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Trend Analysis and Future Prediction of Maximum Temperature for Delhi

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ABSTRACT

General Circulation Models are Hybrid Mathematical Model used for Climate Change Impact Studies. It works on a coarser scale and downscaling is necessary for climate change impact at regional scale. Monthly Temperature in Delhi is downscaled in this study. In this study the future monthly temperature in Delhi is downscaled using outputs of CGCM3 for A2 emission scenario. The data for the base period of 30 years (1971-2000) and for the future period of 100 years (2001-2100) has been employed in downscaling. Gridded data set of temperature from National Climate Centre, IMD Pune has been taken as observed and a relationship is generated between predictand and predictors of CGCM3 and the generated relationship are then used for downscaling temperature for future period. The correlation coefficient shows relationship between observed and predicted data. From the prediction it has been observed that there is a rise in winter session is more than summer session.

Keywords: GCM; Climate Change, CGCM3, IMD, Downscaling.

1. INTRODUCTION

The change in the global climate has been observed recent years due to increasing greenhouse gases (GHGs) in the atmosphere. In India, an increase in the linear trend of about 0.4˚ C in the surface air temperature has been observed in the past century. A warming trend is visible along the west coast, central India, interior peninsula and the North-Eastern India, but some cooling trends are also visible in the North-West India and parts of South-India. To analyze the comparative change in the Indian peninsula, both sea level temperature and land surface temperature are required to be recorded on long term basis at different climatic zones of the country.

2. STUDY AREA AND DATA USED

Delhi is the capital of India. The state is spread over an area of 1,483 square kilometres. The latitudinal and longitudinal location of Delhi is 28.36˚ north and 77.20˚ east. It is located in the northern part of India. Haryana, Uttar Pradesh, Rajasthan and Madhya Pradesh are the other states, which share their borders with Delhi. Delhi geography divides the state into three parts- the Delhi ridge, the Yamuna flood plain and the plains.

2.1 Data used

There are two sources of data:

1. IMD gridded maximum temperature (1° x 1°) special resolution from 1971-2005 (35 years) is collected from National Climate Centre IMD, Pune.
2. GCM outputs of Canadian Centre for Environmental Prediction Model CGCM3.1 are obtained from http://www.cccma.ec.gc.ca for the base period of 1971-2000(30 years) and for the future period of 2001-2100 (100 years) under A2 scenario.

3. METHODOLOGY

In this study a relationship is derived in between observed data and predicted data of maximum temperature using multiple linear regressions. This involves various processes:

- Screening of downscaling predictor variables.
- Re-gridding and standardization.
- Principal component analysis.
- Multiple linear regressions.

4. RESULTS AND DISCUSSIONS

The Statistical downscaling involves developing quantitative relationships between large-scale atmospheric variables (predictors) and local surface variables (predictands). For selecting the potential predictors, a correlation is checked among the predictand and predictors. The probable predictor selected for downscaling having correlation above 0.78 is mean sea level pressure (mslp, in milibars), air temperature at 2m height (temp2, in Kelvin), air temperature at 925hPa height (temp925, in Kelvin), 500hPa geopotential height (zg500, in metres). The scatter plots are also prepared to see the relationship of predictand with GCM predictors. After the standardization of predictor's data set, the principal component analysis is carried out to extract the principal components. Then taking predictand as dependent variable and predictors as independent variable, a multiple linear regression is carried out and the regression coefficient is determined. The prediction has been carried out using regression coefficient obtained from the GCM data set.

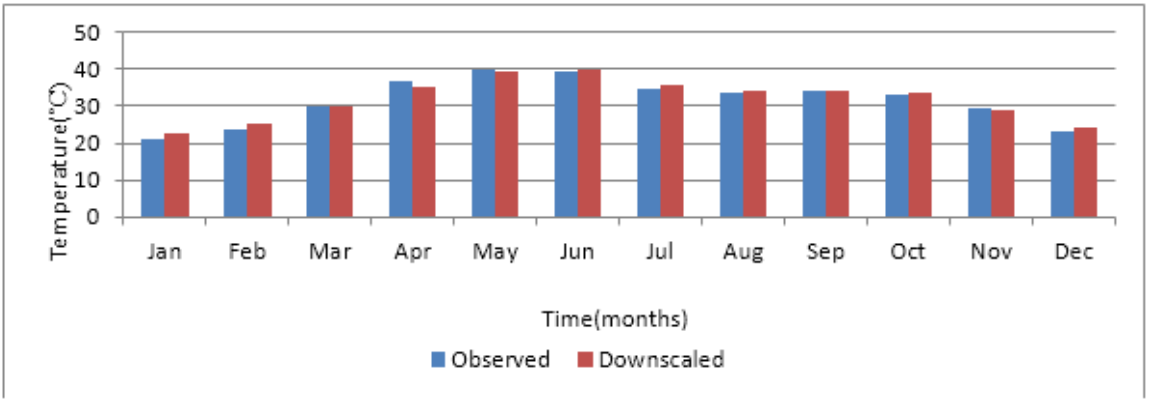

Figure 1: Observed and downscaled monthly mean maximum temperature for the base line period (1971-2000)

The average of monthly maximum observed temperature shows temperature of 41.0 °C in the month of June and minimum of 21.5 °C in the month of January during (1971-2000) as in Figure 1. Downscaled mean maximum temperature for the baseline period is slightly higher than observed mean maximum temperature.

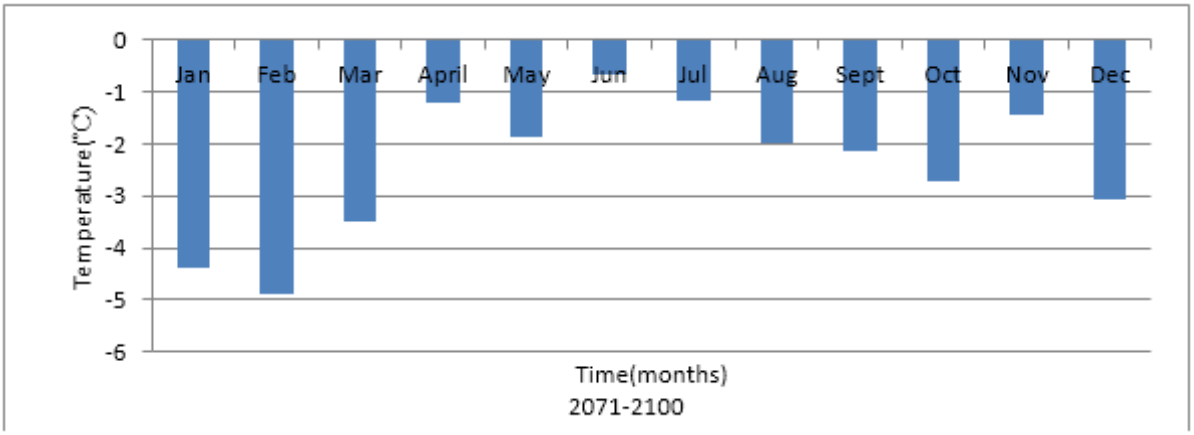

Figure 2: Change in monthly maximum temperature between baseline period and future (2071-2100)

It is clear from the figure 2, maximum temperature from January to December during 2071-2100 will rises. Maximum rise will be in February and minimum rise in maximum temperature will be in June.

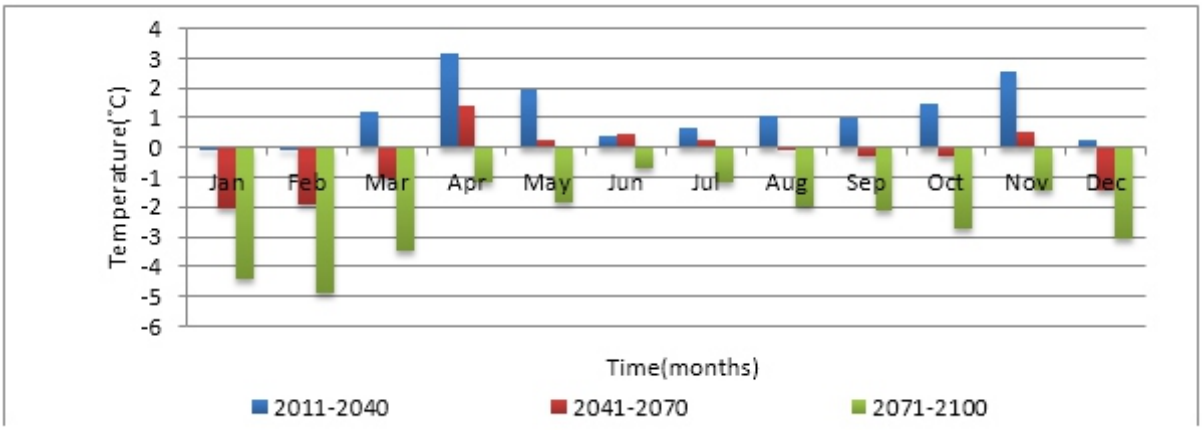

Figure 3: Change in monthly maximum mean temperature between baseline period and future periods.

Figure 3 show that the change in monthly maximum average temperature between baseline period (1971-2000) and future periods (2011-2040, 2041-2070, 2071-2100). In start of the century, rise in maximum temperature will less but at the last of the century, rise in maximum temperature will higher.

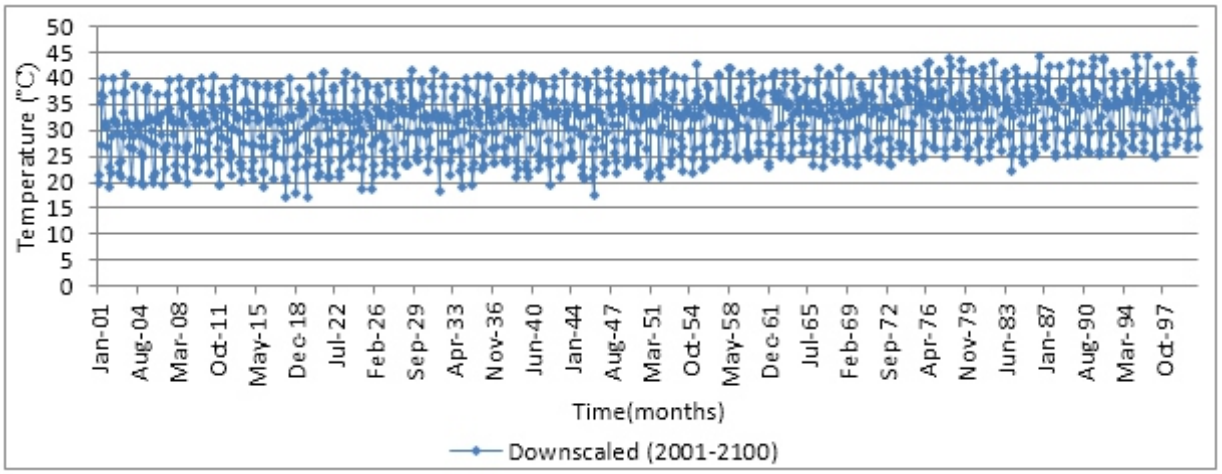

Figure 4: Downscaled monthly maximum temperature for period (2001-2100)

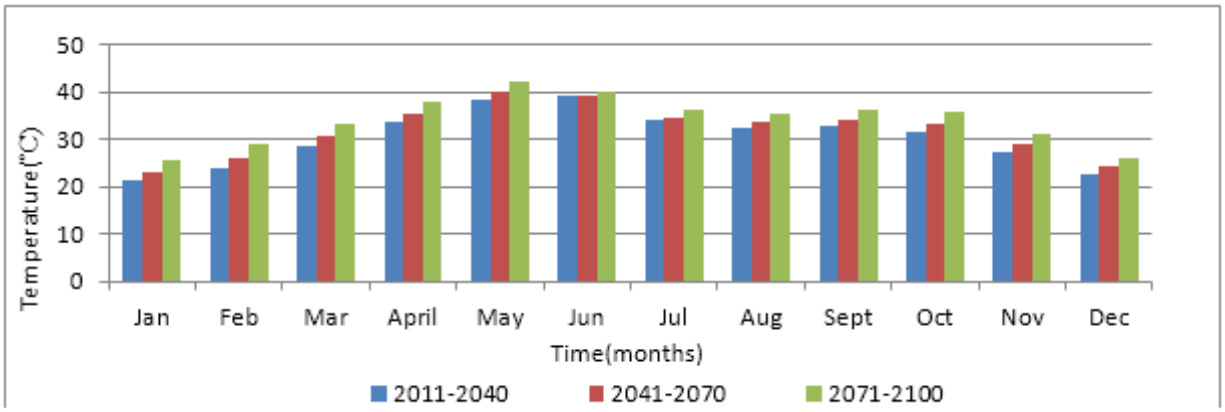

Figure 5: Comparison of downscaled monthly mean temperature for future periods.

From predicted data set, the average temperature for the period 2011-2040 is found lesser than the average temperature for the base period (1971-2000) by 0.3-3.2 ˚C although there is a slightly rise in temperature for the months January and February by 0.1 ˚C and 0.07 ˚C respectively, the results shows that during 2041-2070, there is variations in average temperature, i.e., there is rise in temperature in between (1-2.1 ˚C) from January to March after then fall in average temperature in-between (0.25-1.4 ˚C) from April to December except November in which there is fall of temperature of 0.56 ˚C. It has been observed from the results that maximum rise of 2.1 ˚C is in the month of January and minimum rise of 0.01 ˚C is in the month of August. During (2071-2100) there is a rise in temperature in-between (0.7-4.9 ˚C) from January to December. It has been observed from the results that maximum rise of 4.9 ˚C is in month of February and minimum rise of 0.7˚C is in the month of June as shown in figure 5.

5. CONCLUSION

The rise in monthly temperature for maximum is approximately up to 1 to 3 degree Celsius during summer whereas rise in monthly temperature for maximum rises up to 5 degree Celsius during winter at

the end of century which is within the range as Projected by Intergovernmental Panel on Climate Change (IPCC) that the earth's average temperature will rise 1.4 to 5.8 degrees Celsius during this century.

It is also concluded from the study that in start of the century, rise in maximum temperature will less but at the last of the century, rise in maximum temperature will higher.

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Wash- Out of Air Pollutants by the Southwest Monsoon Rain Over Visakhapatnam

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ABSTRACT

The wash- out of air pollutants by rain, which is of considerable relevance to a monsoonal country like India, was studied. Rain water samples were collected from ten selected stations in Visakhapatnam city during South West monsoon of 2014. The natural scavenging effects of rain and the wash- out factor with respect to ambient sulphur dioxide pollution were also estimated. The wash- out effects were found to be dependent upon the intensity of the rain, the interval between two spells of rain and the amount of pollutants present in the atmosphere.

Key Words: Washout factor, Rain water, South west monsoon and Sulfur dioxide

INTRODUCTION

The activities of man lead to a change in the general atmosphere near the earth's surface and this change may result in the persistence of certain pollutants like sulphur dioxide , oxides of nitrogen , carbon monoxide , sodium, potassium and chloride . These substances interfere with the comfort of the people, cause or tend to cause ill-health and also adversely affect flora and fauna. Further, in the polluted atmosphere a number of chemical reactions take place producing secondary pollutants which add to the unpleasant properties. The problem of air pollutants is not so alarming in India as in the developed countries, but recently it has assumed a serious form in certain urban pockets owing to industrial activity. Nature is a very effective self cleansing agent. The pollutants are carried away and diluted by winds, diffused by heat, absorbed by vegetation and land and washed out by precipitation. Wet precipitation particularly rain is considered quite effective in washing out gaseous pollutants and particulate matter.

Owing to the importance of the chemical composition of rain- water in geochemistry, agriculture, meteorology and environmental pollution, considerable work has been reported from India. In the present study, made in Visakhapatnam city, the chemical composition as well as the wash-out of the air pollutants is reported. The city of Visakhapatnam is situated at 17°421 north latitude and 82° 181 east longitudes, a highly industrialized coastal metropolitan city on the east coast of India. The average rainfall of Visakhapatnam is 955 mm per year and per month is 79.6 mm.

MATERIAL AND METHODS

Ten sampling points well- distributed throughout the Visakhapatnam city were selected according to criteria laid down by A .C Stern (1972) so that an average picture of chemical composition of rain- water could be obtained. The rain water was collected in cleaned and washed polyethylene container fitted with a funnel of 16 cm diameter. The container was mounted on wooden boxes and placed on the top of the buildings at height of 9-16 m from the ground level .Adequate precautions were taken for the catch of precipitation, so that local interferences could be minimized. The samples were collected from each station as early as possible after the rain. All the samples were filtered through what man No.42 filter paper to remove the suspended and undisclosed materials. The filtrate was analyzed for PH, sodium, potassium, sulphate and chloride. The PH value was recorded on a Beckman PH meter. The sodium and potassium ion concentrations were determined with flame photometer using the standard techniques. The chloride was precipitated as silver chloride with silver nitrate and nitric acid at the resulting turbidity was measured at 560 mμ with a spectrophometer. The sulphate content was determined by using the turbidity method. First of all the PH of the samples was adjusted to 4.0 and then sufficient barium chloride was added to precipitate sulphate ion completely in the presence of a conditioning media contains glycerol's, sodium chloride, hydrochloric acid and alcohol. The resulting turbidity was measured with a spectrophometer at 420 mμ. The washout factor W (Peirson, 1973) was calculated as:

W = Concentration in rain- water (μg/kg)/Concentration in air (μg/kg)

The concentration of sulphate in the air was calculated from the sulphation rate measured by using the standard lead peroxide candle method.

Table 1: Chemical Composition of rain water in different locations in Visakhapatnam city

Station Name	July-October Date	PH	SO4 Mg/lit	Cl Mg/lit	Na ppm	K ppm	No3 Mg/lit
	July 1 July12 Aug 1	6.5	14	4	8	2.8	1.32
	Aug-21	6.9	9.5	0.25	6	3.3	0.75
	Sep-26	6.7	7.5	8	6	5.5	1.62
	Sep 27 Oct11 Oct18	6.6	20.02	1.25	3	4.5	0.05
		6.3	9.5	0.5	17	2	1
		6.5	40.9	0.9	8	2.2	0
IE Mariipalem		5.6	12.5	0.6	11	5.5	0
		5.9	16.23	0.9	6	5	0
	Jul-01	6.4	2.8	5.3	6	3	0.25
	Jul-12	6.1	2	2.2	3	5.3	0
N.S.T.L	Aug-01	6.6	10.4	3.5	6	4.8	0.3
	Aug-21	6.01	5.2	3.2	3	4.3	1.15
	Sep-26	7.9	5.2	1.77	6	5.3	0
	Sep-27	7	5.4	1.06	5	3.6	0
	Oct-11	6.4	8.5	2.5	6	3.8	1.2
	Oct-18	6.2	7.6	3.2	6	3.9	0.4

	Jul-01	5.8	53.2	25.79	8	2.3	0.28
	Jul-12	7.25	9.6	0.9	6	2.3	0.8
	Aug-01	6.8	54	10.63	8	3.6	0.19
	Aug-21	6.5	14	0.88	3	5.8	0.87
	Sep-26	6.1	14	0.89	11	3.8	0
OLD POST OFFICE	Sep-27	6.3	15.2	0	11	5.8	1.2
	Oct-11	7.2	25	7.5	6	3.8	1.4
	Oct-18	7.4	16.5	7.1	11	5.8	0.5
	Jul-01	6.8	10.5	9.5	6	3.3	0.5
	Jul-12	6.9	12	8.4	3	3.5	0.3
	Aug-01	6.7	15	12.5	8	2.3	0
	Aug-21	6.6	5	14.6	6	2.4	0
	Sep-05	6.3	12	15.6	6	1.7	0.2
INS Virabahu	Sep-15	6.4	7.2	9.5	4	1.2	0.1
	Oct-05	6.1	8.5	10.5	4	2	0.1
	Oct-10	6.3	10.5	12.5	3	2.1	0.05
	Jul-01	6	1.5	1.2	4	3.3	1.1
	Jul-12	6.1	1.4	1.5	5	3.6	0.5
	Aug-15	5.9	3.4	1.3	3	2.2	0.01
	Aug-22	5.8	5.6	1.2	6	2.6	0.05
	Sep-12	6.3	2.1	0.5	4	3.1	0.4
Seethammadhara	Sep-19	6.4	2	0.6	3	3	0.3
	Oct-12	6.2	1.5	1	5	2.5	0
	Oct-24	6	0.5	1.1	3	2.4	0
	Jul-01	6.1	7.2	4	16	5.5	1.63
	Jul-14	6.2	10	1.8	14	4.5	0.63
	Aug-02	5.7	14.8	12	15	5.2	0.73
Gnanapuram	Aug-13	5.9	7.2	0.9	16	5.1	1.75
	Sep-10	5.8	5.2	9.3	10	4.5	2.7
	Sep-21	5.6	26.8	4	8	5	2.1
	Oct-15	5.5	14.5	12	8	4.8	1.5
	Oct-24	5.6	10.2	1.8	12	5.2	1.35
	Jul-05	5.7	6.5	1.5	8	4.5	1.7
	Jul-15	5.8	12	1.6	12	4.3	1.06
	Aug-17	5.6	15	0.5	7	5.1	1.5
	Aug-18	5.8	19	0.9	14	5	1.16
	Sep-12	5.7	14	1.2	15	4.9	1.4
Gajuwaka	Sep-20	5.8	13.2	0.12	8	4.8	1.5
	Oct 6 Oct17	6	19	1.2	9	4.7	1.3
		6.1	20.5	1.6	8	4.6	1.4
	Jul-15	6.5	58	8.4	17	3.3	1.32
	Jul-23	6.2	37	2.7	7	2.3	0.75
	Aug-18	6.12	52	4.4	3	5.8	1.62
	Aug-19	6.6	12.4	1.8	3	4.3	0.05
	Sep-07	6.9	76	3.54	8	5	1
	Sep 13 Oct15	6.5	20	2.5	6	4	0
Mulagada	Oct-17	6.6	6.8	5.31	11	4	0
		5.39	9.2	2.03	8	4.5	0
	July 18 July28 Aug 9	5.94	19	13.03	11	4	0.4
	Aug-12	6.68	9	6.6	6	2.8	1.22
	Sep-11	6.44	8	39	17	3.6	0.2
	Sep-13	5.6	12	1.77	6	4.5	1.87
	Oct 5 Oct15	6.8	11.2	1.77	8	3.8	0.3

Jagadamba		5.2	12	1.5	6	3.6	0
		6.7	16	1.65	9	4	0
		5.6	14	1.55	11	4.2	0
	Jul-15	6.21	10	6	14	2.3	0.75
	Jul-23	6.5	12	1.8	11	2.8	1.03
Andhra University	Aug-09	6.28	22.8	2	23	3.3	0.15
	Aug-18	6.65	8.4	13.29	3	5	1
	Sep-07	6.9	10	11.52	11	4.8	1
	Sep-11	6.1	9	1.77	6	4.8	0.25
	Oct 5 Oct10	5.8	9.5	1.77	6	4.5	0
		5.6	8	1.65	11	3.6	0

Table 2: MEAN AND RANGE OF CHEMICAL COMPOSITION OF RAIN WATER OVER VISAKHAPATNAM

Sampling point	pH	Na(ppm)	K(ppm)	So4(mg/lit)	Cl^-(mg/lit)	$No3^-$(mg/lit)
Mulagada	4.625	7.428	4.242	60.285	4.025	0.677
	(3.5-5.66)	(3-14)	(2.3-5.8)	(6.82-132.0)	(1.80-8.4)	(0.05-1.62)
Jagadamba	6.468	8.142	4.214	21.142	9.43	0.578
	(5.4-7.32)	(3-17)	(2.5-8.0)	(8-19.2)	(1.77-39)	(0.26-1.87)
Old Post Office	6.876	7.8	4.16	21.84	6.372	0.568
	(5.58-8.8)	(3-11)	(2.3-6.8)	(8.8-54)	(0.88-25.7)	(0.22-1.87)
N.S.T.L.	6.551	5.363	3.845	5.236	3.46	0.331
	(6.0-7.91)	(3-8.0)	(2.3-5.3)	(0-12)	(0.88-16.4)	(0-1.2)
Gnanapuram	6.367	5.75	4.475	13.5	7.2	0.585
	(5.79-6.71)	(3-11)	(2.8-7.3)	(7.2-29.6)	(0.9-22.1)	(0.05-1.5)
INS Virabahu	6.172	9.875	4	14.5	6.226	0.63
	(5.5-6.63)	(3-20)	(2.0-5.5)	(2.0-28.0)	(1.77-12.0)	(0.2-1.2)
Andhra University	6.642	9	3.972	16.981	14.537	0.298
	(5.9-6.9)	(3-23)	(2.3-4.8)	(2-52)	(1.77-60.2)	(0-1.03)

Table 4: Average range of chemical composition of rain water over the Indian cities

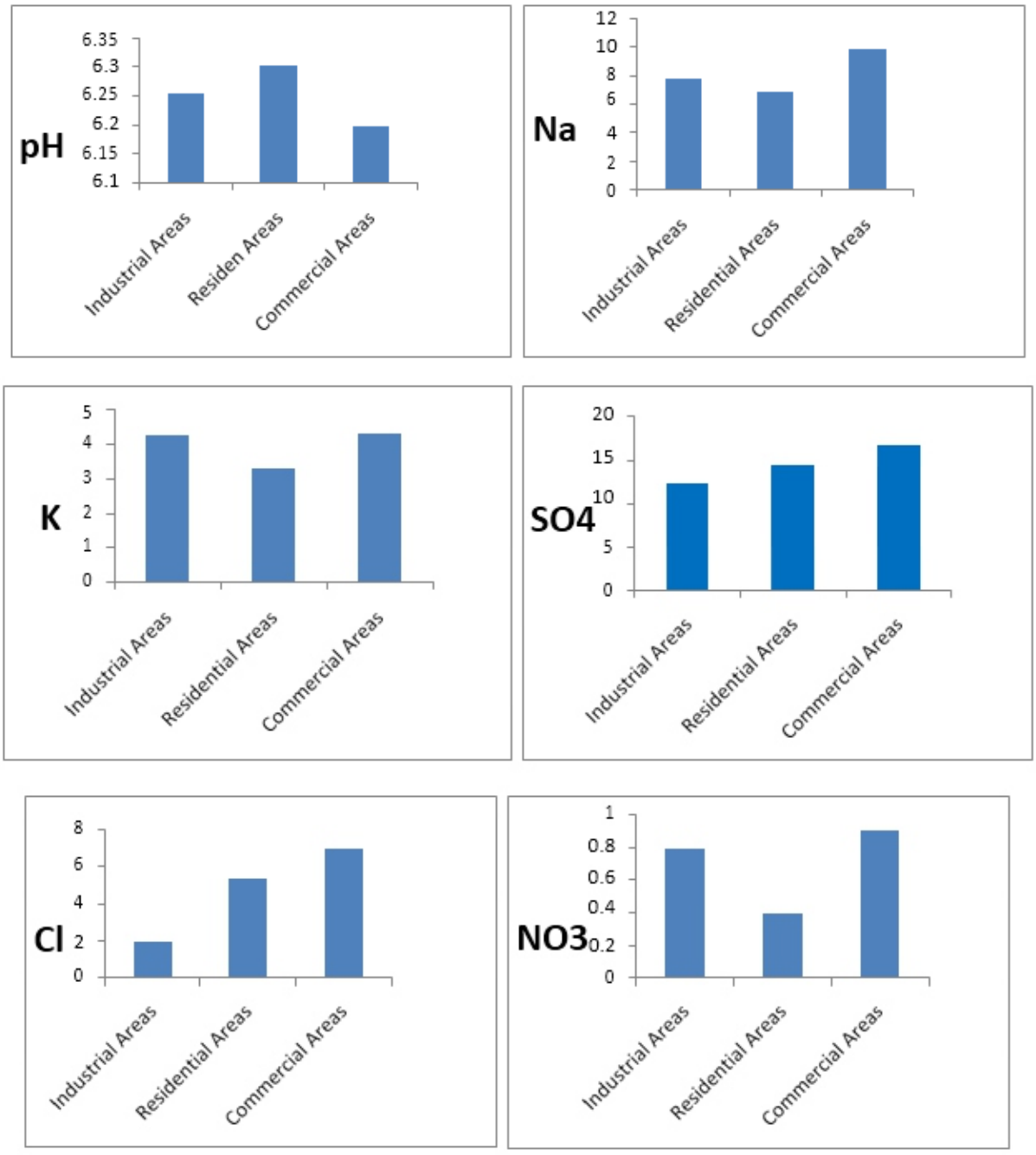
Constituent	Visakhapatnam	Ahmadabad	Calcutta
Ph	6.243	7.84	6.63
	(3.50-8.90)	(6.90-0.1)	(6.8 – 5.5)
Na	7.622	7.57	1.17
	(3.0 - 28.0)	(0.10 – 38.5)	(3.26 – 0.32)
K	4.129	1.79	0.43
	(2.0 – 8.0)	(12.8 – 0.25)	(1.96 - Trace)
So4	21.926	1.39	3.73
	(0 – 132.0)	(7.87 – 0.38)	(7.72 – 0.73)
Cl	7.82	2.51	2.87
	(0.88 – 60.21)	(9.75 - Trace)	(10.92 – 0.5)

Table 5: Average concentrations of SO4 in air and washout factor of µg x 104

Sampling point	SO4 in air µg/lit	SO4 in water µg/lit	Washout factor µg x 10^4
Mulagada	0.1362	60285	44.26
Jagadamba	0.1051	21142	20.11
Old post Office	0.1021	21840	21.39
N.S.T.L	0.0753	52360	69.53
Gnanapuram	0.074	13500	18.24
INS Virabahu	0.069	14500	21.01
Andhra University	0.0531	16981	24.61

Figures

Pollutants concentration over Industrial, Residential and Commercial areas



RESULTS AND DISCUSSIONS

The data regarding the chemical composition of rain- water for different places in Visakhapatnam are given in table: 1.It is referred that the interval between two showers determines to a large extent the pollution wash-out. For example, when the showers were on two subsequent days, viz.18th and 19th September 2014, the pollutant wash- out on the second day was very much less. This smaller amount may be attributed to the fact that there was not sufficient pollution built-up in the atmosphere after the previous spell of rainfall. From the table :2 it is observed that the mean PH value of rain water is less (more acidic) at Mulagada than at reaming places i.e. the PH value in industrial area in much less than both in commercial area and residential areas. The concentration of sulfates is also greater at industrial area than at both commercial areas in between the concentration of sulfates in commercial areas is in between those values in industrial and residential areas. The highest value of sulfate in industrial areas is due to fact that large amount of pollutants emitted from the industrial chimneys. In commercial areas the concentration of sulfate is mainly due to traffic emissions. The sodium and chlorine concentrations at Jagadamba, Gnanapuram and Old post office are higher than the concentrations at Mulagada, Seethammadhara. This is obviously due to the fact that these sampling points are in the vicinity of the coast, where as Mulagada, Seethammadhara are far away from the coast. The concentrations are lower than their corresponding sodium concentrations. The nitrate concentrations also did not vary much and are very low.

The mean and range of the ionic ratios namely sodium/potassium, sulfate/sodium, sulfate/chlorine and chlorine/sodium ionic ratio in rain water given in table 3. Except the chlorine/sodium ionic ratio the remaining ionic ratios at different sampling points are greater than one. From this table it is observed that the value of sulfate/sodium ratio is high in industrial area when compare to the other areas. This is because; the value of sulfate is grater in industrial area than in other areas. The same trend is also observed for sulfate/potassium, sulfate/chlorine ionic ratios. The value of sodium/potassium, sulfate/ chlorine ionic ratio being greater than unity indicates that sodium concentration is greater than the corresponding potassium concentration. The chlorine/ sodium ionic ratios are less than unity and show a reveres trend that is greater over residential and commercial areas than industrial. Sulfate/chlorine ionic ratios at N.S.T.L, INS Virabahu and Andhra University is an attributed to the fact that low sulfate concentration and corresponding high sodium, potassium and chlorine concentrations respectively. It is assumed that all the sulfur dioxide in air was converted into sulfate for the present calculations for wash out factor. The wash-out factor values are indicated in table 5.Mulagada; Jagadamba and N.S.T.L are taken as the representatives of industrial, commercial and residential areas. The chemical compositions of rain water in industrial, commercial and residential are compared in figures. The mean and range of chemical composition of rain water in Visakhapatnam is compared with major Indian cities. These

values are compiled in table 4. The PH of the rain water samples collected over Visakhapatnam varied between 3.5 and 8.8 with an average of 6.24.The PH of the samples collected in other Indian cities like Ahmadabad was found on the basic side 6.9 to 9.1 with an average of 7.89. One possible explanation is that the pollution in the Ahmadabad city is mainly owing to burning of coal. Even though the emission of sulfur dioxide from coal and oil burning are similar, the fly ash which is a producer of only coal burning basic in nature , neutral ions the acidity impacted by the emissions of sulfur dioxide.

SUMMARY AND CONCLUSIONS

Even though it is difficult to draw definite conclusions in view of the number of factors involved and the complexity of the problem, the following tentative conclusions can be drawn. Rain acts as a good scavenger for the ambient air pollution control and is a very important for the monsoonal country such as India, where the rainfall is concentrated in four months (July to October) during the year. This is confirmed in the case of sulfur dioxide by the wash out factor which depends upon the amount of concentration of sulfur dioxide in air, amount of rain fall and its period. The PH of rain water samples collected in Visakhapatnam was acidic. It is relatively more acidic in industrial area. This might be due to burning of fuel, oil and also due to the presence of oil refinery. The sodium and chlorine ion concentrations are relatively higher at Jagadamba; Old post office, INS Virabahu and Andhra University these being in the vicinity of the sea. The analysis of the rain water samples shows be an important parameter for all the monitoring survives, because the only the rain water composition can throw light on the different types of pollutions in the atmosphere and there by one can pinpoint which pollutant is more important to monitor and control in a particular area. From this rain water analysis one can find out how much pollution is washed down by rain.

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"Analysis of SPM(Suspended Particulate Matter) Level in Amravati City"

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ABSTRACT

The health effects of air pollution have been subject to intense study in recent years. Exposure to pollutants such as airborne particulate matter has been associated with increases in mortality and hospital admissions due to respiratory and cardiovascular disease. Suspended particulates matter in ambient air of three stations in Amravati city was collected using a high volume sampling technique. Attention was focused on the roadside, street-level concentration. The sampling was conducted two days in a week. selected location for sampling as MIDC Amravati, Raja Kamal square, Amravati, shri shivaji science college Amravati. This will create awareness within society about health effect.

Key words: Air Pollution, SPM level, Analysis, health, awareness.

INTRODUCTION

Air pollution may be broadly defined as the presence of one or more contaminants like dust, smoke, must and odour. The atmosphere which are injurious to human beings, plants and animals which unreasonably interfere with the comfortable enjoyment of life or property. Air pollution seriously damages human beings. [K. Maharajan, K Samual 2010] Air pollution means any solid, liquid or gaseous substances present in the atmosphere in such concentration as may be or tend to be injurious to human being or other living creatures or plant or property or environment. [Ganesh, et.,al 2011-12].

Air is the name given to atmosphere used in breathing and photosynthesis. Dry air contains roughly (by volume) 78.09% nitrogen, 20.95% oxygen, 0.93% argon, 0.039% carbon dioxide, and small amounts of other gases. Air also contains a variable amount of water vapor, on average around 1%. While air content and atmospheric pressure varies at different layers, air suitable for the survival of terrestrial plants and terrestrial animals. [. Kadam P.B. and Jadhav P. April; 2012].

Pollution is the introduction of contaminants into a natural environment that causes instability, disorder, harm or discomfort to the ecosystem i.e. physical systems or living organisms [T. Baker]

Particulate matter

Besides PM10, limited monitoring and source apportionment of PM2.5 (particles of size less than or equal to 2.5µm) was also included. As a result, assessment of contributions of different source

categories to concentrations of fine particles (PM2.5) that have more severe health impacts was also possible[5] Ever since the advent of the industrial era, anthropogenic sources of PM have been increasing rapidly. [R. Mohanraj and P. A. Azeez]

Particulate air pollution is a mixture of solid, liquid, or solid and liquid particles suspended in the air. In practical terms, a distinction is made between PM10 ("thoracic" particles smaller than 10 _m in diameter that can penetrate into the lower respiratory system), PM2·5 ("respirable" particles smaller than 2·5_m that can penetrate into the gas-exchange region of the lung), and ultrafine particles smaller than 100 nm which contribute little to particle mass but which are most abundant in terms of numbers and offer a very large surface area, with increasing degrees of lung penetration [7]

. Natural sources exceed anthropogenic emissions, but the latter are frequently concentrated in urban environments. Natural sources of atmospheric particles are volcanic out gassing, forest fires, sea salt (directly emitted), and gas phase conversion of other atmospheric compounds. Anthropogenic sources are mainly burning of fossil fuels (industrial, transport and domestic burning), diverse industrial processes, mining and agriculture. Industrial and transport emissions are a significant source of particles mainly due to combustion of fossil fuels. They can be responsible of high concentration of particles in the air in great urban settings. However, the distribution of atmospheric particles in urban settings will depend on the characteristics of the urban planning. In canyon streets higher PM emitted by car Engines have been found closer to the ground [Muchate N. S. and Annarao Maruti Ch 2011] It is estimated that India annually emits 144719 Mg of total Particulate matter from open field burning of rice straw (Gadde et al. 2009). [Gadde, B.et.,al 2009]

MATERIAL AND METHODS

The sampling was conducted for 24 hours at all sites and the mass of SPM was determined by weighing the filter, before and after sampling.

RESULTS AND DISCUSSION:

Suspended Particulate (SPM) Matter: The SPM concentrations at Raja Kamal Chowk,Amravati were relatively high as compared to the concentrations at other sector because of high vehicular emissions and wind-blown dust. In these cities, sources of high SPM values include wind-blown dust, emissions from stationary fuel combustion, industrial processes, heavy transport, solid waste disposal, power plants, construction activities etc. Such emissions result in gas to particle conversion in the atmosphere

CONCLUSIONS

The health impacts of air pollution depend on the sensitivity and the exposure level of the susceptible population to the pollutant. The largest health impacts from exposure to fine particulate. Public awareness regarding suspended particulate matter & control the dust emission at source through different technology.

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OBSERVATION TABLE

Ambient Air Quality Data SPM Sampling Location Shri Shivaji Science College, Amravati

Residential Area Year: 2013

SPM 24 Hrs.Average						
Sr. No.	**January**	**February**	**March**	**April**	**May**	**June**
1	74	93	94	84	95	92
2	84	79	67	101	105	65
3	95	72	101	73	93	76
4	79	83	88	105	108	97
5	59	96	79	98	110	67

Ambient Air Quality Data SPM Sampling Location MIDC, Amravati

Industrial Area Year: 2013

SPM 24 Hrs.Average						
Sr. No.	**January**	**February**	**March**	**April**	**May**	**June**
1	112	109	108	121	144	113
2	107	98	114	136	139	108
3	92	101	111	130	146	73
4	91	106	103	124	134	98
5	100	111	108	138	128	93

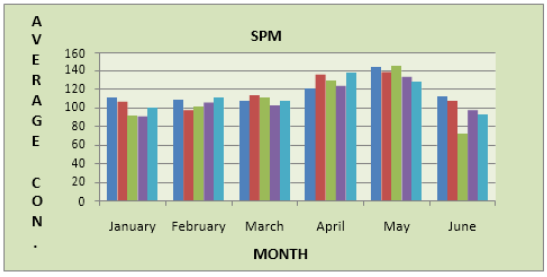
Ambient Air Quality Data SPM Sampling Location Rajkamal Chauk, Amravati

commercial Area Year: 2013

SPM 24 Hrs.Average						
Sr. No.	**January**	**February**	**March**	**April**	**May**	**June**
1	122	116	138	155	148	143
2	119	100	144	142	156	122
3	115	109	143	152	161	129
4	124	116	136	125	165	136
5	119	124	130	136	163	66

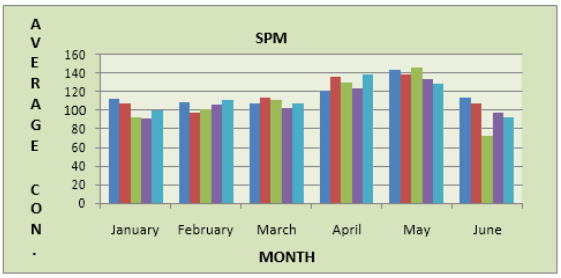
Ambient Air Quality Data SPM Sampling Location Shri Shivaji Science College, Amravati Residential

Area Year: 2013



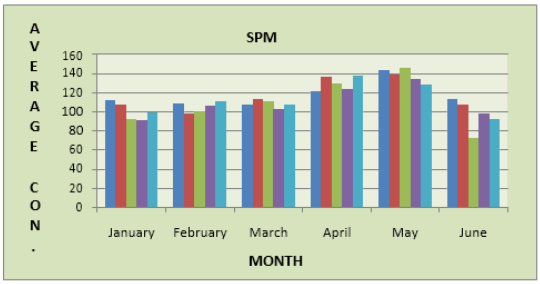
Ambient Air Quality Data SPM Sampling Location MIDC, Amravati

Industrial Area Year: 2013



Ambient Air Quality Data SPM Sampling Location Rajkamal Chauk, Amravati

commercial Area Year: 2013



Enhancing Housing Availability Through Effective Utilization of Indigenous Building Materials in Lapai Local Government Area of Niger State, Nigeria

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A B S T R A C T

The acute lack of affordable housing due to high cost of conventional building materials in Nigeria is condemnable. Consequently, the need to utilize alternative building products in order to reduce the high cost and at the same time ensure high quality building materials necessitated this study. Descriptive survey design was adopted. The study utilized both primary and secondary data. A structured questionnaire as well as interview was used to obtain the relevant data from a sample of 300 respondents. The two hypotheses formulated were tested using Chi-square. The findings of the study revealed that the use of indigenous building materials lowers the cost of housing provision in Lapai local government of Niger State, and the indigenous building materials are being put into use in construction of houses in Lapai Local Government Area of Niger State. Based on the findings, the following recommendations were made; the utilization of the indigenous building materials should be incorporated within the framework of Nigeria's National Policy; practical effort should be made to ensure that the indigenous materials are utilized at both state and local government levels in the entire federation.

Keywords: Affordable housing, conventional building materials, indigenous building materials

INTRODUCTION

Provision of affordable housing for the citizenry should be the centre piece of every responsible government's public policy. Globally, housing is humanity's third most essential need after food and clothing. The rapid growth in population growth and increasing urbanization have led to overcrowding in urban housing, homelessness and overstretching of existing infrastructure and services (Fadairo & Olotua, 2013), thus the sustenance of real estate provision is vital to diminishing the inaccessibility of housing to citizens, and is regarded as one of the best proactive and innovative measures to improve housing estates against the deficit challenge that is prevalence in Nigeria (Ihuah, 2016).

More than 90 percent of future population growth will be concentrated in cities in developing countries and a large percentage of this population will be poor. In Africa and Asia where urbanization is still considerably lower (40 percent), both are expected to be 54 percent urban by 2025 (Fadairo and Ogunmakinde, 2011). The population of Nigeria is over 150 million (Nigerian National Population Census, 2006) and is still rising at an annual growth rate estimated at 3.2% (Fadairo & Ogunmakinde, 2011). As a result of this, Nigeria has a large and increasing housing deficit which stood at

approximately 8 million housing units in 1991 and between 12 and 14 million housing units in 2007 (Fadairo and Ogunmakinde, 2011).Fadairo and Ganiyu (2010) note that in Nigeria, over 7 out of every 10 people live below the minimum poverty level and 9 out of 10 are in the low income group. Therefore, these people cannot provide housing for themselves; they are rendered homeless or live in poor housing.

The deterioration of housing situation in the urban centres, manifested in severe shortages of housing units, and overcrowding in poor quality buildings that are situated in degraded environment. The urban poor constitute the vast majority of urban dwellers and they are in a disadvantaged economic position to build for themselves and are generally unable to make effective demand of existing housing (Olotua & Taiwo, 2013). Even within cities housing problems are almost entirely dominated by the poor, the low and to a large extent the middle income class whose living conditions are squalid and considerably degraded. Hence, in Nigeria today, inadequate accommodation, overcrowding, lack of recreational facilities and inadequate basic facilities are some of the characteristics of urban housing of the poor.

It has become increasingly glaring that most of the urban population are living in dehumanizing housing environment while those that have access to average housing do so at abnormal cost (Nubi, 2001). The rate of provision of new housing stock has lagged severely behind the rate of population growth (Olotuah & Taiwo, 2013), thus the need for accessible and affordable housing.

Appropriate, accessible, ample and sustainable shelter is necessary since it remains a basic need of humankind and requires being continuously available, cheap, affordable, durable, cheap to own and manage/maintain in the built environment (Kabir and Bustani, 2012; Kadiri, 2004). Sustainable construction requires a critical review of prevailing practices, techniques and sources for raw materials. The rising cost of building is a source of concern to most governments in the world, especially in the developing countries (Onyegiri & Ugochukwu, 2016).Residential property development is a capital intensive project and the processes of production are very demanding and self-motivating and as such, should not at the end of the production become void (not productive) because of the high cost to acquire or rent it by people (Isaac, O'Leary & Daley, 2010; Millington, 2000; Ihua, 2016). The prerequisite of undertaking residential property development or any development is to have a functional and economic product within the shortest possible time and cost effectiveness. Achieving this is doubtful due to problems of rising costs of building materials, which in this study context affects or raises the total residential property development cost which is passed as rent on the property upon completion (Ihua, 2016).

The building materials sector is seen as a major contributor to the construction industry because materials constitute the largest impact in construction often accounting for over fifty per cent (50%) of

the total cost of construction (Ezeokwonkwo, 2010; Mogbo, 1999; Okereke, 2003; Oyediran and Odeniyi, 2009 in Ihua, 2016). Building materials have in fact been established to constitute as much as 40-80% of the total input of building construction, its input into low cost housing, which constitutes the bulk of Nigerian housing need is even considered higher. The production and use of building material is thus, not only relevant in housing and other structural development, but also to the economic, social, cultural and environmental sustainability of Nigeria (Atolagbe, 2009). The high cost of conventional building materials in Nigeria is making the government and the private sector to look for alternative sources of building materials locally, in order to, meet the housing needs of the ever-increasing population (Taiwo & Adeoye, 2013).

To help reduce the cost of building materials in Nigeria and the rest of the Third World countries, building materials should be sourced locally in large quantities and at low prices. Because market monopolies frequently dominate the production of cement, roofing, glass and steel, the real price of construction materials is constantly rising. Governments should also encourage the emergence of local suppliers of indigenous and composite building materials on a large scale (Taiwo&Adeboye, 2013).

1.2 STATEMENT OF THE PROBLEM

Real estate sustainability is vital, especially within the residential property where significant industrial and commercial employment opportunities are increasing. The increasing commercial and industrial activities have a substantial potential to attract many people (jobseekers, businessmen and others) into the community with the attendant consequences of increasing the problem of shelter access for all (Ihua, 2016).

In Nigeria, there is an acute lack of affordable houses which is largely due to the high cost of the conventionally processed construction materials such as steel and Portland cement. This crisis situation is occasioned by ineffective administrative machinery to mobilize and organize the country's human and natural resources for efficient housing and urban development. Of the all variables that Dosumu (2002) asserted that affect housing affordability, cost of building materials and construction is perhaps the most crucial to housing affordability. Idirisu (1992), Wahab (1992), Okunola (1998), Olateju (1992), all agree that building materials constitute not less than 50% of the cost of constructing a house. This means that the other factors of the housing problem such as income, land tenure, housing finance and government policy account for the remaining 50%.

The building power of the people has been reduced considerably consequent upon the down turn in the economy. Economic recession has brought about great effect on property development, hence, the

number of new buildings has reduced drastically both in rural areas and in the cities and there are many abandoned building projects. In Laipai local government of Nigeria, most of the materials used for building construction are imported. This has to a great extent contributed to the high cost of building as the value of Naira/per Dollar is on the high side. Consequently, the need to utilize alternative building products in order to reduce the high cost and at the same time ensure high quality end product necessitated this study.

1.3 OBJECTIVE OF THE STUDY

The objectives of the study are to:

1. Ascertain whether the use of indigenous materials in building construction will significantly lower the cost of housing provision in Lapai local government area of Niger State
2. Determine whether the effect of use of indigenous building materials for building construction enhances housing affordability in Lapai local government area of Niger State

1.4. RESEARCH METHODOLOGY

Research Design

Descriptive survey design was adopted for the study

Survey Research

The survey research involves field reconnaissance visits and administration of well structured questionnaire. Initially a map of Lapai were acquired from the Niger State Ministry of Lands and Survey as well as the Department of town Planning. A number of visits were undertaken to update the map by adding new structures and removing non existing structures and information. Once a credible base map has be prepared, two reconnaissance visits were undertaken to identify and indicate the boundaries of the various districts in Lapai and establish the urbanization stages of the town. This information is necessary and essentially for the delimitation and delineation the four zones proposed for the social survey.

Population

The 2006 Nigeria census puts the population of Lapai LGA to be 110,127 persons comprising 53,687 females and 56,440 males. National population commission (2006) figures showed that the population of the town increased from 73,647 in 1991 to 110,127 in 2006.

Sampling Framework

The entire study area is zoned into three which include areas along the four geographic coordinates- North, South, East, West in order to ensure that both the old and newer parts of the city are included in each zone. Important streets and or landmarks were used to identify the boundaries of each of these four zones. Three streets that run throughout the length and breadth of each zone and or run 2/3 of the entire length and breadth of each zones were selected using random sampling with the use of random numbers. To locate buildings and respondents for the study, the varying interval of the systematic sampling method was used. When a sampling interval is giving rise to only residential buildings constructed with indigenous or conventional materials, the interval is varied to in order to accommodate and or ensure that both indigenous and conventional buildings are selected.

At each building selected for the survey, the materials for constructing the house were noted and the residents/occupants of it are served with a questionnaire. They are also orally interviewed on their perceptions, of the quality, durability and cost effectiveness of the building.

Types and Sources of Data

In the course of the study and also to accomplish the aims and objectives of the study, various methods were used in the process of data acquisition. Data that is used for the work is collected from two (2) major sources which are:

— Primary sources

— Secondary sources

Primary Sources of Data

Structured questionnaire were used to obtain the relevant data from the residents while interview guides were used to obtain data from household. Field observation was equally employed.

Secondary Sources of Data

The secondary data is obtained from relevant textbooks, reputable journals, conference and seminar papers, relevant maps, internet and dissertation/thesis, other areas where this data were derived include the department of works and housing at Lapai Local Government Council, Library which were repository of information were also the researcher's source of secondary data for the study and also the Population Census Board were visited for secondary data.

Sampling Techniques

To have a proper coverage of the study area, multistage random sampling was used. This is the division of the study are into three (3) aforementioned zones. However, three hundred (300) questionnaires were

administered. Similarly, one hundred (100) questionnaires were administered to each of the three zones. Field observation is employed as technique to be used.

Method of Data Collection (Instrument)

Three sets of questionnaire were used for this survey. The first questionnaire, PART A were administered on the socio-economic and demographic information of respondents, while PART B were administered on knowledge of indigenous building materials. In the absence of the head of a house, the next person in hierarchy stood in for the head while the PART C cover the level of utilization of indigenous building material. In addition to the questionnaire, other methods were used to obtain information; these are recognizance survey so as to know the indigenous building material and to be familiar with the study area. Also oral interview is conducted in the study area.

Validity of the Instrument

In other to ensure relevant question and to reach meaningful conclusion, the research instrument was subjected to meaningful validation through several criticism and amendment. The structured questionnaire was submitted to the project supervisor and some experts in the department of Urban and Regional Planning, University of Nigeria, Nsukka for their contributions. The final copies after thorough scrutiny were produced and sent to the field for administration.

Reliability of the Instrument

For concrete content and validity to be ensured, the questionnaires were pre-tested on twenty respondents in the four zones in the study area. These were retrieved and revalidated by the project supervisor for final approval.

Method of Administration of Instrument

The questionnaires were administered to respondents in the selected zones in the study area. All the questionnaires were administered by hand; none is administered by post or by any electronic device. However, the researcher and his assistant went personally to the selected zones in the study area to administer the questionnaires. All completed questionnaires were retrieved at the spot by the researcher and his assistant. All instructions regarding how the respondents answered the questions were in very simple and clear terms.

Method of Data Analysis

Statistical method of data presentation such as tables was used to compare and illustrate research finding. Chi-square was used to test the two hypotheses formulated.

1.5 RESULTS

Test of Hypotheses

H_1 = the use of indigenous materials in building construction will significantly lower the cost of housing provision.

Hypothesis One

Table 1: Use of Indigenous Materials in Building Construction will Lower the Cost of Housing Provision.

Attributes	X^2 value	Degree of freedom	Level of significance
Chi-square test	143	63	0
Likelihood ratio	119	63	0
N of valid cases	185		

Source: Field survey (2011).

From the Table, the calculated value is 143.0 while the tabled value is 40.1 at 0.05 level of significance. The analysis shows that the calculated Chi-square value of 143.0 is higher than the table value of 40.1 at 0.05 level of significance; it implies that we accept our research hypothesis and reject null hypothesis. Therefore, the use of indigenous materials in building construction will significantly lower the cost of housing provision in Lapai local government of Niger State.

Hypothesis Two

H_1 = Effective use of indigenous materials in building construction will significantly enhance housing affordability in Lapai.

Table 2: Effective Use of Indigenous Materials in Building Construction and Housing Affordability in Lapai.

Attributes	X^2 value	Degree of Freedom	Level of Significance
Chi-square test	17.4	21	0.689
Likelihood ratio	21.2	21	0.445
N of valid cases	185		

Source: Field Survey (2011).

The above table shows that the calculated value is 17.4 while the tabled value is 32.7 at 0.05 level of significance. The analysis shows that the tabled value of 32.7 is higher than the calculated value at 0.05 alpha levels; Therefore, we reject research hypothesis and accept H0.

Effective use of indigenous building materials in building construction will not significantly enhance housing affordability in Lapai. This implies that people make use of indigenous building materials in construction and hence, people are ready to incorporate the building materials into housing construction.

1.6 SUMMARY OF MAJOR FINDINGS

The findings of the study include:

1. The present problem of housing is caused by the high cost of conventional building materials in Nigeria.
2. There are various indigenous building materials that can be utilized for construction, chief among those identified are Stone, Burnt or Fired clay brick, Stabilized landcrete brick, Fibre concrete roofing tile, Fired clay roofing tile, Rammed earth and Sundried (mud) brick.
3. The knowledge of people on the indigenous building materials is high as majority of the people seems to be aware of the existence of one building material or the other. The level of awareness of people about Stone, Stabilized landcrete brick, Burnt brick and Rammed earth is generally high; while in terms of roofing, the level of awareness of Bamboo roofing tiles and Fired clay roofing tiles is also high.

1.7 DISCUSSION OF FINDINGS

Use of Indigenous Materials in Building Construction Lowers the Cost of Housing.

The study revealed that the use of indigenous building materials lowers the cost of housing provision. This finding collaborates with Belay et al (1995), Olateju (1992), Idirisu,(2003) and Aribigbola (2010). Belay et al (1995) agreed that the roof is the most expensive accounting for nothing less than 20% of the total cost of a house. Supporting their findings, Olateju (1992), informed that where both roofing and ceiling materials are imported, the materials constitute about 50% of the cost of constructing a house. Idirisu (2003) notes that a considerable savings of up to 70% of the cost of finishing could be made by substituting clay wall and floor tiles polished with lacquer instead of marble of terrazzo glazing. Aribigbola (2010), observed that major pathway to making housing available and affordable to more Nigerians is through the increasing utilization of indigenous materials. He reasoned that indigenous building materials are cheaper compared to its' imported counterpart.

The study shows that even though, majority of the respondents (66.6%) are earning more than N10, 000 per month, the choice for construction based on income is 13.59% compared to quality (53.26%) while that of cost effectiveness is 9.97%. From the foregoing therefore, it could be deduced that apart from the fact that indigenous building materials are cost effective, the materials also have high quality; hence, the use of the materials can improve the housing affordability of people as well as giving the needed satisfaction that can match the use of conventional building materials even in terms of availability.

Effective Use of Indigenous Materials in Building Construction and Housing Affordability in Lapai.

The study revealed that various types of indigenous building materials are being put into use in construction of houses in Lapai Local Government Area of Niger State.

This finding agrees with Idrisu (2003), Okunola (1998). Idrisu (2003) note that glazed clay tiles are also recommended for wet areas as toilets, bathrooms and kitchen. Okunola (1998) posits that alluvial or letartic clays could used to produce fired bricks. He also pointed that clay roofing tiles have been put to the best use in the developing countries of Brazil and Portugal where almost 90% of the houses are roofed with clay tile. The material proves to be better roofing material in terms of lower cost, cooling effect and maintenance (Okunola, 1998).Other scholars informed of the use various indigenous materials as alternate to imported building materials (Stulz & Mulkerji, 1988; Arayela, 2005; & Arigbola, 2010).

The findings of the study revealed that various indigenous building materials were available and being used for building in the study area. It is generally noted that the level of utilization of the building materials is high as a larger percentage of the respondents seems to utilize the materials in one element of the building or the other.The degree of utilization of indigenous building materials for wall is 20.84% while that of foundation is 25.71%. The reason adduced to this is due to the quality of the materials as well as the fact that indigenous building materials are cost effective. However, hardwood seems not to be utilized for lintel (0%) due to the fact that hardwood lintel cannot carry the heavy weight that is coming from the roof being imposed on the top. Also, the practice of indigenous roofing material is also high (23.24%). Out of the three indigenous roofing materials that are available in Lapai, Fired clay roofing tile has the highest utilization (13.56%) This is so perhaps because the people are looking for alternative to asbestos roofing sheet due to its health hazards of asbestoses, lung cancer and malignant tumor while that of indigenous ceiling material is 24.73%.

However, timber is the only material that is not utilized for any element of the building except doors and windows. This may be partly due to the life span that is short which explains the reason why the material is used for temporary buildings e.g. commercial and religious buildings for the construction of shops, churches, mosques etc. Foundation, wall and floor serve as the base upon which the building rests and carry the load from the roof. The various materials that are available for foundation, walling and flooring in the area include stone, burnt or fired brick, mud brick, rammed earth and land crete brick. The indigenous building materials that people perceived to be most easily available are sundried mud brick (44.9%), rammed earth (36.2%) and stabilized land crete brick (25.6%). Also, a substantial percentage also sees burnt or fired clay brick (23.9%) as very easy to get. However, the building material that is difficult to get according to the perception of people is stone (15.5%). This may be due to the level of technology required which could range from crude method to high level technology and it is followed by burnt or fired clay brick (13.2%) with sundried mud brick (11.2%) and rammed earth (11.2%) being the easiest to get.

The roof of a building serves as protection against weather elements. Findings reveal that most common indigenous roofing materials in vogue these days are the clay roofing tile due to the high cost of conventional roofing materials. Also, the other roofing materials include fibre concrete roofing tile and Bamboo roofing tile. The roofing materials that are most easily available are fired clay roofing tile (69.3%) and bamboo roofing tile (61.6%). However, that of fibre concrete roofing tile is 44.6%. This suggests that fibre concrete roofing tile is less popular than others in the study area. There are only two traditional ceiling materials being applied in the area. These include saw dust cement sheet and ceiling boards. Of these two, ceiling boards are much cheaper, durable and can compete with the conventional ones.

The only indigenous building material being utilized for doors and windows is timber. Timber has good durability and resistance to insect and water attack as well as moderate cost due to the processes undertaken during conversion to wood. The use is still in vogue throughout the world today and the commonest timber door is the panel door. Timber is the only indigenous building material available for the construction of cabinets and wardrobes. The material is economical in nature, durable and suitable for use in any area which explains the reason why the use is common in any part of the world. The material also has good workable properties. The only indigenous plastering material in the area is Lime. Okunola (1998) reveals that the lime material has good plasticity and better water retention capacity than cement, it retains up to 90% of mixing water while cement retains only 50-60% which makes room for elimination of mortar joint shrinkage and consequently leads to better bond strength.

1.8 CONCLUSION

This study has shown that housing problems being experienced by people in cities could be reduced drastically with the use of indigenous building materials that are durable, culturally accepted, economical and not risky to human health. It could also be used to achieve sustainable housing for all in terms of quality and quantity. There is a need now, to reach out and effectively involve the people and governments at grass root levels in the formulation of housing policies. The Federal government has been directly involved in the construction of buildings for all categories in the past and even presently. This has led to several other problems including expensive contractual procedures as is being experienced in Abuja.

Therefore, in order to increase housing stock in Nigeria and create a more conducive living and working environment as well as developing an appropriate housing construction technology, there is the need to incorporate indigenous building materials into the formulation and implementation of housing policies and programmes which will involve all tiers of government.

1.9 RECOMMENDATIONS

Generally, the problem of housing in Nigerian cities calls for the need to re-address the orientation of the National Housing policy in Nigeria towards the delivery of Housing to the citizens. Based on the findings, the following recommendations are made:

1. The utilization of the indigenous building materials should be incorporated within the framework of the policy in order to attack poverty and the social isolation of the majority groups in the cities. Also, practical effort should be made to ensure that the materials are utilized at both states and local government level in the delivery of housing so that a lot of people will be able to own a house.
2. There is a need to reach out and effectively involve the people and governments at grass root levels in the formulation of housing policies. Various methods of Information, Education and Communication (IEC) using appropriate media organizations should be employed to publicize the use of the materials in order to reach the various target groups.

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