gas / water ratio, and content of each gas. The groundwater conditions under the in-situ pressure and temperature were computed with PHREEQC on the basis of the initial solution. With increasing pressure, the free gases in the solution were expected to be all solved. The equations below the bubble point were expected to differ from those above it according to the presence or dissolution of the gases. In order to estimate the bubble point, a stepwise computation was applied from the surface pressure and temperature conditions to the in-situ ones. If the in-situ mineral information was available, effects of the mineral on pH or ORP were to be considered and added to the simulation result with PHREEQC.

III. Result and Discussion

The in-situ groundwater pH and ORP, estimated in use of PHREEQC, are shown in Figure 6.

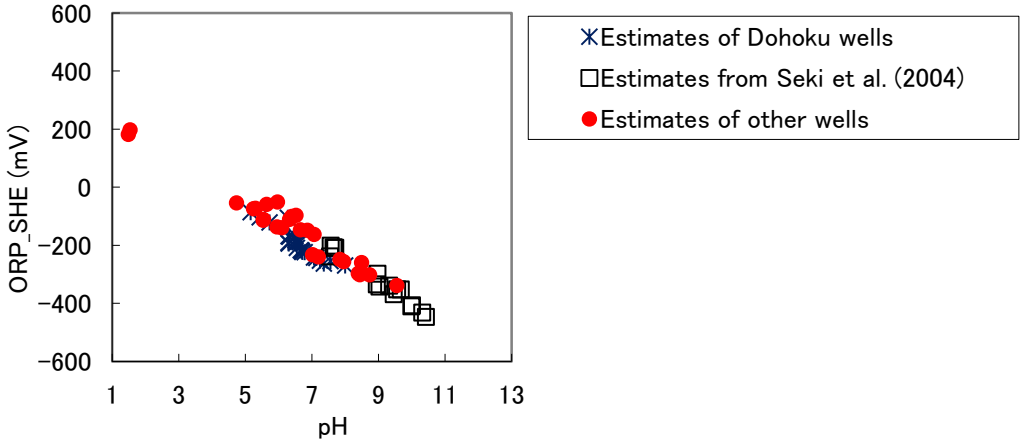

Figure 6 : The in-situ pH and ORP estimates for the 67 groundwaters

Elements involved in redox reactions are contained in the in-situ rocks and the groundwaters, which could vary in valence states depending upon the redox condition. At first, the elements of Fe, Mn, S and C are selected as redox relevant ones in the rocks, because they exist in greater content in the various rocks (Hem, 1970). The contents of the elements in the crust are summarised in Table 1.

Table 1 : Average composition of main elements concerning redox conditions in the crust (Hem, 1970)

Element (ppm)	Igneous rock	Sedimentary rock		
		Sandstone	Shale	Carbonate
Fe	42200	18600	38800	8190
Mn	937	392	575	842
S	410	945	1850	4550
C	320	13800	15300	113500

The following redox reactions including those elements in the underground could possibly be assumed according to Stumm and Morgan (1996) and Langmuir (1997). Since the existing groundwater data seldom include Mn, the redox reactions concerning Mn are not considered here.

$$SO_4^{2-} + 10\,H^+ + 8e^- = H_2S_{(aq)} + 4\,H_2O \quad (6)$$

$$Fe(OH)_3 + 3\,H^+ + e^- = Fe^{2+} + 3\,H_2O \quad (7)$$

$$Fe(OH)_{3(am)} + 3\,H^+ + e^- = Fe^{2+} + 3\,H_2O \quad (8)$$

$$Fe(OH)_{3(am)} + HCO_3^- + 2\,H^+ + e^- = FeCO_{3(s)} + 3\,H_2O \quad (9)$$

$$\alpha\text{-}FeOOH_{(s)} + HCO_3^- + 2\,H^+ + e^- = FeCO_{3(s)} + 2\,H_2O \quad (10)$$

$$Fe^{2+} + 2\,SO_4^{2-} + 16\,H^+ + 14\,e^- = FeS_{2(s)} + 8\,H_2O \quad (11)$$

$$SO_4^{2-} + FeCO_{3(s)} + 9\,H^+ + 8\,e^- = FeS_{(s)} + HCO_3^- + 4\,H_2O \quad (12)$$

where subscripts (am) and (s) represent amorphous and solid states, respectively.

The predominant reaction of all the above could be revealed with thermodynamic analysis using changes in Gibbs free energy of the reactions. The energy change was calculated for each reaction for each groundwater data under the in-situ temperature and pressure conditions. At first, the change in Gibbs free energy of the reaction ΔG^0_r was calculated at a specified standard state (25°C and 1 atm) with Equation (13) (Stumm and Morgan, 1996).

$$\Delta G_r^0 = \sum_i \mu_i \Delta G_{f,i}^0 \quad (13)$$

Where μ_i is stoichiometric coefficient of the species *i* and $\Delta G^0_{f,i}$ is the Gibbs free energy of formation of the species *i* at the standard state. Equation (14) produces the Gibbs reaction energy at a temperature of T Kelvin ΔG^T_r (Appelo and Postma, 2005). The species activities calculated by PHREEQC were used as ones essential for the Gibbs reaction energies.

$$\Delta G_r^T = \Delta G_r^0 + R\,T \prod_i \ln[i]^{\mu i} \quad (14)$$

where *R* is the gas constant and [*i*] is the activity of the species *i*. Pressure compensation was conducted using Equation (15) – (18) (Millero, 1982; Tanger and Helgeson, 1988).

$$\ln\frac{K^P}{K^0} = \frac{1}{R\,T}\left(-\Delta V^0\,P + \frac{1}{2}\,\Delta\kappa^0\,P^2\right) \quad (15)$$

$$\Delta V^0 = \sum_i \mu_i V_i^0 \quad (16)$$

$$\Delta\kappa^0 = \sum_i \mu_i \kappa_i^0 \quad (17)$$

$$\Delta G_r^P = \Delta G_r^0 + R\,T \ln\frac{K^P}{K^0} \quad (18)$$

where K^P and K^0 are the equilibrium constants at a pressure of P and at the reference pressure, which is atmospheric pressure here; ΔV^0 is the standard molar volume change of the reaction, and V_i^0 is the standard partial molar volume of the species *i*; $\Delta\kappa^0$ is the standard molar compressibility change of the reaction, and κ_i^0 is the standard partial molar compressibility of the species κG_r^P -> ΔG_r^P is the Gibbs reaction energy at a pressure of P.

For example, the Gibbs reaction energies of the deepest groundwater sample for Reaction (6) are shown, which is1510m deep and at 61.5 °C. The standard Gibbs reaction energy, the Gibbs reaction energy at 61.5 °C, and the Gibbs reaction energy in-situ are -192.07 KJ/mol, -7.10, and -193.19, respectively. It is found that an effect of temperature on the Gibbs reaction energy is by far greater than those of pressure,

and the pressure compensation for the Gibbs reaction energy is not considered in this analysis.

The probability of each reaction is shown in Table 2.

Table 2 : Analysis result of the predominant in-situ redox reactions

Reaction No	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Probability (%)	0	0	34	1	12	36	17

The above probability means, for example, that Reaction (11) is the most likely to occur in 36 % of all the data. As a result, the pyrite / the sulphate ion reaction is estimated to be predominant in 36 % of all the data, the ferrous ion / ferric oxihydroxide reaction predominates in 34 % of the data, the ferrous sulphide mineral / the sulphate ion reaction prevails in 17 %, and the siderite / the ferric oxihydroxide reaction prevails in 12 %. In other words, the sulphate ions / the iron sulphide, which includes the pyrite and the ferrous sulphide mineral, are estimated to be predominant in more than half, that is, 53 % of all the data. The redox reactions of the ferrous sulphide minerals could govern the in-situ groundwater conditions. The in-situ pH and ORP estimates are analysed on the basis of Reaction (11), as shown in Figure 7. Most of the estimates are plotted on an equilibrium curve between pyrite and sulphate. Analysed data here are located mainly at the northern Hokkaido region and the Kanto District. The groundwaters in the northern Hokkaido region evolve in the sedimentary rocks of the Tertiary period, and the groundwaters in and around the Kanto District evolve in the sedimentary rocks of the Tertiary period, igneous and metamorphic rocks of the Cretaceous period, sedimentary rocks of Jurassic period and sedimentary rocks of the Quaternary period and others. Many data of these two areas are related to the groundwaters in the Tertiary sedimentary rocks. It is deduced from the result that the redox state of the in-situ groundwater could be governed by the pyrite-sulphate reaction in the Tertiary formations of Japan.

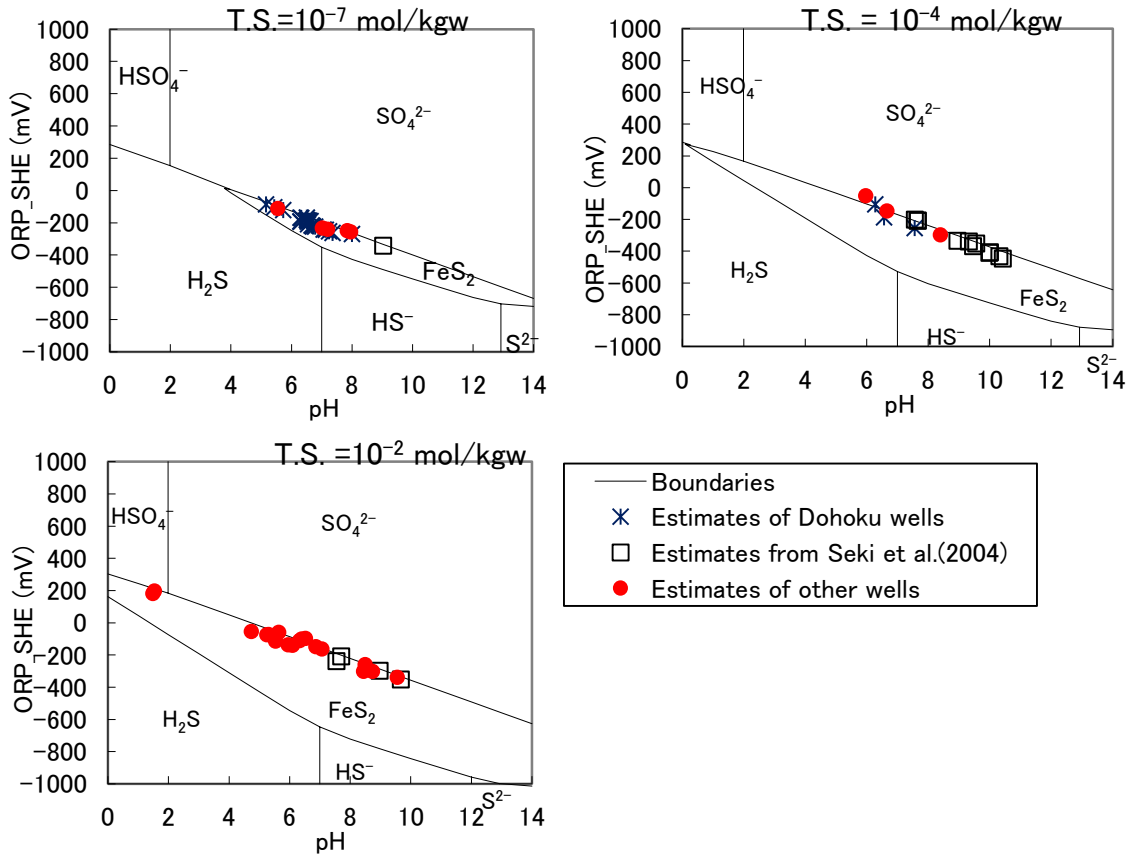

Figure 7 : pH-ORP diagram for the system S-O-H and the pyrite, showing the in-situ pH and ORP estimates for the 67 groundwaters

IV. Conclusion

This study, using the groundwater database in Japan, estimated the in-situ pH and ORP of the groundwaters and hot springs in northern Hokkaido region, in and around the Kanto District and in the other areas. It also thermodynamically investigated possibility that those groundwaters should be governed by redox couples of sulphur and possibility that there should be a

redox reaction governing the in-tiu redox condition of those groundwaters.

As a result, the in-situ predominat redox reaction for the data analysed here was revealed to be the ferrous sulphide mineral / the sulphate ion reaction. It is also confirmed that the in-situ pH and ORP estimates of those groundwaters were plotted on an equilibrium curve between the pyrite and the sulphate ion. The data analysed here are mainly situated in the northern Hokkaido region and the Kanto District, and many of them are related to the groundwaters in the Tertiary sedimentary rocks. It is deduced that the ferrous sulphide mineral / the sulphate ion reaction should govern the in-situ redox condition in the Tertiary sedimentary formations in Japan.

This study revealed that it was possible to estimate the predominant redox reaction by estimating the in-situ groundwater pH and ORP on the basis of the existing groundwater database. When this estimation method is applied to the safety assessment for radioactive waste disposal, it is expected to be very effective at the preliminary investigation, which corresponds to documents investigation and is followed by borehole investigations at the surface.

References Références Referencias

1. Appelo, C.A.L., Postma, D., 2005. Geochemistry, groundwater and pollution, second ed. A.A. Balkema Publishers, Leiden.
2. Asamori, K., Umeda, K., Ishimaru, T., Komatsu, R., 2003. Information of geological features of the Japanese Islands. JNC TN7450 2002-003, Japan Atomic Energy Agency.
3. Furue, R., Iwatsuki, T., Hama, K., 2005. An Appropriate Manner of Hydrochemical Investigation of Groundwater Using Deep Borehole. J. Jpn. Soc. Eng. Geol. 46(4), 232-236.
4. Gascoyne, M., 1997. Evolution of redox conditions and groundwater composition in recharge-discharge environments on the Canadian Shield. J. Hydrol. 5(3), 4-18.
5. Gascoyne, M., 2004. Hydrogeochemistry, groundwater ages and sources of salts in a granitic batholiths on the Canadian Shield, southeastern Manitoba. Appl. Geochem. 19, 519-560.
6. Geotechnical & geoenvironmental software directory, accessed on June 27th, 2008. At <http://www.ggsd.com/>.
7. Grenthe, I., Stumm, W., Laaksharju, M., Nilsson, A.C., Wikberg, P., 1992. Redox potentials and redox reactions in deep groundwater systems. Chem. Geol. 98(1-2), 131-150.
8. Hem, J.D., 1970. Study and interpretation of the chemical characteristics of natural water. University Press of the Pacific, Honolulu.
9. Hokari, T., Kunimaru, T., 2008. Estimation of distributions of the in-situ groundwater physic-chemical parameters, Proc. Symp. Jpn. Assoc. Groundwater Hydrol. 294-299.
10. Hokari, T., Iwatsuki, T., Kunimaru, T., 2014. Estimation of in-situ groundwater conditions based on geochemical equilibrium simulations. J. Sustainable Development of Energy, Water and Environ. Systems. 2(1), 15-29.
11. Ii, H., Horie, Y., Ishii, T., Shimada, J., 1997. Development of an apparatus to measure groundwater qualities in situ and to sample groundwater using boreholes. Environ. Geol. 32(1), 17-22.
12. Iwatsuki, T., Morikawa, K., Hosoya, S., Yoshikawa, H., 2009. A notice for measuring physicochemical parameters (pH, ORP) of deep groundwater. J. Jpn. Assoc. Groundwater Hydrol. 51(3), 205-214.
13. Kunimaru, T., Shibano, K., Kurigami, H., Tomura, G., Hara, M., Yamamoto, H., 2007. Analysis of ground water from boreholes, river water and precipitation in the Underground Research Laboratory Project, JAEA-Data/Code 2007-015, Japan Atomic Energy Agency.
14. Langmuir, D., 1997. Aqueous environmental geochemistry. Prentice Hall Inc., New Jersey.
15. Matsubaya, O., Sakai, H., Kikuchi, I., Satake, H. 1973. Hydrogen and oxygen isotopic ratios and major element chemistry of Japanese thermal water system. Geochem. J. 7, 123-151.
16. Millero, F.J., 1982. The effect of pressure on the solubility of minerals in water and seawater. Geochim. Cosmochim. Acta. 46, 11-22.
17. Nuclear Waste Management Organization of Japan (NUMO), 2004. Development of Repository Concepts for Volunteer Siting Environment. NUMO-TR-04-03, NUMO.
18. Parkhurst, D.L., Appelo, C.A.J., 1999. User's guide to PHREEQC (Version 2) – A computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculation. Water-Resources Investigations Report 99-4259, U.S. Geological Survey, Denver, Colorado.
19. Seki, Y., Nakajima, T., Kanioka, H., Kanai, Y., Manaka, M., Tsukimura, K., 2004. Discharged water from deep wells in the eastern Kanto region – the relationship between water quality and underground geology, J. Balneol. Soc. Jpn. 54(1), 1-24.
20. Stumm, W., Morgan, J.J., 1996. Aquatic chemistry: chemical equilibria and rates in natural waters – third ed. A Wiley-intersceinece publication, John Wiley & Sons, Inc.
21. Tanger IV, J.C., Helgeson, H.C., 1988. Calculation of the thermodynamic and transport properties of aqueous species at high pressures and temperatures: revised equations of state for the standard partial molal properties of ions and electrolytes. Amer. J. Sci. 288, 19-98.

22. Truesdell, A.H., Jones, B.F., 1974. WATEQ, A computer program for calculating chemical equilibria of natural waters, Journal of Research 2, 233-274, U.S. Geological Survey.
23. Xue, Z., Matsuoka, T., 2008. Lessons from the First Japanese Pilot Project on Saline Aquifer CO2 Storage. J. Geogr. 117(4), 734-752.

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An Appraisal of Forest Degradation and Carbon Sequestration of Effan Forest Reserve in Kwara State

By Alhassan Abubakar, Aishatu Abdulkadir, Abdullahi Jibrin & Rukkaya Bahago Abubakar
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Keywords: *degradation, gmelina arborea, above-ground biomass, carbon sequestration, climate change.*

GJSFR-H Classification : *FOR Code: 070599 , 070504*

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I. Introduction

Forest degradation is broadly defined as a reduction in the capacity of a forest to produce ecosystem services such as carbon storage and wood products as a result of anthropogenic and environmental changes. The main causes of degradation vary globally, including unsustainable logging, poor agricultural practices, invasive species, fuel wood gathering, livestock grazing, and wildfire with synergistic effects.

Forest degradation is a widespread global concern and an important contemporary issue for several United Nation (UN) organizations and conventions. These groups include the UN Convention on Biological Diversity (CBD), which set a global target for restoration of at least 15% of degraded ecosystem by 2020 (Convention on Biological Diversity 2010); the UN Forum on Forests that has an objective to reduce Forest degradation; the UN Convention to Combat Desertification (UNCCD) that consider degradation on dry lands; and the UN Framework Convention on Climate Change (UNFCCC) that proposes to recover degraded forests as carbon sinks. Recent climate negotiation have initiated the concept of reducing emissions from deforestation and forest degradation (REDD) to mitigate climate change through forest management, including the restoration of degraded forest (UNFCCC, 2010). Along with deforestation, forest degradation has major consequences for human societies and biodiversity, and significantly contribute to greenhouse gas emissions (Secretariat of the Convention on Biological Diversity 2002, Parry et al. 2007, van der Werf et al. 2009, Mery et al. 2010).

The increased concentration of GHGs in the atmosphere attributes to the change in the world's climate. GHGs destroy the ozone layer allowing the ultra violet rays to pass towards the earth surface. The intense heat emitted in the earth surface through radiation has hazardous effect on plants, animals, human race, and its total environment. Forest trees are considered as an important factor in mitigating climate change because of their role in carbon sequestration – the process of removing carbon dioxide (CO2) from the atmosphere and 'storing' it in plants that use sunlight to turn CO2 into biomass and oxygen (ACIAR, 2008).

Carbon sequestration occurs both naturally and as a result of anthropogenic activities and typically refers to the storage of carbon that has the immediate potential to become carbon dioxide gas. In response to growing concerns about climate change resulting from increased carbon dioxide concentrations in the atmosphere, considerable interest has been drawn to the possibility of increasing the rate of carbon

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sequestration through changes in land use and forest and also through geo-engineering techniques such as carbon capture and storage.

Forests sequester store more carbon than any other terrestrial ecosystem and are important natural `brake' on climate change. When forests are cleared or degraded, their stored carbon is released into the atmosphere as carbon dioxide (CO_2). Tropical deforestation is estimated to have released of the order of 1–2 billion tons of carbon per year during the 1990s, roughly 15–25% of annual global greenhouse gas emissions (Malhi and Grace 2000, Fearnside and Laurance 2003, 2004, Houghton 2005). The largest source of greenhouse gas emissions in most tropical countries is from deforestation and forest degradation. In Africa, for example, deforestation accounts for nearly 70% of total emissions (FAO 2005). Moreover, clearing tropical forests also destroys globally important carbon sinks that are currently sequestering CO_2 from the atmosphere and are critical to future climate stabilization (Stephens et al 2007).

Forests play an important role in the sequestration of carbon; particularly the conservation of forests yields the greatest potential for reducing greenhouse gas emissions. As for the estimation of carbon sequestration, several methods have been proposed such as the sampling of ground biomass, flux tower, model estimation, and remote sensing technique (Aerial Survey Office of Forest Bureau, 2009). Among these methods, remote sensing is an effective and large-scale method to estimate carbon sequestration based on net primary productivity (NPP) and absorbed incident photosynthetically active radiation (APAR) (Monteith, 1972). Therefore, it can improve the problem of spatial discontinuity for the sampling of ground biomass and the observation of flux tower. Previous studies such as Sun and Zhu (2000), Zhu et al. (2005, 2006), Jiang (2009) applied different scales of remote sensing images to estimate net primary productivity and then analyze the change of carbon sequestration.

In Nigeria, the eco-climatic zones range from the very humid fresh water mangrove swamps, in the south to the semi arid Sahelian zone in the north (Salami and Balogun 2004). These varied zones support a variety of vegetation, among which the most extensive vegetation zones are Savannas in the north and forest in the south.

Forest and forest plantation are very important natural resources relied upon by man for food, furniture, fuel wood, timbers, animal and plants to mention a few. In both developed and developing countries, exploitation of these forest resources take place consistently for various purposes which varies from commercial to non commercial, need for space in road construction shifting agriculture, firewood harvesting, construction of residential building, sand excavation etc.

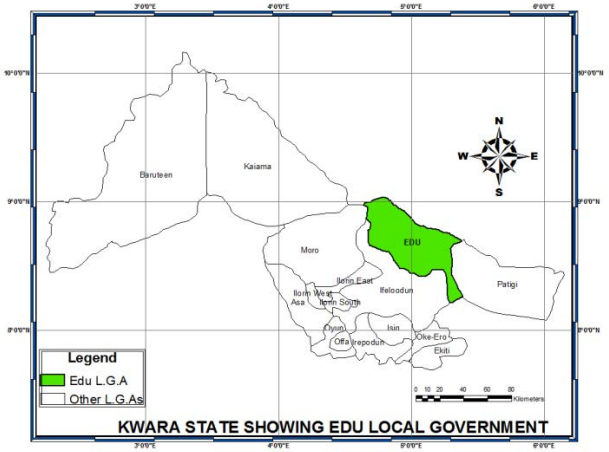
This study aim to assess the rate of Forest Degradation and Carbon Sequestration of Effan Forest Reserve Area of Kwara State, using GIS and remote sensing techniques

II. Research Method and Design

a) Location and description of Study Area

Effan Forest Reserve is located in Edu Local Government Area of Kwara State. The Local Government is made up of three districts; Lafiagi, Shonga and Tsaragi with the headquarter at Lafiagi. The reserve lies within Longitude $5^0$18' to $5^0$23' East of Greenwich Meridian and Latitude $8^0$47' to $8^0$50' North of the Equator. The forest reserve covers a stream plus a strip of dry lands surrounding the stream with a width of 5-10metres. The strip of dry land surrounding the stream was planted with *Gmelina arborea* specie plantation from 1975 to 1981.The total area of the reserve is 14.35 square kilometer which is equivalent to 1435 hectares which was originally acquired by government under the public lands ordinance (1975).

The area is characterized by tropical hinterland climate with two alternate distinct wet (May – October) and dry season (November – April), the length of the raining season is over 180days. The soils here is developed cretaceous sedimentary basement complex, which is sandy alluvium type predominantly shallow soil and low level of organic matter, hydromorphic soils are dominant in the lowest part of the Effan Stream thereby attracting rain fed agriculture and animal rearing during season because of the availability of pasture and water for livestock. Food crops such as maize, guinea corn, groundnut, yams and rice are cultivated by the natives and other ethnic groups living around the area.



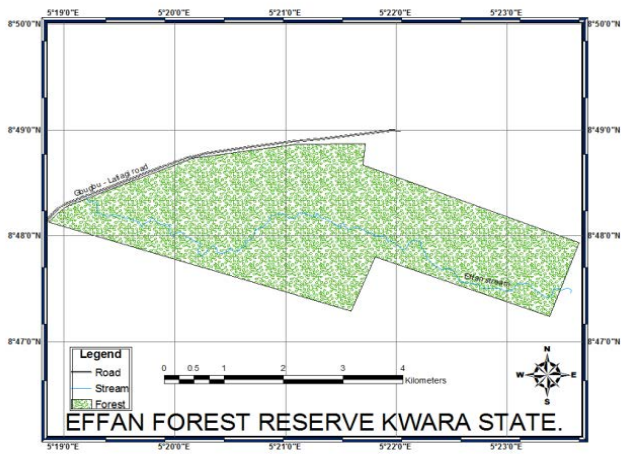


Figure 1 : Location of Effan Forest Reserve Kwara State

b) Data used

The data assembled for this study include; Satellite image – Landsat Enhanced Thematic Mapper (ETM$^+$) of 2001 and 2006 (Band 1, 2, 3 & 4), Google Earth image of 2013. Topographic Map of Lafiagi (sheet 203, Scale 1:100,000) Nigeria of 1968 by Bureau of Lands under Survey department. Field Equipments – GPS, diameter tape 3metre, measuring tape 100metre, digital camera and fieldwork data sheet. Software's – Arc GIS 10.0 version, Idrisi Selva, Microsoft word, Microsoft Excel, and Microsoft PowerPoint.

c) Methodology

The research method for this study followed two major steps i.e. fieldwork, data collection & preparation, and remote sensing & GIS analysis.

d) Delineation of the forest and quantifying the extent of forest degradation

Image Importation – All the four (4) bands of the LandSat ETM$^+$ images of 2001 and 2006 was imported in the Idrisi Selva and as well as into the ArcMap environment and were given unique identifier to make a difference between them, because much data would be generated without deleting the initial raw data. Image Carving/sub-setting – The four (4) bands of the LandSat ETM$^+$ of 2001 and 2006 images imported was windowed / carved based on the latitude and longitude of the study site. The carved images was then exported to the Idrisi Selva environment which was reformatted and geo – referenced using the Re-Sample module. Image composition – despite the fact that all the bands were imported its not all that was used for the work but were tried for better interpretation for training sites later used for classification. The image composition with the greatest variability was chosen for signature training to achieve the best signature separation and avoid classes' mix-up. Image classification – the supervised classification (Maximum classification) was carried out with the development of training site from signature of three (3) classification schemes: *Gmelina arborea*, Shrubs/Sapling and water body in the Idrisi Selva environment. Also the calculation of the area coverage by each scheme was determined in hectare. Map composition – the classified maps was exported back to ArcMap environment for completeness and cartographic representation and exported for presentation. There are growing bodies of potential tools that can be used to study and monitor these large complex ecosystems (Haase and Haase, 1995, Steven *et.al*, 2005 and Rao and Rogers, 2006).

e) Vegetation reflectance of Effan Forest Reserve

The NDVI approach is based on the fact that healthy vegetation has low in the visible portion of the electromagnetic spectrum due to chlorophyll and other pigment absorption and has high reflectance by the mesophyll spongy tissue of green leaf (Campbell, 1981). Band 4 and 3 of the two images was used using the NDVI model, which is a simple linear combination of the visible and near infrared bands with its values ranging from -1 to +1. Healthy vegetation is represented by NDVI values between 0.1 and 1.0, while non- vegetated surfaces such as water body, bare ground yield negative values. This was used for quantitative assessment of vegetation and moisture degradation.

f) Estimates of Above-Ground Biomass and Carbon Sink

The above-ground biomass and carbon sink was estimated through Fieldwork, data collection & preparation which involves going to the field in order to collect relevant information in the area of study. For this particular study, the necessary information that was collected in the field includes: Establishment of sample plots, measurement of diameter at breast height (DBH), measurements of latitude and longitude of each sampled plots, and taking of photographs were all determined in the field.

g) Establishment of Sample Plots in Study Site

The study site covered an area of 1,435 hectares of *Gmelina arborea* specie plantation. Sampling plots measuring 30 m x 30 m (900m^2) were established within the study area. The 30m x 30m dimension of sampled plots was based on pixel resolution of the LandSat image acquired. The plots size was cordoned with a rope so that the perimeter of a plot can be seen. There was 14 sampled plots (quadrants) established and simple-random sampling method was used in the selection of sample areas in the study site.

h) Classification of Tree Stands and Data Collection

The *Gmelina arborea*, regardless of age, were classified into Sapling i.e. young tree ($\leq$10 cm), Poles size (10 – 30 cm), and Standard size trees ($\geq$ 30 cm), according to their diameter at breast height (DBH). The number of trees found inside the perimeter of each classification, was tallied and recorded. Moreover, the diameters at breast height (d.b.h) of the sampled trees

were determined using a Diameter measuring tape. The geographical location or coordinates of each sampled plots was also determined in the field and recorded with the aid of hand held GPS.

i) Biomass Computation per Tree

Diameter at breast height (d.b.h) that is measured from the field was used to determine the biomass of individual trees. The allometric equation developed by Chave et al (2005) was adopted to estimate the biomass since the equation can be used regardless of tree diameter. The equation utilizes data from 2410 trees from 27 study sites across the tropics. The study also concludes that differences in the biomass equations between study sites are small if wood density variation is accounted for. The major significant factor is the forest type.

Equation for dry forests was utilized in this study since the study area has a total annual rainfall below 1500mm. The general equation is as follows:

$W = ƥ.\exp(ß_0 + ß_1.\ln(D) + ß_2.\ln(D)^2 + ß_3.\ln(D)^3$.

Where: W = Tree above ground biomass in kilogram,

ƥ = wood specific gravity (0.64g/cm3 for *Gmelina arborea*),

D = is tree diameter at breast height in centimeter, and

$ß_0$ = -0.667, $ß_1$ = 1.784, $ß_2$ = 0.207, and $ß_3$ = -0.0281

For trees with 2 or more stems, biomass was computed by calculating it separately and adding the biomass of each stem.

j) Biomass Computation per Class

The total above-ground biomass of trees per sampled plots was multiplied by the number of trees per plot. Then, the biomass from all sampled plots per class was added to represent the biomass for each class. The biomass values were then converted to tons/hectare or Metric tons/hectare (Appendix B).

k) Carbon Content

Secondary data for the average carbon content of tree of E. camaldulensis Dehnh at 45% was adopted from the study of Sermpong and Chongrak (2002) which is consistent with the default value of carbon content for all species specified by IPCC. The carbon content value was used to determine the carbon density for all the three classes of Gmelina arborea plantation.

l) Carbon Storage and Sequestration Capacity per Class

Carbon density or the amount of carbon stored by each class was determined using the following equations adapted from the study conducted by Sales (2004):

Carbon density = Biomass_T x %C

Where: Carbon density = total amount of carbon stored by each class expressed as tons of C per hectare (metric tons C/ha).

m) Change Maps of Carbon Sinks:

The change maps of carbon sinks was produced in the ArcMap environment using the Kriging Interpolation in the Spatial Analyst tools. The field biomass data that was generated is linked together with the NDVI values to produce the changed maps of carbon sinks.

III. Results and Discussion

a) Delineation of the Forest and Extent of Forest Degradation

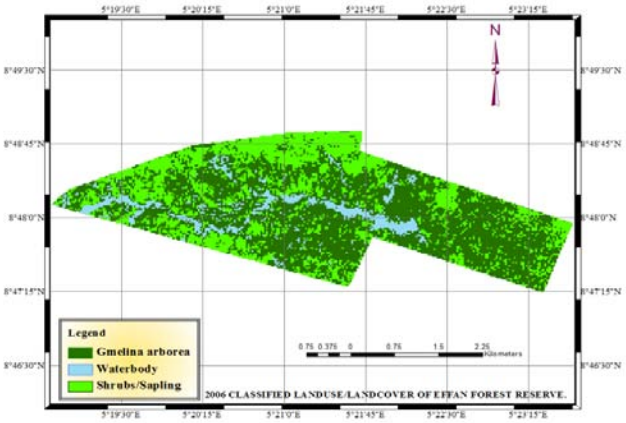


Figure 2 : Classified land use/Landcover changes of Effan Forest Reserve (2001)

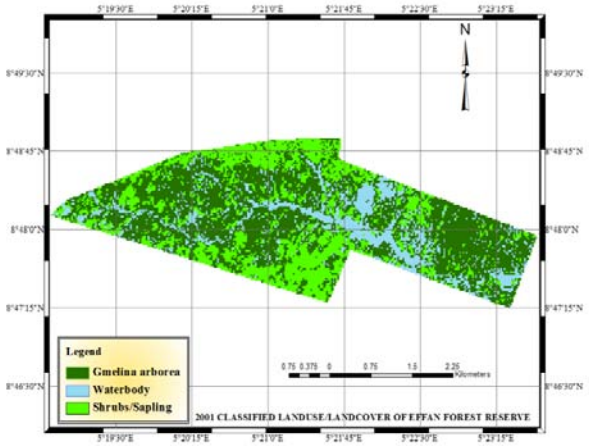


Figure 3 : Classified land use/Landcover changes of Effan Forest Reserve (2006)

Figure 2 and 3 shows illustrate the land use / land cover classification map of Effan Forest Reserve for the year 2001 and 2006. Three (3) categories of land use / land cover were identified; these are: *Gmelina arborea* plantation, Shrubs/sapling and water body.

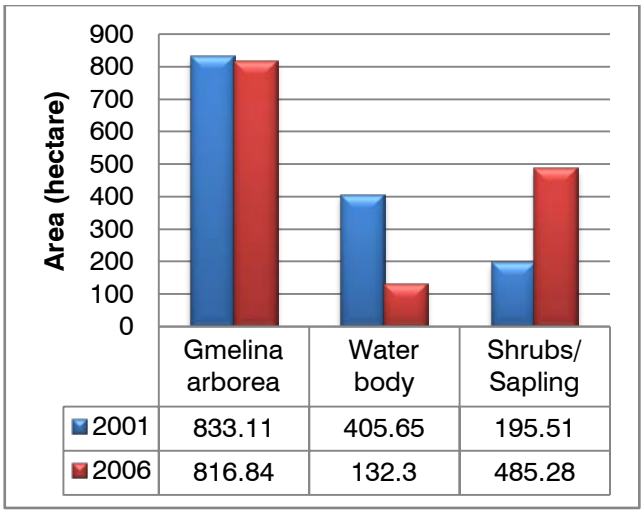


Figure 4 : Chart showing the spatial extent of land cover changes (2001 to 2006)

Figure 4 shows the spatial extent of the 2001and 2006 land use / land cover practice in this Effan Forest Reserve were determined in order to ascertain the causes of forest degradation. The results reveals that there is a small decrease in *Gmelina arborea* plantation between 2001 and 2006 from 833.11 hectares of forest plantation (58.09%) to 816.84hectares of forest plantation (56.95%) which is a loss of about 16.27hectares or 1.95% during the five (5) years intervals.

However, amongst the three (3) major classes identified, two distinct classes was identified as land use practices to be the contributing factor that are partially depleting the reserve; they are the Shrubs/Sapling and the water body in this study. Shrubs/Sapling (i.e. regenerating part) area alone account for 13.63% of deforestation in 2001 and rises up to 33.83% in the year 2006 in which the *Gmelina arborea* are cut down while water body account for 28.26% of degradation in year 2001 and reduces drastically to 9.22% in 2006. All these activities were leading to degradation of the forest plantation.

Furthermore, It was found that shrubs/sapling increased immensely in size from 2001 to 2006 (5 years) i.e. for good 5 years so many trees were harvested in the reserve for fuel wood and charcoal, making matches stick, packing cases, making quality toys and picture frames, timber which is used for construction in roofing houses and as well as for other ornamental works (Plate1). However, with the tremendous increase in the rate of Shrubs/Sapling and as well decrease in water body within that short period of time, it has a fundamental impact on the Reserve since *(Gmelina arborea)* in the reserve is a fast growing specie, though the percentage of degradation is small.

Plate 1 : Image showing Gmelina arborea plantation of the Reserve

b) Vegetation Reflectance of Effan Forest Reserve

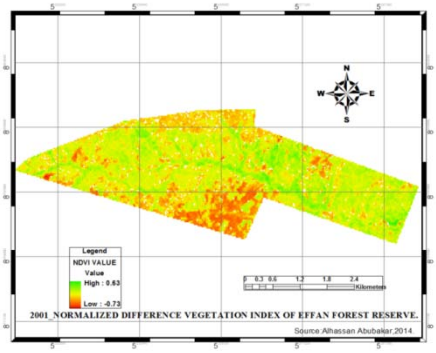


Figure 5 : Vegetation Index Map of Effan Forest Reserve (2001)

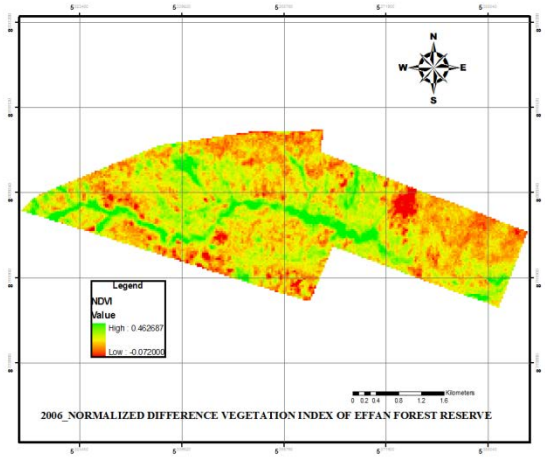


Figure 6 : Vegetation Index Map of Effan Forest Reserve (2006)

Figure 5 and 6 shows the vegetation reflectance of Effan Forest Reserve for the year 2001 and 2006. The 2001 have an NDVI values which ranges from - 0.73 to 0.63 indicate a high biomass. As at this time, the number of Shrubs/Sapling (i.e. regenerating part) is very low signifying that the Reserve is still intact.

However, the 2006 image vegetation reflectance is very low, conversely with an NDVI values ranging from -0.072 to 0.46 indicate a decrease in the biomass of the Reserve. This re-affirms that there was decrease in the number of *Gmelina arborea* plantation in the Reserve as so many trees were cut-down and there is high level of *Gmelina arborea* re-generation (Sapling/Shrubs).

From these, the changing pattern of vegetation reflectance during 2001 and 2006 periods revealed that, the NDVI values in 2001image indicate a high biomass. Conversely vegetation reflectance is low in 2006 image likewise in NDVI value indicate a decrease in the biomass of the Reserve which is an indication of forest degradation.

c) *Estimates of Above – Ground Biomass and Carbon Sink*

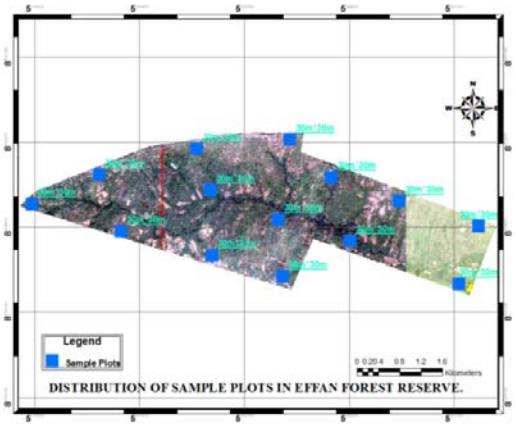


Figure 7 : Locations of Sampled Plots in the Study Area

A total of 14 randomly sampled plots were selected, each plot measuring (30m x 30m) quadrant with an area of 900m^2 was used in this study. *Gmelina arborea* was the dominant tree specie observed in the study area (Fig. 7).

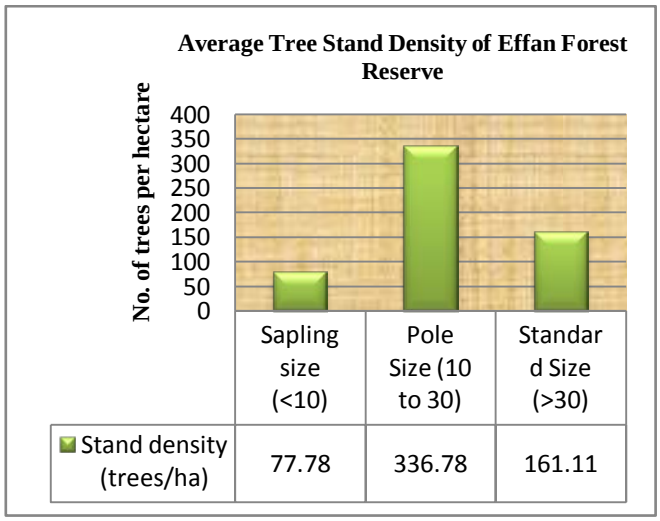


Figure 8 : The distribution of sampled trees in the study site

A total number of trees measured were 652 ranging in diameter at breast height (d.b.h) from 7.0 to 63.65cm which were classified into various classes. The Sapling i.e. Young tree class with diameter at breast height (d.b.h) below 10cm have an average Stand density of 77.78trees/ha, the Pole size tree with diameter at breast height (d.b.h) ranging from 10 to 30cm have an average Stand density of 336.78trees/ha and the Standard tree with diameter at breast height (d.b.h) greater than 30cm have an average Stand density of 161.11trees/ha which were measured for above-ground biomass shown in the Figure 8.

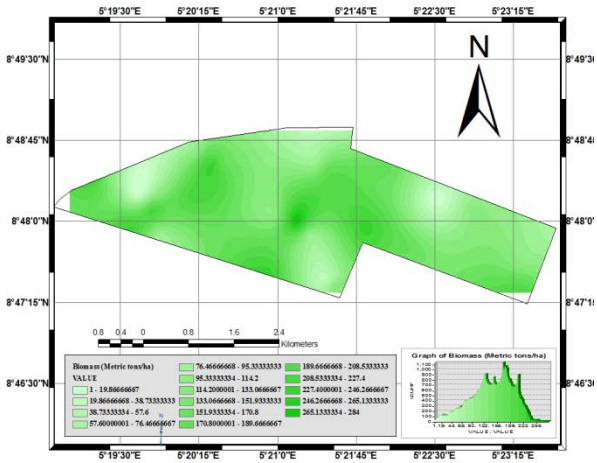


Figure 9 : Distribution of above- ground biomass in Effan Forest Reserve

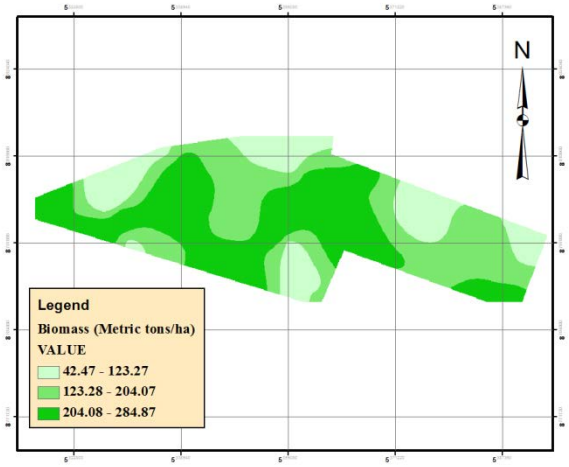


Figure 10 : Re-Classified map of Above – ground biomass

Figure 9 shows the biomass change of Effan Forest Reserve, the Standard size has the highest biomass and capacity to sequester carbon while the Sapling size has the least capacity. Capacity of the plantation to sequester start to decline as the rotation age is achieved like the case of Standard trees. This can be explained by the trend in tree growth that is, as the tree reached its Standard size, its growth starts to decline resulting to less carbon sequestered per year

but have the potential to store more carbon. If the biomass is kept in the plantations it will continue to store more carbon but its sequestration rate will reduce as the trees grow old.

The above – ground biomass map is also re-classified into three (3) Classes as shown in (figure 10) to represent the Sapling, Pole and Standard size classes. This reveals that the Sapling has the biomass ranging from 42.47 to 123.27metric tons/ha, the Pole size has the biomass ranging from 123.28 to 204.07metric tons/ha and the Standard size trees has the biomass ranging from 204.08 to 284.47 metric tons/ha. Therefore, majority of the biomass content in the Reserve fall under the Pole size class in terms of the area covered in the reserve.

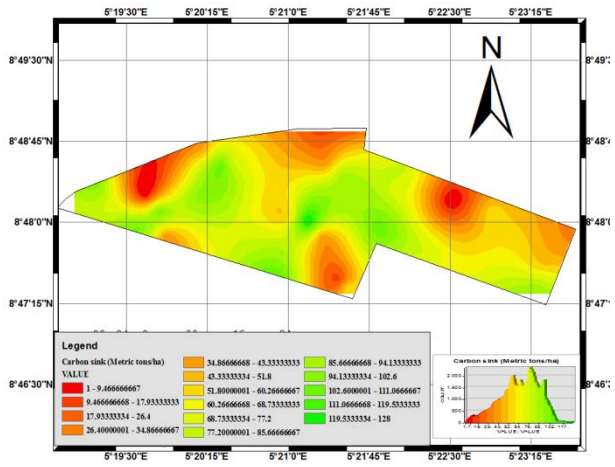


Figure 11 : Distribution of Carbon sinks in Effan Forest Reserve

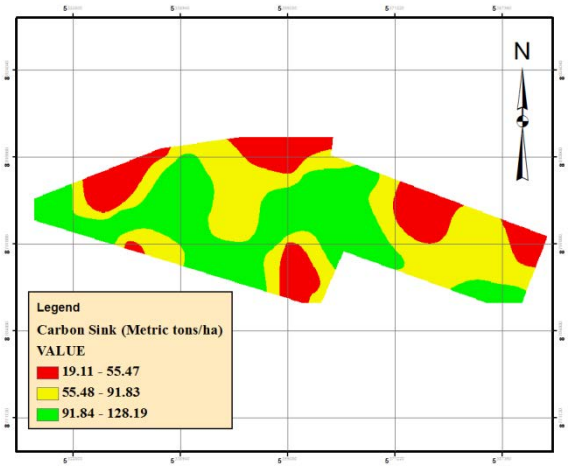


Figure 12 : Re-Classified map of Carbon Sink

The carbon stored and sequestered for different classes of *Gmelina arborea* plantation varies. The plantation had a storage of 19.11metric tons C/ha for Sapling Class, to 128.19metric tons C/ha for Standard size trees (Fig. 11). Standard size trees have the highest sequestration capacity to store carbon since its biomass was also high at 286.29metric tons/ha. From Sapling to Standard size trees, a rapid increase in biomass was recorded and thus its storage capacity is due to the characteristics of *Gmelina arborea* for fast growth.

Furthermore, figure 12 shows the Re-classified map of carbon sinks into three (3) Classes representing the Sapling, Pole and Standard size classes. This revealed that the Sapling has the carbon density ranging from 19.11 to 55.47metric tons/ha, the Pole size has the carbon density ranging from 55.48 to 91.83metric tons/ha and the Standard size trees has the carbon density ranging from 91.84 to128.19 metric tons/ha. Therefore, majority of the carbon content stored in the Reserve fall under the Pole size class as apparent (i.e. area covered) in figure 12.

d) Carbon Dioxide Sequestration Capacity of Effan Forest Reserve

In general, the Effan Forest Reserve in Kwara State has a total area of 1,435 hectares. This area has a total biomass of 89,544metric tons. A total of 40,294.8 metric tons was estimated to be the CO_2 sequestration capacity of the forest stand in Effan Forest Reserve. Thus, the *Gmelina arborea* plantation in Effan Forest Reserve can be useful to reduce the increasing amount of carbon dioxide concentration in the atmosphere, thereby mitigating the effect of climate change.

The parameters considered as wood density, diameter at breast height (d.b.h) may have interplayed, giving additional or compensatory effects. This can be further explained by the fact that the *Gmelina arborea* numerically showed to have the higher amount of carbon sequestered at older stages.

The work of Huy *et al*. (2008) however, revealed that biomass and carbon density varies among tree species. This study may not have been using a large number of sampled trees with significantly varied morphological characteristics. The carbon density value for *Gmelina* used in this study was obtained from the experiment reported by Sales et al. (2005) who studied the carbon density values at various ages of tree species in the Philippines.

In addition, CO_2 sequestration and storage were dependent on the amount of biomass of trees, specifically, on the variable trunk diameter. This conforms to the findings of Terakunpisut *et al*. (2007) who mentioned that carbon sequestration potential in the different forest types tends to be correlated to DBH and tree height . Moreover, the wood density did not differ much from different regions considered so that it did not have a notable effective at removing carbon dioxide from the air, thus, it is considered as one of the variables in computing for carbon density.

The value 40,294.8metric tons as the total CO_2 sequestration capacity of the Effan forest reserve area is sufficient enough to contribute to the mitigation of climate change. Based from the findings of Denman et

al. (2007) and as cited by Lasco *et al* (2009) it is estimated that about 60 Gt C is exchanged between terrestrial ecosystems and at atmosphere every year. Maintenance and expansion of this carbon sink in the study area may even showcase for the adaptation of the smallholders to climate change.

IV. Conclusion

It is apparent from this study, that so many trees were cut-down for domestic and industrial uses which lead to the reduction in the biomass of the Reserve and low vegetation reflectance. The *Gmelina arborea* plantation of the Reserve, regardless of their class, the bigger trees, particularly at their Standard sizes, sequestered the greatest amount of CO_2. Provided that these trees are allowed to grow and were not cut for any purpose at all, they continue to provide the safety net for the adverse effects of climate change. There is significant amount of carbon sequestered at the Effan Forest Reserve in Kwara State (with an area of 1435 hectares) shows the potential and significant CO_2 sequestration by trees. As it was noted, the sequestration capacity increases as the size of forest stand also increases. *Gmelina arborea* tree specie can be used in the reforestation program to help mitigate global warming, since it was also found to be fast regenerating specie and there was significant difference in terms of the rate of CO_2 sequestration capacity as these trees becomes mature. It is now suggested that the option to reserve carbon in the forests is by minimal intervention, with a gradual long – term increase in carbon stocks.

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References Références Referencias

1. Aerial Survey Office of Forestry Bureau. 2000. Multi-satellite remote sensing survey in the island green resources, tracking, analysis and comparison of final report.
2. Chave, J., Andalo, C., Brown, S., Cairns, M., Chambers, J., Eamus, D., et al. 2005. Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia, 145(1), 87 – 99. (Retrieved from http://www.firescience.gov/projects/03-3-3 15/project/03-3-3-15_Litt.pdf on February, 2013).
3. Convention on Biological Diversity. 2010. COP10 Decision X/2. Strategic plan for biodiversity 2011–2020. [online] URL: http://www.cbd.int/decision/cop/? Id = 12268.
4. Convention on Biological Diversity. 2010. COP10 Decision X/2. Strategic plan for biodiversity 2011–2020. [online] URL: http://www.cbd.int/decision/cop/?id=12268.documentation/documents/advanced_search/items/6911.php?priref=600005734.
5. FAO (Food and Agriculture Organization). 2005. Global forest resources assessment. Food and Agriculture Organization, Rome, Italy. [online] URL: http://www fao.org/forestr/fra2005.
6. Haase R. And Haase P. (1995); Above-ground biomass estimate for invasive tree and Shrubs in the Pantanal of Mato Grosso. Forest Ecology and Management, Volume 73, Issues 1-3, May 1995, Pages 29-35.
7. Jiang M. F. 2009. Using 3D remote sensing data to analyze the CO2 balance in Vicinity of road-case study of highway No.84 at Taiwan. Master's thesis, National Cheng Kung Univ.
8. Lasco, R.D., Pulhin, F.B., Cruz, R.V., Pulhin, J.M., and Roy, S.S. (2009). Carbon Budgets of Terrestrial Ecosystems in the Pantabangan-Caranglan Watershed. AIACC Working Paper No.10.
9. Mery, G., P. Katila, G. Galloway, R. I. Alfaro, M. Kanninen, M. Lobovikov, and J. Varjo, editors. 2010. Forests and society: responding to global drivers of change. IUFRO World Series Volume 25. International Union of Forest Research Organizations, Vienna, Austria. [online] URL: http://www.iufro.org/science/special/wfse/forests-
10. Monteith, J. 1972. Solar radiation and productivity in tropical ecosystem. Journal of Applied Ecology, Vol. 9, pp. 747-766.
11. Parry, M. L., O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson, editors. 2007. Contribution of Working Group II to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK. [online] URL: http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html.
12. Rao N.H and Rogers P.P 2006; Assessment of agricultural sustainability. Current Science, VOL. 91, No. 4, 439 – 448.
13. Salami A.T. & Balogun E.E. (2004): Validation of Nigeria Sat-1 for Forest Monitoring in South-west Nigeria NARSDA Abuja. (Retrieved fromhttps://www.fig.net/pub/fig2012/papers/ss03b/SS03B_akingbo gun_kosoko_et_al_6208.pdf on October, 2013).
14. Secretariat of the Convention on Biological Diversity. 2002. Review of the status and trends of, and major threats to, the forest biological diversity. CBD Technical Series 7. Secretariat of the Convention on Biological Diversity, Montreal, Canada. [online] URL: http://www.cbd.int/doc/publications/cbd-ts- 07. pdf. society-global-drivers
15. Steven Loiselle; Simone Bastianoni; Luca Braccini; and Claudio Rossi 2005; Neotropical wetlands: New instruments in ecosystem management. Wetlands Ecology Management. Volume 12, Number 6. Pp. 587-596 (10).

16. UNFCCC (United Nations Framework Convention on Climate Change). 2010. Report of the Conference of the Parties on its fifteenth session, held in Copenhagen from 7 to 19 December 2009. FCCC/ CP/2009/11. United Nations Framework Convention on Climate Change, Copenhagen, Denmark. [online] URL: http://unfccc.int/
17. Van der Werf, G. R., D. C. Morton, R. S. DeFries, J. G. J. Olivier, P. S. Kasibhatla, R. B. Jackson, G. J. Collatz, and J. T. Randerson. 2009. CO 2 emissions from forest loss. Nature Geoscience 2:737 738. http://dx.doi.org/10.1038/ngeo67
18. Zhu W. Q., Pan Y. Z., Long Z. H., Chen Y.H., Li J., & Hu H. B. 2005. Estimating net primary productivity of terrestrial vegetation based on GIS and RS: a case study in Inner Mongolia, China. Journal of Remote Sensing 9(3):300-307.

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Sediment Analysis of Shelar Lake, Maharashtra

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Abstract- The present paper deals with the physico- chemical properties of bottom sediment of a fresh water lake in which fishing is carried out. The soil of the lake under study was found to contain 35 % sand followed by 25% silt and 40 % clay. Thus the bottom soil was clayed loam in texture. The colour of the soil was black. The pH, conductivity, organic carbon, inorganic phosphate and nitrate were measured seasonally for two years. The water retention capacity of soil was observed as 47 % indicating favorable condition for fish culture practices as well as the chemical parameters which were complementary to it.

Keywords: *sediment, productivity, fresh water, fishing.*

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Sediment Analysis of Shelar Lake, Maharashtra

Archana Gupte [α] & Nisar Shaikh [σ]

Abstract- **The present paper deals with the physico- chemical properties of bottom sediment of a fresh water lake in which fishing is carried out. The soil of the lake under study was found to contain 35 % sand followed by 25% silt and 40 % clay. Thus the bottom soil was clayed loam in texture. The colour of the soil was black. The pH, conductivity, organic carbon, inorganic phosphate and nitrate were measured seasonally for two years. The water retention capacity of soil was observed as 47 % indicating favorable condition for fish culture practices as well as the chemical parameters which were complementary to it.**

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I. Introduction

The loose unconsolidated top layer of earth crust is called soil. It is a site of decomposition of organic matters and mineral materials. Lake soil has several roles to play, especially in the production of fish in the lake. The bottom sediment according to Matida(1968), is important as it supplies essential nutrients to the inflowing water as also in the mineralization of organic sediments and in the storage and release of nutrients in the water. The soil is the chief sources of nutrients for primary producers. The aquatic organic matter and potential energy are stored in the soil at the bottom of a lake in the form of organic residue and humus which regulate the biota of the lake. As pointed out by Jackson (1972), different minerals and organic substances impart a complex structure to the soil. Physically, the lake soil is composed of stones, plant roots, leaves, sand, silt, shells of molluscs and humus.

The presence and proportion of sand, clay, and silt give a relative texture to the soil. Depending upon the predominance of it the soil is said to be sandy, clayed or salty. The water retention capacity of soil is the ability of it to hold water after infiltration. Different textures and composition of the soil impart differences occurring in physical and chemical properties of the sediment. The fertility of soil is influenced by basic nutrients like, Nitrogen and Phosphorus present in the sediment. The soil is composed of abiotic components like minerals, organic matter and biotic components. The organic matter comprises residues of plants and animals at different stages of decomposition and biotic components such as sand, silt and clay. The organic matter is mostly found in the upper layer of the soil which influences the physico-chemical properties of the sediments. According to V.K. Anand et al (2000) the physico-chemical characteristics of bottom sediment in a lake are greatly influenced by geological, regional, climatic factors and also being modified by human activity. Shelar Lake is a fresh water body situated in the rural area of Thane district. It lies between $18^0$42'and $20^0$20' North latitude and $72^0$45'and $73^0$45' East longitude. Earlier this water body was used for drinking and for irrigation. Now a day it is used for fish cultivation. Enhanced population explosion, rapid rate of encroachments and increase in utilization of lake water for disposal and dilution of sewage etc have not only deteriorated the water quality of lake but has also affected the biotic flora. In order to study the bottom sediment of lake the present work has been carried out seasonally for the period of two years by selecting three sampling station for soil analysis.

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II. Material and Methods

Seasonal samplings were done twice in every season for sediment analysis i.e. pre monsoon, monsoon and post monsoon. The soil samples collected in glass jars were brought to the laboratory and dried under shade. The dry soils were grinded, mixed and then sieved through 0.02mm sieve. The soil samples are then analyzed in the laboratory to study its physical features such as colour, texture and chemical composition that are pH, conductivity, Organic carbon, phosphorus and nitrate, as prescribed by Trivedy and Goel (1984).

III. Result and Discussion

On the basis of standard methods Physico-chemical parameters of three seasons (pre-monsoon, monsoon and post monsoon) from February 2009 to January 2011 were studied. Arithmetic mean of all values are given in Table-1

The quality of bottom soil plays a vital role in influencing the biological productivity of any water as the overlying water remains in a state of dynamic equilibrium with the bottom soil.

The particle size knowledge is very important for proper management of soil and water quality. The bottom sediment of a lake should be consisting of organic layer followed by thick loam of layer, which help in economic utilization of the nutrients. During the textural analysis of soil of the lake under study it was found that it contains 35% sand followed by 25% silt and 40% clay. Thus the bottom soil is clayed loam in texture.

Soil texture of the lake varied from sandy – clay to clayed loam. Minor variations observed at different seasons may be related to varying composition of suspended materials brought in from surrounding catchments. Kakavipure (2005) observed similar type of clayed loam soil at Khativli lake. The colour of the soil reflects the physical and chemical nature of the soil. During the period of investigation the colour of the soil is observed to be mostly black. The black soil generally consists of high organic matter. In the present investigation the water retention capacity of soil is observed as 47% indicating favorable condition for fish culture practices.

Usually, the quality of sediment of lakes differ from that of other soil, since it is a mixture of different soil profiles and remains submerged for most of the year. In addition, the lakes receive considerable amount of suspended and dissolved materials from their catchments through surface run off most of which eventually settle down at the bottom and gradually alter the soil quality.

The pH of soil determines the chemical nature of soil. Bottom soil of the lake was found to be neutral to alkaline in nature with pH in the range of 7.8 to 8.91.Maximum pH was recorded during pre monsoon while minimum was noted during monsoon. The soil pH plays important role in soil reaction controlling many chemical reactions responsible for availability of nutrients in optimum quantities to the fish food organism in providing congenital healthy environment, A.K. Das (2000). The neutral pH of bottom sediment was observed by Gupta (1988) in Khandia reservoir. While Usha et al (2006) recorded pH in the range of 8.0 to 8.4.at Perumal Lake Tamilnadu.

Table 1 : Showing seasonal variation

Season	Conductivity		pH		Org Carbon		Inorganic Phosphorus		Inorganic Nitrate	
Year	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Pre Monsoon	0.17	0.17	8.23	8.13	0.59	0.74	0.85	0.93	0.36	0.39
Post Monsoon	0.17	0.17	8.91	8.2	0.84	1.02	0.96	1.09	0.15	0.29
Monsoon	0.16	0.17	7.82	7.83	1.02	0.96	0.62	0.61	0.06	0.07

The conductivity is a parameter, which indicates the presence of total soluble salts in the bottom sediments. The changes in conductivity are associated with release of soluble ions in the soil water system which might have indirect effect in the lake productivity. The sediment conductivity was observed in the range of 0.16μmho/cm to 0.17μmho/cm. The conductivity value of soil increases with stagnant condition of any water body due to restricted outflow. It is observed that the stagnation might have resulted in the concentration of dissolved salts, which increases conductivity. Decrease in conductivity values during pre monsoon might be due to the utilization of ionic minerals by the producers.

As pointed out by Sharma (1994), the organic carbon with other nutrients makes the sediments nutrient rich, which influence the productivity of the lake. Organic carbon content of the lake under investigation fluctuated between0.59% to 1.02%. It has been observed that soil with organic carbon content of 1.5 to 2.5 % or above is considered productive in nature (Banerjea, 1967). Lendhe (2004) observed lesser value of organic carbon as compared to present study. Lendhe observed that high yield fish production is more in lake containing less organic carbon. Increase in carbon content in soil during pre-monsoon and monsoon may be due to decomposition of humus.

Phosphorus and nitrogen are the important constituents of plankton; the present study shows phosphate content of soil in the range of 0.61 mg/100gm to 1.09mg/100gm and nitrogen in the range of 0.06 mg/100gm to 0.39mg/100gm. It is observed that the phosphorus content is very low which is responsible for low productivity of the lake. The minimum level of nitrogen-nitrate was observed during monsoon season may be due to mixing of bottom sediments with the lake water. The nitrogen concentration in the lake under study corroborates the findings of Pandey et al (1995) in Kawar Lake. Baig et al (1990) observed that high alkalinity promotes gross productivity where as high nitrates inhibits. Lower nitrates and optimal phosphates influence the productivity.

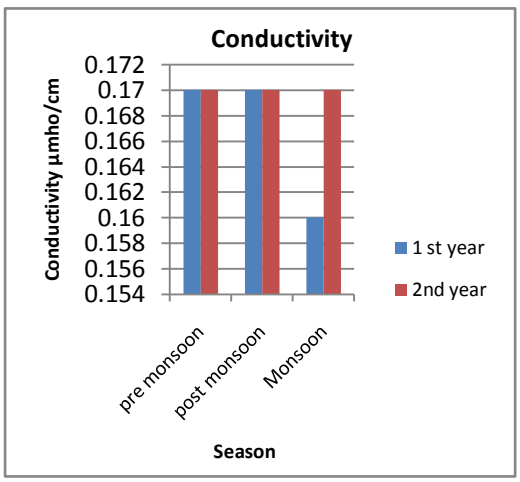

Figure 1 : showing seasonal variation in conductivity of soil

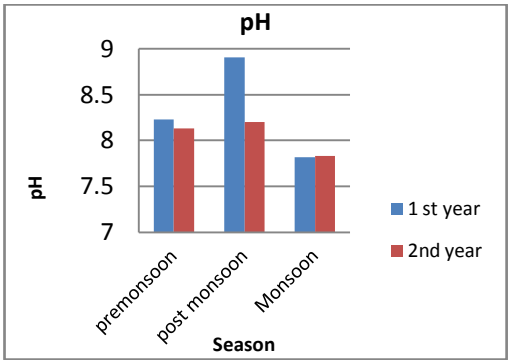

Figure 2 : showing seasonal variation in pH of soil

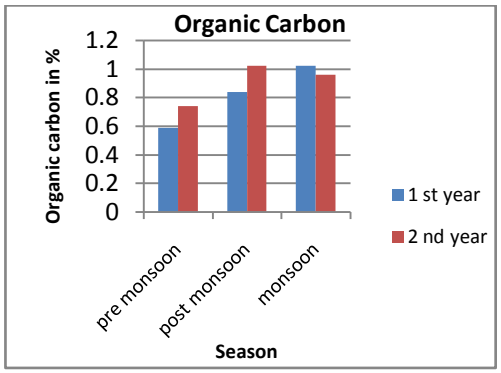

Figure 3: showing seasonal variation in organic C of soil

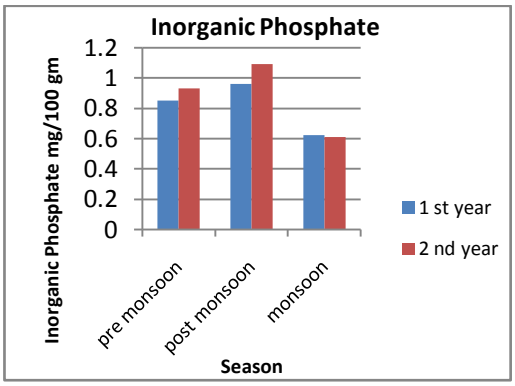

Figure 4 : showing seasonal variation in inorganic P of soil

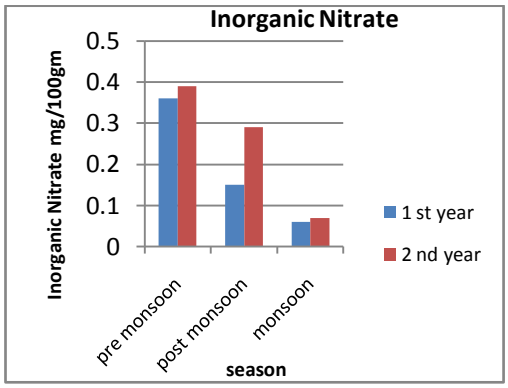

Figure 5 : showing seasonal variation in inorganic N of soil

IV. Conclusion

- Bottom soil was black colour clay loamed with 47 % water holding capacity.
- Sediment of the lake was found to be neutral to alkaline in nature with pH in the range of 7.8 to 8.91. In the present study neutral to alkaline pH is recorded which has been considered favorable for fish production.
- The sediment conductivity was observed in the range of 0.16μmho/cm to 0.17μmho/cm. The narrow range of fluctuation of conductivity in the lake can be attributed to the detention of water for long term due to restricted out flow and also due to reduction in water level which led to stagnation and hence increase in the concentration of dissolved salts. The conductivity of the lake under study is found to be moderate.
- Organic carbon content of the lake under investigation fluctuated between0.59 % to 1.02 %. The organic carbon content in the Shelar Lake shows that the lake is productive.
- Phosphorus and nitrogen are the important constituents of plankton, the present study shows phosphate content of soil in the range of 0.61 mg/100gm to 1.09mg/100gm and nitrogen in the range of 0.06 mg/100gm to 0.39mg/100gm.The lake shows marginally higher soil pH as well as considerably low available nitrogen and available phosphorus which suggest gradual accumulation of organic matter and nutrients in the lake over the years.
- For both the years, P and N accumulation rates were higher in summer than in other seasons.
- Our study provides a useful baseline against which to identify future changes in ecosystem structure and function which could result from a variety of factors.

V. Acknowledgements

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References Références Referencias

1. APHA, AWWA and WEF (2005) Standard Methods for the Examination of Water and Wastewater; 21st Edn. Washington D.C
2. Baig N.M.N. (1990) Study on the river Ulhas with respect to pollution in the vicinity of Shahad-Ambivli industrial area and its effects on Punctrus Sophore. Ph.D. Thesis University of Mumbai.

3. Banerjea, S.M.(1967) Water quality and soil condition of fish ponds in some states of India in relation to fish production, Indian J. Fish., 14 (1and2): 115 – 144.
4. Das A. K (2000) Role of Physical and Chemical features of soil in reservoir productivity, Fishing Chimes, Vol. 20 No.7, pp.30-32.
5. Jackson D.F. (1994) Limnology 14,125:133 Jackson M.L. (1972) Soil chemical analysis Pentic Hall, Inc. Englewood.
6. Kakavipure D.K. (2005) Environmental Studies in relation to aquaculture of Khativali-Vehloli Lake, University of Mumbai.
7. Lendhe R. S. (2004) Ecophysiology of Phirange Kharnav Lake. Ph.D. Thesis submitted to University of Mumbai.
8. Matida Y (1968) the role of Soil in fish pond productivity in Asia and the Far East FAO. Fish Pep. 44. Vol.3: 153-163.
9. Pandey K.N., V. Prakashand U.P. Sharma (1995) Assessment of primary productivity of phytoplankton and macrophytes of Kawar lake wetland (Begusari), Bihar. J. Fresh water Biol. 7(4): 237 – 239 pp.
10. Trivedi R.K. and Goel P.K. (1984) Chemical and Biological methods for water pollution studies. Environmental Publications, Karad, India. Pp.122.
11. Usha R. Ramalingum K.Bharathi Rajan U D(2006) Fresh Water lakes- a potential service for aquaculture activities – a model study on Perumal Lake, Cuddalore, Tamil Nadu,India J .Environ Bol. 27(4) : 713-22.
12. V.K. Anand and Suman Sharma (2000) Physico-chemical characteristics of bottom sediments of Lacustrine habitats of Jammu Lake, Srinagar. Ecol. Env. and Cons. 6(4): pp. 409- 418.

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An Assessment of Religious Ceremonies and their Impact on the Physico-Chemical and Microbiological Characterization of Foremost Seawater in Navagraha Temple, Devipattinam, Tamil Nadu, India

By Nirmaladevi D Shrinithivihahshini, Rajendhiran Viji, Mariyaselvam Sheelamary, Rengaraj Chithradevi, Duraisamy Mahamuni & Dharmaraj Ramesh

Bharathidasan University, India

Abstract- The aim of this study is to assess seawater quality and impacts of traditional ritual ceremonies on foremost seashore Navagraha temple. The seawater samples were collected at seven different station and water quality parameters were analyzed on the standard methods. Physico-chemical parameter; pH, electrical conductivity, temperature, total suspended solids, total dissolved solids, total solids, biological oxygen demand, sulphate and microbiological indicators; total heterotrophic bacterial count, total fungal count, total actinomycetes count, and total enteric bacterial count were performed. These results indicated that the water highly exceeds the Indian primary seawater quality standards criteria-II. To prove this hypothesis unregulated celebrations of religious ceremonies are highly polluting the seawater and it cause significant adverse impact on human and marine biota. Our results can provide the potential value for alternative ritual activities and calls for urgent intervention by government management policy on a local and regional support future policy decisions and awareness.

Keywords: *coastal, pollution, seawater, indicators, devotees, holy-place.*

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Nirmaladevi D Shrinithivihahshini [α], Rajendhiran Viji [σ], Mariyaselvam Sheelamary [ρ], Rengaraj Chithradevi [ω], Duraisamy Mahamuni [¥] & Dharmaraj Ramesh [§]

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I. Introduction

Assessment of seawater quality monitoring for the physico-chemical and microbial indicator is essential for protecting the marine ecosystem and human health (Touron *et al.,* 2007). Worldwide, 60% of the marine ecosystem is in polluted condition, and particularly 40% are because of anthropogenic activities (IOC/UNESCO, IMO, FAO, UNDP, 2011). The coastal and marine pollution impacts are more complex and diverse on earth and human beings (UNEP, 2011). In the past few decades, unregulated anthropogenic activities, such as insufficiently treated urban, municipal, domestic, and industrial wastes water discharges are the major deterioration factors in the marine ecosystem (Borja *et al*., 2008; Subramani and Aalbersberg, 2012; Stabili and Cavallo, 2011). These anthropogenic activities have increased the nutrients load, hazardous chemicals, and pathogenic and nonpathogenic microorganisms (Chao *et al*., 2010). These effects naturally induces changes in the numbers of seawater temperature, transparency, water masses, salinity, dissolved carbon dioxide, increased oxygen demand, deposition of organic matter, and pathogenic microbes growing in favorable condition, such as bacteria, fungi, viruses, parasites, and algae (Spatharis *et al*., 2007; Lloret *et al.,* 2008; Oliveira *et al*., 2010). Long-term survival and adaptation of proliferating pathogenic microorganisms have led to deterioration of marine organisms and environmental conditions (Stewart *et al*., 2008; Janelidze *et al.,* 2011). Particularly, costal economic zone for the coral reef 20%, mangroves 30–50%, and sea grass 29% affects global level (Wilkinson, 2008; Nellemann *et al*., 2009).

In addition, human health impacts of the waterborne disease and infections, such as gastroenteritis, hepatitis, respiratory tract infection, ailment, meningitis, ear, eye, nasal cavity infection, etc., are associated with consumption of contaminated seafoods and contacts of coastal materials for recreational activities (Jones and Oliver, 2009; EFSA, 2010; Carrasco *et al*., 2012). Furthermore, treatment of disease caused by pathogenic marine microbes costs 900 million dollars every year. Particularly, 300 million dollars has been spent for gastrointestinal illness caused by beach recreation (Ralston *et al*., 2009). In this situation, many countries are involved in coastal pollution control by monitoring the physico-chemical and microbiological parameters to meet safety levels (Figueras *et al*., 1997; Georgiou and Bateman, 2005). Especially, microbial pollution is monitored by total heterotrophic bacterial counts (THBC), total coliform counts (TCC), total fecal coliform counts (TFC), and fecal streptococci counts (FSC). These indicators

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assessments are effectively useful for the control of coastal pollution (Stevens et al., 2003; Kistemann *et al*., 2002; Baghel *et al*., 2005; Halliday and Gast, 2011). These spatial and temporal variations emphasize as the important factor of the coastal environment quality (WHO, 1998; Thaddeus *et al*., 2010; Marine Water Quality, 2013). Because higher levels of pathogenic bacteria are recorded in coastal environment, a number of waterborne and communicable diseases are caused to human beings (Dada *et al*., 2012; Janelidze *et al*., 2011).

India is surrounded by coastline to about 8085 km. It is playing a pivotal role in the people population, social, economic, cultural, and religious activities. These regions have a wide range of anthropogenic activities, which have considerable adverse impacts on the marine ecosystem (Nobi *et al*., 2010). Especially, the religious activities have contributed significant part of the coastal pollution because most of the religious ceremonies are conducted in the nearby water bodies (AHEC, 2011). Degradable and non-degradable materials, such as flowers, milk, curd, vegetables, gee, coins, idols, ashes of departed ones, and body hairs are the major pollutants in water bodies; every day, 10,000-50,000 people take ritualistic mass bathing (Marale *et al*., 2010). In addition, approximately, 60,000 human cremated dead bodies and about 15,000 incomplete burnt dead human and animal bodies annually dumped in the holy water bodies (Mishra *et al*., 2009). These types of religious activities have been vigorously affecting the aquatic environment, which cause communicable disease for human being and aquatic organisms (Semwal and Akolkar, 2006; Vinay *et al*., 2005; Bhatnagar and Sangwan, 2009; Sangeeta and Savita, 2011; Sharma and Bhadula *et al*., 2012). Given this situation, this study focuses on the devotees using ablution pond and toward offshore seawater spatial variation of physico-chemical and microbial behaviors compared with the Indian primary water quality criteria for class SW-II waters for bathing, contact water sports, and commercial fishing standard. Output obtained in this study result provides baseline information on coastal pollution identification, valuable suggestion for ritual ceremonies regulation, the waterborne and communicable disease prevention, and management strategies for the resolution by the local authorities.

II. Description of the Study Area

Thilakeswara temple, popularly known as Navagraha temple, is an important venerated pilgrim centre and much remembered and quoted in the cultural heritage and history of India and devotees come from all over India and abroad. This is an ancient temple existing from the time of epic battle of Ramayana. The exact location of the temple comes in Devipattinam village, Ramanathapuram district of Tamil Nadu (Figure 1). It is the only temple situated in the sea (Bay of Bengal) at about approximately 100 m away from the shore, built for the holy Navagrahas. The worship place is located exactly at a latitude of $9.47'97^0$ N and longitude of $78.89'57^0$ E. The temple consists of nine stone pillars representing nine celestial planets (deities); various worshipping rituals are performed in the form of offering coins, nine grains, and flowers in the sea, and many take a holy bath in the ablution pond to escape from the adverse effects caused by the planets (as per Hindu religious basis). Hence, the devotees frequently visit the place, and sometimes the number of population may touch even 3000 approximately. The place is heavily congested with the people during festival time, and particularly, its number highly increases at the time of the festival periods, such as new moon day of January and February months. Puja is a religious ceremony, and for Navagrahas, people offer nine varieties of grains, such as paddy, wheat, dal varieties, pulses, Dil, etc. in nine stones. Devotees have the deep belief that worship will relieve their sufferings and sins of previous birth. Therefore, it's also these coastal regions having potentiality for fishing and aquaculture practices with no other pollution source other than people intervention. This is the main intention, using the physico-chemical and microbial tools, we made a study towards sanitary aspects of those people who are coming from various part of the country.

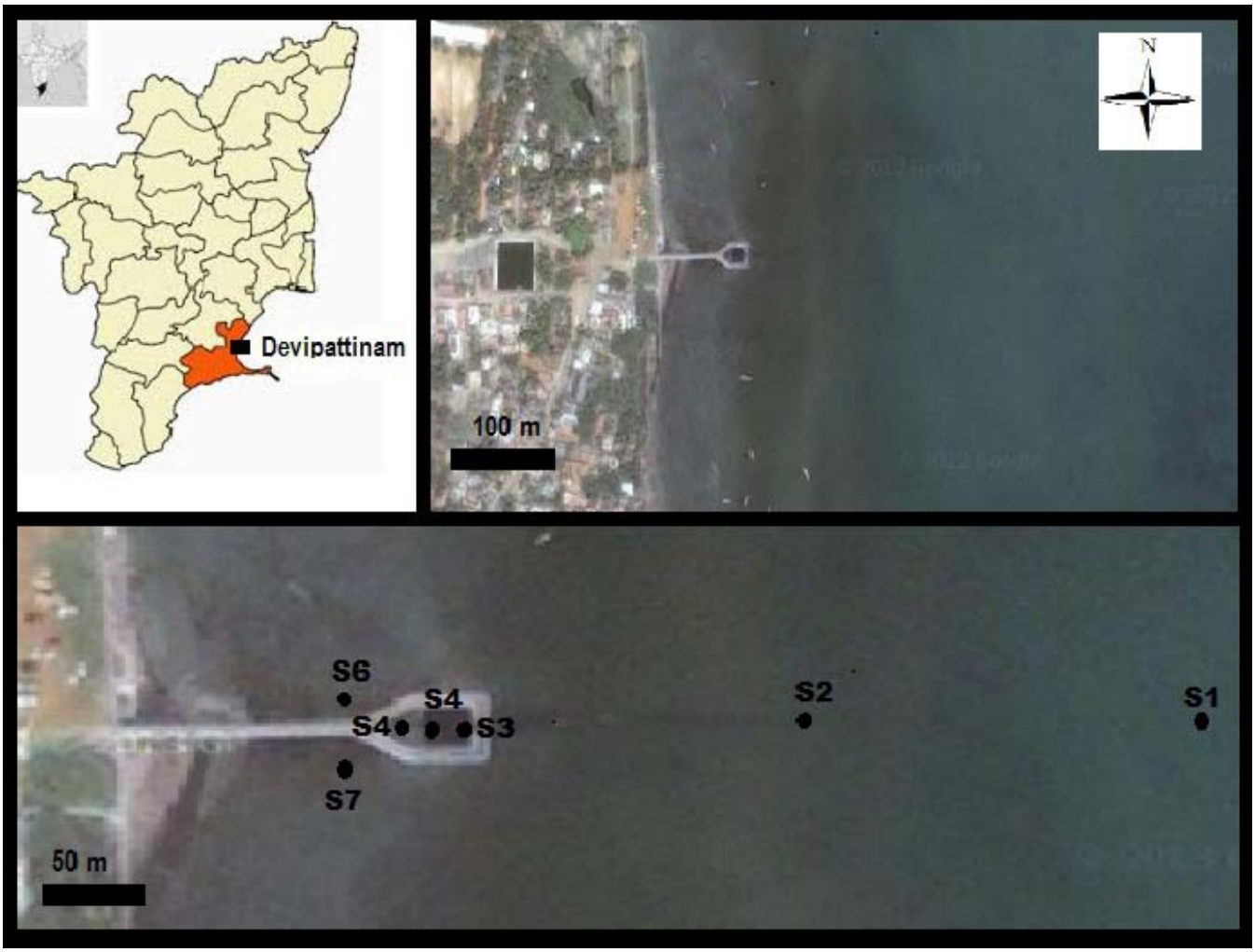

Figure 1 : Aerial photos of sample sites depicted and along the around Devipattinam Navagraha temple coastal environment (available from google.com

III. Materials and Methods

a) Sample collection

Seawater samples were collected from seven different station of ablution pond towards offshore at 1 and 2 km coastal zones near Navagraha temple. Water samples were collected at 30 cm depth in sterile plastic bottles, placed in cooling boxes, and immediately transferred to the laboratory according to the standard methods of APHA, 1998.

b) Physico-chemical parameters analysis

pH, temperature, and electrical conductivity (EC) were measured using water analysis hand meters and temperature measured using a standard mercury-filled centigrade thermometer. Samples were stirred gently, and stable readings were recorded. Total suspended solids (TSS) were determined by filtering seawater 1.2 μm using Millipore GF/C filter paper method; for determining total dissolved solids (TDS) and total solids (TS), hot air oven 105°C 8 h method was applied (Sahu *et al*., 2013). Biological oxygen demand (BOD) and sulphate (SO_4) were measured using standard APHA method.

c) Microbiological parameters analysis

The seawater total heterotrophic bacteria populations were counted (THBC) by pour plate method using the nutrient agar medium. Seawater sample of 0.1 ml was taken with a sterile micropipette and directly poured on the nutrient agar medium plates. All the plates were incubated at 37°C for 24 h. Furthermore, same procedure as mentioned was followed for measuring total fungal count (TFC) by Rose bengal agar medium plate. The plates were incubated at 28°C for 72 hours. Total actinomycetes populations were counted (TAC) by pour plate method. Samples of 0.1 ml were poured into the Kenknight agar medium. The plates were incubated at 28 ± 2°C after 96 h. Total enteric bacterial populations were counted (TEBC) from 0.1 ml sample poured on the (Eosin Methylene Blue Agar) EMB agar medium. The plates were incubated at 37°C for 24 h. (all media were purchased from HI-MEDIA

Laboratories Pvt. Ltd India). All samples were done in triplicate; mean value and averages obtained for microbes densities values were expressed as colony-forming units all samples.

d) Statistical analysis

Statistical analysis was performed using statistical package 'SPSS software version 17'. Data are presented as the Pearson correlation test was performed for physico-chemical parameters and microbial indicators.

IV. Results and Discussion

The results of our study concluded that religious ceremonies highly affect seawater. This study highlights the presence of ubiquitously distributed waterborne disease causing pathogenic enteric bacterial species in seawater. In India, this study is one of the first to evaluate relationships between coastal environment and religious ceremonies activities affecting seawater. The contaminating factors were assessed when comparing with Indian primary water quality criteria of class SW-II waters for bathing, contact water sports, and commercial fishing standards (Anonymous, 2001).

a) Assessment of physico-chemical pollution indices parameters

The measurement of temperature of seawater in seven stations showed slight variations. The temperature ranged from 29.0 to 33.0 °C (Fig. 2a). There was not an appreciable change in the temperature (Leifer, 1988; Solic and Krstulovic, 1992;). The natural pH of seawater ranges from 7.5 to 8.5. Anthropogenic activities and other natural disorders affect seawater pH values to below pH 7.5 and above pH 8.5 (Jayakumar, 2013). pH 7.7 value was recorded in the station 5 and pH 8.3 value was recorded at station 2. The inshore location had basic condition 7.87, 7.83, 7.76, 7.91, and 7.98 at ablution pond zones when compared with offshore environment seawater (Fig. 2b). This might be attributable to the offering of organic materials. The fluctuation of the hydrogen ions concentration has directly affected the marine biotas (WHO, 1989; Kalita *et al*., 2006; Umamaheshwari, 2010; Sharma *et al*., 2012). The EC values showed small changes in the seven sampling station (Fig. 2c). The inshore ablution pond station showed 18.83, 18.87, 18.85, 18.87, and 18.86 mS/cm. The obtained results matched with the findings of Mehta (2013). The measurement of TSS ranged minimum of 3160 mg/l at station 1 and maximum level 8920 mg/L at station 6 (Fig. 2d), TDS minimum level of 34,880 mg/l and maximum level of 38,400 mg/l were recorded station 5 (Fig. 2e), TS minimum value ranged from 38,040 mg/l in station 1 and maximum value to 45,480 mg/l in station 6, respectively (Fig. 2f). Solid particles were highly recorded at the ablution pond and nearby station zones because of mass bathing, offering vegetables, flowers, garlands etc highly promoted the solid particles (Mathur *et al*., 2008). The excess level of solids particles in aquatic environment caused various stresses, such as increasing oxygen demand, low-nitrification rate, and promoted propagation of pathogens. In addition, low level of solid particles reduces light penetration into seawater, and it affects the primary production of algae, macrophytes, and sea grasses and its direct damage reduces fish growth rate and causes fish diseases in the marine ecosystem (Klontz *et al*., 1985, Liltved and Cripps, 1999). These solid particles are transported to the offshore environment which led to many serious deleterious effects affecting the seawater and benthic environment biological species diversity (Kim and Yur, 2004). Especially, this coastal region immensely supports the rich and diverse fauna like corals, sea anemones, mollusks, sea cucumbers, starfishes, and sea urchins, and it also serves as feeding and nursery habitat for endangered species, such as dugong, turtles, and many commercial and recreationally important fishes (Manikandan *et al*., 2011). Therefore, water quality protection is more crucial in this region. The measurements of BOD values observed ranged from 13 mg/l to 26 mg/l. Minimum range values were observed in the offshore station, and maximum level values were observed in the inshore ablution pond station (Fig. 2g). Several authors have reported that religious activities highly promoted the organic load in the aquatic environment because of which more amount of oxygen depleted in the aquatic environment (Kulshrestha and Sharma, 2006; Kaur, 2012). BOD measurement of inshore water showed that aquatic environment is highly affected. This measurement is major prime factor affecting water quality (McCoy and Olson, 1986; Singh *et al*., 1999; Parashar *et al*., 2003; Sangeeta and Savita, 2011). The sulphate showed minimum range of 2715 mg/l recorded from station 1 and maximum range of 3201 mg/l recorded at station 7 (Fig. 2h). The physico-chemical parameters results showed strong correlation as observed with solid particles in ablution pond stations zones (shown in the Table 1).

Fig.2a

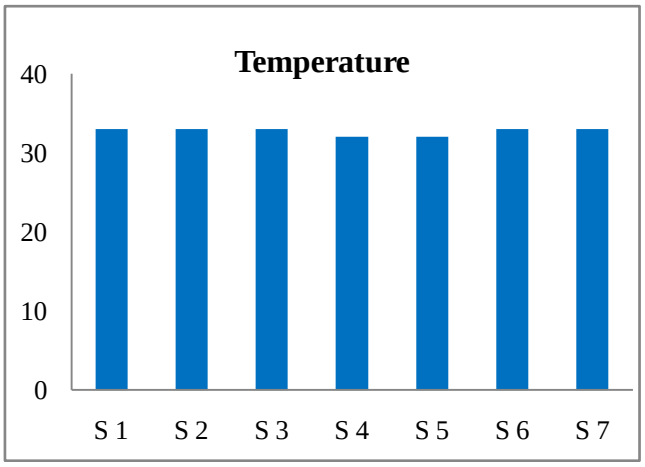

Fig.2b

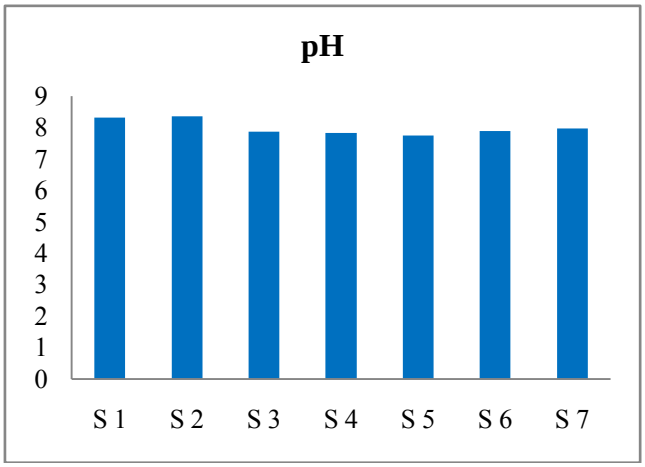

Fig.2c

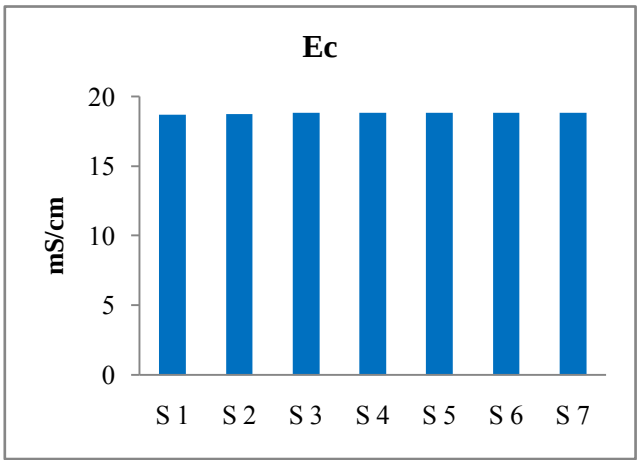

Fig.2d

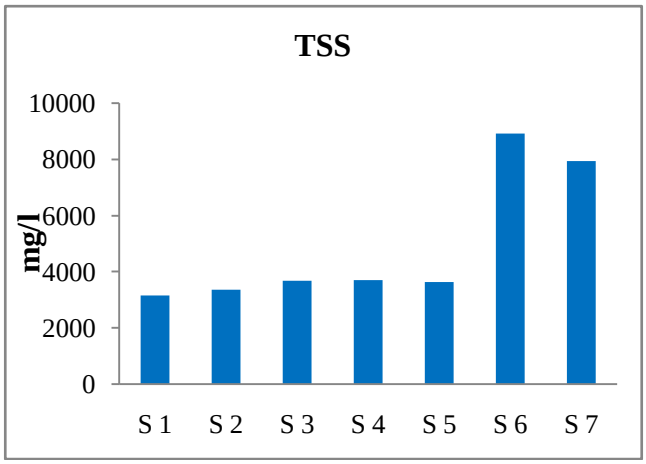

Fig.2e

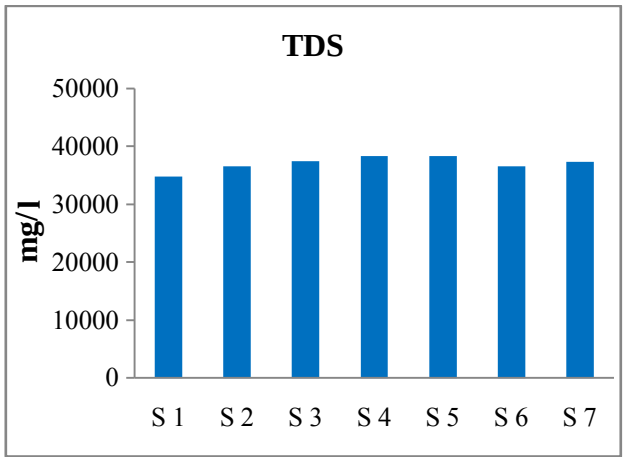

Fig.2f

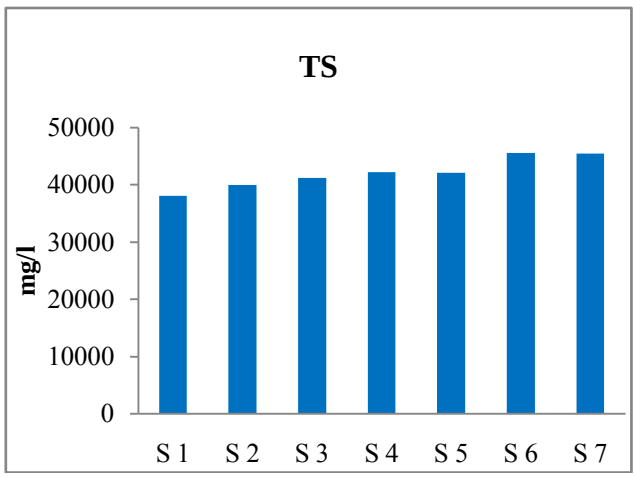

Fig.2g

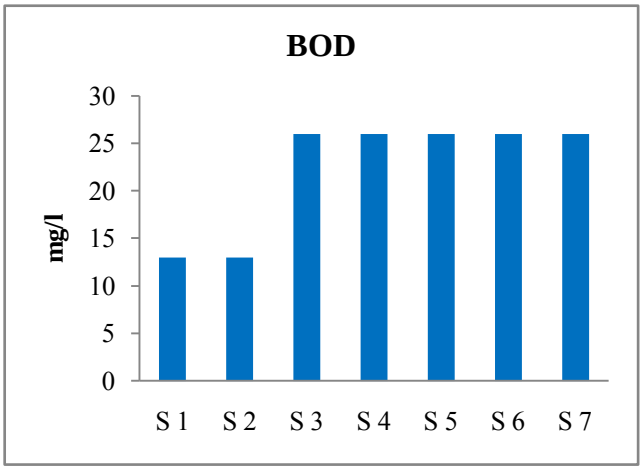

Fig.2h

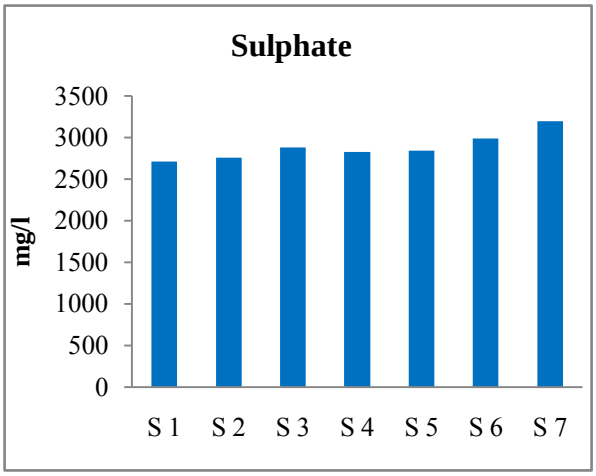

Figure 2 : Spatial variation of physico-chemical parameters in seven station seawater samples

Table1 : Pearson correlation analysis based on physico-chemical parameters and microbial indicators correlation test

	pH	EC	Temp	TSS	TDS	TS	BOD	SO_4	THBC	TFC	TAC	TEBC
pH	1											
EC	-.908**	1										
Temp	.594	-.426	1									
TSS	-.255	.546	.349	1								
TDS	-.815*	.791*	-.722	-.011	1							
TS	-.597	.848*	-.014	.891**	.444	1						
BOD	-.960**	.966**	-.400	.467	.763*	.764*	1					
SO_4	-.420	.665	.210	.845*	.297	.893**	.639	1				
THBC	-.360	.645	.128	.828*	.308	.884**	.577	.976**	1			
TFC	-.514	.772*	.032	.873*	.348	.941**	.710	.937**	.954**	1		
TAC	-.154	.452	.340	.924**	.014	.836*	.379	.922**	.930**	.873*	1	
TEBC	-.267	.507	.194	.720	.232	.753	.483	.953**	.967**	.870*	.896**	1

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*

b) Assessment of microbial pollution load indicators

Preliminary step of microbial pollution assessment was monitored with the specificity of selected microbial indicators in the study area. The microbial pollution was immense which showed high value for the selected indicators (Sato *et al*., 2005). The measurements of THBC indicators showed highest numbers observed as 603 cfu/0.1 ml at the station 7 and lowest level 105 cfu/0.1 ml as observed in station 1. This obtained result showed that there is consistently unbelievable increase in the level of THBC counts in ablution pond station (Fig. 3a). Recent studies have shown links between the religious activities and aquatic environment recorded from observations for the total heterotrophic bacteria counts (Mishra *et al*., 2009). The measurement of TFC showed highest number of 47 cfu/ml at station 7 and 3 cfu/ml lowest level recorded at station 1 (Fig. 3b). Monitoring fungal organism has crucial role of sea organisms and human health impacts associated with coastal environment recreational places (WHO, 1998). Global population of 20–25% has been affected with fungal disease infections (Havlickova *et al*., 2008). Particularly, sea and other natural surface water recreational contacts have caused many infections in skin, keratinized tissues, such as nails, fur, and hair piodermiae, and inner organs, such as digestive organs, brain, lungs illness, and urogenital tract infections which are possible even without previous mechanical injury (Milan *et al*., 2005; Boutiba *et al*., 2012). The measurement of TAC at offshore station showed lowest

level of 17 cfu/0.1 ml and highest level of 104 cfu/ml were observed at station 7 (Fig. 3c). Actinomycetes colonies grown well in organic, and other waste materials accumulated environment. This immensely supports that the most of the waste materials decomposes because of which immobilization of mineral nutrients in organic matter occurs. In addition, it also plays a significant role for the protection of the physical and chemical process in the marine ecosystem (Goodfellow and Haynes, 1984; Baskaran *et al*., 2011). The measurement of TEBC lowest levels were recorded in offshore station 1 as 15 cfu/0.1 ml and highest level for the station 7 recorded as 425 cfu/0.1 ml (Fig. 3d). This data supports similar observations as reported for other studies while investigating the highly populated enteric bacteria attributable to the religious activities in aquatic environment (Bhatnagar and Sangwan, 2009). Here, enteric bacterial assessment was significant in parts of the public health and coastline biosphere. Some studies in India indicated that devotees' religious activities causes number of waterborne and other communicable diseases from enteric bacteria polluting pilgrimage places (Pandey *et al*., 2005; Semwal and Akolkar, 2006; Saini *et al*., 2009) Because of everyday holy bathing and other contacts from polluted ablution pond environment. It may lead to the transmission of waterborne disease and infection spread among human beings through seafood. In India, 21% of the diseases are water-related (Srikanth, 2009). In addition, 80% global level of all disease and infections are spread through pathogenic materials contaminating in water and food (Tayo *et al*., 2011). Especially, pathogenic enteric bacterial species of Salmonella, Vibrio, and Escherichia coli O157:H7 contaminating seawater are responsible for the food-borne disease outbreaks in worldwide (Velusamy *et al*., 2010). These regions are seafood-productive ecosystem, and 22% of Tamil Nadu state is fishing on these polluted environments (Johnson *et al*. 2013). The Pearson correlation test showed a positive correlation for the religious activities affecting seawater physico-chemical quality and microbial indicators (except for the some parameters; shown in the Table). The observed seawater physico-chemical and microbial parameters results exceeded the maximum permissible limit of Indian primary class SW-II quality standard values. These types of religious activities are highly affecting the ablution pond seawater and nearby coastal zone.

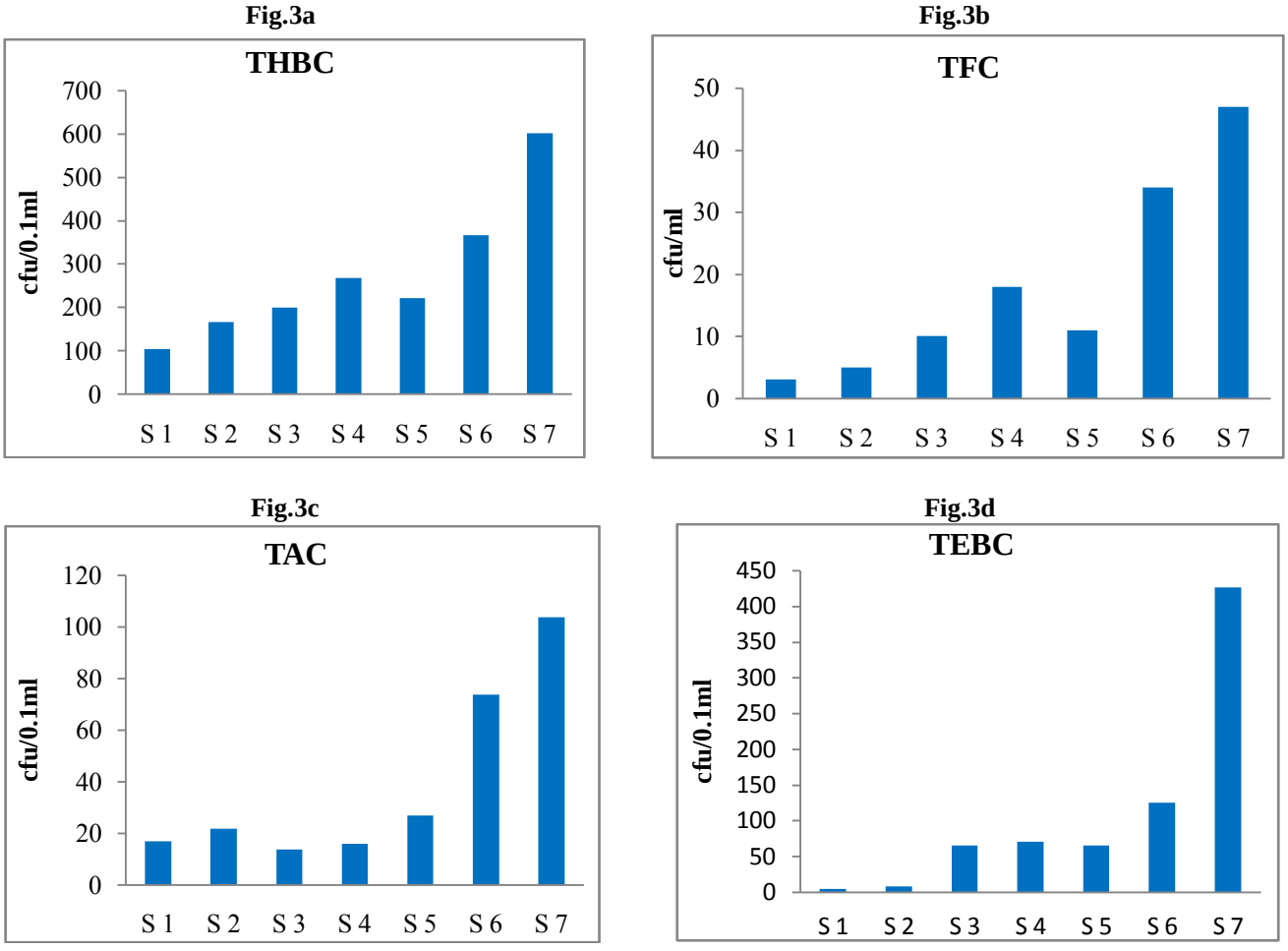

Figure 3 : Spatial variation of microbial indicator in seven station seawater samples

V. Conclusion

The present findings clearly revealed that the devotees conducting ritual ceremonies highly affects the physico-chemical and microbial characters of the seawater in Devipattinam, Navagraha temple. Pathogenic microorganisms affecting humans are found significantly high in the ablution pond locations. The contaminated holy ablution pond seawater is obviously unfit for human beings usage according to the category of Indian seawater II standard. Furthermore, ritual bathing is not recommended in that water. In addition, this coastal zone is the marine fisheries sector in Tamil Nadu state. Hence, ritual ceremonies practice should be regulated. This study plays a crucial role for ensuring coastal quality management and provides prevalent information to prevent the waterborne disease to human beings. Hence, the government must implement some strict effective regulations and monitoring methods and impart in parts of coastal zone.

References Références Referencias

1. Touron A, Berthe T, Gargala G, Fournier M, Ratajczaka M, et al. (2007) Assessment of faecal contamination and the relationship between pathogens and faecal bacterial indicators in an estuarine environment (Seine, France). *Marine Pollution Bulletin*. 54 (9): pp 1441-1450.
2. IOC/UNESCO, IMO, FAO, UNDP (2011) A blueprint for ocean and coastal sustainability. Paris: IOC/UNESCO.
3. UNEP (2011) Towards a Green Economy: pathways to sustainable development and poverty eradication (a synthesis for policy makers), United Nations Environment Programme.
4. Borja, A., Bricker, B.S., Dauer, M.D., Demetriades, T.N., Ferreira, G.J., Forbes, T.A., Mahutchings, P., Jia, X., Kenchington, R., Marques, C.J. and Zhu, C. 2008. Overview of integrative tools and methods in assessing ecological integrity in estuarine and coastal systems worldwide. *Marine Pollution Bulletin*. 56: 1519-1537.
5. Subramani, R. and Aalbersberg, W. 2012. Marine actinomycetes: An ongoing source of novel bioactive metabolites. *Microbiological Research*. 167 (10) pp 571-580.
6. Stabili, L. and Cavallo, R.A. 2011. Microbial pollution indicators and culturable heterotrophic bacteria in a Mediterranean area (Southern Adriatic Sea Italian coasts). *Journal of Sea Research*. 65 (4): pp 461-469.
7. Chao, X., Jia, Y., Shields, F.D.J., Wang, S.S.Y. and Cooper, C.M. 2010. Three-dimensional numerical simulation of water quality and sediment-associated processes with application to a Mississippi Delta lake. *Journal of Environmental Management*. 91 (7): pp 1456-1466.
8. Spatharis, S., Tsirtsis, G., Danielidis, D., Chi, T.D. and Mouillot, 2007. Effects of pulsed nutrient inputs on phytoplankton assemblage structure and blooms in an enclosed coastal area. *Estuarine Coastal and Shelf Science*. 73 (3-4): pp 807-815.
9. Lloret, J., Marin, A. and Guirao, L.M. 2008. Is coastal lagoon eutrophication likely to be aggravated by global climate change?. Estuarine. *Coastal and Shelf Science*. 78 (2): pp 403-412.
10. Oliveira, A.J.F.C., Franca, P.T.R.D. and Pinto, A.B. 2010. Antimicrobial resistance of heterotrophic marine bacteria isolated from seawater and sands of recreational beaches with different organic pollution levels in southeastern Brazil: evidences of resistance dissemination. *Environ Monit Assess*. 169 (1-4): pp 375-384.
11. Janelidze, N., Jaiani, E., Lashkhi, N., Tskhvediani, A., Kokashvili, Z., Gvarishvili, Jgenti, D., Mikashavidze, D., Diasamidze, R., Narodny, S., Obiso, R., Whitehouse, A.C. Huq, A. and Tediashvili, M. 2011. Microbial water quality of the Georgian coastal zone of the Black Sea Microbial water quality of the Georgian coastal zone of the Black Sea. *Marine Pollution Bulletin*. 62(3): pp 573-580.
12. Stewart, J.R., Gast, R.J., Fujioka, R.S., Gabriele, H.M.S. and Meschke, J.S. 2008. The coastal environment and human health: microbial indicators, pathogens, sentinels and reservoirs. *Environ Health*. 7 (3) pp 1-14.
13. Wilkinson, C. 2008. Status of coral reefs of the world: 2008. Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre, Townsville, Australia. pp 296.
14. Nellemann, C., Corcoran, E., Duarte, C., Valdés, L., Young, C.D., Fonseca, L. and Grimsditch, G. 2009. Blue Carbon. A rapid response assessment. United Nations Environment Programme, GRID-Arendal, ISBN: 978-82-7701-060-1.
15. Jones, M.K. and Oliver, J.D. 2009. Vibrio vulnificus: disease and pathogenesis. *Infect Immun*. 77 (5): pp 1723-1733.
16. EFSA, 2010. The community summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in the European Union in 2008. *EFSA Journal* 8(1): pp 410.
17. Carrasco, E., Rueda, A.M. and Gimeno, R.M.G. 2012. Cross-contamination and recontamination by Salmonellain foods: A review. *Food Research International*. 45(2): pp 545-556.
18. Ralston, E.P., Powell, H.K. and Beet, A. 2011. An estimate of the cost of acute health effects form food- and water-born marine pathogens and toxins in the United States. *Journal of Water and Health*. 9(4): pp 680-694.
19. Figueras, M.J., Polo, F., Inza, I. and Guaro, J. 1997. Past, present and future perspectives of the EU

bathing water directive. *Marine Pollution Bulletin*. 34(3): pp 148-156.
20. Georgiou, S. and Bateman, I.J. 2005. Revision of the EU Bathing Water Directive: Economic Costs and Benefits. *Marine Pollution Bulletin*. 50 (4): pp 430-438.
21. Stevens, M., Ashbolt, N. and Cunliffe, D. 2003. Review of coliforms as microbial indicators of drinking water quality. National Health and Medical Research Council, Canberra, Australia. /http://www.health.gov.aus.
22. Kistemann, T., Claben, T., Koch, C., Dangendorf, F., Fischeder, R., Gebel, J., Vacata, V. and Exner, M. 2002. Microbial load of drinking water reservoir Tributaries during extreme rainfall and runoff. *Appl Environ Microbiol*. 68(5): pp 2188-2197.
23. Baghel, V.S., Gopal, K., Dwivedia, S. and Tripathi, R.D. 2005. Bacterial indicators of faecal contamination of the Gangetic river system right at its source. *Ecol Indic*. 5(1): pp 49-56.
24. Halliday, E. and Gast, J.R. 2011. Bacteria in beach sands: an emerging challenge in protecting coastal water quality and bather health. *Environ. Sci. Technol*. 45(2): pp 370-379.
25. WHO, 1998. Guidelines for safe recreational water environments. Coastal and freshwater, vol.1.Consultation draft, WHO/EOS/Draft/98.14.Geneva:World Health Organization 124.
26. Thaddeus, K., Graczyk, Sunderland, D., Grace, N., Awantang, Mashinski, Y., Frances, E., Lucy, Graczyk, Z., Chomicz, L., Patrick, N. and Breysse, 2010. Relationships among bather density, levels of human waterborne pathogens, and fecal coliform counts in marine recreational beach water. *Parasitol Res*. 106(5): pp 1103-1108.
27. Marine Water Quality (2013) <http://monitorauckland.are.govt.nz/natural-environment-and-heritage/coastal-management> (accessed 04.02.13).
28. Dada, A.C., Asmat, A., Gires, U., Heng, L.Y. and Deborah, B.O. 2012. Bacteriological monitoring and sustainable management of beach water quality in Malaysia: problems and prospects. *Global Journal of Health Science*. 4(3): pp 126-138.
29. Nobi, E.P., Shivaprasad, A., Karikalan, R., Dilipan, E., Thangaradjou and Sivakumar, K. 2010. Microlevel mapping of coastal geomorphology and coastal resource of Rameswaram Island, India: A remote sensing and GIS perspective. *Journal of Coastal Research*. 26(3): pp 424-428.
30. AHEC, 2011. Assessment of cumulative impact of hyderopower projects in Alaknanda and Bhagirathi basins.1: pp 1-29.
31. Marale, S., Mahajan, D., Gavali, R. and Kumar, R. 2010. Multi-ceriteria assessment of different temporal water quality changes causing impact on public health. *In J of Integrative Biology*. 9(3): pp 123-127.
32. Mishra, A., Mukherjee, A. and Tripathi, B.D. 2009. Seasonal and temporal variations in physico-chemical and bacteriological characteristics of river Ganga in Varanasi. *Int J Environ Res* 3(3): pp 395-402.
33. Semwal, N and Akolkar, P. 2006. Water quality assessment of sacred Himalayan Rivers of Uttaranchal. *Current Science*. 91(4): pp 486-496.
34. Vinay, S., Baghel, Gopal, K., Dwivedi, S., Rudra, D. and Tripathi, 2005. Bacterial indicators of faecal contamination of the Gangetic river system right at its source. *Ecological Indicators*. 5(1): pp 49-56.
35. Bhatnagar, A and Sangwan, P. 2009. Impact of mass bathing on water quality. *Int J Environ Res*. 3(2): pp 247-252.
36. Sangeeta, D and Savita, D. 2011. Hydro chemical changes in two eutrophic lakes of central India after immersion of durga and ganesh idol. *Res J of Chemical Sciences*. 1(1): pp 38-45.
37. Sharma, V., Bhadula, S. and Joshi, B.D. 2012. Impact of mass bathing on water quality of Ganga river during maha kumbh-2010. *Nature and Science*. 10(6): pp 1-5.
38. APHA, 1998. Standard Methods for the Examination of Water and Wastewater, 20th ed. American Public Health Association, Washington, DC.
39. Sahu, B.K., Begum, M., Khadanga, M.K., Jha, K.D., Vinithkumar, N.V.and Kirubagaran, R. 2013. Evaluation of significant sources influencing the variation of physico-chemical parameters in Port Bay, South Andaman, India by using multivariate statistics. *Marine Pollution Bulletin*. 66(1-2): pp 246-251.
40. Anonymous: environmental standards for ambient air, automobiles, fuels, industries and noise, pollution control law, series: PCLS/4/2000-2001, central pollution control board, ministry of environment and forests, Government of India. pp 109.
41. Leifer, A. 1988. The kinetics of environmental aquatic photochemistry (ACS Professional Reference Books). Washington, DC: American Chemical Society.
42. Solic, M and Krstulovic, N. 1992. Separate and combined effects of solar radiation, temperature, salinity, pH on the survival of fecal coliform in seawater. *Marine Pollution Bulletin*. 24(8): pp 411-416.
43. Jayakumar, R., Steger, K., Chandra, T.S. and Seshadri, S. 2013. An assessment of temporal variations in physicochemical and microbiological properties of barmouths and lagoons in Chennai (Southeast coast of India). *Marine Pollution Bulletin*. 70(1-2): pp 44-53.
44. WHO, 1989. Microbiological quality control in coastal recreational and shellfish areas in the

Mediterranean (MED POL-Phase II). Valetta, WHO, Regional Office for Europe.
45. Kalita, B., Bhuyan, K.C., Kusre, D. and Dutta, A. 2006. Physicochemical quality of beel water in Morigaon district, Assam. *Journal of Ecobiol*. 18(1): pp 17-21.
46. Umamaheshwari, S. 2010. Water quality index of temple pond at Talakadu, Karnataka, India. Lake 2010: Wetlands, *Biodiversity and Climate Change*. pp 1-5.
47. Mehta, P. 2013. Alteration in water quality parameters and consequential impacts due to festival waste in Jodhpur. *The Experiment*. 17(1): pp 1166-1176.
48. Mathur, P., Agarwal, S. and Nag, M. 2008. Assessment of physico-chemical characteristics and suggested restoration measures for Pushkar Lake, Ajmer Rajasthan (India). Proceedings of taal 2007: The 12th World Lake conference. pp15181529.
49. Klontz, W., Stewart, B.C. and Eib, D.W. 1985. On the etiology and pathophysiology of environmental gill disease in juvenile salmonids. In: Ellis, A.E. (Ed.), Fish and Shellfish Pathology. Academic Press, London. pp 199-210.
50. Liltved, H and Cripps, S.J. 1999. Removal of particle associated bacteria by prefiltration and ultraviolet irradiation. *Aquacult Res*. 30(6): pp 445-450.
51. Kim, B.G.H and Yur, J.H. 2004. Effects of the non-point source pollution on the concentration of pathogen indicator organisms in the Geum river Basin, Republic of Korea. *KSCE J Civ Eng* 8(2): pp 181-187.
52. Manikandan, S., Ganesapandian, S., Manoj, S. and Kumaraguru, A.K. 2011. Seagrass diversity and associated flora and fauna in the coral reef ecosystem of the gulf of Mannar, southeast coast of India. *Res J Environ Earth Sci*. 3(4): pp 321-326.
53. Kulshrestha, H and Sharma, S. 2006. Impact of mass bathing during Ardhkumbh on water quality status of river Ganga. *Jour of Environ Biology*. 27(2): pp 437-440.
54. Kaur, R. 2012. Effect of idol immersion on marine and fresh water-bodies. *Adv Appl Sci. Res*. 3(4): pp 1905-1909.
55. McCoy, W.F and Olson, B.H. 1986. Relationship among turbidity particle count and bacteriological quantity with in water distribution lines. *Water Res*. 20(8): pp 1023-1029.
56. Singh, H.P., Mishra, J.P. and Mahawar, L.R. 1999. Observation on biochemical and chemical oxygen demands of certain polluted stretch of river Ganga. *J Environ Biol*. 20(2): pp 111-114.
57. Parashar, N.B., Kaushik, P. and Pandey, S. 2003. Physico-chemical and Microbiological studies of Ganga canal at Hardwar, during Kumbh Period-1998. *Him J Env Zool*. 17(2): pp 167-171.
58. Sato, M.I.Z., Bari, M.D., Lamparrlli, C.C., Truzzi, A.C., Coelho, M.C.L.S. and Hachich, E.M. 2005. Sanitary quality of sand from marine recreational beaches of Sao Paulo, Brazil. *Braz J Microbiol*. 36(4): pp 321- 326.
59. Havlickova, B., Czaika, V.A. and Friedrich, M. 2008. Epidemiological trends in skin mycoses worldwide. *Mycoses*. 51(1): pp 2-15.
60. Milan, N., Matavulj, Vulikia, N., Gojkovia, I., Maja, A. and Karaman 2005. Conditionally pathogenic fungi in recreational waters. *Proc Nat Sci Matica Srpska Novi Sad*. 109: pp 149-160.
61. Boutiba, A.M., Ruiz, N., Namont, C.S., Grovel, O., Amiard, J.C, Pouchus, Y.F and Boutiba, Z. (2012) Screening for toxigenic marine-derived fungi in Algerian mussels and their immediate environment. *Aquaculture*. 342-343: pp 75-79.
62. Goodfellow, M and Haynes, J.A. 1984. Actinomycetes in marine sediments. In: Ortiz-ortiz L, Bojalil LF, Yokoleff V, editors. Biological, biochemical and biomedical aspects of actinomycetes. Orlando: *Academic press*. pp 453-72.
63. Baskaran, R., Vijayakumar, R. and Mohan, P.M. 2011. Enrichment method for the isolation of bioactive actinomycetes from mangrove sediments of Andaman Islands, India. *Mal J Microbiol*. 7(1): pp 26-32.
64. Pandey, M., Dixit, V.K., Katiyar, G.P., Nath, G., Sundram, S.M., Chandra, N., Shomvansi, A.K., Kar, S. and Upadhy, V.K. 2005. Ganga Water pollution and Occurrence of Enteric disease in Varanasi City. *Indian Journal of community Medicine* 30(4): pp 115-120.
65. Saini, P., Sharma, V. and Joshi, B.D. 2009. A random survey report about rise in water borne diseases in Haridwar city during Kanwar mela-2008. *J Environ Bio-Sci*. 23(2): pp 215-219.
66. Srikanth, R. 2009. Challenges of sustainable water quality management in rural India. *Current Science*. 97(3): pp 317-325.
67. Tayo, B.C.A., Okonko, I.O., Esen, C.U., Odu, N.N., Onoh, C.C. and Igwiloh, N.J.P. 2011. Incidence of potentially pathogenic vibrio spp. in Fresh seafood from Itu Creek in Uyo, Akwa Ibom State, Nigeria. *World Appl Sci J*. 15(7): pp 985-991.
68. Velusamy, V., Arshak, K., Korastynska, O., Oliwa, K. and Adley, C. 2010. An overview of food borne pathogen detection in the perspective of biosensors. *Biotechnology Advances*. 28(2): pp 232-254.
69. Johnson, B., Shyam, S., Salim, S. and Narayanakumar, R. 2013. Market structure analysis of fish markets in Ramanathapuram district of Tamil Nadu. *Marine Fisheries Information Service T&E Series*. 217: pp 35-37.

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Note :

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27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

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30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

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· Present your points in sound order

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- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
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- Center on shortening results - bound background information to a verdict or two, if completely necessary
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- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

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- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
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Approach:

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The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

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	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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