International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

An Assessment of Indoor Environment Quality: A Case Study of Bijnor City, Uttar Pradesh

Samina Quazi

Department of Geography, Jamia Millia Islamia

Abstract: ***Indoor quality is one of the major issues to which we are facing today. Indoor environment quality (IEQ) is defined as the wholesome indoor environment in which people spend most of their time. According to the EPA (Environmental Protection Agency of U.S) people on an average spend approximately 90 percent of their time indoors, most of it in their residences. Therefore, the IEQ bears directly on the human health and wellbeing though not immediately but slowly. The World Health Report, 2002 reveals that it is the 10th risk factor and accounts for 2.7 percent of the global burden of disease. With adoption of the New Economic Policy in 1991, environmentalists and concerned scientists became active and a large number of researches have been and still are being carried out on the pollution of outdoor air and its ill health effects. But, there are few and far between such researches in the case of indoor air. These too have focused on the big cities, perhaps underlying assumption being that this problem is more acute in these big population agglomerations. But, the reality is contrary to general perception of the situation. In spite of the fact of widespread use of LPG, the biomass is still a major fuel in the majority of households in small cities, towns and particularly in villages. This fuel not only produces lot of smoke but also is the main source of many hazardous gases and also of volatile organic compounds (VOC), sustained exposure to which may be fatal. This constituted the stimulus to make a case study of Bijnor, a small town in the western Uttar Pradesh which in popular notion is a wholesome area with ambient air away from the industrial, vehicular and other sources of air pollution.***

Keywords: types of fuel, fuel burning place, ventilation of kitchen, type of houses,indoor quality.

1. Introduction

Indoor quality (IQ) described as how inside air can affect a person's health, comfort, and ability to work. Among the numerous environmental threats facing modern man today, indoor quality has become a serious social issue of vital concern. For various works like cooking, warm water, heating or cooling in living places some type of energy source is used, mostly gaseous, liquid or solid. In India in most cases, it involves combustion of different types of fuels in the houses. These different types of fuels determine varying levels of concentration of pollutants in the ambient air of residences. In developed countries exposure to indoor pollution is an important cause of morbidity and fatality rate. (World Health Organization1997,2002). Various surveys have indicated that biomass smoke exposures increase the risk of acute respiratory infection among women and children especially less than five years. Recently, scientific techniques and methods have been developed that provided better opportunities for quantifying the contaminants and their likely effects. In the past it has been the notion, that humans are safe indoors from exposure to outdoor pollutants from the exhaust of vehicles and poison emitting industries. However, new development in science and technology to evaluate the concentration of pollutants indoors has demolished this myth. Indoor air pollution refers to toxic contaminants that occupants encounter in daily life in schools, offices, other workplaces, hospitals and especially in residential buildings. In small city like Bijnor lack of proper ventilation and fuel burning within the houses is also a major problem because concentrated pollutants cannot escape easily from the houses. An attempt was made to see the household indoor quality on the sampled residents of Bijnor city. The study deals with the use of various types of fuel for cooking, fuel burning place, ventilation of fuel burning place and also the poor indoor quality condition responsible for the rate of diseases. In view of all these considerations, in the present study, indoor environment quality of Bijnor city is judged on the basis of three criteria a) types of fuel, b) fuel burning place, c) ventilation of fuel burning place

2. Study Area

Bijnor city is the head-quarter of Bijnor district. Bijnor is a small city which forms the north-western part of the Meerut Division. The city lies at 29°2′ N latitude 78°0′ E longitude. Its elevation with reference to the MSL is about 237.7 m. The total area of the city is about 365 hectares. The city is built on the slightly undulating ground, about 4.8 km from the left bank of the Ganga. The total population of the city is 93,297 as per census of India 2001.

3. Objectives

- To analyse the Indoor Environment quality in terms of spatial pattern of types of fuel used by households in Bijnor city.
- To examine the ventilation and kitchen type in the residential houses and its spatial pattern in Bijnor city.
- To develop the index of Indoor Environment quality and examine its spatial pattern in the city of Bijnor.

Database and Methodology

This study is totally based on primary sources of data which has been collected through field survey. Survey of sampled households in the selected wards of the city was conducted on the basis of questionnaire/interviews. The field work was done by the scholar during the year 2012. Households of the sampled wards were visited frequently, for getting the accurate information. The field survey has been conducted adopting a sampling strategy which at best can be described as somewhat stratified random. Bijnor city is subdivided in to 25 wards. The indoor quality has been evaluated in terms of fuel, fuel burning place and ventilation of fuel burning

place. In the case of indoor environment quality, the fuels used have been given ranks according to their perceived pollution potential. All fuels have been given subjective ranks for their types, e.g., LPG has been given the highest rank and *cow dung cakes* the lowest rank. The ranks of fuel types have been converted into weights by summing up the ranks and dividing the individual ranks by their sum. For example weight of a fuel is equal to:

$$W_i = \frac{R_i}{\sum_i^n R_i},$$

Where,
W_i is weight of fuel of specific type i, R_i is rank of that fuel, $\sum_i^n R_i$ refers to sum of all ranks of fuel of different types that vary from 1 to n, n being the highest rank. Percentages of fuel of different types of fuel have been multiplied by their respective weights and these weighted percentages of fuel have been added to obtain an index of fuel quality.

In the same way, ventilation in houses and kitchens has been evaluated from worst to the best on the qualitative assessment to remove pollutants and flow of air. The highest rank has been assigned to the house having the best ventilation in both in rooms and kitchens and vice versa. As explained above, ranks have been converted into weights and these weights have been multiplied by the percentages of the respective houses of wards and added to for a composite indicator of ventilation.

The fuel types, index of housing materials and the ventilation status of houses have been made scale free or standardised applying following formula:

$$V_i = \frac{O_i - O_{min}}{O_{max} - O_{min}};$$

Where,
V_i is new scale free variable, O_i is original variable, O_{max} *and* O_{min} are maximum and minimum values of original variable, O_i.
As a first approximation, these standardised variables added together to form a composite index of indoor environment quality.

4. Discussion

Types of Fuel: The various types of fuel used by the households in Bijnor city include the LPG, kerosene, coal, wood and dung cake. According to the data collected from sample households, the percentage proportion of households using these types of fuels is 47.6, 11.4, 10.2, 14.1 and 16.7 percent, respectively. Figure 1.1 shows the percentage proportion of various types of fuels use in Bijnor city.

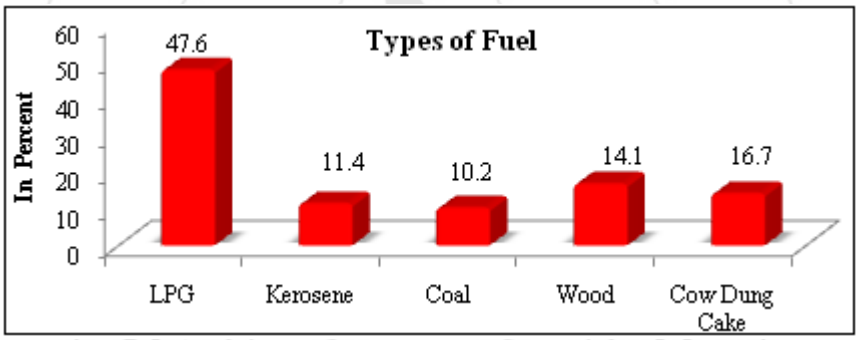


Figure 1.1: *Source:* Based on calculation of data from field survey

The LPG is found to be most prominent fuel in Bijnor city as revealed in fig 1.1. The users of LPG are highest in all wards, while in other hand kerosene fuel has been also used for cooking and lighting purpose but its accounts only 11.4 percent. In Bijnor city only 10.2 percent of households use coal as a fuel. The sample data reveal that 14.1 percent of households use wood as a fuel in Bijnor city. The dung cake has been found to be second most important fuel in Bijnor city. Sample data reveal that 16.7 percent of households use dung cake as a fuel in Bijnor city.

Fuel Burning Place: The oldest fuel burning technology, the home cooking fire, still remains the most prevalent fuel-using method in the world. For much of the world population, the home cooking fire accounts for most of direct and household energy demand. Cooking place is significant component of the housing facilities like the bathroom and latrines. Location of cooking place in a house is very important, as it involves burning of fuel, which produces fumes, ashes and smell and affects the air quality of the indoor environment. The survey data of Bijnor city reveal that kitchens do not exist in all houses. In many cases aangan, verandah and rooms are used as a cooking place. The percentage proportion of cooking places is shown in Figure 2.1.

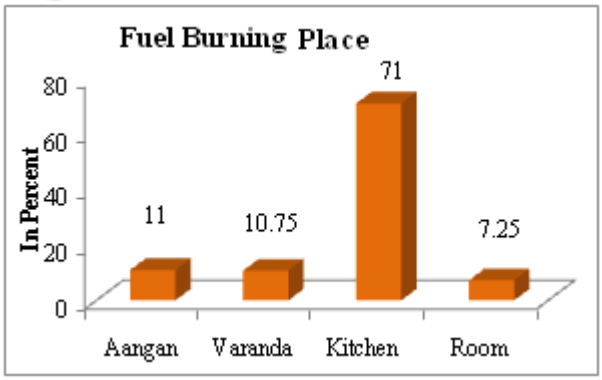


Figure 2.1: *Source:* Based on calculation of data from field survey

The sample data clearly shows that the large proportion of households are using kitchen for cooking purpose. Aangan has been found to be second most important place for

cooking. In most of the Indian traditional families Veranda has been the most prominent place for communication, especially in ladies, where they perform several types of household activities, and used veranda for cooking food also, in Bijnor city 10.75 percent of households use Veranda for cooking food, while there are still some household in the city which are forced to use rooms as their cooking place but the percentage of this situation is very low it accounts only 7.25 percent.

Ventilation of Fuel Burning: Ventilation of fuel burning place is an important parameter of indoor environment quality because it helps to remove the pollutants of fuel, cooking and supply fresh air for households. The pollutants which are generally encountered in fuel burning place are carbon monoxide, sulphur dioxide and particulate matter. The reason for emission of carbon monoxide is incomplete combustion. Presence of nitrogen dioxide in the fuel burning place is a result of complex reaction. Nitrogen from the air combines with oxygen at high temperatures and this forms various nitrogen oxides. This family of nitrogen oxides continuously changes its chemical composition and, therefore they are commonly referred to as unstable nitrogen dioxides. Particulates less than 10 micron in diameter can be inhaled by humans and hence are known as respirable suspended particulates. At higher smoke, temperatures more of particulates will be in vapours form, while at lower temperatures they remain suspended in the air. Smoke near the fuel burning place is a sign of incomplete combustion, so ventilation of fuel burning place is a way to control the smoke, heat and temperature of the houses and cool the burning place. Figure 3.1 shows the percentage proportion of ventilation of fuel burning place in Bijnor city.

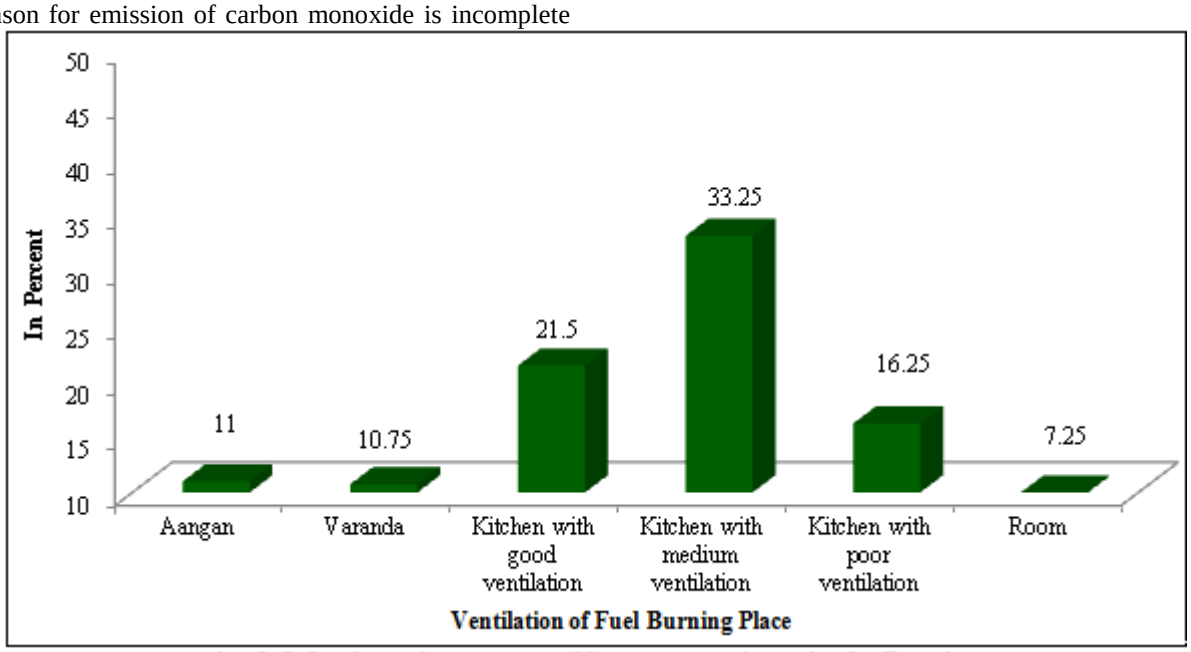


Figure 3.1: *Source:* Based on calculation of data from field survey

Building Material: Material of housing is also a very important component of indoor quality. **F**ive types of houses are recognized on the basis of building material in the study area. These are 1) ferro-concrete, 2) concrete-brick or *pucca* house, 3) *kutcha-pucca* or mixed houses, 4) *kutcha* houses and 5) *jhuggis* and *jhopris.*

The ferro-concrete houses include all residential houses built of good material of concrete and bricks. These are good quality and good ventilated house, and according to the survey they account for 14.75 percent of all sample houses. The concrete-brick or *pucca* houses include those houses built of concrete and bricks. These are also good quality house, and according to the survey they account for 59.5 percent of all sample houses. The *kutcha-pucca* or mixed houses are generally built of bricks and mud. The percentage proportions of this house houses is 15 percent of all surveyed houses and are of medium quality. The *kutcha* houses are made of mud and sun- burnt bricks and is of low quality houses. The proportion this low quality house in the total sample house is worked out as 7.25 percent. The *jhuggi*s very low quality houses and are made up of makeshift material. They are found only 3.5 percent of the total sampled houses. Ward-wise distribution of the material of the houses is shown in Fig. 4.1.

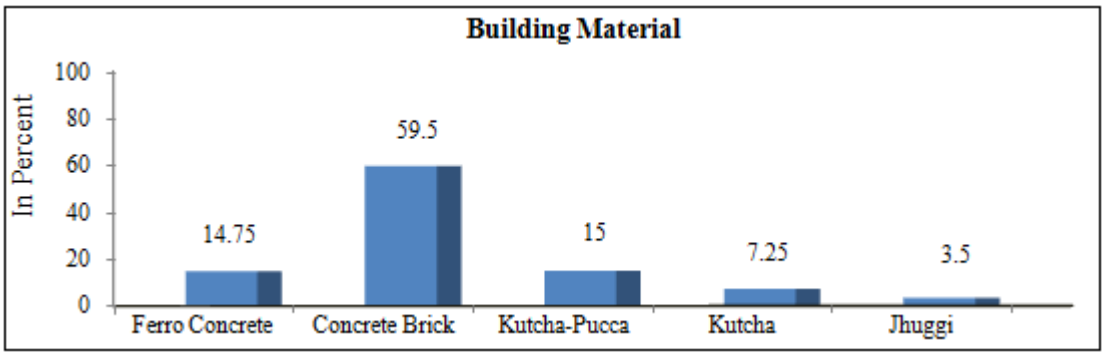


Figure 4.1: *Source:* Based on calculation of data from field survey

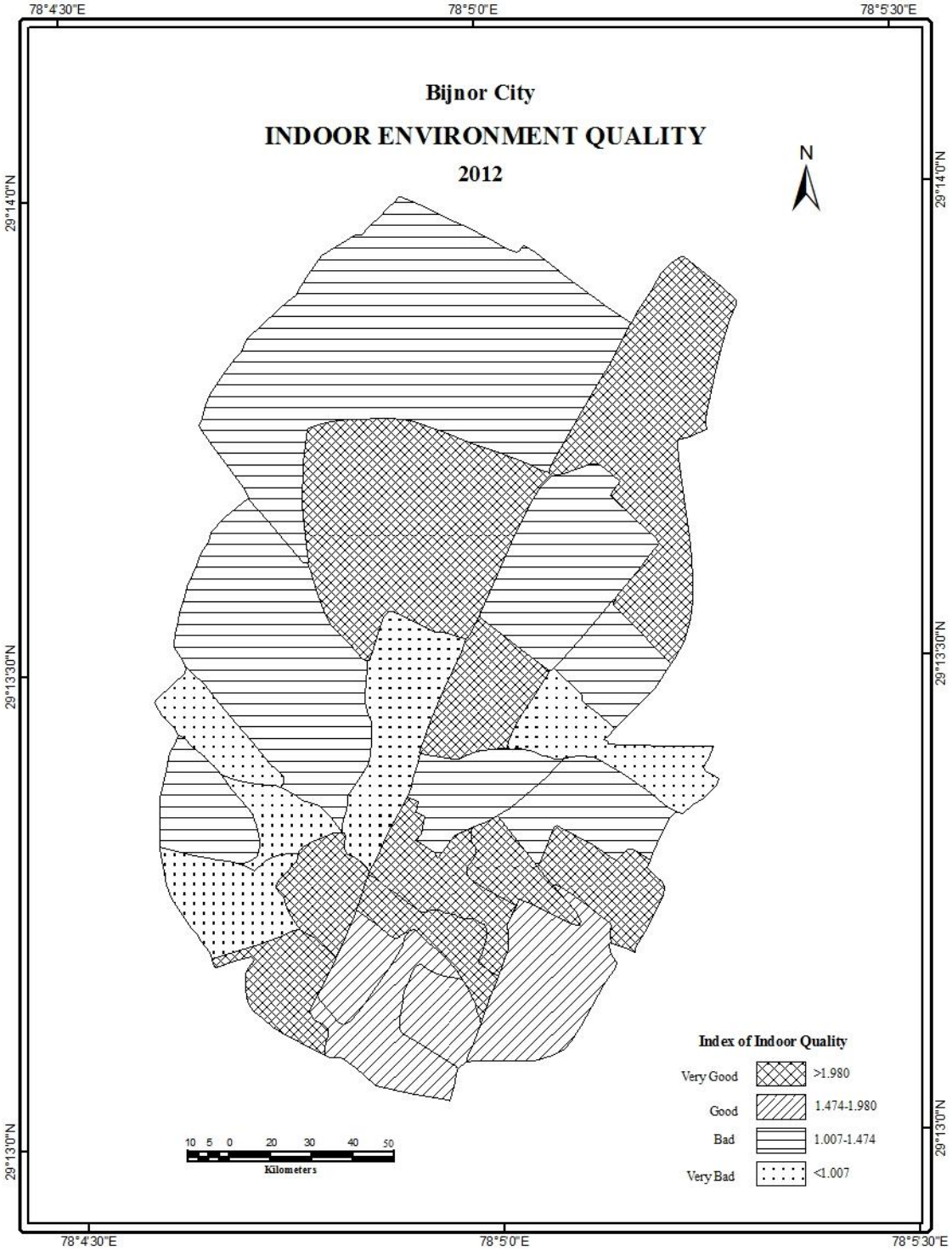
The quality of buildings material shows a random pattern which is most probably related to the socio-economic status of the residents. However, in the case of low quality building material there is observed a strong tendency to locate in the centre or outer periphery of the city, while the northern and southern part of the city has good material or high quality housing.

Indoor Quality Status: Indoor air quality is the most important component of the IEQ as mention earlier. Indoor quality is not only a function of indoor activities and housing facilities, in many big towns more than half of indoor pollutants are contributed by outdoor pollution impairing indoor air quality. However, in small and medium cities where vehicular traffic flow is not at large scale and industrial sector is lowly developed, these are housing conditions and indoor activities which contribute most to the impairment of indoor air quality. The primary causes of poor indoor quality are those sources that release pollutants indoors, i.e. type of fuel burnt indoors, inadequate ventilation and place where fuel is burnt. Parikh *et al.* (2000) have found a strong correlation between the concentration of RPM in the indoor air and combustion of solid fuels traditional stoves. Another study carries out by Mishra *et al.* (1997) found a significant relationship between the excess use of solid fuels and partial or complete blindness. Lung cancer, chronic pulmonary diseases, asthma, etc. are associated with the quality of indoor air. Therefore, it's important to assess the indoor air quality in houses. In the present case, the quality of indoor environment is estimated using a surrogate measure on the basis of factors affecting it as mention above. The method to develop a surrogate index of level indoor quality is dealt with in methodology at length. The indoor environment quality in Bijnor city is classified into four classes of very good, good, bad, very bad by applying nested mean method.

Very good quality: The very good quality obtains in the nine wards. The quality index in these wards is more than 1.980. The total population of these wards is 27,142 which are 29.09 percent of the city's total population. It means that almost 30 percent population has very good indoor air quality. In these wards, the majority of households used LPG as fuel. Houses in these wards are mostly made of concrete-bricks and they have very good ventilation facilities. Some *kutcha-pucca* houses are also found in these wards, but they are in good condition. No *jhuggi/jhopdi* has been found in these wards. All the houses have separate kitchens with quite adequate ventilation. People are generally highly educated and are able to afford better quality of life and aware of hygiene and health. On an average, these wards are characterized by highly good quality of indoor air.

Good quality: There are four wards in the study area where indoor air quality is high or good. The indoor air quality index of these wards varies from 1.474-1.980. The total population of all these wards of this category is 21,328 that is, 22.86 percent of the total population of the city. All these wards are located in the southern part of the city. In these wards houses are mostly made of concrete-brick with sufficient ventilation. Some *kutcha-pucca* houses are also found in these wards, but they are in good condition. The LPG is used in most of the houses except in a few where kerosene is used as fuel. In these wards ventilation of fuel burning places has been found adequate.

Bad indoor quality: The bad quality is found in those wards wherein the indoor quality index ranges between 1.007-1.474. Seven wards have this quality of indoor air. The use of solid fuels and percentage of *kutcha* houses have been found to be the highest in one ward. While, in two wards LPG fuel is used in a large number of houses, but kitchen ventilation in them is not adequate enough and is generally poor. The concentration of concrete-brick houses in these wards has been found comparatively more than the *kutcha-pucca* houses. *jhuggis/jhopdis* are found mostly in two wards. In these *jhuggis/jhopdis*, the indoor air quality is found worst. Of wards of low indoor quality, four exist in the north and eastern peripheral zone, two in western periphery, one in the middle zone and one in the central part of Bijnor city.



Source: Based on calculation of data from field survey

Very bad indoor quality: Very Low Indoor air quality is observed in the five wards. The index of indoor air quality in these wards is less than 1.007. The total population of these wards is 18,247 which constitute 19.56 percent of the city's total population. In these wards, in the majority of houses dung-cake and wood are used as fuel. The cooking places in these houses also have inadequate ventilation. Houses in these wards are mostly made of concrete-brick, but they don't have *aangan* and verandah. Some of the houses in these wards use rooms for cooking food. This makes the indoor quality worst in these houses. Out of these five wards, in one ward which is located in the central part of the city the concentration of *jhuggis/jhopdis* is high. In remaining four wards three wards located in the southwest and last one ward in the northeast part of the city.

5. Conclusion

Indoor Environment quality in Bijnor city presents a very miserable picture of the city. On an aggregate level about fifty percent of the population lives in sub-standard indoor quality. Indoor quality in the city, though show some relation with the gradual occupation of the city, it is more

closely associated with socioeconomic status and concentration of population. The core of the city is more problematic as it shows. The low income and middle income groups have densely concentrated in the centre of the city. As a result, dwelling units have multiplied by construction, addition and partition of houses which generally are old. This has resulted, in the absence of proper ventilation, and housing facilities. Therefore, due to congestion and crowding in the central zone, high income people have also developed their residential enclave in the outer zone. Thus the outer zone is characterised by both substandard and high quality housing environments. It is suggested that more and more analytical researches of small cities should be conducted to extend this exploratory study.

References

[1] Bruce, N. (2000), USAID/WHO, "Global technical consultation on the health impacts of indoor air pollution and household energy in developing countries." Washington DC. Journal
[2] Nigel Bruce, *et.al.* (2000) "Indoor air pollution in developing countries: a major environmental and public health challenge", *Bulletin of the World Health Organization*, 78 (9) pp. 1078-1092.
[3] Smith, K.R. (1987), Biofuels , Air Pollution and Health: A Global Review, Plenum Publishing, NY, 1987
[4] Smith, K.R. (1993).Fuel combustion, air pollution and health: the situation in developing countries. An Rev Energy Environment, 18: 529-566.
[5] Smith, K.R, (1994). "Air pollution and the energy ladder in Asian cities." *Energy*, 19(5): 587-600.
[6] Jiboye, D. A; (2010), "Evaluating the Pattern of residential Quality in Nigeria: The case of Osogbo Township." *Architecture and Civil Engineering* Vol8, No 3, pp. 307 – 316.
[7] Kain. J. F and Quigley.J.F (1970), "Measuring the Value of Housing Quality" *Journal of the American Statistical association*, Volume 65, Nov.330, pp 532-550.
[8] Koning D. *et. al* (1985), Biomass Fuel Combustion and Health. Bull WHO; 63 (1): 11-26.
[9] Liu.Jiang, Liu Guang-qun (2005), " Some Indoor Quality Problems and Measures to Control them in China" *Indoor and Built Environment*, 14;:75-81.
[10] Mushir S, Khan. M.F. (2007) "Quality of urban environment- A case study of Saharanpur city, Uttar Pradesh."
[11] Sowman, M. & Urquhart, P. (1998). "A place called home: Environmental issues and low -cost housing." UCT Press. Cape Town.
[12] Wheeler, R. (1986) "Housing and Health in Old Ages, A Research Agenda" University of York Centre for Health Economics, November, pp 1-28, IRISS.
[13] Bijnor Mahayojna – (2011) Uttar Pradesh. National Press. Offset. Meerut(U. P)
[14] Bruce N., R. Perez-Padilla, and R. Albalak (2000). "Indoor Air Pollution in Developing Countries: A Major Environmental and Public Health Challenge," Bulletin of the World Health Organization 78(9): 1078-92.
[15] Bruce, N, Perez-Padilla, R and Albalak, R. (2000). Indoor air pollution in developing countries: a major environmental and public health challenge for new millennium. Bulletin of the World Health Organization, 78(9): 1078-1092.
[16] Census of India, (2001), Registrar General and Census Commissioner, New Delhi, India.
[17] Dangli Prasad Varun (1981): Uttar Pradesh District Gazetteers Bijnor. Page 20-56.
[18] Gazetteer of Province of Oudh Vol-I-A TOG Low Price Publication Delhi-110052.
[19] Mishra, V., Retherford, D., Smith, R., (1997) "Effects of cooking smoke on prevelence of blindness in India", *Working Paper Population Series*, 91, East West Centre.
[20] Parikh, J., *et al.*, (2000) "Exposure to Air Pollution from Combustion of Cooking Fuels: A Case Study of Rural Tamil Nadu, India," Energy, 26: 949-962.
[21] H.C. Cony Beare, B.C.S.(1879) Statistical Descriptive, and Historical Account of the North-Western Province of India- Vol-V-Rohilkhand Division Part-1
[22] Henery Prowde (1908): The Imperial Gazetteer of India Vol-VIII, Page 193-200
[23] Nevill H.R.*at.al*. (1908): District Gazetteers of the united provinces of Agra and Audh Vo/XIV Bijnor, Page-213- 222.
[24] United State Environmental Protection Agency (1991) Building Air Quality: A Guide for Building and Facility Managers. Washington, D.C.
[25] United State Environmental Protection Agency (1997) An Office Building Occupant's Guide to Indoor Air Quality. Washington, D.C.
[26] WHO (1999), Air quality Guidelines.
[27] World Bank. (1993)Investing in health. World Development Report, Oxford University Press, New York.
[28] World Health Organization.1997. Health and environment in sustainable development. Geneva.
[29] World Bank (2000) Household energy, air pollution and health. UNDP/ESMAP, Washington DC.
[30] World Health Organisation (2002) World Health Report: Reducing Risks, Promoting Healthy Life, Geneva.
[31] World Health Organization, (2007) Indoor Air Pollution: National Burden of Disease Estimates, Geneva.
[32] World Health Organization (1999) Guidelines for air quality. WHO Publications, Geneva.
[33] World Resources Institute (1999) UNEP, UNDP, World Bank. 1998-99 World Resources: a guide to the global environment. Oxford University Press