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Spatial Distribution of the Heavy Metals: Ni, Fe, Cr, and Mn in Roadside Soils of Maiduguri Metropolis, Borno State Nigeria

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Abstract- In this research work the level and distribution pattern of the metals: Ni, Cr, Mn, and Fe were determined in soil samples collected within Maiduguri Metropolis. Samples were collected from places of high anthropogenic activity such as automobile maintenance workshop (AMW), Car park or Bus stops (CP), and the highways (HW) to places of low activity the Residential areas (RA) at the depth of 5 to 15cm. To avoid washing away of the metals by rainfall, all collections were done during the dry season in the month of September/October 2012 to April/May of the following year 2013. These periods are period of incessant wind and sandstorm marked with low or no rainfall in this part of the country (far north-eastern part of Nigeria). Soil samples were analyzed using ICP-OES following digestion with aqua-regia and the results shows that; the levels; 14.48, 8264.17, 24.26, and 84.75µgg-1 were observed in the samples from AMW for the metals: Ni, Fe, Cr, and Mn respectively. The RA has the levels; 4.96, 804.50, 4.56, and 13.93 µgg-1 for the metals; Ni, Fe, Cr, and Mn respectively. The HW and CP had level of the metals; greater than the RA but less than the AMW. The high concentration of the metal (Fe) in the soil suggests that this metal could be mainly of natural origin with adequate contribution from anthropogenic influences. The concentrations of the metals was found to decrease with increasing distance from the places of high anthropogenic activity AMW, HW, CP to the places of less anthropogenic activities the RA. The distribution pattern of metals; Ni, Cr, Fe, and Mn in Maiduguri Metropolis could be arranged in the order; AMW > CP > HW > RA. This trend further confirms that automobiles are the main contributor of the heavy metals in the urban environment.

Keywords : *pollution, automobiles, traffic, car parks, residential area, power generating plant, environment.*

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I. Introduction

Pedos means soil in Greek and the term pedosphere is used to donate the soil cover, the terrestrial part of the earth. Pedology is the science of soil and the method of studying and analyzing it. Soil is the main component of the biosphere, the vital layer of our planet. It is populated by various organisms ranging from tiny bacteria to higher plants, animals and human. It provides the means of physical support for all terrestrial organisms. Presence of heavy metals at elevated levels in the environment may be hazardous to human health. In the urban environment roadside soil has been identified as a sink for heavy metals. Moreover the road side soil is contaminated with heavy metal it can discharge these pollutants into the air and water sectors of the city's environment. It is evident that the urban soil containing the heavy metal pose a serious threat to the safety of the human life by ingestion, inhaling (Wei and Yang, 2010) and through the direct contact with the soil on the road sides contaminated by heavy metal (Yang et al., 2010).

Environmental pollution by heavy metals from road traffics emissions has become a serious issue in the recent past due to their long-term accumulation. Sources of heavy metals in soils in urban environment mainly include; its natural occurrence in the soil derived from parent materials and human activities which are associated with activities such as atmospheric deposition, industrial discharges, waste disposal, waste incineration, urban effluent, long-term application of sewage sludge, fertilizer application in soil, and vehicle exhausts (Bilos et al., 2001; Turer and Maynard, 2003). In many cities in the developing countries in the world, especially in Africa, Nigeria in particular, lack of access to land make many places to be used as garages, parks, including places such as road verges, and any other spot that motorist could occupy. All setbacks along major highways are occupied by motorist and the alarming rate at which this is going is unprecedented. The traffic source of pollutants includes vehicles tire wear, brake linings, fuel combustion, etc. (Pagotto et al., 2001), and road infrastructure such as pavement wear, corrosion of galvanized steel, crash barriers, etc. It has been reported that the pollutants such as As, Cd, Cr, Cu, Ni, Pb and Zn due to traffic density are mostly found at high levels in soils at sites closer to the roadside that can even affect the environmental air quality (Culbard et al., 1988).

These heavy metal pollutants, derived from a growing number of diverse anthropogenic sources, have had enormous impact on different ecosystem (Macfarlane and Burchett, 2002). In urban areas, heavy metals in the roadside soils can be accumulated in human body via direct inhalation, ingestion and dermal contact absorption (Poggio et al., 2008; Lim et al., 2008). The majority of the heavy metals are toxic to the living organism and even those considered as essential can be toxic if present in excess. Excess heavy metals

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can impair important biochemical process posing a threat to human health, plant growth and animal life (Ikenaka et al., 2010). Reports have shown that such pollutants can be harmful to the roadside vegetation, wildlife and the neighboring human settlements (Nakayama et al., 2010). A number of studies have indicated that such metals could be stored in fatty tissues of human beings and consequently affect the functions of the vital organs and disturb the nervous system and endocrine system (Ali and Malik 2010). Diseases related to high level of heavy metal in the system include lung tissue damage, respiratory illness, liver and kidney failure and others (Popescu, 2011). Cr for instance is carcinogenic and can lead to nasal septum perforation, asthma and liver damage, whereas Ni has been reported to cause nasal and lung cancer (Li et al., 2013). This paper is aimed at determining the level and distribution pattern of the heavy metals; Ni, Cr, Fe, and Mn in the roadside soils within Maiduguri Metropolis, the capital city of Borno state, Nigeria.

a) Sample and Sampling Sites

Samples were collected within Maiduguri metropolis. Four different sampling sites were designated for this study, these include: Car parks or bus stop (CP) this site covers areas of; tashan Bama Motor Mark (Mari), Tashan Baga Motor Park (Baga Road), tashsn Kano Motor Park (Maduganari), maiduguri Terminus and Tashan Joni all within Maiduguri Metropolis. The Highways (HW) this site includes; the highway from Post Office to Tashan Baga; from Post Office to Tashan joni (Air port Road); from custom to the University compus; these are the bussiest roads within the Metropolis. Automobile Maintenance workshops (AMW) this site includes: the Bank of the north area of post office, Dauda mechanic workshop area of Leventis super market, and the automobile maintenance workshop around the flour mill area. And the Residential areas (RA), this site covers the areas of Jiddari Polo ward, Silimri ward, Sulemanti ward and Kafanti ward. These sites represent areas of high anthropogenic activities (automobile maintenance workshops, car parks, and highways) as well as areas of less activity (the residential areas). Five different samples were collected at each sampling site. Samples were collected at the depth of five to fifteen centimeters from the surface and at the intervals of two meters apart using broom and hand trowel. To avoid washing away by rainfall, all collections were done during the dry season in the month of September/October 2012 to April/May of the following year 2013. These periods are period of incessant wind and sandstorm marked with low or no rainfall in this part of the country (far north-eastern part of Nigeria). Samples collected were preserved in an acid prewashed cleaned polyethylene bags for subsequent analysis.

b) Sample Preparation and Analysis

Composite samples collected were homogenized, dried at 60°C to a constant weight, grounded into fine powder using an acid pre-washed mortar and pestle and sieved through a 2mm nylon sieve (Ikenaka et al., 2010). Analysis was done using ICP-OES following digestion with 10 ml Aqua regia (Akbar et al., 2006) in a digestion tube, for the level of the metals: Ni, Cr, Fe, and Mn, in the soil samples.

c) Statistical Data Handling

All statistical data handling were performed using SPSS 17 package. Differences in heavy metal concentrations among the different sites of sampling were detected using One-way ANOVA, followed by multiple comparisons using Turkey tests. A significance level of ($P \leq 0.05$) was used throughout the study.

d) Results and Discussion

Table 1 : Mean concentration (μgg-1) of the Heavy metals in the soil from the Mechanical

Sample	AMW ±SD	CP ±SD	HW ±SD	RA ±SD
Ni	14.86 ±5.40**a**	14.82 ±5.12**c**	13.20 ±4.17**e**	4.96 ±2.00**g**
Fe	8264.12 ±10.17	5760.61 ±28.88	6298.43 ±47.76	804.50 ±17.82
Cr	24.26 ±2.45**a**	12.78 ±1.59**c**	4.78 ±1.36**ef**	4.56 ±1.17**gx**
Mn	84.75 ±4.01	51.33 ±2.22	12.96 ±1.73**ef**	13.93 ±2.66**gx**

AMW= Automobile Maintenance Workshop, CP= Car parks or bus stops, HW=Highways and RA= Residential Areas. Differences of the mean values with bold small letters were found not significantly at ($p \leq 0.05$) according to the Turkey test. Data are presented in mean ±SD ($n = 5$).

Heavy metals are a group of widespread pollutants in the environment that mostly originate from traffic emission, industrial activities, domestic emission and weathering of buildings and pavements (Kong et al., 2012). Although some natural activities result in the release of heavy metals in the environment, report has it that human activities contributed most to the release of this metals in the ecosystems (Sun et al., 2010).

Table one shows the level and distribution pattern of the metals; Mn, Ni, Cr, and Fe determined in the soil samples collected within Maiduguri Metropolis, Borno state, Nigeria. The level of the observed metals was found in direct proportion with the activities occurring at the sampling sites. The observed level of manganese (Mn) ranged from 12.96μg/g - 84.75 μg/g with the automobile maintenance workshop (AMW) having the highest (84.75 μg/g) whereas the lowest level of 12.96 μg/g came from the highways (HW). In this study, the levels of manganese in soils were relatively low. The highest level of the metal (Mn) observed in this study was much lower than 95.48 mg/kg, 132 mg/kg and 408 mg/kg as reported by (Olukanni and Adebiyi, 2012; Okunula and Uzairu, 2007; Ho and Tai, 1988). It has been reported that the level of manganese in the soil generally ranged between 200 – 3000 mg/kg (Lindsay and Norvell, 1979). Manganese has been reported to be relatively less toxic or harmless, in contact with human, the metal is absorb in the body and the excess excreted (Habeck, 1992).

The level of the metal; Ni in Maiduguri Metropolis ranges from 4.96 μg/g-14.86μg/g. Automobile maintenance workshop (AMW) has the highest level of the metal (14.86 μg/g) whereas the residential area has the lowest value of 4.96 μg/g. Car parks or bus stops and the highways have the levels; 14.82 and 13.20 μg/g respectively. The highest concentration of nickel (14.86 μg/g) observed in this study is lower than the highest concentration recorded for Lagos (42.73 mg/kg) (Olukanni and Adeoye, 2012). On international ground, the highest concentration of nickel (14.86μg/g) observed in this study was found lower than the highest levels recorded in Baoji 72.1mg/kg (Li and Huang, 2007), Ethiopia, 200.6 mg/kg (Melaku et al., 2005) and India 1409 mg/kg (Abida et al., 2009). On the other hand, this value 14.86 μg/g was higher than the concentration recorded in mubi (8.62μg/g) (Shingu et al., 2007). The lowest value of the metal; Ni observed from the residential areas in this study was found higher than what was observed in Enugu(0.8 mg/kg) and Otta Metropolis; 0.33 mg/kg (Ekere and Ukoha, 2013; Olukanni and Adebiyi, 2012). The distribution pattern of Ni in the environment could be arranged in the order; AMW > CP > HW > RA.

The range of the level of nickel in roadside soil samples has been reported by Fergusson and Kim (1991) to be 50-100 μg/g, whereas in this study the range as shown in table was found far less than what was reported by Fergusson and Kim (1991) but the concentration is higher compared to what was observed in the less anthropogenic areas (the residential areas). The largest anthropogenic source of Ni in the urban environment is the corrosion of cars, burning of fuel and residual oils, (Arslan, 2001; Fergusson and Kim, 1991; Akhter and Madany, 1993). Oil contains more Ni than coal; there are also large natural sources of Ni present in the atmosphere, e.g. windblown soil, volcanic activity, forest fires, meteoric dust and sea salt spray or particles which later settle under gravitational force (Frey, 1967).

Chromium (Cr) is considered as a serious environmental pollutant, due to its wide industrial applications. Contamination of soil and water by Cr2+ is of recent concern. The Cr6+ compounds are used in industry for metal plating, cooling water treatment, hide tanning, and until recently, wood preservation (Nriago, 1990). These anthropogenic activities have led to the wide spread contamination that Cr shows in the environment and have increased its bioavailability and biomobility (Kotas and Stasicka, 2000). The level of chromium in this study varies greatly and in accordance to the degree of activities taking place at a given sites. For instance the automobile maintenance workshop was found to have the highest concentration of 24.26 μg/g, the car park or bus stop has 12.78 μg/g and the highways 4.78 μg/g, whereas the residential areas, the site with the less anthropogenic activity has the lowest concentration of 4.56 μg/g. The upper limit of Cr observed in this study (24.26 μg/g) is very much lower than the limit observed in India 343-1409 mg/kg (Abida et al., 2009); in the center of Hail city 95ppm (Odat and Alshammari, 2011); in Ethiopia 86.3mg/kg (Melaku et al., 2005 and the limit of 100 mg/kg recommended by EU (Yahaya et al., 2010). However this limit is higher than the highest level observed in Mubi 5.4 μg/g (Shingu et al., 2007). The natural concentration of Cr in soil has been reported to ranged from 10 to 50 mg kg-1 depending on the parental material whereas (Adriano, 1986). Vehicle exhaust, brake lining, catalytic converters and chrome pigment for automobiles are also some of the primary major source of the metal (Cr) in urban environment (Shu et al., 2001; Fang et al., 2010). Soil is a complex system and its constituents are constantly undergoing changes due to weather conditions, geographic location and human activities, such as traffic, industrial and agricultural ones. With the advent of democracy high and rapid economic development in Nigeria was recorded, the number of motor vehicles has therefore dramatically increased in recent years. Significantly more heavy metals are likely to be emitted into the urban environment by vehicle emissions. The distribution pattern of the metal (Cr) in the environment could be arranged in the order; AMW > CP > HW > RA.

The consistently high load of iron recorded in all the sites is not surprising considering the fact that iron

(Fe) is one of the constituents (alloy) found in almost all vehicles and other metallic substances. Quite a number of research works has it that, the pollution sources of heavy metals in environment especially urban environment are mainly derived from anthropogenic sources. In urban soils and urban road dusts, the anthropogenic sources of heavy metals include traffic emission (vehicle exhaust particles, tire wear particles, weathered street surface particles, brake lining wear particles), industrial emission (power plants, coal combustion, metallurgical industry, auto repair shop, chemical plant, etc.), domestic emission, weathering of building and pavement surface, atmospheric deposited and so on (De Miguel et al., 1997; Han et al., 2006; Morton et al., 2009). The process of corrosion, rusting, wear and tears of all metallic substance in the environment might have contributed to the high concentration of this metal (Fe) when compared with other metals in this research work. Moreover, it had been earlier stated by a good number of researchers that iron occurs in high proportion in Nigeria soil, implying that the concentration is contributed from both anthropogenic and crustal origin. The presence of iron in soils and plants is desirable (Eze and Hillary, 2008) since it is one of the metals that are essential to human biochemical processes, for example haemoglobin in the human blood system contains iron which aids blood formation (Okoye, 1992).

II. Conclusion

The result of the study shows moderate contamination of the soil in the Metropolis by the metals: Ni, Cr, and Mn. The levels of which could be attributed to ninety-five percent anthropogenic source. The high concentration of the metal (Fe) in the soil suggests that these metals could be mainly of natural origin with adequate contribution from anthropogenic influences. The result shows that the concentration decreases with increasing distance from the places of high anthropogenic activity {the automobile maintenance workshop (AMW), the highways (HW), Car park or Bus stops (CP)} to the places of less anthropogenic activities (the residential areas (RA).

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Diversity of Aquatic Insects and Function of Fluvial Ecosystem of Song River of Rajaji National Park, India

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Abstract- Aquatic insect diversity of Rajaji National Park, India has been monitored for a period of twelve months. Some of the important hydrological attributes were also measured in continuity of one-month interval. Aquatic insects were sampled from two sites (S1 and S2) of the Song River of the Rajaji National Park. A significant difference in the density ($t=2.86455$, $p<0.05$) and diversity ($t=5.23425$, $p<0.001$) of aquatic insects was found due to differences in physicochemical setup of aquatic environment of these sites. It was also revealed that the nature, size and composition of bottom substrates have their significant impact on the diversity of benthic aquatic insects. The diversity of benthic aquatic insects ranged from 3.0270-4.4561 indicating the good quality of water. A high diversity (4.1085-4.4561) among aquatic insects was recorded in winter months when the water was almost clear with moderate temperature and water current, and high dissolved oxygen in the Song river of Rajaji National Park.

Keywords: *aquatic insects, monitoring, rajaji national park, physico-chemical parameters, song river, uttrakhand.*

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Nusrat Samweel [α] & Tahir Nazir [σ]

Abstract- Aquatic insect diversity of Rajaji National Park, India has been monitored for a period of twelve months. Some of the important hydrological attributes were also measured in continuity of one-month interval. Aquatic insects were sampled from two sites (S1 and S2) of the Song River of the Rajaji National Park. A significant difference in the density ($t=2.86455$, $p<0.05$) and diversity ($t=5.23425$, $p<0.001$) of aquatic insects was found due to differences in physico-chemical setup of aquatic environment of these sites. It was also revealed that the nature, size and composition of bottom substrates have their significant impact on the diversity of benthic aquatic insects. The diversity of benthic aquatic insects ranged from 3.0270-4.4561 indicating the good quality of water. A high diversity (4.1085-4.4561) among aquatic insects was recorded in winter months when the water was almost clear with moderate temperature and water current, and high dissolved oxygen in the Song river of Rajaji National Park.

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I. Introduction

Importance of aquatic insects in an aquatic ecosystem cannot be ignored as they constitute important part of the food chain in the fluvial ecosystem. They have also been considered as an indicator of stream condition and assessment of river water quality (Noris, Noris 1995). They exhibit a great breadth of species diversity; hence their maintenance is essential for the survival of any lentic and lotic ecosystem.

Distribution, density and biomass of aquatic insects depend upon the physico-chemical attributes of water, nature of substratum, biological complexes such as food, predation and other factors. Aquatic insects have been used to assess the biological integrity of stream ecosystem in various studies (Rosenberg, Resh 1993; Resh, McElravy 1993; Resh, *et.al* 1995; Baroor, *et.al*; 1996). The majority of these efforts have been conducted on variety of streams at global level (Clausen, and Biggs, 1997, 1998 and 2000; Collier *et al*, 1997, 2000 and 2001; Royer *et.al*. 2001; Walsh *et.al.* 2001, Joshi *et al*.2002, LeFevre 2003, Jacobsoen *et al*. 2003, Anbalagan *et al*. 2004, McIntosh *et al*.2004, Anbalagan and Dinakaran, 2006; Sarmistha *et al*., 2009) and at national level (Sivaramakrishnan *et.al,* 1996, and 1998; Bhattacharya, 1998; Mukerjee *et.al* 1998; and Sharma, 1986; Bhattacharaya, 2000; and Balaram, 2005,Subramanian and Sivaramakrishnan 2005). A very little information is available on the diversity of aquatic insects of Garhwal Himalaya except some scattered reports (Badola 1979; Sharma 1986). However, no information is available so far on the aquatic biodiversity and the function of fluvial ecosystem of the Song river of Rajaji National Park. Therefore, the present work on the diversity of aquatic insects and function of fluvial system of river Song of the Rajaji National Park was undertaken.

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II. Study Area

Rajaji National Park is situated in the foothills of Shiwalik Range of the newly carved out state Uttarakhand of India. It is the part of the Dehradun, Hardwar and Pauri district of Uttarakhand State ($77^0 55'$-78^0 $30'$; Latitude 29^0 $50'$-30^0- $15'$N). Three sanctuaries, Motichur (59.5 km^2), Rajaji (247.0 km^2), Chila (249.02 km^2) and other reserve forests (234.5 km^2) are amalgamated into large protected area which is named as Rajaji National Park. The total area of the Rajaji National Park is 820.42 km^2. To the north of the Rajaji National Park lie the Dehradun and Tehri Forest Division. River Suswa forms the northern natural boundary up to Ganges (Fig. 1).

Song is the perennial river draining Rajaji National Park in northeastern slopes of Shiwalik. The northeastern slopes of Shiwaliks are very steep and rugged in the upper portion but in the lower portion, it has a quiet easy gradient. There are large number of short, shallow dry and bouldery streams locally known as 'raus'coming down from upper slopes and more or less on flat or gently sloping area often cut by small drainage (nalas). Suswa and Song rivers drain the forests of eastern Doon. River Song forms its confluence in the Banbaha forest block. From there, it flows in a southeastern direction till it discharges into the Ganges near Satyanarian. Some seasonal tributaries also meet Song river at Bindal, Rispana, Ren and Jakhan. The river Suswa flows very closely and opposite to Asan River to the east of Saharanpur-Mussoorie highway and flows in a southeasterly direction to discharge into the Song.

River Ganges divides the Park into two units, the Chila Sanctuary complex in the east and Rajaji Motichur Sanctuary Complex in the west. To the south of Rajaji, lie the revenue lands and villages of Haridwar district. A part of southeastern portion is covered by Bijnore forest division. The Garhwal forest division lies to the east of the park. Rawsan River forms a small portion of natural south eastern boundary of the park. To the west of the Rajaji lies the Shiwalik Forest Division.

III. Materials and Methods

a) Sampling

A preliminary survey of the Park was done for undertaking the present study. Two sampling sites (S_1 and S_2) were identified at the Song River in the Rajaji National Park. The first sampling site S_1 was identified at Shampur (320m above m.s.l.), while the second sampling site S_2 at Chhidarwala (300m above m.s.l.) (Fig. 1).

Monthly sampling was conducted during the period of September 2001-August 2002. Water temperature was recorded with the help of a Centigrade (0-110 ^{0}C) thermometer. The mean velocity was measured using electromagnetic current meter (model-PVM-2A). pH was estimated by control dynamics pH meter (model-APX15\C), while turbidity was measured by turbidity meter (model-5D1M). The control dynamics conductivity meter (model-5DIM) was used for measuring conductivity. Nitrates and phosphates were estimated by the microprocessor based spectrophotometer (Spectronic 20D Series) and sodium and potassium were estimated by the digital flame photometer (model-1381). Dissolved oxygen and Free CO_2 were measured following the titrimetric methods outlined in Wetzel, Likens (1991) and APHA (1998).

The percentage composition of different sized substrata was estimated visually using the substrate size classes (after Bovee, Milhous 1978) of sand (0.06-2mm), fine gravel (2-32mm), coarse gravel (32-64mm), cobbles (64-256mm) and boulders (>256mm). Aquatic insects were sampled with the help of a Surber Sampler (0.5mm mesh net) to a depth of 10cm in a quadrate. Samples were preserved in 4% formalin .The invertebrate fauna were identified to the possible lowest taxonomic level and counted. The quantitative analyses were made by using Ward, Whipple (1992) and several taxonomic keys of Freshwater Biological Association, UK.

b) Diversity Index

Diversity indices are mathematical expressions that combine three components of community structure-richness (number of species present), evenness (the distribution of individuals among species) and abundance (total number of organisms present). It is used to describe the response of a community to the quality of its environment. The most widely used diversity index, Shannon Wiener (1964) has been used:

Shannon Weiner diversity indices: Species diversity index ($\overline{H}$) was calculated using the Shannon Wiener information function (Shannon and Weiner 1964).

$$(\overline{H}) = \sum_{l-1}^{s}\left(\frac{ni}{N}\right)\log_2\left(\frac{ni}{N}\right)$$

Where,

$\overline{H}$ = Shannon Wiener index of diversity;
ni = Total no of individual of a species;
N = Total no of individuals of all species.

c) Concentration of Dominance (C)

The Concentration of Dominance (C) was computed by Simpson (1949) index as

$$C = -\sum_{i=1}^{s}\left(\frac{n_i}{N}\right)^2$$

where,

C = concentration of dominance;
ni = total no of individuals of a species;
N = total no of individuals of all species.

IV. Results

a) Composition of bottom substrates

Composition of bottom substrates at both the sampling sites of Song River has been presented in Table 1. Bottom substrates were contributed by boulders (50%), cobbles (20%), pebbles (15%), sand (12%), silt (2%) and clay (1%) at S_1. However, these substrates were contributed by boulders (40%), cobbles (25%), pebbles (20%), sand (10%) and silt (3%) and clay (2%) at S_2. Sparse riparian vegetation was found to occur at S_1 while a dense riparian vegetation cover was noticed at S_2.

b) Analysis of the physic-chemical parameters

Analysis of physic-chemical setup of the aquatic environment of both the sampling sites of the Song river revealed that air temperature ranged from 23^{0}C to 30^{0}C at both the sites. Water temperature ranged from 21^{0}C (January) to 28.5^{0}C (August) (Table II). However, the water temperature ranged from a minimum of 20^{0}C in January to a maximum of 25^{0}C in the month of August at S_2 (Table III). The water current ranged from 0.280 m sec^{-1}(January) to 1.525 m sec^{-1} (July) at S_1 and at S_2 it ranged from 0.49 (January) to 1.54 m sec^{-1} (July). The turbidity was higher only in the monsoon (July-September) months and fluctuated between 58-97 NTU at both the sampling sites at the Song river. The hydro median depth (HMD) ranged from 40 - 49.20 cm at both the sites. The conductivity did not show any significant variation in different months at both the sites. Total dissolved solids (TDS) ranged from 120 mg l^{-1} to 780 mg l^{-1} at S_1 and 180 mg l^{-1} to 780 mg l^{-1} at S_2. Dissolved

oxygen concentration fluctuated between 8.00-15.50 mg l^{-1} at S_1 however it fluctuated between 9.30-14.90 mg l^{-1} at S_2. Free CO_2 concentration in the Song River ranged from 0.15-1.92 mg l^{-1} at S_1 and 0.6-1.61 mg l^{-1} at S_2. pH fluctuated between 8.00-8.50 at S_1 and 7.86-8.20 at S_2. The concentration of dissolved phosphates ranged from0.070-0.083 mg l^{-1} at S_1 and 0.070-0.92 mg l^{-1} at S_2. Nitrates in the Song water ranged from 0.001 mg l^{-1} to 0.060 mg l^{-1} at S_1 and 0.041 mg l^{-1} to 0.080 mg l^{-1} at S_2. Chlorides concentration fluctuated between 5.02-6.96 mg l^{-1} at S_1 and 4.00- 5.96 mg l^{-1} at S_2. The concentration of dissolved sodium ranged from 10.00-20.00 mg l^{-1} at S_1 and at S_2 it fluctuated between 12.00-20.00 mg l^{-1}. Potassium concentration in the Song water fluctuated between 0.40-0.90 mg l^{-1} at S_1 (Table II) and 0.30-0.90 mg l^{-1} at S_2 (Table III).

A significant difference in mean air temperature ($t = 2.239$, $p<0.05$), water temperature ($t = 9.608$, $p<0.01$), water-current ($t = 3.466$, $p<0.01$), conductivity ($t = 2.994$, $p< 0.05$), dissolved oxygen ($t = 4.938$, $p<0.001$), nitrates ($t = 4.456$, $p< 0.001$), alkalinity ($t = 6.733$, $p<0.001$), phosphates ($t = 3.033$, $p<0.01$), chlorides ($t = 6.181$, $p<0.001$), and pH ($t = 3.989$, $p<0.01$) was found between the two sampling sites sustaining aquatic insect diversity under the present study.

c) Qualitative and quantitative analysis of aquatic insects

Aquatic insects dwelling the Song River are represented by immature stages of the insect orders Ephemeroptera, Plecoptera, Tricoptera, Coleoptera, Odonata and Diptera class of insect. Eight species *(Ephemerella, Ecdyonurus, Baetis, Centroptilum, Cloeon, Siphlonurus, Potamanthus, Habrophlebia)* of Ephemeropterans were found to occur during the study period. Ephemerella was found to be the abundant species among Ephemeropterans. Plecopterans *(Taeniopteryx, Claassenia, Phasganophora, Neoperla),* Tricopterans *(Hydropsyche, Diplectrona, Philopotamus, Hydroptila)* and Dipterans (*Tendipes, Eulalia, Megistocera, Ephydra)* were represented by four genera each. Coleopterans were represented by three genera *(Psephenus, Ectopria, peltodytes).* However, the Odonatans were represented by five genera (*Gomphus, Agrion, Macromia, Sympetrum, Ischnura, Libellua*). Ephemeropterans, Plecopterans, Tricopterans and Dipterans were present throughout the study period whereas Odonatans, could not show their regular presence in the Song river.

Percentage composition profile of the aquatic insects of Song River revealed that this composition was contributed by Ephemeropterans (30.5%), Plecopterans (19.76%), Tricopterans (18.30%), Dipterans (14.03%), Coleopterans (14.40%) and Odonatans (2.92%) at S_1. However, at S_2 Ephemeropterans, Plecopterans, Tricopterans, Dipterans, Coleopterans and Odonatans contributed 31.27%, 21.86%, 17.66%, 11.73%, 13.31% and 4.14% respectively (Fig.2).

The quantitative abundance of aquatic insects dwelling the Song river of Rajaji National Park revealed that the maximum benthic density (1406 ind.$m^{-2}$and 1372 ind.m^{-2})was found in the month of February (winter) at both the sampling sites. However, the minimum density of aquatic insects (97 ind.$m^{-2}$and 90 ind.m^{-2}) was recorded during July (monsoon) at both the sampling sites of the Rajaji National Park (Table IV).

d) Diversity indices and concentration of dominance (C)

The diversity indices (Shannon-Wiener) of aquatic insects ranged from 3.1282 - 4.4561 at S_1 and 3.0270 - 4.3960 at S_2 under the present study. Maximum values of the diversity indices, 4.4561 and 4.3960 was recorded in February (winter) respectively at S1 and S2 and minimum values, 3.1282 and 3.0270 at S1 and S2 during July (monsoon), respectively (Table V).

A significant difference in the density ($t = 2.86455$, $p< 0.05$) and diversity ($t = 5.23425$, $p<0.001$) was computed between the two sampling sites (S_1, S_2) located at the river Song of the Rajaji National Park.

The Concentration of dominance (C) varied between 0.0565-0.1315 at S_1 and 0.0586-0.1328 at S_2 during the study period. The concentration of dominance was found to be maximum, (0.1315 and 0.13280) in July while minimum (0.0565 and 0.0586) in January at both the sampling sites, respectively (Table VI).

e) Statistical correlation among hydrological attributes

Correlations among hydrological attributes are presented in (Table VII). A highly positive correlation ($r=0.826$) was found between the air temperature and water temperature. Total dissolved solids were positively correlated to Turbidity ($r=0.696$). Dissolved oxygen was negatively correlation with water temperature ($r = -0.7360$) and turbidity ($r=-0.880$). Free CO_2 was negatively correlated with dissolved oxygen ($r=-0.690$). However, no significant correlation was found between the concentration of nitrates and phosphates during the study period.

f) Relationship between hydrological attributes and aquatic insects' density

Aquatic insects density had a significant inverse relationship with water temperature ($r=-0.744$, $p>0.01$), turbidity ($r=-0.723$; $p>0.01$), hydromedian depth ($r=-0.777$; $p>0.01$), free CO_2 ($r=-0.566$; $p>0.05$), TDS ($r=-0.848$; $p>0.001$) and potassium ($r= -0.898$, $p>0.001$). However, a positive relationship ($r= 0.858$; $p>0.001$) was found between the aquatic insects density and dissolved oxygen (Table VII).

A multiple regression analysis showed that a myriad of different abiotic factors played a significant role (multiple $R=0.9898$, $R^2=0.9798$ and $F=21.234$,

P<0.0002) in determining the density of the aquatic insects dwelling Song river.

V. Discussion

The nature of bottom substrates is one of the most significant environmental parameters in influencing the biodiversity of stream (Wisely 1962, Hynes 1970, Hawkins 1984, Minshall 1984, Angrerdi 1996). The riverine ecosystem of Song River comprises of boulders, pebbles, sand, silt and clay. The sampling site S_1 is dominated by big boulders which do not provide a suitable shelter to aquatic benthos while site S_2 was dominated by small boulders and cobbles which provide a suitable shelter for aquatic benthic organisms. Ward (1994) also pointed out that the boulders and cobbles are the dominant features of headwater streams. Physico-chemical parameters play an important role in determining the structure and function of an ecosystem. Density of aquatic insects showed negative correlation with water temperature (r =-0.744) indicating that an increase in density with decrease in water temperature *i.e.* they increased with the decreasing temperature and *vice-versa*. Temperature pattern influences the life cycle life cycle phenomenon of insects such as emergence which leads to increase in density. (Ward and Dufford 1979). A negative correlation (r =-0.723) was found to occur between turbidity and density of aquatic insects. Dutta, Malhotra (1986) also noticed that increased load of suspended solids reduce the abundance of benthos by creating unfavorable conditions on bottom due to blanketing action. There exists a negative correlation (r =-0.566) between free CO_2 and density of aquatic insects.

Dissolved oxygen concentration decreased with increasing temperature in the Song River of the Rajaji National Park. Solubility of oxygen is affected non-linearly by temperature and increase in the cold water (Welch 1952, Wetzel 1983). The high concentration of dissolved solids in the monsoon season may be due to the addition of inorganic salts and organic matter carried along with the increased rain water and surface run-off. Water current and nature of substrata are also important factors responsible for seasonal variations in aquatic insects. A negative correlation (r =-0.689) between water current and density of aquatic insects was found indicating that an increase in water current decreases the density of aquatic insects. According to Hynes, (1970), current speed is an important factor of major importance in running waters. It controls the occurrence and abundance of species and hence the whole structure of aquatic insects community. He also stated that larger the stones, more complex are the substratum and more diverse is the benthic fauna, which is true in case of the river Song where maximum aquatic insects existed during the period of low water current. The complex substrata structure of the river consists of mainly boulders, cobbles and pebbles supported a rich diversity of aquatic insects.

The Shannon-Weiner diversity index for aquatic insects remained above 3.0 throughout the study period indicating the good quality of Song water. Maximum insect diversity was recorded during winter season while monsoon period showed minimum diversity of aquatic insects which may be attributed to intense competition among aquatic insects for the limited food supply within the community during monsoon season. The similar seasonal pattern of occurrence of macro- invertebrates has been recorded Badola and Singh (1981) from Alaknanda River and Gusian (1994) from river Bhilangana. However, Singh et al. (1982), Sharma (1985), Mohan et al. (1989) and Sunder (1997), also observed the similar trend in other Himalayan rivers. The concentration of dominance was found to be inversely proportional to the diversity indices.

Singh and Nautiyal (1990) recorded 30 taxa of macro-invertebrates dominated by Ephemeroptera and followed by Diptera, Tricoptera and Plecoptera in the river Ganges. Sehgal (1990) recorded 57 genera of insects from 11 rivers of the North-Western Himalaya. Joshi (1991) observed 50 genera of insects from Sherkhad stream in Himachal Pradesh and Bhatt and Pathak (1992) recorded 68 genera of insects from various rivers of Kumaon region. Under the present study, 29 genera of aquatic insects dominated by Ephmeroptera and followed by Diptera, Trichoptera, Plecoptera and Odonata indicates that Song River which has all major components of typical hill stream shows a good distributional pattern of benthic invertebrates.

Free carbon dioxide was recorded higher in monsoon months while a low concentration was observed in winters. The rise in CO_2 concentration during monsoons and low oxygen consumption by the organic matter in turbid state of water retards the photosynthetic activity. Bhatt *et al.* (1985) reported the similar type of observations.

A significant difference in density and diversity of the aquatic insects between the two sampling sites in the Song River may be attributed to the significant difference in physic-chemical parameters (air temperature, water temperature, water current, conductivity, dissolved oxygen, pH, nitrates, alkalinity, phosphates and chlorides). This difference in the density and diversity of aquatic insects may also be attributed to some of the anthropogenic influences (heavy tourist influx, grazing near stream bank) in the stream water. Presence of Van Gujjars (nomads) in the Rajaji National Park is also responsible for deteriorating the quality of water. Extraction of building materials such as boulders, pebbles, stones, gravel and sand form the river beds destroying the niche of the aquatic insects consequently decline in the density and diversity of the aquatic insects.

Thus, it was revealed that the variations in the density and diversity of aquatic insects may be due to the function of dominant physico-chemical attributes (water temperature, turbidity, free CO2, pH, dissolved oxygen, total alkalinity and conductivity) in addition to the natural and anthropogenic disturbances.

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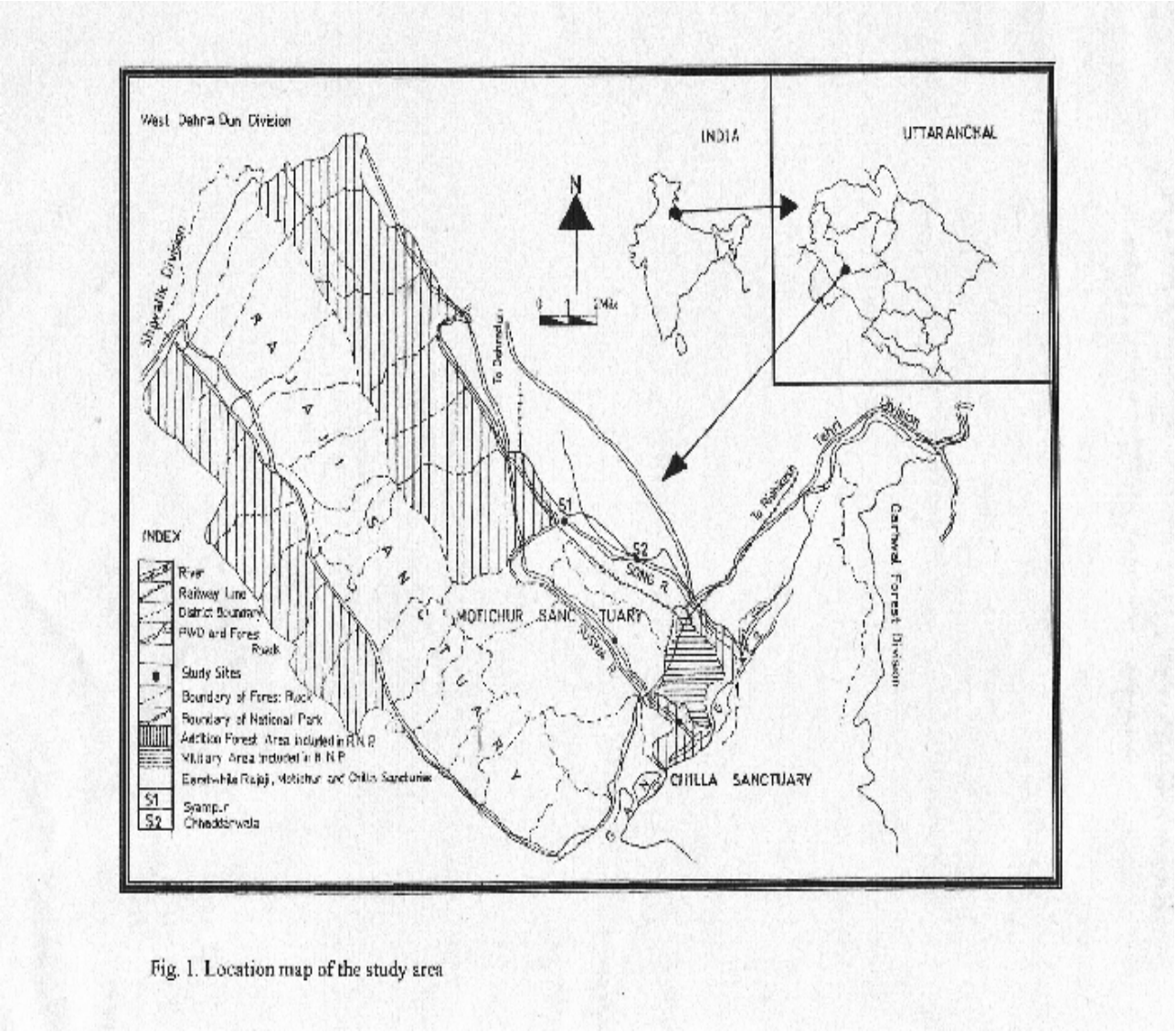

Fig. 1. Location map of the study area

Figure 1 : Location map of the study area

Table 1 : Physiographic characteristics of aquatic habitat of the Song river of Rajaji National Park

Parameters	S1	S2
Latitude	30°02'	30°11'30"
Longitude	78°12'	78°07'
Altitude (m above m.s.l)	320	300
Embankment	Sparse riparian vegetation	Dense riparian vegetation
Boulders (%)	50	40
Cobbles (%)	20	25
Pebbles (%)	15	20
Sand (%)	12	10
Silt (%)	2	3
Clay (%)	1	2

Table 2 : Monthly variations in physico - chemical parameters recorded at sampling site S_1 of the Song river of Rajaji National Park, Uttarakhand during the period from September 2001-August 2002

Parameters	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	x ± S.D.
Air temperature (^{0}C)	28.00	27.00	27.60	23.50	23.00	24.00	27.00	27.00	28.00	28.50	29.50	30.00	26.9±2.27
Water temperature (^{0}C)	25.00	23.00	23.30	22.00	21.00	22.50	24.50	25.00	26.00	27.00	26.70	28.50	24.54±2.25
Water current (m sec^{-1})	0.802	0.450	0.354	0.300	0.280	0.270	0.500	0.350	0.360	0.615	1.525	1.320	0.59±0.41
Turbidity (NTU)	58.0	0	0	0	0	0	0	0	0	89.0	93.00	97.00	28.08±42.51
HMD (cm)	46.70	46.50	44.00	45.00	45.3	40.20	40.00	43.00	47.00	48.00	48.00	48.20	45.15±2.86
Conductivity (μm cm^{-1})	0.361	0.364	0.377	0.373	0.370	0.371	0.173	0.214	0.246	0.403	0.305	0.309	0.32±0.07
TDS (mg l^{-1})	410	400	320	160	120	250	460	500	520	560	630	780	393.63±164.63
Dissolved oxygen (mg l^{1})	10.30	13.60	14.00	14.5	15.0	15.50	13.4	13.0	12.50	10.80	9.80	8.00	12.53± 2.31
Free CO_2 (mg l^{-1})	0.40	0.20	0.15	0.20	0.30	0.20	0.60	0.54	0.60	1.10	1.92	1.80	0.56± 0.52
pH	8.50	8.30	8.50	8.40	8.30	8.00	8.20	8.40	8.00	8.50	8.50	8.00	8.83 ± 0.20
Phosphates (mg l^{-1})	0.079	0.080	0.082	0.080	0.070	0.083	0.079	0.074	0.079	0.082	0.080	0.081	0.07 ± 0.00
Nitrates (mg l^{-1})	0.060	0.040	0.020	0.030	0.060	0.020	0.020	0.010	0.001	0.001	0.013	0.012	0.02 ± 0.02
Chlorides (mg l^{-1})	5.24	5.30	5.10	5.10	5.02	5.15	6.96	6.400	6.96	5.84	5.26	5.21	5.61±0.74
Alkalinity (mg l^{-1}	35.00	33.00	40.00	36.00	32.00	30.00	34.00	40.00	35.00	45.00	46.00	30.00	41.22±6.48
Sodium (mg l^{-1})	20.00	15.00	13.00	14.0	13.0	12.00	12.00	15.00	13.00	12.00	20.00	20.00	14.91 ± 3.23
Potassium (mg l^{-1})	00.80	00.60	00.60	00.50	00.40	00.40	00.50	00.50	00.60	00.80	00.90	00.90	0.62± 0.18

Table 3 : Monthly variations in physico - chemical parameters recorded at sampling site S_2 of the Song river of Rajaji National Park, Uttarakhand during the period from September 2001-August 2002

Parameters	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	x ± S.D.
Air temperature (^{0}C)	27.50	27.30	27.50	23.90	23.30	23.80	26.00	26.90	27.40	28.00	28.30	28.70	26.55±1.86
Water temperature (^{0}C)	22.90	22.00	21.00	19.80	20.00	20.60	23.00	23.30	23.70	24.00	24.90	25.00	22.51±1.81
Water current (m sec^{-1})	0.63	0.54	0.52	0.50	0.49	0.53	0.55	0.66	0.67	0.67	1.54	1.50	0.73±0.37
Turbidity (NTU)	60.00	0	0	0	0	0	0	0	0	77.00	80.00	94.00	25.91±38.96
HMD (cm)	46.00	45.00	40.00	43.00	44.00	44.50	44.80	47.30	48.00	48.50	48.70	49.20	45.75±2.73
Conductivity (μm cm^{-1})	0.362	0.365	0.380	0.373	0.352	0.365	0.370	0.381	0.400	0.512	0.486	0.400	0.39±0.05
TDS (mg l^{-1})	500	480	340	180	200	300	500	480	500	520	780	600	448.33±169.37
Dissolved oxygen (mg l^{1})	10.30	11.70	13.00	14.20	14.90	14.70	15.00	14.40	12.00	10.9	10.00	9.30	12.53±2.09
Free CO_2 (mg l^{-1})	0.60	0.63	0.60	0.78	0.80	0.76	0.70	0.67	0.76	0.61	0.96	1.61	0.79±0.27
pH	8.00	7.96	8.00	8.20	8.10	8.00	7.86	7.93	8.00	7.94	7.96	8.20	8.01±0.10
Phosphates (mg l^{-1})	0.091	0.086	0.084	0.070	0.079	0.080	0.086	0.080	0.090	0.092	0.089	0.092	0.08 ± 0.00
Nitrates (mg l^{-1})	0.058	0.057	0.050	0.041	0.050	0.052	0.060	0.063	0.070	0.073	0.080	0.060	0.05±0.01
Chlorides (mg l^{-1})	4.83	4.96	4.26	4.16	4.00	4.23	5.46	5.96	4.90	4.70	4.69	4.65	4.73±0.56
Alkalinity (mg l^{-1}	32.00	30.00	35.00	40.00	39.00	36.00	35.00	37.00	40.00	38.00	38.00	45.00	41.66±13.20
Sodium (mg l^{-1})	19.00	14.00	17.00	16.00	10.00	20.00	10.00	18.00	13.00	16.00	20.00	20.00	16.08±3.65
Potassium (mg l^{-1})	00.60	00.60	00.50	00.40	00.30	00.30	00.50	00.60	00.60	00.70	00.90	00.80	0.56±0.18

Table 4 : Monthly variations in the density (ind.m^{-2}) of aquatic insects dwelling the river Song during September 2001-August 2002

Aquatic insects	Site	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Annual Mean	%
Ephemeroptera	S_1	126	127	226	322	378	646	296	211	106	66	37	26	198.7	30.50
	S_2	120	130	204	306	404	503	289	123	67	57	20	50	189.4	31.27
Plecoptera	S_1	107	123	180	223	239	273	193	89	43	27	17	30	128.6	19.76
	S_2	117	143	173	210	240	273	193	113	50	27	20	30	132.4	21.86
Trichoptera	S_1	107	120	163	164	230	252	157	123	57	23	10	23	119.0	18.30
	S_2	100	123	173	187	200	227	113	73	43	33	0	17	107.4	17.66
Diptera	S_1	40	46	83	116	173	200	176	100	77	44	17	23	91.25	14.03
	S_2	40	53	80	90	111	166	197	50	30	16	10	10	71.08	11.73
Coleoptera	S_1	43	73	107	153	177	193	146	96	63	30	13	30	93.66	14.40
	S_2	40	80	99	130	153	170	110	80	33	23	20	30	80.66	13.31
Odonata	S_1	9	10	37	33	44	24	20	16	13	13	3	6	19.00	2.92
	S_2	15	14	42	30	40	33	20	26	24	14	20	23	25.08	4.14
Total Density (ind.m^2)	S1	432	499	769	1011	1241	1406	988	635	359	203	97	138	650.2	
	S2	432	543	771	953	1148	1372	922	465	247	170	90	160	605.6	

Table 5 : Diversity indices calculated for aquatic insects of the river Song river of Rajaji National Park during September 2001- August 2002

Months	S_1	S_2
Sep	3.5610	3.4723
Oct	3.5287	3.6038
Nov	4.1085	4.1825
Dec	4.2810	4.3333
Jan	4.4385	4.3841
Feb	4.4561	4.3960
Mar	4.4232	4.2298
Apr	4.2461	4.0018
May	4.1662	3.7355
Jun	3.8867	3.3777
Jul	3.1282	3.0270
Aug	3.7820	3.4876

Table 6 : Concentration of dominance calculated for aquatic insects of the Song river of Rajaji National Park during September 2001- August 2002

Months	S_1	S_2
Sep	0.1015	0.1058
Oct	0.1011	0.0957
Nov	0.0732	0.0695
Dec	0.0645	0.0614
Jan	0.0565	0.0586
Feb	0.0566	0.0596
Mar	0.0561	0.0631
Apr	0.0659	0.0772
May	0.0629	0.0892
Jun	0.0746	0.1111
Jul	0.1315	0.1328
Aug	0.0801	0.0948

Table 7 : Correlation between hydrological attributes and density of aquatic insects of Song river of Rajaji National Park for the period September 2001-August 2002

	Dn	AT	WT	WC	Tu	HMD	Co	TDS	DO	F Co2	pH	PO3	NO3	Chl	Alk	Na	K
Dn	1																
AT	-0.89	1															
WT	-0.744	0.826	1														
WC	-0.689	0.637	0.560	1													
Tu	-0.723	0.669	0.685	0.814	1												
HMD	-0.777	0.516	0.535	0.617	0.665	1											
Co	-0.21	-0.024	-0.216	0.225	0.304	0.428	1										
TDS	-0.848	0.879	0.818	0.751	0.696	0.592	0.020	1									
DO	0.858	-0.839	-0.736	-0.787	-0.88	-0.644	-0.125	-0.806	1								
F Co2	-0.566	0.546	0.557	0.838	0.722	0.499	-0.031	0.658	-0.685	1							
pH	-0.016	0.055	0.219	-0.03	0.15	0.017	-0.240	-0.199	-0.068	-0.029	1						
PO3	-0.493	0.476	0.221	0.416	0.415	0.378	0.491	0.528	-0.468	0.211	-0.443	1					
NO3	-0.061	-0.147	-0.439	0.183	0.004	0.239	0.659	-0.029	-0.006	-0.126	-0.472	0.428	1				
Chl	0.166	0.299	-0.552	-0.187	-0.109	-0.039	-0.665	0.277	0.003	-0.099	-0.181	-0.221	-0.557	1			
Alk	-0.367	0.249	0.237	0.384	0.367	0.356	0.140	0.189	-0.224	0.456	0.456	0.068	-0.11	-0.067	1		
Na	-0.455	0.437	0.278	0.685	0.584	0.420	0.190	0.443	-0.624	0.479	0.304	0.191	0.241	-0.269	0.109	1	
K	-0.898	0.876	0.832	0.79	0.843	0.709	0.203	0.828	-0.886	0.597	0.191	0.415	-0.046	0.155	0.301	0.531	1

Abbreviations: Den = density, A.T= Air temperature, W.T = Water temperature, W.C = Water current, HMD = Hydro medium depth, Ta = Transparency, Tu = Turbidity, Co = Conductivity, TDS = Total dissolved solids, pH = Hydrogen ion concentration, D.O = Dissolved oxygen, F.CO_2 = Free carbon dioxide, NO_2 = Nitrates, PO_3 = Phosphates, Na = Sodium, K = Potassium

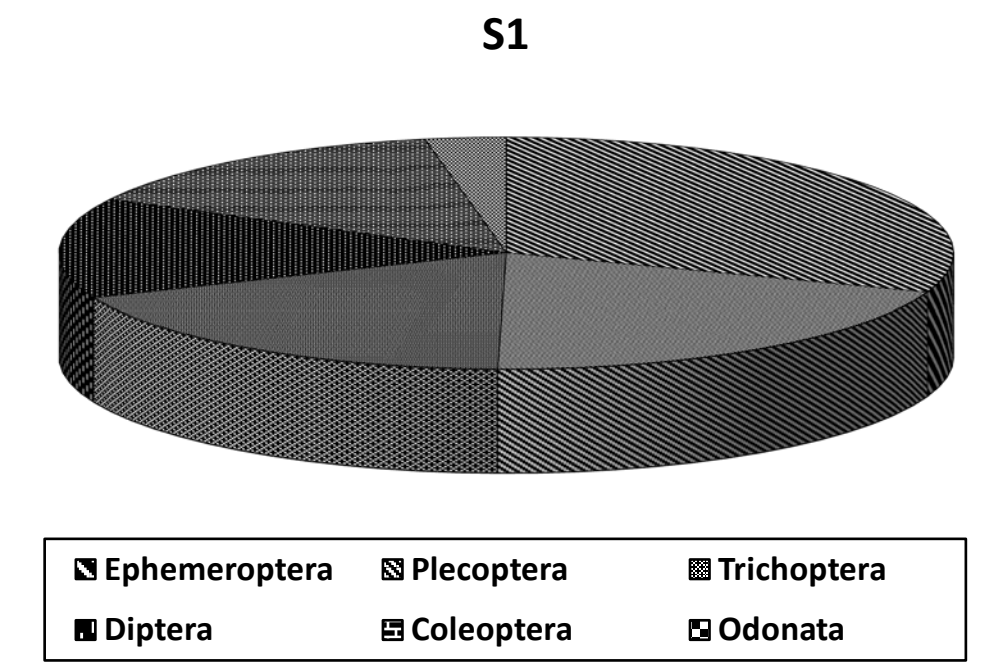

Figure 2

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Evaluation of Waterloss Impacts on Water Distribution and Accessibility in Akure, Nigeria

By Olotu Yahaya, Bada Olatunbosun, Ehibor O. G & Ososomi A.S
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Abstract- Safe drinking water is a necessity for life. Providing quality drinking water is a critical service that generates revenues for water utilities to sustain their operations. Population growth put an additional strain on the limited resources. The annual volume of water lost is an important indicator of water distribution efficiency, both in individual years, and as a trend over a period of years. Application of deterministic simulation model on public water supply variables reveals the volume of non-revenue water (NRW) and its cost effects have further created a complex system for the availability, distribution and affordability of the utility. Gradual annual increase in public water supply (AWS) from 9.0 $*10^6 m^3$ to 14.4* $10^6 m^3$ had negative effect on annual water accessed(AWA) with $R^2 = 0.096$; and highly significant with annual water loss (AWL) with $R^2 = 0.99$. This development indicates that water loss mainly through leakages and bursts is a function of public water supply. Hence, estimated volume and cost annual revenue water (NRW) in Akure is 6 million m^3 and 15.6 million USD respectively. Critical analysis shows that the lost annual revenue could be used to provide education and health services for a period of 6-month in the region.

Keywords: *water, NRW, simulation, distribution, resources, public, cost.*

GJSFR-H Classification : *FOR Code: 969999*

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I. Introduction

The accessibility and even distribution of potable water is a serious global issue. Safe drinking water is limited, the population growth, industrial and social advancement have further complicated the already scarce utility through overstressing the provision of potable water and infrastructural mechanisms for water distribution such as reticulation pipeline networking system, reservoir construction, fitting of flowmeter e.t.c. Ensuring safe, adequate and affordable water supply is becoming an ever more pressing issue for government, water professionals and researcher across the globe. More than 75% of the drinking water infrastructure in Edo North has been in service for decades without replacing with integrated and efficient system this leads to significant source of water loss through leaks, cracks, expiration and damage (Idogho et al., 2013).

Gathering, converting and distribution of safe drinking water is a serious challenge in Nigeria and some other developing nations, these constraints occurred as water loss due to leakages in conveyance pipeline, wastages, theft, improper billing and metering systems (May,1994). The annual volume of water lost is an important indicator of water distribution efficiency, both in individual years, and as a trend over a period of years. High and increasing water losses are an indicator of ineffective planning and construction, and of low operational maintenance activities (Lambert, 1999). Water loss from a utility's distribution system is a serious constrain which is always associated with loss of revenue and production efforts. Water losses in the distribution system require more water to be treated, which requires additional energy and chemical usage, resulting in wasted resources and total loss of revenues (Mckenzie, 2001). Determining how much water is being lost and where losses are occurring in a distribution system can be a difficult task. Without consistent and accurate measurement, water losses cannot be reliably and consistently managed (Benser and Camper, 2011). The confusion over inconsistent terms and calculations has led to the development of better tools and methods to track water losses from distribution systems. This scenario has an increasing effect on socio-economic development of entire region of Akure and its environs. Having considered the huge budgetary allocation for publication water supply and distribution, it is important to device technically-based approaches of reducing water loss through physical or real and apparent water losses and also improves water quality at the end-point or delivery stage. Water loss reduction (WLR) often represents an efficient alternative to exploiting new resources, which frequently involves cost-intensive measures, such as new dams, deep wells, seawater desalination or even transferring water from one river basin to another. Therefore, water loss reduction and pressure management contribute to sustainable and integrated water resources management (IWRM). However, this research study is focused on the estimation and analysis of the effects of water losses on public water supply and distribution (PWSD) in relation to social-economic development and integration in Akure, Nigeria.

II. Materials and Methods

a) Study Area

Akure is made up of 18 districts and located in the South-western Zone of Nigeria. Akure lies between

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longitudes 4"30" and 6" East of the Greenwich Meridian, 5" 45" and 8" 15" North of the Equator. This means that the city lies entirely in the tropics. It is bounded North by Ilara Mokin; in the East by Obanle; in the West by Ondo and Oda in the South. Population: 763,000 comprising Male (56%) and Female (46%). The map of the city is shown in Fig. 1.

(Source: Google, 2013)

Figure 1 : Map of Akure

b) Water loss modelling

Many drinking water utilities around the world do not give instantaneous respond to leaks problems until the situation becomes complicated. Leaks can effectively be corrected using sensitive optimization modelling approaches which involves monitoring of real-time leaks problem, computerization of adequate pressure system, provision for eddy losses to prevent pipe burst (Fanner,2009). However, soil conditions for example can have a great effect on the real losses as well as to the ability for them to be identified and located at the ground surface. Apparent and physical losses are computed as follows:

$$WL\epsilon = NRW\tau - KWS\beta \quad (1)$$

Where ***NWR*** is total Non- Revenue Water; ***WLp*** is real Water Loss; and ***WLϵ*** is apparent Water Loss (Idogho et al., 2013).

c) Unavoidable Real Losses (Url)

Output of various studies conducted shown that it is impossible to eliminate real losses from a water distribution system. Therefore Unavoidable Real Losses is therefore computed as follows:

$$URL = 18 \times Lm + Nc + 25 + L \times P \quad (2)$$

Where; Lm = main length inKm;
Nc = number of service connections;
Lp = total length in Km; and
P = average pumping pressure.

Leak volume is the function of time (t) and flowrate (R); this development is therefore evaluated as:

$$L = t(W + L + P) * R \quad (3)$$

The expression in equation (3) is modified to produce sensitive leak volume value as:

$$\boldsymbol{Lv = t\mu(W + L + P) * R} \quad (4)$$

Where;
Lv = Leak volume (m^3);
t = Time (sec);
μ = Flow constant (0.88);
W = Awareness;
L = Location; and
P = Repairs.

d) Water supply and demand formation

Water resources involve simulating systems made up of many component parts that are interrelated. The hydrological system is driven by stochastic variables (i.e., precipitation, evaporation, demand) and involves uncertain processes, parameters, and events. The challenge when evaluating water supply and resource systems is to find an approach that can incorporate all the knowledge available to planners and management into a quantitative framework that can be used to simulate and predict the outcome of alternative approaches and policies (Butler, 2009). While developing a system, the starting point can also be some specific consumption that does not necessarily include leakage. In that case the leakage percentage has to be added in the following way:

$$\text{Qph} = \frac{Qav.day}{f}\left(k1k2 + \frac{\text{l}}{100 - l}\right) \quad (4)$$

Factor, f, in the equation is a unit conversion factor while l represents the leakage percentage of the

total quantity supplied to the system; Qph is the quantity of water demand at the peak hour, while, *Qav. day* is the average quantity of water demanded daily. Therefore, annual average water supply is computed using the relationship on equation (5):

$$AWS = cPiAvNd \quad (5)$$

Where C = Coefficient of target population;
Pi = Total population;
Av = Average total water volume;
Nd = Number of water supplied days.

The volume of annual water supply that could finally be assessed by the targeted population is evaluated using the interconnectivity between annual water supply ***(AWS)*** and annual water loss ***(AWL)*** as elated in equation(6):

$$AWA = AWS - AWL \quad (6)$$

Where;
AWA = Annual water assed (m^3).

e) Water Cost Index Computation

It is very important and useful to calibrate the water supply-cost benefit ratio in order to monitor and improve on the service delivery of the utility (Idogho et al., 2013). The Rickards Real Cost Water Index serves as a benchmark for helping measure hundreds of critical projects on a like-for-like basis (Bond and Richard, 1997). Index values reflect estimated water production costs measured in US dollars per cubic meter for a variety of major global water infrastructure projects ranging from retail water utilities to wholesale water utilities. However, Water Cost index is calculated using Richard's relationship as follows:

$$\boldsymbol{WCI = \frac{Tp}{Td}} \quad (7)$$

Where;

Tp = Total cost of production is calculated as the sum of operating costs, capital costs, and identified subsidies;

Td =Total delivered freshwater volume (in m^3) is the amount the producer reports as delivered, and excludes water lost either due to system leakage, pilfering, or other forms of loss. This penalizes producers with a large fraction of production volume being lost due to system inefficiency;
WCI = Water Cost Index

f) Data analysis

Data on water loss variables were generated using a set of modelled relationships from the measured data. The generated outputs were subjected to statistical and dynamic simulation processes. Excel software and Sigma Plot were used for spread sheet calculations and graphical representations.

Plate 1 Leakage from the burst pipeline

III. Results and Discussion

a) Calibration of Water supply; loss and accessible variables

Many drinking water utilities around in Akure, Nigeria respond to leaks development only after receiving report of water erupting from a street or a complaint from a customer about a damp basement. Leakage control requires a proactive leakage management program that includes a means to identify hidden leaks, optimize repair functions, manage excessive water pressure levels, and upgrade piping infrastructure before its useful life ends. The result in Table. 1 shows the Public water supply system in Akure for a period of 10-year (2003-2012). The volume of annual water loss and accessed was simulated using the public water supply data obtained from the Ondo State Water Corporation. The result in Table 1 indicated

that there is an increase in volume of water supply from year 2003 down to 2012. The output of simulation iteration shown that the increase in annual water supply *(AWS)* had negative effect on annual volume of water accessible *(AWA)* with R^2 = 0.096; and strong agreement exist between annual water supply (AWA) and annual water loss with the R^2 = 0.999 as shown in Fig. 1 and 2 respectively. In 2007, equilibrium exists among the public water supply variables; with the annual water supply *(AWS)* of value *10.8 *10^{6}m^3*; annual water loss (AWL) is *5.4 *10^{6}m3 and* annual water accessed (AWA) is *5.4 *10^{6}m^3* respectively. The implication of this development is that half of annual water supply is lost to leaks.

Table 1 : Public Water Supply and Loss

N/S	Year	AWS (m^3*10^6)	AWL (m^3*10^6)	AWA (m^3*10^6)
1	2003	9.0	3.2	5.9
2	2004	9.6	3.8	5.8
3	2005	10.0	4.5	5.5
4	2006	10.3	4.8	5.5
5	2007	10.8	5.4	5.4
6	2008	11.0	5.7	5.3
7	2009	11.3	6.1	5,2
8	2010	11.8	6.7	5.1
9	2011	12.1	7.1	4.9
10	2012	14.4	8.6	5.8

Source : (OSWC, 2013; Simulation output)
Note: AWS = Annual water supply (m3): AWL = Annual water loss (m3)
AWA = Annual water accessible (m3)

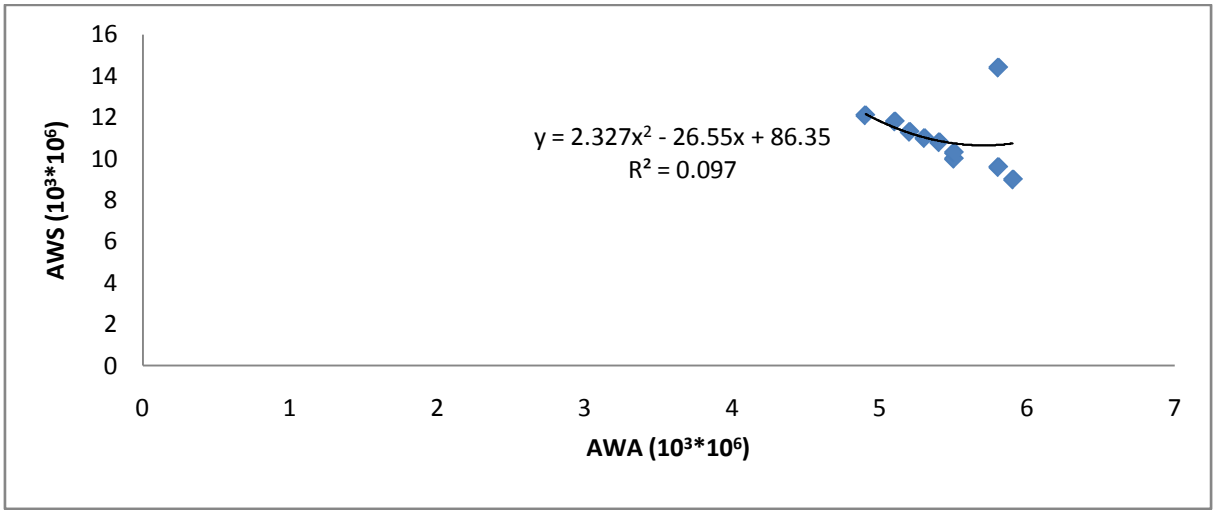

Figure 1 : Calibration of Public Water Supply-Accessibity

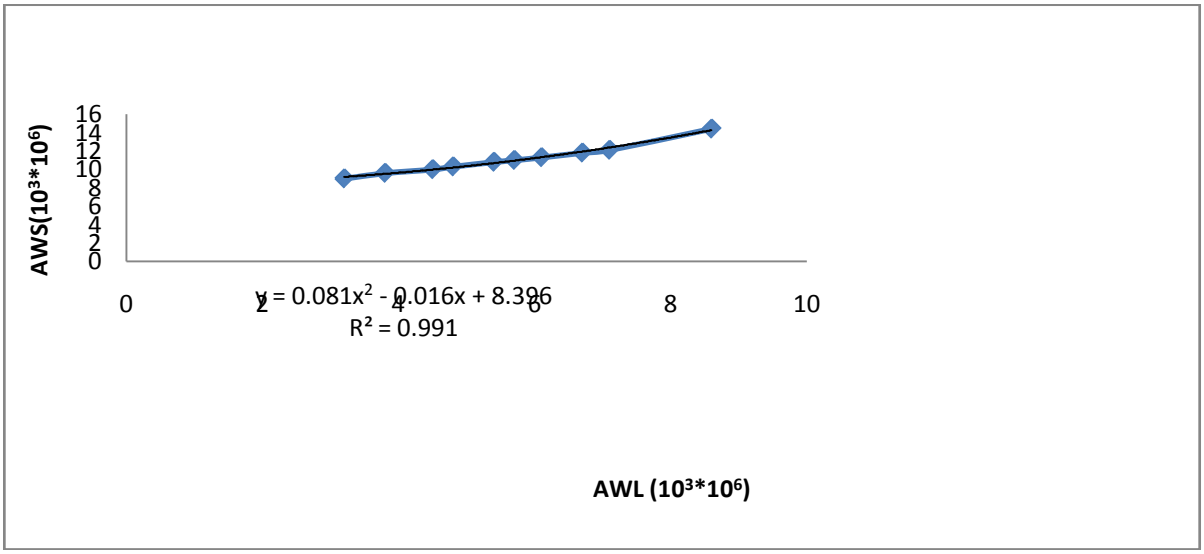

Figure 2 : Calibration of Public Water Supply and Loss

Most drinking water infrastructure in Akure, Nigeria has been in service for many years and this could be a significant source of water loss through leaks. The pipelines got weak and usually burst if there is any pressure variation. Since pipelines were not properly marked, a lot of them could also be destroyed during road and construction of other infrastructure amenities. This type of water loss is referred to as Real/Physical loss. In addition to leaks, water could be "lost" through unauthorized consumption (theft), administrative errors, data handling errors, and metering inaccuracies or failure; and this is referred to as Apparent loss. Based on the output of simulation RUNS, multiple model ling of optimized public water supply accessibility function was formulated as follows:

$$Y = \mu_0 + \alpha 1(AVjan.) + \alpha 2(AVfeb.) + \alpha 3(AVmar.) + \alpha 1(AVapril.)$$
$$+ \cdots \ldots \ldots \ldots . + \alpha 12(AVdec.) + \alpha 13(Ndjan.) + \alpha 14(Ndfeb.)$$
$$+ \cdots \ldots \ldots \alpha 24(Nddec) + \alpha 25(Pijan.) + \alpha 26(Pifeb.) + \cdots \alpha 36(Pidec.)$$
$$+ \alpha 37(C) + \alpha 37(LeakP) + \alpha 38\,(BurstP) + \alpha 39(PresureS)$$
$$+ \alpha 40(PipelineP).$$

Where;
Y = Public water supply accessibility;
Av = Average volume of water supply (m3);
N d = Number of days for water supply;
Leak P = Leakage from the pipe conveying water;
Burst P = Burst of pipeline;
PressureP = Pressure in the pipe;
C = Coefficient of the target population.

b) Water Cost Benefit Estimates

It is important to establish sound relationship on water production cost, cost of water loss or Non-Revenue Water in order to monitor the degree of utility distribution and its impact on the end-user for possible optimization for better service delivery. Evaluation of water production varies from geographical location to another; and also depends on the hydrological formation of the region. The results in Table. 2 show the cost of water production; water loss and billed water (i. e water that finally reached the consumers). The true cost of water production in individual geographic areas, which includes operating, capital, and "hidden economic" costs. Highest cost of annual water loss of 30.1 million USD was estimated in 2012 compared 4.8 million USD in 2003. However, there was a progressive increase in the investment of water production from 13.5 million USD in 2003 to 50.4 million USD in 2012. Strong relationship exist between cost of annual supply of water (CAWS) and cost of annual water loss (CAWL) with R2=0.931.

Table 2 : Water Production Cost and Loss Index

N/S	Year	CAWS (Million$)	C AWL (Million $)	CAWA (Million $)	WLI
1	2003	13.5	4.8	8.7	0.35
2	2004	19.2	7.8	11.4	0.40
3	2005	22.0	9.9	12.1	0.45
4	2006	24.7	10.8	13.9	0.43
5	2007	28.1	14.0	14.0	0.50
6	2008	30.8	16.0	14.8	0.51
7	2009	33.9	18.3	14.4	0.53
8	2010	37.8	21.4	16.4	0.56
9	2011	41.1	22.7	18.4	0.55
10	2012	50.4	30.1	19.9	0.59

Source : (OSWC, 2013; Simulation output)
Note: CAWS = Cost of annual water supply ($): CAWL = Cost of annual water loss ($): CAWA = Cost annual water accessible ($): WLI: Water loss index

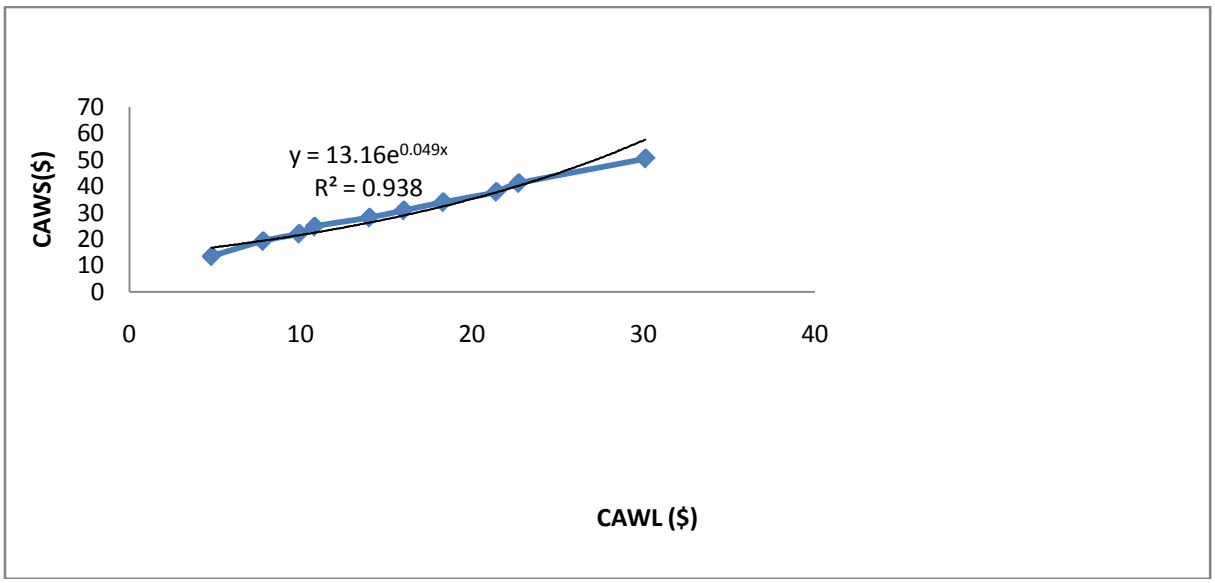

Figure 3 : Cost Benefit of Public Water Supply- Loss

Akure is estimated to have an annual Non-Revenue Water (NRW) (i.e mostly from real loss) volume of 6 million m3. This represents approximately 15.6 million USD in revenue that water utilities lose every year.

IV. Conclusion

Ensuring safe, sufficient and affordable water supply is becoming an ever more pressing issue for politicians and water professionals. This development has become a serious problem in most of the developing countries. Effective public water supply system is a productive function of many related variables such as non-revenue water (NRW). Annual water loss mainly through physical processes is estimated to revenue loss of 15.6 million USD. This value of fund could be applied for 30% budgetary allocation for Education and Agricultural section for the city. In addition, 60,623 people could be provided with potable water at the rate of 75 litres per person per day annually. Integrated water auditing model (IWAM) is a pivotal step in calibrating an effective water loss management program. Constructive application of the formulated model coupled with the introduction of automated metering device, burst and leak detector will produce a quantified understanding of the integrity of the distribution system and address sound plan to resolve water losses.

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Modelling Land use Patterns of Lahore (Pakistan) using Remote Sensing and GIS

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Abstract- In this research, an attempt was made to reveal the land use patterns of Lahore, the 2nd largest city of Pakistan, using remote sensing and GIS techniques. Results revealed that at present more than 1200 hectares of agricultural and forest land is acquired for urban uses every year. From 1972 to 2009, the urban area of Lahore expanded 68 percent while a loss of 32500 hectares in agricultural land is recorded. Around 5000 hectares of forest land had vanished from the landscape of the city. More than 200 rural localities have been merged into the city since 1972. Around 100 new housing schemes are approved to accommodate the ever increasing population at the expense of loss in agricultural land. Most of the expansion took place in south and southwest direction along major roads and highways.

Keywords: *land use, remote sensing, GIS, lahore.*

GJSFR-H Classification : *FOR Code: 050299*

Strictly as per the compliance and regulations of :

Modelling Land use Patterns of Lahore (Pakistan) using Remote Sensing and GIS

Omar Riaz [α], Abdul Ghaffar [σ] & Ibtisam Butt [ρ]

Abstract- In this research, an attempt was made to reveal the land use patterns of Lahore, the 2nd largest city of Pakistan, using remote sensing and GIS techniques. Results revealed that at present more than 1200 hectares of agricultural and forest land is acquired for urban uses every year. From 1972 to 2009, the urban area of Lahore expanded 68 percent while a loss of 32500 hectares in agricultural land is recorded. Around 5000 hectares of forest land had vanished from the landscape of the city. More than 200 rural localities have been merged into the city since 1972. Around 100 new housing schemes are approved to accommodate the ever increasing population at the expense of loss in agricultural land. Most of the expansion took place in south and southwest direction along major roads and highways.

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I. Introduction

The present research is focused on the land use patterns of Lahore, the 2nd largest city of Pakistan. The term land use is often applied to the urban centers where cities are expanding at the expense of loss in agricultural or forest land. In the realm of urban studies, urban sprawl is a matter of great interest and is seen as having harmful effects on people as a whole. The uncontrolled and haphazard urban sprawl over rural landscape is a matter of great concern; these urban expansions are swallowing rural land and green fields at a rate twice than the actual growth of population (Sultana and Weber, 2007). Urban expansion can lead to problems, such as transportation, ecological imbalance, income and ethnic segregation of neighborhoods, the differences among jobs and shelter, local economic disparities, alteration of agricultural land to urban uses, and civic isolation, among other maladies (Galster et al., 2001).

Sullivan (2007) states that land is a common good, meaning that an increase in the amount of wealth of a person, leads to a desire to obtain more land. In addition, he further states that the low cost travelling allows people of fair income to purchase larger housing units of comparatively less expensive land surrounding the city and commute daily to work and social functions, creating an urban land use of low-density. One method used to analyze the spatial aspects of the expansion of urban development is remote sensing. Since the launch of Landsat 1, the first "land sensing satellite," in the summer of 1972 the Landsat Program has archived imagery nearly twice per month for public use at a moderate spatial resolution. The USGS (United States Geological Survey) currently maintains and collects data from Landsat 5 and Landsat 7. These data are collected frequently and are cost-effective (Ryznar and Wagner, 2001). However, one disadvantage of these images is cloud cover. This cover can limit the number of useful scenes required for analyses in any given year, especially in the tropical, humid and sub humid climates. Remotely sensed data incorporated with a geographic information system (GIS) has made it easy to monitor urban growth patterns in different ways and manners that was not possible by using conventional methods of using census data (Sultana and Marzen, 2004).

II. Study Area

Lahore District lies on the left bank of river Ravi. It lies between 74˚1′1″E to 74˚38′10″E longitude and from 31˚15′ to 31˚44′2″ N latitude. It is the 2nd largest city of Pakistan after Karachi both in terms of population and urban hierarchy. The total area of Lahore is 1772 square km (177200 hectares). Total population of Lahore was 6.319 million in 1998 with a population density of 3,566 persons per square kilometer (GOP, 2000). The latest studies argue that the population of Lahore has increased to 9 million inhabitants (Riaz, 2011). The urban population of Lahore increased steadily since independence in 1947. Physiographically, the land of Lahore is made of alluvial soil deposited by Ravi through ages. Lahore is plain alluvial land with a gentle slope towards south east. Its height above sea level ranges from 700 feet in north east to 680 feet in south west with a slope gradient of 1 feet per 5-10 kilometers. The first underground water table is found at depth of 35 to 40 meters. But this water is not drinkable. Drinkable water is available at a depth of 125 to 150 meters. Lahore district is a part of Indo-Gangetic plain formed in front of the Himalayas (Bender & Raza, 1995). Lahore has fertile soil suitable for vegetation and plantation. Its soil and climatic conditions support all types of crops. Major crops of Lahore are wheat, rice, sugarcane, cotton, and vegetables. The cropping pattern of Lahore also shifted from cash crops to food grain crops and vegetables to fulfill the needs of the city. Now the major cash crops like cotton and sugarcane

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are not seen on the city profile. In 1998, the land area under wheat was 50,000 hectares; rice, 32,000 hectares; and vegetable, 6,317 hectares. The major vegetable was potatoes, which accounted for 70% of the area under vegetables (GOP, 2000).

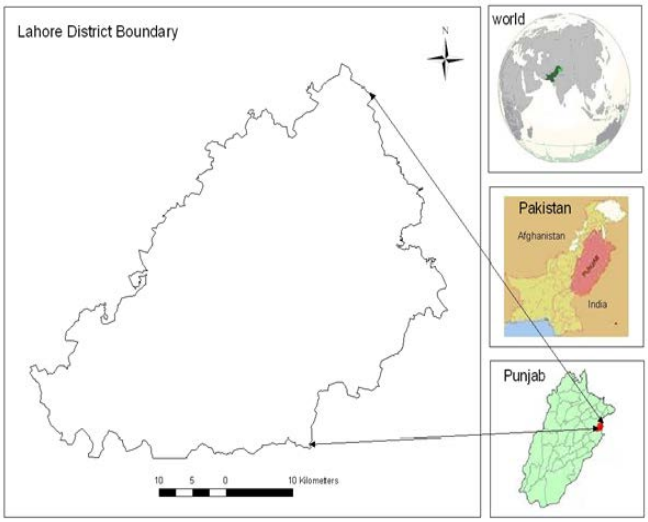

Figure 1 : Locational Map of the Study Area

III. Methodology

Research methodology is a critical part of any type of research. This is a systematic and scientific method to achieve goals. A number of steps involved to accomplish the present research. Figure 2 presents the whole picture of the presents study.

a) Image Processing

Satellite images for this research were acquired from the United States Geological Survey (USGS) website. Five satellite images were acquired for the years 1972, 1981, 1992, 2000, and 2009. This site provides images in different layers. Each layer represents a band. Every image has commonly seven layers except 1972 and 1981 images which have four layers.

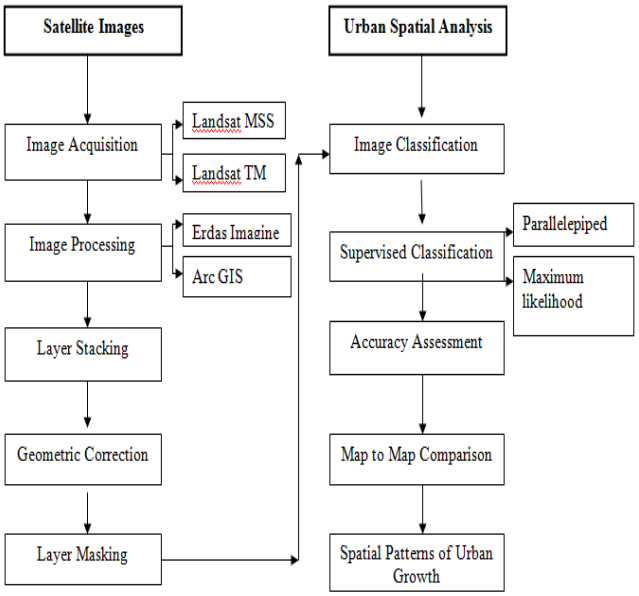

Figure 2 : A Flow diagram of the research methodology

These layers were than merged with each other through layer stacking process in Erdas Imagine software. The end product is an image file that is ready to be used. The images acquired from USGS have fair resolution. The scene size in these images was approximately 185 by 185 km. These images were rectified and georeferenced to a Universal Transverse Mercator Projection with WGS 84 datum and zone 43. Zone 43 is best suitable for the locations lie between 72˚E to 78˚E latitudes. Lahore lies at about 74˚E, so zone 43 was the best choice. Lahore district boundary was extracted from these images through masking of the image for analysis.

b) Image Classification

After the extraction of Lahore district boundary image, the next step was to classify the image according to its land use. But, before classifying an image, it is necessary to define a classification scheme (Yang, 2002). Keeping in view the scope of the present research and the resolution of images, following scheme was developed:

- *Urban Land use Area:* this land use area consists of 80 to 90 percent construction material including commercial and industrial.
- *Agricultural/cultivated land area:* this area includes land under different crops.
- *Forest land area:* consists of mixed forest with a concentration of 80 to 100 percent.
- *Water Bodies:* comprising of open water like river, lakes, and canals.
- *Others:* includes open spaces and undeveloped land.

After establishing the classification scheme, the land use data from different images was reclassified from more than fifteen classes into five classes (table 1). These five Landsat images were classified through parallelepiped algorithm with maximum likelihood classification method. The parallelepiped classification algorithm is widely used digital image classification decision. This algorithm is computationally efficient method for classification that involves spectral bands to perform classification (Gibson and Power, 2000). The maximum likelihood algorithm is based on probability. It calculates the predefined set of classes and then the pixel is assigned to the class for which the probability is highest (Jensen, 2005). Yet, it is one of the most commonly used algorithms for supervised classification (Wu and Shao, 2002; Mclever and Friedl, 2002). With the help of Signature Editor Toolbar in Erdas Imagine, different signatures were allocated to the different land uses according to the already established classification scheme.

c) Accuracy assessment

Accuracy assessment is difficult rather important procedure for remote sensing analysis. Random sample strategy was adapted for unbiased assessment (Jensen, 2005). More than 50 ground control points (GCPs) for each class are used. A fieldwork was conducted and GPS is used to collect and compare the sampled pixels and their corresponding land cover on the ground. These results are accurate and efficient for the Landsat image of 2009 because the fieldwork was done in early half of 2010. To assess the accuracy of historical images of 1972, 1981, 1990, and 2000, following technique was adopted. Firstly, the randomly collected GCPs were verified through field observations for the areas that had almost no change over the period of study, such as water bodies, forests, and historical buildings. Secondly, additional verifications of these localities were employed through already published census reports of population and agriculture.

Table 1 : Classification Scheme of Land Use

Sr No	Reclassification patch type	Actual land use type (Satellite images)
1	Urban Land Use	All built up areas (Residential, commercial, industrial, and educational) and new housing schemes
2	Agricultural Land	Cultivated and non cultivated farm land
3	Forest Land	Mixed forest
4	Water Bodies	Water
5	Others	Sand, barren land, recreational parks etc.

The accuracy results are shown in table 2, indicating the producer accuracy, user accuracy, overall image accuracy and Kappa statistics of agreement for all five images. The producer accuracy and user accuracy for each is calculated separately for all images. To assess the accuracy of all five images, error matrix was drawn. The landsat thematic images of 1990, 2000, and 2009 show the overall accuracy of 90.64%, 86.7%, and 88.7% respectively. The landsat MSS images of 1972 and 1981 have an accuracy of 83.2% and 83.9% respectively. The three thematic images of 1990, 2000, and 2009 show slightly higher accuracy than the MSS images of 1973 and 1981. This might be the result of comparatively higher spatial, spectral and radiometric resolution. However, all the images show acceptable overall accuracy. The Kappa index of agreement for each image is displayed in table 2. The images of 1973, 1981, 1990, 2000, and 2009 displayed the kappa index of agreement of 0.791, 0.80, 0.882, 0.883, and 0.859 respectively. The error matrix for the image of 1972 is shown in the table 3. The procedure adopted for the calculation of accuracy and kappa index for 1972 is displayed on the next page. The error matrix for other four images to assess accuracy is also drawn and only the results are shown here in table 2.

Table 2 : Accuracy Assessment of the Classified Images

	Urban		Agriculture		Forest		Water		Others		Overall Accuracy	Kappa indexes
	P(%)	U(%)	P(%)	U(%)	P(%)	U(%)	P(%)	U(%)	P(%)	U(%)		
1972	81.36	84.2	81.8	83.3	88.0	84.6	83.3	94.0	81.8	72.5	83.2%	0.791
1981	84.85	78.8	82.6	83.8	84.7	93.8	82.8	88.3	84.8	76.7	83.9%	0.80
1990	95.95	92.2	92.3	91.1	88.4	95.8	88.4	90.2	86.6	82.5	90.64%	0.882
2000	87.76	93.4	88.4	77.9	85.7	91.3	83.3	89.7	87.5	84.4	86.7%	0.833
2009	88.06	93.6	86.9	90.9	91.2	88.1	91.6	91.6	86.6	81.2	88.7%	0.859
P stands for producer's accuracy and U stands for user's accuracy.												

Table 3 : Error matrix of the Classification Map Derived from the 1972 Image of Lahore.

	Urban	Agriculture	Forest	Water	Others	Row total
Urban	**48**	3	0	3	3	57
Agriculture	2	**45**	4	0	3	54
Forest	2	2	**44**	0	4	52
Water	3	0	0	**47**	0	50
Others	4	5	2	6	**45**	62
Column Total	59	55	50	56	55	**275**

Overall accuracy = 229/275=83.2%

Table 4 : Producer and User Accuracy of the Image 1972

Producer's Accuracy		User's Accuracy	
Urban	48/59=81.36%	Urban	48/57=84.21%
Agriculture	45/55=81.82%	Agriculture	45/54=83.33%
Forest	44/50=88%	Forest	44/52=84.62%
Water	47/56=88.93%	Water	47/50=94%
Others	45/55=81.82%	Others	45/62=72.58%

Kappa Index of Agreement Calculation

$$K = \frac{N\sum_{i=1}^{k} x_{ii} - \sum_{i=1}^{k}(x_{i+} \times x_{+i})}{N^2 - \sum_{i=1}^{k}(x_{i+} \times x_{+i})}$$

(Jensen, 2005).

Where N = 275

$$\sum_{i=1}^{k} x_{ii} = 48 + 45 + 44 + 47 + 45 = 229$$

$$\sum_{i=1}^{k}(x_{i+} \times x_{+i}) = 57 \times 59 + 54 \times 55 + 52 \times 50 + 50 \times 56 + 62 \times 55 = 15143$$

Therefore

$$K = \frac{275(229) - 15143}{275^2 - 15143} = \frac{62975 - 15143}{75620 - 15143} = \frac{47832}{60482} = 0.791$$

IV. Results and Discussion

Figure 3 displays the total land use change occurred during 1972 to 2009 for different time periods. The urban land use has increased from 58,977 hectares in 1972 to 99,173 hectares in 2009 (table 5). The share of urban land was 33.28% in 1972 which increased to 55.97% in 2009. It added 40,196 hectares in urban land use giving an addition of 68.16% in total urban area (table 6). While there is a loss of 32,500 hectares in agricultural land during this period. The percentage share of agricultural land decreased from 54.08% in 1972 to 35.74% in 2009. Area under forest cover decreased from 5,706 hectares in 1972 to 856 hectares in 2009. This means 85% land under forest vanished from the study area. It is necessary to reveal the fact that the total loss of agricultural and forest land was acquired by urban land use. The population of Lahore increased from 2.6 million in 1972 to 9.3 million in 2009. The population increased three times during this period. This speedy population growth is the chief factor of rapid urban expansion in Lahore. It is also found that no major change occurred in the area consisted of water bodies during this period. The water bodies lost only 457 hectares of area. It is also evident that the area under other land uses like bare soil, barren land etc also recorded little change. From the table 6 and figure 3 is noted that the major and dramatic change in urban land use occurred during the period 1990-2000.

Table 5 : Land Use Statistics of Lahore: 1972-2009

Sr. No	Land Use	1972 Area (hectares)	1981 Area (hectares)	1990 Area (hectares)	2000 Area (hectares)	2009 Area (hectares)
1	Urban	58977	71361	76406	96697	99173
2	Agriculture	95838	85627	82720	65324	63338
3	Forest land	5706	4298	2637	1056	856
4	Water	8129	7724	7685	7646	7672
5	Others	8550	8190	7752	6477	6161
6	Total	177200	177200	177200	177200	177200

Table 6 : Land Use Change During Different Time Periods 1972-2009.

Periods		Urban	Agriculture	Forest	Water	Others
1972-1981	Hectares	12384	-10211	-1408	-405	-360
	%	21	-10.65	-24.68	-4.98	-4.21
1981-1990	Hectares	5044	-2907	-1661	-39	-438
	%	7.07	-3.39	-38.65	-0.50	-5.35
1990-2000	Hectares	20291	-17396	-1581	-39	-1275
	%	26.56	-21.03	-59.95	-0.51	-16.45
2000-2009	Hectares	2476	-1986	-200	26	-316
	%	2.56	-3.04	-18.94	0.34	-4.88
1972-2009	Hectares	40196	-32500	-4850	-457	-2389
	%	68.16	-33.91	-85	-5.62	-27.94

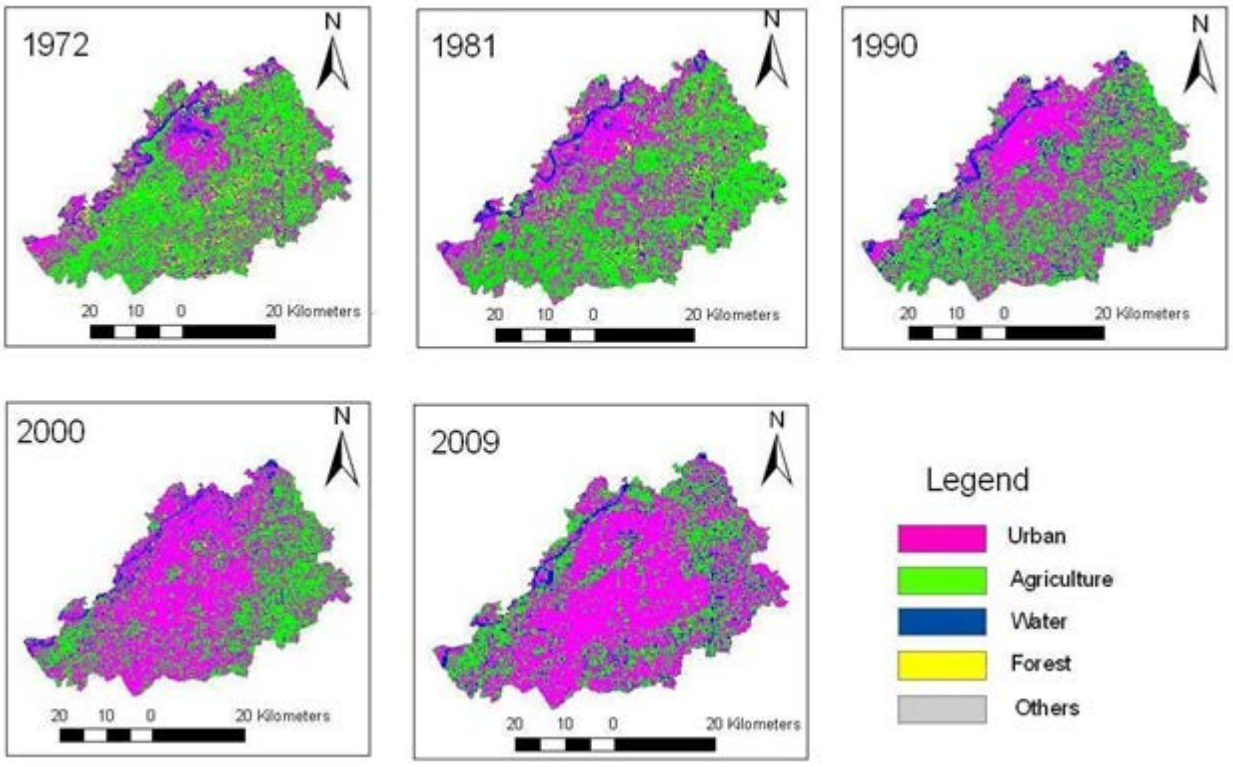

Figure 3 : Land Use Change maps of Lahore from 1972 to 2009

V. Conclusion

The results revealed that the urban area of Lahore recorded 68% increase since 1972. In 1972 the share of urban land was just 33.2% of the total land area which increased to 55.97% in 2009. The total built up area of Lahore was 58,977 hectares in 1972 that has increased to 99,173 hectares in 2009. In order to cater for the demand of the land more than half of the agricultural land of the study area was acquired for urban land use. The area under agriculture has decreased from 95,838 hectares in 1972 to 63,338 hectares in 2009. The share of agricultural land decreased from 54% in 1972 to 35.7% in 2009. The expanding urban housing replaced the natural vegetation cover with the urban infrastructure .The same time duration recorded a loss of 85% forest land in the study area. Lahore is bounded by river Ravi in North and India in the east. The river channel and territorial demarcation of India have been hindering the urban expansion towards the areas. Resultantly the major urban expansion took place in the south and south western part of the district. It is also observed that most of the urban expansion took place along the highways and major roads. The urban expansion history reveals that more than 200 housing schemes were approved to accommodate the residential demands of increasing population in the city. This expansion reached the boundaries of villages and it is estimated that this urban population specter has swallowed around 250 villages since 1972 to onwards. This rapid urban expansion has changed the land use profile of the district from agriculture to urban. Over the past few decades, urban expansion of Lahore has significantly modified the land use patterns of the area. The built up area has increased remarkably at the expanse of agricultural as well as forest land. This rapid expansion has resulted as haphazard growth, high density population, air, water and noise pollution and unplanned expansion along canal road, Ferozpur road and Raiwind road. This situation has been further aggravated by the lack of an integrated urban development approach and absence of proper integrated urban planning and zoning. It is, therefore, strongly recommended that further research must be carried on the aspects such as disorganized development, traffic congestion, loss of agricultural land and other environmental issues.

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Integrated Geophysical Methods for Post Construction Studies: Case Study of Omuo Comprehensive High School, Omuo Ekiti, Southwestern, Nigeria

By A. O. Adelusi, A. A. Akinlalu & B. W. Daramola
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Abstract- An integrated geophysical survey was carried out within the Precambrian Basement Complex of Omuo Comprehensive High School and its environ in Omuo-Ekiti, Ekiti State, South-west Nigeria to assess buildings in the area that are intensively affected by cracks resulting in structural instability. The geophysical methods adopted for the investigation are the Very Low Frequency Electromagnetic (VLF-EM), Magnetic, 2-D electrical resistivity profiling using the dipole-dipole array and Vertical Electrical Soundings (VES) using the Schlumberger array. The traverses were established E – W direction cutting across geologic strike. A total of five traverses were established with length ranging from 130 – 200m and of varying inter-traverse spacing. The station interval is 10m. Also, a total of thirty-five (35) VES stations were occupied covering the entire study area. The acquired data were processed and interpreted integrally to elucidate the shallow subsurface geology of the study area. The results were qualitatively and quantitatively interpreted and are presented as sounding curves and geo-electric sections. The magnetic interpretation shows relatively uneven bedrock topography with variable overburden thicknesses of between 5m – 15m. However, the VLF-EM results reveal ten (10) conductive zones which manifest as low resistivity zones in the generated geo-electric sections. The characteristic sounding curves obtained from the study area are H, HA, KH, HK, KHK, HAK and QH.

Keywords: *structural instability, lateral inhomogeneity. incompetent materials.*

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Keywords: structural instability, lateral inhomogeneity, incompetent materials.

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I. Introduction

Incessant failure of buildings has often dominated headlines in Nigeria in recent times and this has generated concerns prompting the entire citizenry to continue to ponder on the causes of the failures of buildings in most part of the country. Previous works over the years in geosciences have attributed these failures to lateral inhomogeneity of the subsurface, differential settlement and failure due to the presence of geologic structures such as faults, joints, cavities e.t.c beneath the buildings (Adelusi et.al. 2013, Akintorinwa et.al. 2009, Ako and Olorunfemi, 1989). Geophysical methods such as the Electrical Resistivity (ER), Seismic Refraction, Electromagnetic (EM), Magnetic and Ground Penetrating Radar (GPR) have been found useful in engineering site investigation (Akintorinwa and Adeusi, 2009). The research examines the use of geophysical methods for post construction studies in and around Omuo Comprehensive High School, Omuo Ekiti, Southwest, Nigeria. This becomes imperative due to the (failure) of buildings in the school and its environs.

II. Description of the Study Area

The study area is Omuo Comprehensive High School, Omuo Ekiti. The site occupies an area of about 204,375m^2. It lies between latitudes 07^0 44'.787"N and 07^o 44'.919N", and longitudes 005^{0}42".934'E and 005^{0}43'.042E" (Fig. 1). The relief of the area is a low-lying type with a relatively undulating topography.

a) Geophysical Investigation

The geophysical investigation involved the Magnetic method, very low frequency electromagnetic method and electrical resistivity methods. The electrical resistivity method adopts both the vertical electrical sounding and dipole-dipole techniques for the purpose of this study. Magnetic and VLF-EM measurements were made at 10m interval along five (5) traverses established perpendicular to the geologic strike in the E-W direction with traverse length ranging from 130-200m.

The electrical resistivity method adopts two configurations for this study. 2-D profiling using the

dipole-dipole array, and vertical electrical soundings using the Schlumberger array. A total of thirty five (35) stations were occupied (Fig. 3.). The ohmega resistivity meter was used in data collection.

b) Data Processing and Interpretation

Magnetic method involves the plotting the relative magnetic intensity against station positions after drift has been corrected for. Automated Euler 1.0 software (Durrheim and Cooper, 1998) was used to estimate the depth to probable fracture zones in the study locations. The corresponding geomagnetic sections were generated using the Surfer 10 software.

EM data can be interpreted via qualitative and quantitative means. The acquired data was downloaded from the VLF-EM equipment (ABEM WADI). The data processing involves the plotting of the percentage ratio of the vertical component and the horizontal component of the field (raw) real and Q-factor.

$$\text{Q-factor; } Q = (Q_4 + Q_3) - (Q_2 + Q_1) \quad (1)$$

(Where Q is EM data and the subscript are station positions) was performed on the raw real data which is then plotted against distance. The peak positive Q-factor are identified as probable fracture zones on the profiles. Qualitatively, 2-D models of the VLF-EM data were obtained by using the Karous-Hjelt (KH) filter (Karous and Hjelt, 1983).

Vertical Electrical Sounding (VES) data interpretation is completely quantitative via partial curve matching technique (Keller and Frischknecht, 1966), which involves segment by segment interpretation of field curves starting from small electrode spacing and progress gradually to large electrode spacing. The partial curve matching can be regarded as preliminary interpretation of the field curves, which produces the geo-electric parameters needed for forward modelling. WinRESIST version 1.0 (Vander Velpen, 1988) was used to perform the computer iteration(s). The resultant geo-electric parameters obtained from the iteration were used to establish the geo-electric sections.

The dipole-dipole data is interpreted via inverse modelling (automatic interpretation) using Dippro™ SOFTWARE which is followed by qualitative interpretation of the generated pseudo-sections.

III. Results and Discussion

Integrated geophysical approach using magnetic, VLF-EM and Electrical Resistivity Methods involving vertical electrical Sounding (VES) and 2-D dipole-dipole techniques allows the delineation of structures and or materials responsible for the cracks observed on block 1 and block 3 in the study area. The Magnetic profile along traverse three (3) shows variable anomaly signatures at 20 – 35m, 60 – 70m, 110m – 125m. The corresponding geomagnetic sections reveals a relatively thick overburden of about 12m which thinned out at distance of 60 – 80m;. (Figure 4a). The 1-D Euler deconvolution software estimates depth to probable fracture zones of 12m and 10.5m at distance 22m and 70m respectively (Table 1).

The VLF –EM profile along this traverse shows peak positive amplitude of the Q-factor indicative of conductive zones designated as CZ_5 and CZ_6 occurred at distances of approximately 36m and 104m across the traverse. The 2-D model of the VLF-EM along the traverse 3 identifies zones conductive features between 10 – 65m and 100 – 130m along the traverse. These zones agree with the delineated conductive zones on the VLF-EM profile (figure 4b).

The geo-electric section along traverse three (Figure 4c.) has four VES stations, which include stations 1, 2, 3 and 4 moving from west to east. Three prominent geologic layers were delineated. The layers include topsoil layer, the weathered layer and the fresh basement. The resistivity values of the topsoil range from 112 – 1673 ohm-m, with thickness varying from 0.5 – 1.0m and is also presumed to be lateritic, clay, sandy clay and clayey sand. The second layer which is the weathered layer has resistivity ranging from 81 – 163 ohm-m with thickness variation of 1.6 – 9.1m; it is however presumed to be clay/lateritic materials. The resistivity range of the fresh basement is between 2488 - ∞ ohm-m, with a depth to bedrock range of 3.1 – 12.1m. There exists thick overburden in the western flank of the section between VES stations 1 – 2 of the traverse. However, the failed segment of block 1 as shown on the data acquisition map is situated between VES 2 and VES 3.

The 2-D resistivity structure along traverse 3 is as shown in figure 4d. The model shows thick conductive overburden (>10m) towards the western flank of the traverse with resistivity ranging from 45-219 ohm-m. The very conductive overburden at the western flank is presumed to be clay/lateritic clayey while the eastern flank shows that competent bedrock is closer to the surface. However, the resistivity structure shows uneven bedrock.

Correlating the geophysical methods employed along this traverse especially the 2-D models generated from the VLF-EM and dipole-dipole techniques, traverse three is a highly fractured zone with portion of classroom designated as block 1 constructed on this fracture. These structures contribute a great deal to the cracks observed on the classroom block (figure 5). The presence of clay materials beneath VES 2 could also be a contributor to the cracks observed on block 1.

Along traverse four, the magnetic profile delineates probable fracture zones that could be inimical to engineering works between distance 15m – 20m, 50m-70m, 90m-110m, and 130-180m. The geomagnetic section in traverse 4 distinctly shows a relatively thin overburden at the western part between 0-100m and thickens eastward confirming the fracture

zones that are more deeply seated at distances 160m and 180m respectively (figure 6a). The 1-D Euler deconvolution software delineates five probable fracture zones of depths of about 6m, 8m,10m, 15m and 15m at distances 18m,60m,80m, 160m and 180m respectively.

The VLF-EM profile and its corresponding 2-D model along Traverse 4 (Figure 6b) reveals two positive peak anomalies on the Q-factor which manifest as CZ_7 and CZ_8 at the approximate distance of 75m and 130m respectively along the traverse in the study area. The model shows zones of conductive features between 70 – 90m and 110 – 150m along the traverse. Also, zones of linear resistive features distinctly manifest between 70 – 120m and 150 – 180m along the same traverse.

The geo-electric section along traverse four, with eight VES stations include stations 1, 2, 3, 4, 5, 6, 7 and 8. Three distinct geologic layers were delineated which include: the topsoil, the weathered layer and the fresh basement. The topsoil has resistivity values in the range of 15 – 1100 ohm-m and the thickness varies from 0.5 – 2.4m. The weathered layer has resistivity values which range from 57 – 244 ohm-m, with thickness of between 3.1 – 6.6m. The fresh basement has resistivity values varying from 1243 - ∞ ohm-m (figure 6c). The depth to bedrock varies from 4.0 – 12.0m. The section generally has thin overburden but valley-like depression exist around VES 5 of the traverse. Also, the failed segment of block 3 is located along traverse 4; between VES 2 – VES 4.

2-D resistivity structure along traverse 4 (Figure 6d) shows thick conductive overburden within a hollow-like (basement depression) structure that has a span of between 60 – 148m within the station range of 6 - 15; which is an evidence of faults, fractured zones or buried channels. Along this traverse, the basement is close to the surface at both ends of the traverse (i.e. at the western and the eastern flanks).

Integrated geophysical method employed for this work clearly showed that they complement each other along this traverse as revealed by the resistive zone delineated at the eastern segment which is distinct on the 2-D model of the VLF-EM method at distance 150-180m. This portion coincides with the highly resistive zone delineated on the 2-D resistivity pseudo section with resistivity of about 1822 ohm-m. These zones are also found to be outside the depression that is obvious on the geo-electric section. However, distances 150-180m are delineated to be probable fracture zones on the geomagnetic sections but the deep seated nature of the fracture zones could be responsible for the high resistivity observed on the VLF and 2D- resistivity pseudo sections. The conductive zones observed on the 2-D models of the VLF corresponds to the fracture zones delineated on the geomagnetic sections, depression on the geo-electric section and fracture zones which corresponds to low resistivity delineated on the 2-D pseudosection. A portion of block 3 between VES 2 and VES 4 falls on the fracture zones towards the east with a little portion erected on a competent bed rock. This explains why a portion of the building is stable and the part on the fracture and depressed zone giving way (figure 7).

IV. Conclusions

An integrated geophysical survey was carried out around Omuo Comprehensive High School, Omuo Ekiti, Ekiti State; where buildings in the study area were severely damaged by a series of cracks as pronounced on the walls of the buildings which affect their stability. The objective is to investigate the cause(s) of building failures in the area whether it is precipitated by geological factors or otherwise. In doing this, three surface geophysical methods were used in this study: 2 – D resistivity profiling using dipole – dipole and Schlumberger arrays, magnetic and very low frequency electromagnetic (VLF-EM). The geophysical data collected using these methods were processed and interpreted to image the subsurface structures of the investigated area. However, various anomalous zones were delineated by the three geophysical methods and from the comprehensive interpretation it is deduced that: the failures of the buildings arise from three factors which are incompetent clay materials, near surface structures such as fractures/faults and lateral in-homogeneity.

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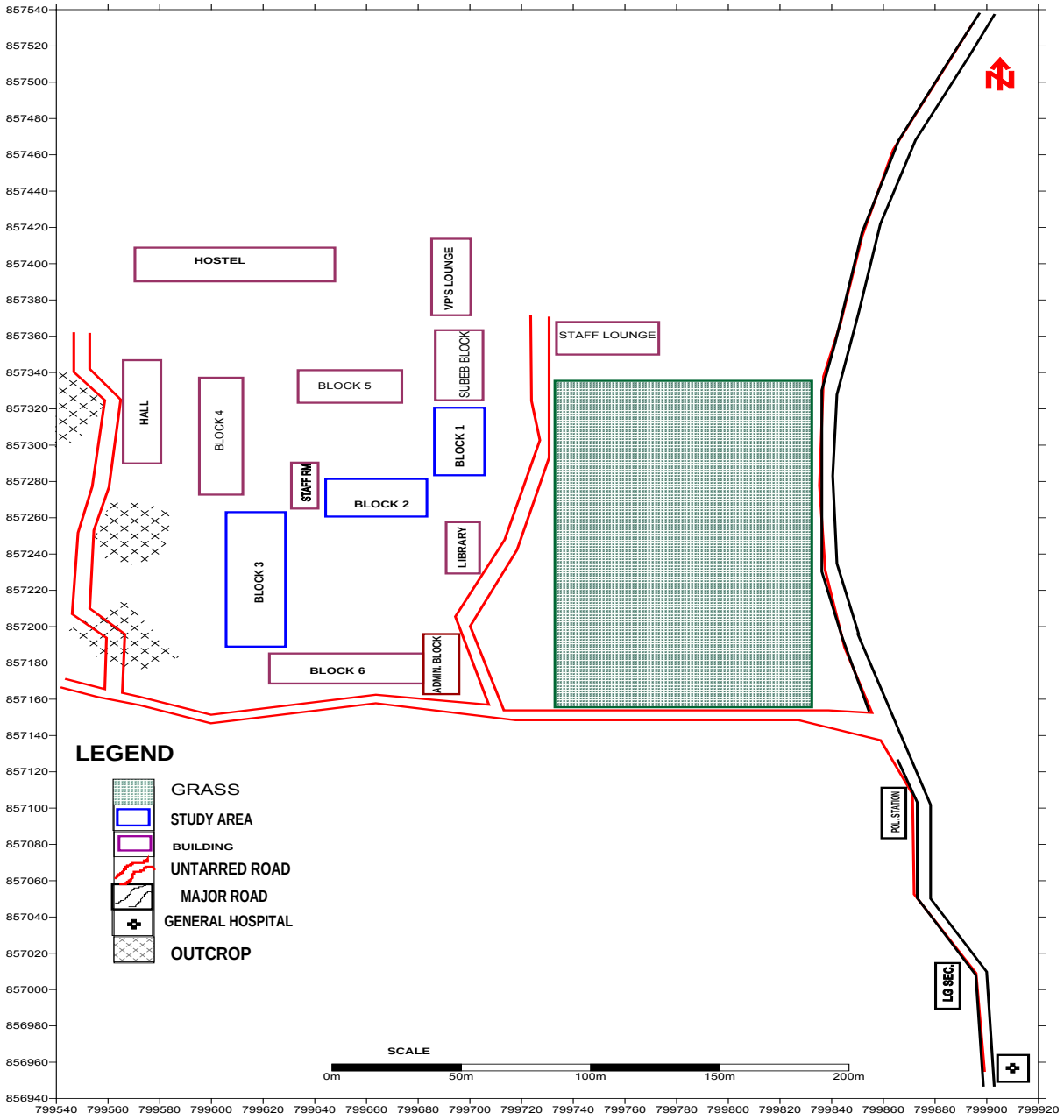

Figure 1 : Base Map of the Study Location

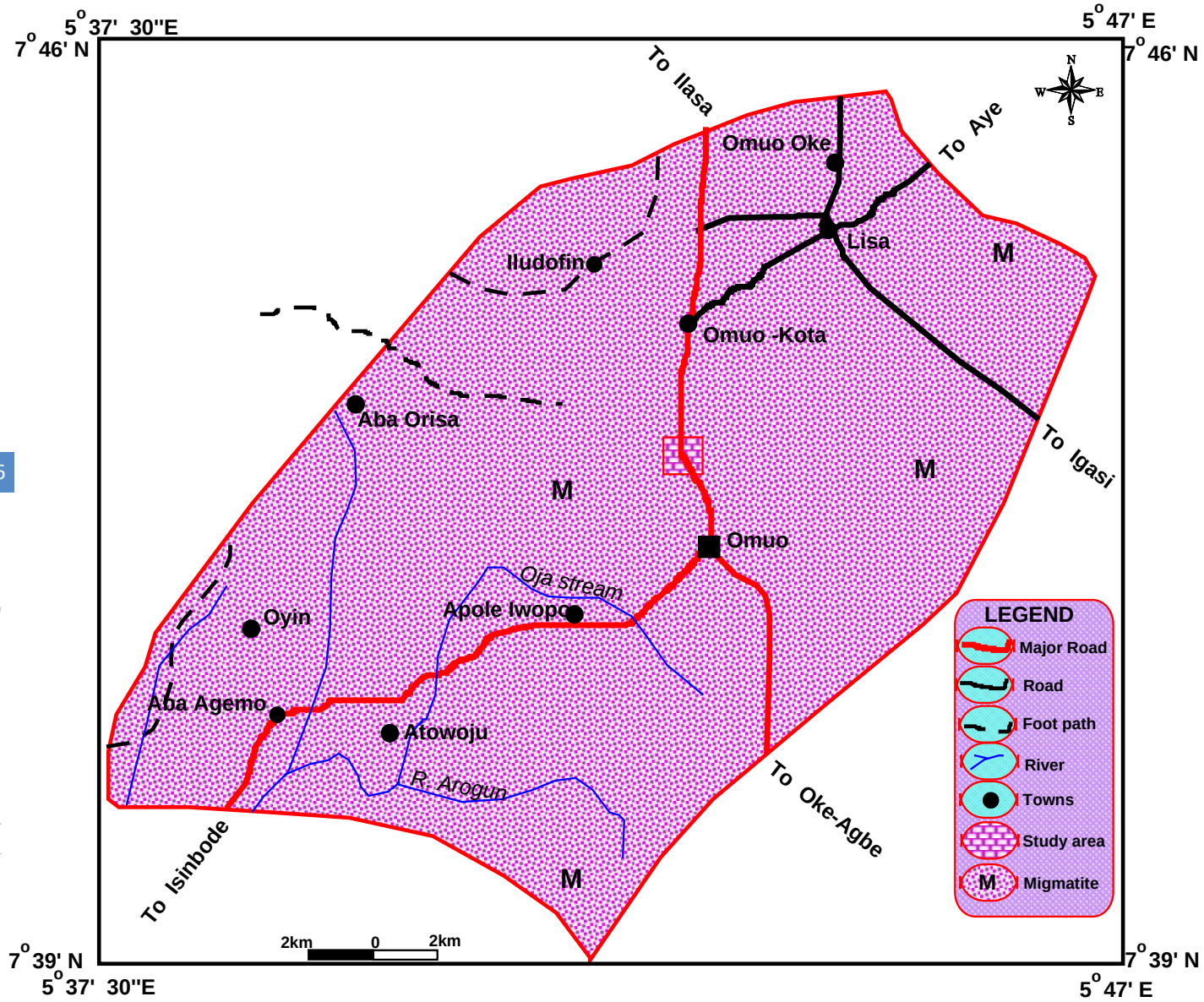

Figure 2 : Geological Map of Omuo Area (after Malomo; 2006)

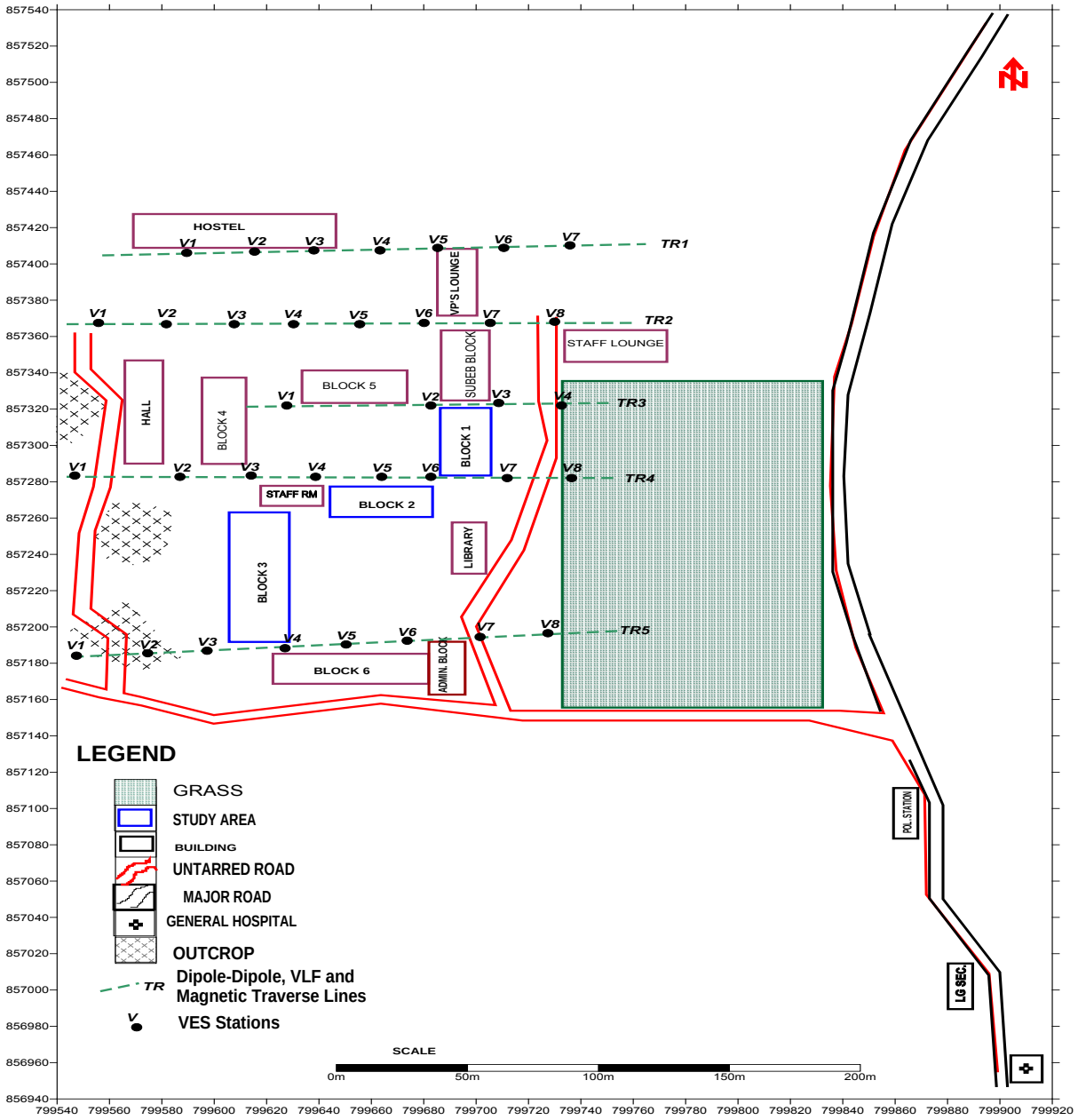

Figure 3 : Data Acquisition Map of the Study Area

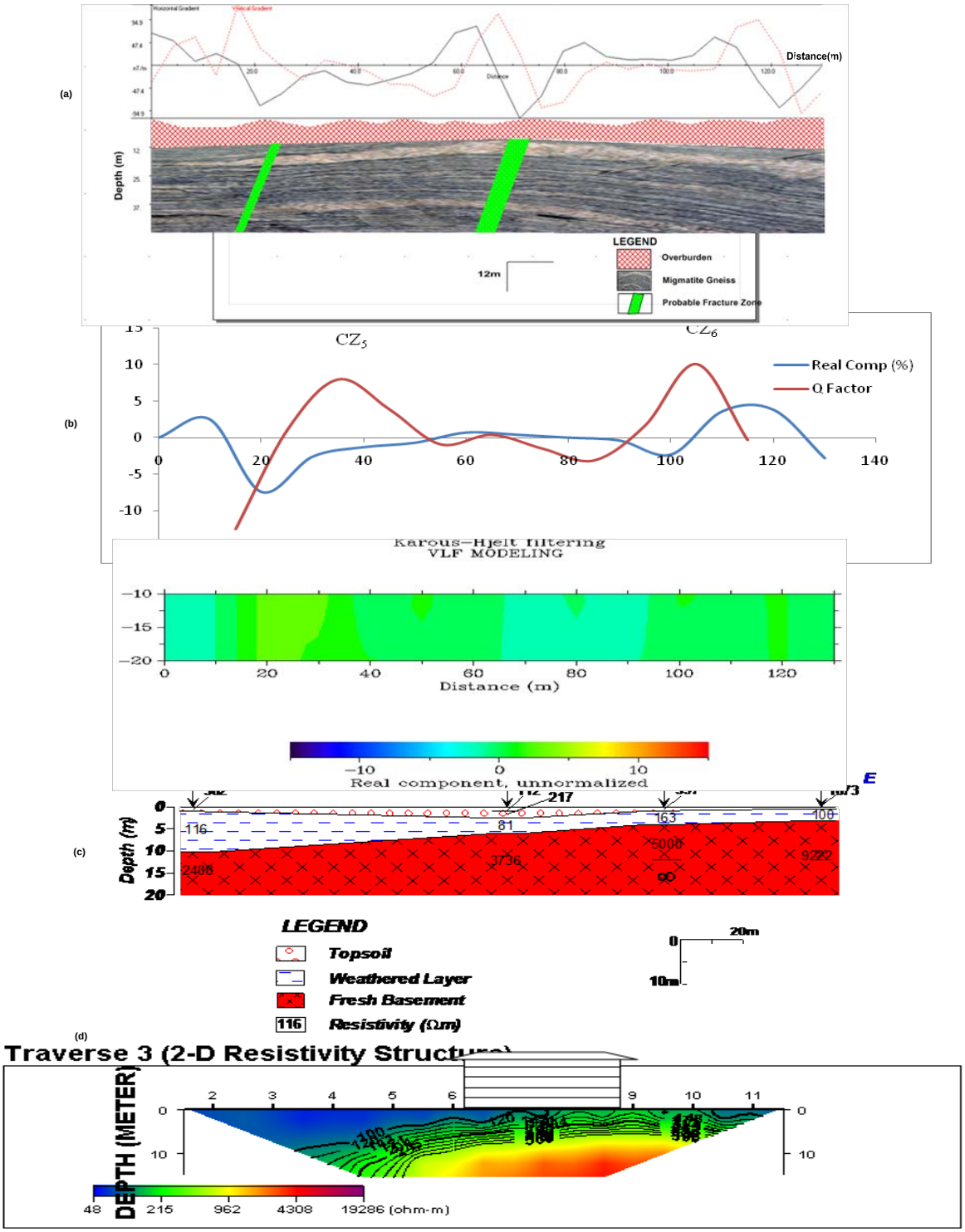

Figure 4 : (a) Ground Magnetic Profile and its Corresponding Geomagnetic Section (b) VLF-EM Profile and its KH Section, (c) Geo-Electric Section and (d) 2-D Resistivity Image along Traverse 3 respectively

Figure 5 : Showing the Cracks in the Building Named Block 1 Located Along Traverse 3

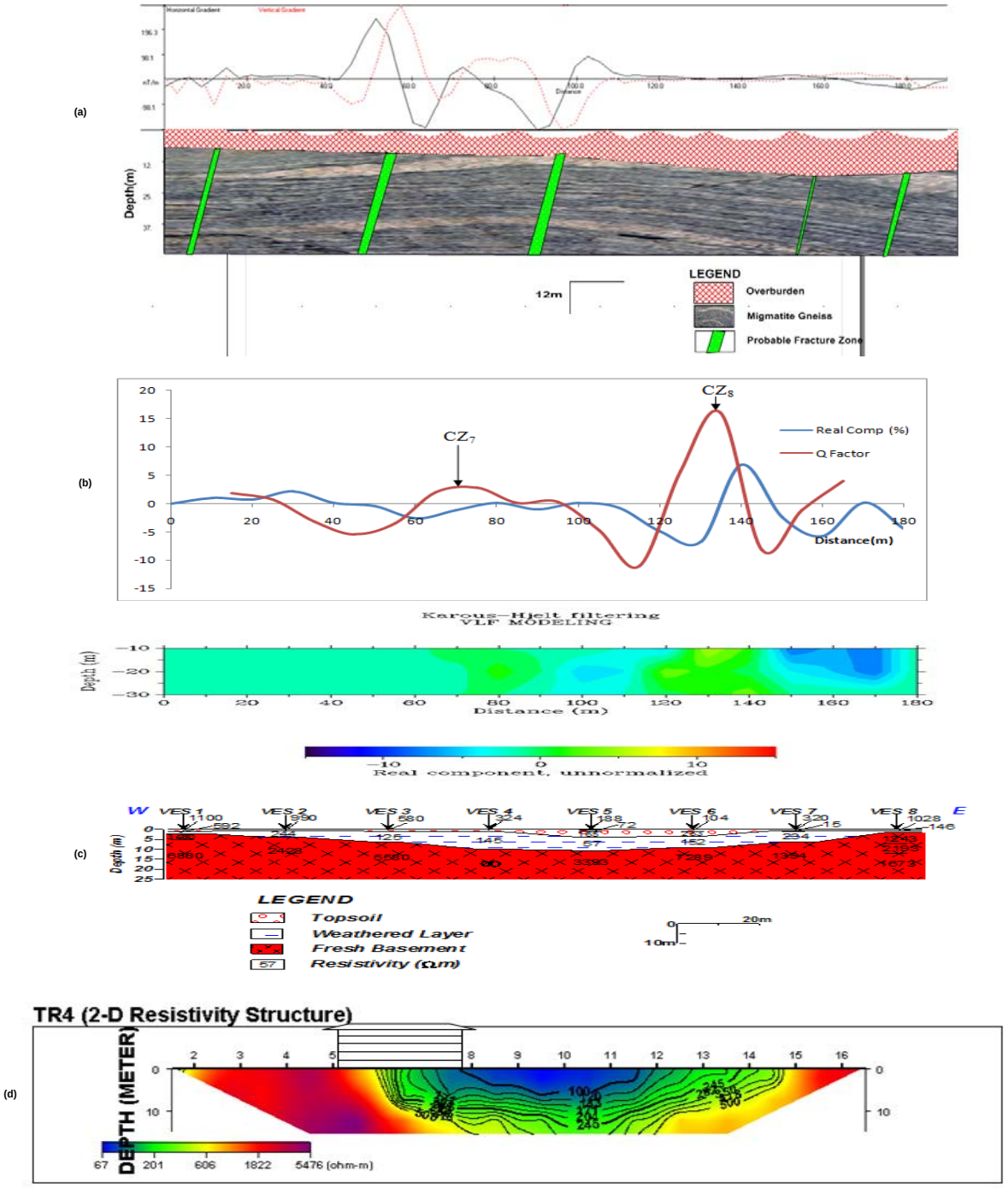

Figure 6 : (a) Ground Magnetic Profile and its Corresponding Geomagnetic Section (b) VLF-EM Profile and its KH Section, (c) Geo-Electric Section and (d) 2-D Resistivity Image along Traverse 4 respectively

Figure 7 : Showing the Cracks in the Building Named Block 3 Located Along Traverse 4

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An Analysis of Non-Point Source Water Pollution in China and the Economic Policies for Combatting Non-Point Source Water Pollution

By Larissa Paschyn

Abstract- This study explores the incentive instrument to avoid overuse of nitrogen. Overuse of nitrogen, typically in the form of fertilizers and pesticides, causes Non-point source pollution (NPS). This study therefore attempts to identify and discuss what the mechanism and reason that results in this nitrogen over-use. It also assesses how to introduce market tools that would provide the right incentives to stop its overuse. The paper compares the current water pollution management systems in the Chesapeake Bay, USA, where payments for capital costs at the farmandabatement programs of agricultural measureshave been undertaken, with the current systems of Dianchi Lakein China.

The methodology used involves a comprehensive review of the relevant definitions of terms used in Payment for Ecosystem Services (PES) by the Chinese and the international community. It discusses implementation of PES for managing farmers' use of fertilizer in China, and includes the steps needed to determine appropriate compensation levels in these PES systems. The analysis uses interviews conducted with farmers in Yunnan Province and an economic analysis of current subsidy policies, taxes, and grants used domestically and internationally to determine the best PES measures needed

Keywords: *NPS; Chesapeake bay; dianchi lake; PES; BMPs.*

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The findings suggest that one of the main ways to reduce the overuse of nitrogen and thus reduce run-off pollution (NPS) is to change the current Chinese Subsidy programs by creating new direct subsidies that will promote and reward behavior change. This will give incentives to farmers to curb their overuse of chemical fertilizers.

Keywords: NPS; Chesapeake bay; dianchi lake; PES; BMPs.

I. Introduction

Non-point source pollution (NPS) is identified as one of the prominent sources of water quality deterioration. NPS is caused by agricultural runoff (EPA, 2003), and agricultural runoff is caused by the overuse and dissemination of various chemical and nitrogen fertilizers and pesticides typically used in farming practices. These chemicals are distributed via water sources, water operations, and rain runoff, and are often carried to downstream rural and urban populations. This polluted water can then affect the quality of life and health of local communities. Thus, controlling agricultural NPS pollution source is a necessary priority.

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However, effective work has yet to be done on how NPS can be mitigated, and what ecological compensation mechanisms could be effective. Though China has attempted to implement several ecological compensation mechanisms, most of the focus has been on curbing pollution identified from single localized sources, a. k. a. Point-source pollution. This study will show that many international governments and organizations, including the USA, utilize environmental Payment for Eco-system Services (PES) and subsidies through central government grants and taxes. These taxes and grants encourage better environmental practice by considering local watershed development costs and economic effects on the local farmers/ community, while developing NPS curbing measures. Therefore, this study will examine and consider how such PES schemes implemented in the USA can also be used in China to mitigate the overuse of chemical fertilizers.

a) Background: General Water Resource Situation

Three quarters of all rivers in China suffer water pollution (China Daily, 2005). Agricultural NPS is considered to be a predominant source of this pollution. It results in health problems for citizens, soil erosion, and loss of land productivity. NPS modeling using Soil and Water Assessment Tools by XiaoyanZhai (2013) has shown that since 2001, NPS has been increasing in China. NPS sources of water pollution are those such as agricultural chemicals (fertilizers, pesticides, herbicides), and the discharge of wastewater from animals released via soil erosion and water runoff.

The main causes of NPS are overuse of chemical fertilizers as well as overuse of insect killing sprays known as pesticides (Sun, et al., 2012). The yearly use of these toxins has risen to almost 120% (Norse, 2005). In fact, China is the main consumer as well as manufacturer of these fertilizers. The application of chemical fertilizers is typically over-used by up to 50% more than necessary, which is more than intensive vegetable production needs (Norse, 2005). Farms are the largest source of sewage runoff and nitrogen emissions, and intensive agriculture has been found to be the main source of phosphorus emissions. In fact, nitrogen and phosphorus have been found to directly

contribute to the wide range of water quality problems in China (China Environmental Protection, 2010).

The main issues found in curbing the over-use of such fertilizers relate to high inefficiency in fertilizer application. Ammonia and nitrogen found in these fertilizers is released unintentionally through rains, flood and general water loss. This then leads to high amounts of such chemicals in local waterways (Norse, 2005). Why farmers over-use these fertilizers is a difficult question to answer and involves various socio-economic factors, including yield losses, costs and profit margins, as well as climate discrepancies.

Thus, the behavior of small farmers is a main cause of agricultural runoff pollution (PRC, MEP, 2010). It is important to understand the farmers' choices and incentives, and to develop and implement sound measures that take their choices into consideration when adopting NPS mitigation policies. There are a number of tools to combat NPS pollution. These include direct regulation (such as censoring certain practices), economic incentives (such as taxes, subsidies, allowances), and promotional activities (such as educational campaigns, training workshops, and pamphlets) However, the long-term interests of the farmers need to be a priority before the implementation of any or all of the suggested above policies and measures.

b) Research Question

This paper's' research question is the following: How to introduce market tools that would provide the right incentives to stop nitrogen and chemical fertilizer over-use in conjunction with legal, institutional and educational policies?

This study discusses why farmers currently over-use nitrogen fertilizer, which causes Non-point source pollution (NPS). It explores what economic incentive instruments can assist in curbing the over-use of nitrogen, when combined with additional legal, institutional, educational and social policies.

c) Methodology

This paper discusses current developments in Dianchi Lake in China with developments in the Chesapeake Bay, USA and provides suggestions for the watershed component of China's projects. It assesses the implementation of PES trials and successes in the USA, and studies the relevancy it may hold for China. Furthermore, the main water pollution schemes that have been implemented in China for NPS processing are discussed and reviewed in order to determine what distinct characteristics a Chinese PES system will need to embodyin order to achieve successful curbing of nitrogen over-use.

This methodology of using survey and analysis of secondary data, combined with the comparison of domestic and international case studies, will allow for the assessment of both Chinese and US policy models and will allow for the discernment of gaps and deficiencies in current Chinese methods.

d) Case Study

Since the 1990s, Dianchi Lake has been suffering from serious water pollution due to the increase discharge of NPS by agricultural practices and livestock production. Water analysis, and documented interviews with farmers conducted in Dianchi Lake will be incorporated in order to understand how effective PES can be in China.

These interviews are secondary sources, derived from previously published reports. These established interviews will be used as part of the survey-research for determining if PES Subsidies could be a viable alternative and practically implemented, or if they contrast to the beliefs and needs of local farmers. This will provide the data necessary to make recommendations for the implementation of such subsidies, and allow for the mapping of the potential implementation scheme needed in water pollution management in China.

Information and data for Dianchi Lake is compiled from reports by the CCICED Task Force and Center for Agriculture in China.

e) International Comparison

For an example of a successful case of PES implementation, the Chesapeake Bay, USA project will be analyzed. It will define and examine the steps taken in the Chesapeake Bay to curb NPS pollution and farmer participation. This international comparison will focus specially on the following: tradable pollution permits used, NPS pollution control in the area, nitrogen fertilizer use, farmer's perspective in past and current programs, and farmer's perspective on reforms in subsidy policies. Project data, project information documents, implementation completion reports of PES and subsidy policies in New York are provided by the Chesapeake Bay Committee.

II. NPS Pollution in China

There are two types of pollutants typically found in water. One is the biological variety that includes microorganisms that can cause diseases. The other is that of chemical pollutants like those found in chemical fertilizers. The main two chemical pollutants are nitrogen and phosphorous. In China, only 5% of water is characterized under Grade I, which means that it is considered 'pristine' (Huang, pg. 5). 27.6% of China's water is classified as Grade II, meaning that it is drinkable and sanitary for use.

a) Classes of Agricultural NPS Sources – Prevention and Modification of Land-Use Practices

All NPS sources are derived from soil loss caused by water run-off. This water run-off usually is derived from rainfall, snow melt or over water-use and

irrigation. These pollutants eventually reach main water sources such as rivers, lakes, and streams, and hurt the local ecosystems including animal and human populations (Ren, pg. 250).

Thus, NPS agricultural pollution is a result of the excess use of fertilizers and pesticides, as well as the burning of straw, manure, and sewage in rural areas and solid waste emissions. It is transported through the leakage of run-off and soil (Ren, pg. 250).

Excessive nitrogen fertilizer in the production of grain and vegetables in China leads to the loss of 1,740,000 tons of nitrogen per year (Williams, p. 12) and is a direct source for pollution in China's water systems. Fertilizers play a vital role in crop production. The production and consumption of fertilizers in China has grown to 41.24 million tones. At present, the use of fertilizers is about 400 kg / ha of fertilizer in China. Average use of fertilizer in China is only 30% to 35%. The remaining 60-70% of the fertilizer is absorbed and lost into the environment, thus polluting the soil and water (Ren, pg. 250).

Chemical fertilizers have polluted the rivers and lakes of China, such as in the Dianchi basin. Approximately 23% of nitrogen discharge in Dianchi Lake is from fertilizer use. In fact, throughout China, there has been the loss of 1,740,000 tons of nitrogen per year due to the production of grain and vegetables (Williams, page 12).

Use of these chemical contaminants is detrimental to long-term health. Chinese pollution studies have found a correlation between NPS pollution and increased occurrences in liver cancer and stomach cancer. This is due to the consumption of chemicals and heavy metals via water and produce (Ediger, pg. 6). In fact, China has the highest mortality from cancer of the liver and stomach in the world. This is 4-8 times higher than the world average (Facts and Details, 2010).

III. Dianchi Lake Case Study

Since the 1990s, Dianchi Lake has been suffering from serious water pollution and NPS discharge of agricultural practices due to an increase in the intensification of livestock production. Therefore this analysis addresses pesticide and chemical fertilizer use in Dianchi Lake. It will show how new policy suggestions are beneficial to locals. The comparison focuses on key farmer fertilizer use and their reasons for chemical fertilizer dependency. It also focuses on the farmer's perspective in past and current programs and the farmer's perspective on potential reforms in subsidization policies.

a) Dianchi Lake Background

Dianchi Lake is the main water resource of Yunnan's Kunming,. The lake is used for industry, irrigation, and even provides drinking water (Huang, pg. 2).

Dianchi Lake received nearly 240 million cubic meters of wastewater in the year 2000, including industrial wastewater of about 50 million cubic meters and urban wastewater of about 190 million cubic meters. These are the sources of pollution. It also received large amounts of rural waste NPS pollution. According to the 2002 statistics, more than 30% of the water pollution in Dianchi Lake originates from agricultural NPS pollution now (Huang, pg. 3).

b) NPS in Dianchi Lake

Surveying and testing in the towns around Dianchi Lake has focused on the use of phosphorus and nitrogen in the area. It has revealed that farmers, urban dwellers in the city, and the chicken factory are the main source of the chemicals. The contribution of phosphorus and nitrogen from NPS in the Dianchi Lake region has been studied with farming being shown to cause 38% of phosphorous levels and 48% of nitrogen levels (Guo, pp. 147-156). NPS makes 68% of the phosphorous and 74% of nitrogen in the lake, exceeding Point-source pollution.

These tests have shown that there has been inefficient use of agricultural chemicals, which is directly caused by the excessive use of chemicals and a large loss of nutrients in the water.

c) The Farmer's Perspective

The key questions to ask are, firstly, whether farmers are overusing fertilizer from an economic point of view and, if so, to what extent? Secondly, what have been the factors determining the level of fertilizer use? In particular, what is the role of information in this process? These questions are the most important aspect in developing a NPS policy to convince the farmer. Any policy, regulation, system of incentives, or outreach programs to change the application of fertilizer should consider how the farmer makes his decision on what type of fertilizer he choose to use. Williams interviewed farmers in Yunnan regarding their farming policies, and found that nitrogen and phosphorous were used heavily. Some farmers also admitted to considering the experience of other farmers, and their advice on agricultural services when making a choice (Williams, pg. 8).

The reason for limiting the use of or over-using of chemical fertilizers includes the purchase prices of fertilizers, and the effect the fertilizer has on the taste and quality of their fruits and vegetable products. The inefficiency of chemical fertilizer and how it affects crops was also considered, especially whether or not there were weak reactions of some crops to the fertilizer (Williams, pg. 19). These seemed to be the reasons s for the overuse of nitrogen fertilizer.

Williams' empirical data and survey shows that farmers who used chemical fertilizers did so because they believed in the efficiency of these fertilizers. The efficiency counterbalanced the cost of purchase. In

addition, chemical fertilizers were readily available whereas manure access was limited (Williams, pg. 19).

As evidenced above, fertilizer use is determined by a variety of factors, and varies from farmer to farmer. One of the causal mechanisms appears to be price and affordability of chemical fertilizer. However, for many, the decision to use or not use is also influenced by technical service extension agencies and by irrigation restrictions (Williams, pg. 19). For any policy, farmers' demand for agricultural economic development needs to be considered and policy makers need to recognize this crucial fact (Williams, pg. 19).

In summary, fertilizer overuse is an issue; farmers in China appear to be systematically overusing fertilizer. The reason is this may due to a lack of financial resources coupled by the low price of chemical fertilizers, and low productivity and lack of irrigation systems. Reasons for such high demand for chemical fertilizer are complicated. Part of reason may be related to the high opportunity cost of labor. Furthermore, the traditional extension system encourages overuse, and does not educate on alternative farming practices, and the poor control on the quality of fertilizer induces farmers to use more fertilizer.

d) Current Policy Developments

Current Chinese agricultural policies and environmental protection laws do not curb chemical use, and only encourage farmers to make production decisions based on short-term benefits and to engage in production of environmentally-unfriendly ways. For example, the price of subsidized fertilizer and pesticides leads to lower prices of these chemicals on the market, and encourages farmers to increase pesticide use and fertilizer use (Huang, pg. 4). In addition, there are no subsidies for agricultural production of ecological agriculture, but only for circulation of agricultural products. A series of "green box" subsidies that are non-trade impeding government sponsored funds have not yet been implemented in China (Huang, pg. 5), and local policies and schools have not been able to make the external costs of agricultural production successfully internalized to encourage sustainable use because of a lack of specific regulations or penalties (Huang, pg. 4). Current water laws (as mentioned in Chapter 2) leave water rights and polluting penalties vague and make enforcement difficult. In addition, local governments do not encourage educational training programs or lectures on NPS management (CCICED Working Group, 2004).

It is important to implement policies, both economic and social, that can persuade farmers to adjust their model of soil employment, reduce agricultural chemicals and improve farming techniques, thereby dropping nutrient concentrations of nitrogen and phosphorus in the lake. However it is also important to note that any eco-compensation practice in China must manage agricultural pollution while dealing with the distinctive societal features of the country's agriculture. This includes taking into consideration the low farmer income and very small farm size. A holistic, integrated approach must be used.

Given the current characteristics of the NPS and the institutional context of the watershed of Dianchi Lake, one of the most important tasks to achieve the objectives of the fight against agricultural NPS, is to implement policies that can encourage farmers to change their pattern of land use, reduce inputs of agricultural chemicals and to improve agricultural production techniques, thereby reducing nutrient concentrations of nitrogen and phosphorus in the lake.

Policy makers should take more care of the farmers' demand for agricultural economic development, and a policy instrument cannot be set down solely for attaining an environmental protection target. Rather, each factor of the local economic development and institutional backgrounds should be considered in order for the policy instruments of controlling agricultural NPS water pollution in Dianchi Lake area to be practical and effective.

e) Policy Options

Based on the above analysis, economic based policies for agricultural NPS pollution control in Dianchi Lake need to include reforms in agricultural taxation and fees (Williams, pg. 13), as well as new payment systems. There will also need to be reforms in the current subsidy policies. To ensure subsidy reform, China needs to withdraw the original subsidies on chemical fertilizers and pesticides, and instead implement "green box" subsidies. These "green box" subsidies should include subsidies for technological improvement, and stopping the use of pesticides and chemical fertilizers. Below is a more detailed explanation of the types of taxes, fees and subsidies that could be effective specifically for Dianchi Lake.

f) Polluters pays principle in agricultural NPS control

Pollution fees or taxes are a specific application of the "Polluters pays principle" (PPP) in environmental management. This mandatory fee on polluters encourages them to reduce their pollution and find alternative practices, subsequently improving the local ecosystem (Huang, pg. 4). This policy instrument is hard to apply to NPS because pollutant emissions of farmer's crop-land are too difficult to monitor or identify since the discharge is discrete and scattered.

However, since nutrient pollution of nitrogen and phosphorus comes from agricultural production causing water deterioration of Dianchi Lake, and since a main strategy for reducing these toxins from farm land is to decrease the application rate of agricultural chemicals, PPP can be an effective way to restrict the amount of fertilization and pesticide utility of the local farmers for controlling agricultural NPS in the Dianchi Lake area. In this case, adopting a transformation form

of pollution fees, i.e. agricultural chemicals over-use fee, which is levied upon the over-use of fertilizers and pesticides (Huang, pg. 4) could be successful. This however must ensure that cropland yield is in direct proportion to the agricultural chemicals utility amount. The nutrient loads discharged from the same cropland must also be in direct proportion to the agricultural chemicals utility amount. This is necessary because the social cost is more than the private cost of the farmer's in this case. If the local government implements a regulation on agricultural chemicals utility amount per unit of cropland, and stipulates a specific and high-enough penalty rates upon the farmer's overuse of agricultural chemicals, then the farmer will reduce his agricultural chemical input level to make his/her private marginal cost equal to the social marginal cost. In other words, the farmer will reduce the input to the optimal level.

g) Reforms in Subsidization Policies

Using only PPP as the NPS policy scheme would be unfeasible as one of the most important criterions in choosing an effective environmental policy or policies is that no extra burden is imposed on farmers as a result. Hence, to ensure attainment of water pollution control targets, subsidies to farmers to reduce NPS pollution must be a necessary component.

A potential subsidy would be a yield reduction subsidy. Subsidizing yield reduction caused by the reduction of agricultural fertilizers and pesticides utilities, would offset profit losses and operation costs of the farmers. There should also be subsidies and payments that encourage farmers to buy bio-scientific or commercial organic fertilizers with less hazardous ingredients. The government could also encourage the abandonment of tillage with a subsidy that promotes the use of ecological forestry.

For farmers who view the use of these chemical fertilizers as crucial to their livelihood, these subsidies would ensure the development of an agricultural economy while also protecting environmental resources. Therefore, if the subsidy is high or large enough, the farmer will maintain the lower yield caused by lower input of agricultural chemicals. Otherwise, the farmer will be likely to increase input of agricultural chemicals again to get more private financial benefits.

h) Tradable Pollution Permits

Implementing tradable pollution permits could also be an effective way to control agricultural NPS under some certain preconditions. Since agricultural NPS is mainly caused by nutrient discharges from the use of fertilizers and pesticides, tradable pollution permits could become marketable agricultural chemical use permits. These may be traded between at least two NPS sources, or between a point-source and NPS source to restrain the total deterioration of the water pollution in Dianchi Lake.

However, the prerequisite of implementing tradable pollution permits is that a gross pollution control system must be set up in the local water environmental management office, which Dianchi Lake has not done. Further, equitable distribution of starting emission permits among the local polluters is another critical factor to effectively implement this policy. Finally, calculations of the transaction costs for emission permit trading must be undertaken, and these can be hard to determine (Huang, pg. 5). Despite this, tradable emission permits in pollution control can be more efficient compared with conventional policy instruments.

i) Non-economic Policies

Economic incentive instruments can assist in curbing the overuse of nitrogen, but only when combined with additional legal, institutional, educational and social policies. This will be discussed in greater detail in the subsequent chapters, but will also be touched upon briefly below.

Technical assistance services should be increased and should include expert guidance, such as water quality maintenance, soil erosion management, inorganic and organic fertilizer management, proper and efficient use of fertilizers, agricultural transition, and the application of new technologies. These plans are vital for agricultural productivity and environmental protection.

The development of a composting facility and waste treatment site could also improve NPS dispersion. Demonstrations of this in the Dianchi Lake of sewage treatment and recycling has shown to prevent as much as 32.2t nitrogen and 3.9t phosphorous from entering the water, when 92 of solid waste was collected and approximately 88% was recycled (Lu, pg. 19).

j) Summary and Dianchi Lake NPS Policy Analysis

As of now, Dianchi Lake's watershed programs are only in the initial stages of development, with planned subsidies for organic fertilizer use and better agricultural operations. Currently, there are no subsidies for production of ecological agriculture, but only for circulation of agricultural products. A series of "green box" subsidies that are non-trade impeding government sponsored funds have not yet been implemented. The current agricultural policies and environmental protection laws of China induce farmers to make production decisions from views of short-term benefits and engage in production activities in environmental-unfriendly ways. Current production subsidies for chemicals and pesticide manufacturers results in lower prices of these fertilizers. Thus current economic-incentives in fact make chemical fertilizer cheap to use and encouraged. This is why current PES schemes for NPS in Dianchi Lake have not been effective. Further, Dianchi Lake watershed management is still only beginning to implement pilot programs for economic-incentive schemes. Coupled with the corruption and

bureaucratic infighting of the MEP, MWR, and RBOs, mentioned in earlier chapters and their lack of information-sharing, this prevents PES programs from taking root.

In the following chapter, methods for curbing NPS in the USA will be analyzed to see if and how they can be adopted by China.

IV. International Comparison: The Chesapeake Bay

Just like in Dianchi Lake, the Chesapeake Bay, USA, has also faced NPS issues, particularly NPS caused by farming practices. Given the current characteristics of NPS and the institutional context of the watershed of Dianchi Lake, one of the most important tasks to achieve the objectives of the fight against agricultural NPS, is to implement some policies that can encourage farmers to change their pattern of land use, reduce inputs of agricultural chemicals, improve agricultural production techniques, thereby reducing nutrient concentrations of nitrogen and phosphorus in the lake. The Chesapeake gives an example of the steps China can take for curbing farmers' practices.

a) The Chesapeake Bay Project

Located in the United States, the Chesapeake Bay watershed includes encompasses a total of six different US states, and also includes Washington D.C, the capital of the US. The Bay's "total area is 64,000 miles", and includes "150 major rivers and streams" (Cestti, pg. 3). Agricultural chemicals, animal waste and food dispersal has resulted in high levels of toxic chemicals in the Bay. This has caused an increase in turbidity, reduced sediment, and the death of fish and shellfish due to disease. Agricultural NPS is chiefly to blame for this, and is caused by the manufacturing industry and factories along the Bay, as well as from agricultural practices and urban NPS pollution caused by residential construction (Cestti, pg. 3). NPS has accounted for 68% of nitrogen 77% of the phosphorus, with agricultural run-off being the single biggest polluter (Chesapeake Bay Program, 1997).

Common strategies for curbing water pollution include land management and water use management, the establishment of best management practices (BMPS), training programs for farmers, and financial aid and cost splitting for monitoring, enforcement, and implementation of projects. Furthermore, in the US, there has been government agency funding for market-based water quality trading, and subsidy grants for targeted watersheds. There also has been financial support for technological development from the federal government as well as financial support from states (ADB 2011, pg. 1). In addition, there have been established quotas for nutrient discharges with the Clean Water Act that has established maximum daily loads, thereby allowing for the nutrient discharge permits to be adopted and the subsequent trading of them (ADB 2011, pg. 13).

The Chesapeake Bay has various BMPs for agricultural management. They include: pesticide management, waste management, tillage and irrigation policies, soil erosion prevention methods, nutrient organization and budgeting, technical regulation, crop rotation, and covering crops in winter (Cestti, pg. 9).There are also monetary incentives and technical facilities and programs that encourage the adoption of the BMPs mentioned above. The Agricultural Water Quality Cost-Share Program pays for 88% of the cost of BMP installation in the state of Maryland. There is also cost-shared assistance for animal waste control and handling. Each farm receives a maximum of fifty thousand dollars. However, they receive sixty-five thousand dollars if they combine the treatment/ containment program with other BMPs (Cestti, pg. 9). Each other BMP program can entitle a farm to receive ten thousand dollars to thirty-five thousand dollars, depending on the farm and program. Virginia's program pays for 75% of BMP installation, and tax credits of 25% for agricultural BMPs also support farmers to set up management practices (Cestti, pg. 9).

Finally, there are now upstream and downstream payment systems, where farmers upstream are given payments for the services they provide in environmentally friendly ways. An example is that farmers along waterways in the Catskills and in Delaware are given monetary compensation from New York City which uses the water from upstream for drinking. In addition, new water regulations have allowed for public participation by local communities, state and federal government funding for programs, well-developed quotas and standards for measuring program success and water quality, and guaranteed accountability and transparency by having both local enterprises and local community members serve on monitoring and policy committees (ADB 2011, pg. 13).

b) Financial Incentives and Educational Services for Farmers

The Chesapeake Bay Area offers financial incentives for farmers to reduce nitrogen use. Taxes, subsidies and Best Management Practices have been organized by the local and state governments (Cestti, pg. 8). These assist farmers in implementing better practices, and especially ease costs of farmers by compensating them for initial product and profit losses. For example, Maryland gives tax credits to farmers to change their fertilizer brand. However, in states like Virginia, farmers are given tax breaks when they participate in their best management schemes (Cestti, pg. 10). Farmers need to buy nutrient management plan accredited technology that applies nutrient qualification testing. The state pays for 25% of this cost via tax break (Faverno, 1997).

c) *Factors influencing farmer involvement and implementation of BMPs*

The Department of Agriculture in the U.S. (Feather and Cooper, 1995) has shown that, much like in Dianchi Lake, the profitability of the farm is the most important factor to influence farmers' decisions. Any management approach that is adopted by the views of farmers, and its impact on profitability, and farmers' knowledge and familiar practices affects their desire to implement BMPs. Successful BMPs promote inexpensive changes in existing agricultural practices. As mentioned earlier, the Chesapeake Bay program uses various monetary incentives, including tax breaks, payments and government funding, as well as training programs to promote BMP implementation. The use of BMPs and financial incentives improve environmentally-friendly agriculture, and incentives to off-set the initial cost of the additional use of BMPs are crucial for successful implementation. All the BMPs used in the Cheesecake Bay have required some sort of incentive system (Cestti, pg. 20). Of course this must be combined with educational policies to ensure successful BMP implementation. It is shown by the program that certain types of financial assistance are essential for agricultural NPS control, and cost-benefit analysis, including the use and implementation of technology, has to be considered for any financial incentive plan to be effective and efficient (Cestti, pg. 20).

d) *Lessons to Be Learned from Chesapeake Bay*

The successful NPS reduction results of the Chesapeake Bay Program are due to BMPs. However, the Chesapeake Bay program also shows how crucial it is to design a system of cost-sharing. All BMPs in the program were given the same level of state support, and the cost-sharing allowed mitigation of the cost of agricultural operations following the adoption of BMPs. This ensured effectiveness of programs. The Chesapeake Bay project gives examples of what would occur without such financial aid. In Virginia, BMPs were adopted when government funding was provided, but when funding ceased, BMP use also ceased (Cestti, pg. 21).

Therefore sustained or continuing financial assistance is crucial to control and curb agricultural NPS (Cestti, pg. 22). Tax incentives and subsidies are needed to make farm practice changes feasible and economically non-damaging to the farmers. A survey of New York Catskill farmers within the Chesapeake Bay participating in the Water Agricultural Program found that 44.3% of surveyed farmers believe monetary payments maintain or improve their income level. Extra income has also allowed for development of infrastructure and allowed them to focus on marketing their enterprises too. These added bonuses have also improved their overall profits and management systems (Pagiola et al. 2003; Rosa et al. 2003; Orrego 2003). They represent a level of financial stability for tenants and as a result the tenants can make informed investment decisions for the future, while also continuing their farming as their main source of income. Nevertheless, economic incentives would not have been successful without the educational campaigns and community participation mentioned above, nor without the BMP training programs they offered to participants.

e) *Implications for Dianchi Lake*

Based on the above, several lessons from the Chesapeake Bay may be applied to Dianchi Lake's treatment of NPS. Firstly, training programs and lectures should be launched for farmers in order to change the behavior of farmers in their agricultural operations and to educate them in sustainable practices. However, a key part of the training program is the availability of cost share assistance for these volunteer projects and its personnel. Also subsidy programs encouraging adoption of BMPs are needed to offset loss of profits from lower yield. Finally, environmental regulations or regulatory threats such as fines and fees may be an incentive to the producers involved in agricultural projects to curb nitrogen overuse.

Comparing Dianchi Lake and the Chesapeake Bay reveals two different approaches to NPS management. The Chesapeake Bay has active central/federal government and local government participation in regulating, financing, and managing NPS control. The program encourages strong community participation by local citizens and enterprises. This is done through website platforms for public information sharing, allowing for outreach, education, and citizen involvement. Dianchi Lake has not developed such community participatory platforms yet, and the technical extension services available are limited in size and scope.

Dianchi Lake in contrast has a fragmented government management structure, typical of most watersheds areas, with MWR, RBOs and the MEP fighting over jurisdiction, roles and duties. Monitoring and regulating is not strongly enforced and inconsistent. There is also weak community participation with local farmers not having access to education and training.

In terms of economic policy, Chesapeake Bay uses subsidies and grants to encourage farmers to adopt new BMPs and to curb fertilizer use. Dianchi Lake does not currently use such schemes to off-set the costs of adopting new BMPs. In general, NPS management needs more participation in Dianchi Lake by the local community.

Finally, the Chesapeake Bay program has a regional regulator body that uses monitored data and has training programs for encouraging the adoption of BMPs. In Dianchi Lake, this is not yet the case, though the regional government is starting to develop PES and BMP programs for future use. In summary, though

Chesapeake Bay shows how new subsidies and economic policies can assist in curbing NPS; the Chesapeake Bay program also shows that educational/training programs, government monitoring and enforcement, as well as legal policies are needed to effectively change the behavior of farmers.

Based on the above analysis, economic policies for agricultural NPS control in Dianchi Lake should include carrying out reforms in agricultural taxation and fees. There should be an exemption on the original agricultural taxes on special products. The government should also stipulate the max allotment of chemicals that can be put on each farmland unit based on the crop being planted. The government needs to also develop a standard set of penalties for those who overuse fertilizers and pesticides. Reforms on the subsidy policies should also be carried out. The original subsidies on chemical fertilizers and pesticides ought to be canceled, and "Green Box" subsidies must be implemented. One of these green subsidies can include a yield decrease caused by reducing agricultural fertilizers and pesticides utility. A second could be a subsidy for technological improvement while a third could be a subsidy for giving up tillage and instead for planting ecological forestry, etc.

The government ought to also set up a gross water pollution control system and needs to create conditions for implementing tradable pollution permits. In addition, there needs to be the establishment of a centralized plant-scale composting system. Finally, the government must set up a waste treatment facilities.

V. Recommendations

This study has attempted to explain how to introduce economic market tools and what economic incentive instruments would work best to avoid and curb the overuseof nitrogen, which causes NPS, when used in conjunction with institutional/legal/education policies. It has also attempted to identify the market mechanism through which this nitrogen use over-develops, and suggest what market system would provide the right incentives to lessen this current over-use.

Various economic incentive instruments could assist in curbing the overuse of nitrogen, when combined with additional legal, institutional, educational and social policies have been studied and explored. This has been achieved by assessing the experiences of the Chesapeake Bay program and theorizing if the use of PES in the market would make the market more efficient, and if it would provide financial incentives for farmers to limit its use of the conservation of natural resources on the market. The paper also compared the current systems of the Chesapeake Bay, where payments for capital costs at the farm/abatement of agricultural measures have been undertaken, with the current systems of Dianchi Lake of China.

a) Main Findings Correlation between Nitrogen Overuse and Economic Incentives

A survey of reports on the environment of Dianchi Lake has shown that chemical fertilizer is over-used and has resulted in NPS for the area. It was established that farmers were generally over-using fertilizers for largely economic reasons and then specific factors were identified which led to fertilizer over-use and why it was still continuing. The key questions were if farmers were overusing fertilizer for economic reasons and what specific factors have caused this overuse. The reasons for this overuse include an imprecise agricultural economic policy. This seems to be one of the main causal mechanisms for the over-use of nitrogen fertilizer. Indeed, the current price of subsidized fertilizer and pesticides, leads to lower prices of these chemicals, and provides negative incentives for farmers to reduce pesticide use and fertilizer. As a result, they acquire short-term high yields, but neglect environmentally sustainable tools and outcomes. Therefore, one of the major economic causal mechanisms appears to be price and affordability of chemical fertilizer when compared to their income.

b) Other Reasons for Overuse

Agricultural practices in Dianchi Lake have shown that fertilizer over-use is an issue; and that farmers in China generally appear to be systematically overusing fertilizer. Reasons for the high demand of chemical fertilizer are complicated and include issues over production efficiency, income and costs for alternative practices, and lack of education on BMPs. The traditional extension system also encourages over-use by not providing information on alternative practices or encouraging their adoption of BMPs. It is likely that poor control of the quality of fertilizer has induced farmers to use more fertilizer in an effort to provide adequate yields of acceptable quality.

Furthermore, the reason for the use of chemical fertilizers also included the relative affordability of fertilizer, and its beneficial effects on the taste and quality of fruit and vegetable products. Farmers who used chemical fertilizers did so because they also believed in the effectiveness of these fertilizers, and that efficiency off-set the cost of purchase. In addition, chemical fertilizers were readily available while access to more environmentally acceptable fertilizers such as manure was limited (Williams, pg. 19). As a result, any policy for curbing fertilizer over-use needs to consider the farmers' demand for agricultural economic development and improvement in order to ensure adoption of new BMPs.

c) Problems with China's Water Enforcement and Legislation

Because of the many sources of NPS, China has no overall management strategy. A Department of Agricultural Management of NPS does not exist, and

therefore no one is responsible when pollutants are generated in agricultural production. China needs to build complete system for managing NPS.

In addition, there is a lack of defined roles and duties in the water laws (Wang, 2007, pg.403). The "Water Law" (2002) approves the MWR to supervise water management. However, the MWR also considers water quality protection as one of its main tasks, even though SEPA views water quality monitoring as its main duty, resulting in strife over the scope of authority. The two agencies do not share data, do not have a common set of data, and do not work together in data analysis of quantitative and qualitative tests of water (Wang, 2007, pg. 403). This undermines the value of any analysis of current water quality in China, or enforcement of environmental policies for local and regional areas.

d) Steps to Curb Overuse

China needs to remove sub sidiesoninitial chemical fertilizers and pesticides, and instead implement "green" subsidies. These green grants should include subsidies for technological improvement, and the commitment to stop the use of pesticides and chemical fertilizers. Therefore, pollution markets are an effective way to reducediffuse pollution, while at the same time using only the marginal costs. Input and process objectives also provide practical solutions and they may be more practical rather than developing policies to reduce the average load of nitrogen.

Using the Chesapeake Bay program as a model, while factoring in profit costs for farmers, policy changes could include structural and technological change, as well as institutional reform that include the formulation of laws, policies and regulations. These policies should include a ban on wastewater/sewage discharge and the establishment and management of water rights. There must also be the formation of a water-saving type of society (in order to encourage community participation including water-use associations. For example, specific water-associations for root vegetable farmers for continuing education and training should be considered as a priority. Capacity building at all levels, and public participation must be encouraged. In addition, there should be coordination and negotiation with neighbour provinces/state on common water sources. Finally, the government should incorporate the use of economic tools such as payments for ecosystems services, as well as private sector involvement (economic aspects and sharing of good practices).

e) Problems with Current Subsidies

Current Chinese agricultural policies and laws on the protection of the environment do not curb consumption of chemicals, and only encourage farmers to make production decisions based on short-term benefits and to engage in production in environmentally hostile ways. For example, the price of subsidized fertilizer and pesticides leads to lower prices of these chemicals on the market, and encourages farmers to increase the use of pesticides and fertilizers. In addition, there are no subsidies for agricultural production to or ganic farming, but only for the movement of agricultural products(Huang, pg. 3). Local policies have not been able to encourage sustainable use of land and water and fertilizer due to alack of specific regulations or penalties(Huang, pg. 4).

f) Recommendations

The various agricultural sources of agricultural NPS inhibit the ability to use only one individual policy in managing NPS. Rather, the characteristics of NPS mean that several policy instruments need to be used in tandem (Braden and Segerson, 1993). In addition, any policy program must be established on a case basis, and determined by the specific area and the characteristics of the polluters, victims, and the body of land and water.

A variety of tools can be used to reduce NPS agricultural pollution. Tools include educating farmers, taxes, subsidies, tax efficiency and governmental research of BMP prospects. Each tool has its own strengths and weaknesses but is strongest when combined. For example, taxation can be highly successful in curbing NPS and changing behavior patterns thus improving water features, but can result in higher costs for pollution producers/farmers. Therefore, in addition to taxes, a combination of subsidies is needed so that farmers can adopt new technologies and consulting services (Wei, pg. 11).

Taking this into consideration, the best program is likely to include a mixed permit and trade scheme system combined with taxation for polluters to curb their chemical use, and subsidies/grants encouraging alternative practices/technologies. This system does not need to factor in costs of agricultural profits, losses or gains, and off-site damage information. However, continuous water rate increases could easily impact on low-income households, which is why subsidies and grants are crucial.

g) Institutional Reform, Education and Public Participation

Partnerships with the NGOs to provide the public and private sectors with agricultural extension services can be useful to encourage farmers to adopt agricultural BMPs. Through the provision of training and certification programs (Xie, pg. 53), the government can promote better agricultural BMPs for farmers, while also maintaining low costs for administration. Hence, new funding policies are needed to provide these additional programs for farmers. Agricultural extension services can be utilized to implement these information meetings, give advice on programs, and provide demonstrations.

These programs need to focus on three key lessons: enhanced rural policy, superior compost policy,

and general water and ecological policy knowledge. This is very important for farmers developing greater land and water resource knowledge and understanding of and desire for sustainable development.

Other issues that need to be looked into include the capability of government bodies and their financial investment means, as well as coordination between sectors/activities that could prevent their in-fighting. Furthermore, the function of water user associations has not been adequately explored and developed and water laws and water rights also needs clarification.

h) PES Incentive Schemes

PES would encourage market forces to be more efficient and sustainable thus improving environmental services. Through the development of national standards, market transactions should begin to protect the use of new technologies which will reduce the cost of protection and support environmental defense (Force, 2006 pp. 15-23).

This can be done through: Regulation, Agricultural Taxes and Fees, Environmental Cross-Compliance (farmers must achieve certain pollutant quotas for acceptance into certain subsidy programs), Water Quality Trading Programs (polluters purchase credits from other polluters to offset their pollution discharge) and Green Payments to Farmers (PES and conservation practice subsidies).

i) Summary

In summary, a variety of methods are available for improving watershed ecological compensation. This would include taxes, funds, and concessional loans for project support. Payment can be in the form of direct agreements between companies or farmers with those communities or cities affected downstream by their pollution. It can also be through trade permits that assist polluters in reaching environmental quotas or through permit credits to be able to carry out certain practices, or through direct compensation. In this plan, the downstream communities, such as industry or government help pay for safeguard measures. Upstream communities pay the water fee on regional market prices, and those supplying water and wastewater treatment downstream would be compensated at a competitive price.

Overall, this study recommends a framework for curbing NPS that include the following items below.

There must be a tax that corresponds to approximately the cost of 50%of the nitrogen fertilizer. Fertilizer use should also only be allowed in the spring season, when growth yields are at their highest due to spring's temperature and rain level. This makes fertilizer use most efficient. In addition, the government should force or encourage the use of alternative fertilizers including slow organic fertilizer.

With the introduction of new fertilizer policies, the government needs to provide subsidies that will encourage the use of compost. The government must also provide subsidies for recycling manure, and a PES system of environmental trading units/permits between upstream and downstream users must be established.

In addition, there should be a system for the local community, for farmers and for environmental advisers to share information and water management techniques and BMPs experiences among one another. Training programs and networking events that offer courses for farmers by experts in water management should be developed by local agencies as well as overseen by the provincial and municipal agencies. Consumer-oriented activities are also needed so that the public is aware of water quality, causes of water pollution and ways to combat it.

Finally, water assessment and monitoring by a team that includes local residents, farmers, businesses and communities is crucial. The use of surveys by local governments to understand current water and health perceptions is necessary to ensure full program effectiveness. There must also be a full public exposé of environmental information so they too can monitor the agencies activities.

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- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- 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.

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(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.

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(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.

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(h) Brief Acknowledgements.

(i) References in the proper form.

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References

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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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- To the point depiction of the research
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- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
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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:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

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

INDEX

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