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Valuation of Urban Environmental Amenities in Developing Countries: A Case Study from Chandigarh, India

By Pradeep Chaudhry, M.P. Sharma, G. Singh & Arun Bansal
Indian Institute of Technology Roorkee, India

Abstract - Studies related to the valuation of urban environmental amenities like water bodies, green spaces and clean air are very scarce in developing countries. The present study is a first of its kind in India where Hedonic Pricing Method (HPM) has been used to study the impact of key environmental attributes like proximity of an urban lake having good water quality, parks/gardens, clean air and traffic noise attenuation on the market rates of residential plots in a planned city. Two functional hedonic pricing models, double log with weighted least square and ordinary least square, were constructed. Both the models offered comparable and reliable results. Proximity to Sukhna lake of Chandigah city and Leisure valley chain of green spaces raised housing prices by about 10 % and 2 % respectively. Air quality showed significant improvement near green spaces. The study demonstrates that there is significant scope of enhancing government controlled collector rate of urban residential property in areas near to Sukhna lake. The revenue so realized could be ploughed back in conservation efforts of the lake and expanding the green spaces in the city.

Keywords : hedonic price method, urban lake, green spaces, urban forests, environmental amenities, residential property valuation.

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VALUATION OF URBAN ENVIRONMENTAL AMENITIES IN DEVELOPING COUNTRIESA CASE STUDY FROM CHANDIGARH, INDIA

Strictly as per the compliance and regulations of :

Valuation of Urban Environmental Amenities in Developing Countries: A Case Study from Chandigarh, India

Pradeep Chaudhry [α], M.P. Sharma [σ], G. Singh [ρ] & Arun Bansal [ω]

Abstract - Studies related to the valuation of urban environmental amenities like water bodies, green spaces and clean air are very scarce in developing countries. The present study is a first of its kind in India where Hedonic Pricing Method (HPM) has been used to study the impact of key environmental attributes like proximity of an urban lake having good water quality, parks/gardens, clean air and traffic noise attenuation on the market rates of residential plots in a planned city. Two functional hedonic pricing models, double log with weighted least square and ordinary least square, were constructed. Both the models offered comparable and reliable results. Proximity to Sukhna lake of Chandigah city and Leisure valley chain of green spaces raised housing prices by about 10 % and 2 % respectively. Air quality showed significant improvement near green spaces. The study demonstrates that there is significant scope of enhancing government controlled collector rate of urban residential property in areas near to Sukhna lake. The revenue so realized could be ploughed back in conservation efforts of the lake and expanding the green spaces in the city. Values accorded to urban environmental amenities in the study can justify the public spending and seek more funding for the betterment of urban water bodies and green spaces in developing countries.

Keywords : hedonic price method, urban lake, green spaces, urban forests, environmental amenities, residential property valuation.

I. Introduction

World is rapidly urbanizing and it is expected that half of the population of Asia will live in urban areas by 2020, while Africa is likely to reach 50 % urbanization rate in 2035. Population growth is largely becoming an urban phenomenon in the developing world (Satterthwaite, 2007; U.N, 2012). India is not lagging behind on urbanization front. About 25.72 % of country's population lived in cities and towns in 1991 which increased to 27.86 % during 2001 and 31.16 % in 2011(Bhagat, 2011).Urban environmental amenities like green spaces, urban forests, lakes, wetlands and rivers are under severe stress as the people move towards cities for better employment opportunities and schooling of their children. All these activities cause increased urban sprawl leading to more noise, water and air pollution. New and planned cities in India like Chandigarh and Gandhinagar have special provision for creation of urban parks/gardens and water bodies in their respective master plans but this is not the case with majority of other cities. With the advent of education and environmental awareness, demand for urban nature and environmental resources is growing gradually in developing countries (Jim and Chen, 2006; Kong *et al.,* 2007; Jim and Chen, 2007).

Urban parks/gardens, wetlands, rivers and good environments provide intangible benefits that contribute to the quality of urban life (Bouland and Hunhammar, 1999; Shafer *et al.,* 2000; Chiesura, 2004). Environmental economists have devised various methods to quantify values of such non-market or intangible benefits of urban tress and water bodies to the society (Adamowicz *et al.,* 1994; Wilson and Stephan, 1999; Price, 2000; Woodward and Wui, 2001; Boyer and Polasky, 2004; Bin, 2006; Qiu *et al.,* 2006 and Tapsuwan *et al.,* 2009). Methods like Contingent Valuation Method (CVM), Travel Cost Method (TCM) and Hedonic Pricing Method (HPM) have been more popular, used and improved in recent decades. CVM falls under direct methods or 'stated preference methods' category whereas TCM and HPM fall under indirect methods or 'revealed preference methods' category. In CVM, a hypothetical market is created before a respondent who tells about his/her willingness to pay for a particular amount of non market commodity e.g. for a given quality of water in a river or lake, air quality or urban greenery at a particular location. However, as the responses do not involve actual market purchases, the responses of the respondents are based on hypothetical rather than actual behavior (Tyrvainen and Vaananen, 1998). Moreover CVM should be used very carefully with respondents in developing countries (Chaudhry *et al.,* 2007) because the chances of getting reliable results with CVM are low in developing countries and indirect methods like TCM and HPM are likely to yield more reliable results (Chaudhry and Tewari, 2006). In TCM, the people or tourists must reach a recreation site or resource from different distances after spending travel and time expenses, otherwise, this method does not work well (More *et al.,* 1988). Indirect methods like TCM and HPM make use of substitute markets to find

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out individual preferences (Garrod and Willis, 2000). The HPM links property values and the presence of features like lakes/wetlands/streams/green spaces with variables such as distance, view or access. Quality of these features can also be one of the variables. The purpose is to take into consideration a bundle of factors that affect house prices (Choumert and Salanie, 2008). HPM has been used extensively in USA and European countries to value urban greenery, water bodies and combination of these items (Mahan *et al.,* 2000; Loomis and Feldman, 2003; Garrod and Willis, 1992; Tyrvainen and Miettinen, 2000; Luttik, 2000, Tajima, 2003 and Morancho, 2003). Among developing countries, researchers in China have achieved a commendable progress in valuation of urban environmental attributes e.g. Jim and Chen (2006), Kong *et al.,* (2007), Jim and Chen (2009), Jiao and Liu (2010). However, India is lagging behind on this front as evident from only two studies which were conducted in Mumbai and Bhopal cities, regarding the valuation of urban environmental attributes (Gupta and Mythili, 2010; Verma and Negandhi, 2011).

The main objective of the present communication is to assess the environmental factors which make a location attractive to live in, particularly, in a planned city of a developing country like India and to assist urban land use planning with emphasis on urban nature conservation like green spaces and water bodies. Another objective is to find out the possibility of revenue generation for the conservation of Chandigah city's environmental attributes using Hedonic Pricing method.

II. Theoritical Background of HPM

The hedonic theory was first introduced by Rosen (1974), summarized by Freeman (1979, 1985) and later by Palmquist (1991). Hedonic Price Method/Model (HPM) is based on the hypothesis that goods are actually aggregations of characteristics features and that the demand for goods relates to these characteristics features. For example, price of a house/flat in a locality depends on market components e.g. size of plot, number of rooms, number of balconies, number of bathrooms etc and non market components like air quality, nearness to water bodies, parks/gardens, exposure to traffic noise etc. Hedonic price models have been developed to quantify the contributions of the market and non market components of a particular good to its market price through statistical analysis. People often pay more for a charming view if two houses are identical except for the views and the extra payment can be estimated as the value of the aesthetic and recreational service. In practice, many attributes jointly contribute to the selling price of a house. Statistical techniques have been developed to separate parts of transaction prices due to each contributory attribute (Jim and Chen, 2006).

In general, the purchase price of heterogeneous housing goods could be expressed by a hedonic pricing method which embraces a bundle of housing characteristics:

$$P = f(X_1, X_2, \text{--------}, X_n, Z) \qquad (1)$$

where P is the market price of house and X_1, X_2,-------X_n are the structural and locational characteristics the house embodies and Z is the environmental variable without a market price (the hedonic variable). The partial derivatives of the price with respect to the constituent variables provide information on the marginal willingness to pay for an additional unit of each characteristic (Palmquist, 1991; Garrod and Willis, 2000; Sheppard, 1999 and Malpezzi, 2003). As a result, the implicit price of individual characteristics could be deduced (Jim and Chen, 2006). HPM is based on assumptions that the observed prices reflect equilibrium conditions in the market. Secondly, the model assumes that both the buyers and sellers of properties have perfect information about the market and non market components of the good (Sarker and McKenney, 1992). HPM is based on actual transaction behaviors in the market and is considered to be the most convincing approach to quantify amenity value (Hoevenagel, 1994; Ready *et al*, 1997; Hidano, 2000; Tajima, 2003 and Jim and Chen, 2006).

The HPM typically makes use of multiple regression analysis to relate housing price details with diverse characteristics of different properties and to find out the different contributions. Enough guidance is not available in economic theory about the choice of functional form which connects housing price with multiple attributes including structural, locational and environmental attributes (Rosen, 1974; Freeman, 1979; Halvorsen and Pollakowski, 1979). Therefore, it is better to try several functional forms like linear, semi-logarithmic, double logarithmic and Box-Cox while using multiple regression technique (Cassel and Mendelsohn, 1985). Each functional form has its own merits and demerits e.g. Box-Cox transformation could provide better results in terms of better fit of data than other transformations, but requires complicated transformation processes which could result into random errors (Davidson and MacKinnon, 1993; Jim and Chen, 2006). Three functional forms i.e. linear, semi logarithmic and double logarithmic have been tried for the analysis and results obtained from best form in terms of R^2 and least standard error estimate are presented in the paper.

III. About Chandigarh City

Chandigarh, the City Beautiful, is India's first planned city constructed after 1947 when country got independence. A number of famous town planners remain associated with concept and planning of the city e.g. Albert Mayer and Matthew Nowicki from America, Le Corbusier from France and English nationals E. Maxwell Fry, Jane and Pierre Jeanneret. Le Corbusier played major role till the city came to life. The construction of the city began in 1952 and Dr. Rajendra Prasad, the first President of India, inaugurated the city on October 7, 1953. Located at the foothills of the picturesque Shivalik mountain ranges, the city is an epitome of tradition blended with modernity. In the city's master plan, trees and plants are as much a part of the construction plans as the buildings and the roads. The geographical area of the city is 114 km^2, supporting a population of more than one million as per latest census of India in 2011. The basic unit of urban planning is the 'sector' and the entire city has been designed with an ordered framework of 'sector' that looks like a chess board (Figure 1). The dimensions of most of the sectors are 120m x 80m except the sectors located just near the Sukhn lake. The Sukhna lake is an artificial lake constructed in 1958 with a water spread area of about 2.50 km^2. This lake is one of the important tourist spots of the city with 'good' water quality according to National Sanitation Foundation Water Quality Index (NSFWQI) criteria (Chaudhry *et al.,* 2013 (A and B)).

Figure 1 : Chandigarh city map showing sectors, green spaces and Sukhna lake

Chandigarh is a fully grown city of modern architectural splendor and nestles in a picturesque setting in the foothills of the Shivalik mountains. The city has attracted people from nearby states of Punjab, Haryana and Himachal Pradesh over the years due to its educational, environmental and career oriented facilities. Le Corbusier designed the city for a population of 0.5 million but now the population has gone over 1 million as shown in Figure 2.

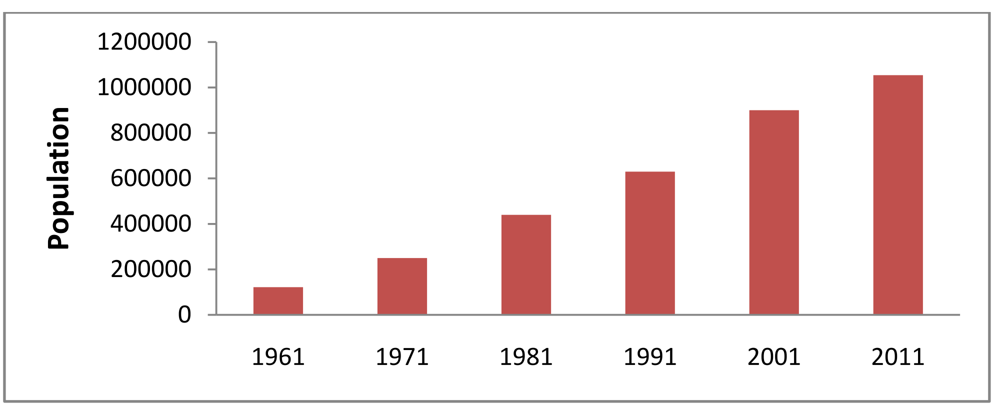

Figure 2 : Population of Chandigarh city between 1961 to 2011

Chandigarh has the largest numbers of vehicles per capita in India. The data provided by the Registering and Licensing Authority, Chandigarh administration, indicates that the number of vehicles per household is two (D.O.E, 2008). Increasing numbers of petrol and diesel vehicles in the city are causing significant decrease in ambient air quality. The number of vehicles in Chandigarh has risen from 5, 73,035 in 2004 to 8, 29,145 in 2011 i.e. an increase by over 40 % in a span of seven years (Figure 3).

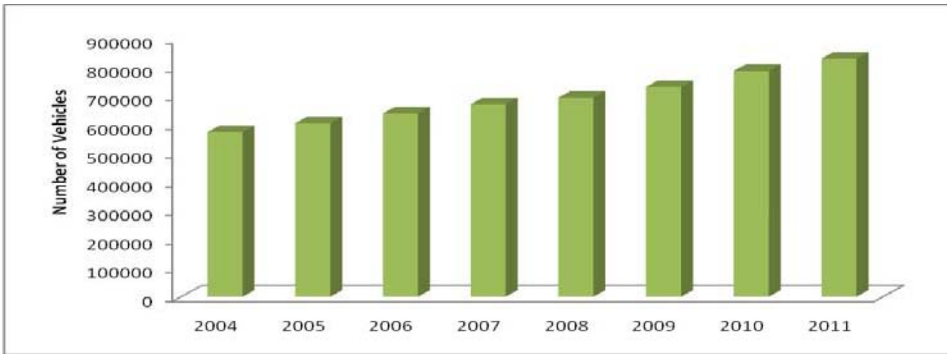

Figure 3 : Rise in number of vehicles in Chandigarh city

IV. Materials and Methods

Based on a sample size of 176 numbers of urban residential plots located in different sectors of Chandigarh city, details regarding prevailing rate (Rs/sq yard)*, overall price (Rs) and plot size (yard) were collected from residents and property dealers of the city. Numbers of residential plots between 4 to 5 were covered in different (40) sectors of the city for collecting above details. Sectors like 1, 6, 12, 14, 17 and 25 were not considered as no private residential plots are located except mostly the governmental, educational and commercial properties (Figure 1). Sectors adjoining Mohali city of Punjab were also not covered as the multi-storied flats are mostly located here whereas maximum of city's geographical area is devoid of private multi-storied flat culture. Further the city areas around Manimajra, Halomajra, Ram darbar, airport and railway station vicinity were also not considered for primary data collection as no systematic residential sectors are formed in these areas. In addition to above details regarding residential plots, primary survey was conducted in different sectors of the city among residents to find out status of air quality, drinking water quality and its availability round the year, exposure to traffic noise, quality of sector parks/gardens and general garbage removal around living areas of the residents. Secondary data about air quality and noise pollution in residential areas of different sectors was also collected from Chandigarh Pollution Control Committee (CPCC), Department of Environment, Chandigarh administration. Deputy Commissioner, Chandigarh office was approached for finding out 'collector rate' applicable to sale and purchase of residential property in the city. Collector rate comes into picture when a particular property is sold or purchased and property registration is required to be done at rates equal or higher than the applicable collector rate. Property registration ensures a kind of revenue for the local administration.

*The residential plot rates are expressed in Rupee per sq yard in the region in and around the Chandigarh city.
One sq yard=0.8361 sq metre or one sq metre=1.196 sq yard.

V. Results and Discussion

The city area from sector 2 to 47 was divided into four (4) zones from 'zone 1' to 'zone 4' based on existing market rate of plots found during the survey. The survey was conducted during the period Oct 2012 to Dec 2012. It is observed that zone 1 near Sukhna Lake has the highest average plot rate of Rs 1,76,000 per sq yard, followed by Rs 1, 52,000 for zone 2, Rs 1,33,000 for zone 3 and Rs 1,12,000 for zone 4 (Figure 4).

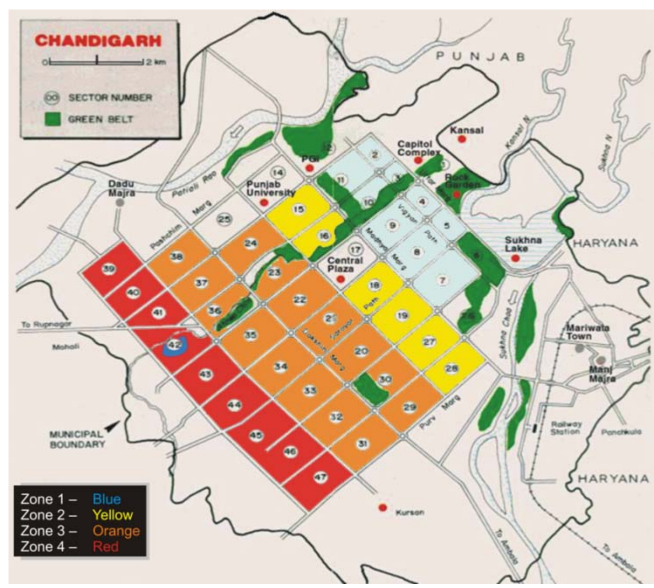

Figure 4 : Division of Chandigarh city area in to four zones

Sample number of plots considered in different zones, maximum, minimum and mean size of plots, maximum, minimum and mean rate of plots in a particular zone and mean distance from Sukhna Lake are given in Table 1, where it is observed that mean rate of residential plots decreases as the distance from Sukhna lake increases.

Table 1 : Details about number of plots, sizes, rates and distance from lake

Details	Zone 1	Zone 2	Zone 3	Zone 4
No of residential plots considered	40	32	68	36
Mean size (sq yard)	1590	575	315	200
Max size (sq yard)	4000	2000	1000	500
Min size (sq yard)	250	200	125	100
Mean rate (Rs /sq yard)	1,76,000	1,52,000	1,33,000	1,12,000
Mean plot price (Rs million)	280.00	87.40	41.80	22.40
Mean distance from lake (m)	1300	2560	4437	6090

ANOVA has been used to compare the means of three or more than three unrelated groups, using F statistics was applied. Variables considered were rate, price, size and distance of residential plots from the Sukhna lake. Higher value of F statistics implied that samples were drawn from populations with different mean values. The respective values of F statistics ($p < 0.01$) indicated that the division of the geographical area of the city under consideration (i.e. Sector 2 to 47) into four zones (zone 1 to 4) based on the above variables is statistically correct.

The definitions of the dependent variable (RATE) and 8 explanatory variables included in this study are presented in Table 2. One variable i.e. size of residential plot (PLOTSIZE) is related to the structural characteristics and the rest are environmental variables. Last five variables are dichotomic in nature that takes the value of 1 or 0 i.e. 1 for good air and water quality and 0 for bad quality. Similarly 1 is adopted for low traffic noise and 0 for higher noise disturbance. Variables other than PLOTSIZE can also be called hedonic variables as their inclusion in the price equation allows us to assess the influence of environmental attributes on housing market value.

Table 2 : Variables related to plots and their environs

Variable name	Definition	Unit
RATE	Market rate of residential plots in different sectors	Rs per sq yard
PLOTSIZE	Size of residential plots	Sq yard
DISTLAKE	Distance of plot from Sukhna Lake	m
DISTLVALLEY	Distance of plot from Leisure valley chain of parks/gardens	m
AIRQUALITY	Quality of air in the vicinity of plot	0,1
NOISE	Exposure to traffic noise	0,1
GARBAGE	Garbage removal facility from house & in the vicinity of plot	0,1
WATERQUALITY	Quality and availability of drinking water during the year	0,1
QUALITYSECPARKS	Quality of sector parks in comparison to Leisure valley	0,1

Leisure valley chain of parks and gardens consists of number of linear parks and theme gardens developed along eight km stretch of a seasonal rivulet running across the city (Figure 1). Various parks and gardens developed along this rivulet include Rajendra Park (16,19,400 m^2), Bougainvillea Garden (80,970 m^2), Leisure Valley Garden and Fitness Trail (3,80,566 m^2), Zakir Rose Garden (21,450 m^2), Shanti Kunj (72,875 m^2), Bamboo Valley Garden (1,11,336 m^2), Bulbous Garden (28,340 m^2), Hibiscus Garden (16,194 m^2), Fragrance Garden (40,486 m^2) and Dahlia Garden (18,318 m^2). These parks/gardens are in addition to numerous small and big sector parks and green belts in the city. Due to the strategic location and importance of the Leisure valley chain of parks/gardens, the distance of residential plots from Leisure valley chain of parks/gardens (DISTLVALLEY) has been taken as one of the hedonic or environmental variables in the present study.

Various hedonic pricing studies involving influence of environmental amenities with either water bodies or green spaces or both as main ingredient on housing prices in developed (Luttik, 2000; Mahan *et al.,* 2000; Paterson and Boyle, 2002; Price, 2003; Tajima, 2003; Morancho, 2003; Tapsuwan *et al.,* 2009) and developing countries (mainly China e.g. Jim and Chen, 2006; Kong *et al.,* 2007; Jim and Chen, 2007) have been conducted with 'price' or 'rate' of residential flats as dependent variable. Present study is the first of its kind where 'rate' of 'residential plots' has been taken as dependent variable. Further, locational variables like nearness to schools, workplace and market have not been considered in the study. This is mainly due to two reasons. One, the city area is not very large (114 km^2) and secondly, the public transport system in the form of government owned local buses is good. The 'Transport Performance Index' of Chandigarh city is highest among

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major cities of India (Figure 5; Department of Environment, 2008). Moreover, Chandigarh has also the highest density of private vehicles (two and four wheeled) in India (Department of Environment, 2008).

Figure 5 : Transportation Performance indices of different cities of India

Table 3 gives the estimation of double log model using weighted least square (WLS) method. Statistical Package for Social Sciences (SPSS 16.0 for Windows) was used for regression analysis. Variable 'zone' was used as the source variable for the weight in above software. In double log form, natural log is applied on both sides of the equation (except on dichotomic variables) describing relationship between price or rate of housing to various variables. The set of explanatory variables was found to account for more than two third of the rate variance (Adj R^2 = 0.678) and the F ratio test indicated that model fits properly. The results indicate that all independent variables are significant except exposure to traffic noise and garbage removal variables. A close look at the Student's t-statistics reveals that distance from the lake was most significant variable affecting the rates of residential plots. Rates of plots decrease @ 10.5 % per zone as the distance from lake increases. This trend is also evident from Table 1. If the rates of plots are analyzed with the linear distance from Sukhna lake, it is found that the rates decrease @ 1600/- per sq yard for every 100 m distance upto 3000 m and @ 800/- per sq yard for every 100 m from 3000 to 6000 m (Figure 6). The steeper slope of curve upto 3000 m and relatively gentle slope after 3000 m indicates a clear positive effect of lake proximity on residential property.

Table 3 : Multiple regression analysis results using WLS method (double log form)

Independent variable	Coefficient	t-ratio	p-value
In PLOTSIZE	-0.024	-1.90	0.05
In DISTLAKE	-0.105	-5.54	0.00
In DISTLVALLEY	-0.019	-2.36	0.01
AIRQUALITY	0.031	3.72	0.00
NOISE	0.00	0.00	0.99
GARBAGE	0.00	-0.05	0.95
WATERQUALITY	0.048	5.10	0.00
QUALITYSECPARKS	0.068	4.05	0.00
CONSTANT	12.64	51.92	0.00

Adj R^2 =0.678, F=46.98 ($p<0.00$), Log-likelihood function value=160.982, n=176

Source variable for weighting=Zone, Dependent variable=In RATE

However, the rates of plots decrease at lesser rate of 1.9 % per zone as distance from Leisure valley chain of parks/gardens increases. This means that the effect of lake proximity is more influential on property prices than the green belt. Similarly, the rates of plots decrease @ 2.4 % as plot size increases (Table 3). This is a general feature in Indian property market in majority of cities where smaller size residential plots fetch higher selling rate. If the rate of plots is analyzed with linear distance from Leisure valley, it is observed that rates decrease @ 800/- per sq yard for every 100 m distance (Figure 9). Among other environmental variables, drinking water quality, its availability round the year and air quality are affecting the rates of property as the zones nearer to lake have the advantages of having better quality of air and drinking water availability. Quality of sector parks was also as an important variable (t-statistics=4.05), indicating comparatively better quality of sector parks in areas near to the lake and poorer quality in southern sectors of the city which are away from the lake.

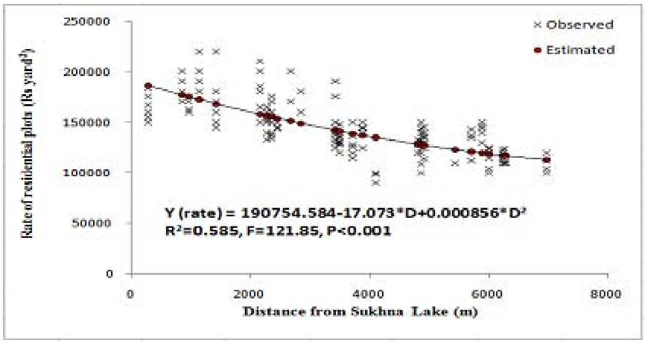
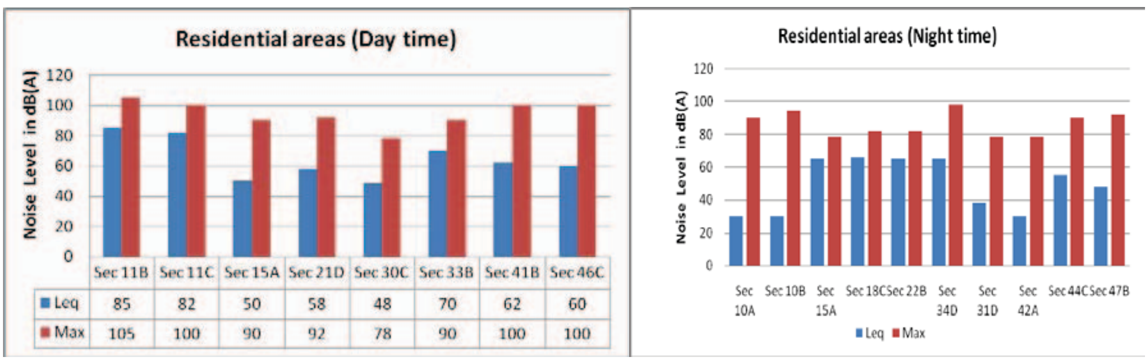
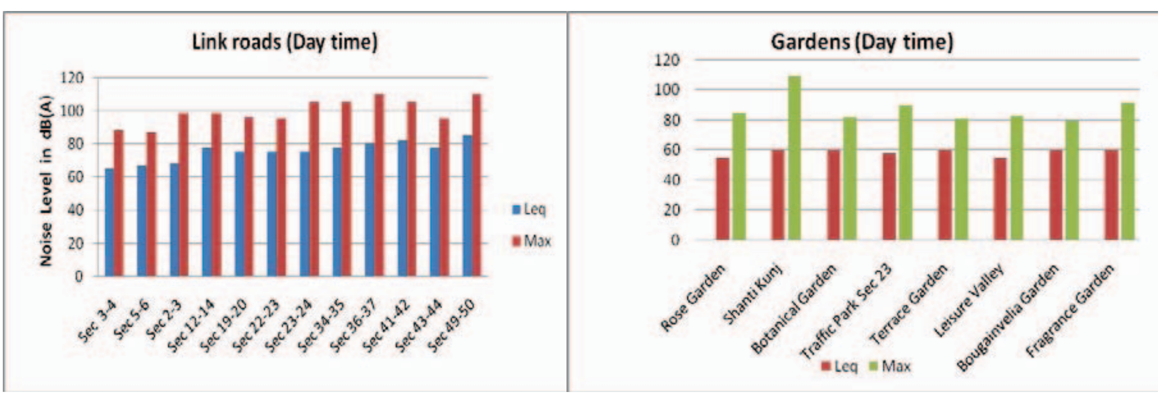


Figure 6 : Variation of residential plot rates vs distance from Sukhna Lake. 'Y' is rate of residential plots (Rs per sq yard) and D is distance from lake

The traffic noise was not found to influence the rates of plots. This finding is similar to the finding in Chinese city of Guangzhou (Jim and Chen, 2006) but opposite to European countries (Luttik, 2000). People of the city found traffic noise present in almost all the areas, except few pockets near Zone 1 and 2. Secondary data from CPCC of Chandigarh administration also points out towards the same fact (Department of Environment, 2008). Noise level in the city during day and night times in residential areas and at link roads remains generally higher than the permissible limits of 55 dB(A) and 45 dB(A) respectively (Figures 7a, 7b and 8a). However, various gardens/ parks in the city display relatively calm areas (Figure 8b).



Figures 7a & 7b : Noise level in residential areas of Chandigarh city



Figures 8a & 8b : Noise level at link roads and gardens of Chandigarh city

Household garbage collection was not a problem for majority of houses as garbage collectors were coming regularly but it was the heaps of garbage around community garbage bins or containers along roads and green belts that were creating the problems for the residents. Another common problem was non-regularity of sweepers on the roads most of the times and lack of their supervision. Residents of the city considered stray cattle, dogs and monkeys also responsible for littering garbage from common bins in different sectors and presenting unhygienic situations. This problem was found prevailing almost all over the city with some marginal improvement in northern sectors near the lake. Therefore, in present analysis, the traffic noise and garbage removal were found as insignificant variables affecting the rates of residential plots in the city.

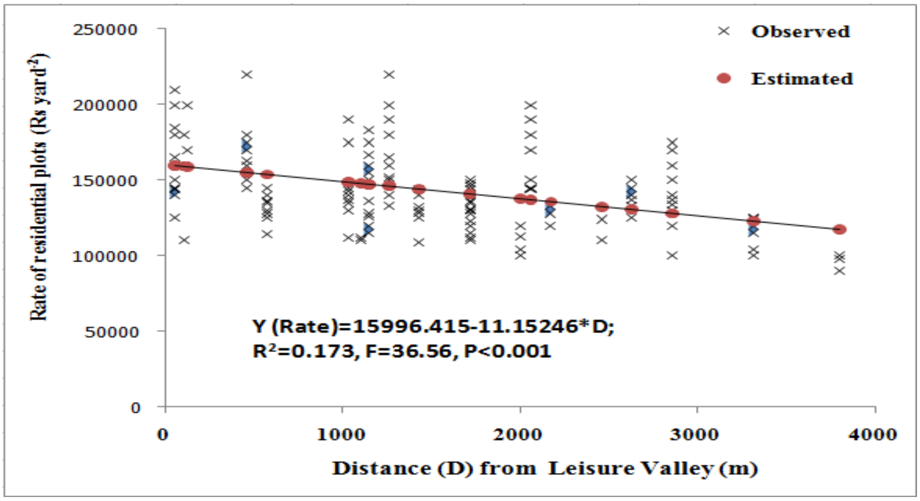


Figure 9 : Variation of residential plot rates vs distance from Leisure Valley. 'Y' is rate of residential plots (Rs per sq yard) and D is distance from Leisure valley

Almost similar results were found when multiple regression analysis was conducted using ordinary least square (OLS) method with double log functional form (adj R^2 = 0.69, F = 50 ($p<0.00$)). Distance from lake was again found most significant variable (t-statistics = 5.55). Exposure to traffic noise and garbage removal were again found insignificant variables (Table 4).

Table 4 : Multiple regression analysis results using OLS method (double log form)

Independent variable	Coefficient	t-ratio	p-value
In PLOTSIZE	-0.033	-2.67	0.00
In DISTLAKE	-0.101	-5.55	0.00
In DISTLVALLEY	-0.022	-2.64	0.00
AIRQUALITY	0.032	3.59	0.00
NOISE	0.00	-0.048	0.96
GARBAGE	0.00	0.127	0.89
WATERQUALITY	0.051	5.31	0.00
QUALITYSECPARKS	0.074	4.193	0.00
CONSTANT	12.66	54.31	0.00

Adj R^2 =0.69, F=50.00 ($p<0.00$), Dependent variable=In RATE, n=176

Ambient air quality of Chandigarh city is under pressure since last three decades due to increase in vehicle population. Respirable Suspended Particulate Matter (RSPM) in the city is crossing its permissible limits in all the residential areas where monitoring is done by CPCC. However, the SO_2 and NO_X levels are within permissible limits (Figures 10, 11, 12).

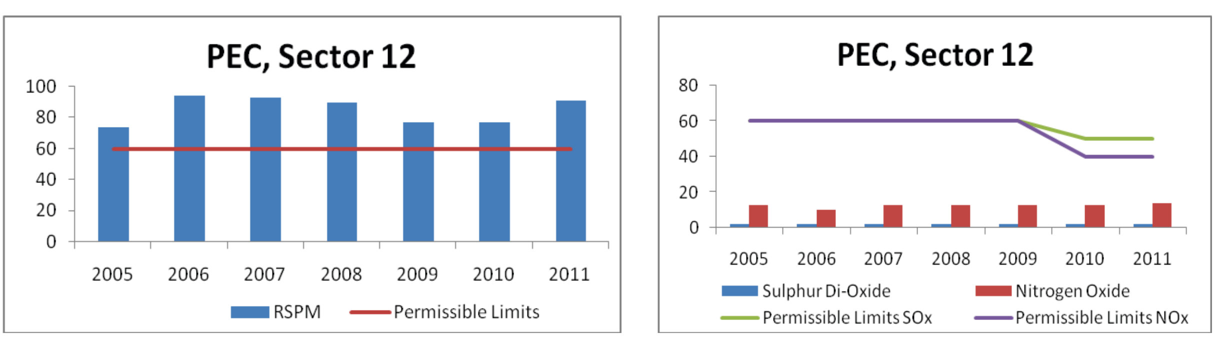


Figure 10 : RSPM, Sulphur Dioxide and Nitrogen Oxide concentrations in zone 1

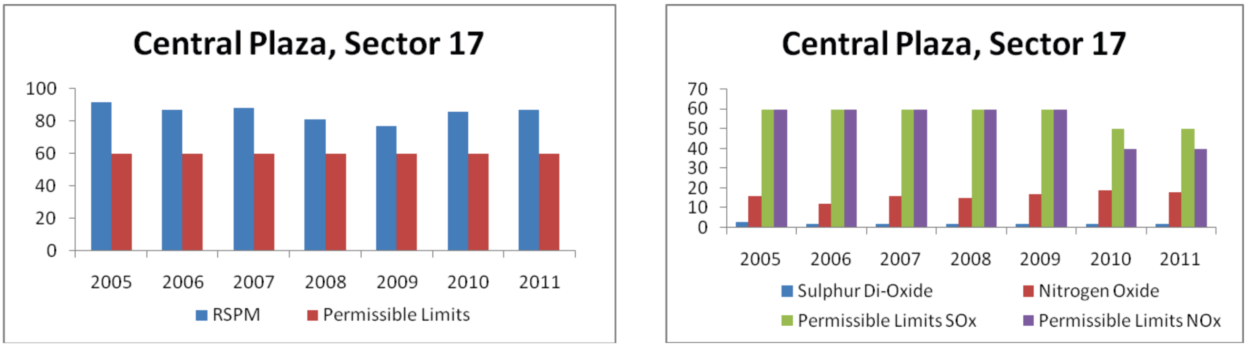


Figure 11 : RSPM, Sulphur Dioxide and Nitrogen Oxide concentrations in zone 2

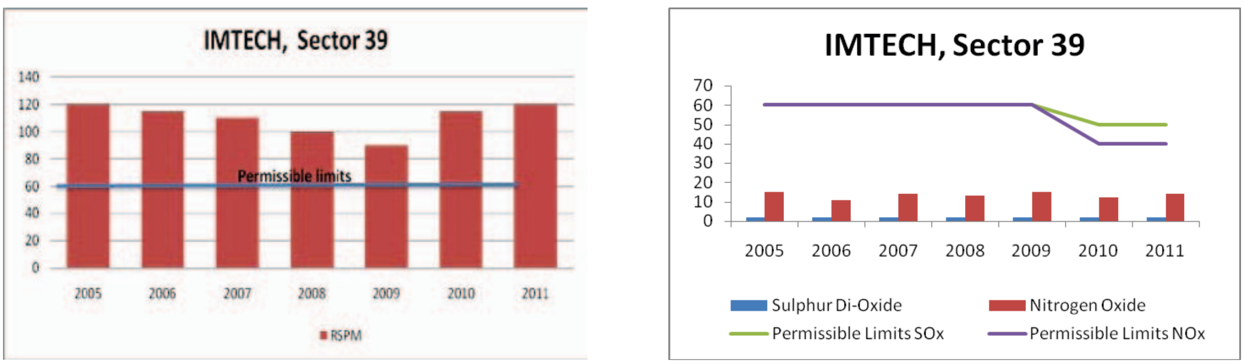


Figure 12 : RSPM, Sulphur Dioxide and Nitrogen Oxide concentrations in zone 4

a) Urban greenery and its environmental effects

As per the two analysis by WLS and OLS method, air quality is found as good in areas nearer to lake and Leisure valley i.e. zones 1 and 2. Air pollution monitoring stations at Punjab Engineering College (PEC) University of Technology, Sector 12 (zone 1) and Central Plaza, Sector 17 (zone 2) of Chandigarh city recorded comparatively lesser average annual RSPM concentration in comparison to those recorded at Institute of Microbial Technology (IMTECH), Sector 39 (zone 4) as evident from Figures 10, 11 and 12. Probable explanations for this are not difficult to find. First, the density of human population n, vehicles and number of plots are less in this region (due to comparatively bigger size plots in comparison to zone 3 and 4). Secondly, more road side greenery, tree avenues, boulevards and parks/gardens in the form of Leisure Garden chain are available in zone 1 and 2 like Rajendra Park, Bougainvillea Garden, Fitness Trail, Zakir Rose Garden and Shanti Kunj (Figure 1). Quality of sector parks was also found comparatively well in zone 1 and 2 (Table 3 and 4). In fact, Chandigarh city is among top India's cities having forest and tree cover of more than 35 % of its area and per capita green space availability around 55 m^2 (Chaudhry and Tewari, 2011; Chaudhry *et al.,* 2011). Maximum of this forest and tree cover is concentrated around zone 1 and 2 (Figure 1).

The enhancement of urban vegetation is one of the ways, which has the potential to mitigate the adverse effects of urbanization, mainly air pollution, in a sustainable manner. Nowadays there is an increased societal demand for more green areas in and around cities (Ridder *et al.,* 2004). Many studies conducted in developed and developing countries support this view. According to a research conducted in Santiago city of Chile which is facing worst urban air pollution in Latin America, managing municipal urban forests (comprising trees, shrubs, and grass) to remove suspended particulate matter (PM_{10}) was a cost effective policy for abating PM_{10} based on criteria set by the World bank (Escobedo *et al.,* 2008). In a study conducted in USA, it was found that atmospheric pollution worth more than 7,00,000 metric tons per year was removed in 55 cities of the country by the urban vegetation (Nowak et al., 2006). Urban forests of Guangzhou city of China, covering an area of 7360 ha, removed 312 metric tons of atmospheric pollution annually, out of which PM_{10} accounted for 234 metric tons (Jim and Chen, 2008). Similarly, urban greenery of Beijing, China with 4.5 million human population, was responsible for removal of 1261 metric tons of environmental pollution every year, out of which 776 metric tons were particulate matter (Yang *et al.,* 2005).

Two way ANOVA was performed with 'rates' of plots as dependent variable and 'distance from Leisure valley chain of parks/gardens' and 'distance from lake' as fixed factors. For distance from Sukhna lake, the following groupings were adopted i.e. 0 to 1500 m, 1501 to 3000 m, 3001 to 4500 m, 4501 to 6000 m and > 6000 m. For distance from Leisure valley chain of parks/gardens following groupings were made i.e. 0 to 200 m, 201 to 600 m, 601 to 1500 m, 1501 to 2000 m and >2000 m. Duncan multiple range test (DMRT) was used to find effect of 'zone' and 'distance from L.valley' on Air quality. It is found that about 77 % of residents up to 1500 m from L.valley were satisfied with air quality, whereas < 53 % residents were satisfied with air quality at far away places i.e. >1500 m distance from L.valley. Duncan multiple range test (DMRT) was also employed to find the effect of 'zone' and 'distance from lake' on air quality. It was found that > 73 % of residents were satisfied from air quality upto a distance of 3000 m from lake and less than 54 % were satisfied as distance from lake increased more than 3000 m. When 'quality of sector parks' was selected as dependent variable, it was noticed that nearly cent percent residents are satisfied with quality of sector parks upto 1500 m from the lake and up to two thirds were satisfied upto 3000 m from the lake. Less than one third of residents were satisfied with quality of sector parks after 3000 m distance from lake. Above analysis shows that 'zone 1' and 'zone 2', which enjoy nearness to S. lake and Leisure Valley, constitute the best region of the Chandigarh city as far as the air quality and urban greenery are concerned (Figure 4). The Sukhna lake has an attractive dam promenade with lot of trees, shrubs, herbs and lawns over it. A road nearby allows walking by visitors and sightseeing of the lake with tropical deciduous forests in the background, adding to recreational and aesthetic value of the spot. Therefore, it is not surprising for the zones 1 and 2 of the city to have highest residential property value. Such green spaces provide recreational and leisure opportunities to the residents and tourists (Tzoulas and James, 2010). They serve as an important place for the people to meet and have social get-togethers (Seeland *et al.,* 2009).

b) Scope of revenue generation

Current government approved collector rate for all the urban residential areas in the Chandigarh is uniform @ Rs 54,912/- per sq yard (Chandigarh Administration, 2012). This rate is very less in comparison to prevailing residential property market rates in zone 1 to 4 (Table 1). Ideally, the collector rate should be very near to prevailing market rate of the property. The huge gap not only leads to the loss of government revenue in the form of stamp duty and registration charges applicable for selling/purchase of such property, it also encourages circulation of black money in the economy as investment in real estate is one of the most favorable options for the persons/firms having black money. Use of unaccounted money in property market in India has become a major problem (Nayar, 1996; Kumar, 1999; Bhigania, 2012). Hence, there is an immediate need to enhance the present collector rate for urban residential property in the city from Rs 54, 912/- per sq yard to at least Rs 1,50,000/- for zones 1 and 2 and to Rs 1,00,000/- for zones 3 and 4. This means an increase of about 173 % for zone 1 and 2 and about 82 % for zone 3 and 4. The Chandigarh administration can take a clue from Government of National Capital Territory (NCT) of Delhi where the property prices for category A (posh areas like Defence colony, Greater Kailash, Gulmohar Park, Golf links, Green Park etc) were increased by 200 % and for category B (areas like Kalkaji, Andrew ganj, Munirka vihar etc) by 50 % in December 2012 (Delhi Administration, 2012). A comparison regarding percent increment in such rates in two cities shows that Delhi Government has been following more pragmatic and practical approach in property matters than Chandigarh administration (Table 5).

Table 5 : Comparison of percent increase in urban property rates in Chandigarh and Delhi

City	Remarks	Year 2010	Year 2011	% Increase	Year 2012	% Increase
Chandigarh	Uniform rates all over the city	Rs 39,936 per sq yard	Rs 49,920 per sq yard	25	Rs 54,912 per sq yard	10
Delhi	Category A	Rs 86,000 per sq m	Rs 2,15, 000 per sq m	150	Rs 6,45,000 per sq m	200
	Category B	Rs 68,200 per sq m	Rs 1,36,400 per sq m	100	Rs 2,04,000 per sq m	50

Extra revenue generated, thereby, can be utilized for creating better parks/gardens in sectors devoid of greenery, maintaining the existing parks/ gardens and the lake. This will help in curbing increased air and noise pollution, as it has been proved not only in developed countries but also in a densrly populated city of Dhaka, Bangladesh, a developing country where the research concluded that urban vegetation was very effective in controlling air and noise pollution (Islam *et al.,* 2012).

Local city municipalities in developing countries often fell short of budget for urban nature conservation related works. In developing countries, research studies related to valuation of urban environmental amenities

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are scanty (Jim and Chen, 2006). Present study is a small step in this direction and provides significant information about people's attitude and behavior towards such amenities in a developing country like India. More and more such studies should be conducted in different cities of the country, wherever possible, to provide scientific justification and platform for generating revenues for creating and maintaining the urban nature components like lakes, wetlands, parks and gardens.

VI. Conclusions

Very few studies are available involving valuation of urban environmental amenities in develop-ping countries including India. These environ-mental amenities include water bodies, clean air and urban forests. Quantification and valuation of environ-mental, social and economic values of these attributes has remained a difficult task. This study is an effort to extract and value the environmental externalities embodied in housing market of Chandigarh city. Municipalities in developing countries always struggle in financing urban nature conservation projects. Attempts were made in this study to establish that the local municipalities and city administration can generate sufficient revenue to further consolidate urban nature elements and provide better quality of urban life and recreational /leisure opportunities to the citizens. This study can also serve as a model for future city planning in the country as the city planners, architects and policy makers can consider the information about the utility of water bodies and urban green spaces in urban land use planning. It is expected that the results of the present study will boost future research about the valuation of the urban environmental amenities in Indian cities.

VII. Acknowledgement

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Comparative Study of Vegetation Status and Species Richness around Alakhnanda and Bhagirathi Valley under Kotli - Bhel Hydroelectric Power Projects (IA and IB), Uttarakhand, India

By Vikaspal Singh, V. Jhaldiyal, S. Dasgupta, D. S. Chauhan, N. P. Todaria

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Keywords : alaknanda valley, bhagirathi valley, submer-gence zone, influence zone, species richness.

GJSFR-H Classification : FOR Code: 059999p

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Strictly as per the compliance and regulations of :

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I. Introduction

Biodiversity has attracted world attention because of the growing awareness of its importance on the one hand and the anticipated massive depletion on the other (Singh 2002). India in general and Himalayan region in particular is known for its biological richness and has always been a botanist's paradise. Its diversified landforms, relief and environmental conditions support a wide range of vegetations (Rana *et al.* 2010). Biodiversity is considered an important aspect of ecosystem energy because it allows building complex trophical networks and it functions as insurance for ecosystem stability and resilience (Gaston and Spicer, 2004). The encroachment on the land by different development works by the people leads to various types of disturbance on the forest vegetation in Himalayan region. In man made landscapes, agricultural activities are the most frequent causes of species loss and, in addition to these deterministic causes of extinction, reductions in area and increases in isolation of semi natural habitats lead to further stochastic species losses (Saunders *et al.,* 1991; Rosenzweig, 1995). Loss of biodiversity may result in loss of stability and functioning of ecosystems (Lawton, 1994; Naeem *et al.,* 1995).

Although India is endowed with rich natural resources and considered as one of the important biodiversity pools for genetic, economic and ecological prudence, it suffers from a variety of problems, ranging from demographic pressure to accelerated land degradation. (Navalgund *et al.,* 2007). Floristic dynamics of landscape reflects variation in climatic conditions, habitat and physiography of the region. The study of natural biotic community is a prerequisite to understand the structural as well as functional attributes to locate for better landscape management (Thakur *et al.,* 2007). Human activities, such as agriculture and forestry, and natural disturbances, such as outbreaks of insects and diseases, can modify the physical environment of an ecosystem (i.e., the patterns of temperature, moisture, wind, and light) by altering structural features (Chen *et al.,* 1999).

II. Methodology

To analyze the plant diversity, phytosociological study was conducted at Alakhnanda and Bhagirathi valley in the Ganga river system under "Kotlibhel Hydroelectric Project (Stage-IA & Stage- IB). The "Kotlibhel H.E. Project (Stage I-A) was situated on river Bhagirathi near village Muneth which is at 3.80 km. upstream of the confluence of river and Alakhnanda at Devprayag in Distt. Tehri Garhwal. The Alakhnanda valley was start from the tail end of the proposed reservoir of Kotlibhel hydro electric power project (Stage I-B) in river Alakhnanda at Srinagar (Garhwal) to 5km. downstream of the proposed power house near confluence of Bhagirathi and Alakhnanda at Devprayag. This covered the total stretch of about 30 km long and 7 km wide.

The ecological survey was conducted during June 2005 to Feb 2006. Study area was divided into two categories, influence and submergence zone along the

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reservoir. A total of 8 transects were laid in the entire study area for both of the valleys. Each Transects were spatially distributed so as to minimize the autocorrelation among the vegetation. 'S' or species richness, was determined following Whittaker (1976) by tabulating the number of woody species in each plot. Biodiversity Pro (vers. 2) software (1997) was used to Bray-Curtis analysis.

III. Results and Discussion

After detailed ecological study in both valleys, a total of 134 species were recorded which were represented by 56 families and 118 genus. Out of 134 species, 39 species were under tree layer, 36 under shrub layer and 59 were found under herb layer. Taxonomically, among different vegetation layer of both valley Poaceae was most diverse family with maximum (11) number of species followed by Asteraceae (10), Fabaceae (9), Lamiaceae (9), Euphorbiaceae (6) and Caesalpinaceae (5) (Table-1, 2 and 3).

In Alakhnanda valley total 31 tree species were recorded in which 26 were in Influence zone and 21 in submergence zone. In Bhagirathi valley total 27 tree species were recorded in which 12 were in Influence zone and 27 were in the submergence zone. As far as shrub specie were concerned, 32 species were found in Alakhnanda valley in which 32 were in the influence zone and 24 were in submergence zone while in the Bhagirathi valley total 31 shrub species were recorded in which 30 were in the influence zone and 27 species were in the submergence zone. Herb layer of both valleys in both zones followed the same trend as for tree and shrub species. A total of 42 herb species were found in the Alakhnanda valley in which 41 were in the influence zone and 38 were in the submergence zone while in the Bhagirathi valley a total of 55 herb species were recorded in which 51 species were in the influence zone and 45 species were in the submergence zone (Table 4).

Between both of the valleys the species richness was greater in the influence zone, except for tree layer of Bhagirathi valley where it was fount higher (27 individuals) in the submergence zone. Adhikari *et al.,* (2009) explored the vegetation structure and community pattern of Tehri Dam submergence zone and reported maximum species richness in Bhagirathi submergence zone compare to the Bhilangana Submergence zone.

Maximum (48) and minimum (12) genera were occurred in the influence zone of Bhagirathi valley for the herb layer and tree layer respectively. In Alakhnanda valley, herb layer also occupied maximum (38) genera in the influence zone followed by (36) in submergence zone for herb layer, 32 for shrub layer in influence zone and 26 in influence zone for tree layer. Tree layer of submergence zone of Alakhnanda valley showed minimum (21) genera. In the Bhagirathi valley highest numbers (48) for genera were recorded for the herb layer followed by 41 for herb layer in the submergence zone, 30 for shrub layer in influence zone and same number (27) of genera recorded for shrub layer and tree layer in the submergence zone (Table-4).

The proportion of genus, species and family presents in table-5. The proportion of family to species was recorded higher compare to proportion of genus to species and family to genus in both of the zone in both valleys. While, maximum proportion (2.20) of family to species was recorded in the influence zone of Alkhnanda valley. In present study in both of the valley, the proportion among species, genus and family followed the trend as family to species > family to genus >genus to species. Pokhriyal *et al.,* (2009) reported the greater proportion of family to species and genera to species in a comparative study of *Annogeissus latifolius* mixed forest in Phakot and Pathri Rao watersheds of Garhwal Himalaya. In hilly districts of Garhwal Himalaya, Negi *et al.,* (2008) also found higher proportion of family to species followed by family to genus and genus to species in a comparative study between Panchayat and Reserve forests. Kharkwal *et al.,* (2005) found higher proportion between family and species with a little difference compare to genus to species and family to genus in three different Oak forests of Nainital district.

Bray-Curtis cluster analysis was used to find out the species assemblage in influence and submergence zone at both of the Alaknanda and Bhagirathi valley. Figure 1 – 3 represents different species assemblage in both of valleys. In the tree layer *Acacia catechu, Aegle marmelos, Cassia fistula, Haldinia cordifolia, Holoptelea integrifolia, Mallotus philippensis, Mangifera indica* and *Pinus roxburghii* formed separate cluster as these species assemblage was found in both of the zones as well as both valleys. While *Ougenia ooginansis, Grevillia robusta* and *Eucalyptus camaldulensis* were found only at submergence zone of Alaknanda valley (Figure 1). In the shrub layer *Adathoda zeylanica, Artemisia roxburghiana, Cajanus mollis, Cassia tora, Colebrookia oppositifolia, Debregeasia longifolia, Eupatorium adenophorum, Euphorbia royleana, Ficus hederaceae, Lantana camara, Murrya koenigii, Rhus parviflora, Tephrosia candida, Woodfordia fruticosa* and *Ziziphus oxyphylla* was distributed at both of the zones of Alaknanda and Bhagirathi valley. While *Agave americana, Berberis lycium, Pteracanthus angustigrons, Reinwardtia indica* and *Jatropa curcas* found only at the influence zone of Bhagirathi valley (Figure 2). In the herb layer out of total 59 species, 29 herb species were recorded at both zones of Alaknanda and Bhagirathi valley. Only 2 species viz; *Aster peduncularis* and *Bidens bipinata* were found at only submergence zone of the Bhagiratgi valley (Figure 3)

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Table 1 : Tree species composition in submergence and influence zone of Alaknanda and Bhagirathi valley

S.No.	Species	Family	Alakhnanda valley		Bhagirathi valley	
			IZ	SZ	IZ	SZ
1	*Acacia catechu*	Mimosaceae	+	+	+	+
2	*Aegle marmelos*	Rutaceae	+	+	+	+
3	*Albizia lebbek*	Mimosaceae	+	+	-	-
4	*Anogeissus latifolius*	Combretaceae	-	-	+	+
5	*Bauhinia variegata*	Caesalpiniaceae	+	-	-	-
6	*Boehmeria rugulosa*	Urticaceae	-	-	-	+
7	*Bombax cieba*	Bombaceae	+	+	-	+
8	*Carica papaya*	Cacricaceae	+	-	-	+
9	*Cassia fistula*	Caesalpinaceae	+	+	+	+
10	*Celtis australis*	Ulmaceae	-	+	-	+
11	*Dalbergia sissoo*	Fabaceae	+	+	-	-
12	*Delonix regia*	Caesalpiniaceae	+	-	-	-
13	*Eucalyptus camaldulensis*	Myrtaceae	-	+	-	-
14	*Ficus benghalensis*	Moraceae	-	-	-	+
15	*Ficus palmata*	Moraceae	-	-	-	+
16	*Ficus religiosa*	Moraceae	-	+	+	+
17	*Grevillia robusta*	Proteaceae	-	+	-	-
18	*Grewia optiva*	Tiliaceae	-	-	+	+
19	*Haldinia cordifolia*	Rubiaceae	+	+	+	+
20	*Holoptelea integrifolia*	Ulmaceae	+	+	+	+
21	*Juglans regia*	Juglandaceae	+	-	-	-
22	*Lannea coromendelica*	Anacardaceae	+	+	-	+
23	*Leucaena leucocephala*	Mimosaceae	+	+	-	+
24	*Mallotus philippensis*	Euphorbiaceae	+	+	+	+
25	*Mangifera indica*	Anacardaceae	+	+	+	+
26	*Melia azedarach*	Miliaceae	+	+	-	+
27	*Morus alba*	Moraceae	+	-	-	-
28	*Musa paradisca*	Musaceae	+	-	-	+
29	*Ougenia ooginansis*	Fabaceae	-	+	-	-
30	*Phoenix humilis*	Arecaceae	-	-	-	+
31	*Phyllanthus emblica*	Euphorbiaceae	+	-	-	-
32	*Pinus roxburghii*	Pinaceae	+	+	+	+
33	*Prunus cerasoides*	Rosaceae	-	-	-	+
34	*Psidium guajava*	Myrtaceae	-	-	-	+
35	*Pyrus phasia*	Rosaceae	+	-	-	+
36	*Syzygium cumini*	Myrtaceae	+	-	+	+
37	*Tectona grandis*	Verbenaceae	+	-	-	-
38	*Terminalia chebula*	comberetaceae	+	+	-	-
39	*Toona hexandra*	Miliaceae	+	-	-	+

Table 2 : Shrub species composition in submergence and influence zone of Alaknanda and Bhagirathi valley

S.No.	Species	Family	Alakhnanda valley		Bhagirathi valley	
			IZ	SZ	IZ	SZ
1	*Adathoda zeylanica*	Acanthaceae	+	+	+	+
2	*Aerva sanquinolenta*	Amaranthaceae	+	+	-	-
3	*Agave americana*	Agavaceae	-	-	+	+
4	*Agave fastigata*	Agavaceae	+	+	-	-
5	*Artemisia roxburghiana*	Asteraceae	+	+	+	+
6	*Asparagus adscendens*	Liliaceae	+	-	+	+
7	*Bambusa arundinaceae*	Fabaceae	+	+	-	-

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8	*Barleria cristata*	Acanthaceae	+	+	+	-
9	*Berberis lycium*	Berberidaceae	-	-	+	+
10	*Cajanus mollis*	Fabaceae	+	+	+	+
11	*Cannavis sativa*	Cannabinaceae	+	-	+	+
12	*Carrisa opeca*	Apocynaceae	+	+	+	+
13	*Cassia tora*	Caesalpiniaceae	+	+	+	+
14	*Colebrookia oppositifolia*	Lamiaceae	+	+	+	+
15	*Cotinus coggygria*	Anacardiaceae	+	+	-	-
16	*Debregeasia longifolia*	Urticaceae	+	+	+	+
17	*Eupatorium adenophorum*	Asteraceae	+	+	+	+
18	*Euphorbia royleana*	Euphorbiaceae	+	+	+	+
19	*Ficus hederaceae*	Moraceae	+	+	+	+
20	*Jatropa curcas*	Euphorbiaceae	-	-	+	-
21	*Lantana camara*	Verbenaceae	+	+	+	+
22	*Murrya koenigii*	Rutaceae	+	+	+	+
23	*Nyctanthes arbo-tritis*	Oleaceae	+	+	-	-
24	*Pteracanthus angustigrons*	Acanthaceae	-	-	+	+
25	*Pueraria tuberosa*	Fabaceae	+	+	+	-
26	*Pupalia lapaca*	Amaranthaceae	+	-	+	+
27	*Reinwardtia indica*	Linaceae	+	-	-	+
28	*Rhus parviflora*	Anacardaceae	+	+	+	+
29	*Ricinus communsis*	Euphorbiaceae	+	-	+	+
30	*Rubus ellipticus*	Rosaceae	+	-	+	+
31	*Sida cordifolia*	Malvaceae	+	-	+	+
32	*Tephrosia candida*	Fabaceae	+	+	+	+
33	*Urtica dioica*	Urticaceae	+	+	+	-
34	*Woodfordia fruiticosa*	Lythraceae	+	+	+	+
35	*Xanthium indicum*	Asteraceae	+	-	+	+
36	*Ziziphus oxyphylla*	Rhamnaceae	+	+	+	+

Table 3 : Herb species composition in submergence and influence zone of Alaknanda and Bhagirathi valley

S.No.			Alakhnanda valley		Bhagirathi valley	
	Species	Family	IZ	SZ	IZ	SZ
1	*Ageratum conyzoides*	Asteraceae	-	-	+	+
2	*Ajuga bracteosa*	Lamiaceae	+	+	+	+
3	*Alysicarpus bupleurifolius*	Fabaceae	+	+	+	+
4	*Anaphalis adnata*	Asteraceae	+	-	+	-
5	*Apluda mutica*	Poaceae	-	-	+	+
6	*Arisaema tortuosum*	Areceae	-	-	+	-
7	*Artimissia capalaris*	Asteraceae	+	+	+	+
8	*Arundinella nepalensis*	Poaceae	+	-	+	+
9	*Aster peduncularis*	Asteraceae	-	-	-	+
10	*Bidens bipinata*	Asteraceae	-	-	-	+
11	*Bidens pilosa*	Asteraceae	+	+	+	+
12	*Brachiaria ramosa*	Poaceae	+	+	+	+
13	*Brassica rapa*	Brassicaceae	-	-	+	+
14	*Bupleurum falctaum*	Apiaceae	-	-	+	-
15	*Carex myosuras*	Cyperaceae	-	-	+	+
16	*Cassia absus*	Caesalpiniaceae	+	+	+	+
17	*Celosia argentea*	Areceae	+	+	+	+
18	*Chenopodium album*	Chenopodiaceae	-	-	+	+

19	*Chrysopogon aciculatus*	Poaceae	+	+	+	+
20	*Chrysopogon fulvus*	Poaceae	+	+	+	+
21	*Commelina benghalensis*	Commelinaceae	-	-	+	+
22	*Crotolaria medicagina*	Fabaceae	+	+	+	+
23	*Cynadon dactylon*	Poaceae	+	+	+	+
24	*Cynoglosum glochidiatum*	Boraginaceae	+	+	+	+
25	*Cyperus comprsssus*	Cyperaceae	+	+	+	+
26	*Datura innoxia*	Solanaceae	+	+	-	-
27	*Datura stramonium*	Solanaceae	-	-	+	-
28	*Desmodium triflorum*	Fabaceae	+	+	+	+
29	*Digitaria ciliaris*	Poaceae	+	+	+	+
30	*Elusine coracana*	Poaceae	-	-	+	+
31	*Eragrostis minor*	Poaceae	+	+	+	+
32	*Euphorbia hirta*	Euphorbiaceae	+	+	+	+
33	*Evolvulus alsinoides*	Convolbulaceae	+	+	+	+
34	*Fumaria indica*	Fumariaceae	+	+	-	-
35	*Galium aprine*	Rubiaceae	+	+	-	-
36	*Geranium ocelatum*	Geraniaceae	+	+	+	+
37	*Heteropogon controtus*	Poaceae	+	+	+	+
38	*Heteropogon melanocarpus*	Poaceae	-	+	+	+
39	*Ipomoea hederifolia*	Convolbulaceae	+	+	+	+
40	*Leucas cephalotes*	Lamiaceae	+	+	+	+
41	*Leucas lanata*	Lamiaceae	+	+	+	+
42	*Malva sylvestris*	Malvaceae	+	+	+	+
43	*Micromaria biflora*	Lamiaceae	+	+	+	+
44	*Nepeta hindostana*	Lamiaceae	+	+	-	+
45	*Nicotiana plumbaginifolia*	Solanaceae	+	+	+	-
46	*Origanum vulgare*	Lamiaceae	+	-	+	-
47	*Oxalis corniculata*	Oxalidaceae	+	+	+	+
48	*Physalis divaricata*	Solanaceae	+	+	+	+
49	*Rumx hastatus*	Polygonaceae	+	+	+	+
50	*Scutellaria linearis*	Lamiaceae	-	-	+	-
51	*Scutellaria scandems*	Lamiaceae	+	+	-	+
52	*Sedum multicaule*	Crasulaceae	+	+	+	+
53	*Sida rhombifolia*	Malvaceae	+	+	-	-
54	*Sida cordata*	Malvaceae	+	-	+	+
55	*Stellaria media*	Caryophyllaceae	-	-	+	+
56	*Tagetus erecta*	Asteraceae	-	-	+	-
57	*Thalictrum foliolosum*	Ranunculaceae	-	-	+	-
58	*Verbascum thapsus*	Scrophulariaceae	-	-	+	+
59	*Viola canescens*	Violaceae	+	+	+	-

\+ Presence and – Absence of species

Table 4 : Distribution of species, families and genus in both zone of Alakhnanda and Bhagirathi valley

Site	Alakhnanda valley Influence Zone			Alakhnanda valley Submergence Zone		
	Tree	Shrub	Herb	Tree	Shrub	Herb
Species	26	32	41	21	24	38
Family	19	23	19	15	18	19
Genus	26	32	38	21	24	36

	Bhagirathi valley Influence Zone			Bhagirathi valley Submergence Zone		
Species	12	30	51	27	27	45
Family	12	21	24	19	22	21
Genus	12	30	48	27	27	41

Table 5 : Proportion of Species, genus and family in both zone of Alakhnanda and Bhagirath valley

Zone	Genus: Species	Family: species	Family: Genus
Alakhnanda valley Influence Zone	1.09	2.20	2.02
Alakhnanda valley Submergence Zone	1.09	2.05	1.88
Bhagirathi valley Influence Zone	1.11	2.02	1.83
Bhagirathi valley Submergence Zone	1.14	1.98	1.74

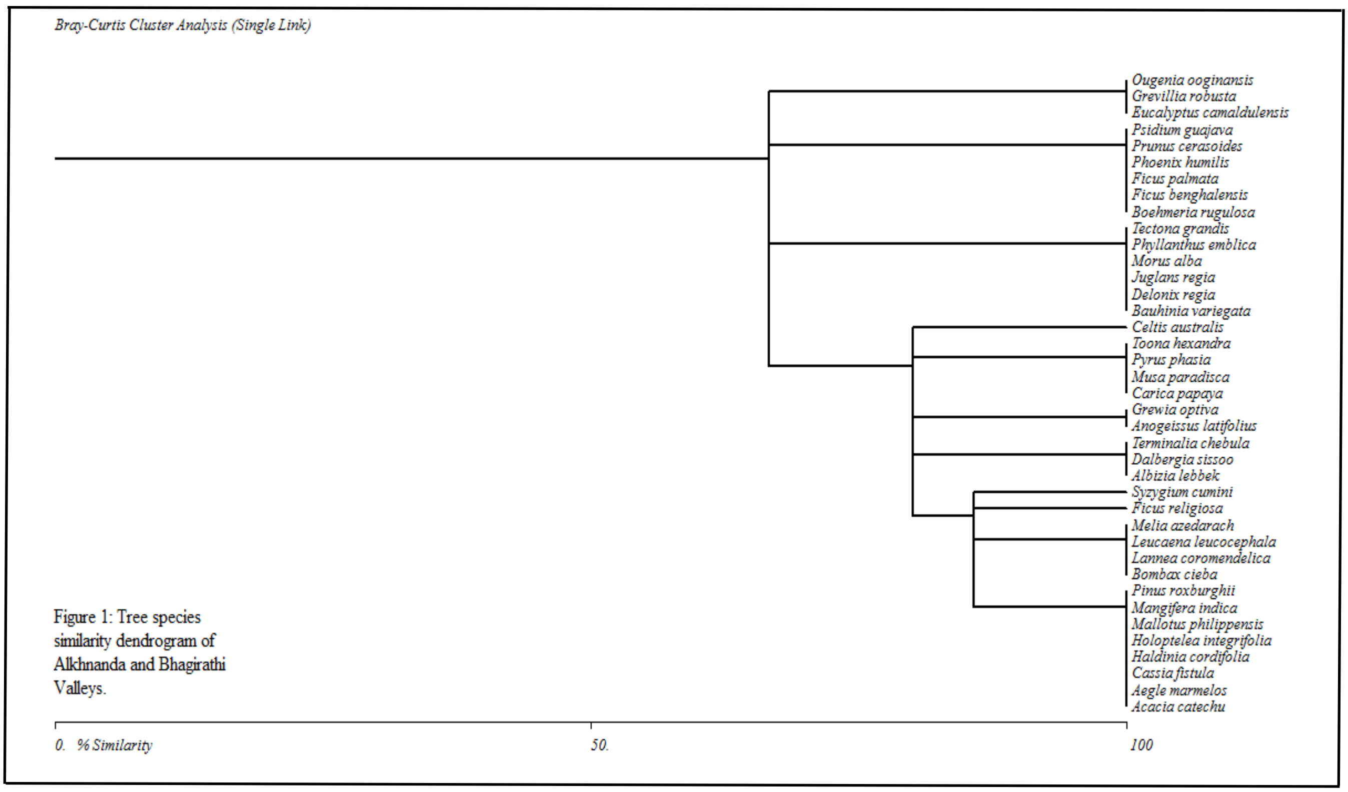

Figure 1 : Tree species similarity dendrogram of Alkhnanda and Bhagirathi Valleys

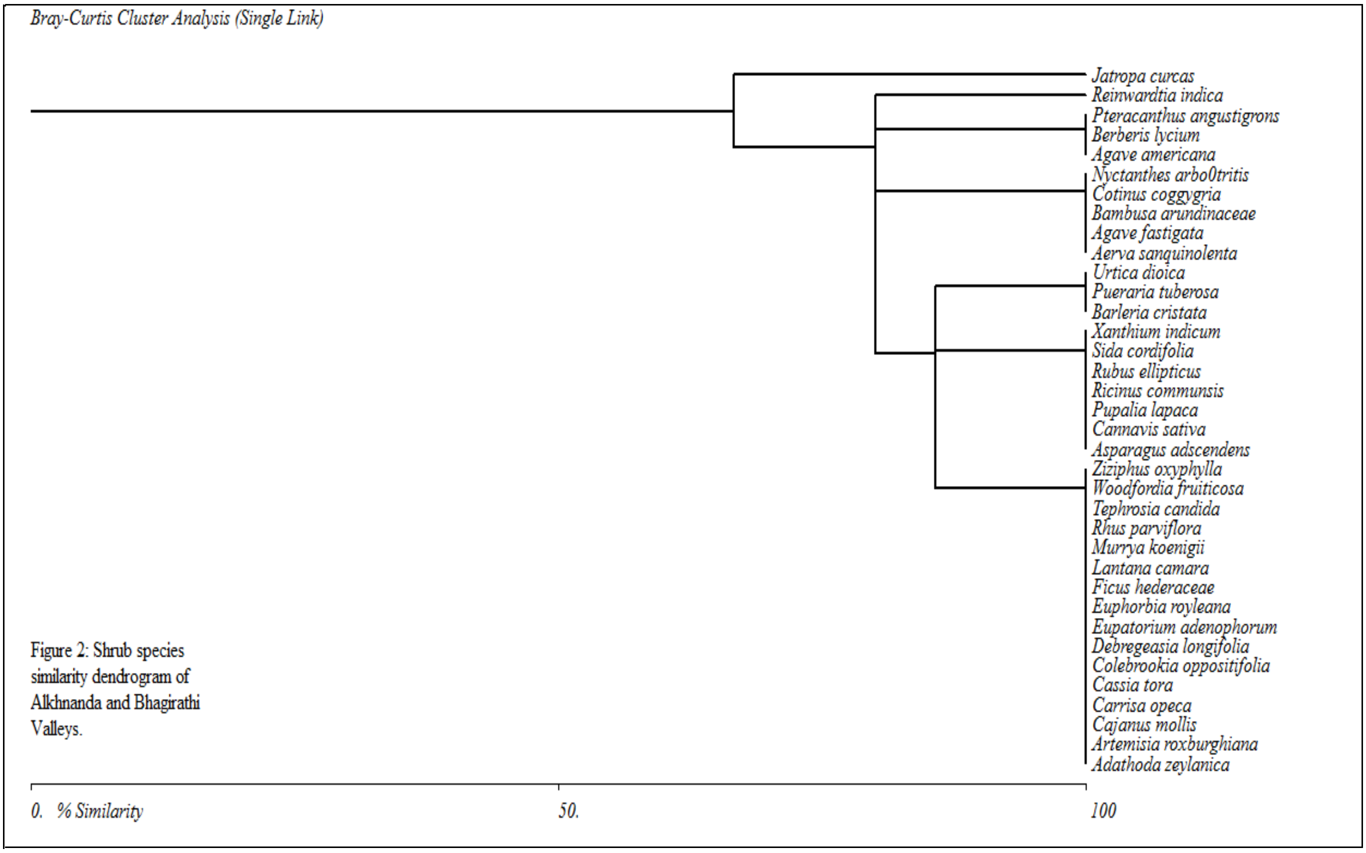

Figure 2 : Shrub species similarity dendrogram of Alkhnanda and Bhagirathi Valleys

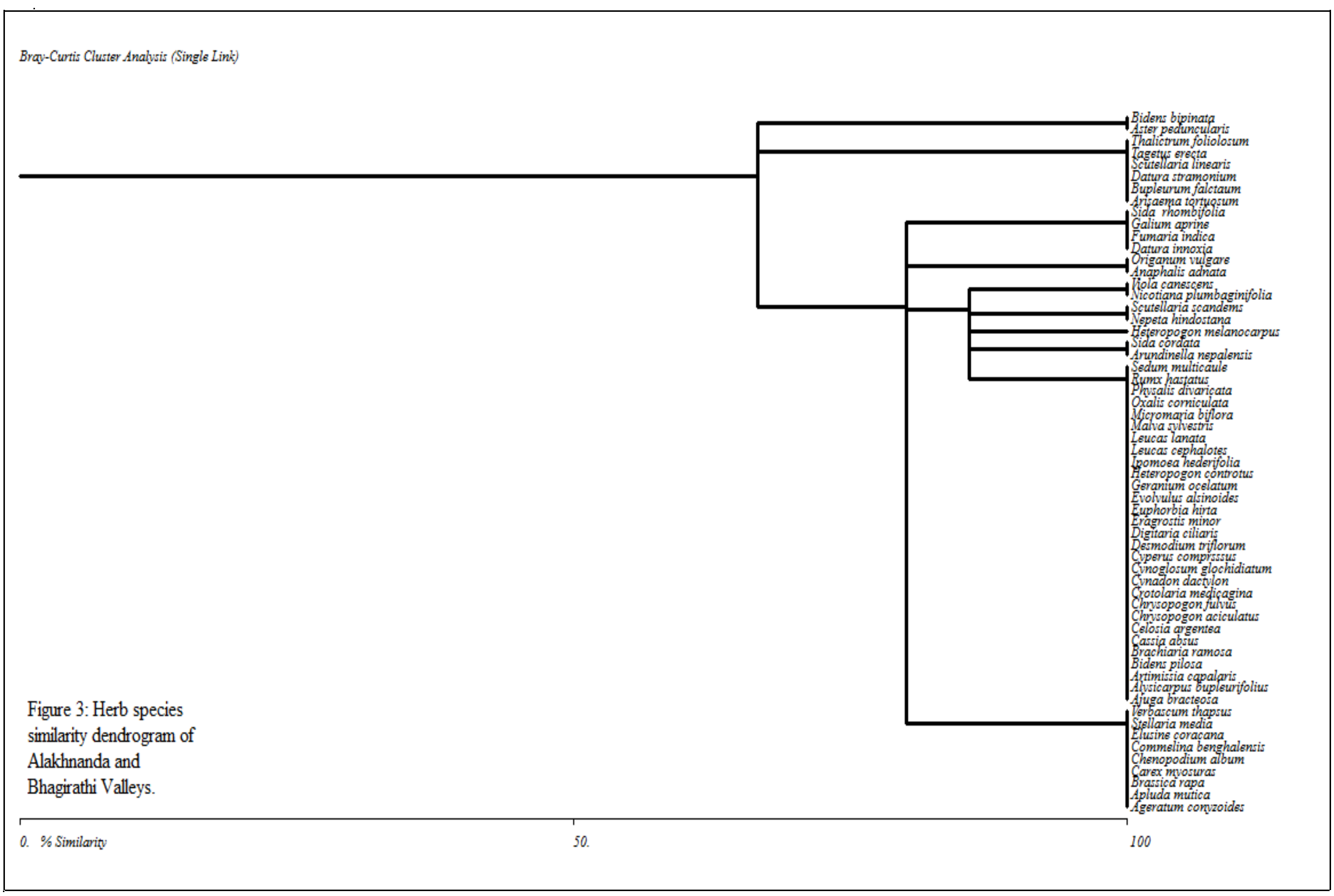

Figure 3 : Herb species similarity dendrogram of Alkhnanda and Bhagirathi Valleys

IV. Conclusion

Comparing both of the valleys, tree species richness was high at the submergence zone of Bhagirathi valley. Number of shrub was higher at the influence zone of Alaknanda valley. While herb species richness was observed higher at Bhagirathi valley. In both valleys the vegetation composition both valleys was found almost in similar pattern, though species richness was greater in the Influence zone. Hence, it may be hypothesized that after construction of proposed hydropower projects there may be negligible effect on the species richness of the surrounding vegetation, but definitely a significant portion of the vegetation is going to be lost forever. All the plant species as well as their surrounding diversity are, in order to protect the whole range of biodiversity, these plant communities need to be conserved.

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"A Comparative Study of Premonsoon and Postmonsoon Status of Different Physical and Chemical Parameters of Water Samples Collected from the Various Sources of Water in Todaraisingh Tehsil of Tonk (Rajasthan) India"

By Ashok Kumar Yadav & Praveen Khan

Govt. P.G. College, Tonk, India

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Keywords : premonsoon, postmonsoon, concentration of ions, fluoride, fluorosis, water quality standards, water quality parameters.

GJSFR-H Classification : FOR Code: 040699, 960608

A COMPARATIVE STUDY OF PREMONSOON AND POSTMONSOON STATUS OF DIFFERENT PHYSICAL AND CHEMICAL PARAMETERS OF WATER SAMPLES COLLECTED FROM THE VARIOUS SOURCES OF WATER IN TODARAISINGH TEHSIL OF TONK RAJASTHAN INDIA

Strictly as per the compliance and regulations of :

"A Comparative Study of Premonsoon and Postmonsoon Status of Different Physical and Chemical Parameters of Water Samples Collected from the Various Sources of Water in Todaraisingh Tehsil of Tonk (Rajasthan) India"

Ashok Kumar Yadav [α] & Praveen Khan [σ]

Abstract - The study of the water quality of Todaraisingh tehsil of tonk district, rajasthan india has carried out to assess the risk to human health. A comparative study has also been done in premonsoon and postmonsoon periods considering the change in various parameters and concentration of different ions. It has been found that the concentration of ions in premonsoon period is higher than postmonsoon which is natural phenomenon. This study is main consideration to assess the quality of water for its best utilization like drinking. For this purpose the study area has been divides into five zones. Only two sample sites named hamirpura (s-5) and lamba khurd (s-7) are found fit for in all studied water quality parameters on comparision with standards. These two villages are located in north zone of tehsil.

Contamination of ground water with fluoride is due to the naturally fluoride rich rock salt system. Hence almost all the area is fluorosis prone.

Keywords : premonsoon, postmonsoon, concentration of ions, fluoride, fluorosis, water quality standards, water quality parameters.

I. Introduction

Today cry of environment pollution is heard from all corners of the world. Pollution has become a distinct threat to the very existences of mankind on this earth. For centuries man has been disturbing the balance of nature for comfort, wealth and ego but now nature has started its revenge.

The unique physical and chemical properties of water have allowed life to evolve in it. The following quote from Szent Gyorgyi ellustrates this point of view "That water function in varieties of ways within the cell cannot be disputed life originated in water, is thriving in water. Water beings its solvent and medium. It is the matrix of life."

Water is colour less, tasteless and odourless liquid in its pure form. Since it has very high dielectric constant, it is used as a universal solvent. As it dissolves nearly all natural compounds it transports the minerals and nutrients necessary for growth of plants. Many body fluids are water solution of biologically important solutes. More than two third of the earth's surface is covered by water out of which 71 % is covered by oceans. The earth therefore appears blue from space and hence called "blue planet"

The water in oceans and seas is highly saline, the estimated 1011 million cubic km of the total water present on earth, only 33400 cubic meter of water is available for drinking, industrial consumption and waste disposal.[1]The main sources of water are rain, sea, ground water and surface water. According to an assumption, the annual rain fall in india is about 400 million hectare meters (mhm) out of which, 70 mhm of water evaporates immediately, 115 mhm runs off into surface water bodies and the remaining percolates into the soil. Net annual recharge in India is 67 mhm although only 35 mhm is available for utilization. The great Indian Thar Desert which is a part of Rajasthan cover most of the area of state has extremely arid and dry climate condition. It receives only 5mm to 20mm annual rainfall, thus ground water is deeper and contains high mineral concentrated chemicals. Eastern part of the state is semi desert and hilly therefore, water availability in this area is limited. This geographical and geological setup, arid and semi-arid climate lead to insufficient water resources and deterioration of water quality hence Rajasthan mostly depended on ground water for drinking and agriculture purposes. Unfortunately the groundwater quality in a large number of districts is not according to WHO and ISI standards.

Rajasthan is the only state where almost all the districts are affected by high fluoride. Geological distribution of rocks in Rajasthan reveals that fluoride ores occupy large area of eastern and south east part of this state, in constricted synclinal bands in the central region of Aravali Synchronium. Secondly, around the mica mines ground water is rich in fluorides and Rajasthan is a rich source of mica.[2]

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In Rajasthan all the 33 districts have been declared as fluorosis prone areas and fluorosis problem can be visualized at various intensity levels i.e. Dental fluorosis, skeletal fluorosis and non-skeletal fluorosis etc. PHED habitations survey 1991-93 shows total 83200 villages and habitations have fluoride problem.[3] In Tonk district (part of eastern Rajasthan) occurrence of high fluoride in ground water is quite common.[4]

Besides this pollution of sources of drinking water is frequent due to domestic water, earthen septic tanks, urban and rural garbage, agriculture discharges, soluble effluents, industrial effluents, seepage pits etc.

So water from all sources may not be fit for drinking it can have dissolved salts along with suspendebal particles and microorganisms.

The physico-chemical water parameters viz-pH, turbidity conductivity, alkalinity, total dissolved solid (TDS), hardness concentration of chloride, fluoride, sulphate, nitrate etc. should be in limited values.[5-9]

Quality of water is affected adversely, when these parameters in water exceed permissible limit that can be tolerated. So WHO has published the maximum and minimum values for each parameter with in that limit the water quality is considered suitable for drinking, agriculture and other uses.

Besides other factors discussed above, monsoon factor also affects the concentration of ions in water in pre monsoon periods and post monsoon period. So it is very important to study and compare the physico-chemical parameters before rainfall and after rainfall. Many researchers have been reported seasonal physico-chemical parameters studies in India since 1990[10] up to now.[11-16]

Hence we are discussing here the change in the physico-chemical parameters in the pre and post monsoon season in Todaraisingh Tehsil of Tonk district Rajasthan, India.

a) *Study Area and Climatic Conditions*

To darisingh is in the east of Tonk district at the 75.19' & 76.16' at the longitude position. The latitude position is 25.41' & 26.24'in north. Its area is 7194 sq. km whereas forest area is 27048 hectares. Temperature remains 26-45°c in summer and 8-22°c in winter. The annual average rainfall is 613.6mm is recorded.

Study area:

In this block most of area is rural and public depends on farming and so that on ground water and rain water. People are not aware about impact of water due to lack of knowledge. On primary investigation it was found that people of this area suffered from fluorosis (Dental and Skeletal) and the symptoms of fluorosis could be seen by naked eyes too. So an attempt was made to screen of water quality in Todaraisingh area of Tonk.

II. Materials and Methods

The standard known methods and quality material is used for analysis of different ions in water. pH and conductivity are determined by PH metric and conductometric methods while other parameters are also determine and compared by standard methods.[17-19] Fluoride ion was determined by ion selective electrode method by ion selective meter.

a) *Comparison and discussion of results obtained*

Water quality standards are discussed and shown in table -1. Drinking water standards prescribed by different agencies are given in table-2.

The study area Todaraisingh is divided into main five regions to cover north, south, east, west and central part for the comparison and discussion purpose. We have collected 60 water samples of different sources of 30 villages in this Tehsil from the above divisions. We have taken samples from tube wells and hand pumps sources. The results of physico-chemical characteristics of various samples are discussed and region wise – monsoon wise observation are tabulated in the various tables and compared by different methods viz: graphs.

b) *Colour, Odour and Taste*

All the physical characteristics of the samples collected from different places and various sources are not objectionable. All water samples are colourless and odourless. They have agreeable taste. The appearance of the all water samples showed that the water quality is fit to drink. From physical appearance the water seems suitable for drinking.

Table 1 : Water Quality standards

Parameters	USPH Standards	ISI Standards (IS:10500-1991)
Colour	Colourless	Colourless
Odour	Odourless	Odourless
Taste	Tasteless	Tasteless
pH	6.0-8.5	6.5-8.5
T.D.S.	500	500-2000
Chloride	250	250-1000
Calcium	100	75-200
Magnesium	30	30-150
Fluoride	1.5	1.5

Nitrate	10	45
Total Hardness	-	300-600
Alkalinity	-	200-600

USPH: United state Public Health drinking water standards (USPH)
ISI: Indian standard Institution (ISI)

Table 2 : Drinking water standards prescribed by different agencies

Parameter	Agencies									
	BIS Limit		WHO Guideline		MUD Limit		MWH Limit		ICMR Limit	
	Desirable	MPL	Desirable	MPL	Desirable	MPL	Desirable	MPL	Desirable	MPL
pH	6.5-8.5	No Relaxation	7-8.5	6.5-9.2	7-8.5	6.5-9.2	7-8.5	6.5-9.2	7-8.5	6.5-9.2
Fluoride	1	1.5	0.5	1-1.5	1	1.5	–	–	–	–
TDS	500	2000	500	1500	500	1500	–	–	500	1500
Chloride	250	1000	200	600	200	1000	200	1000	200	1000
Ca Hardness	75	200	75	200	75	200	–	–	75	200
Mg Hardness	30	150	30	30	30	150	–	–	50	150
Nitrate	45	45	45	45	45	100	45	45	20	50
Alkalinity	200	600	–	–	200	600	–	–	–	–

BIS - Bureau of Indian Standard
WHO - World Health Organization
MUD - Ministry of Urban Development
MWH - Ministry of Works and Housing
ICMR - Indian Council of Medical Research
MPL - Maximum Permissible Limit

c) pH

Here pH was found in the range of 6.75 to 8.95 comparatively higher pH recorded during pre-monsoon than post monsoon be due to dilution of water as a result of precipitation.[20]

Graph 1 : pH Comparison in Pre & Post Monsoon Season

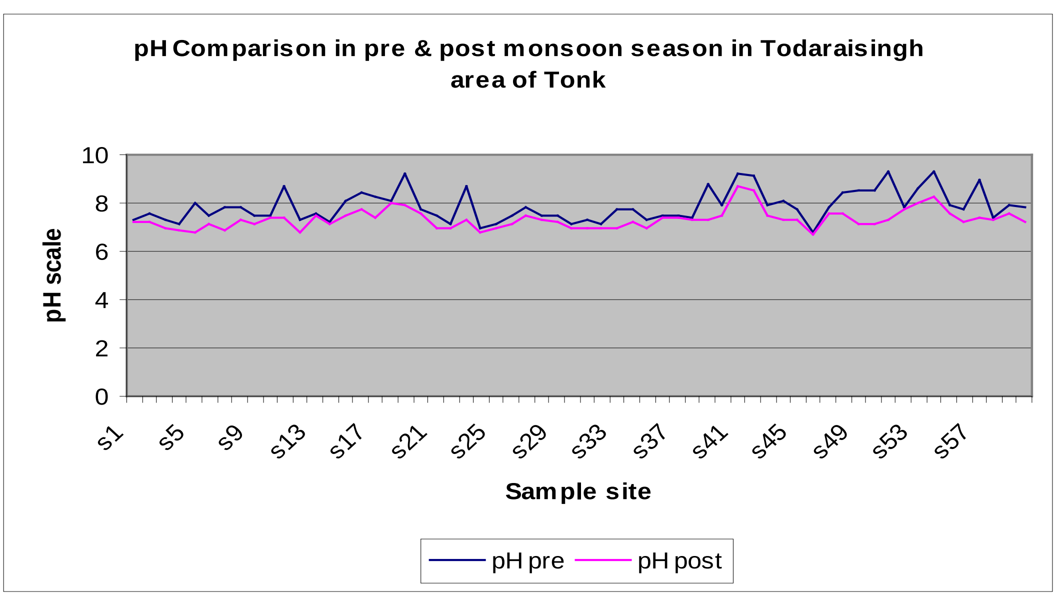

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Table 3 : Comparison of Data of pH in Study Area (Pre & Post-Monsoon)

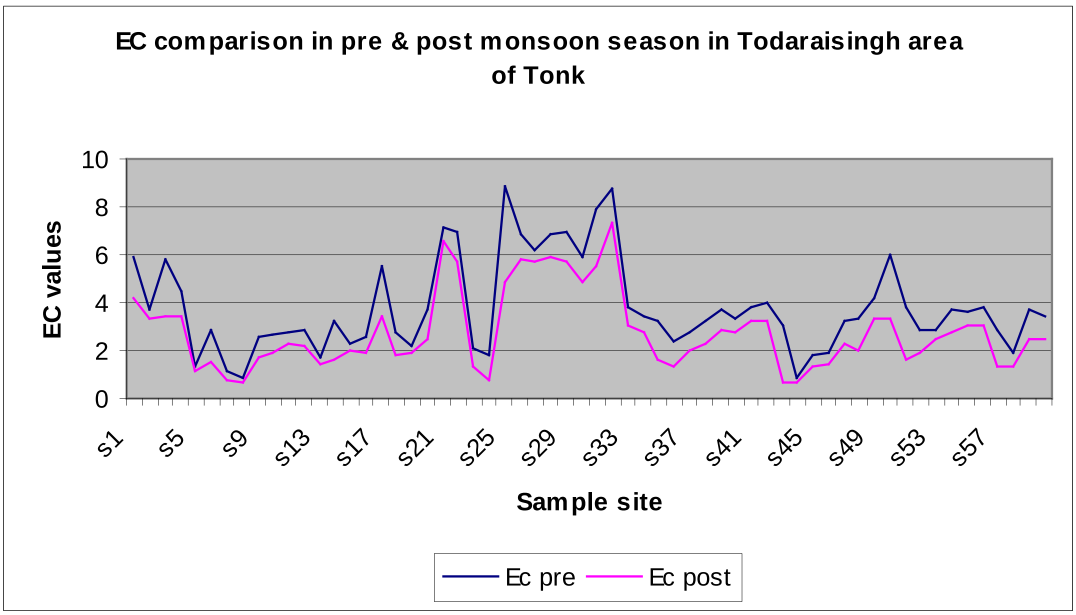
Parameter	Pre-monsoon				Post-monsoon			
	N	Min A	Max B	Range (A-B)	N	Min A	Max B	Range (A-B)
pH	60	6.8	9.3	2.5	60	6.7	8.7	2

Table 4 : Comparison of pH Content in the Groundwater of the Study Area with Drinking Water Standards

Parameter	ISI		WHO		NO of sample exceeding permissible limit	% of sample exceeding permissible limit
	HDL	MPL	HDL	MPL		
pH	6.5	8.5	6.5	8.5	4	6.66

d) EC

Graph 2 : EC Values Comparison in Pre & Post Monsoon Season



Conductivity in pre-monsoon maximum and post-monsoon minimum values observed due to increased rate of evaporation leading to high concentration of salts and dilution resulting from precipitation respectively.[21, 22]

Table 5 : Comparison of EC (Pre & Post-Monsoon) in Study Area

Parameter	Pre-monsoon				Post-monsoon			
	N	Min- A	Max- B	Range (A-B)	N	Min- A	Max- B	Range (A-B)
EC	60	0.87	8.85	7.98	60	0.64	7.3	6.66

e) Total Dissolve Solids (T.D.S.)

The TDS concentration varied from 532 mg/L to 4837.5 mg/L in Todaraisingh tehsil 21.77% villages are within the desirable limit. In present study concentration of TDS was found influenced by physical factor such as evaporation. This can be evident by the fall of TDS in postmonsoon season.[21, 23, and 24]

Graph 3 : TDS Content Comparison in Pre & Post Monsoon Season

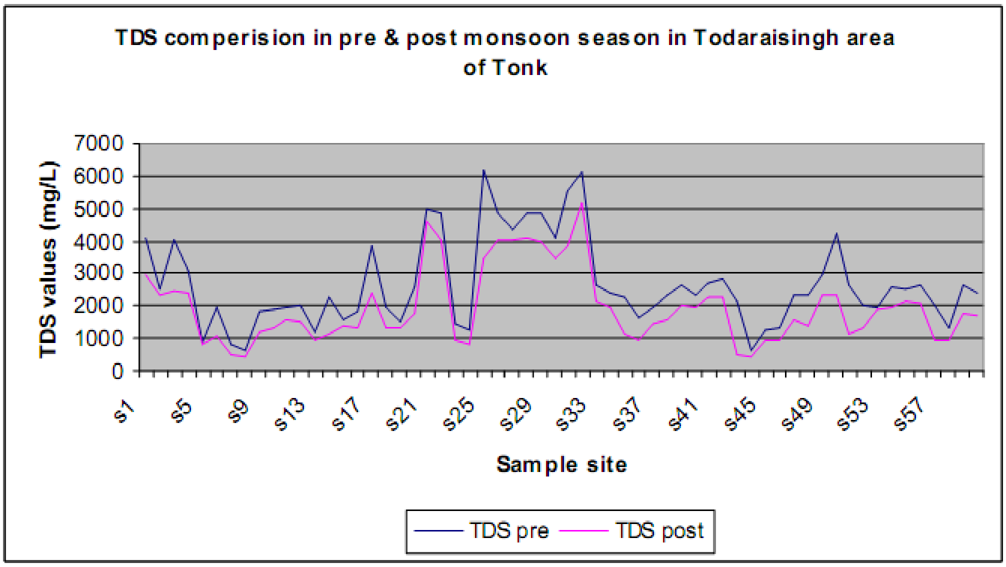


Table 6 : Comparison of Data of TDS in Study Area (Pre & Post-Monsoon)

Parameter	Pre-monsoon				Post-monsoon			
	N	Min A	Max B	Range (A-B)	N	Min A	Max B	Range (A-B)
TDS	60	609	6195	5586	60	448	5160	4712

Table 7 : Comparison of TDS Content in the Groundwater of the Study Area with Drinking Water Standards

Parameter	ISI		WHO		NO. of sample exceeding permissible limit	% of sample exceeding permissible limit
	HDL	MPL	HDL	MPL		
TDS	500	2000	1500	500	29	48.33

f) Alkalinity

Groundwater samples shows alkalinity value fluctuates between 200mg/L to 810mg/L. excess alkalinity in water is harmful for irrigation which lead to soil damage and reduce the crop yield.[25]

Increase level in pre monsoon and decrease in post monsoon may result of evaporation and the dilution of water during monsoon.[26]

Graph 4 : Alkalinity Comparison in Pre & Post Monsoon Season

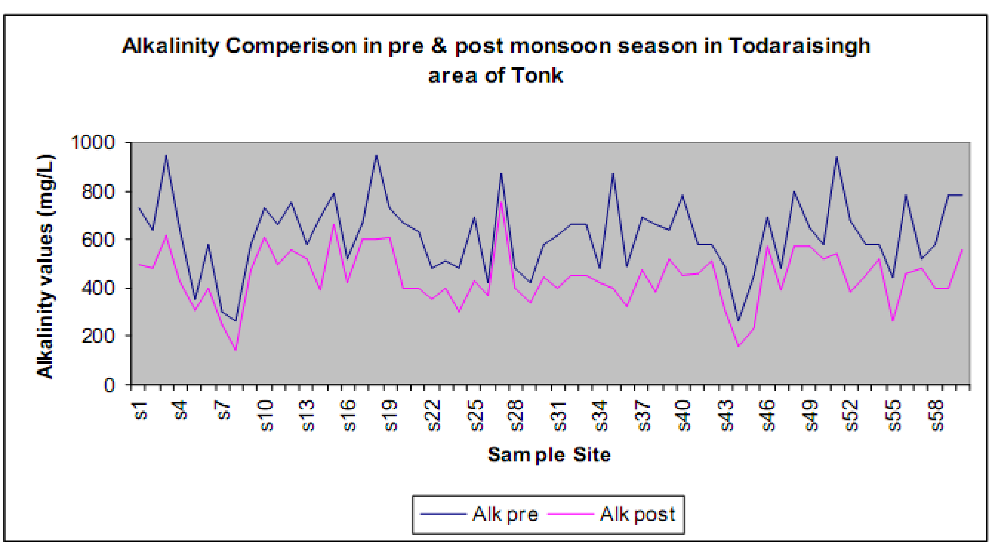


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Table 8 : Comparison of Data of Alkalinity in study area (Pre & Post-monsoon)

Parameter	Pre-monsoon				Post-monsoon			
	N	Min A	Max B	Range (A-B)	N	Min A	Max B	Range (A-B)
Alkalinity	60	260	950	690	60	140	750	610

Table 9 : Comparison of Alkalinity Content with Drinking Water Standards in the Study Area

Parameter	ISI standards		WHO standards		No. of sample exceeding permissible limit	% of sample exceeding permissible limit
	HDL	MPL	HDL	MPL		
TH	200	600	200	600	17	28.33

g) Total Hardness

It was observed with minimum of 205 mg/L and maximum 1465 mg/L. hardness of water is mainly due to the presence of ca^{2+} and Mg^{2+} and is an important indicative of toxic effects of poisonous elements.[27] Hardness value observed high in premonsoon and low in postmonsoon season is in agreement with Baggde and Verma[28].

h) Calcium Hardness

Graph 5 : Comparison of Calcium Hardness in Pre & Post Monsoon Season

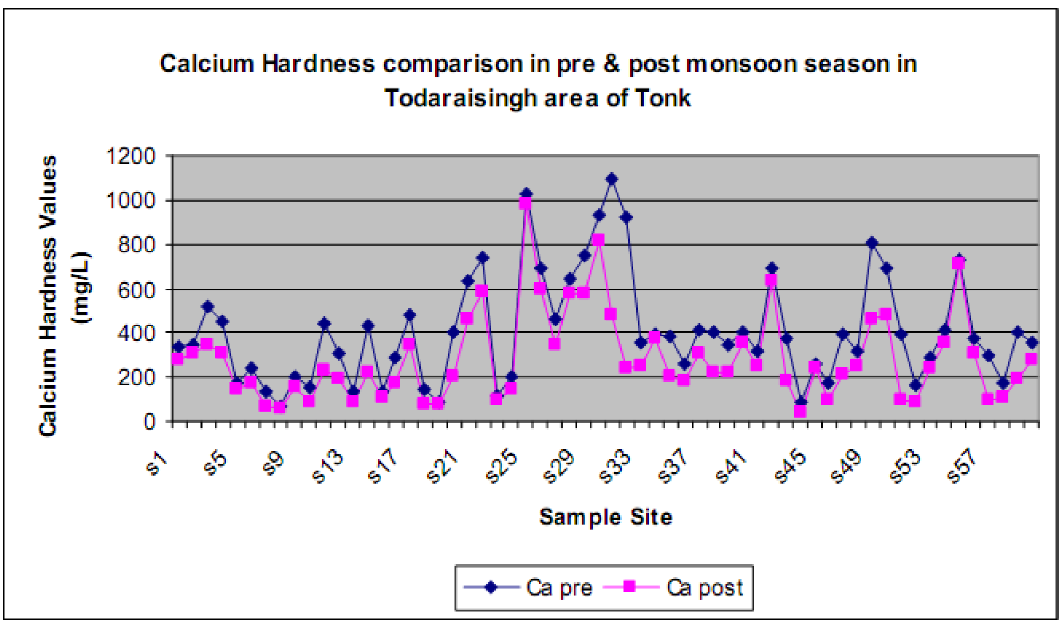

Table 10 : Comparison of Data of Calcium Hardness (Pre & Post-Monsoon) In Study Area

Parameter	Pre-monsoon				Post-monsoon			
	N	Min A	Max B	Range (A-B)	N	Min A	Max B	Range (A-B)
Calcium Hardness	60	70	1090	1020	60	40	980	940

Table 11 : Comparison of Calcium Hardness Content in the Ground water of the Study Area with Drinking Water Standards

Parameter	ISI		WHO		No. of sample exceeding permissible limit	% of sample exceeding permissible limit
	HDL	MPL	HDL	MPL		
Ca^{+2} Hardness	75	200	75	200	44	73.33

It was observed with minimum of 62 mg/L and maximum 1005 mg/L high concentration of Ca^{2+} is due to its presence in rocks; from there it has leached to ground water.[29]

i) Magnesium Hardness

Graph 6 : Comparison of magnesium hardness in pre & post monsoon season

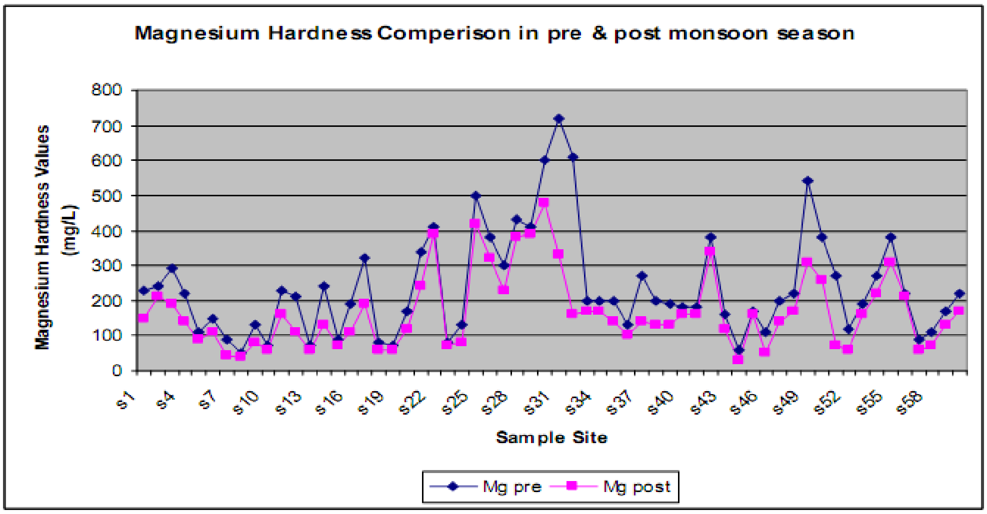

Table 12 : Comparison of Data of Magnesium Hardness in Study Area (Pre & Post-Monsoon)

Parameter	Pre-monsoon				Post-monsoon			
	N	Min A	Max B	Range (A-B)	N	Min A	Max B	Range (A-B)
Magnesium Hardness	60	50	720	670	60	30	480	450

Table 13 : Comparison of Magnesium Hardness Content in the Groundwater of the Study Area with Drinking Water Standards

Parameter	ISI		WHO		No. of sample exceeding permissible limit	% of sample exceeding permissible limit
	HDL	MPL	HDL	MPL		
Mg^{+2} Hardness	30	150	30	30	38	63.33

It was found with minimum of 43 mg/L and maximum 540 mg/L. the study shows that calcium hardness is higher than magnesium hence it may be suggested that hardness of water is mainly due to salts of calcium.[30]

j) Chloride

Graph 7 : Comparison of Chloride Content in Pre & Post Monsoon Season

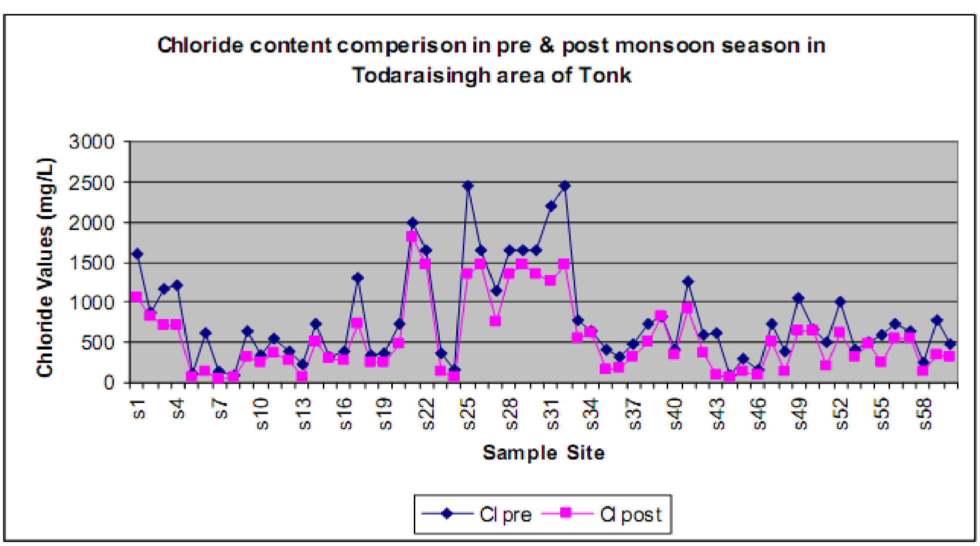

Table 14 : Comparison of Data of Chloride in Study Area (Pre & Post-Monsoon)

Parameter	Pre-monsoon				Post-monsoon			
	N	Min A	Max B	Range (A-B)	N	Min A	Max B	Range (A-B)
Chloride	60	90	2450	2360	60	50	1820	1770

Table 15 : Comparison of Chloride Content in the Groundwater of the Study Area with Drinking Water Standards

Parameter	ISI		WHO		No. of sample exceeding permissible limit	% of sample exceeding permissible limit
	HDL	MPL	HDL	MPL		
Chloride	250	1000	250	600	12	20

Chloride concentration varied from 80mg/L to 1955 mg/L. chloride in water influence salinity balance and ion exchange by dissolution of salts deposits, sewage discharge and irrigation drainage to natural water. High value in premonsoon may be due to evaporation and anthropogenic influences.[31]

k) Nitrate

Graph 8 : Comparison of Nitrate Content in Pre & Post Monsoon Season

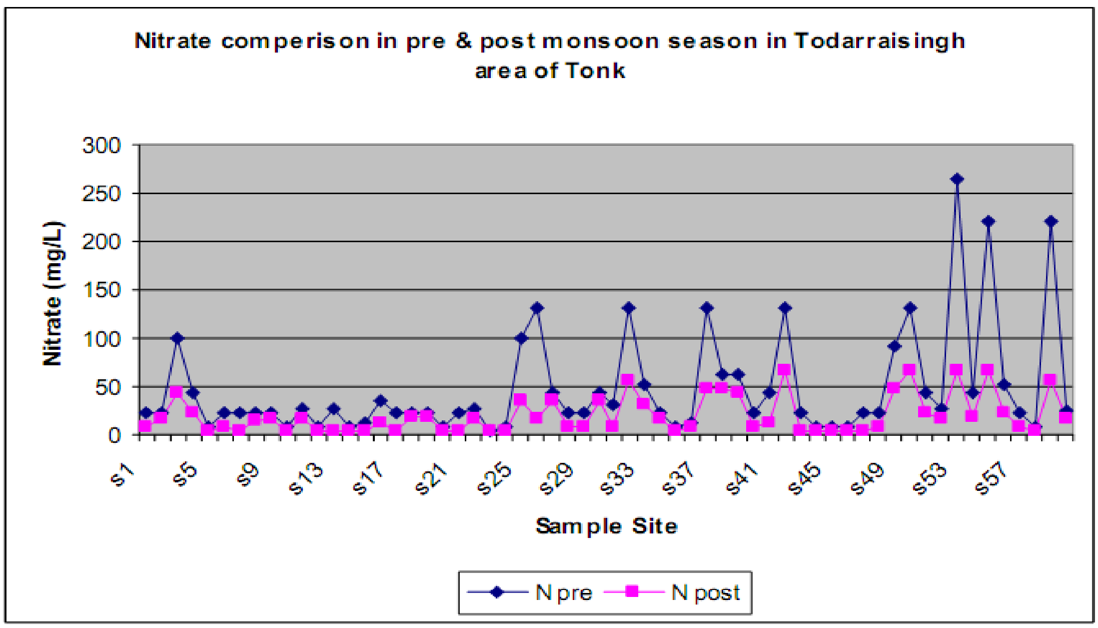

Table 16 : Comparison of Data of Nitrate in Study Area (Pre & Post-Monsoon)

Parameter	Pre-monsoon				Post-monsoon			
	N	Min A	Max B	Range (A-B)	N	Min A	Max B	Range (A-B)
Nitrate	60	4.4	264	259.6	60	4.4	66.6	62.2

Table 17 : Comparison of Nitrate Content in the Groundwater of the Study Area with Drinking Water Standards

Parameter	ISI		WHO		No. of sample exceeding permissible limit	% of sample exceeding permissible limit
	HDL	MPL	HDL	MPL		
Nitrate	45	45	45	45	13	21.66

Nitrate is used mainly in inorganic fertilizers so as to results of agricultural activities and nitrate concentration may rise easily in natural water.[32]

l) Fluoride

Graph 9 : Comparison of Fluoride Content in Pre & Post Monsoon Season

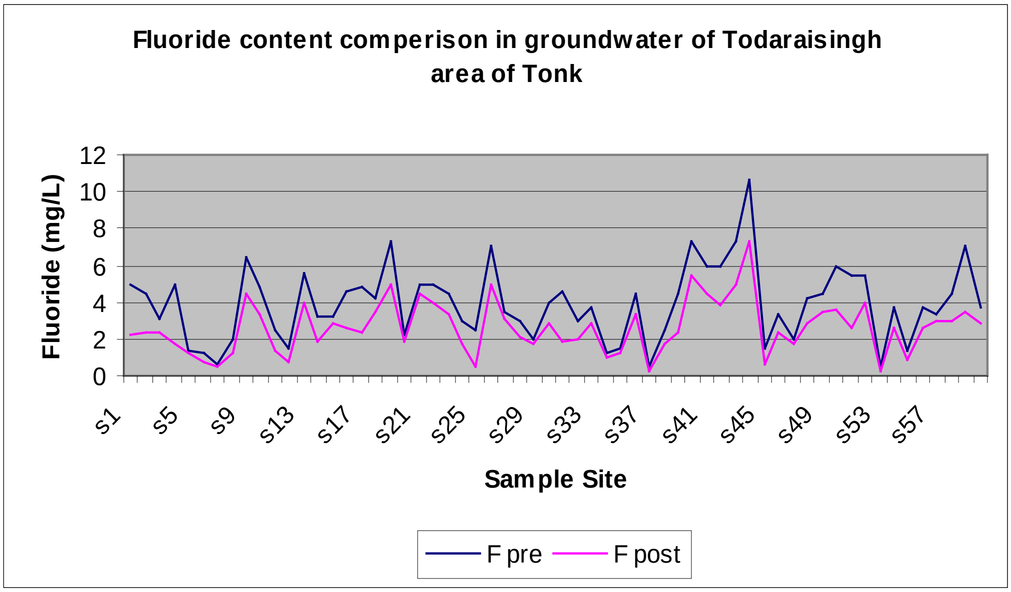

Table 18 : Comparison of Data of Fluoride in study area (Pre & Post-monsoon)

Parameter	Pre-monsoon				Post-monsoon			
	N	Min A	Max B	Range (A-B)	N	Min A	Max B	Range (A-B)
Fluoride	60	0.4	10.7	10.3	60	0.2	7.3	7.1

Table 19 : Comparison of Fluoride content in the groundwater of the study area with drinking water standards

Parameter	ISI		WHO		No. of sample exceeding permissible limit	% of sample exceeding permissible limit
	HDL	MPL	HDL	MPL		
Fluoride	1	1.5	0.5	1.5	49	81.66

Fluoride content in the present study are ranged from 0.35 mg/L to 9 mg/L. The higher value of fluoride in pre monsoon period may be due to the evaporation, lowering of water table and geological rock system.[33]

Summary of highest and lowest reading of water quality parameters of Todaraisingh Area of district Tonk

S No	Parameters	L R in mg/l	H R in mg/l	Range
1	pH	6.75	8.95	2.2
2	EC	0.76	6.87	6.11
3	TDS	532	4837.5	5121
4	Alkalinity	200	810	610
5	Total Hardness	105	1465	1360
6	Ca^{2+} Hardness	62	1005	943
7	Mg^{2+} Hardness	43	540	497
8	Chloride	80	1955	1875
9	Nitrate	4.4	165.3	160.9
10	Fluoride	0.35	9	8.65

LR: Lowest Reading HR: Highest Reading

*All parameters results are in mg/l except pH and EC

III. Conclusion

In this study we have analysed almost 60 samples from the different regions of the Todaraisingh Tehsil area of Tonk (Rajasthan), India, in premonsoon and postmonsoon periods the higher values were generally found for each parameter in the premonsoon period.

It may be due to the evaporation of water and lowering of water table as the atmospheric temperature increases up to 46ºc in the summer before monsoon.

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Provenance and Tectonic Setting of Amasiri Sandstone (Turonian) in Ugep Area, Southern Benue Trough, Nigeria: Evidences from Petrography and Geochemistry

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Abstract - The petrographic and geochemical study of sandstones of Eze-Aku Formation (Turonian) outcropping in Ugep area southern Benue Trough Nigeria was carried out to ascertain the sandstone provenance and tectonic setting. Field studies show that the sandones occur in linear, parallel northeast-southwest trending ridges alternating with shale sequence. The sandstone facies show coarsening upward sequence, slightly bioturbated, cross-stratified, rippled bedded which infer foreshore to shallow marine below wave base. Petrographic studies show the occurrence of quartz, feldspar, rock fragments and muscovite. The calculated framework grains suggest feldsparthic (subarkosic) sandstone. The geochemical analysis of the major elements of the sandstones show that they are enriched in SiO2, TiO2, Al2O3 and Fe2O3 and depleted in K2O, Na2O, MgO and CaO. Tectonic setting discrimination plot diagrams based on major elements suggest the provenance for the sandstones to be of metamorphic and igneous rocks of Passive Continental Margin Basin. The results of petrographic and geochemical study suggest Oban Massif and Cameroon Basement as the source regions for the sandstone which are characterized by humid climate and low-relief during the Turonian.

Keywords : eze-aku formation, petrography, geoche-mistry, sandstones, provenance.

GJSFR-H Classification : FOR Code: 040201

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Strictly as per the compliance and regulations of :

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Keywords : eze-aku formation, petrography, geochemistry, sandstones, provenance.

I. Introduction

They have not been a sufficient work in the study area. However several geologic survey works have been conducted based on regional scales, noting that, the study area fall under the lower Benue Trough. The southern Nigeria sedimentary Basin which is housing the study area have been investigated by many researchers such as Reyment (1965) Cratchley and Jones (1965) and Offodile (1976). Murat (1972) attempted a paleogeographic description of the Cretaceous and lower Tertiary rocks in the southern Nigeria based on major depositional cycles resulting from three main tectonic episodes. Kogbe (1976) and Offodile (1976) have contributed to the recognition of the sedimentary units within the Benue trough.

The Turonian Eze-Aku Formation of the lower Benue Trough is dominated by shales and sandstones with subordinate limestones (Reyment, 1965). However, in the south eastern part of the trough, there are a number of northeastern-southwest trending sand bodies forming prominent sandstone ridges and are parallel to the axis of the Trough (Amajor, 1987). The stratigraphy and petrography of the sandstones have been carried out (Reyment, 1965; Banerjee, 1980; Amajor, 1987). The work of Reyment (1965) suggested that Eze-Aku sandstones were deposited in a shallow marine environment and possibly a tidal deposit (Banerijee, 1980). Amajor (1987) argued that sandstones of Eze-Aku Formation are storm dominated, not tide dominated base on facies analysis of the sandstones. Hoque (1977) and Amajor (1987) considered the sand bodies to be texturally and compositionally immature feldspathic Arenites, based on petrographic studies.

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II. Geologic Setting of the Area

Investigation on Benue Trough has always been a serious concern to most geologists, as its complex nature has resulted to varying theories on its origin.

Benue Trough has been described as a rift depression of up to 80km long and 90km wide on the average, in eastern Nigeria; composed of marine and fluvio-deltaic sediment that have undergone distortion by compressional folding (Cratchley and Jones, 1965). While some trace the origin of the Trough to be triple junction; one arm of which gave rise to Benue Basin (Wright, 1976). With the emergence of sea floor spreading tectonics hypotheses Burke, et al (1970) came up with a new theory for the origin of the trough. The authors contended that the Benue rift first opened, in the cretaceous, due to the spreading of a crustal ridge in the region of the present trough. This spreading, according to Burke,et al (1970), seized by late cretaceous and then was followed by a closing episode of the North Atlantic and South Atlantic African plates, in the Santonian. The resultant differential motion of the two parts of the African plate, in their view, resulted in the santoinan folds and gave them their unique parallel and sub-parallel structure along the trough. Nwachukwu (1972), apparently, disagreeing slightly, suggested that while the tectonic evolution of the Benue Trough may be reconstructed in terms of disruptive and convergent interactions of the two continental plates, under thrusting was not likely and crustal spreading therefore was minimal.

Nevertheless, the continuity of the sediments of the Benue Trough with the Nigeria Coastal Basin is not disputed as has been shown by Cratchley and Jones, (1965) to be marked by:

(1) The continuity of the paleontological zonation with the coastal marine formations
(2) The series of long narrow folds with East-Northeast-West-Southwest trend linked with the south-western folds of the Abakaliki sedimentary area.
(3) The narrow lead-zinc mineralization belt running from Abakaliki area to the north east part of the Basin.

The Benue Trough consist of a linear stretch of sedimentary basin running from about the present confluence of the Niger and the Benue rivers to the northeast, and bounded by the Basement Complex areas in the north and south of the River Benue. This elongate trough Basin is continuous with the Coastal Basin, has been described as the long arm of the Nigeria Coastal Basin (Reyment, 1965). Stratigraphically, the Benue Trough is arbitrarily subdivided into three regions; the upper or north-east regions; middle Benue region or the lafia-muri area; and the lower or southern Benue Trough (Obaje. et al; 2oo4), which is the area south and west of Markurdi.

The stratigraphy of southern Benue Trough is marked by a series of transgressive and regressive phases which affected the Benue Trough. According to (Reyment, 1965), description of the stratigraphy and palaeogeography of different sedimentary basins in Nigeria, the sediments of Benue Trough show markable variation in lithostratigraphy and Biostratigraphy. The various lithologies ranges from the Albian to the Maastrichtian age, with the oldest sediments been of Albian age.

The study area is of Turonian age (Eze-Aku Formation) deposited in the second transgressive phase in Nigeria (Simpson, 1955),. The type locality is the Eze-Aku River valley in southeastern Nigeria. The formation consists of hard grey to black shales and siltstones with frequent facies changes, to sandstones or sandy shales. The thickness varies, but may attain 100 meters in some places (Reyment, 1965). Locally, the outcrops of this sequence are seen at Amasiri "Amasiri Sandstone", Egede-Olu (South of Otukpo), Nkalagu, Ezillo, Ugep, with its lateral equivalence is the Markurdi Formation. The Eze-Aku formation is of shallow Marine deposit. The fossils consist mainly of vascoceratids, pelycypods, gastropods, echinoids, fish teeth, which indicate a basal Turorian age (Kogbe, 1989). The area is made ace-ssible by three major road network; the Abakaliki/ Afikpo road diversion in Abaomege area through Abaomege Ediba road to Ugep, Calabar/ Biase road to Ugep and Ikom/Obubra road to Ugep (Fig.1).

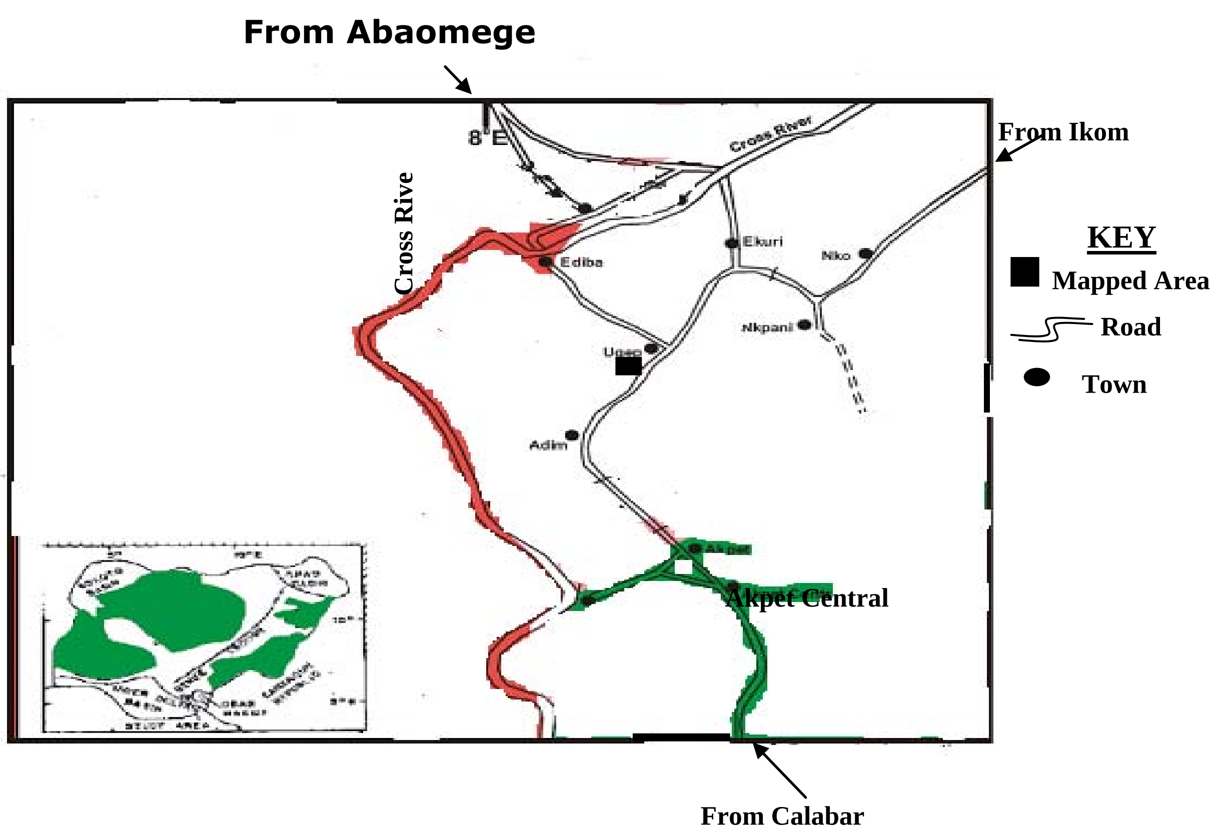

Figure 1 : Accessibility Map of the Study Area (Adapted from, Ogungbesan, G.O. and Akaegbobi, I.M, 2011)

III. Method of Study

The sandstones outcropping in places Ekpanti farm Road along Idomi major Road, Kebur stream in Iabokem Idomi village, Akpepon Ntiefoli Road Ugep, Akpepon farm Road Ugep, Epanipaniti, along park Road Ugep, Ementi along Idomi major Road, Egeiti farm Road in Ugep, Yidobiti farm Road, Kiwel stream along stadium Road, Omilakwa oil filling station along Ikom Calabar major Road and Ntankpo Areas, were studied and described. Five thin sections were prepared from the collected samples. The produced thin section slides were studied using petrographic microscope for minerals identification, the photomicrograph taken (Fig.2) the modal composition (Table 1) and the recalculated modal analysis data (Table2) generated. Petrographic classification was done using quartz (Q), feldspar (F) and rock fragment (RF), after Dott (1964). The mineral maturity calculated using the mineralogical maturity index (IMM) of Nwajide and Hoque (1985).

Geochemistry analyses (major elements) of seven samples were performed by x-ray difraction technique **(Minipal 4ED Version).** The required filters for each element were selected accordingly and probed. The initial results of concentration of the elements selected were shown in diffractions, which were then converted to concentration in weight percentage of the major oxide of the elements in question. The results are shown in Table 3.

IV. Results and Discusion

a) Lithostratigraphy

Based on field observations the sandstones are divided into two units; Unit A (Idomi sandstone) and Unit B(Ugep sandstone).

Idomi sandstone Unit covers the North-eastern and south-eastern part of the mapped area. The sandstones exposures are massive, vary in thickness, about 10 to 34cm, silty, well consolidated, poorly bedded and show little or no laminations. The grain sizes are very fine to fine, angular to sub-rounded, and well sorted. The attitude of the beds shows NW-SE strike direction generally with dip amount between 8^o and 14^oNE. It is dirty white to whitish in colour. The minerals composition include; quartz, feldspar and muscovite.

Ugep sandstone Unit covers more than half of the mapped area .The sandstones are mostly whitish, yellowish and brownish in colour. In some locations, the rocks occur in colour bands from yellow to reddish brown coloration which is attributed to the effect of iron oxide in the cement. The mineral composition observed include; quartz, feldspar, muscovite. The sandstone show a coarsening upward grain size gradient, which ranges from fine to very coarse sandstone indicating upper and middle shore face depositional environment. The sandstones exposures are massive, non calcareous, friable and ranging in thickness between 3m and 22m from ground level and a lateral extent up to 350m. The beds are less distinct in some areas and others are thin and range between 30cm to 65cm in thickness. The grains are angular to sub-rounded, and poorly to moderately sorted. The general strike direction of the beds is NW-SE with dip amount between 3^o and 20^oNE. The sandstones are characterized by nodules and few rip clast, less resistance and bioturbations with calcite and iron oxide been the main cementing materials.

b) Petrology

The detrital frame work grains of the Ugep sandstone include quarts, feldspar, and muscovite. Quartz has been the dominating framework grain in the studied thin section (Table 1). The percentage range of quartz is 64 to 84%. The monocrystalline and polycrystalline grains have straight to strongly undulose extinction (Fig.2). The quartz grains are subangular to subsurrounded. Feldspar constitutes 6 to 14% of the detrital grains of the sandstones. Rock fragment about 4 to 15%. The muscovite is present in minor amounts. Matrix is between 4 to 8% of the detrital fraction. Cementing materials of about 3 to 7%. From the plot of the framework composition of quartz, feldspars and rock fragments for sandstone classification after Dott (1964) (Fig.3), all the samples plotted in the subarkose field; the sandstones are therefore classified as subarkosic sandstones.

The plot of the compositional framework grain data after Suttner *et al.,* (1981) diagram (Fig.4) suggest both metamorphic and igneous source rocks for the Ugep sandstones. In the QFR ternary diagram of Dickinson *et al.,* (1983), the compositional framework grain data plot in the Craton interior and recycled Orogen fields (Fig.5). These sandstones plotted in the Craton interior field are mature sandstones derived from relatively low-lying granitoid and gneissic sources, supplemented by recycled sands from associated platform or Passive Margin Basins (Dickinson *et al.,* 1983). This low relief and short transport distance gave rise to typically quartzo-feldsparthic sandstones of classic subarkosic character.

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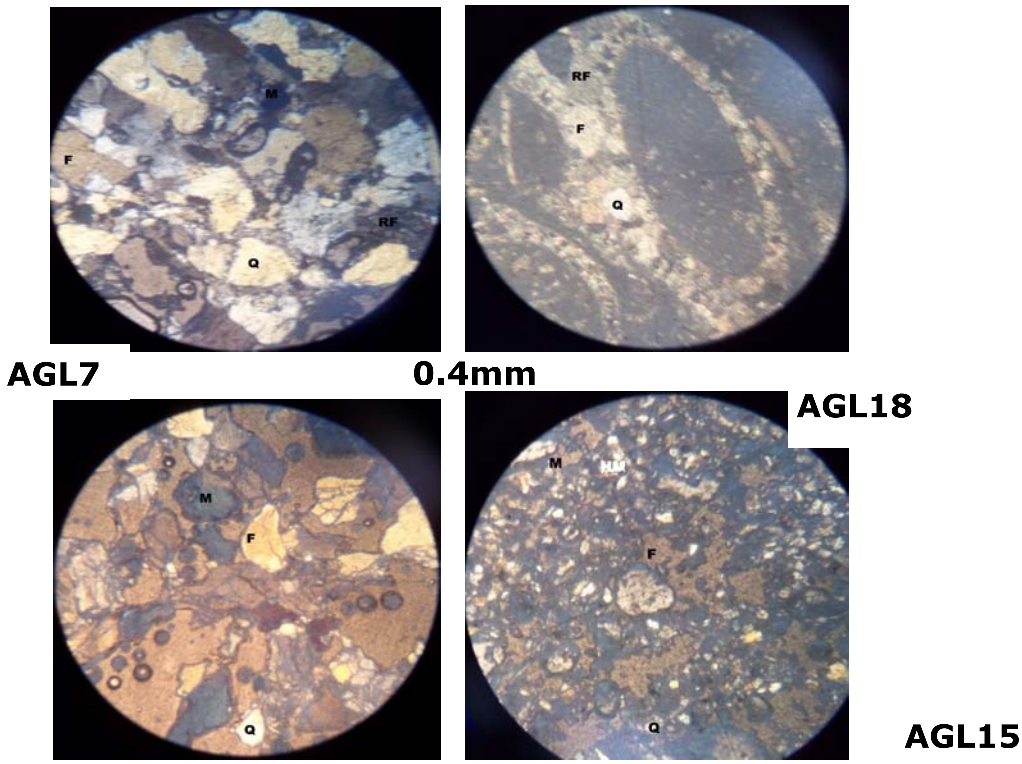

Figure 2 : Photomicrograph showing Q; Quarts grain; F; Feldspar; R.F; Rock Fragment; M; Heavy metals

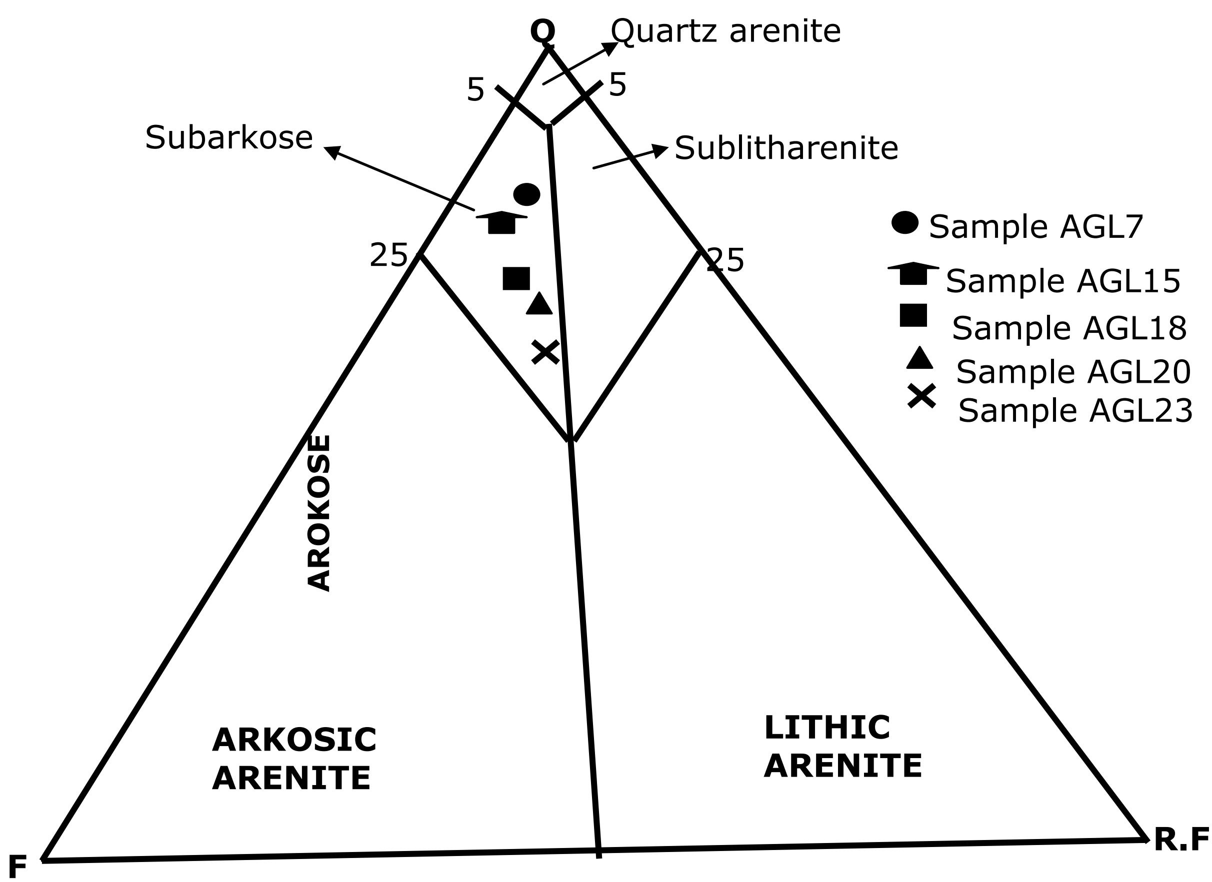

Figure 3 : Classification of terrigenous sandstones of Ugep using Dott, 1964 diagram

Table 1 : Petrographic Analysis Data

Sample No	Quartz	Feldspar	Rock Fragment	Muscovite	Matrix	Cement	Unfilled Void
AGL7	74	10	4	-	5	5	2
AGL15	62	8	9	3	7	9	2
AGL18	59	11	15	-	7	5	3
AGL20	49	14	13	5	9	8	2
AGL23	69	10	4	6	5	4	2

Table 2 : Re-calculated petrographic Analysis data

Sample No	Quartz	Feldspar	Rock Fragment
AGL7	84	11	4
AGL15	79	10	11
AGL18	69	13	18
AGL20	64	18	17
AGL23	83	12	5

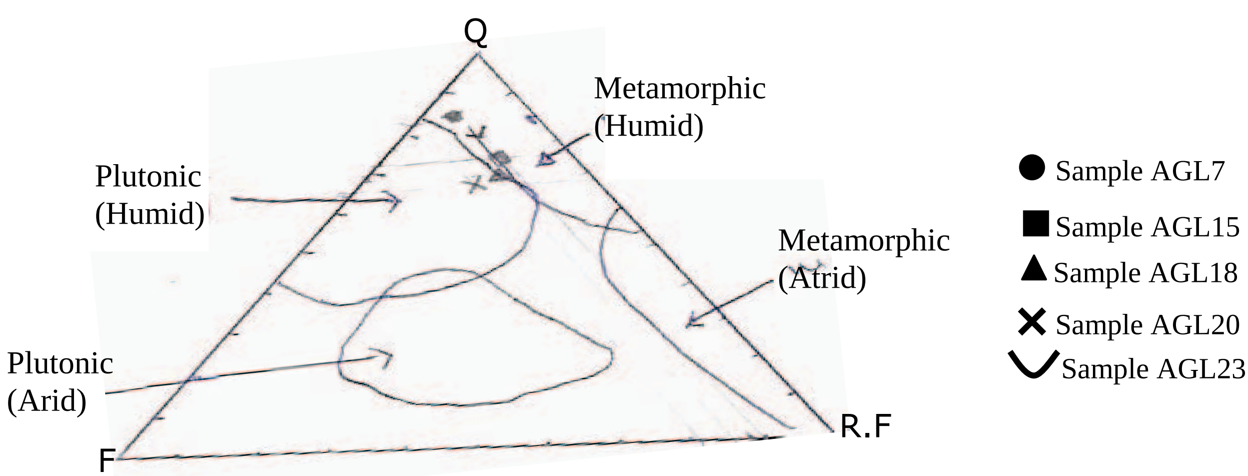

Figure 4 : The effect of source rock on composition of Ugep sandstone using suttner *et al.*, (1981) diagram

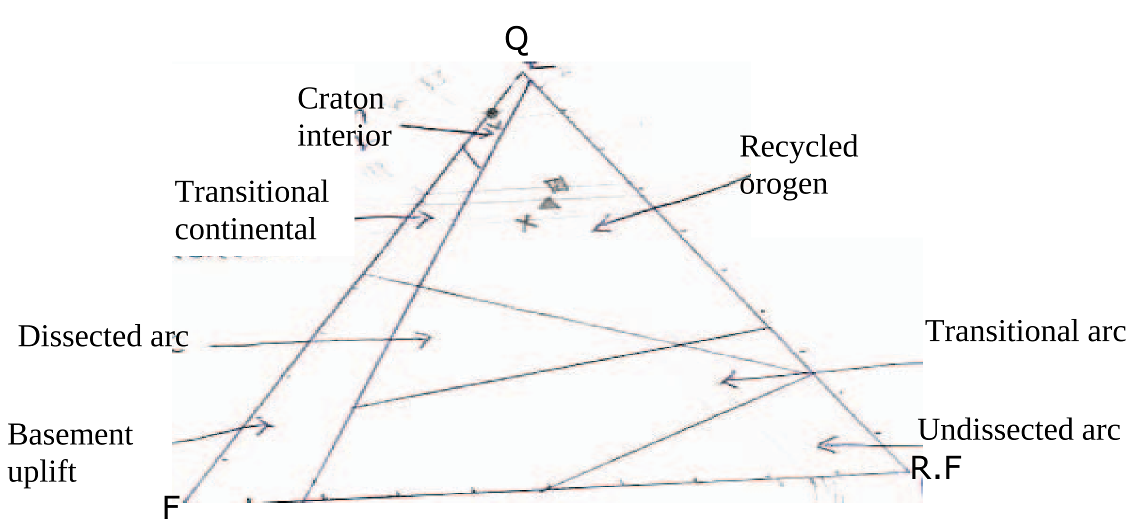

Figure 5 : QFRF Ternary diagram for the Ugep sandstone, after Dickinson *et al.*, (1983)

c) Mineralogical Maturity

The mineral maturity is calculated using the mineralogical maturity index (IMM) of Nwajide and Hoque(1985), given as;

$$\text{IMM} = \frac{\text{Proportion of Q}}{\text{Proportion of F + Proportion of R.F}}$$

From (Table 2), the mineralogical maturity Index is calculated thus;

$$\text{IMM} = \frac{75.8}{12.8+11} = \frac{75.8}{23.8} = 3.18$$

Since IMM value is less than 9 but greater than 3 as calculated above; hence the Sandstone is said to be mineralogically submature (Nwajide and Hoque, 19885). See table 3.

Table 3 : Maturity scale of Sandstone by Nwajide and Hoque (1985)

Limiting % of Q and (F + RF)	MI and maturity stage
Q =≥ 95% (F + RF) = 50%	MI = ≥ 19 suppermature
Q =95-90% (F + RF) = 5-10%	MI = 19- 9.0 submature
Q = 90-75% (F + RF) =10-25%	MI =9.0-3.0 submature
Q =75-5O% (F + RF) = 25-50%	MI =3.0-1.O immature
Q = < 50%	MI ≤ 1
(F + RF) > 50%	Extremely immature

d) Geochemistry

From (table 4) below ,the result shows a slight variation in element composition of all the samples analysed, reflecting homogeneity of all the sediment suit and indicating constancy of provenance and sedimentary environment of the rock. This variation reflects changes in the chemical and mineralogical composition of the sediment, especially in the quartz-feldspar ratio. SiO_2 abundance ranges from 55.56% to 71.78%; TiO_2 ranges from 0.05 to 0.18%; Al_2O_3 ranges from 13.83 to 25.22%; Fe_2O_3 ranges from 0.42 to 1.32%; Mno_2 NiL; MgO ranges from 0.07 to 0.32%; Na_2O ranges from 0.17 to 4.2%; CaO ranges from 0.22 to 0.41% and K_2O ranges from 4.66 to 6.14%.

The Ugep sandstone is enriched in SiO_2, TiO_2, Al_2O_3 and Fe_2O_3 and depleted in K_2O, Na_2O, MgO, CaO and absent of MnO_2. Mineralogical studies revealed that SiO_2 is mainly present as quarts and Al is mainly held in the clay mineral lattice as an essential constituent.

Characterizing the tectonic setting of the depositional basin, the geochemistry data of the Ugep sandstone samples are plotted on discrimination digram after Kroonenberg (1994). The diagram show that Ugep sandstone was deposited in a Passive Continental Margin as most of the plotted points shows in the Fig.6.

Table 4 : Major Element Composition in Percentage

Sample No	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2	TiO_2	SO_2	LO_1	Fe_2O_3+MgO	Al_2O_3/SiO_2	K_2O/Na_2O	$Al_2O_3/(Ca+Na_2O)$	K_2O+Na_2O	TiO_2+Na_2O	$SiO_2/20$
AGL7	55.78	25.76	1.13	0.12	0.27	4.63	0.13	0.06	0.01	11.95	1.40	0.46	35.61	103.04	4.76	1.46	2.79
AGL13	60.81	21.25	0.44	0.22	0.3	6.14	0.19	0.05	0.01	10.53	0.74	0.35	32.32	51.83	6.33	0.79	3.04
AGL14	57.88	24.21	1.14	0.19	0.27	5.01	0.15	0.07	0.02	10.93	1.41	0.42	33.40	71.21	5.16	1.48	2.89
AGL16	60.17	21.34	0.43	0.24	0.28	5.98	0.21	0.07	0.01	10.44	0.71	0.35	28.48	47.42	6.15	0.78	3.01
AGL18	55.56	25.22	1.04	0.41	0.2	5.34	0.17	0.05	0.01	12.00	1.24	0.45	31.41	43.48	5.15	1.29	2.78
AGL20	71.78	13.83	0.69	0.23	0.07	4.66	4.2	0.18	0.19	3.99	0.76	0.19	1.11	3.09	8.86	0.94	3.59
AGL23	60.57	21.1	0.48	0.39	0.32	5.12	0.21	0.06	0.02	11.7	0.87	0.35	24.38	35.2	5.33	0.86	3.03

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V. Conclusions

The Turonian sandstone of Ugep is made up of medium to coarse grain, poorly to moderately sorted, subarkosic Sandstones occur in fairly parallel, linear, Northeast-Southwest trending ridges characterized by a coarsening upward textural sequence.

The field relationship revealed that the sandstone is deposited in lower foreshore to shallow marine environment. The sandstone is texturally and mineralogically sub-mature and indicates a relatively short distance of transportation.

The petrographic and geochemical analysed suggest basement igneous and metamorphic rocks as the source rock, probably from Oban Massif and the Cameroon Basement which are under humid climatic setting. The major elements abundance also suggests a Passive Margin tectonic setting for the sandstones of the study area.

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Water Pollution Status of Hiranyakeshi River from India

By Rajaram S. Sawant, Sachinkumar R. Patil, Ashvin G. Godghate & Shobha D. Jadhav

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Abstract - The present study reveals with seasonal analysis of various physico-chemical parameters like Air temperature, Water temperature, E. C., pH, Free CO_2, Alkalinity, Total hardness, Calcium hardness, Magnesium hardness, Sodium, Potassium, Chlorides, Nitrates, Phosphates, Sulfates and DO of surface water collected from six different sampling sites from Hiranyakeshi River during January 2010 to December 2010. During this period seasonal variation were observed in all the parameters from all sampling sites and found within the limits of WHO standards except at Site V. Electric conductivity at Site VI during winter and summer season were exceeding limits of WHO standards. Total hardness at Site V considerably increased than that of other Sites. Concentration of Chlorides was also considerably high at Site V in all seasons which are indication of pollution. Over all it has been concluded that Site V is considerably polluted than that of all other Sites.

Keywords : hiranyakeshi river, physico-chemical para-meters, pollution, water quality.

GJSFR-H Classification : FOR Code: 899899, 700401p

WATER POLLUTION STATUS OF HIRANYAKESHI RIVER FROM INDIA

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Rajaram S. Sawant [α], Sachinkumar R. Patil [σ], Ashvin G. Godghate [ρ] & Shobha D. Jadhav [ω]

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I. Introduction

Freshwater is essential for agriculture, industry and human existence; it is a finite resource of earth. Without adequate quality and quantity of freshwater, sustainable development will not be possible (Kumar, 2000; Mahananda *et. al.*, 2005). Freshwater resource are becoming deteriorate day-by-day at very faster rate. Now water quality is a global problem (Mahananda *et. al.*, 2005). The healthy aquatic system is dependent on the biological diversity and physicochemical characteristics (Venkateshraju *et. al.*, 2010).

Water is one of the important natural resources useful for development purposes in both urban as well as rural areas. Most of the rural communities depends upon rivers, streams, water reservoirs, ponds, lakes etc. for their domestic as well as agricultural needs, whereas urban people depends on these water sources for domestic and industrial purposes. But on the other hand the domestic, agricultural and industrial wastes have been discharged back to these water sources, from which these water resources get polluted and ultimately lead to different types of diseases and toxic effects. Most of surface water resources accessible to household use in rural areas are subjected to chemical and biological contaminations which may come from animals, septic tanks, storm water runoff. There are various sources which are responsible to change the biodiversity of particular area (Ingole *et. al,* 2011). In hydro biological studies Ganapati (1960), Sinha and Srivastava (1997) have shown that urbanization is the root cause of water pollution. Nevondo and Cloete (1991) observed that in area where potable water supply are provided the supplies are unreliable and insufficient, forcing residence to reverse to traditional contaminated water resources. It is therefore essential to monitor the physico-chemical and microbiological quality of water supply in rural areas in order to highlight the quality of water supply to sustained government intervention. The present study has been carried out to analyze physico-chemical parameters of water from Hiranyakeshi River which flows from two important states of India viz. Maharashtra and Karnataka and joins Ghataprabha River in Karnataka state.

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II. Materials and Methods

a) Study area and sampling

Hiranyakeshi River (Figure I) is one of the important Rivers flowing intwo states of India (Maharashtra and Karnataka). The River originates at Amboli hill station from Sindhudurg district of Maharashtra and within a fewkilometers it enters into Kolhapur district of Maharashtra. From this district itenters into Belgaum district of Karnataka, overall it travels about 140 KM sdistance and finally meets to Ghataprabha River. Geographically the area is flat except some part of Sawantwadi and Ajara Tahsil.

The climate is moderate subtropical with average rainfall 1500 mmannually. Major area of the basin of River is under agricultural practice whereas remaining is forest covered. The quantity and quality of water from this Riveris affected by municipal, industrial as well as agricultural discharge. Foranalysis, six different sampling sites have been selected as shown in picture I. Site no. I is birth place of this river at Amboli (N $15^0$57'30" E $74^0$01'65"). Site No. II is at Medhewadi (N $16^0$07'60" E $74^0$07'37") where effluent from Ajara Sugar mill, Gavase has being discharged. Site No. III is at Hajgoli (N $16^0$08'62"E $74^0$13'58"). Site No. IV is at Harali (N $16^0$14'03" E $74^0$23'22"). At this siteeffluent from Gadhinglaj sugar mill as well as municipal waste of Gadhinglajcity has being discharged. Site No. V is at Chikalgud (N $16^0$12'40" E$74^0$31'10"). Municipal waste of Sankeshwar city and effluent of Hira sugarmills, Sankeshwar has being added into river water at this site. Site No. VI is at Sultanpur (N 16^{0}10'90" E 74^{0}39'18"). This is last site before joining of Gathaprabha River. At all sites except Site No. I agricultural waste being added.

b) Collection of Samples

The samples of surface water were collected seasonally from six differentsites of Hiranyakeshi River during January 2010 to December 2010. The samples were collected in plastic container in the morning hours and brought to the laboratory for further analysis.

c) Analysis Analysis of physico-chemical properties

For the analysis, standard methods were used. Some parameters like Temperature and pH were done at the investigation sites. The sample for DO as fixed in the BOD bottle at the sites and then brought to the Laboratory for analysis. Winkler's method was followed for this analysis, while remaining analysis was made by the standard methods of APHA (2005) and Trivedy and Goel (1984).

III. Result and Discussion

The seasonal physico-chemical parameters of six different sites of Hiranykeshi River has been analyzed from January 2010 to December 2010 and shown in Table I, II and III along with the mean and standard deviation.

a) Temperature

Air temperature (Graph I) values ranged from 20^{0}C to 33^{0}C. Water temperature (Graph II) values ranged from 19^{0}C to 27^0 C. In present study it has been found that air and water temperature goes more or less parallel proving the fact that the atmospheric temperature governs the water temperature (Welch,1952; Naik & Purohit, 1996; Mishra & Patel, 2001; Yadav, 2003).

b) Electric Conductivity

The electrical conductivity values (Graph III) ranged between 0.03mS cm^{-1} to 0.58 mScm^{-1}. It was minimum during winter season at site I and maximum during summer season at site VI. Conductivity gives an idea of the total solids content of water. The electric conductivity was low at birth place of river. This was due to low salts as there were no polluted areas. Higher valuerecorded during summer months may be due to the accumulation of ions owingto evaporation, biological turn over and interaction with sediments. These findings are in agreement with statement of Payne (1986). EC values at site VIduring winter and summer seasons were exceeding the limits of WHO. Elevatedlevel of conductivity along with high dissolved solids can cause certain physiological effects on desirable food plants and habitat forming plant species, gives a mineral taste in drinking water and can be a problem in water used forirrigation (Sikder *et. al,* 2012).

c) pH

The pH concentration values (Graph IV) ranged between 4.91 and 7.80. It was minimum during winter at site I and maximum during winter at site V. Inall seasons it was acidic at site I. The pH is an important factor in determining productivity of an ecosystem. The indirect effects of pH are more important than the direct effects (Singh *et. al.* 2009). Most of the biochemical param-etersof aquatic bodies are influenced by pH (Davis, 1955; Singh & Swarup, 1979). Nair *et. al* (1989) and Sugunan (1980) recorded maximum pH values duringwinter followed by summer and monsoon season. Similar results were found by Fadtare *et. al.* (2007) from Mula, Mutha and Pawana River from Pune.

d) Free CO_2

The concentration of free carbon dioxide values (Graph V) ranged between 4.4 mg L^{-1} to 30.8 mg L^{-1}. It was maximum during winter season at site IIIand minimum during all seasons at site I and during rainy season at site VI. Similar results were observed by Chanu and Devi (2008). Lower level of freecarbon dioxide during summer months might be due to high photosyntheticactivity utilizing free CO2, which is in agreement with the work of Yusuf *et.al.* (1996).

e) Total Alkalinity

The total alkalinity values (Graph VI) ranged between 04 mg L^{-1} to 76 mg L^{-1}. It was minimum during rainy season at site I and maximum during summer season at site VI. The values having 40 mg L^{-1}and more levels of total alkalinityare considered to be more productive than the water with low alkalinity (Sonawane *et. al.*, 2009). According to Durrani (1993), withdrawal of CO2 from bicarbonates for photosynthesis by algae may increase total alkalinity. To talalkalinity may be used as a tool for measurement of productivity.

f) Total Hardness

The total hardness (Graph VII) ranged from16 mg L^{-1} to192 mg L^{-1}. It was minimum during winter and rainy seasons at site I and maximum during summer season at site V. Kannan (1991) has classified wateron the basis of hardness values in the following manner, 0-60 mg L^{-1} soft, 61-120mg L^{-1} moderately hard, 121-180 mg L^{-1} hard and above 180 mg L^{-1} very hard. Total hardness of water is not a pollution parameter but indicates water quality interms of Ca^{++} and Mg^{++} cations. Hardness of the Hiranyakeshi River was within the permissible limit of WHO. Hardness below 300 mg L^{-1} is consideredpotable but beyond this limits cause gastrointestinal irritation (ICMR, 1975).Normal water hardness does not pose any direct health problems. Due to addition of sewage and large scale human use, this might cause elevation of hardness (Dakshini & Soni, 1997; Kumar, 2000; Mohanta & Patra, 2000). The total hardness above 200 mg L^{-1} is not suitable for domestic use like drinking and cleaning.

Calcium hardness (Graph VIII) ranged between 2.4 mg L^{-1} to 64.10 mg L^{-1}. It was minimum during rainy season at site I while maximum during summer season at site V. Magnesium hardness values (Graph IX) ranged between 1.02 mg L^{-1} to 31 mg L^{-1}. It was minimum and maximum in summer season at site VI and site Vrespectively.

g) Sodium

Sodium ion concentration (Graph X) ranged between 00 mg L^{-1} to 90 mg L^{-1}. It wasnil at site I during summer season while maximum at site V during winter season.

h) Potassium

Potassium ion concentration (Graph XI) ranged between 00 mg L^{-1} to 10 mg L^{-1}. It was near about totally absent during summer and rainy seasons at all the sites and it was recorded highest during winter at site V. Similar range was noted by Azadeh *et. al.* (2009) at sediments of Kabini River. The similar trend of increased sodium and potassium in winter season anddecreased range in summer season were also observed by Chanu *et. al* (2008).

In general, concentration of sodium remains quite higher than the potassium innatural water, thus high values being an indication of pollution by domesticsewage (Trivedi & Goel, 1984). The concentration of sodium is higher than thatof potassium in the present study.

i) Chloride

The concentration of chloride values (Graph XII) ranged from 7.44 mg L^{-1} to 86.8 mg L^{-1}. It was minimum during rainy season at site I while maximum during summer atsite V. In site V the trend of chloride concentration is high in all the seasons because the municipal sewage as well as effluent of Hira Sugar Factory was released in river water. Chloride is reported to be an indication of pollution when present in higher concentration. The suggestions of Royal Commission that water having 30 mg L^{-1} of chloride is reported to be fairly clean. Sources of chloride pollution in water include fertilizers, sewage, effluents from drainage, salts and human as well as animal wastes. High chloride content cause highblood pressure in people (Subin *et. al.* 2011). Similar trend was observed by Gunale (1981) and he has reported chloride concentration ranged between 11.4 mg L^{-1} and 36.4 mg L^{-1} for various sites in Pune. Chlorides are toxic to most plants so they should be checked for irrigation water. The tolerance limit for surface water used for irrigation is 600 mg L^{-1} (Fadtare *et. al.* 2007). The values obtained from above investigation from river Hiranykeshi for all the sites can be suitably used for irrigation without any hazardous effect.

j) Nitrate

The nitrate concentration values (Graph XIII) ranged from 00 mg L^{-1} to0.114 mg L^{-1}. It was maximum during winter at site V and was nil during summerand rainy at all the sites except site V & VI. The similar trend was observed by Rita Kumari *et. al.* (2011) which was ranged between 0.038 mg L^{-1} and 0.28 mg L^{-1}.

k) Phosphate

The phosphate concentration values (Graph XIV) ranged from 00 mg L^{-1} to 0.165 mg L^{-1}. It was maximum during winter at site VI because of agricultural runoffand nil during summer and rainy at site I, II and III. Similar results were observed by Gunale (1981), who found the range in 0.113 mg L^{-1} to 0.912 mg L^{-1}. Inriver Bhavani at Erode region. Kulandaivel *et. al.* (2009) shown similar range of 0.06 mg L^{-1} to 0.24 mg L^{-1}. The total phosphates in river are due to mixing up of agricultural runoff. From above investigation it reflects that on the both the sites of river banks, the agricultural activities results in flowing of excess fertilizersinto the river streams.

l) Sulfate

The sulfate concentration values (Graph XV) ranged between 00 mg L^{-1} to 20 mg L^{-1}. It was maximum during winter at site V and it was nil during summer at site I, II, III and IV. Similar results were observed by In gole *et. al* (2011) at Sipna river, Melgh at. The tolerance limit for sulfate in surface waters used forirrigation is 1000 mg L^{-1}. Values of sulfates for the river are low hence suitable for irrigation.

Similar trend for phosphate, sulfate and nitrates were also observed by Rita Kumari *et. al.* (2011), Sinha and Prasad (1998), Ahmad (1996) and Foy *et. al.* (2003) which were within the permissible limit suitable for fish production. From the above results it has been concluded that the increasing trend of nutrients like nitrate, sulfate and phosphate were observed only in winter season because during this season al though the agricultural runoff is there, water dilution do not takes place and during summer season because of scarcity of water, agricultural runoff might not be seen hence in winter season because of agricultural runoff and low dilution rate nutrient level increases.

m) Dissolved Oxygen

The DO concentration values (Graph XVI) ranged between 4 mg L^{-1} to 9mg L^{-1}. It was minimum during summer at site V while maximum during rainy atsite V. DO concentration more than 5 mg L^{-1} favors good growth of flora and fauna (Das, 2000). Similar results were observed by Ingole *et. al* (2011) from Sipna river. The DO was least during summer and high during monsoon season. Low D. O. level indicates that the oxygen replenishment rate is lower than that of utilization. The decomposition of organic matter and microbial activity washigh in warm weather (Morissote, *et. al* 1978). The saturation of atmosphericoxygen is more intense in running water than confined water (Singh *et. al.* 2009).

IV. Conclusion

Physico-chemical parameters at all sites were observed under the limits of WHO standards but at Site V comparatively these were increased than that of other sites because of continuous addition of domestic sewage and sugar milleffluents in heavy quantity. Although there is no direct effect might be seen at present but it might affect the quality of water and ultimate consequences would be faced in future.

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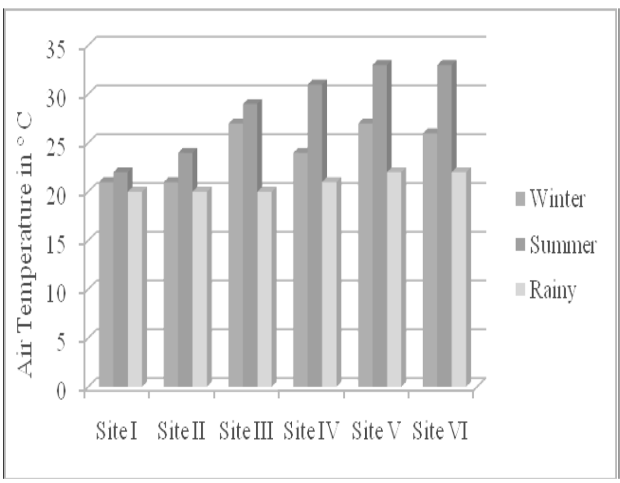
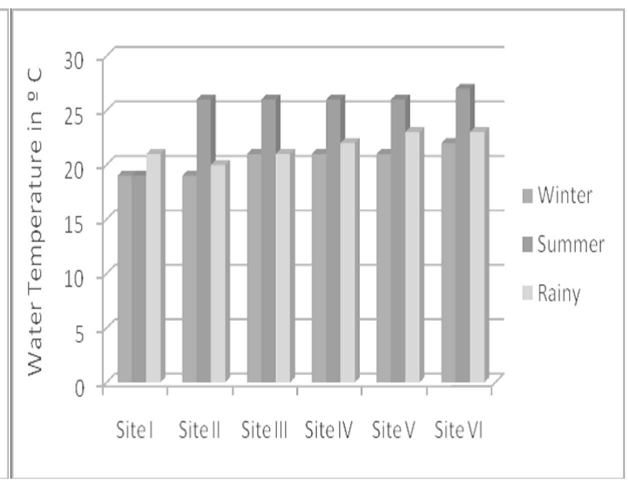
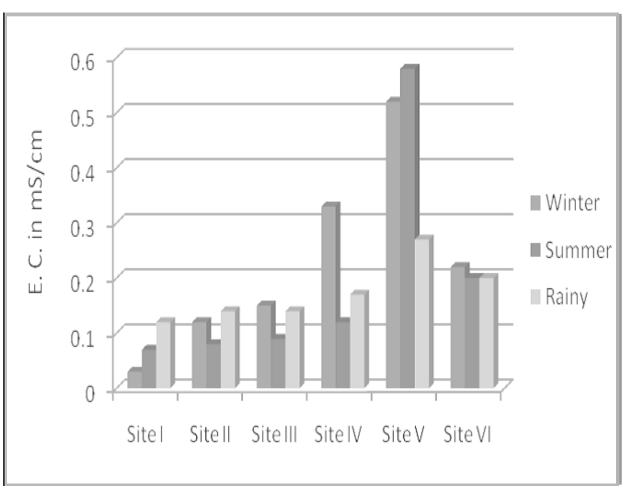
Graphical representation of physico-chemical parameters of Hiranyakeshi River



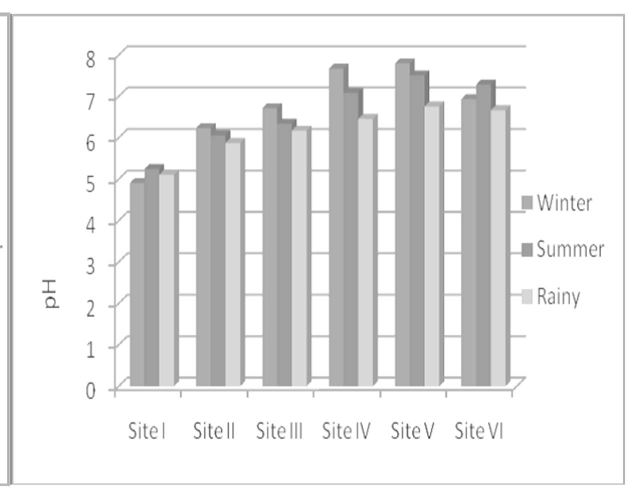
Graph. i : Seasonal variations in Air temperature



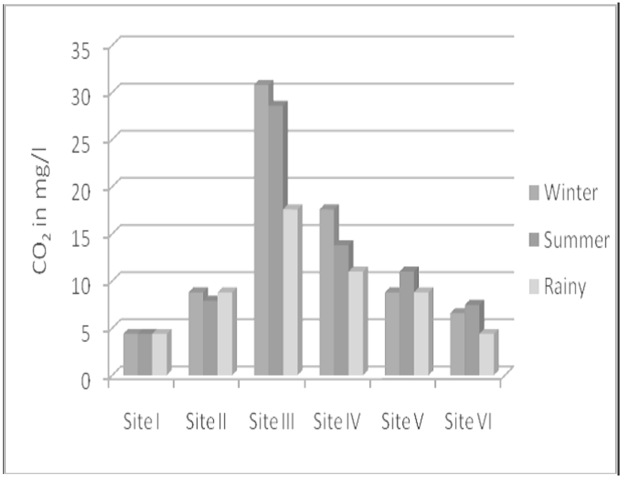
Graph. ii : Seasonal variations in Water temperature



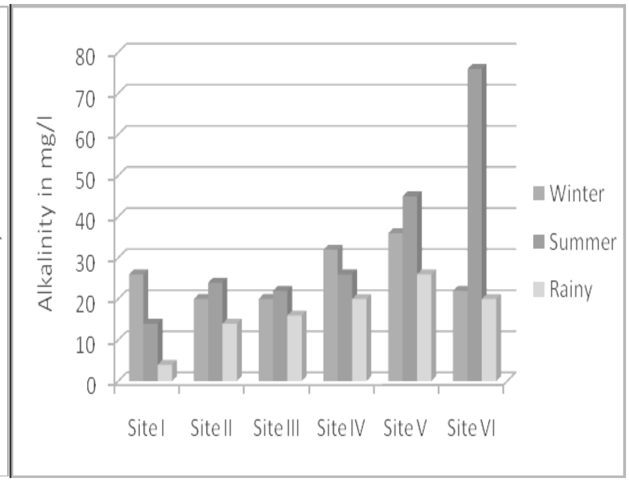
Graph. iii : Seasonal variations in E.C



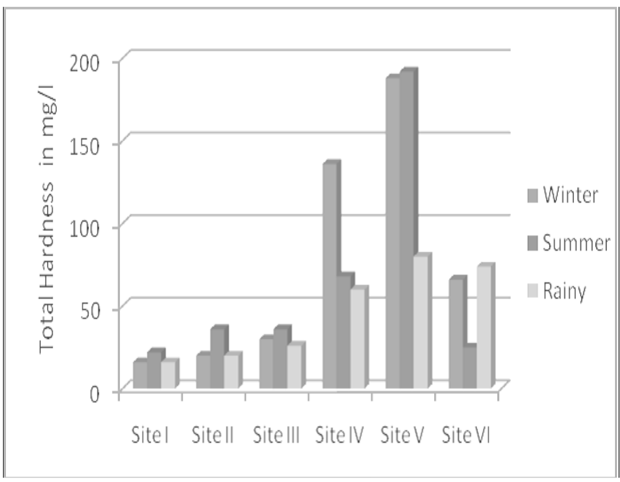
Graph. iv : Seasonal variations in pH



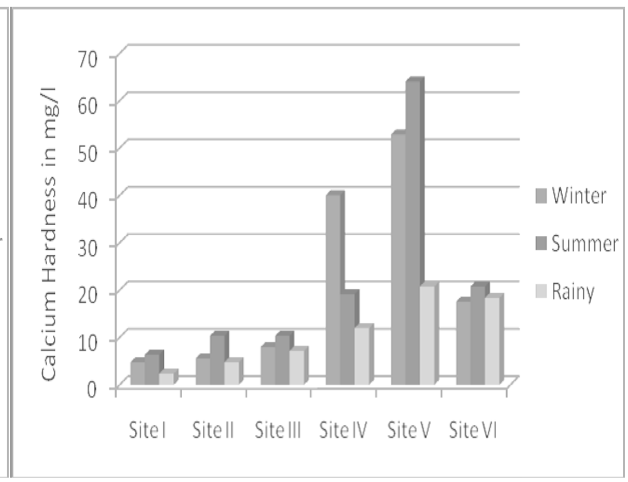
Graph. v : Seasonal variations in CO_2



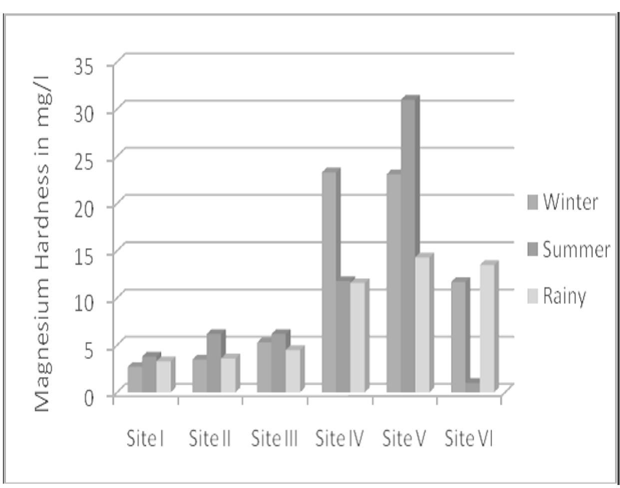
Graph. vi : Seasonal variations in Alkalinity



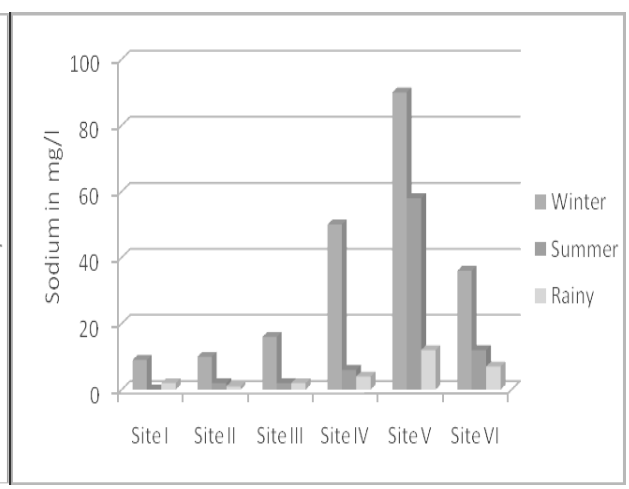
Graph. vii : Seasonal variations in Total Hardness



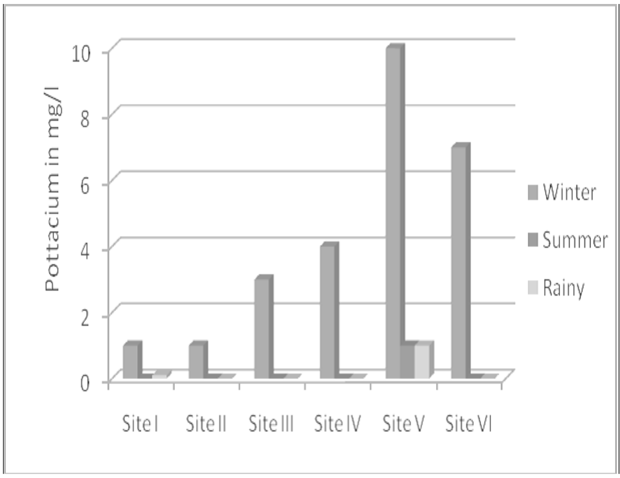
Graph. viii : Seasonal variations in Calcium Hardness



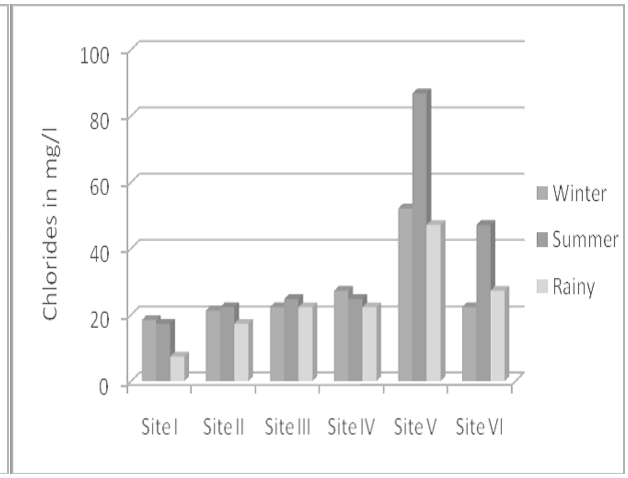
Graph. ix : Seasonal variations in Magnesium Hardness



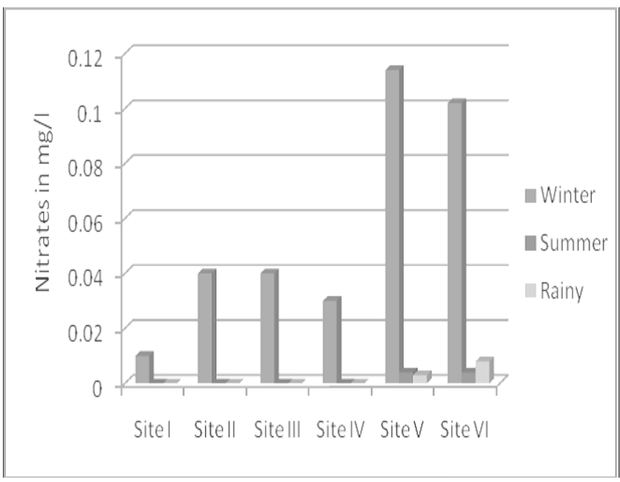
Graph. x : Seasonal variations in Sodium



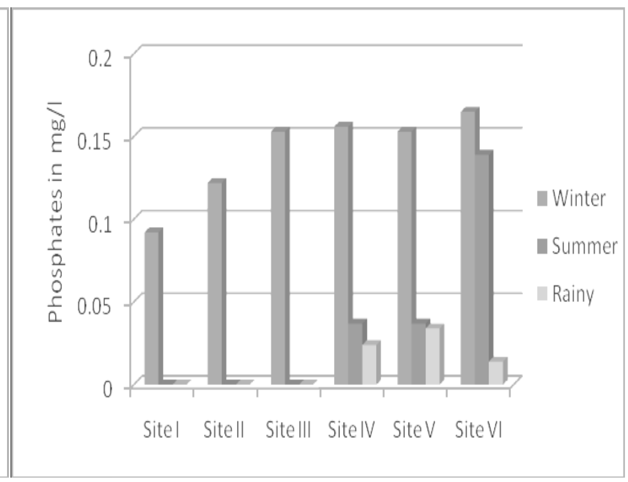
Graph. xi : Seasonal variations in Potassium



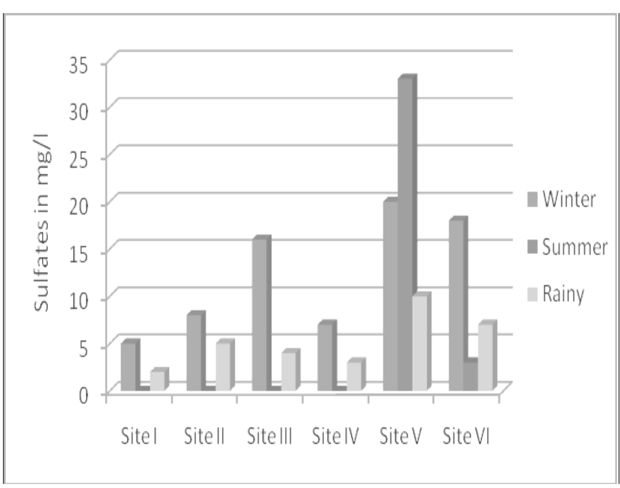
Graph. xii : Seasonal variations in Chlorides



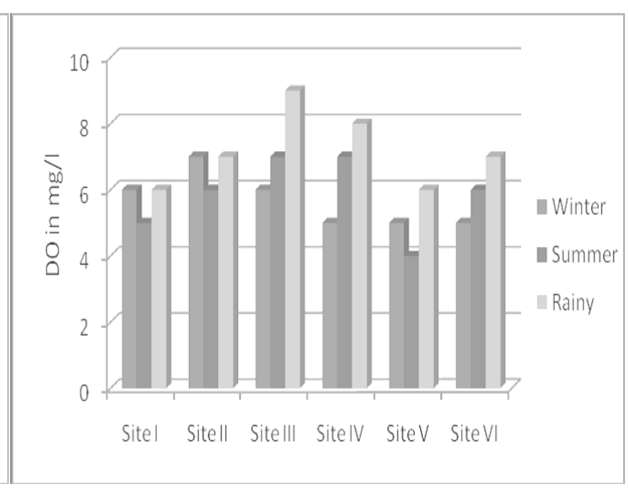
Graph. xiii : Seasonal variations in Nitrates



Graph. xiv : Seasonal variations in Phosphates



Graph. xv : Seasonal variations in Sulfates



Graph. xvi : Seasonal variations in DO

Table 1 : Physico- chemical parameters of six sites of Hiranyakeshi River during Winter Season

Parameter/Sites	Site I	Site II	Site III	Site IV	Site V	Site VI	Mean	S. D.
Air Temperature	21	21	27	24	26	26	24.16667	2.409472
Water Temperature	19	19	21	21	21	22	20.5	1.118034
E. C.	0.03	0.12	0.15	0.33	0.52	0.22	0.228333	0.159522
pH	4.91	6.24	6.72	7.67	7.8	6.94	6.713333	0.96812
Free CO_2	4.4	8.8	30.8	17.6	8.8	6.6	12.83333	9.018808
Total Alkalinity	26	20	20	32	36	22	26	6.110101
Total Hardness	16	20	30	136	188	66	76	64.67354
Ca- Hardness	4.8	5.6	8.02	40.1	52.9	17.6	21.50333	18.53169
Mg- Hardness	2.72	3.5	5.3	23.3	23.1	11.7	11.60333	8.691992
Sodium	9	10	16	50	90	36	35.16667	28.61478
Potassium	1	1	3	4	10	7	4.333333	3.248931
Chlorides	1846	21.3	22.32	27.28	52.08	22.32	331.8833	677.2178
Nitrates	0.001	0.004	0.04	0.03	0.114	0.102	0.0485	0.044354
Phosphates	0.092	0.122	0.153	0.156	0.153	0.165	0.140167	0.025321
Sulfates	5	8	16	7	20	18	12.33333	5.849976
DO	6	7	6	5	5	5	5.666667	0.745356

Table 2 : Physico- chemical parameters of six sites of Hiranyakeshi River during Summer Season

Parameter/Sites	Site I	Site II	Site III	Site IV	Site V	Site VI	Mean	S. D.
Air Temperature	22	24	29	31	33	33	28.66667	4.268749
Water Temperature	19	26	26	26	26	27	25	2.708013
E. C.	0.07	0.08	0.09	0.12	0.58	0.2	0.19	0.179629
pH	5.25	6.06	6.34	7.09	7.51	7.29	6.59	0.787972
Free CO_2	4.4	7.92	28.6	13.8	11	7.48	12.2	7.899333
Total Alkalinity	14	24	22	26	45	76	34.5	20.7826
Total Hardness	22	36	36	68	192	25	63.16667	59.51027
Ca- Hardness	6.4	10.4	10.4	19.2	64.1	20.8	21.88333	19.55372
Mg- Hardness	3.8	6.2	6.2	11.8	31	1.02	10.00333	9.93479
Sodium	0	2	2	6	58	12	13.33333	20.35245
Potassium	0	0	0	0	1	0	0.166667	0.372678
Chlorides	17.36	22.32	24.8	24.8	86.8	47.12	37.2	24.08709
Nitrates	0	0	0	0	0.004	0.004	0.001333	0.001886
Phosphates	0	0	0	0.037	0.037	0.139	0.0355	0.049155
Sulfates	0	0	0	0	33	3	6	12.12436
DO	5	6	7	7	4	6	5.833333	1.067187

Table 3 : Physico- chemical parameters of six sites of Hiranyakeshi River during Rainy Season

Parameter/Sites	Site I	Site II	Site III	Site IV	Site V	Site VI	Mean	S. D.
Air Temperature	20	20	20	21	22	22	20.83333	0.897527
Water Temperature	21	20	21	22	23	23	21.66667	1.105542
E. C.	0.12	0.14	0.14	0.17	0.27	0.2	0.173333	0.050222
pH	5.11	5.88	6.18	6.46	6.76	6.67	6.176667	0.561209
Free CO_2	4.4	8.8	17.6	11	8.8	4.4	9.166667	4.475737
Total Alkalinity	4	14	16	20	26	20	16.66667	6.798693
Total Hardness	16	20	26	60	80	74	46	26.17887
Ca- Hardness	2.4	4.8	7.2	12.03	20.8	18.4	10.93833	6.815156
Mg- Hardness	3.3	3.6	4.5	11.6	14.3	13.5	8.466667	4.748567
Sodium	2	1	2	4	12	7	4.666667	3.815174
Potassium	0.1	0	0	0	1	0	0.183333	0.367045
Chlorides	7.44	17.36	22.32	22.32	47.12	27.28	23.97333	12.03645
Nitrates	0	0	0	0	0.003	0.008	0.001833	0.002967
Phosphates	0	0	0	0.024	0.034	0.014	0.012	0.013317
Sulfates	2	5	4	3	10	7	5.166667	2.67187
DO	6	7	9	8	6	7	7.166667	1.067187

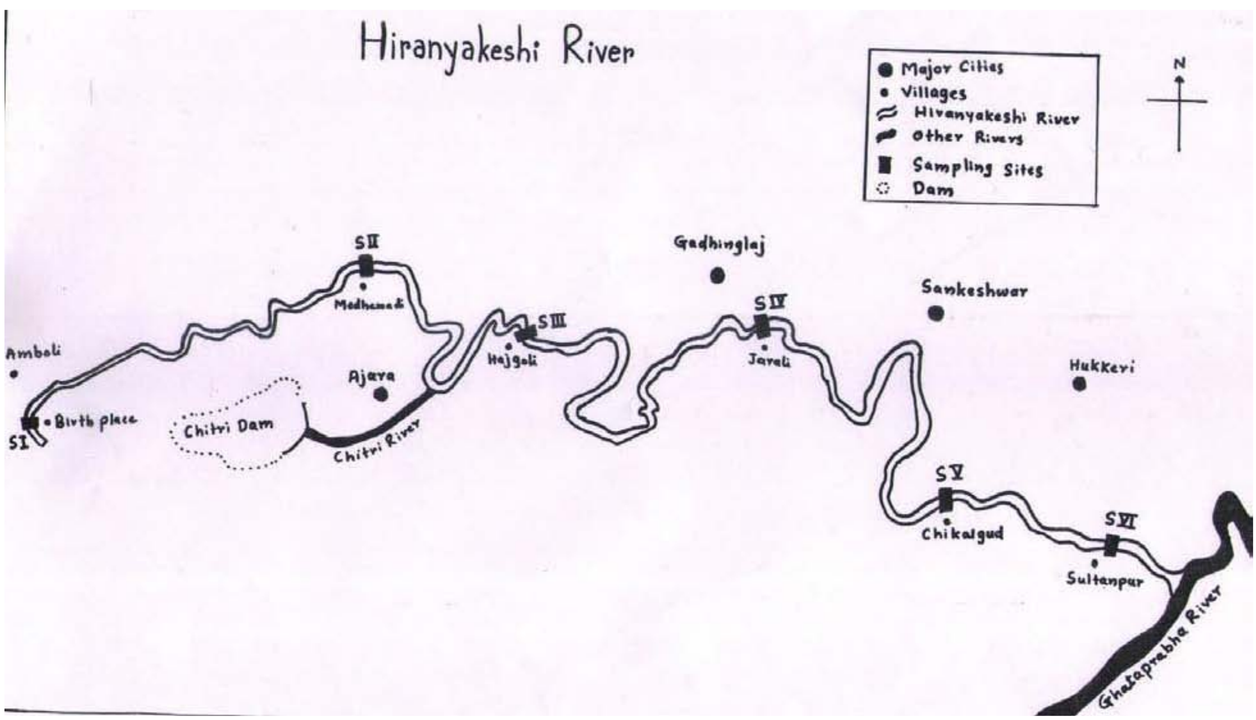


Figure I : Map of Hiranyakeshi River showing sampling sites

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Analysis of Exhaust Emission of Vehicles in Dhaka City of Bangladesh

By M. Hasan, S. Rahman, N. Paul, P. K. Halder, M. Alam, M. A. Raquib, M. A. Islam & P. A. Khan

Bangladesh University of Engineering & Technology, Bangladesh

Abstract - Mega cities in South Asia are an epitome of traffic snarls and resulting vehicular pollution. Dhaka, a center of polity and economy in Bangladesh, is no exception. This study is focused on the measurement of air pollution levels at traffic congestion and road in Dhaka City. The aim of this paper is to discuss the vehicle engine emissions and the technologies and methodologies available to help reduce these emissions. It has been revealed that the pollution level at traffic congestions has considerably improved due to the large scale introduction of CNG vehicles in Dhaka city. Vehicle exhaust emission level assessment data show that Dhaka city is exposed to high concentration of CO, NO_x and SO_x. Some recommendations for air pollution control in Dhaka city are also incorporated in the paper.

Keywords : *exhaust emissions, vehicle emission standards, air quality standards, flue gas analyzer.*

GJSFR-H Classification : FOR Code: 889899

ANALYSIS OF EXHAUST EMISSION OF VEHICLES IN DHAKA CITY OF BANGLADESH

Strictly as per the compliance and regulations of :

Analysis of Exhaust Emission of Vehicles in Dhaka City of Bangladesh

M. Hasan [α], S. Rahman [σ], N. Paul [ρ], P. K. Halder [Ѡ], M. Alam [¥], M. A. Raquib [§], M. A. Islam [χ] & P. A. Khan [ν]

Abstract - Mega cities in South Asia are an epitome of traffic snarls and resulting vehicular pollution. Dhaka, a center of polity and economy in Bangladesh, is no exception. This study is focused on the measurement of air pollution levels at traffic congestion and road in Dhaka City. The aim of this paper is to discuss the vehicle engine emissions and the technologies and methodologies available to help reduce these emissions. It has been revealed that the pollution level at traffic congestions has considerably improved due to the large scale introduction of CNG vehicles in Dhaka city. Vehicle exhaust emission level assessment data show that Dhaka city is exposed to high concentration of CO, NO_x and SO_x. Some recommendations for air pollution control in Dhaka city are also incorporated in the paper.

Keywords : exhaust emissions, vehicle emission standards, air quality standards, flue gas analyzer.

I. Introduction

Dhaka one of the mega cities of the world, witnessed a very fast growth of urban population in recent times. Air pollution in Dhaka city is reported to be serious and damaging to public health. In the winter of 1996-97, air pollution of Dhaka city became the severest when lead in the air was reported higher than in the atmosphere of any other place of the world. Concern over air pollution rate of Dhaka city ultimately led to the promulgation of National Ambient Air Quality Standards in Bangladesh in 1997.

A study of impact of auto-exhaust on air quality of Dhaka city has been conducted in the year 2000, it is revealed that traffic congestion, fuel quality and brick field emission are the main reasons of air pollution in Dhaka city. To control air pollution level, CNG at large scale has introduced in Dhaka city. Deterioration of air quality is a major environmental problem in many large urban centers in both developed and developing countries. In our modern society, quality of life is greatly measured by the amount of consumption of electricity or by the use of car. Electricity generation and operation of vehicles mostly use fossil fuel. As these fuels are burnt, huge quantity of lethal chemicals and poisonous particulate matter are released as a part of emission into the surrounding atmosphere due to incomplete combustion causing serious air pollution, affecting public health. The auto exhaust affects our valuable cultural heritage, historical places, monuments, architecture and the environment. Meteorological and topographical conditions affect dispersion and transport of these pollutants in ambient air.

As people spend most of their time indoors and the concentrations of pollutants may build up in an enclosed space, the risk to health may be greater to exposure to air pollution indoor than outdoor.

Reduction of PM_{10} concentration in Dhaka by 20% would result in avoiding 1200 deaths, 80 million cases of sickness and a health cost savings of US$169.00 million. If PM_{10} concentration could be further reduced by another 80%, then that would result in avoiding of 3500 deaths, 235 million cases of sickness and resulting in a health cost savings of US$492.00 Million. But all these estimates need to be given a sound basis by detailed and scientific studies on an urgent basis. So, the emission analysis and reduction technology should implement in our country to reduce exhaust emission.

II. Combustion in Internal Combustion Engine

The internal combustion engines are those engines in which the combustion of the fuel takes place inside the engine cylinder. The distinctive feature of the I.C engine is that combustion and conversion of heat energy into mechanical work occur inside a cylinder. These engines are noted for their high overall efficiency and low operating cost, lightweight and compactness and constant readiness for starting. Exhaust emission from internal combustion engine is the major source of air pollution.

Combustion Stoichiometry means relations between the composition of the reactants (fuel and air) of a combustible mixture and the composition of the products. These relations depend only in the conservation of mass of each chemical element in the reactants.

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The overall complete combustion equation is-

$$C_a\, H_b + \left(a + \frac{b}{4}\right)(O_2\, +\, 3.773N_2) = aCO_2 + \frac{b}{2}\, H_2O\, +\, 3.773\left(a + \frac{b}{4}\right) N_2 \qquad (1)$$

Let, the fuel is octane C_8H_{18}. Equation becomes-

Fuel ↓ Air ↓ Products ↓

$$\underbrace{C_8H_{18}}_{\text{Fuel}} + \underbrace{12.5\,(O_2 + 3.773N_2)}_{\text{Air}} = \underbrace{8\,CO_2 + 9\,H_2O + 47.16\,N_2}_{\text{Products}} \qquad (2)$$

In moles:

$1+ 12.5\ (1+3.773) = 8+9+47.16$

$1+ 59.66 = 64.16$

Relative mass:

$114.15+59.66\times28.96 = 8\times44.01+9\times18.02+47.16\times28.16$

$114.15+ 1727.8 = 1842.3$

Per unit mass fuel:

$1 + 15.14 = 16.14$

For stoichiometric combustion, 1 mole of fuel requires 59.66 moles of air and produces 64.16 moles of products. The stoichiometric $(A/F)_s$ is 15.14 and (F/A) is .0661.

III. Pollutions from Internal Combustion Engine

Emission from vehicles especially automobiles contribute significantly two-third of air pollution in the urban area.

a) Major pollutants emitted from gasoline fueled vehicles

i. CO: Carbon monoxide is colorless and odorless gas, slightly denser than air that is very harmful for environment.

ii. HC: Hydrocarbon Compounds consisting of carbon and hydrogen and include a variety of other volatile organic compounds (VOCs).

iii. NO_x: Nitrogen oxides (NO_X) include nitric oxide (NO), nitrous oxide (N_2O), nitrogen dioxide (NO_2), dinitrogen trioxide (N_2O_3) and nitrogen pentoxide (N_2O_5).

iv. Pb: Lead is also emitted from the vehicles which is very harmful for human health.

b) Pollutants from diesel-fueled vehicles

i. NO_x: Nitrogen oxides (NO_X) include nitric oxide (NO), nitrous oxide (N_2O), nitrogen dioxide (NO_2), dinitrogen trioxide (N_2O_3) and nitrogen pentoxide (N_2O_5).

ii. SO2: Sulfur dioxide is a stable, nonflammable, non-explosive, colorless gas. In the atmosphere, SO_X may be converted to sulfur trioxide (SO_3) by reacting with O_2.

iii. PAH: Motor vehicles emit toxic HC including benzene, aldehydes and polyaromatic hydrocarbons (PAH).

iv. Particulate matter (including smoke): Particulate matter consists of fine solids and liquid droplets other than pure water that are dispersed in air.

IV. Experimental Setup and Procedure

a) Experimental Setup

Figure 1 shows the experimental setup Flue Gas Analyzer.

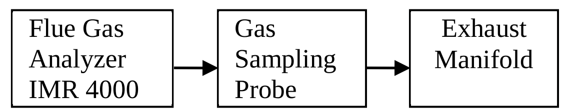

Figure 1 : Experimental setup of IMR 4000 Flue Gas Analyzer

b) Working Procedure

The system should be connected to the mains. Operation via accumulators allows an operating time of eight hours. Gas temperature probe has to connect to the system. Ambient air probe has to connect to the system. Hose has to connect to the port 'GAS Input' at the analyzer. Particle filter should be checked, change if severely polluted. Switch on by flip switch. The probe is not to be in the flue gas as the calibration is done with ambient air. Computer's initialization and zero point-calibration (3 minutes) are displayed. Calibration runs automatically. After that the program changes to the main menu. Failure during calibration will be displayed. The flue gas probe should Place in the stack, looking for the core flow (highest temperature), fixing the probe. The measurement run automatically and continuously, the measured and calculated values are shown simultaneously at the display. Probe should remove from the measurement point and getting the system purged with ambient air, need to wait until the display shows 0 ppm for every component or the oxygen sensor shows 20.95%. Now the system may be switched off.

V. Experimental Data Analysis

The objectives were to collect data from different types of vehicles running inside Dhaka city and to analysis the data by comparing with the standard data. Then, to reach in a conclusion about the present air quality of Dhaka city whether it is on the safe zone or not and recommendations of which steps can be taken.

a) Case study for diesel engine

Firstly, BN Jeep-1165 Land Cruiser was used which has 6 cylinders and is running by diesel as shown in Table I. Three observations had been taken and every observation was taken for average 25 to 30 minutes. Table II shows the various data from diesel engine.

Table i : Engine Specification

Types of vehicles	BN Jeep-1165 Land Cruiser
Cylinder	6
Stroke	4
Fuel Used	Diesel
Run Time	25-30 min (about)

Table ii : Data from Diesel Engine

No. of Obs.	1	2	3
CO_2 max.	5.50 %	15.50 %	15.50 %
Temp. Gas	67 ˚C	70 ˚C	73 ˚C
Temp. Air	30 ˚C	32 ˚C	26 ˚C
O_2	18.17 %	18.10 %	18.05 %
CO_2	0.00 %	0.00 %	0.00 %
CO	50 ppm	50 ppm	52 ppm
CO	57 mg/m³	57 mg/m³	64 mg/m³
NO	86 ppm	83 ppm	83 ppm
NO	105 mg/m³	114mg/ m³	114mg/ m³
NO_2	14 ppm	17 ppm	13 ppm
NO_2	27 mg/m³	32 mg/m³	23 mg/m³
SO_2	1 ppm	0 ppm	0 ppm
SO_2	2.8 mg/m³	0 mg/m³	0 mg/m³
H_2S	0 ppm	0 ppm	0 ppm
H_2S	0 mg/m³	0 mg/m³	0 mg/m³
Lambda	7.54	7.35	7.23
qA	1.57 %	1.66 %	1.91 %
ETA	98.38%	98.33 %	98.08 %

b) Case study for petrol engine

Then Nissan, super 10112 saloon was used which has 6 cylinders and is running by petrol as shown in Table III. For this, three observations had been taken and various data from petrol engine are shown in Table IV.

Table iii : Engine Specification

Types of vehicles	Nissan, super 10112 saloon
Cylinder	6
Stroke	4
Fuel Used	Petrol
Run Time	25-30 min (about)

Table iv : Data from Petrol Engine

No. of Obs.	1	2	3
CO_2 max.	15.50 %	15.50 %	15.50 %
Temp. Gas	149 ˚C	118 ˚C	91 ˚C
Temp. Air	30 ˚C	31 ˚C	33 ˚C
O_2	9.20 %	12.97 %	2.00 %
CO_2	0.00 %	0.00 %	0.00 %
CO	76 ppm	68 ppm	73 ppm
CO	87 mg/m³	77 mg/m³	83 mg/m³
NO	141 ppm	65 ppm	107 ppm
NO	191 mg/m³	80 mg/m³	131mg/ m³
NO_2	0 ppm	0 ppm	0 ppm
NO_2	0 ppm	0 ppm	0 mg/m³
SO_2	0 ppm	1 ppm	2 ppm
SO_2	0 mg/m³	2.8 mg/m³	5.6 mg/m³
H_2S	0 ppm	0 ppm	0 ppm
H_2S	0 mg/m³	0 mg/m³	0 mg/m³
Lambda	1.78	2.63	1.11
qA	3.5 %	4.46 %	2.78 %
ETA	98.47%	98.12 %	98.79 %

c) Case study for CNG vehicles

At last, A CNG vehicle was used. For CNG vehicles only one observation was taken. The specification of CNG engine is shown in Table V. Table VI shows the various data from CNG engine also Table VII shows the revised ambient air quality standards for Bangladesh.

Table v : Engine Specification

Types of vehicles	CNG
Cylinder	1
Stroke	4
Fuel Used	Compressed Natural Gas
Run Time	25-30 min (about)

Table vi : Data from Cng Engine

No. of Obs.	1
CO_2 max.	11.75 %
Temp. Gas	115 °C
Temp. Air	34 °C
O_2	14.97 %
CO_2	0.00 %
CO	46 ppm
CO	52 mg/m³
NO_2	0 ppm
NO_2	0 mg/m³
SO_2	75 ppm
SO_2	215 mg/m³

Table vii : Revised Ambient Air Quality Standards for Bangladesh

Pollutant	Objective	Averaging Tim
CO	10 mg/m³ (9 ppm)	8-hour
	40 mg/m³ (36 ppm)	1-hour
Lead	0.5 mg/m³	Annual
NO_2	100 µg/m³ (0.053 ppm)	Annual
PM-10	50 µg/m³	Annual
	150 µg/m³	24-hour
PM-2.5	15 µg/m³	Annual
	65 µg/m³	24-hour
Ozone	235 µg/m³ (0.12 ppm)	1-hour
	157 µg/m³ (0.08 ppm)	8-hour
SO_2	80 µg/m³ (0.03 ppm)	Annual

From the above tables it is found that, for diesel engine, the average value of CO is 50.66 ppm which is near to the standard air quality whether it has been taken for 20-25 minutes only. Thus for petrol engine, the average value is 72.33 ppm and for CNG, it is 46 ppm.

And for diesel engine the average value of NO_2 is 14.66 ppm. For petrol engine and CNG, the amount of NO_2 is negligible.

The amount of SO_2 is 1 ppm for diesel engine in observation no. 1 and others are negligible. For petrol engine, the average value is 1 ppm which is negligible. But for CNG, it is 75 ppm.

So it can be said that the exhaust emission of vehicle in Dhaka city that is found in the experiment is in the range of revised ambient air quality standards for Bangladesh.

VI. Conclusions

The problem of traffic congestion and uncontrolled vehicle emissions make life miserable and causing threat to health and economic loss as well. Public transport service and air quality situation of Dhaka City is continuously deteriorating every year and imposing huge cost on the society. Though there is little information on human health, there is clear evidence that the air quality in Dhaka is harmful for the city dwellers and it is causing not only discomfort but also several diseases including allergy and asthma. Such a problem needs immediate attention from the policy makers. As vehicle and emissions is a major contributor to air pollution, it is possible to improve air quality by reducing the vehicle stock through improving the public transport system service. Government should strengthen vehicle emission standards (VES), regulations, enforcement and measures to reduce fuel demand and improve traffic conditions. Improved public transport facilities of the city could solve the transport and congestion problems, as well as improve the air quality.

VII. Nomenclature

A/F Air fuel ratio
PAH Poly aromatic hydrocarbons
PPM Parts per million
PM Particular matter
VES Vehicle emission standards

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- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript’s Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

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Complete support for both authors and co-author is provided.

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Original research paper: Such papers are reports of high-level significant original research work.

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Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

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The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

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Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

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- One should avoid outdated words.

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References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

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TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

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20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

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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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Key points to remember:

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- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

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An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

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- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

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- Center on shortening results - bound background information to a verdict or two, if completely necessary
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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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- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

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- Explain materials individually only if the study is so complex that it saves liberty this way.
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- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

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- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

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What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

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.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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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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