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Droughts in the Sudano-Sahelian Ecological Zone of Nigeria: Implications for Agriculture and Water Resources Development

By Dr. Abaje, I.B., Ati, O.F., Iguisi, E.O. & Jidauna, G.G.
Federal University, Dutsin-ma, Katsina State, Nigeria

Abstract - This study evaluates the extent and degree of severity of droughts in the Sudano-Sahelian Ecological Zone of Nigeria using rainfall data spanning a period of 60 years (1949-2008) for eight meteorological stations in the zone. The Normalized Rainfall Index was used in depicting periods of different drought intensities in the region. The results revealed that the zone was characterized by larger extent of severe drought since the beginning of 1968 through the early 1970s, and then the 1980s in which the drought was so severe than any other decade in the study period. The late 1990s and the 2000s on the other hand have been witnessing a decrease in the number of drought occurrences in the zone. The mean absolute probability of mild, moderate and severe droughts for the zone was 0.13 (recurrence interval of 7.7 years), 0.11 (recurrence interval of 9.1 years), and 0.08 (recurrence interval of 12.5 years) respectively.

Keywords : *drought probability, normalized rainfall index, recurrence interval, severe drought.*

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Droughts in the Sudano-Sahelian Ecological Zone of Nigeria: Implications for Agriculture and Water Resources Development

Abaje, I.B. [α], Ati, O.F. [σ], Iguisi, E.O. [ρ] & Jidauna, G.G. [ω]

Abstract - This study evaluates the extent and degree of severity of droughts in the Sudano-Sahelian Ecological Zone of Nigeria using rainfall data spanning a period of 60 years (1949-2008) for eight meteorological stations in the zone. The Normalized Rainfall Index was used in depicting periods of different drought intensities in the region. The results revealed that the zone was characterized by larger extent of severe drought since the beginning of 1968 through the early 1970s, and then the 1980s in which the drought was so severe than any other decade in the study period. The late 1990s and the 2000s on the other hand have been witnessing a decrease in the number of drought occurrences in the zone. The mean absolute probability of mild, moderate and severe droughts for the zone was 0.13 (recurrence interval of 7.7 years), 0.11 (recurrence interval of 9.1 years), and 0.08 (recurrence interval of 12.5 years) respectively. The implications for agriculture and water resources include: reduction in weight and increased deaths of livestock, food shortages, and soil depletion, the existence of few rivers and streams, and the lowering of the water table. The study recommends the adoption of better herds management practices to include: the reduction in herd numbers, strategic weaning of calves, herd segregation, and parasite control. The establishment and improvement of early warning systems, analysis of observed climatic data, the establishment of Drought and Flood Research Centers in all the universities of the zone among others were the mitigating measures recommended.

Keywords : drought probability, normalized rainfall index, recurrence interval, severe drought.

I. Introduction

Drought is one of the most important natural disasters that show its influences slowly by time. It is one of the costliest natural disaster of the world and affects more people than any other natural disaster (Loukas and Vasiliades, 2004; Bacanli *et al.,* 2008). It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another. Drought is a temporary aberration; it differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate (NDMC, 2006).

There is no universally accepted definition of drought due to the wide variety of sectors affected by drought, its diverse geographical and temporal distribution and the demand placed on water supply by human-use systems (Loukas and Vasiliades, 2004). Based on the nature of the water deficit, many authorities such as Ayoade (1988, 2004), Barry and Chorley (2003), Okorie, (2003), AMS (1997, 2004), Loukas and Vasiliades (2004), NDMC (2006), and Trenberth *et al.* (2007) amongst others inclusively defined four types of droughts: a) the meteorological drought which is defined as a lack of precipitation over region for a period of time, b) the hydrological drought which is related to a period with inadequate surface and subsurface water resources to supply established water uses of a given water resources management system, c) the agricultural drought, which, usually, refers to a period with declining soil moisture and consequent crop failure without any reference to surface water resources, d) the socio-economic drought which is associated to the failure of water resources systems to meet the water demands and thus, associating droughts with supply of and demand for an economic good (water).

One characteristic seems to be common with all the definitions: drought is caused by a deficiency in precipitation for a fairly long period of time. This may cause widespread crop failure, death of livestock, water shortages, famine and other hardships that may result in the loss of human lives.

Drought is an inherent characteristic of Africa. One-third of the people in Africa live in drought-prone areas and are vulnerable to the impacts of droughts (Bates *et al.,* 2008). Since the devastating Sahelian drought of the early 1970s, drought has reoccurred in many parts of Africa (Oladipo, 1993). In West Africa, a decline in annual rainfall has been observed since the end of the 1960s, with a decrease of 20–40% in the period 1968–1990 as compared with the 30 years between 1931 and 1960 (Nicholson *et al.*, 2000; Chappell and Agnew, 2004; Dai *et al.,* 2004).

The Sudano-Sahelian Ecological Zone (SSEZ) suffered from seasonal and inter-annual climatic variability, and there have been droughts and effective desertification processes, particularly since the 1960s (FRN, 2003). The Sahelian droughts of the 1970s and the 1980s ravaged this zone and left farmers impoverished (Ati *et al.*, 2007). It has also been noted that the frequent occurrences of drought in this zone is

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responsible for the social backwardness and general poor quality of life especially among the less privileged ones (Alatise and Ikumawoyi, 2007). The situation is being aggravated by the increase in human population, which appears to be stressing the natural support system (FRN, 2005).

Since drought is an extreme weather event, appropriate techniques should therefore, be applied to determine its occurrence based on relevant data in order to ameliorate its impact on the people of Nigeria with particular reference to the SSEZ. This study, therefore, examines the extent and degree of severity of drought in the zone. It discusses the implications of the occurrence of droughts for agriculture and water resources development, and also recommends possible solutions based on the findings.

II. Study Area

The SSEZ is located in northern Nigeria between latitude 10^0N and 14^0N and longitude 4^0E and 14^0E (Fig. 1). This zone occupies almost one-third of the total land area of the country. It stretches from the Sokoto plains through the northern section of the high plains of Hausaland to the Chad Basins (Odekunle *et al.*, 2008).

The climate of the zone is the tropical wet and dry type, classified by Koppen as Aw. The zone has an average annual rainfall of about 500 mm in the extreme northeastern part to 1000 mm in the southern sub-region (Abaje *et al,* 2012a&b). The rainfall occurs between the months of April to October with a peak in August. The pattern of rainfall in the zone is highly variable in spatial and temporal dimensions with inter-annual variability of between 15 and 20%. As a result of the large inter-annual variability of rainfall, this zone is subject to frequent dry spells which can result in severe and widespread droughts (Oladipo, 1993; FRN, 2000; Okorie, 2003).

The geology, relief and geomorphological processes that shaped the landforms have greatly influenced the soils (FRN, 2000). More than half of the region is covered by ferruginous tropical soils which are heavily weathered and markedly laterized (Oladipo, 1993; FRN, 2000). They are mostly formed on granite and gneiss parent materials, and on aeolian and many sedimentary deposits (Abaje, 2007). The vegetation is the Savanna type consisting of Sudan and Sahel with the density of trees and other plants decreasing as one move northwards (Abaje, 2007). These two zones (Sudan and Sahel) are together referred to as the SSEZ. This zone has been described by many researchers as the Nigerian dry-land, containing most of the range-land of the country. It constitutes the main source of fodder and grazing land for livestock, and therefore supports large numbers of cattle and other domestic animals. Donkeys and camels are very characteristic of this zone (FRN, 2000).

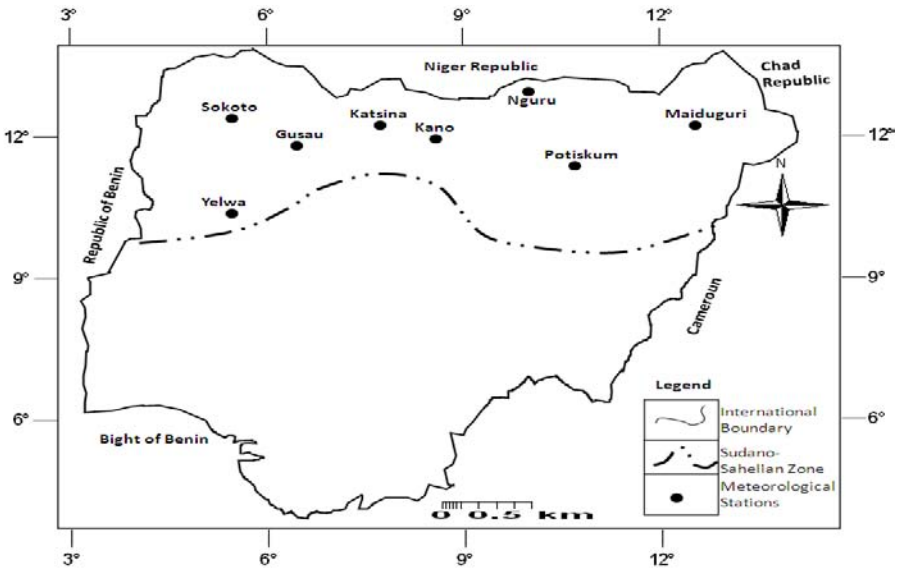


Figure 1 : The Sudano-Sahelian Ecological Zone of Nigeria (Extracted from Iloeje, 1982)

III. Materials and Methods

Rainfall data spanning a period of 60 years (1949-2008) was used in this study (Table 1). The data were sourced from the archive of Nigerian Meteorological Agency (NIMET), Oshodi-Lagos. The data were collected at eight synoptic meteorological stations in the SSEZ of Nigeria-Yelwa, Potiskum, Maiduguri, Kano, Gusau, Sokoto, Nguru, and Katsina. These stations were selected based on the following criteria: 1) they are evenly distributed, 2) all the stations have long period of recorded rainfall data that cover the period of study, 3) they have not been affected by site relocation since their establishment, and 4) the data were tested and found to be normally distributed.

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Table 1 : Eight Meteorological Stations in the Sudano-Sahelian Ecological Zone

Station	Station No.	Latitude	Longitude	Altitude	Period	No. of years
Yelwa	1004.54	$10^0$53'N	$04^0$45'E	224.00m	1949-2008	60
Potiskum	1111.40	$11^0$43'N	$11^0$07'E	487.68m	1949-2008	60
Maiduguri	1113.50	$11^0$51'N	$13^0$05'E	348.00m	1949-2008	60
Kano	1208.03	$12^0$03'N	$08^0$32'E	475.80m	1949-2008	60
Gusau	1206.14	$12^0$10'N	$06^0$42'E	468.00m	1949-2008	60
Sokoto	1205.51^A	$12^0$55'N	$05^0$12'E	309.00m	1949-2008	60
Nguru	1210.52^E	$12^0$58'N	$10^0$28'E	341.00m	1949-2008	60
Katsina	1307.04	$13^0$01'N	$07^0$41'E	516.63m	1949-2008	60

Source : Nigerian Meteorological Agency (NIMET), Oshodi-Lagos.

a) Test for Normality

The standardized coefficients of Skewness (Z_1) and Kurtosis (Z_2) statistics as defined by Brazel and Balling (1986) were used to test for the normality in the seasonal (April to October) rainfall series for each of the stations. These are the months during which most of the stations in the region receive over 85% of their annual rainfall totals. The standardized coefficient of Skewness (Z_1) was calculated as:

$$Z_1 = \left[\left(\sum_{i=1}^{N}(x_i - \bar{x})^{3/N}\right) \Big/ \left(\sum_{i=1}^{N}(x_i - \bar{x})^{2/N}\right)^{3/2}\right] \Big/ \left(6/N\right)^{1/2}$$

and the standardized coefficient of Kurtosis (Z_2) was determined as:

$$Z_2 = \left[\left(\sum_{i=1}^{N}(x_i - \bar{x})^{4/N}\right) \Big/ \left(\sum_{i=1}^{N}(x_i - \bar{x})^{2/N}\right)^{2}\right] - 3 \Big/ \left(24/N\right)^{1/2}$$

Where $\bar{x}$ is the long term mean of x_i values, and N is the number of years in the sample. These statistics were used to test the null hypothesis that the individual temporal samples came from a population with a normal (Gaussian) distribution. If the absolute value of Z_1 or Z_2 is greater than 1.96, a significant deviation from the normal curve is indicated at the 95% confidence level.

b) Drought Indexing

The Normalized Rainfall Index (NRI) as defined by Türkes (1996) was used in depicting periods of different drought intensities in the region. This index uses annual or seasonal rainfall totals and the standard deviation to indicate the shortage of water of any given season. The Index for a given station is computed as:

$$A_{sy} = \frac{R_{sy} - \bar{R}_s}{S_s}$$

Where: *Rsy* = the rainfall total for the station *s* during a year (or a season)

$\bar{R}_s$ = the long-term mean (of the period specified for the station) and,

Ss= standard deviation of the annual (or seasonal) rainfall total for that station.

In this very study, a modified classification of NRI was adopted. This is because extreme values, that is, greater than or equal to 1.76 and less than or equal to -1.76 are very infrequent throughout the period of study. This modified classification is presented in Table 2.

Table 2 : Modified Classes of NRI Values

Index	Character of Rainfall
1.31 or more	Very wet
0.86 to 1.30	Moderately wet
0.51 to 0.85	Mildly wet
0.50 to -0.50	Near normal
-0.51 to -0.85	Mild drought
-0.86 to -1.30	Moderate drought
-1.31 or less	Severe drought

c) Drought Probabilities and Recurrence Intervals

The frequencies of occurrence of mild, moderate and severe droughts were then calculated and their absolute empirical probabilities were computed as the ratio of the number of actual occurrences of mild, moderate and severe drought to the number of possible occurrences. From these absolute probability values, drought recurrence intervals (or return periods) were also obtained as their inverse. This technique is computed as:

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$$P = \frac{n}{Ny}$$

for absolute probability and

$$Ri = \frac{1}{P}$$

for drought recurrence intervals where:

$P =$ absolute probability of drought;

$n =$ number of occurrences of a given category of drought;

$Ny =$ total number of possible occurrence (the period specified for the station);

$Ri =$ drought recurrence intervals (or return periods).

IV. Results and Discussion

a) Test for Normality

The results of the standardized coefficients of skewness (Z_1) and kurtosis (Z_2) for the eight stations are presented in Table 3. All the stations were accepted as normal at 95% confidence level. Therefore, no transformation was made to the rainfall series.

Table 3 : Standardized Coefficients of Skewness and Kurtosis for the Eight Meteorological Stations

Statistics \ Stations	Yelwa	Potiskum	Maiduguri	Kano	Gusau	Sokoto	Nguru	Katsina
Skewness (Z_1)	0.41	0.10	0.23	0.84	0.76	0.07	0.09	-0.24
Kurtosis (Z_2)	1.80	0.52	0.59	0.48	1.07	-0.50	-0.64	-0.17

b) Occurrence of Drought

The results of analysis of Normalized Rainfall Index (NRI) in the study area are presented graphically in Figure 2 (a-h) for the 8 stations.

The results show that the zone is generally replete with severe and prolonged drought events. Mild to severe drought conditions existed over this zone in 1949. The only exception was Sokoto that experienced very wet condition while mildly wet condition existed in Yelwa.

The 1950s generally experienced normal to very wet conditions in the study area. The only exception in the zone was found at Yelwa when moderate drought affected the area in 1950 and 1952. Interestingly, the extreme northern part of the study area that was expected to be affected by drought, had a normal moisture condition throughout the decade. Nguru that is at the extreme northeastern part of the study area was the wettest in that decade.

The early 1960s featured generally normal to wet conditions, except in 1964 when moderate drought affected the northeastern part of the zone. In contrast, the other half of the 1960s was characterized by some isolated mild to severe droughts that affected different parts of the study area. About 29% of the areas were affected by moderate to severe droughts in 1966 to 1968, but this was replaced by a normal condition in 1969. The year 1968 is often referred to as the beginning of the Catastrophic Sahelian Droughts; but from the results of this analysis, only 38 % of the study area was affected by severe droughts in 1968. This implies that the Catastrophic Sahelian Droughts of 1968-1973 did not start simultaneously in the whole of the region. It started in the northern part of the West African Sahel in 1968 and retreated southwards until 1973 when the whole study area was affected by drought.

The Sahelian droughts of the 1970s were more severe and significant in the zone than those previously discussed. In 1971, mild to moderate drought affected some part of the zone. This drought continued in many areas in 1972 and was severe at Nguru. The drought hit the highest point in 1973 in which the whole study area was affected by 50% of moderate and 50% of severe drought conditions. There was a slight break in the intensity and percentage coverage of drought in 1974-1977, with only Sokoto and Potiskum area affected by severe drought in 1974 and 1977 respectively. By 1978-1979, normal conditions return to the environment.

The 1980s were characterized by more widespread, more severe and more persistent droughts than the decade 1970-1979. This decade (1980-1989) witnessed the persistent of drought in the zone beginning in 1981. It was the decade in which severe drought became more extensive. About 63% of moderate to severe droughts cover the zone in 1981-1987. The year 1987 was the driest in that decade in which about 37.5% and 62.5% of the zone was affected by moderate and severe droughts respectively. In particular, the drought of the 1987 was more severe than the driest year (1973) of the Catastrophic Sahelian Droughts of 1968-1973.

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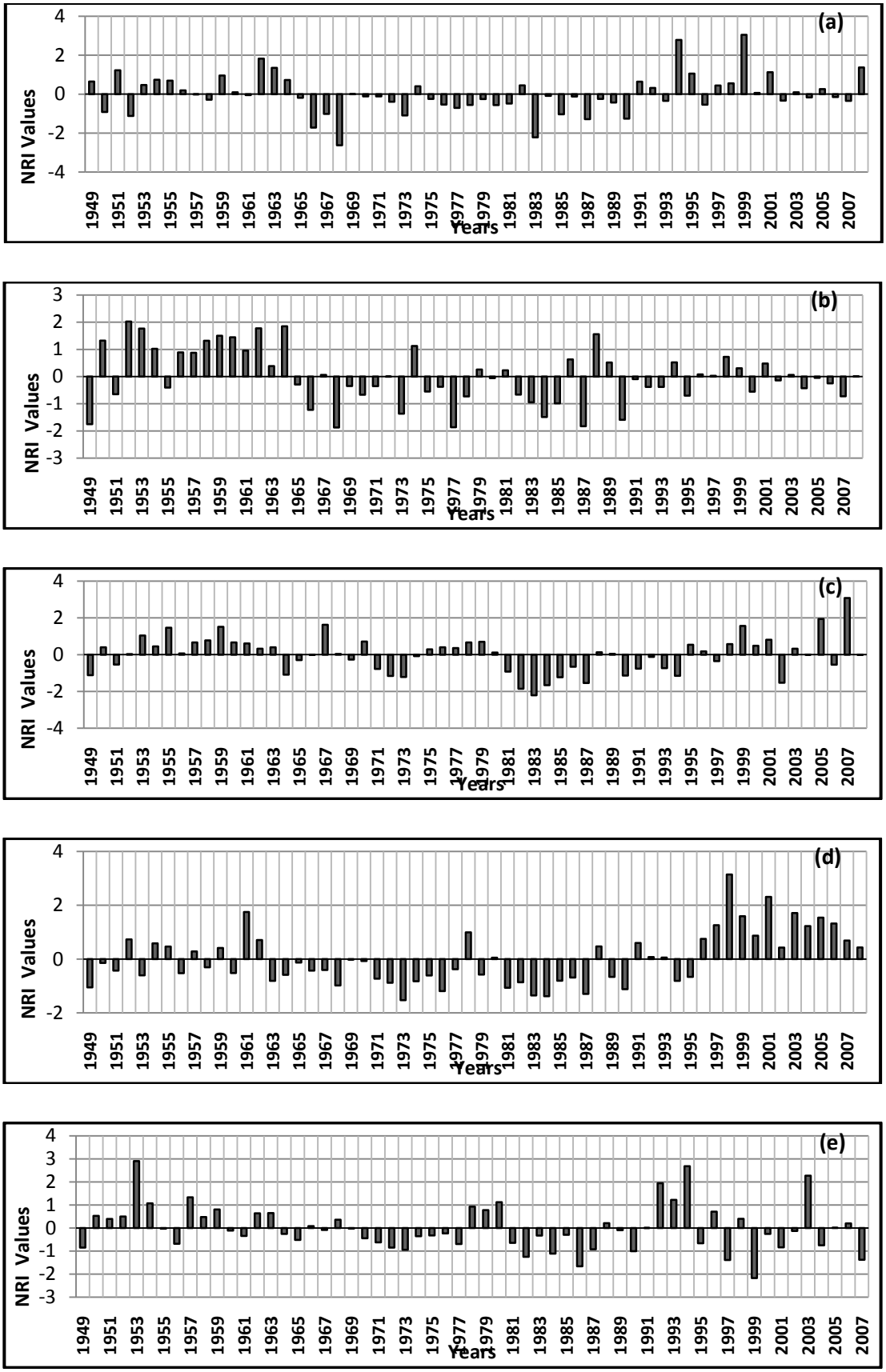


Figure 2 : Normalized Rainfall Index for (a) Yelwa; (b) Potiskum; (c) Maiduguri; (d) Kano; (e) Gusau; (f) Sokoto; (g) Nguru; and (h) Katsina

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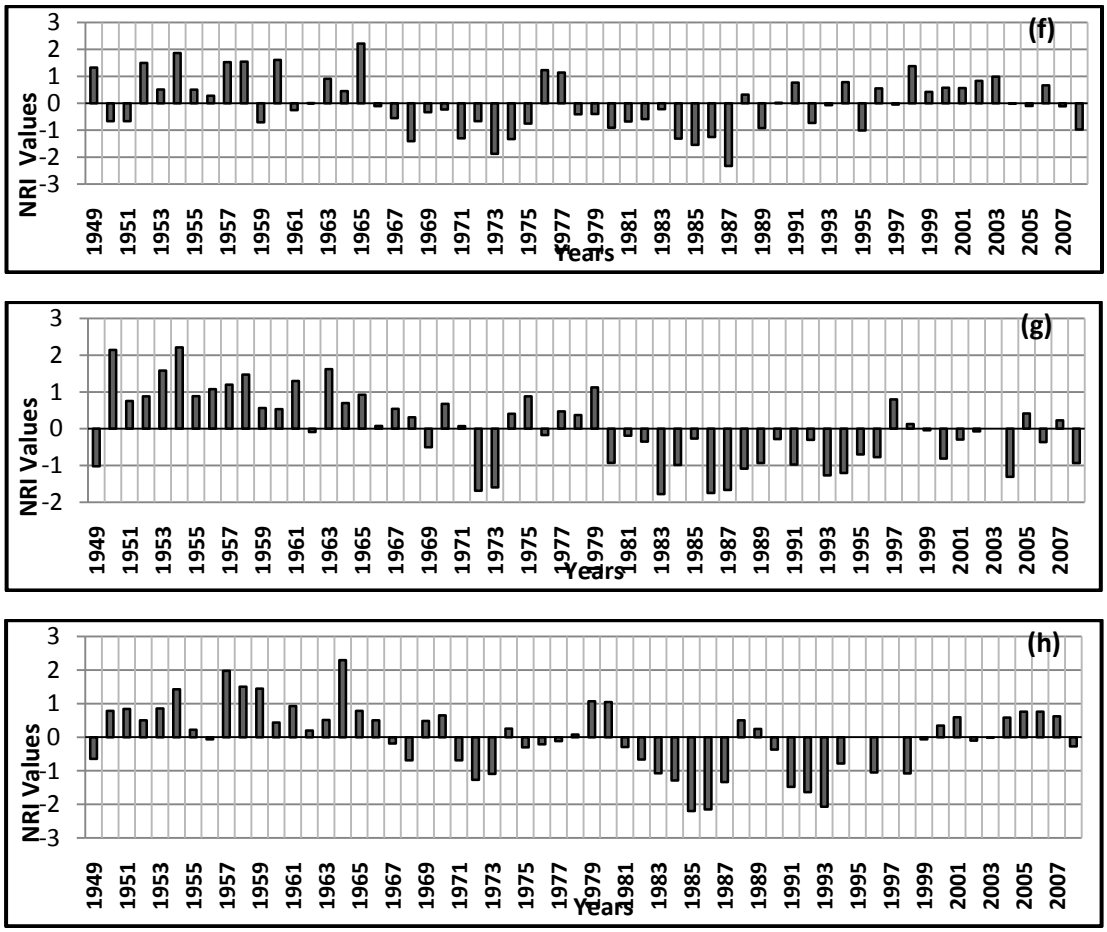


Figure 2 Continued

The first half of the 1990s featured some isolated mild to severe droughts; except 1990 in which 63% of the study area was affected by moderate to severe drought. Surprisingly, the extreme northern part of the zone had a normal moisture condition throughout that year. Contrariwise, the same extreme northern part of the zone was affected by moderate to severe drought in 1991 to 1994. Near normal to very wet conditions of about 78% dominated the other half of the 1990s.

About 85% of the study area during the period 2000-2008 generally experienced near normal to very wet conditions except some isolated mild, moderate and severe droughts that affected about 8%, 3% and 4% of the area respectively. The year 2002 was the driest in the period in which the northeastern part was affected by severe drought. After that normal condition returned in 2003 which is also the wettest year in the period.

Generally, the SSEZ of Nigeria was characterized by larger extent of severe drought since the beginning of 1968 through the early 1970s, and then the 1980s in which the drought was so severe than any other decade in the study period. The year 1987 was the driest in the whole series of drought during the study period followed by 1973 and 1983 in that order. The late 1990s and the 2000s on the other hand have been witnessing a decrease in the number of drought occurrences in the zone. The finding is in agreement with the observation made by Abaje *et al* (2012a) that the SSEZ of Nigeria has been experiencing increasing wetness over the recent years. This may be due to awareness and the general reduction in human activities that causes drought and desertification as a result of the high level of commitment from International Governmental and Non-Governmental Organization such as Intergovernmental Panel on Climate Change (IPCC), United Nations Environment Program (UNEP), and National Drought Mitigation Center (NDMC) amongst others.

c) Frequency of Drought

The absolute probabilities of occurrence of mild, moderate and severe droughts and their respective recurrence intervals were calculated for each station in the study area (Table 4). The values show variation among individual stations. Kano has the highest probability of occurrence of mild drought (0.23) than any other station in the zone with a recurrence interval (or return period) of 4.3 years, while Nguru has the least probability of occurrence of mild drought of 0.07 with a recurrence interval of 14.3 years.

The probabilities of occurrence of moderate drought for the 8 stations show that Nguru has the

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highest probability of 0.15 with a return period of 6.7 years, followed by a probability of 0.13 each for Maiduguri and Kano with a recurrence interval of 7.7 years.

On the other hand, the probabilities of occurrence of severe drought for the 8 stations revealed Potiskum as having the highest probability of occurrence (0.12) with a recurrence interval of 8.3 years. Sokoto, Nguru and Katsina have a probability of 0.10 each with a recurrence interval of 10 years. The least probability of occurrence of severe drought (0.05) is found in Yelwa and Kano with a return period of 20 years.

Table 4 : Probabilities of Occurrence of Droughts and Recurrence Intervals in Years for the Sudano-Sahelian Ecological Zone of Nigeria

Stations	Mild Drought		Moderate Drought		Severe Drought	
	Probability	Recurrence Interval	Probability	Recurrence Interval	Probability	Recurrence Interval
Yelwa	0.08	12.5	0.12	8.3	0.05	20.0
Potiskum	0.13	7.7	0.05	20.0	0.12	8.3
Maiduguri	0.10	10.0	0.13	7.7	0.08	12.5
Kano	0.23	4.3	0.13	7.7	0.05	20.0
Gusau	0.17	5.9	0.08	12.5	0.07	14.3
Sokoto	0.15	6.7	0.10	10.0	0.10	10.0
Nguru	0.07	14.3	0.15	6.7	0.10	10.0
Katsina	0.08	12.5	0.10	10.0	0.10	10.0
Mean for the Zone	0.13	7.7	0.11	9.1	0.08	12.5

A closer examination of the probabilities of occurrence of severe drought in the zone shows that the extreme northern parts and northeastern parts are more susceptible to severe drought. This is in good agreement with earlier researchers that these areas are more prone to drought and desertification (Oladipo, 1993; FRN, 2000; Ayuba, 2007).

The mean absolute probability of mild drought, moderate drought and severe drought for the zone is 0.13 (recurrence interval of 7.7 years), 0.11 (recurrence interval of 9.1 years), and 0.08 (recurrence interval of 12.5 years) respectively. On the whole, the mean absolute probability of occurrence of drought in the zone is 0.11 with a recurrence interval of 9.1 years. The computed recurrence intervals are also in good agreement with the analyzed data in Fig. 2.

V. Implications for Agriculture and Water Resources Development

Water scarcity due to the occurrence of droughts affects the agricultural outputs of the zone. Food shortages result from an abnormal reduction in crop yield. Irrigation projects which would have served to mitigate these problems are also affected by water shortages as most of the dams dry up during droughts. This implies that agro-allied industries may be affected since their raw materials will be lacking. For example, lower production of cotton, tobacco and groundnuts has made the ginneries and textiles industries, tobacco, and cooking oil companies respectively to resort to importation of their raw materials. This may leads to unemployment because most of these industries/companies have to downsize their work force.

During drought periods, the land is under increased stress from both humans and livestock. This often results in the depletion of the soil. Overgrazing becomes destructive during drought when large areas that would normally have been available for grazing dry up. Animal are force to feed on any available edible vegetation they could find. This may be severe enough to cause severe damage to the environment. Once the precarious equilibrium of the plant communities adapted to the characteristically variable climate is upset by persistent drought, complete ecological recovery may be impossible, even when the rains return. Thus, drought has often been regarded as the major cause of desertification.

The occurrence of droughts in this zone has great implications on the cattle sector. The occurrence of mild drought results in cattle losing weight, whereas the occurrence of severe drought results in increased livestock mortality rates due to scarcity or lack of feed. This affects revenue generation and household income. Subsistence farmers who derive other benefits from cattle such as milking and draught power also suffer losses because the quality and quantity of the milk is reduced and also, the weight and strength of cattle for the purpose of draught power is drastically reduced.

The occurrence of droughts leads to the sustenance of few rivers and streams and the lowering of the water table. This has an implication for developmental projects that depend on water from rivers and ground water sources. The lowering of the water

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table on the other hand has an implication in digging of wells and construction of bore holes because the water table may never be reached in some places; as a result, there may be scarcity of water especially in rural areas that depend solely on underground and some surface water sources.

VI. Conclusions

Drought occurs in every part of the globe and adversely affects the lives of a large number of people, causing considerable damage to economies, the environment, and property. It also affects countries or regions differently, having a greater impact on countries or regions with poor economic conditions.

Findings revealed that this zone is generally replete with severe and prolonged drought events and that the Catastrophic Sahelian Droughts of 1968-1973 did not start simultaneously in the whole of the region. It started in the northern part of the West African Sahel in 1968 and retreated southwards until 1973 when the whole study area was affected by drought. Findings further revealed that the decade (1980-1989) witnessed the persistent of drought in the zone. It was the decade in which severe drought became more extensive. In particular, the drought of the 1987 was more severe than the driest year (1973) of the Catastrophic Sahelian Droughts of 1968-1973. The late 1990s and the 2000s on the other hand have been witnessing decreasing in the number of drought occurrences in the zone.

The frequency of drought was computed, and the results revealed that the mean probability of mild, moderate, and severe droughts for the zone were 0.13 (recurrence interval of 7.7 years), 0.11 (recurrence interval of 9.1 years), and 0.08 (recurrence interval of 12.5 years) respectively.

a) Recommendations

It is a bitter reality that abnormal climatic change such as droughts in the Sudano-Sahelian zone of Nigeria cannot be averted and Man can only take measures to lessen their impacts on various disciplines. Therefore, based on the findings, the following recommendations are made:

Herd management practices are of utmost important in this zone. This is because nearly 70% of Nigerian cattle are concentrated here. The zone supports about two-thirds of the goats and sheep and almost all the donkeys, camels and horses found in the country. Herd management practices to be adopted should include the following:

- Reduction in Herd Numbers: When feed resources are getting short, one solution is to critically evaluate the members of the herd and eliminate those that are less useful. Sale or adjustment (relocating herd to non-affected pastures) are the two options available to reduce stock numbers.
- Strategic Weaning of Calves: During a drought, the production of milk rapidly depletes a cow's body reserves, while the calf derives little benefit. Weaning the calf gives the cow a better chance of survival. In drought years, early weaning is recommended. However, calves should not be weaned before 3 months of age unless absolutely necessary.
- Herd Segregation: Segregating animals into classes gives the herd a better chance of getting needed feed supplies. Segregation makes possible the preferential treatment of vulnerable classes. Pregnancy testing is a useful tool to identify heavily pregnant cows for special feeding, especially young cows that are pregnant for a second time.
- Parasite Control: Cattle under nutritional and other stresses are less resistant to parasites than in normal conditions. During drought conditions, all cattle under 18 months of age should be treated for worms.

The establishment and improvement of early warning systems for monitoring the occurrence of meteorological drought in these areas would help in planning of relief measures and will also provide input to determine agricultural drought.

The analysis of existing series of observed climatic data is of paramount important in order to develop the probability distribution of rainfall amount and timing. These distributions will provide information on the beginning, the end and the length of the rainy season and on the amount of available water during the season. Such knowledge is pertinent to the introduction of new, more productive and more drought resistant varieties of different crops and for introduction of improved farming systems. Where water retention and supplemental irrigation are possible, agricultural production can be boosted in a significant way through the use of high yielding varieties together with organic and inorganic sources of fertilization.

Construction of new wells, boreholes, and water harvesting are all mitigating measures that could be taken after the onset of drought.

Considering the importance of ground water as the major water resource for rural, urban, industry and agricultural applications in this zone, opportunities should be provided by the government for professionals to study and develop realistic methods for utilization of ground water without socio-political concerns. In such a case, it would be possible to counter drought crises by using static and dynamic storage capacities of ground water resources.

Drought and Flood Research Centers should be established in all the universities of the zone, and there should be regular organization of educational-/professional short courses on drought management for professional staff and managers and public educational programs to deal with drought problems.

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Remediation of Pesticide-Polluted Water using Ozonation as a Safe Method

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Abstract - The effectiveness of ozone to remove the organic compound, chloropyrifos or cypermethrin from water at the two different levels of 1 and 2 ppm, for each and different contact times was studied. The recovered amounts of chloropyrifos or cypermethrin were extracted based on the solid phase extraction (SPE) method and then analyzed by GC-MS. The results demonstrated that the removal of these organic compounds by ozone increased with increasing the contact time. The removal percentages of chloropyrifos following ozone bubbling for different periods of 15, 30, 45 and 60 minutes at room temperature were 10.5, 96.3, 97.4 and 98.5% in case of samples fortified at the level of 1 ppm, while they were 79.6, 93.9, 94.7 and 96.1% at the level of 2 ppm, respectively. In case of cypermethrin, the removal percentages were 68.6, 90.5, 97 and 99.2% at 1 ppm level, whereas they found to be 30.5, 50, 84.7 and 92% at 2 ppm, respectively. Kinetic studies revealed that chloropyrifos and cypermethrin were found to be easily removed from water by ozone treatment.

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Remediation of Pesticide-Polluted Water using Ozonation as a Safe Method

Prof. Dr. Ahmed K. Salama [α] & Khaled A Osman [σ]

Abstract - The effectiveness of ozone to remove the organic compound, chloropyrifos or cypermethrin from water at the two different levels of 1 and 2 ppm, for each and different contact times was studied. The recovered amounts of chloropyrifos or cypermethrin were extracted based on the solid phase extraction (SPE) method and then analyzed by GC-MS. The results demonstrated that the removal of these organic compounds by ozone increased with increasing the contact time. The removal percentages of chloropyrifos following ozone bubbling for different periods of 15, 30, 45 and 60 minutes at room temperature were 10.5, 96.3, 97.4 and 98.5% in case of samples fortified at the level of 1 ppm, while they were 79.6, 93.9, 94.7 and 96.1% at the level of 2 ppm, respectively. In case of cypermethrin, the removal percentages were 68.6, 90.5, 97 and 99.2% at 1 ppm level, whereas they found to be 30.5, 50, 84.7 and 92% at 2 ppm, respectively. Kinetic studies revealed that chloropyrifos and cypermethrin were found to be easily removed from water by ozone treatment. This is clearly reflected in the half-live values ($t_{1/2}$), where $t_{1/2a}$ values of chlropyrifos were 15.0 and 4 minutes at the levels of 1 and 2 ppm, respectively, following ozone treatment. The $t_{1/2a}$ values of Cypermethrin at the same previous levels and treatments were found to be 8.89 and 21.71 minutes. The present results illustrated that ozone may offer an efficient, fast, safe and friendly treatment for pesticide-polluted water.

I. Introduction

The excessive use of pesticides, their volatility and long-distance transports eventually results in widespread environmental contamination. In addition more toxic and environmentally persistent pesticides are used extensively in developing nations, creating serious acute health problems and local and global environmental impacts (Ecobichon, 2001). Several pesticides were detected in groundwater (Garcia deLlasea and Bernal-Gonzales, 2001; Johnson et al, 2001; and Kadian et al 2008). The amount and type of pesticides in the water of a particular area depends largely on the intensity of production and type of crops being cultivated (Belmonte et al, 2005). Also, the rate at which a pesticide is degraded in both surface and subsurface soils is an important factor in determining the groundwater contamination potential of the pesticide (Di et al, 1998). This implies that most of the applied pesticides find their way as 'residue' in the environment into water and the terrestrial and aquatic food chains where they undergo concentration and exert potential, long term, adverse health effects (Ekstrom et al, 1996; Chirone et al, 2000; and Osman and Al-Rehiayani, 2003). Since the late decades, concern about the contamination of water sources has risen due to the increasing number of pesticides detected. Regulations for drinking water are required in order to limit human risks and environmental pollution. These regulations are well defined in North America, depending on the toxicity level of each compound, and Europe (Directive, 1998) setting at 0.1 ppm of pesticide concentration for a single pesticide compound and 0.5 ppm for the sum of all pesticides in water samples. Chlorpyrifos (O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphorothioate) is one of the most organo-phosphorus pesticides that is a widely-used for controlling various insect pests in agricultural and urban settings. Chlorpyrifos enters aquatic systems through spray drift, runoff, erosion, and spills (Racke, 1993). Cypermethrin has been widely used in both indoors and outdoors (Kaufman et al, 1981). It is especially effective towards the control of insect pests in many crops, outdoor mosquito control and as an indoor insecticide (Takahashi et al, 1985). Cypermethrin is commonly found in rivers, sediments, soils, and even foodstuffs (Allan et al, 2005 and Amweg et al, 2005). In recent times the removal of organic harmful pollutants present is investigated by means of a variety of chemical procedures. Advanced oxidation processes (AOPs) which are constituted by the combination of several oxidants, have proven to be very effective in treating a wide variety of organic contaminants. These technologies utilize powerful oxidizing intermediates (mainly OH radicals) to oxidize organic pollutants, leading not only to their destruction, but also, given sufficient conditions, to their complete mineralization. The OH radicals can be generated, for example, by the application of ozone/hydrogen peroxide, ultraviolet radiation/ozone, ultraviolet radiation/hydrogen peroxide, ozone/electron beam (Gehringer et al, 1992; Legrini et al, 1993 and Acero et al 2001). Ozone is a triatomic form of oxygen and is referred to as activated oxygen, allotropic oxygen or pure air. It is an unstable gas and the half-life ozone in distilled water at 20 ^{0}C is about 20-30 min and degrades in pure water rather quickly to

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oxygen, and even more rapidly in impure solution (Hill and Rice 1982), while It has a long half-life in the gaseous state (Rice, 1986). Ozone has been approved for use as a disinfectant or sanitizer in foods and food processing in the United States for removing residual pollutants such as pesticides and other pollutants which are difficult to get rid of in biological oxidation processes due to its high oxidability, high reaction rate and absence of any secondary pollution. It is considered as a powerful oxidant having electrochemical oxidation potential of 2.0V versus 2.8V for hydroxyl radical. Consequently, oxidation by ozone have usually been used as an effective method for removing residual pollutants such as pesticides and other hazardous chemicals from raw water used for drinking and for wastewater treatment (Lafi and Al-Qodah, 2006). There is no data about the removal of chropyrifos or cypermethrin from water in KSA and the search for means to improve the production of clean water in KSA is always the target of scientists, politicians and businessmen, who seek new techniques to enhance the quality and safety of this product. A wide range of water and terrestrial ecosystems might be contaminated with chlorpyrifos and cypermethrin (EPA, 1997 and Sapozhnikova et al, 2004) which have increased the public concern to establish an efficient, safe, and cost effective method to remove or detoxify chlorpyrifos and cypermethrin residues in contaminated water. Therefore, the present study was carried out to evaluate the effectiveness of ozone at different contact times as a safe method for removal of chropyrifos and cypermethrin in water samples.

II. Materials and Methods

a) Chemicals

Technical grade standard of chlropyrifos (O,O-diethyl O-(3,5,6-trichloro-2-pyridinyl) phosphorothioate) was obtained from Chemservice, USA, with purity of 99% purity, while cypermethrin (cyano(3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethyl cyclopropanecarboxylate) was purchased from Agrochemicals, Egypt, with purity of 91.5%. Certified HPLC-grade of actone, methanol, cyclohexane and ethyl acetate were purchased from BDH Company, while the Water spe-20G Column Processor designed vacuum manifold capable of processing up to 20 solid phase extraction (SPE) columns and SPE columns (Waters spe™, C18, 500 mg per column) were purchased from Waters, USA. Ultra-pure deionized water of 15 MΩ cm resistivity was obtained from a water purification system (PURELAB Option-R, ELGA, UK) and used throughout this study. All other chemicals used in this study were of the highest grade available.

b) Experimental Procedure

i. *Removal of organic compounds residues from groundwater*

Groundwater samples were collected from different locations at Al-Qassim region. Water samples were fortified with the organic compounds, chlropyrifos and cypermethrin at two levels for each compound (1 and 2 ppm). Removal of organic compounds from water samples was studied at four different contact times to ozone gas (15, 30, 45 and 60 min) at room temperature (25 ± 1^0C). Triplicate random water samples (4 L each) were treated with ozone at the previous mentioned periods. Ozone gas (100 ppm at air flow rate of 2.5 L/min with ozone output of 300 mg/hr) produced by Xetin Ozone Air &Water purifier (Model XT 301, Xetin Co. Ltd, Taiwan) was bubbled into 10 liters deionized water in polypropylene cylinder. The duration of dissolved ozone levels were controlled via adjusting the duration of bubbling. A 500 ml volume of water was withdrawn after different time on intervals and kept at 4^0C until analysis.

ii. *Extraction Procedure*

Water samples were extracted according to the procedure of Quintana et al (2001). with slight modification. In brief, A 500 ml volume of water, in which 5 ml of methanol had been added, was passed over the conditioned sorbent (3 ml of ethyl acetate, 3 ml of methanol and 6 ml of water, the sorbent of SPE was never allowed to dry during the conditioning and sample loading steps.) at a flow-rate of 5 ml/min. The sorbent was afterwards dried under vacuum for 20 min. Elution was performed by soaking the cartridge with 2.5 ml of ethyl acetate at a flow-rate of 0.8 ml/min, eluted with a second portion of 2.5 ml of ethyl acetate and collected in a glass vessel containing 0.5 ml of isooctane. The elute was then dried under vacuum to 0.45 ml. The volume was precisely readjusted to 0.5 ml of isooctane and then analyzed by gas chromatography-mass spectroscopy (GC-MS).

iii. *Recovery Experiments*

Pure water samples were spiked with either chlropyrifos or cypermethrin standard solutions in acetone to give the four levels of 0.25, 0.50, 1 and 2 ppm prior to extraction. They were then prepared according to the proposed procedure as described previously and then absolute recoveries were measured. The recovery values were found to be ranged from 98-104 and 92-106% for chlropyrifos and cypermethrin, respectively.

iv. *Determination of detection and quantitation limits*

The limits of detection (LOD) and limit of quantitation (LOQ) were calculated from the signal-to-noise ratios obtained by analyzing unspiked samples (n = 10); LOD and LOQ were taken to be the concentrations of pesticide resulting in a signal-to-noise ratio of 3 and 10, respectively. The LOD values were

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1.90 and 0.2 ppb, while and LOQ values were 6.30 and 0.67 ppb for chlropyrifos and cypermethrin, respectively.

v. *Gaschromatography-mass spectrometry (GC-MS)*

Gas chromatography (Model GC 450, Varian Inc., The Netherlands) with a mass spectrometry (MS 220.41) detector equipped with split/splitless injector with electronic pressure control was employed. A Fused silica CP-Sil 8 CB-LB/MS capillary column (30 m x 0.25 mm i.d) was used in combination with the following oven temperature programme for chlropyrifos: initial temperature 50 °C, 5 °C/min ramp to 160 °C held for 10 min (first step) and from 160 to 250 °C (20 min) at 15 °C (final step) and 90 °C, 5 °C/min ramp to 160 °C held for 10 min (first step) and from 160 to 250 °C (20 min) at 15 °C (final step) for cypermethrin. The injector temperature was 280 °C and mass range from 50-650 amu. The carrier gas (helium, 99.999%) flow rate was set to a constant head pressure of 200 kPa at flow rate of 1.0 ml min-1 with split ratio of 1: 20 min. The mass spectrometer was operated in electron ionization mode with a transfer line temperature of 280 °C, manifold temperature 40 °C, ion trap temperature 200 °C, ion source 240 °C and selected ion monitoring (SIM) mode. The ion energy for electron impact (EI) was kept at 70 eV. MS Workstation version 6.9.1. was used for data acquisition. For positive identification, both retention time (Rt) and the presence of five fragment ions (z/m ions: 197, 97, 199, 29 and 414 for chlropyrifos and 163, 165, 181, 91 and 77 for cypermethrin) were considered. Figures 1 and 2 represent the GC-MS chromatgrams for chlropyrifos and cypermethrin, respectively.

III. Results and Discussion

The study shows one of the analytical methods that use a solid phase extraction (SPE) to pre-treat the sample and further analysis of the extract by gas chromatograph- mass spectrometer(GC-MS) equipped with electron impact ionization (EI) detector. SPE is particularly suited for the isolation of organic micro-pollutants from water and has now become the method of choice in order to carry out simultaneously the extraction and concentration of many pesticides and metabolites in aqueous samples (Heberer et al, 1994; Font, 1993 and Sabik et al, 2000). The most widely used sorbents are C8 and C18 chemically bonded to silica, carbon black and polymeric resins (Sabik et al, 2000).

a) Removing of chlropyrifos and cypermethrin by ozone treatment

The effect of ozone treatment on either chlropyrifos or cypermethrin residues for different contact times was investigated. The amount of either chlropyrifos or cypermethrin levels was significantly decreased exponentially as the contact time increased in water samples at the two tested levels of the pesticides (1 and 2 ppm) compared to the initial levels, control, (Tables 1-2). The data showed that ozone declined the amount of chlropyrifos in water samples following the all intervals of treatment. The removal percentages were 10.5, 96.3, 97.4 and 98.5% in samples spiked with 1ppm of chlropyrifos after 15, 30, 45 and 60 min, respectively, while they were 79.6, 93.9, 94.7 and 96.1% in samples spiked with 2 ppm. In case of cypermethrin, the removal percentages were 68.6, 90.5, 97 and 99.2% in water samples spiked with 1ppm following ozone bubbling for 15, 30, 45 and 60 min, respectively, whereas they were 30.5, 50, 94.7, 84.7 and 92% at 2 ppm fortification level in the same order.

b) Kinetic Studies

A biphasic model was assumed according to Sigma Plot (2011) in order to carry out the statistical study of the of either chlropyrifos or cypermethrin removal in water (equation 1).

$$C_t = A_0 e^{-\alpha t} + B_0 e^{-\beta t} \quad (1)$$

Where Ct is the recovered amount of pesticide at t min, A_0 and B_0 are the concentrations of the pesticide at t=0, while α and β are the disappearance rate constants for the first and second and phases, respectively. The half-life ($t_{1/2}$) of the exponential decay was calculated according to the equation (2).

$$t_{1/2} = (2.303 \log 2)/ \text{rate constant} \quad (2)$$

The data fitting results in case of all ozone treatment using second order kinetic showed that the coefficients of determination (R2) were 0.829 and 0.999 for chropyrifos as well as 0.9990 and 0.9510 for cypermethrin when the tested levels of pesticide were 1 and 2 ppm, respectively (Tables 5 and 6). The biphasic model is characterized by a rapid phase (first phase), and a much slower phase (second phase). This is clearly reflected in the half- live values ($t_{1/2}$), where $t_{1/2\alpha}$ values for chlropyrifis were 15.0 and 4 min, and $t_{1/2\beta}$ values were 15.1 and 17.96 min, at the spiking levels of 1 and 2 ppm, respectively, following ozone treatment. On the other hand, $t_{1/2\alpha}$ values of cypermethrin were 8.89 and 21.71 min and $t_{1/2\beta}$ values were 9.00 and 21.71 min at the spiking levels of 1 and 2 ppm, respectively, following ozone treatment.

The present findings are in accordance with those of many investigators who reported that the kinetics of pesticide degradation is commonly biphasic with a very rapid degradation rate at the beginning followed by a very slow prolonged dissipation (Alexander, 1994; Jones et al, 1996; Rigas et al, 2007 and Osman et al, 2009). The relative importance of the phases depends on the availability of the pollutants, hydrophobicity, and affinity for organic matter. So it is recommended to use such simple and non-toxic treatment to reduce such residues in water. The present study revealed that removing of either of chlropyrifos or cypermethrin from water depends on the contact times. Also, the amount of pesticide removed by water is

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related to its water solubility and octanol–water partition coefficient.

One of the health concerns of using oxidants to degrade pesticide is the formation of toxic intermediates. The present study investigated the efficacy of ozone to remove chlropyrifos and cypermethrin from water. Ozone was assayed for treatment has a powerful oxidant having electrochemical oxidation potential of 2.0V, and thus, can modify the chemical structure of the selected pesticides creating derived by-products. If these by-products are more toxic than the parent pesticide, such washing treatments should not be utilized to reduce pesticide residue levels in water.

Ozone selectively reacts with compounds containing hetero-atoms such as S, N, O, and Cl via two different pathways, namely direct molecular and indirect radical chain-type reactions Gottschalk et al, 2000). Thus, pesticides, which usually have some hetero-atoms on the molecules, are often expected to be destroyed by ozonation (Reynolds, 1989). However, as has been found by many researchers, the reactivity of pesticides with ozone varies largely due to their diverse structural features (Reynolds, 1989; David et al, 1991) the characteristics of the wastewater to be treated, i.e., pH, concentration of ozone decomposition initiators, promoters and scavengers in the reacting medium (Glaze et al, 1987).

IV. Conclusions

Water is the basic necessity of life and water contaminated with toxic pesticides is associated with severe effects on the human health. Hence it is pertinent to explore strategies that address this situation of water safety especially for the developing countries where pesticide contamination is widespread due to indiscriminate usage. It is therefore of significance to evaluate simple and effective strategies as such ozone to enhance water safety from harmful pesticides. Due to its high oxidability, high reaction rate and absence of any secondary pollution, ozonolysis technique should be used in the sanitization of water especially in the treatment of pesticides which are difficult to get rid of. Results of this work, provided some basic concepts that can be helpful in water treatment for consumers. Therefore, the present study validated that ozone treatment is safe and promising processes for the removal of pesticides from water under domestic conditions. Results found in the present study must not be extrapolated to other pesticides.

V. Acknowledgements

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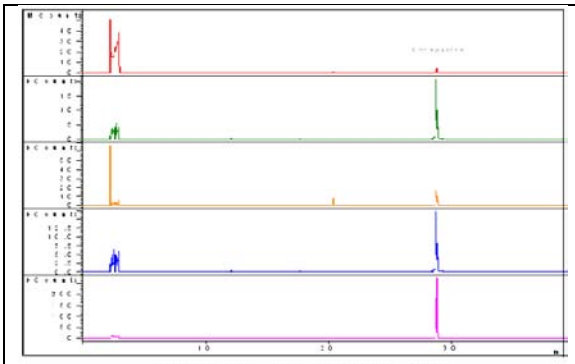


Fig (1). GC-MS profiles for chlorpyrifos

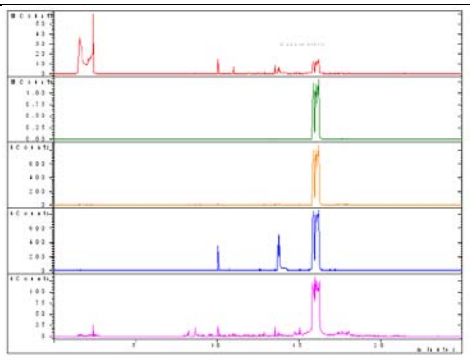


Fig (2). GC-MS profile for cypermethrin

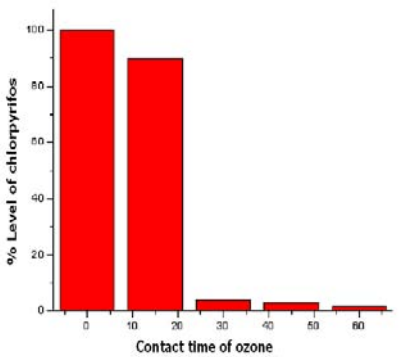


Fig (3). Effect of ozone treatment on removing of chlorpyrifos at 1 ppm level from water

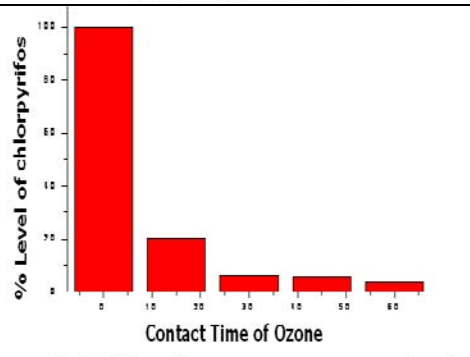


Fig (4). Effect of ozone treatment on removing of chlorpyrifos at 2 ppm level from water

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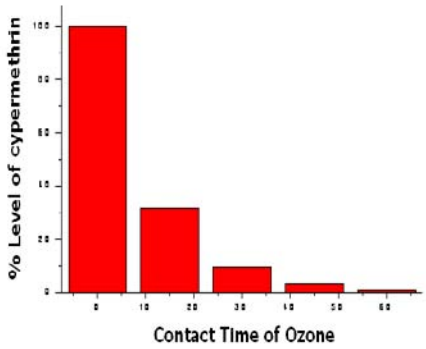


Fig (5). Effect of ozone treatment on removing of cypermethrin at 1 ppm level from water

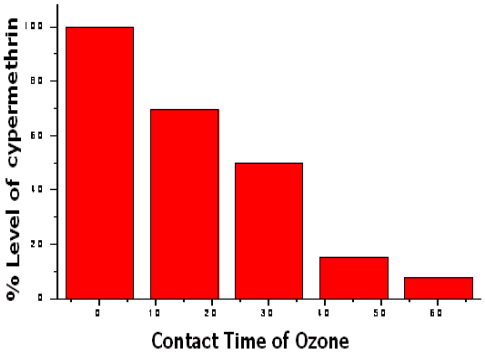


Fig (6). Effect of ozone treatment on removing of cypermethrin at 2 ppm level from water

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Table 1 : Effect of ozone treatment on chlorpyrifos removal from water samples spiked with either 1 or 2 ppm

Contact time (min)	1 ppm			2ppm		
	Chlorpyrifos amounts (ppm)	% of pesticide level	% of pesticide removal	Chlorpyrifos amounts (ppm)	% of pesticide level	% of pesticide removal
0	1.001±0.11	100	0	2.012±0.20	100	0
15	0.896±0.12	89.5	10.5	0.410±0.11	20.4	79.6
30	0.037±0.01	3.7	96.3	0.122±0.009	6.1	93.9
45	0.026±0.01	2.6	97.4	0.107±0.005	5.3	94.7
60	0.015±0.0	1.5	98.5	0.078±0.007	3.9	96.1

Each value is the mean ± S.D of three replicates with 6 determinations

Table 2 : Effect of ozone treatment on cypermethrin removal from water samples spiked with either 1 0r 2 ppm

Contact time (min)	1 ppm			2ppm		
	Cypermethrin amounts (ppm)	% of pesticide level	% of pesticide removal	Cypermethrin amounts (ppm)	% of pesticide level	% of pesticide removal
0	1.006±0.17	100	0	1.998±0.00.9	100	0
15	0.316±0.08	31.4	68.6	1.388±0.030	69.5	30.5
30	0.091±0.012	9.5	90.5	0.919±0.033	50	50
45	0.033±0.010	3.0	97	0.306±0.007	15.3	84.7
60	0.008±0.002	0.8	99.2	0.159±0.006	8	92

Each value is the mean ± S.D of three replicates with 6 determinations

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Table 3 : Kinetic parameters for chlorpyrifos dissipation in water in presence of ozone treatment

Pesticide Level	Kinetic Parameter						
	A_0 (ppm)	α (min^{-1})	$t_{½\,\alpha}$ (min)	B_0 (ppm)	β (min^{-1})	$t_{½\,\beta}$ (min)	Regression coefficient (R^2)
1ppm	56.71	4.62×10^{-2}	15.0	52.11	4.60×10^{-2}	15.10	0.803
2ppm	81.79	1.40×10^{-1}	4.95	18.22	3.86×10^{-2}	17.96	0.999

α and β are the disappearance rate constants for the first and second phases.
$t_{½\,\alpha}$ and $t_{½\,\beta}$ are the half-life times for the first and second phases.
Each value is the mean of three replicates with six determinations.

Table 4 : Kinetic parameters for cypermethrin dissipation in water in presence of ozone treatment

Pesticide level	Kinetic Parameter						
	A_0 (ppm)	α (min^{-1})	$t_{½\,\alpha}$ (min)	B_0 (ppm)	β (min^{-1})	$t_{½\,\beta}$ (min)	Regression coefficient (R^2)
1ppm	50.93	7.79×10^{-2}	8.89	49.11	7.79×10^{-2}	9.00	0.999
2ppm	53.10	3.19×10^{-2}	21.71	50.69	3.19×10^{-2}	21.72	0.951

α and β are the disappearance rate constants for the first and second phases.
$t_{½\,\alpha}$ and $t_{½\,\beta}$ are the half-life times for the first and second phases.
Each value is the mean of three replicates with six determinations.

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Landscape Dynamics in Relation to Slope and Elevation in Garo Hills of Meghalaya, India using Geospatial Technology

By Sarma, K. Yadav, P.K & Sarmah, R.K.
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Abstract - Garo hills region of northeast India is severely affected by sheet erosion mainly because of the age old tradition of shifting cultivation in the fragile hill slopes aided by other anthropogenic activities. Slope and elevation are important parameters that provide varieties of topographical feature for ecological patches. Vegetation is one of the major factors controlling soil erosion, while most soil erosion occurrences are due to the removal of vegetation and topsoil. Change matrix result indicates dynamic character of landscape.The present study is conducted to examine the landscape dynamics to relate vegetation cover with slope and elevation in three Garo hills districts of Meghalaya using temporal remote sensing data of 2001 and 2010. It is revealed that there is decrease in open forest during the study period while areas under dense forest and non-forest increased. This increased forest areas are confined in the high slopes which are inaccessible.

Keywords : *change matrix, GIS, jhum, northeast india, remote sensing.*

GJHSS-B Classification : *FOR Code : 040601*



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Landscape Dynamics in Relation to Slope and Elevation in Garo Hills of Meghalaya, India using Geospatial Technology

Sarma, K.[α] Yadav, P.K [σ] & Sarmah, R.K. [ρ]

Abstract - Garo hills region of northeast India is severely affected by sheet erosion mainly because of the age old tradition of shifting cultivation in the fragile hill slopes aided by other anthropogenic activities. Slope and elevation are important parameters that provide varieties of topographical feature for ecological patches. Vegetation is one of the major factors controlling soil erosion, while most soil erosion occurrences are due to the removal of vegetation and topsoil. Change matrix result indicates dynamic character of landscape.The present study is conducted to examine the landscape dynamics to relate vegetation cover with slope and elevation in three Garo hills districts of Meghalaya using temporal remote sensing data of 2001 and 2010. It is revealed that there is decrease in open forest during the study period while areas under dense forest and non-forest increased. This increased forest areas are confined in the high slopes which are inaccessible. Considerable portionsin the vulnerable slopes are utilized for shifting cultivation which could be devastating. The present study shows more than a double fold increase in shifting cultivation in the high altitudinal area which is negative sign in terms of environment protection. Conversion of dense forest to open forest occurred in all the slope categories while alteration from open to dense forest predominated in the moderate and high slope categories. Maximum change from open to non-forest is in the slope categories of moderate andlow. There is considerable change from current jhum to open forest mostly in the moderate slope category. The maximum exchange between dense to open and open to dense occurred in the moderate slope and elevation areas.

Keywords : *change matrix, GIS, jhum, northeast india, remote sensing.*

I. Introduction

Landscape dynamic is concerned with the effect of spatial heterogeneity on ecological process. The physical environment including climate, geology, topography, plant succession, species extinction and evolution is often regarded as one of the most important factors controlling this heterogeneity of the landscape in mountain areas. Disturbances like shifting cultivation, landslide, floods, deforestation, urbanization, forest fire, and the ecosystem modification are responsible for landscape dynamics (Zimmermann & Eggenberg, 1990). Land use/ coverstudy shows present as well as past conditions of the earth surface and it is a central component and strategy for managing natural resources and monitoring environmental changes (Yadav*et al.,* 2012a). Landscape ecology is the study of patterns and structures across temporal and spatial scales. Spatial patterns observed in landscape result from complex interactions between biotic and abiotic processes and disturbances that occur within environment (Turner *et al.,* 2001). As changes occur in the landscape, the overall structure and composition of ecological community is affected, hence the importance of the study related to landscape is increasing for maintainingthe ecological diversity. Among different environmental factors that produce landscape patches slope and elevation are important parameters that provide varieties of topographical features (Sarma and Barik, 2010). The study of the slope is important not only it provides the variety of topographical features but also provides evidence for the interpretation of complex form of the existing landscape and reflects the evolutionary history of the landform (Fairbridge, 1968). Elevation pattern of landscape have been responsible for many factors like climate, isolation, species-area effects, historic events and biomass productivity of landscape patches (ICIMOD, 2000 and Acharya*et al.,* 2011).Vegetation is one of the major factors controlling soil erosion, while most soil erosion occurrences are due to removal of vegetation and topsoil(Bochet and Fayos, 2004 and Yadav*et al.,* 2012b). The shifting cultivation accounts for 60 percent global forest loss each year (Lele*et al.,* 2008) and in northeast India annual forest loss is about 10,000 sq.kmdue to this unhealthy practice. The total area affected by shifting cultivation (locally known as jhum) in northeast is estimated to be 44,000 sq.km (Singh, 1990). The jhum cycle in northeast has been decreased from 20 to 30 years in the past to about 5 years (Toky and Ramakrishnan, 1981)and in many areas even up to 3-5 years (Sarma, 2010a). Vegetation and land characteristics of Garo hills of Meghalaya, northeast India are heavily influenced by jhum activities (Figure 1) which have greatly amplified in recent decades with increase in human population, resulting in severely

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fragmenting previously undamaged forest tracts (Singh *et al.,* 2011).

Remote sensing and geographical information system (GIS) coupled with computer programs allow to use landscape ecological principle for biodiversity characterization more efficiently (Yadav*et al.,* 2013). This technology has improved the efficiency of land use/ cover mapping and change detection with respect to slope and elevation pattern at landscape level. Digital Elevation Model (DEM) is a potential tool for terrain analysis at the varied spatial and temporal scales. The objectives of the present study include generation of slope and elevation maps of Garo hills districts of Meghalaya, preparation of land use/ cover maps for two different decades and to examine the dynamic relationships of slope and elevation with land use/ cover using temporal remote sensing data.

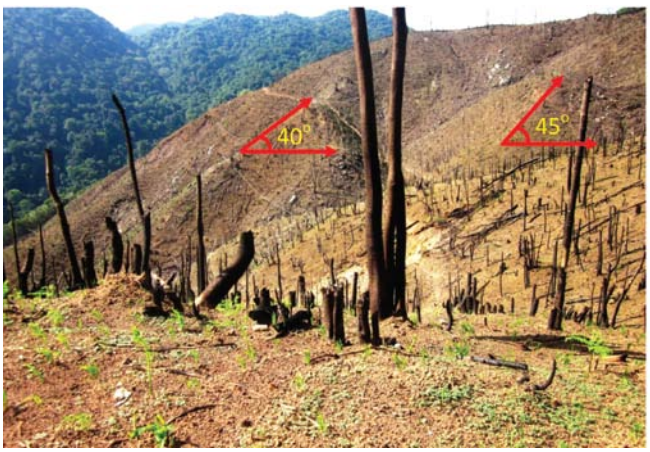


Figure 1 : Photograph showsthe base in different slopes for cultivation after removing the vegetation by slushing and burning in Nokrek biosphere reserve of Garo Hills

II. Study Area

The Garo Hills of Meghalaya consist of three districts viz., East Garo Hills, West Garo Hills and South Garo Hills (Figure 2). The districts are bordered in the north and west by Assam state, south by Bangladesh and east by West Khasi Hills district of the state. The districts are highly dissected with irregular terrain. The highest point of Garo hills is theNokrek peak with an altitude of 1,412m above msl. The total area of Garo Hills districts is 8,167 sq. km, which is 36.4 percent of the total area of the state(Sarma, 2010b). The soil of the districts is red loam and is poor in silica but rich in clay forming materials. The soil is generally loamy but often found clay to sandy loam. The surface horizon which is about 30 cm thick has colours ranging from reddish brown to dark reddish brown. The soils are rich in organic matter and nitrogen but deficient in phosphorous and potassium and they are acidic in reaction (Sarma and Barik 2012). The climate of the area is monsoonic and directly influenced by the south-west monsoon (Sarmaet al. 2004). The vegetation of Garo hills could be broadly classified into tropical and subtropical types depending on the altitude. The tropical vegetation is found up to an elevation of about 1000 m (Sarma et al. 2005).

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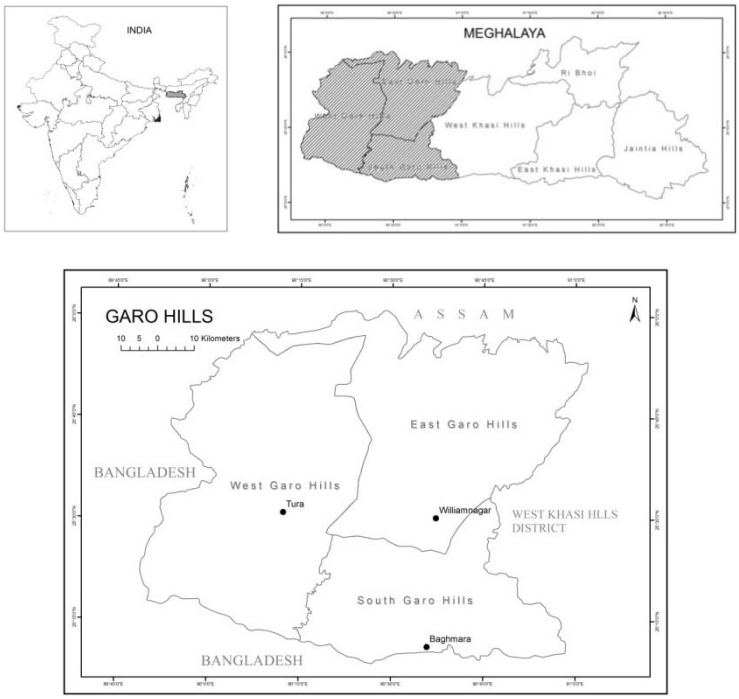


Figure 2 : Location of the study area

III. Materials and Methods

For landscape dynamic study temporal remote sensing imagery of 2001 and 2010 were utilized while for generating digital elevation model 2001 base year was considered (Table 1). The satellite images with bands (7) were stacked to prepare an FCC of bands 3(Red), 2(Green) and 1(Blue). The relevant topographic maps and image were geometrically rectified in 1:50,000 scale using geographic projection system UTM; speroid and datum used were WGS 84 with UTM zone 45N. The GIS and image processing software used are ArcGIS 10, Erdas Imagine 2011 and Quantum GIS 1.6. The paradigm for the study is described in Figure 3. Field verification was carried out during 1st February to 11th April 2012. Accuracy assessment of the classification schema is given in Table 2.

Table 1 : Details about the satellite imagery used for the study

Path & Row	Data Type	Date Production
138& 42	Landsat TM	15-12-2001
137& 42	Landsat TM	21-11-2001
137& 43	Landsat TM	26-12-2001
138 &42	Landsat ETM+	06-02-2010
137 &42	Landsat ETM+	30-01-2010
137 &42	Landsat ETM+	30-01-2010
137 &42	LiDAR STRM (DEMs)	2001

Table 2 : Accuracy of assessment of supervised classification

Year	Overall classification accuracy	Overall kappa statistics
2001	85.94%	0.77
2010	92.19%	0.85

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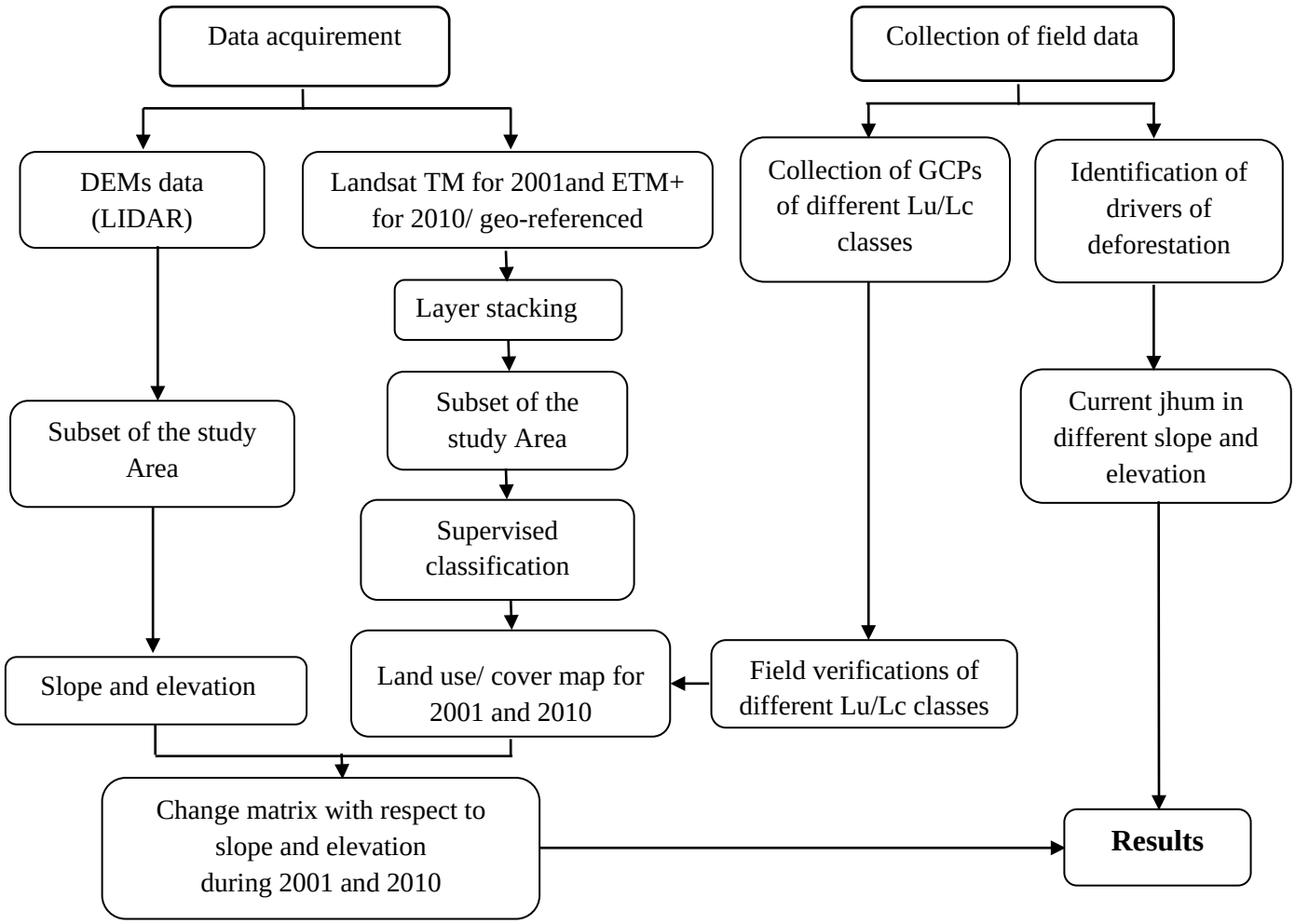


Figure 3 : Paradigm for assessing the landscape dynamics in relation to slope and elevation

IV. Results

Four land use/cover classes viz., dense forest (more than 40% canopy cover), open forest (10% to 40% canopy cover),non-forest (less than 10%) and current jhumhave been delineated for the study area (FSI, 2005). For slope three categories of high (above 14 degree), moderate (6 to 14 degree) and low (below 6 degree) are considered. Accordingly for elevation high (above 900 m), moderate (300 to 900 m) and low (below 300 m) categories are fixed.

It is found that in both the years the area under open forest (6,365 sq.km and 4,307 sq.km) has the maximum coverage which is followed by non-forest area (2,155 sq.km and 2,846 sq.km). There is a decrease of 2,058 sq.km open forest during the period while areas under non-forest increased by 1,591 sq.km. The area of dense forest increased in the decade(218 sq.km). This may be due to the efforts put by government and other organizations who are working for the regeneration of the natural forests of Garo hills. This increase is found mostly in the areas under moderate and high slope areas. Loss of open forest areas is found in all the slope categories where maximum loss found in low slope category. Similar trend is followed by non-forest areas. The high slope areas are also utilized for shifting cultivation which is vulnerable in terms of sheet erosion. In fact the areas under shifting cultivation in the high slope areas increased during the decade in considerable proportion (Table 3). Maximum areas of dense forest are concentrated in the high and moderate altitudinal areas which are mostly inaccessible. Open forests are dominating in the moderate and low elevation areas. Non-forest areas are found in excess in the low elevation areas. It is observed that in the high altitude the jhum area increased in more than double fold during 2001 and 2010 (Table 4).

Change matrix result indicates dynamic character of landscape. Here, land use/cover change matrix was categorized in eight classes viz., dense forest to open forest, open forest to dense forest, open forest to current jhum, open forest to non-forest, current jhum to open forest, no changes and others with respect to different slope and elevation categories. Conversion of dense forest to open forest occurred in all the slope categories. The alteration from open to dense forest predominated in the moderate and high slope

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categories. Maximum change from open to non-forest is in the slope categories of low and moderate. There is considerable change from current jhum to open forest mostly in the moderate slope category. The maximum exchange between dense to open and open to dense occurred in the moderate slope elevation areas. Changes in other categories from open forest are found mostly in moderate and low elevation areas. In these two zones only changes occurred from jhum to open forest (Table 5 and Table 6).

Table 3 : Area statistics of LULC in different slope (in degree) category of Garo hills, 2001 and 2010

Land use/cover class	Slope Year 2001			Total	Slope Year 2010			Total
	Area in km^2 in low	Area in km^2 in moderate	Area in km^2 in high		Area in km^2 in low	Area in km^2 in moderate	Area in km^2 in high	
Dense forest	35	162	178	375	18	247	328	**593**
Open forest	1,697	3,403	1,265	6,365	897	2,576	834	**4,307**
Current jhum	67	86	19	172	107	268	46	**421**
Non-forest	913	306	36	1,255	1,690	866	290	**2,846**
Total	**2,712**	**3,957**	**1,498**	8,167	**2,712**	**3,957**	**1,498**	**8,167**

Table 4 : Area statistics of LULC in different elevation (in meter) category of Garo hills, 2001 and 2010

Land use/cover class	Elevation Year 2001			Total	Elevation Year 2010			Total
	Area in km^2 in low	Area in km^2 in moderate	Area in km^2 in high		Area in km^2 in low	Area in km^2 in moderate	Area in km^2 in high	
Dense Forest	88	163	124	**375**	98	365	130	**593**
Open Forest	4,146	2,197	22	**6,365**	2,534	1,762	11	**4,307**
Current Jhum	107	48	17	**172**	174	209	38	**421**
Non-Forest	1,040	173	42	**1,255**	2,575	245	26	**2,846**
Total	**5,381**	**2,581**	**205**	**8,167**	**5,381**	**2,581**	**205**	**8,167**

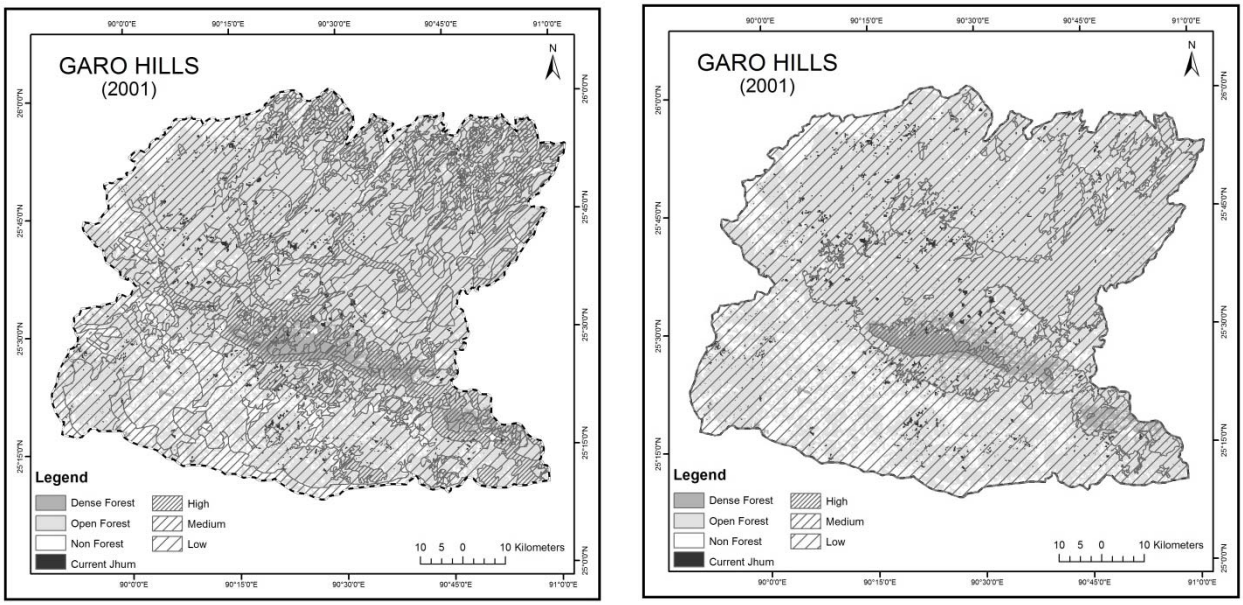
Table 5 : Area statistics of change matrix in respect to slope of Garo hills landscape

Changes in land use/cover	Year 2001 to 2010						Total
	Low		Moderate		High		
	Area in km^2	Area in %	Area in km^2	Area in %	Area in km^2	Area in %	
Dense to open forest	43	1.59	34	0.86	43	2.87	120
Open forest to dense forest	22	0.81	124	3.13	139	9.28	285
Open forest to current jhum	90	3.32	208	5.26	65	4.34	363
Open forest to non-forest	902	33.26	746	18.85	195	13.02	1,843
Current jhum to open forest	14	0.52	152	3.84	13	0.87	179
Non-forest to open forest	67	2.475	217	5.48	22	1.47	306
No changes	1,519	56.01	2,400	60.65	1,003	66.96	4,922
Others	55	2.03	76	1.92	18	1.20	149
Total	**2712**	**100**	**3,957**	**100**	**1,498**	**100**	**8,167**

Table 6 : Area statistics of change matrix in respect to elevation of Garo hills landscape

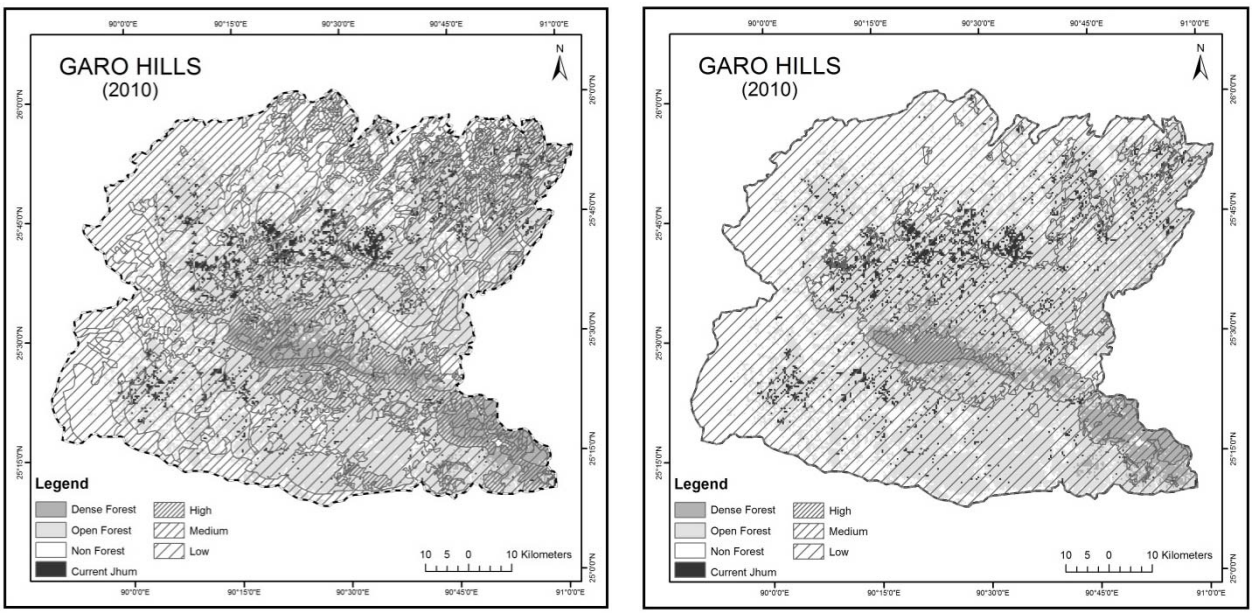
Changes in land use/cover	Year 2001 to 2010						Total
	Low		Moderate		High		
	Area in km^2	Area in %	Area in km^2	Area in %	Area in km^2	Area in %	
Dense to open forest	14	0.26	97	3.76	9	4.39	120
Open forest to dense forest	87	1.62	183	7.09	15	7.32	285
Open forest to current jhum	154	2.86	191	7.40	18	8.78	363
Open forest to non-forest	1,637	30.42	195	7.56	11	5.37	1,843
Current jhum to open forest	108	2.00	64	2.48	7	3.41	179
Non-forest to open forest	275	5.12	26	1.00	5	2.44	306
No changes	2,996	55.68	1,791	69.39	135	65.85	4,922
Others	110	2.04	34	1.32	5	2.44	149
Total	5,381	**100**	2,581	**100**	205	**100**	**8,167**

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(A) (B)

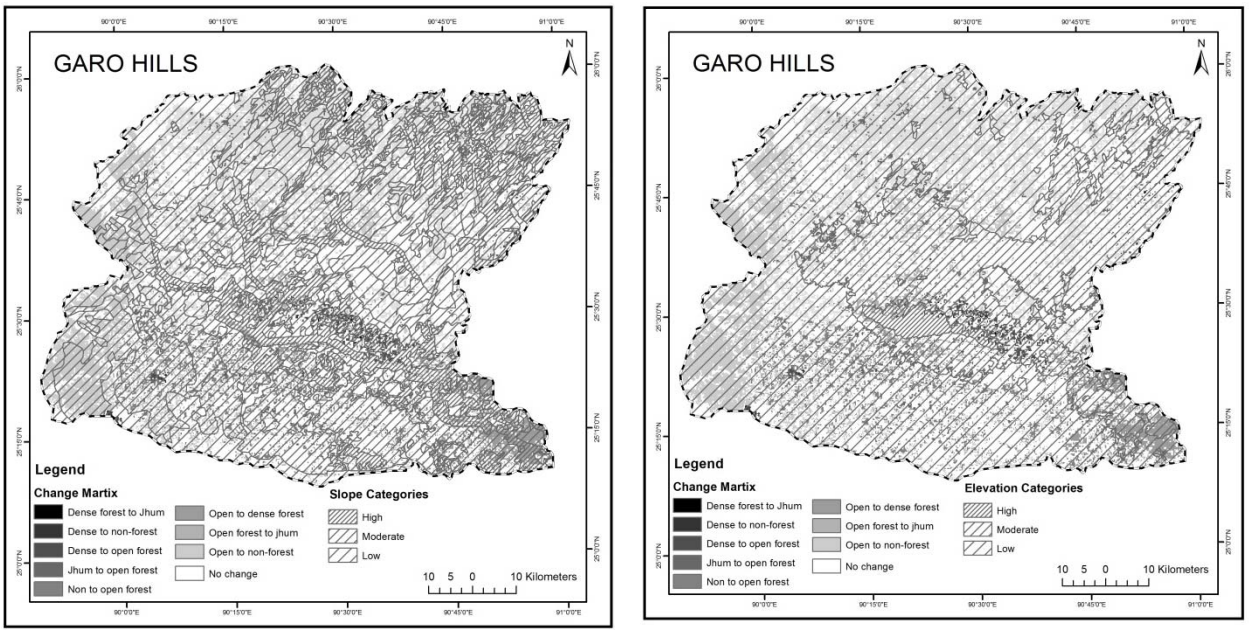
Figure 4 : Land use/cover in different slope (A) and elevation (B) categories for 2001



(A) (B)

Figure 5 : Land use/cover in different slope (A) and elevation (B) categories for 2010

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(A) (B)

Figure 6 : Change matrices during 2001 and 2010 in terms of slope (A) and elevation (B) categories

V. Discussions

Based on Landsat TM (2001) and Landsat ETM+ (2010) data fourbroad types of land use/ cover were observed for the two different years in Garo hills. Classifications of these satellite imagery show that dense forest is confined mostly to the inaccessible area whereas other three types fall mainly in the moderate and low slope and elevation. The primary forest of the districts have been destroyed to a great extent by age old tradition of shifting agriculture which is extensively practiced in the hilly regions of the northeast India (Ramakrishnan, 1992; Yadav*et al.,* 2012). This activity has led to the development of a variety of successional plant communities ranging from open forest to recently abandoned shifting cultivation fields (Prabhu, 2004). In the present study, the proportion of open forestand non-forests increased with the decrease in slope. These areas represent a mosaic of degraded landscape owing to the gentle slope of the area. This finding is similar to that of Susana & Mario (2000) who reported that deforestation may be widespread in areas where slopes are relatively gentle. There is general trend for mountain ecology that with increasing altitude there exists good ecological conditions (Hamilton *et al.* 1999). This criterion is fulfilling in the present study. The findings of the present research reflect the similar results of Ramesh *et al.* (1997) who stressed that deforestation process characterized by removal of the smallest and most accessible forest patches, followed by other developmental and livelihood activities. The present study is supported by Sarma and Barik (2010) who revealed that even vulnerable slopes are not spared from shifting cultivation consequences of which could be devastating. Semwal*et al.* (2004) revealed that deforestation may be widespread in an area where slope is relatively mild in nature. Balaguru*et al.* (2003) established while relating vegetation with slope angles of Shervayan hills of Eastern Ghats that number of species increases with increasing degree of slopes. Their finding is very much supportive to the present research. Whereas, Smith *et al.* (2005) while studying relationships between geomorphology and tree density revealed all type of trees in all slope categories but density was high in the stable landforms despite slope variations.

VI. Conclusions

Garo hills districts support animpressive forest cover which is mainly concentrated in inaccessible areas and theseshould be conserved for biodiversity. It was observed in this study that the remote forest areas are also slowly encroached by the local people for shifting cultivation, mining and other activities. The districts have witnessed the conversion of forests to other non-forest areas during the last decade. This alteration needs to be checked immediately. After shifting cultivation the fallowland should be allowed to regenerate at least 15-20 years before another cycle. The short cycle not only effects soil fertility but also exposes the top soil for erosion. Further, the conversion of forest areas into other land use should be properlyplanned. The most important step that needs to

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be undertaken to prevent the area from further deterioration is to educate the people and make them aware of the consequences of the effect of deforestation, mining and shifting cultivation.Landscape dynamics study is important to understand and assess the changes in natural resources due to various natural and anthropogenic reasons. The findings of the present study could be useful for management authority for making strategies for management of natural resources and monitoring its changes in due course of time. Temporal remote sensing data with detailed field observation could be an authentic tool for studying the landscape dynamics in any part of the globe which are environmentally fragile.

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Urban Vacant Land and Spatial Chaos in Ogbomoso North Local Government, Oyo State, Nigeria

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Abstract - Vacant land is seen as important component of urban environment capable of generating a detrimental effect on quality of life and the living environment. The study attempts to examine the characteristics, distribution pattern, utilization and the attendant challenges of urban vacant land within Ogbomoso north a local government area in Oyo State, Southwestern Nigeria with a view to assessing the level of maintenance of the vacant lands. In order to achieve these objectives, both primary and secondary data were employed. Primary data were gathered through direct survey and interviews. Simple random sampling was used to purposively select 320 adult interviewed from a compiled list of households obtained from National Population Commission. Secondary data were obtained from internet, books and journals. Data were analyzed making use of descriptive and inferential statistics to present discussion.

Keywords : *contiguity, environment, facilities, management, vacant land.*

GJHSS-B Classification : *FOR Code : 960604, 269999*



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Urban Vacant Land and Spatial Chaos in Ogbomoso North Local Government, Oyo State, Nigeria

J. O. IGE [α] & T.A. Atanda [σ]

Abstract - Vacant land is seen as important component of urban environment capable of generating a detrimental effect on quality of life and the living environment. The study attempts to examine the characteristics, distribution pattern, utilization and the attendant challenges of urban vacant land within Ogbomoso north a local government area in Oyo State, Southwestern Nigeria with a view to assessing the level of maintenance of the vacant lands. In order to achieve these objectives, both primary and secondary data were employed. Primary data were gathered through direct survey and interviews. Simple random sampling was used to purposively select 320 adult interviewed from a compiled list of households obtained from National Population Commission. Secondary data were obtained from internet, books and journals. Data were analyzed making use of descriptive and inferential statistics to present discussion. The results showed that the nature of urban vacant land utilization is dynamic and that they owned their existence to diverse purposes. The spatial distribution of these vacant lands was conformed to regular pattern but spread across the diverse spatial and socio-economic segments of the study area. Less vacant lands were found in the centre of the city while their sizes increased as one moved towards the fringe of the city. Poor management turned out the vacant lands to dumping sites, hideouts for hoodlums and indiscriminate sitting of artisan workshops. The result of research hypothesis showed a strong relationship between the size and value of vacant lands in the study area. It was, however, concluded that the uses of vacant lands were generally poor undermining public health and safety, owing to concomitant low level of public awareness and inadequate system of social support. The study therefore underscored the need for efficient back up of institutional outfit to obviate danger and risk of uses.

Keywords : contiguity, environment, facilities, management, vacant land.

I. Introduction

In Nigeria, as in most other developing countries, there is no issue more topical than vacant land management if we are serious in enhancing the livability of urban environment. Therefore the uses of urban vacant land should not be overlooked in urban awareness and in urban studies as these uses play a daily role in the lives of urban dwellers. However, rapid spatial growth has become one of the most notable features of urban centres in Nigeria in the last few decades. This is a result of concentration of socio-economic, recreational and administrative facilities the nation could boast of in urban centres. In developing countries like Nigeria, this urban growth has not been marched by a proportional increase in services, facilities and an efficient urban management. This has led to case of isolated, haphazard and incidental vacant spaces with their attendant negative consequences of the environment which led to urban decay and environmental degradation (Odedare, 1998). Olatubara, (2004) also stresses that the accelerating growth of urban centre has brought stresses and strains upon the city environment. Significant among the problems are those of overloading on existing facilities thereby causing traffic congestion, inadequate housing, slums, pollution in all its ramification, poor environmental quality and indiscriminate use of urban vacant land. Kufoniyi (1997) opined that the environment is made up of scenes of uncollected garbages and the infilling of vacant spaces and parks which contribute to the environmental degradation of urban areas. He also identified encroachment and illegal occupation of land as part of the urban land.

Nigerian cites have continued to grow at a faster rate than the facilities provided. The phenomenal rate of urbanization in Nigeria is considered as one of the highest in the world (Oyesiku, 2004). As increase urbanization exerts more pressure on urban facilities, the supply of these facilities is increasingly becoming inadequate. Since the last four decades, there has been unprecedented interest in different nature of urban problems. Unfortunately, nothing has more caused urban decay than the indiscriminate use of urban vacant land and vulgar disposition to vacant land management, and more than elsewhere Nigeria has visibly failed in paying attention to this component of urban structure.

Vacant land is a term of reference that has different interpretation for different people. Some refers to vacant land as land within the urban area that is not devoted to development like residential, commercial, industrial etc. Others refer to it as land on the margin of the urban area that is undeveloped. Generally, vacant land provides a function of creating openness in the urban expanse (space). In this study however, vacant

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land within the cities is defined as the area generally free from development or developed with low intensive uses. Vacant lands are parcels of land that are not devoted to any functional use or that have been by-passed by developmental activities of the urban area. Vacant land are used as reference to urban open space that are not devoted to any functional use, but not to vacated or razed buildings (Olaleye, 1998). Urban open spaces are parcels of land that have been by-passed by the developmental activities of the urban area and that exist as enclaves surrounded by parcels that have been converted to one or more types of urban use. They account for about one-fifth of the land area of the city (Falade, 1985).

Regarding the overall spatial setting where vacant land are found, one might consider the location of these parcels relative to different types of developed urban land. These spatial relationships can be expressed by means of coefficient of correlation between the amount of buildable vacant land in an area, such as a quarter-section and the distance to a specific major centre or focus in the urban centre, such as the central business district (CBD), a major commercial centre or an industrial district. Most important to note that in the course of planning and developing a town, the provision of open spaces is very vital among other things for hygiene and aesthetic; relaxation and entertainment, personal and social development; recreation etc. The planning and growth of human settlements is very vital to enable a community lives a meaningful and satisfying life.

Previous studies have shown that a sizeable percentage of urban problems arise from the negative impacts generated by the unguided incidental urban vacant land.(Filani, 1985; Falade, 1985; Onibokun, 1992) Moreover, they also slow down the space of economic growth. This study seeks to mitigate these negative effects and enhance the positive ones on the environment by the aid of technical objectives policies to properly maintain urban vacant land in Nigerian cities. However, a case study of Ogbomoso North Local Government, a typical historical Yoruba traditional city coping with contemporary growth and spontaneous anarchical and unguided developments shall be brought to focus. In the study area, there are many undeveloped vacant lands within the built-up area and the phenomenon keeps increasing. This study therefore intends to examine the concept and nature of urban vacant land, its characteristics, utilization, management and various challenges with a view to proposing the prudent use of urban land in the study area.

The study aims at studying the characteristics utilization, management and the attendant challenges of urban vacant land within the study area with a view to proffering objective policy recommendations for an effective management of urban vacant land in the study area. Specific objectives of the study are to: (a) *examine the location, size, use, ownership and value of identified urban vacant lands,* (b) *study the contiguity of the urban vacant lands with the predominant use in the area,* (c) *evaluate the state of the vacant spaces within the study area, with a view to identifying their level of maintenance.*

The hypotheses that guide this study are stated in null and alternate forms;

(i) *There is no relationship between the size and values of urban vacant land.* (H_0-Null hypothesis) *There is a relationship between the size and value of urban vacant land* (H_1-Alternative hypothesis).

(ii) *There is no relationship between the size of urban vacant land and its distance to the city centre* (H_0-Null hypothesis). *There is a relationship between the size of urban vacant land and its distance to the city centre* (H_1-Alternative hypothesis).

(iii) *There is no relationship between the value of urban vacant land and its distance to the city centre* (H_0-Null hypothesis). *There is a relationship between the value of urban vacant land and its distance to the city centre* (H_1 Alternative h ypothesis).

II. Materials and Methods

a) The Study Area

Ogbomoso is located on the main highway connecting the North and South West of Nigeria. The town which is the second largest in Oyo state (next to the capital) is (104km) one hundred and four kilometers her state capital – Ibadan and forty-eight kilometers (48km) south of Ilorin – the Kwara State Capital. The town (Ogbomoso) lies on latitude $8^{o}07^{1}N$ – $8^{o}16^{1}N$ of the equator and longitude $4^{o}16^{1}E$ – $4^{o}30^{1}E$ of Greenwich meridian time. The town is divided into two Local Government and they are; Ogbomoso North and the Ogbomoso South Local Governments. Their headquarters are at Kinnira and Arowomole respectfully. An American Baptist Missionary estimated the population of Ogbomoso in the 1850 to be 25000 by 1952, the town had grown to a population of 139,500 (Kraft Askari 1969 Pp35) and by 1986; the population was 564,465 (Ogbomoso Local Government Publication, 1986, Pp10)

b) Methodology

The major procedure used in carrying out this research was a cross-sectional procedure in which all necessary information was collected from a set of observed vacant land within the study area. Both primary and secondary sets of data were colleted and analyzed for the study.

Primary data collection was through oral interview and questionnaire administration. Oral interview schedules were conducted with the Director of Town planning, Ogbomoso North Local Government. The questionnaire elicited information about the respondents, sex, age, religion, income, occupation, highest educational qualification, perception of

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individuals about the vacant land and the environmental problems created by the available incidental vacant land among others. The questionnaire were administered on the residents and the users of the vacant land to collect information on the impact of the urban vacant land on them and what they would want to be done to such spaces.

The opinion surveys were viewed together with the market value, the location and the predominant use in the area to arrive at the optimum use for the vacant plots. With a view of knowing the appropriate market value of land, some estate valuers "land agents" were consulted in the study area and an open market valuation was also adopted to elicit information on how much the people could afford to buy a particular piece of land if it were to be offered for sale. Oral interviews were also held with occupiers or owners of the properties and the adjourning properties. Secondary data for this study were sourced from journals and books.

The structured questionnaire was used with pre-coded answers to the questions from which respondents were able to select best alternatives that were suitable their opinions. The questionnaire were randomly served on the residents of the adjoining plots and the occupiers (if any) of the identified vacant lands. The second types of questionnaire were filled on inspection of each plot by people employed to record information about each vacant plot's characteristics. A total of three hundred and twenty questionnaires were administered while two hundred and forty copies were retrieved.

The areas where the vacant land or undeveloped plots were situated were selected for sampling. The study area was divided into six zones and samples were drawn independently and randomly from each zone. In each of these zones or localities, respondents were selected using the random technique. In most cases, heads of the households were first respondent. However, where heads of households could not be found, male or female adults (who have right to vote) above the ages of 18 years were always in the forefront to respond to the questions. Notwithstanding, children were given the privilege of responding to the questions.

The data collected through the questionnaire, pilot survey and interviews were processed through the use of statistical packaged for social scientists (spss). Descriptive statistical analysis was employed to obtain the frequencies, distribution and percentages. Frequency count, tables and percentages were used to enhance vivid discussion of result. Correlation (coefficient) analysis using Pearson product moment was adopted to test the research hypotheses.

III. Discussion of Findings

The following were the research findings for the study:

a) Distance of Respondents with respect to vacant land in the study area

With a view to knowing the public opinions about impact of urban vacant land on the quality of life on adjoining households, a total of two hundred and forty questionnaires were retrieved out of the three hundred and twenty (320) administered randomly on occupants of adjoining undeveloped plots in the localities chosen for the study.

A study of the distance of the respondent to the vacant plots showed that (45 percent) of the respondents live next door to vacant plots 24 percent lives within 100 meters from one vacant plot or another, (22 percent) of respondents live at more than 100 meters while the remaining (10 percent) respondents lives at more than 200 meters. See Table1.

Table 1 : Distance of Respondents to the vacant land

Distance of Respondent	Number	Percentage (%)
Next plot	108	45
Within 100m	56	23.33
Above 100m	52	21.67
Above 200m	24	10.00
Total	240	100.00

Source : Field survey, December, 2011.

b) Characteristics of land ownership in the study area

Significant majority of the respondent (72.5%) provided information on the ownership status of the vacant plots in terms of whether privately or publicly owned. Forty-seven (47) of the vacant plots identified were held by individuals while the remaining eight (8) were held by public institutions. A further analysis shows that, out of 47 plots held by private individuals, 39 were held by Ogbomoso indegenes while the remaining 8 plots were held by other indigenes but not of Ogbomoso origin. Out of the eight held by public institutions, two undeveloped plots belonged to the Christian Association of Nigeria (CAN), another 2 plots belonged to the Anglican Communion/ Diocesses, one was held by the Ogbomoso Chapter Muslim Society of Nigeria and the remaining three belonged to the government (Ogbomoso North and Oyo state Governments). See Appendix 1.

When asked about the visitation of owners to the vacant lands, 13 percent could identify those that visit their plots on monthly basis, one percent identified those that visit bi-monthly, 18 percent say the owners rarely visit the plots, 8 percent could identified those that visit annually. Five (5) percent visit on weekly basis while about 56 percent of the respondents did not know when owners visit their vacant plots.

c) Perversion of current vacant land use in the area

The field survey as represented in Table 2 revealed that not all the urban vacant lands within the town were really vacant or bare (that is, those that were not put to any use and most of the time were bushy), this represents about 15 percent of the identified vacant land. These undeveloped plots were in most cases being used as hideouts for hoodlums and about five cases of robbery were reported to have been

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perpetuated through the use of these undeveloped/bushy plots. Nine plots (about 16 percent) were being temporarily cultivated. There were seven plots (13 percent) being used for block making. 11 plots (20 percent) being used for automobile mechanic workshop, 16 percent of such plots have been unofficially committed to refuse dumping sites. 5 plots were being used by children as playing ground. The remaining six (6) undeveloped plots (11%) were committed to petty trading activities.

The study also established that the large percentage of urban vacant land in the area was being put to one temporary use or the other which was in most cases not compatible to the dominant uses in the area. For instance, about nine (9) refuse dumping grounds were found located at various places within the residential locality. This has been proved to a greater extent in contributing to pubic health hazard like outbreak of diseases such as cholera, malaria, typhoid, tuberculosis, pneumonia (upper respiratory infection).

Some of these vacant lands were not put to any use and were either taken over by bush or junk yard and this has been seen to be generating negative effects on the occupiers of adjoining parcels of land. For instance, eight vacant plots were found being taken over by bush and served as hideout for hoodlums who threatened lives and properties of the residents and users of the adjoining parcels of land.

The study revealed the non-existence of conscious planning for open spaces. There was no designated open space in the study area. However, there were spaces between buildings, spaces in and around the area, spaces within or enclosed by the individual yards and spaces along the streams and streets which were often used as depots of refuse and human wastes. Likewise, after completing building operations, the remaining unbuildable parts of land were always used in providing commercial kiosks, provision of additional rooms to the house due to the present dire need of places to trade and places of abode respectively.

It was observed that the rights of ways were also discovered to have been taken over by mechanic workshops, street trading, places of worship even right under high voltage electric cables which endanger lives of many inhabitants of the study area.

The study shows that there is a general lack of proper rational uses of land and this makes the development of land for various activities to grow in most haphazard manner resulting in incompatible land uses. The problems and the challenges posed by the rapid rate of uncontrolled and unplanned urban growth are immense in the study area. Most of the localities are growing without adequate planning. People live in sub-standard and sub-urban environments plagued by slum, squalor and grossly inadequate social amenities. Low level of awareness on the part of the people, absence of effective advocacy and inappropriate programmes of development have further compounded the problems of growth and development of the study area. The findings revealed that the area is devoid of a well landscape space with facilities for different forms of recreation like active and passive recreation of different ages groups.

Instead, the spaces have been so bastardized by turning them to dumping sites, farmlands, mechanic workshop, block making industries etc. thereby making them to loose their potentials and proper functional uses they could have been

The land use study revealed that the area is a predominant built up residential area. Other uses spring up in the area with little or no regard for conforming uses or zoning policy.

Table 2 : Current Vacant Land Uses in the Study Area

Uses	Number	Percentage)%
Refuse dumping	9	16.36
Mechanic workshop	11	20.00
Trading activities	6	10.91
Farming	9	16.36
Bare (hideouts)	8	14.55
Block making	7	12.72
Playing ground	5	9.10
Total	55	100.00

Source : Field survey, December, 2011.

d) Contiguity of Ogbomoso North Vacant Land

The study shows that most of the identified vacant lands exist in isolation. Only seven of them representing about 13 percent were contiguous with another vacant land.(See Table 3) Owners of the seven (7) contiguous plots were not ready to surrender them for any consolidation programme. Their reasons vary from one owner to another. Three argued that the land (undeveloped plot) symbolize their attachment to their origin, two lamented unstable and uncommitted nature of the government to such programmes of resettlement in the past while the remaining two said that their reasons are purely personal. The study again established the fact that vacant urban land is the part of the overall urban environment and that the vacant land within cities owned their existence to diverse reasons.

Table 3 : Contiguity of Ogbomoso North Vacant Land

Nature of plots	Number	Percentage (%)
Plots that are contiguous	7	12.72
Non-contiguous plot	48	87.28
Total	55	100.00

Source : Filed survey, December, 2011.

e) State of Maintenance of Vacant land in the Study Area

Assessment of maintenance level of these undeveloped plots within the built up areas shows that 55 percent of them were poorly maintained which resulted in them being overgrown with bushes, taken

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over by refuse and human wastes as dumping sites and constituting "eye sore" within the urban setting. Those that could be taken as being fairly maintained represent 29 percent while those that were adequately maintained represent 16 percent of the identified urban vacant land in the area. (See Table 4).

Note:

Good - The plot is adequately maintained

Fair - The level of maintenance has not started generating negative impacts

Poor - The plot is not adequately maintenance in terms of weeding, cutting, sweeping and general hygienic and is generating lots of negative impacts to its surrounding. This study has revealed some of the ways in which large parcel of urban land are being utilized in a less intensive manner, if put to use at all. The study also dealt with various ways in which urban vacant land are developed/evolved, managed and administered by both public and private sectors. Moreover, the study showed the dynamic nature of urban vacant land utilization because their present roles are likely to change from one use to the other with the passage of time, such as vacant land being utilized for functional uses.

For instance, the field survey revealed that various functional uses (such as residential, commercial, institutional etc.) were being proposed to developed some of the identified vacant land in the study area especially those that were classified or certified as fairly maintained.

Table 4 : Current state of maintenance of urban vacant land in the study Area

Level of maintenance	Number	Percentage (%)
Poor	30	54.55
Fair	16	29.09
Good	9	16.36
Total	55	100.00

Source : Filed survey, December, 2011.

Therefore, since their existence was part of the urban scenario, it then becomes imperative that a pragmatic approach should be evolved to manage them within the larger context of urban environment planning and management.

IV. Testing of Hypotheses

The details of computation of the correlation coefficient are presented in table5.10.

Extracting from the calculation using the pearson product moment correlation analysis between (i) the size of identified vacant plots and their corresponding distances (in kilometers) to Oja'gbo (the city centre); (ii) the distance from the city centre (Oja'gbo) and the appropriate value of plots; (iii) the size and the value of plots.

The relationship between distances and sizes of identified vacant plots were computed and found to behave in accordance with the expectation. The correlation analysis shows a positive relationship of +0.9 at 0.05 level of significant between the distance and the size, which implies that the farther one moves away from the city centre, the bigger the sizes of the undeveloped plots. For example, Takie is closer to Oja'gbo than Oke Aanu. When the sizes of vacant plots at Takie area range between 20 by 20 square meters to 40 by 30 square meters, the sizes of the vacant land at Oke Aanu area range from 25 by 30 to 35 by 70 square meters. This could among other reasons be explained by the larger concentration of development within the city centre and scanty development as one move to the outskirts of the town. Another reason could be larger parcel of land acquired by the Government at the periphery for future development. For instance, a large parcel of land was acquired as a new site for Ogbomoso Girls High School located at Oke Aanu area. Moreover, a large parcel of land was allocated for the Federal Government low cost Housing project along Ayoka road. Another reason could be the fact that new areas always grow out on layouts where adequate provisions are made for roads, buffer zones, recreational centers, neighborhood playing ground and so on. These among other things account for the reasons why there are bigger sizes of vacant land at the periphery of the city than the city centre.

The results also show that there is a strong relationship between the size and the land value as indicated by the positive correlation of +1 at 0.05 level of significant that existed between sizes and values of urban vacant land identified in the study area.

It shows that, the larger the sizes of the vacant land the higher its economic value. For instance, the appropriate values of vacant land with sizes 20 by 20 and 20 by 25 square metres range from 50,000 to 60,000 naira while those with sizes 30 by 30 square metres and above range from 65,000 to 140,000 naira.

V. Recommendation and Conclusion

In spite of a myriad of problems and challenges of urban vacant land as identified in this study, a maximum practicable degree of aesthetic environment can still be achieved by proper utilization and management of the vacant land. Most of vacant land with reasonable sizes could be re-designed so as to add glamour to the town and afford the kids and adults with appreciable facilities to recreate. This will encourage and improve the active recreational habit of the generality of the populace.

It is therefore suggested that a redevelopment proposal for the vacant land of considerable sizes within the city (especially those that belong to the government) be made. The redevelopment proposal should make provision for the aged people relaxation area, children active relaxation area; children passive relaxation area, adult active and passive relaxation areas. Other provisions should include parking lots, water fountain

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service building, security etc. All these facilities are to be located with due regard to compatibility, accessibility and maximum security.

However, other undeveloped plots within the study area should be protected, conserved and adequately maintained. The adequate maintenance will enable it achieve the objectives of its existence. The unkempt ones which are either bushy or turned to dumping sites could be uniquely designed so as to enhance a greater utilization, maintenance and compatibility to the surrounding uses.

Based on the findings of this study and knowledge gained from field survey, a stern government action needs to be taken against the occupation of the right of ways by the automobile mechanic, the artisans that occupy the right of ways of high voltage electric cables and unauthorized vendors. Strategic locations of mechanic workshops within the city should be introduced and the mechanic village programmes on a sustainable basis should be resuscitated. The artisans and vendors should be made to leave the right of way of high voltage electric cables. This will reduce the risk of human lives and add to the aesthetic of urban form.

The study revealed that the management of these vacant lands is under the individuals, families and some public institutions. The study showed that the urban plots could be better managed if handled by the community organization. The involvement of Landlord Association of all quarters or localities in the management of vacant plots in their domains will go a long way in checking some of the negative externalities of these vacant plots as earlier mentioned. Individuals and the community in which landlord associations are, are the immediate occupants or users and they live within the area where the vacant land exist, so they will be in better position to manage, monitor and protect the spaces. They can properly handle the management and monitoring of urban vacant land in the study area so as to reduce to its barest minimum the negative challenges of vacant land in Ogbomoso North Local Government. The suggestion made above can be effective if backed up by efficient institutional outfit. Public authorities of all levels must support development control at local level if vacant land generated nuisance is to be prevented in our communities. Also, long-term solution must be set in motion whilst at the same time immediate needs must be addressed in order to confront the circumstances that generate or facilitate urban decay, Therefore, what is required to maintain proper utilization of vacant spaces is not a new creation of new bodies or institutions. What government needs do is to strengthen the capacity of the existing bodies (Town Planning Officers and Environmental Health Officers) in term of personnel, training and equipment in controlling development, monitoring environmental sanitation and in the discharge of the professional and legal obligations imposed by law. Conclusively, we must all work together for the collective good. Environmental management is everyone's responsibility if we are to enhance the livability of our community.

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Appendix

Appendix 1 : The Exisitng Situation Reports of Urban Vacant Land in Ogbomoso North Loca Government

Route /locality	Plots/No	Size in metre(m)	Ownership type	Present use	Predominant use in the area	Proposed use	Appr. Value # (000)	Level of maintenance
Rounder to Ayoka Road	1	20 by 25	private	Refuse dump	Residential	Resident	60	Poor
	2	40 by 35	Private	Bare	Residential	Commercial	110	Fair
	3.	20 by 25	Private	Farming	Mixed	Residential	50	Poor
	4	20 by 25	Private	Block making	Mixed	Residential	50	Poor
	5	30 by 30	Private	Farming	Residential	Residential	80	Fair
	6.	20 by 25	Public	Bare	Residential	Public	70	Fair
	7.	20 by 30	Private	Mechanic workshop	Residential	Comm.	55	Poor
	8	25 by 40	Private	Block making	Residential	Industry	100	Fair
	9	20 by 35	Public	Bare	Commercial	Public	65	Good
	10	20 by 28	Private	Refuse dumping	Residential	Residential	60	Poor
	11	20 X 25	Private	Trading activities	Residential	Residential	65	Fair
	12	25 by 30	Public	Playing ground	Mixed	Public	70	Poor
Soun Palace to stadium	13	25 by 30	Private	Mechanic workshop	Mixed	Residential	65	Poor
	14	20 by 25	Private	Petty trading	Mixed	Residential	60	Poor
	15	20 by 20	Private	Bare	Mixed	Residential	60	Poor
	16	20 by 20	Private	Block making	Residential	Public	55	Poor
	17	30 by 35	Public	Refuse dumping	Residential	Commercial	70	Poor
	18	20 by 20	Private	Trading	Mixed	Residential	60	Fair
Takie to Gen. Hospital	19	30 by 35	Private	Mechanic workshop	Residential	Residential	66	Fair
	20	40 by 30	Private	Farming	Residential	Residential	100	Good
	21	20 by 20	Public	Bare	Public	Public	55	Fair
	22.	30 by 65	Private	Playing ground	Public	Residential	120	Fair
	23	20 by 30	Private	Farming	Residential	Mixed	75	Poor
	24	30 by 35	Private	Refuse dumping	Residential	Residential	70	Poor

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	25	25 by 30	Private	Mechanic workshop	Mixed	Residential	65	Poor
	26	20 by 25	Private	Trading activities	Residential	Residential	60	Poor
Oja'gbo to owode	27	20 by 25	Private	Block making	Residential	Residential	60	Poor
	28	25 by 25	Private	Refuse dumping	Residential	Residential	55	Poor
Oja 'gbo to owode	29	35 by 60	Private	Bare	Mixed	Residential	120	Poor
	30	30 by 30	Private	Playing ground	Residential	Residential	65	Fair
	31	20 by 25	Private	Trading	Mixed	Commercial	55	Poor
Idi Abebe to NEPA	32	20 by 30	Private	Farming	Commercial	Residential	80	Fair
	33	20 by 20	Private	Mechanic workshop	Residential	Residential	60	Good
	34	18 by 36	Private	Mechanic workshop	Residential	Commercial	70	Poor
	35	20 by 40	Private	Farming	Mixed	Commercial	90	Poor
	36	40 by 45	Private	Bare	Mixed	Residential	70	Fair
	37	18 by 30	Private	Block making	Industrial	Residential	70	Poor
	38	30 by 65	Public	Refuse dumping	Public	Public	120	Fair
	39	30 by 40	Private	Welding mechanic workshop	Residential	Residential	60	Poor
	40	25 by 25	Private	Trading	Mixed	Residential	60	Fair
	41	20 by 35	Private	Refuse dumping	Residential	Residential	65	Poor
Sabo to Oke Aanu	42	25 by 30	Private	Farming	Residential	Commercial	80	Good
	43	20 by 45	Private	Mechanic workshop	Residential	Industrial	70	Good
	44	20 by 30	Private	Playing ground	Industrial	Industrial	60	Poor
	45	20 by 25	Public	Playing ground	Public	Public	65	Fair
	46	35 by 70	Private	Mechanic workshop	Residential	Residential	140	Poor
	47	30 by 30	Private	Refuse dumping	Mixed	Residential	65	Poor
	48	20 by 20	Private	Farming	Public	Residential	50	Fair
	49	25 by 35	Private	Bare	Commercial	Commercial	70	Good
	50	25 by 30	Private	Mechanic workshop	Residential	Residential	60	Poor
	51	20 by 30	Private	Farming	Residential	Residential	60	Poor
	52	40 by 50	Private	Block ground	Mixed	Industrial	120	Fair
	53	25 by 30	Private	Refuse dumping	Residential	Residential	70	Poor
	54	35 by 40	Public	Block making	Mixed	Mixed	80	Fair
	55	20 by 25	Private	Mech.wo-rkshop	Residential	Residential	55	Fair

Source : Filed survey, December, 2011.

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Significant of Geology and Geophysical Investigations in Groundwater Prospecting. A Case Study from Hard Rock Terrain of Southwestern Nigeria

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Abstract - Electromagnetic (EM) profiling and VES are the two complementary and widely used geophysical methods in the delineation of basement regolith and location of fissured media and associated zones of deep weathering in crystalline terrains. In many instance, reconnaissance EM surveys are used to locate aquiferous zones such as fractures, faults and joints while Vertical Electrical Sounding on the other hand provides information on the vertical variation in electrical resistivity with depth. It is commonly used to assess the reliability of the fractures delineated from EM survey (Ariyo, et al, 2008, Olayinka *et al,* 2004).

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Significant of Geology and Geophysical Investigations in Groundwater Prospecting. A Case Study from Hard Rock Terrain of Southwestern Nigeria

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I. Introduction

Electromagnetic (EM) profiling and VES are the two complementary and widely used geophysical methods in the delineation of basement regolith and location of fissured media and associated zones of deep weathering in crystalline terrains. In many instance, reconnaissance EM surveys are used to locate aquiferous zones such as fractures, faults and joints while Vertical Electrical Sounding on the other hand provides information on the vertical variation in electrical resistivity with depth. It is commonly used to assess the reliability of the fractures delineated from EM survey (Ariyo, et al, 2008, Olayinka *et al,* 2004).

This study is focused on the significant of geologic mapping and integrated geophysical methods in assessing the groundwater prospect of a typical basement terrain in some parts of Southwestern Nigeria. Figures 1 and 2 shows the VLF-EM traverse and VES points superimposed on the geological map of the study area. Fig.1 is Akaka area and Fig.2 is Fidiwo/Ajebo area of Southwestern Nigeria. The study area is underlain by the Precambrian Basement complex rock of Southwestern Nigeria (Rahaman, 1988). The basic rock identified in Fig.1 is Biotite granite gneiss while in Fig.2 the area is underlain by Biotite Granite Gneiss, Migmatite Biotite Gneiss and Schists.

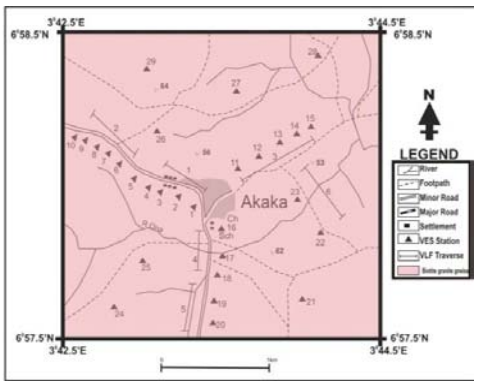


Figure 1 : Site and Geological Map of Akaka, Southwestern Nigeria

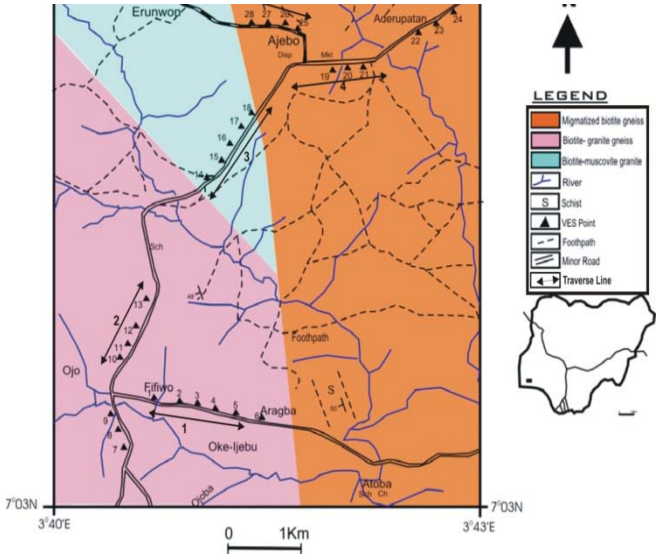


Figure 2 : Site and Geological Map of Fidiwo/Ajebo, Southwestern Nigeria

II. Materials and Methods

A detailed geological mapping and interpretation of satellite imageries map of the area were carried out before as a reconnaissance tools before the detailed geophysical investigation was carried out.

Two geophysical methods were employed in the course of this research work and these are Very Low Frequency Electromagnetic (VLF-EM) and Electrical Resistivity methods.

These two methods are both responsive to water bearing fractures columns due to their relatively high-bulk electrical conductivities. Fifty-seven (57) Vertical Electrical Sounding (VES) points were probed in the study area and Eleven (11) VLF-EM traverses were also occupied.

The VLF-EM data were presented as profile by plotting filtered real and imaginary values against their station positions while partial curve matching and computer iteration techniques were adopted in the interpretation of VES data. From the curve matching technique initial estimates of the resistivity and thickness

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of the various geoelectric layers at each VES station were obtained. These were later used as a starting model for a fast computer interpretation (iteration) technique called Resist (Vander Velpen, 1988).

III. Results and Discussion

The results obtained from the EM and VES data interpretation are presented as profiles, geoelectric section and maps. Fig.3a-c shows typical VLF-EM anomaly profiles from the study area. The EM anomalies vary greatly; some of the anomaly peaks are narrow and sharp while others are broad with varying width extent. Several major linear features (suspected geological interfaces, with positive peak filtered real amplitude were delineated using characteristic feature of coincident inflection on real component anomaly curves with positive peak on filtered real anomaly and only small anomaly in the imaginary parts. Zones with peaks positive filtered real anomalies are considered priority areas for groundwater accumulation since they often correspond to zones with high conductivity characteristic of water-filled fractures or fault (Olorunfemi *et al,* 2004, Ariyo *et al,* 2009) or effect of appreciable depth to bedrock or lithological variations within the consolidated regolith.

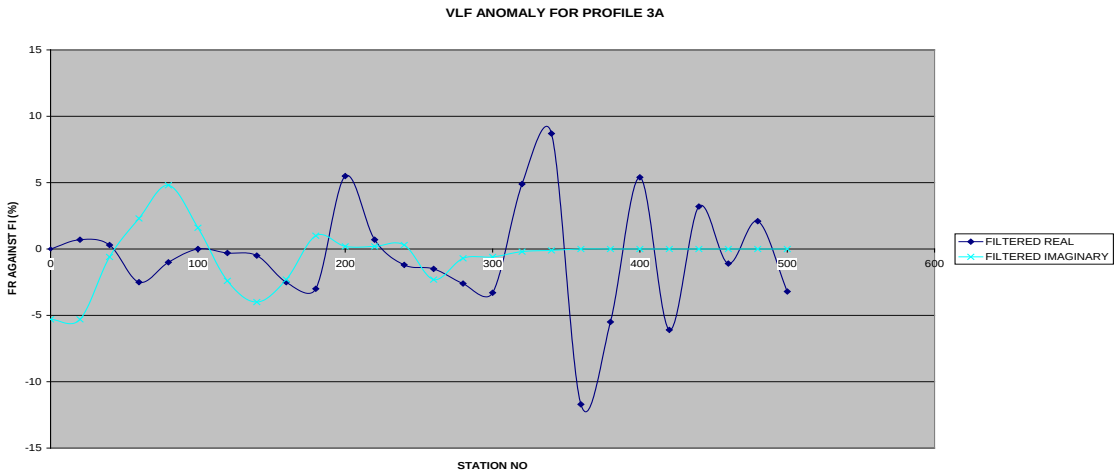


Figure 3a : VLF-EM anomaly Curve for Ajebo Profile

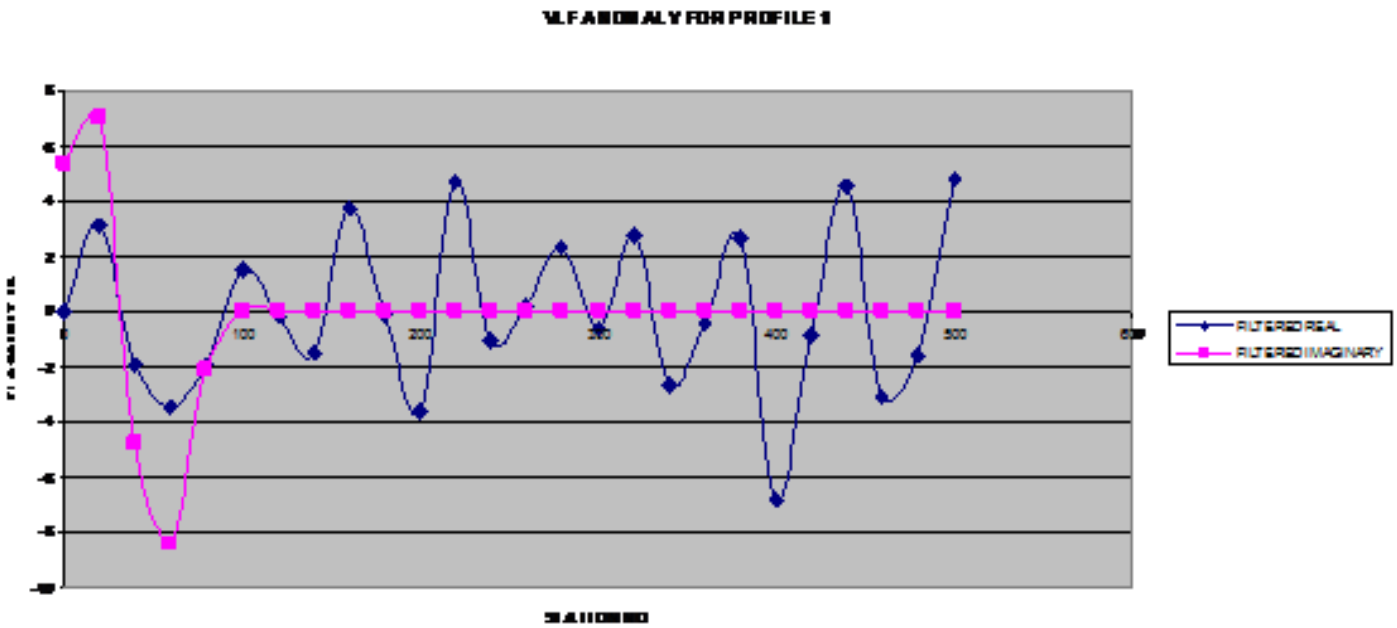


Figure 3b : VLF-EM anomaly Curve for Fidiwo profile 1

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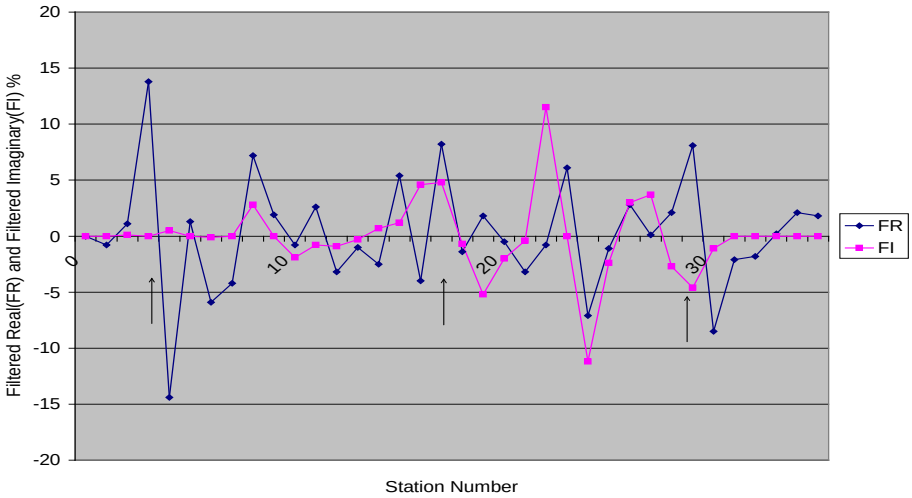


Figure 3c : VLF-EM anomaly Curve for Akaka profile 1

The results of the soundings conducted in the area studies reveal the existing of 3 to 5 geoelectric layers. The geoelectric layers comprise of topsoil made up of sandy clay, clayey sand and gravel. The weathered layers, which constitute the 2nd to 4th layers as the case may be has layer have it resistivity varied from one place to another and constitute part of aquiferous layer in the study areas. The last layer which consists of fracture/fresh bedrock depending on their resistivity values. The overburden thickness varies from 16.3 to 91.5m.

The H type curve is the most predominant in the study areas, which typifies a typical basement complex environment contains a low resistivity intermediate layer underlain and overlain by more resistant materials (Olayinka and Mhachi, 1992). In Basement area, the intermediate layer of the H-type is commonly water saturated and it is often characterized by low resistivity, high porosity, low specific yield and low permeability (Jones, 1985) with the main aquifers found at the base of the weathered profile where mineral decomposition resulting from in-situ chemical weathered as produced a gravel-like material of moderate to high permeability (Jones, 1985 and Acworth, (1987). like material of moderate to high permeability (Jones, 1985 and Acworth, (1987). Fig.3a & b shows the geoelectric sections that relate the VES stations. The geoelectric section reveals the subsurface variation in electrical resistivity and attempts to correlate the geoelectric sequence across the profiles. The geoelectric inter-pretation inferred for the VES station are topsoil, weathered layer, which may be lateritic clay, clayey sand, sandy and sandy clay and the basement which may be fractured or fresh basement base on their resistively values. The figure shows that the study area is characterized by moderately thin weathered layer in some of the VES stations which are < 20m thick. However the partly weathered/fractured basement unit is significantly thick and extensive with tendency for large storage capacity and significant groundwater yields capacity.

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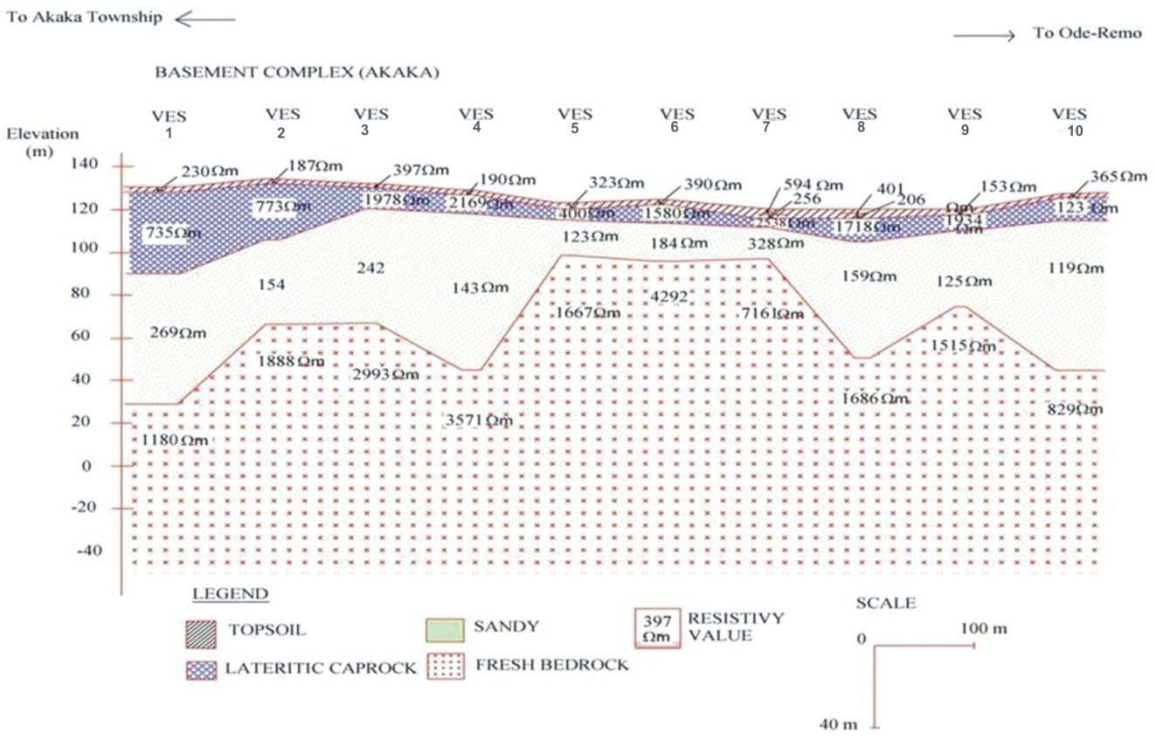


Figure 4a : Geoelectric Section Along VES 1-10 in Akaka area

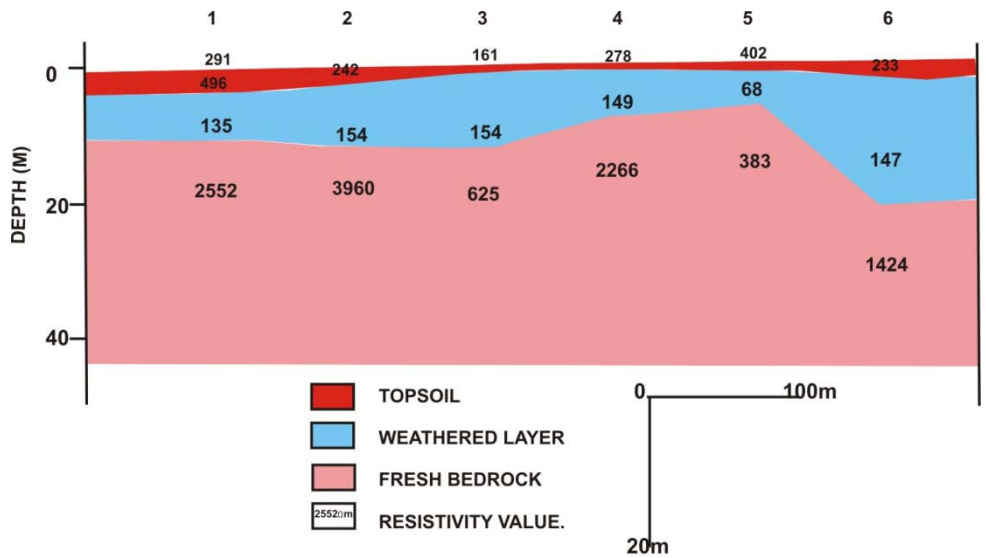


Figure 4b : Geoelectric Section of Along VES 1-6 in Fidiwo Area

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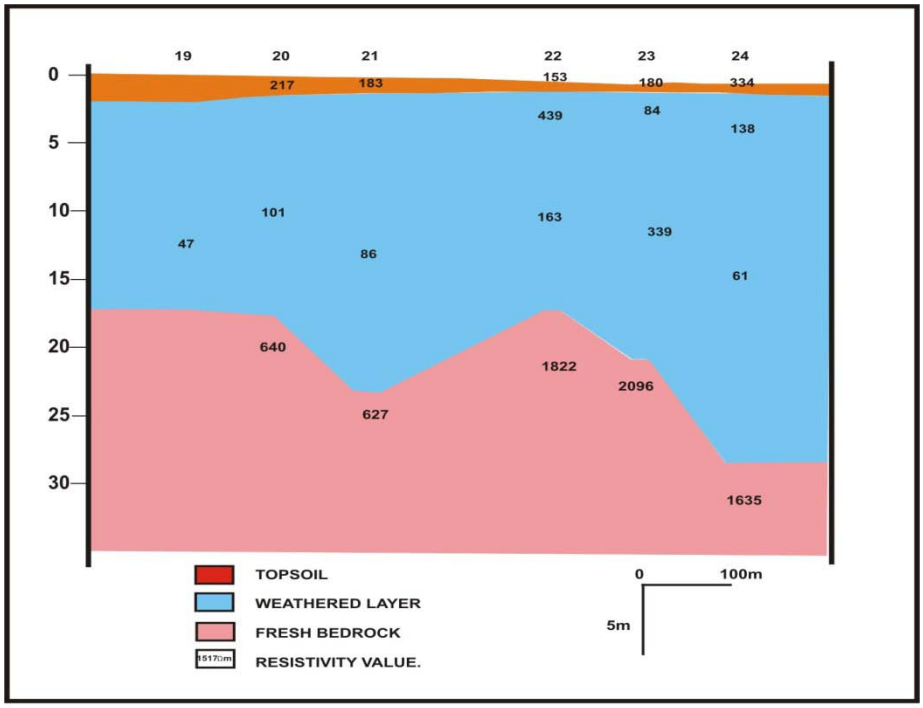


Figure 4c : Geoelectric Section of Along VES 19-24 in Ajebo Area

Also, from the interpreted data, it was observed that the thickness and resistivity value of the aquiferous layers varies from one rock to another. This variation is attributed to the fact that different rocks respond to weathering activities differently. From Both VES and VLF-EM data interpreted results, it was observed that aquiferous layers were encountered at shallower depth in area occupied by Schists than area occupied by Gneiss.

IV. Conclusion

Geological features suspected to be basement fractures identified from VLF- EM anomaly curves were confirmed by geoelectric subsurface images developed from interpretation results of Vertical Electrical Soundings. VLF can detect shallow fracture zones if the weathered layers are not too thick or too conductive like the case of the study areas. The presence of sandy layer in Fig.4a will enhance availability of groundwater. Based on this, area underlay by granite gneiss will be more prolific in term of groundwater exploitation than area underlay by migmatised gneiss. The VLF method can be a tool for detailed groundwater exploration because of its rapid data acquisition, and lower cost than the conventional cumbersome and time- consuming electrical method, particularly in hard-rock terrain. Based on the results obtained from this survey, it can be concluded that the integration of EM profiling and DC Electrical Method together with detailed geological mapping are efficient tools for borehole siting in groundwater exploration in a typical crystalline terrain.

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Developing, Searching and Moving Sustainable Through Renewable Technologies

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Abstract - The use of renewable energy sources is a fundamental factor for a possible energy policy in the future. Taking into account the sustainable character of the majority of renewable energy technologies, they are able to preserve resources and to provide security, diversity of energy supply and services, virtually without environmental impact. This paper outlines possible energy savings and better performance achieved by different solar passive strategies (skylights, roof monitors and clerestory roof windows) and element arrangements across the roof in zones of cold to temperate climates. The aim of this work is to find possible design strategies, and to find solutions to provide thermal and luminous comfort in spaces of intermittent use and a poor aspect or orientation. In regions where heating is important during winter months, the use of top-light solar passive strategies for spaces without an equator-facing façade can efficiently reduce energy consumption for heating, lighting and ventilation.

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Developing, Searching and Moving Sustainable Through Renewable Technologies

Abdeen Mustafa Omer

Abstract - The use of renewable energy sources is a fundamental factor for a possible energy policy in the future. Taking into account the sustainable character of the majority of renewable energy technologies, they are able to preserve resources and to provide security, diversity of energy supply and services, virtually without environmental impact. This paper outlines possible energy savings and better performance achieved by different solar passive strategies (skylights, roof monitors and clerestory roof windows) and element arrangements across the roof in zones of cold to temperate climates. The aim of this work is to find possible design strategies, and to find solutions to provide thermal and luminous comfort in spaces of intermittent use and a poor aspect or orientation. In regions where heating is important during winter months, the use of top-light solar passive strategies for spaces without an equator-facing façade can efficiently reduce energy consumption for heating, lighting and ventilation. Passive solar systems for space heating and cooling, as well as passive cooling techniques when used in combination with conventional systems for heating, cooling, ventilation and lighting, can significantly contribute to the energy saving in the buildings sector, and the thermal behaviour of the dependent on the alternatives and interventions made on the building's shell. Exploitation of renewable energy in buildings and agricultural greenhouses can significantly contribute to energy saving. Promoting innovative renewable applications and reinforcing renewable energy market will contribute to preservation of the ecosystem by reducing emissions at local and global levels and will contribute to the amelioration of environmental conditions by replacing conventional resources with renewable sources that produce no air pollution or greenhouse gases and coexist comfortably with existing urban, agricultural and tourist land uses. Sustainable low-carbon energy scenarios for the new century emphasise the untapped potential of renewable resources. Energy efficiency brings health, productivity, safety, comfort and savings to homeowner, as well as local and global environmental benefits.

Keywords : renewable energy sources, technologies, applications, sustainable development.

I. Introduction

Spaces without northerly orientations have an impact on the energy behaviour of a building. For sustainable development, the adverse impacts of energy production and consumption can be mitigated either by reducing consumption, or by increasing the use of renewable or clean energy sources [1]. Bioclimatic design of buildings is one strategy for sustainable development, as it contributes to reducing energy consumption and therefore, ultimately, air pollution and greenhouse gas (GHG) emissions from conventional energy generation. Bioclimatic design involves the application of energy conservation techniques in building construction, and the use of renewable energy such as solar energy and the utilisation of clean fossil fuel technologies.

In the design or refurbishment of buildings to reduce energy consumption, the implementation of passive solar and day-lighting systems may not respond as expected since not all spaces might have a north-facing façade. Spaces without a northerly orientation impact on the energy behaviour of a building in three ways:

- They have reduced availability of daylight,
- Heating in winter due to solar gain will also be reduced, and
- For temperate (mesothermal) climates in summer, solar gain will add to the cooling load.

For buildings with these attributes, to achieve the same energy performance as buildings that benefit from a good orientation and passive solar energy design, air-conditioning/heating is required, thus increasing the total power consumption. To improve the energy performance of a room without a north-facing façade, environmentally sensitive design strategies for lighting, ventilation, cooling or heating can be used depending on the location of the space. Zenithal openings horizontally or vertically glazed, light pipes, light shelves [2], tubular skylights [3] or sun ducts [4] can be used to meet lighting requirements.

To improve the thermal performance, different strategies for indirectly gained solar heat, either through the ceiling or floor, are commonly used (e.g., roof ponds or rock beds). For ventilation, natural forces and passive systems such as solar chimneys can induce air movement or wind towers can have a major beneficial impact on ventilation [5]. Most systems are designed only for one purpose (e.g., lighting, heating or ventilation), and the overall energy performance can potentially be improved in combination with other systems [6]. For example, light pipes or light tubes can be combined with some passive heating strategies (e.g., sun spaces or thermal storage mass on roofs), or solar chimneys for natural ventilation and cooling in warm climates can be combined with day-lighting systems to reduce heat gains, thereby achieving better comfort levels. Skylight, roof monitors and clerestory roof

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windows represent a combination of thermal, day-lighting and natural ventilation systems, whereas operable windows are required for natural ventilation. There are several types of spaces that may not possess a suitable northerly aspect or exposure, depending on the location, orientation or connection of that space to the exterior:

- Rooms facing south, east or west.
- In between spaces such as hallways, staircases and attics.
- Spaces where adjacent buildings obstruct north-facing windows.
- Spaces that have problems in lighting, heating, and cooling performance because of poor building design.

The present paper aims with energy using and energy saving technologies in farming, horticulture, livestock production, crop conservation, crop storage, underfloor heating, root zone warming, air knives, supplementary lighting, and energy efficient technologies available to farmers and growers. Examples include slurry treatment, dehumidification, horticultural lighting, and grain drying, environmental control for healthy livestock and heat recovery in combined heat, power and renewable energy sources. Monitoring projects on farms and nurseries, evaluate the costs and performance of new technologies. Computerised design programmes for calculating heating and ventilation requirements in livestock buildings, grain drying systems or lighting in horticultural units, e.g., Venturi aeration of farm waste and disinfection of horticultural waste solutions. Typical applications: making parlour ventilation and fly control, calf pens, poultry houses, pig and sheep units, potato stores, greenhouses, and packing sheds.

The information technology in renewable energy brings with it a set of tools, expertise, in sight and support that may prove invaluable. Specially tools expertise and support in the areas of data and information quality, knowledge management, information dissemination, electronic publishing, networking, data acquisition, management, and control of complex systems, and group-ware. Effective application of these tools give even small and mid-size organisations the ability to manage their products, disseminate their ideas, discover knowledge they require, find project partners, manage projects, acquire data, process and manipulate that data, work on that data with colleagues around the world, lobby politicians, publish results and sell. The technologies required realising an information platform of the scope and nature. Development a technology platform would contain the necessary tools and building blocks with which such an ambitious information management environment could be realised. Very specific requirements within which any such technology platform had to be developed were set right at project inception. These included:

- Modular, extensible architecture.
- Tools for rapid module construction.
- Uniform interface/functionality across modules.
- Full multimedia support.
- High interaction levels.
- Strong information ordering functions.
- Feature-rich application framework.
- Web-based, and fully searchable.
- Sensitivity to future technology trends.

A primary goal of the initiative was to realise, over time, a high level of acceptance and trust from the user community. Several attributes of any information system that could lead to such a level of acceptance were identified. These include:

- Global participation.
- Quality through peer review.
- Author-oriented system.
- Association with the society.
- Broad spectrum of services.
- Easy access to information.
- Good marketing.

For proper rural development the following must be considered:

- Analyse the key potentials and constraints on development of rural energy.
- Assess the socio-technical information needs for decision-makers and planners in rural development.
- Utilise number of techniques and models supporting planning rural energy.
- Design, import and interpret difference types of surveys to collect relevant information and analyse them to be an input to planners.

The unavailability and the acute shortages of the conventional energy supply (petroleum and electricity) to rural people forced them to use alternatives available energy sources like biomass. This situation caused serious environmental degradation beside the poor unsatisfactory services of some basic needs such as:

- Food security.
- Water supply.
- Health care.
- Communication.

In order to raise rural living standards, the per capita energy availability must be increased, through better utilisation of the local available energy resources. It is necessary that a vigorous programme for renewable

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energies should be set up (the challenge is to provide a framework enabling markets to evolve along a path that favours environmentally sustainable products and transactions). The use of renewable energy sources is a fundamental factor for a responsible energy policy in the future. Taking into account the sustainable character of the majority of renewable energy technologies, they are able to preserve resources and to provide security, diversity of energy supply and services, virtually without environmental impact. A reliable strategy has potential benefits for research and technology development:

- It contributes to the development of new solar applications, expanding their use and offering to enterprise ways to improve their competitiveness, productivity and their position in the market.
- It stimulates the renewable energy market by improving reliability, durability, efficiency, and competitiveness.
- Dissemination of the appropriate information will raise public awareness on environmental problems and at the save time will emphasise on the role of renewable energy technologies as a reliable, clean and environmentally friendly solution, thus enhancing its social acceptance.
- Will contribute to the improvement of the quality of the life by promoting an environmentally clean and innovative technology.
- Will, via collaboration among partners from different countries and regions, allow the establishment of continuing working relations, create new links, improve ways of communications and remove technical and non-technical barriers.

With environmental protection posing as the number one global problem, man has no choice but to reduce his energy consumption. One way to accomplish this is to resort to passive and low-energy systems to maintain thermal comfort in buildings. The conventional and modern designs of wind towers can successfully be used in hot arid regions to maintain thermal comfort (with or without the use of ceiling fans) during all hours of the cooling season, or a fraction of it. Climatic design is one of the best approaches to reduce the energy cost in buildings. Proper design is the first step of defence against the stress of the climate. Buildings should be designed according to the climate of the site, reducing the need for mechanical heating or cooling. Hence maximum natural energy can be used for creating a pleasant environment inside the built envelope. Technology and industry progress in the last decade diffused electronic and informatics' devices in many human activities, and also in building construction. The utilisation and operating opportunities components, increase the reduction of heat losses by varying the thermal insulation, optimise the lighting distribution with louver screens and operate mechanical ventilation for coolness in indoor spaces. In addition to these parameters the intelligent envelope can act for security control and became an important part of the building domotic revolution. Application of simple passive cooling measure is effective in reducing the cooling load of buildings in hot and humid climates. Forty-three percent reductions can be achieved using a combination of well-established technologies such as glazing, shading, insulation, and natural ventilation. More advanced passive cooling techniques such as roof pond, dynamic insulation, and evaporative water jacket need to be considered more closely. The building sector is a major consumer of both energy and materials worldwide, and that consumption is increasing.

Most industrialised countries are in addition becoming more and more dependent on external supplies of conventional energy carriers, i.e., fossil fuels. Energy for heating and cooling can be replaced by new renewable energy sources. New renewable energy sources, however, are usually not economically feasible compared with the traditional carriers. In order to achieve the major changes needed to alleviate the environmental impacts of the building sector, it is necessary to change and develop both the processes in the industry itself, and to build a favourable framework to overcome the present economic, regulatory and institutional barriers. This article describes various designs of low-energy buildings. It also, outlines the effect of dense urban building nature on energy consumption, and its contribution to climate change. Measure, which would help to save energy in buildings, is also presented.

II. Methods of Expressing Concentration

The methods of expressing the concentration of a constituent of a liquid or gas are:

1) Mass/volume: The mass of solute per unit volume of solution (in water chemistry). This is analogous to weight per unit volume, typically, mg/L = ppm (parts per million).
2) Mass/mass or weight/weight: The mass of a solute in a given mass of solution, typically, mg/kg or ppm (parts per million).

If the density of a solution = ρ = mass of solution/volume of solution (kg/L) and, concentration of a constituent in mg/L = CA1 = mass of constituent/volume of solution (mg/L), and, concentration of a constituent in ppm = CA2 = mass of constituent/mass of solution (mg/kg).
Then rearranging,
ρ = CA1/CA2.

$$\text{If } \rho = 1\text{kg/L; then CA1} = \text{CA2}, \quad (1)$$

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i.e., the concentration of a constituent in ppm mg/kg = concentration of a constituent in mg/L.

For most applications in water and wastewater environments, ρ = 1kg/L. For applications in the air environment, Eq. (1) does not hold. The use of mg/L is most common in water applications as the volume of the solution is usually determined as well as the mass of the solute. The unit ppm is typically used in sludges or sediments. To prove the portable of transmutation of pollutants, experimental investigations may be conducted to bombard C or CO_2 or CH_4 or other air pollutants by accelerated alpha particles in a low-pressure vacuum tube in a similar condition of ionosphere. Heating them with gamma radiation can accelerate the alpha particles. The results of such experimental investigation may prove the probable transmutation of pollutants and self-sustaining equilibrium of the global environment [6].

III. Particles

Particle contamination of evaporative cooling loops can be created by an entry, make-up water, and corrosion by-products and precipitated mineral development. According to the ASHARE guidelines, when legionella are present in aquatic environment, there are multiple factors that control the risk of infection such as:

- Conditions favourable for amplification of the organism
- A mechanism of dissemination
- Inoculation of the organism at a site where it is capable of causing infection
- Bacterial strain-specific virulence factors
- The susceptibility of the host

Table 1 representing of one billion particles in a range of sizes, shows that even a relatively small number of particles 10-75 microns in size can represent a very large volume of particles.

Table 1 : Particle size vs volume

Size of particle (micron)	Quantity of particle (billion particles)	Total volume (Cm^3)
5	212.5	14.58
3	212.5	3.11
1	212.5	0.11
0.45	212.5	0.0089
Sub-total	850	17.83
10	37.5	21.30
25	37.5	303.16
50	37.5	2459.70
75	37.5	8260.72
Sub-total	150	11044.88

IV. Need of Ventilation With energy Recovery in Cold Stores

Table 2 present solutions for proper ventilation with energy recover. CO_2 accumulation – respiration is a basic biological process which occurs in living body to provide it energy to live, as all the fruits and vegetables are living so they carry out respiration. The respiration can be explained by following reaction;

$$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + \text{energy (heat)} \quad (2)$$

Table 2 : Size of the equipment

Capacity of cold storage	5000 Mt
Number of chambers and capacity	4 x 1250 Mt
Size of cold storage chambers	21.00 m x 16.00 m x 13.70 m (L x W x H)
Ventilation requirements	2-6 air changes per day
Volume of cold storage	4603 m^3 or 162400 ft^3
Fresh air required for CA	677 cfm
Total fresh air required for chambers	677 x 4 = 2708 cfm

CA Controlled atmosphere
cfm Cubic feet minute

A large number of the phase-change materials (PCMs) are available in any required temperature range. Within the human comfort range of 25-30°C, some PCMs are very effective (*Table 3*).

Table 3 : A phase-change materials (PCMs) for building insulation

PCMs	Type	Melting point (°C)	L atent heat (kJ/kg)
45% Ca $(NO_3)_2.6H_2O$+55% $Zn(NO_3)_2.6H_2O$	Mixture	25	130
66.6% $CaCl_2.6H_2O$+33.3 % $MgCl_2.6H_2O$	Mixture	25	127
Octadecane + docosane	Eutectic	25.5-27	204
Mn (NO_3)+$6H_2O$	Salt hydrates	25.5	126
Octadecane + heneicosane	Eutectic	25.8-26	174
Lactic acid	Fatty acid	26	184
34% myristic acid + 66% capric acid	Organic	26	148
1-Dodecanol	Organic	26	200
48% $Cacl_2$+4.3% NaCl+0.4 KCl+47.3%H_2O	Mixture	26.8	188
86.6% capric acid + 13.4% stearate acid	Mixture	26.8	160
50% CH3CONH2 + 50% NH_2CONH_2	Eutectic	27	163

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4.3% NaCl+0.4% KCl+48% $CaCl_2$+47.3%H_2O	Mixture	27	188
Vinyl stearate	Organic	27	122
Paraffin C18	Paraffin	27.5	244
n-Octadecane	Paraffin	28	200
$CaCl_2.6H_2O$	Salt hydrates	29	191
Methyl stearate	Organic	29	169

The coefficient of performance (COP) is the ratio between useful energy acquired and energy applied and can be expressed as:

$$COP = Hu/Ha \quad (3)$$

Hu is the useful energy acquired (Btu)

Ha is the energy applied (Btu)

V. Energy Efficient Water Cooler

It is observed that modified water cooler with the facility to use of waste water along with the tap water for condenser cooling performs better in comparison to conventional water cooler. Almost 44% COP improvement is observed due to reduction in power consumption (*Figure 1*). Typical results comparing COP and power consumed are shown in *Table 4. Table 5* Energy consumption and corresponding expenses occurred.

Table 4 : Performance parameter comparison

Item	Air cooled condenser	Water cooled condenser without use of waste water	Water cooled condenser with use of waste water
COP	2.5274	3.2248	3.6278
Power consumed (kW)	0.52	0.3541	0.3254

Table 5 : Energy consumption and corresponding expenses occurred

Item	Per day	Per day	Per month	Per month	Per year	Per year
Water cooler system	Energy (W)	Expenditure ($)	Energy (W)	Expenditure ($)	Energy (W)	Expenditure ($)
Conventional water cooler with air cooled condenser	4.6	19.32	138	743.4	1656	8920.8
Modified water cooler with water cooled condenser	3.94	16.55	118.2	658.26	1418.4	7899.12

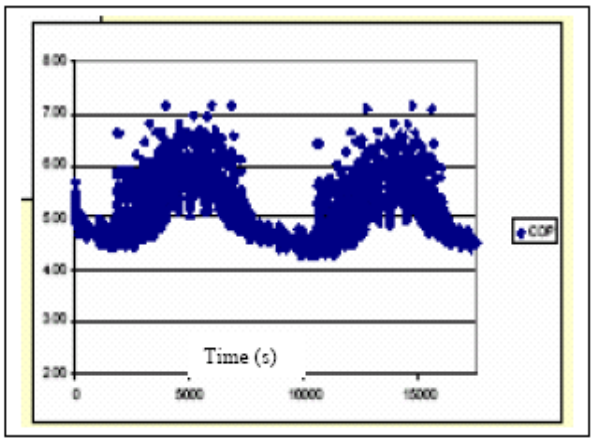


Figure 1 : Coefficient of Performance (COP)

This theme presents the study of energy efficiency improvements of water pumping systems refrigeration and air conditioning plants (R&AC). Pumps account for nearly 13-20% of electrical power and 22-30% of the electrical energy input of R&AC plants. *Table 6* gives the acceptable pump, motor and overall (composite pump – motor) efficiencies.

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Table 7 gives the recommended practices to ensure that efficiency does not deterioration with operating period. The beginning of pump deterioration starts with balance operating point (BP) deviating away from the best efficiency point (BEP) resulting in creation of unbalanced forces and vibrations *(Figure 2). Table 8* gives the requirements for choice of pumps.

Table 6 : Guidance valves for overall efficiency of pump-motor sets

Electric rating (kW)	Motor efficiency (%)	Pump efficiency (%)	Overall efficiency (pump+motor)(%)	Margin in active power (%)
<10	90	80	72	20
10-20	92	85	78	15
20-30	93	85	79	15
30-50	94	85	80	15
50-100	95	85	81	10
>100	96	85	62	10

Table 7 : Recommended operation and maintenance (O&M) practices for pumps

Particular	Details
Timber	Number of hours clocked, time between repairs, frequency of repairs must be recorded. This information in itself is a good diagnostic tool. Can be used as a basis for life cycle costing in future.
Condition monitoring	Bearing and winding temperatures and bearing vibrations are diagnostic in predicting failures.
Planned maintenance schedules after 1 k, 4 k and 8 k hours	Strict adherence including recording of observations/ documentation of observations is a good diagnostic tool. Many of time valuable information about the equipment is known only to the technical and does not get translated into management information.
Root cause analysis	Shaft misalignment, unbalanced forces, off the best efficiency point (BEP) operation, filter clogging can lead to other problems like seal leaks, bearing failures, motor burn out, etc. It is very important to understand root cause of a failure or else it will occur again and again in different forms.
Periodic shaft alignment	Radial shaft alignment must be below 0.06 mm. Angular shaft alignment must be below 0.5°C.
Impeller and casing wear ring clearance measurement	Must be measured when the impeller is opened. It must not be over 0.0025 mm beyond factory setting. Typical factory clearance is 0.20-0.24 mm.

The heating or cooling of a space to maintain thermal comfort is a highly energy intensive process accounting for as much as 60-70% of total energy use in non-industrial buildings. Of this, approximately 30-50% is lost through ventilation and air infiltration. However, estimation of energy impact of ventilation relies on detailed knowledge about air change rate and the difference in enthalpy between the incoming and outgoing air streams. In practice, this is a difficult exercise to undertake since there is much uncertainty about the value of these parameters [7]. As a result, a suitable datum from which strategic planning for improving the energy efficiency of ventilation can be developed has proved difficult to establish [8]. Efforts to overcome these difficulties are progressing in the following two ways:

- Identifying ventilation rates in a representative cross section of buildings.
- The energy impact of air change in both commercial and domestic buildings.

The challenge before many cities today is to support large numbers of people while limiting their impact on the natural environment. Buildings in a modern society are significant users of energy and materials and, hence, energy conservation in buildings plays an important role in urban environmental sustainability. A challenging task for architects and other building professionals, therefore, is to design and promote low energy buildings in a cost effective and environmentally responsive way. Passive and low energy architecture has been proposed and investigated in different locations around the world, and design guides and handbooks have been produced for promoting energy efficient buildings.

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Table 8 : Specifications/requirements for procurement of energy efficient pumps

Particular	Details
Duty point	The duty point of the pump must be specified by providing the suction head (pressure, velocity, elevation) and discharge head (pressure, velocity, elevation) based on actual measurements and not on assumed data.
Best efficiency point (BEP)	BEP flow rate must coincide with duty point or balance point flow rate. The balance point is the flow rate point at which the pressure rise of the pump coincides with the pressure drop of the circuit.
Minimum efficiency	Minimum efficiency must be specified as per guidance values.
Range of applicability of minimum efficiency	The minimum efficiency must be applicable for a change in total head of + 10% and -25%.
Testing of the pump	Pump must be tested and witnessed by owner personnel.
Seal life	Seal life of 24 months from date of commissioning.
Bearing life	Bearing life of 36 months from date of commissioning.
Mean time between failure (MTBF) = [Total time period x number of failures in the time period]	Guarantee MTB may be specified as 40,000 hours for the impeller and motor.
Performance guarantee at site	The vendor must demonstrate the energy efficiency through measurement performance guarantee test (PG test).

VI. Natural Ventilation

Generally, buildings should be designed with controllable natural ventilation. A very high range of natural ventilation rates is necessary so that the heat transfer rate between inside and outside can be selected to suit conditions [*9*]. The ventilation rates required to control summertime temperatures are very much higher than these required to control pollution or odour. Any natural ventilation system that can control summer temperatures can readily provide adequate ventilation to control levels of odour and carbon dioxide production in a building. Theoretically, it is not possible to achieve heat transfer without momentum transfer and loss of pressure. Such ideas work well for small buildings.

VII. Mechanical Ventilation

Most of the medium and large size buildings are ventilated by mechanical systems designed to bring in outside air, filter it, supply it to the occupants and then exhaust an approximately equal amount of stale air. Ideally, these systems should be based on criteria that can be established at the design stage. To return afterwards in attempts to mitigate problems may lead to considerable expense and energy waste, and may not be entirely successful [*10*]. The key factors that must be included in the design of ventilation systems are: code requirement and other regulations or standards (e.g., fire), ventilation strategy and systems sizing, climate and weather variations, air distribution, diffuser location and local ventilation, ease of operation and maintenance and impact of system on occupants (e.g., acoustically). These factors differ for various building types and occupancy patterns. For example, in office buildings, pollutants tend to come from sources such as occupancy, office equipment, and automobile fumes. Occupant pollutants typically include metabolic carbon dioxide emission, odours and sometimes smoking. When occupants (and not smoking) are the prime source. Carbon dioxide acts as a surrogate and can be used to cost-effectively modulate the ventilation, forming what is known as a demand controlled ventilation system. Generally, contaminant sources are varied but, often, well-defined and limiting values are often determined by occupational standards.

It may mean achieving zero energy requirements for a house or reduced energy consumption in an office building. However, a major goal of low energy building projects and studies is usually to minimize the amount of externally purchased energy, such as electricity and fuel gas. Sometimes the target may focus on the energy costs or a particular form of energy input to the building.

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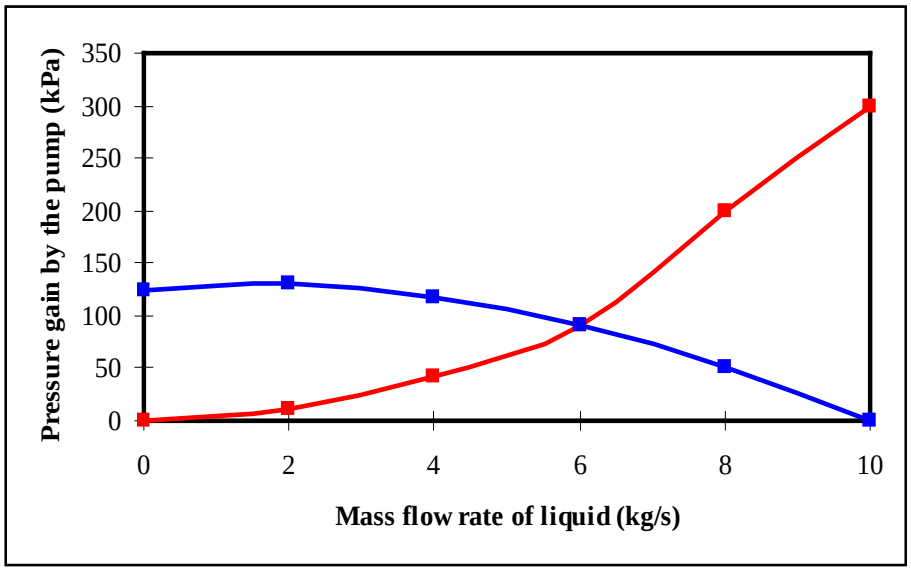


Figure 2 : Balance point (BP) of the pump must coincide with the best efficiency point (BEP)

Passive solar systems for space heating and cooling, as well as passive cooling techniques can significantly contribute to energy saving in the building sector when used in combination with conventional systems for heating, cooling, ventilation and lighting. The overall thermal behaviour of the building is dependent on the alternatives and interventions made on the building's shell. Passive ventilation systems share the use of renewable energy to provide ventilation with infiltration. But unlike air leakage and open windows, passive ventilation systems are designed to provide specific amounts of ventilation to minimise both energy liabilities due to excessive ventilation and periods of poor air quality due to under-ventilation [*11*]. However, the most common passive ventilation system is the passive stack, which is normally used to extract air from kitchen and bathrooms. In this method, prevailing wind and temperature differences are used to drive airflow through a vertical shaft. Various stack designs can be used to control or enhance the performance, based on local climate. However, careful design is required to avoid backdraughting and to insure proper mean rates. Although there is significant experience with this approach in Europe, it has been rarely used in North America [*12*]. Well-designed passive ventilation systems can be used to provide whole-building ventilation as well as local exhaust. Some efforts are currently underway to develop passive ventilation systems that incorporate heat recovery to minimise the need for conditioning the ventilation air [*13*]. These approaches aim towards a fully renewable ventilation system in that it requires no non-renewable resources for either providing the ventilation air or conditioning it. *Table 9* shows natural ventilation vs mechanical ventilation.

An expression for the airflow induced by the stack effect is:

$$Qstack = Cd*A*[2gh\ (Ti-To)/Ti]^{1/2} \quad (4)$$

Where:

Qstack is the volume of ventilation rate (m^3/s)

Cd is a discharge coefficient (0.65)

A is a free area of inlet opening (m^2), which equals area of outlet opening

g is the acceleration due to gravity (9.8 m/s^2)

h is the vertical distance between inlet and outlet midpoints (m)

Ti is an average temperature of indoor air (K), note $27^oC = 300$ K

To is an average temperature of outdoor air (k)

However, as building design needs to consider requirements and constraints, such as architectural functions, indoor environmental conditions, and economic effectiveness, a pragmatic goal of low energy building is also to achieve the highest energy efficiency, which requires the lowest possible need for energy within the economic limits of reason. Therefore, since many complicated factors and phenomena influence energy consumption in buildings, it is not easy to define low energy building precisely or to measure and compare the levels of building energy performance. The loose fit between form and performance in architectural design also makes quantitative analysis of building energy use more difficult.

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Table 9 : Natural ventilations Vs mechanical ventilation

Natural ventilation	Mechanical ventilation
Natural ventilation regulates the indoor climate by a controlled air flow through the windows. Compared to mechanical ventilation natural ventilation uses only a small amount of energy when the windows open and close. A head to head comparison shows that natural ventilation has 40% lower CO" emission than a system with mechanical ventilation.	Effective solution when building geometry prevents natural ventilation solution or scheme design requires set ventilation rate.
Reduced capital, space and running costs compared to conventional air conditioning.	
Potential for integrated day-to-day and smoke control as well as hybrid natural and mechanical ventilation systems.	Potential for integrated day-to-day and smoke control as well as hybrid natural and mechanical ventilation systems.
Custom solutions for all types of buildings.	
Total support from design, installation, through to service and maintenance.	Total support from design, installation, through to service and maintenance.
Energy-efficient and cost-effective	A particularly important aspect of mechanical ventilation is having heat recovery, which allows incoming air to be warmed by outgoing air through a heat exchanger, therefore avoiding heat loss through the ventilation system.

VIII. Refrigeration

If temperature of hot gas is too high, the tendency of coil is to steam. Also, as the air temperature goes, its relative humidity drops. This leads to increased evaporation of surface water. It also, adds to refrigeration load if it is a cold storage or if the freezers are in the open area then it leads to fog/mist formation. Warmer temperatures will not necessarily improve defrost efficiency. This is because most of the defrost heat comes from latent heat of hot gas, rather than sensible heat (*Table 10*).

Table 10 : Ammonia Refrigerant

Temperature (°C)	Pressure (Bar)	Latent heat (kJ/kg)
4	4	1240
10	5	1220
16	6	1200
21	8	1180

After the corrective actions taken by Montreal protocol and subsequent Kyoto protocol, in recent years, the consumption of potential greenhouse gases has increased, whist at the same time the consumption of CFCs, HCFCs and other substances, which are depleting the ozone layer, is approaching zero.

Refrigerants are identified by number, preceded by the letter ''R'' designation has been established by ASHRAE and is used throughout the industry. Common refrigerants are listed in *Table 11* along with their chemical name and the ODP. The prefix ''CFC' refers to the family of refrigerants containing chlorine, fluorine and carbon. Compounds that also contain hydrogen precede the abbreviation with the letter ''H'' to signify an increased deterioration potential before reaching the preceded with an ''H'' as in 'HFC''.

Table 11 : Characteristics of some common refrigerants

R Number	Chemical type	ODP	Similar to	comments
Rr-11	CFC	1.00		11
R-12	CFC	1.00		12
R-22	HCFC	0.05		22
R-123	HCFC	0.02		123
R-134a	HFC	0.00		Single
R-401a	HCFC	0.05	R-12	22, 152a, 124
R-402b	HCFC	0.02	R-12	125, 290, 22
R-404a	HFC	0.00	R-502	125, 143a, 134a

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R-500	CFC	0.74	R-502	12, 115
R-502	HCFC	0.28		
R-507	HFC	0.00	R-502	125, 143a
R-410A	HFC	0.00	R-22	125, 32
R-407C	HFC	0.00	R-22	R32, 125, 134a

CFC Chlorofluorocarbons
HCFC Hydro chlorofluorocarbons
FC Fluorocarbons
ODP Ozone depletion potential
GWP Global depletion potential

Table 12 summarises the overall impact of the three refrigerants with respect to R-22 performance. It is based on information from system tests. There is high potential for significant material and labour savings for air conditioning systems with R - 410 A refrigerant *Table 13*).

Table 12 : Performance comparison for alternate refrigerants

Efficient effect (%) relative to R-22	R-134a	R-407C	R-410A
Thermodynamics	3	-4	-7
Compressor	-3	-1	5
Heat exchanger	-6	-2	2
Lines	-2	0	2
Total (net)	-9	-7	5

Table 13 : Characteristics of some substance refrigerants

Substance	R-number	Chemical formula	ODP value	GWP value
HCFC-22	R-22	CHF2Cl	0.005	1700
HFC-134a	R-134a	CH_2FCF_3	0	1300
HFC-407C	R-407C	CH_2F_2, CF_3CHF_2, CH_2FCF_3	0	1526
HFC-410A	R-410A	CH_2F_2, CHF_2CF_3	0	1725

The input data required are the following:

- Thermal gains related data: solar protection is assumed good, thermal gains can be varied and the user specifies the occupancy period.
- Building fabric data: glazing ratio can be any value while thermal mass can be varied at three levels.
- Ventilation data: infiltration, day ventilation and night ventilation can be specified as necessary.
- Weather data: solar data are fixed but temperature is user specified for seven days although temperature profiles need not be the same for all days. The weather data are specified in the form of maximum and minimum temperature for each day and hourly values are calculated by sinusoidal fitting.

However, a primary strategy for cooling buildings without mechanical intervention in hot humid climates is to promote natural ventilation. To control the energy used for the cooling of buildings in hot-arid regions with ambient air temperatures during the hottest period between 42 to 47°C, passive cooling approaches should be implemented [*14*]. A solar chimney that employs convective currents to draw air out of the building could be used. By creating a hot zone with an exterior outlet, air can be drawn into the house, ventilating the structure as well as the occupants. Since solar energy in such a region is immense, the hot zone created with a black metal sheet on the glazing element can draw hotter air at a slightly higher speed [*15*]. Applications of solar chimneys in buildings were limited to external walls. Integrating a solar chimney with an evaporatively cooled cavity could result in a better cooling effect. However, this should be applied with care since water sources are limited [*16*]. Average room and ambient air temperatures are 23 and 27°C respectively. Air velocity required to achieve thermal comfort in the room should reach a maximum of 0.3 m/s [*17*].

IX. Air Pollutants and Transmutation

Controlling the pollution of the present civilisation is in an increasing concern. More importance is given to control global carbon dioxide, which is considered to be the main factor of green house effect. Though the complete experimental result on the fact is yet to be debated, the immense heat, temperature and turbulence of nuclear explosion oxidising the atmospheric nitrogen into nitric oxide, are considered to be similarly responsible for depletion of ozone layer [*18*]. At present, more importance is given for plantation to reduce the level of global carbon dioxide. The plantation over the whole earth surface may control only 50% of carbon dioxide disposed to atmosphere and its greenhouse effect. There are, also, explosions in the ozone layer time to time to add to the problem. Irrespective of the relative importance of each factor, the ozone layer protects us from harmful cosmic radiations and it is believed that the depletion of ozone layer increases the threat of outer radiations to human habitation if environmental pollution is not controlled or there is no possibility of self-sustainable stability in nature [*19*].

The presence of ionosphere in the outer-sphere is most probably for ionic dissociation of the gases of the outer-sphere in the presence of low pressure and cosmic radiation [*20*]. Moreover the ionosphere contains charged helium ions (alpha particle). Therefore, it may

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be concluded that the explosion in the ozone and transmission of radiations through it are the possible effects of transmutation of pollutants with exothermic reaction (emission of radiations) [*21*]. The existence of a black hole in the space, which is found in the photo camera of astrologist, is still unexplored. This black hole may be an effect of transmutation process with absorption of heat energy (endothermic reaction). The idea of transmutation of pollutants has been proposed for one or more of the following reasons:

- The experimental results support the transmutation of materials.
- To search the sinks of the remaining carbon dioxide not absorbed by plants or seawater.
- To find out the possible causes of explosion in the ozone layer other than the depletion of ozone layer.
- To investigate the possibilities of the self-sustaining stability of global environment.

To prove the portable of transmutation of pollutants, experimental investigations may be conducted to bombard C or CO_2 or CH_4 or other air pollutants by accelerated alpha particles in a low-pressure vacuum tube in a similar condition of ionosphere. Heating them with gamma radiation can accelerate the alpha particles. The results of such experimental investigation may prove the probable transmutation of pollutants and self-sustaining equilibrium of the global environment [*22*].

X. Energy and Environment

Today, renewable energy is some 20% of the world's annual energy use of about 9 x 10^9 tonnes of oil equivalent (Mtoe/a; 1 toe = 42 GJ) [*23*]. Fossil fuels account for the bulk; about 80% of the energy use. In the future, it is postulated that these roles will change as energy demand rises and cheap oil and gas are depleted; even without consideration of global warming effects. The changes will be driven mainly by the developing areas, which have relatively less of the fossil fuel reserves, but have a substantial potential to deploy renewable energies [*24*]. A substantial potential is believed to exist in the world for renewable energy sources. This is estimated as 4900 Mtoe/a for biomass, 780 Mtoe/a (electric) for hydropower, and 4540 Mtoe/a (electric) for wind-power [*25*]. Roughly half of these energy resources are in developing countries. The rest of the energy will have to be supplied by fossil, solar, geothermal and nuclear (fission and fusion) sources. An example distribution of world energy sources is shown in *Figure 3.*

They are campaigning for sustainable development, which has been defined as development, which meets present needs without compromising the ability of future generation to meet their needs [*26*].

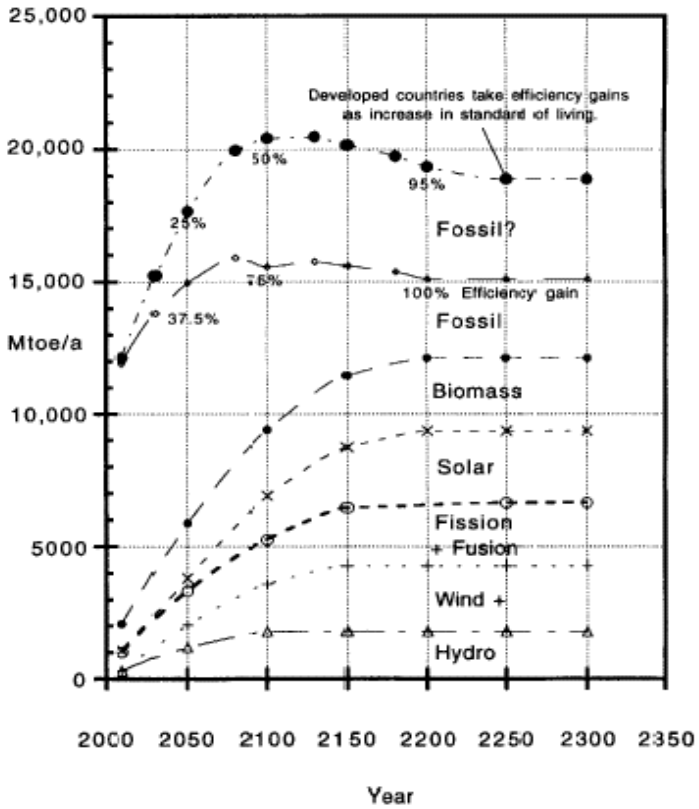


Figure 3 : Total energy uses for 2010-2300 with potential energy sources (added to give total)
(a) Lower efficiency and developed countries take efficiency gains as increase in standard of living.
(b) Higher efficiency gains and developed countries use gains to reduce energy use.

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It is, therefore, essential that energy efficiency improvements and all energy sources, particularly renewables, are developed and deployed rapidly in order to ensure that population stabilisation, with a decent standard of living for all, is realised. There is a need to move towards a sustainable energy policy with the objectives of environmental protection, sound natural resource management and energy security [27]. Opportunities exist for the increased development of renewable energy and energy efficiency through regulation, changes to institutional and economic arrangements, and through liberalisation of the energy market, which offers the potential for the development of energy service companies and a market for green electricity. Friends of the Earth have been one of the leading environmental groups campaigning in support of renewable energy and energy efficiency over the last two decades.

Industry's use of fossil fuels has been blamed for our warming climate. When coal, gas and oil are burnt, they release harmful gases, which trap heat in the atmosphere and cause global warming. However, there has been an ongoing debate on this subject, as scientists have struggled to distinguish between changes, which are human induced, and those, which could be put down to natural climate variability. Industrialised countries have the highest emission levels, and must shoulder the greatest responsibility for global warming. However, action must also be taken by developing countries to avoid future increases in emission levels as their economies develop and population grows. Human activities that emit carbon dioxide (CO_2), the most significant contributor to potential climate change, occur primarily from fossil fuel production. Consequently, efforts to control CO_2 emissions could have serious, negative consequences for economic growth, employment, investment, trade and the standard of living of individuals everywhere. Scientifically, it is difficult to predict the relationship between global temperature and greenhouse gas concentrations. The climate system contains many processes that will change if warming occurs. Critical processes include heat transfer by winds and currents, the hydrological cycle involving evaporation, precipitation, runoff and groundwater and the formation of clouds, snow, and ice, all of which display enormous natural variability. The equipment and infrastructure for energy supply and use are designed with long lifetimes, and the premature turnover of capital stock involves significant costs. Economic benefits occur if capital stock is replaced with more efficient equipment in step with its normal replacement cycle. Likewise, if opportunities to reduce future emissions are taken in a timely manner, they should be less costly. Such flexible approaches would allow society to take account of evolving scientific and technological knowledge, and to gain experience in designing policies to address climate change.

XI. Renewable Energy

The energy conservation scenarios include rational use of energy policies in all economy sectors and use of combined heat and power systems, which are able to add to energy savings from the autonomous power plants. Electricity from renewable energy sources is by definition the environmental green product. Hence, a renewable energy certificate system is an essential basis for all policy systems, independent of the renewable energy support scheme. It is, therefore, important that all parties involved support the renewable energy certificate system in place. The potential of the most important forms of renewable energy, such as solar, wind, biomass, and geothermal energies, is shown in *Table 14*. Existing renewable energy technologies could play a significant mitigating role, but the economic and political climate will have to change first. Climate change is real. It is happening now, and greenhouse gases produced by human activities are significantly contributing to it. The predicted global temperature increase of between 1.5 and 4.5 degrees C could lead to potentially catastrophic environmental impacts.

Table 14 : Potential, productive, end-uses of various energy sources and technologies

technology	Productive end-uses and commercial activities
Solar	Lighting, water pumping, radio, TV, battery charging, refrigerators, cookers, Dryers, cold stores for vegetables and fruits, water desalination, heaters, baking, etc.
Wind	Pumping water, grinding and provision of power for small industries
Hydro	Lighting, battery charging, food processing, irrigation, heating, cooling, cooking, etc.
Biomass	Sugar processing, food processing, water pumping, domestic use, power Machinery, weaving, harvesting, sowing, etc.
Kerosene	Lighting, ignition fires, cooking, etc.
Dry cell batteries	Lighting, small appliances
Diesel	Water pumping, irrigation, lighting, food processing, electricity generation,
	Battery charging, etc.
Animal and human power	Transport, land preparation for farming, food preparation (threshing)

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In order to meet challenges, the future energy policies should put more emphasis on developing the potential of energy sources, which should form the foundation of future global energy structure [*28*]. The concept of an integrated renewable energy farm (IREF) is a farming system model with optional energetic autonomy, which includes food production and if possible, energy exports. Energy production and consumption at the IREF have to be environmentally friendly, sustainable and eventually based mainly on renewable energy sources. A combination of different possibilities exists for non-polluting energy production, such as modern wind and solar electricity production, as well as the production of energy from biomass. An IREF system based largely on renewable energy sources would seek to optimise energetic autonomy and an ecologically semi-closed system while also providing socio-economic viability and giving due consideration to the newest concept of landscape and bio-diversity management. Ideally, it would promote the integration of different renewable energies and rural development, as well as contributing to the reduction of greenhouse gas emission as shown in *Table 15.* The overall objective is that the IREF concept be successfully introduced into agricultural production systems, which have to be completely sustainable, taking into account the following influential factors [*29-30*]:

- Impact, influence and needs of climate, soil and crops.
- Ratio of required food/bio-fuel production.
- Input/output requirement for cultivation, energy balance and output/input ratio.
- Equipment choices (wind, solar, biomass generation and conversion technology).

Table 15 : The possible shares of different renewable energies in diverse climatic zones produced on an energy farm

Climatic Region	Energy source	Power production (% of total need)	Heat production (% of the total need)	Biomass need (total area)	Biomass area (5 of the total area)
Northern and Central Europe	Solar 200 m^2 Wind 100 kW Biomass	7 100 100	15 - 105	60	12
South Europe	Solar 250 m^2 Wind 100 kW Biomass	12.7 100 70	40 - 65	36	48
Northern Africa Sahara	Solar 300 m^2 Wind 100 kW Biomass	21 75 25	90 - 29	14	1.2
Equatorial Region	Solar 200 m^2 Wind 100 kW Biomass	18.2 45 70	37.5 - 80	45	

XII. Conclusions

Many cities around the world are facing the problem of increasing urban density and energy demand. As cities represent a significant source of growth in global energy demand, their energy use, associated environmental impacts, and demand for transport services create great pressure to global energy resources. Low energy design of urban environment and buildings in densely populated areas requires consideration of a wide range of factors, including urban setting, transport planning, energy system design, and architectural and engineering details. It is found that densification of towns could have both positive and negative effects on the total energy demand. With suitable urban and building design details, population should and could be accommodated with minimum worsening of the environmental quality.

Energy efficiency brings health, productivity, safety, comfort and savings to homeowners, as well as local and global environmental benefits. The use of renewable energy resources could play an important role in this context, especially with regard to responsible and sustainable development. It represents an excellent opportunity to offer a higher standard of living to local people and will save local and regional resources. Implementation of greenhouses offers a chance for maintenance and repair services. It is expected that the pace of implementation will increase and the quality of work improve in addition to building the capacity of the private and district staff in contracting procedures. The financial accountability is important and should be made transparent.

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The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

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Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
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- Fundamental goal
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Approach:

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Approach:

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- If use of a definite type of tools.
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Approach:

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Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
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Approach

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- 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.
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- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



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