Assessment of Post-Project Compliance of Environmental Impacts of Housing Projects in Lucknow City Using Leopold Interaction Matrix

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Abstract

Cities in all parts of the world especially developing countries, face mounting challenges such as haphazard suburban development, spread of informal settlements, loss of open space, inadequate and aging infrastructure, water and air pollution, land degradation and traffic congestion. Most of these problems are related to poor urban planning, and such pattern of urban growth, if left unchecked, could result in substantial economic and environmental loss in future. There are several ongoing housing projects and new sub-urban colonies in Lucknow city, the capital of Uttar Pradesh, which are coming up in response to rising demands from public for their growing housing needs. All the new housing projects are expected to get environmental impact assessment done before the start of the project. However, there are apparent incompliances with respect to regulatory standards. Therefore

there is a need to assess the post-project compliance for such projects. This paper uses two dimensional Leopold interaction matrix using nine criteria to evaluate the overall impact of the housing projects on the environment. The impacts are measured on a magnitude scale of -10 to + 10and a significance level of 1 to 10by employing the scaling of attributes of environmental quality. The study reveals that some of the newly developed projects are characterized by severe shortage of basic services like potable water, well laid-out drainage system, sewerage network, sanitation facilities, electricity, roads and waste disposal system. These in turn result in numerous environmental and health impacts. The green cover and water bodies have been destroyed to give way to the rapidly developing urban settlements at the outskirts. The paper argues that through early planning before the start of the project as well as through all phases of the project's development, if environmental concerns are considered simultaneously with other technical and economic criteria, it may be possible to develop the housing projects with the protection of natural resources of that area.

Keywords: Environmental Impact Assessment, Leopold interaction matrix, Housing Projects

1. Introduction

One of the most pressing issues with regard to the environment is linked to human settlement in world's growing cities and towns. Cities present significant thereat as well as opportunities for new landscape perspectives that can help inform policy makers on important environment and development parameters (Steiner, 2014). It has been widely discussed in the literature that unplanned urban growth or sprawl has high environmental and economic costs (Forman, 2014). In general, settlements in sprawling cities generate more carbon emissions due to higher energy and resource consumptions.

Several agencies use procedures for environmental impact assessment (EIA) of housing projects which might result in significant environmental impacts. The EIA study is necessary to prepare a detailed account of environmental impact of the proposed activity so that appropriate interventions could be taken.In India's rapidly growing cities, sprawl development and informal settlements have been the dominant growth trend, and has accelerated since last two decades. It is being spurred by growing housing demands, urban migration, transportation network and rising quality of life.

EIA is the process to identify, predict, evaluate and mitigate the environmental, social, and other potential impacts and consequences of any developmental projects (IAIA, 1999; Kaya and Kahraman, 2011; Sadler and Verheem, 1996; Canter, 1996). The main function of EIA is to predict and reduce the negative impacts suffered by the environment as a result of sustaining all human action (Moron *et al.,* 2009). Human activities is beneficial and harmful for environment such as biological, cultural, social, economical and so on, both must be taken into consideration when the projects or plans are evaluated (Deng *et al.*, 2014). The rapid growth in the urban population has increased the demand for land and cost of living, and it has also spurred the new housing projects activities (Mabogunje, 1975). The housing project activities cause several harmful impacts on the environment. The high demand of urban land and housing is often in short supply and out of the economic reach of the people at the base of the pyramid and majority of the urban households (Oladapo, 2007; Olotuah, 2010). The

new urban space is characterized by a large mushrooming growth of people with irregular houses, commercial areas and markets and lack of open space. Therefore, the main role of EIA in housing projects is to determine the impact on the environmental quality and human wellbeing.

This paper uses two dimensional Leopold interaction matrix using nine criteria to evaluate the overall impact of the housing projects in Lucknow City on the environment. The impacts are measured on a magnitude scale of -10 to + 10and a significance level of 1 to 10by employing the scaling the attributes of environmental quality. The Leopold interaction matrix provides a comprehensive format for review of the interactions between proposed anthropogenic actions and environmental factors including its characteristics and conditions. The Leopold matrix method was developed by Dr. Luna Leopold and others of the United States Geological Survey (Leopold *et al.*, 1971)**.** The matrix is designed for the assessment of impacts linked with almost any type of construction project. It not only gives the qualitative information on cause-and-effect relationships, but it is also useful for communicating results. When an action or activity is expected to have an environmental impact, it is noticed by the intersection cell and is further described in terms of magnitude and importance. This provides a layout for comprehensive review of the interactions between proposed anthropogenic actions and environmental factors including its characteristics and conditions.

2. Literature Review

2.1 EIA as Significant Tool in Housing Projects

Environmental impact assessment (EIA) is a planning and management tool that seeks to identify and assess the type, magnitude and probability of environmental and social changes likely to accrue form a proposed development or policy and to design the possible mitigation plans (Harvey, 1998; Momtaz, *et al.,* 1998; Thomas, 1998). EIA is being used worldwide in order to reduce the harmful consequences of development. It is an illustration of the precautionary principle (Debbarma,2012) because it focuses on prevention. The primary goal of EIA is ensuring environmental protection and management (Bailey, 1997; Morrison and Bailery, 1999). EIA is typically concerned with the prediction and identification of impacts at a pre-decision level focusing only on the steps before and up to the planning decision but ignoring post development follow-up actions, such as monitoring and auditing (Art *et al.*, 2001; Glasson, 1994; Petts and Eduljee, 1993). Moreover, it would seem that the procedural emphasis of EIA upon the pre-decision investigation keeps it isolated from its goal, i.e. environmental protection. In a major study on international EIA effectiveness (Sadler, 1996; Cashmore et al., 2004)**,** it is found that there was a deficient or poor performance of follow-up activities in EIA. This is considered to be a major weakness of EIA internationally (Arts *et al.*, 2001; Bisset and Tomlinson, 1988; Buckley, 1989a; Dipper *et al.,* 1998; Glasson *et al*., 1999; Ortolano and Shepherded, 1995; Sadler, 1996; Wood, 2003).

2.2 Leopold Interaction Matrix in EIA

Interaction matrices were one of the most primitive methods used in assessment of environmental impacts. The simple matrix refers to a display of project actions or activities

on one axis, with suitable environmental factors listed on the other axis of the matrix. The matrix method developed by Leopold et al., 1971, is an illustration. Leopold interaction matrix is a comprehensive matrix, which had initially 88 environmental characteristics, along the top axis, and 100 project actions in the left hand columns (Leopold *et al.*, 1971). This method is flexible and allows extension of component or characteristics to be affected by the environment. It shows the relations between causes and effects or actions and impacts relationship. It enabled us to make unbiased decision which depends on experience. This method employs the use of scaling to rate environments quality. Possible impacts are marked in the suitable cell and a numerical value can be assigned to indicate their magnitude and significance. Typically the numerical value ranged from 1, for small magnitude, to 10, for large magnitude. The assignment of numerical values is based on an assessment of available facts and data. In the same way, the scale of importance also ranges from 1, for very low interaction, to 10, for very important interaction. The numbers are used to identify concern arising from the interaction of project activities with the environment (PME/UNEP, 1989; Ghurayba and Alfarhan, 2000). Assignment of numerical values for significance is based on the subjective judgment of the interdisciplinary team working on the EIA study.

2.3 Previous Studies of Leopold Matrix

The use of Leopold interaction matrix in the EIA processes has been cited in several literature. The EIA of Nigeria national petroleum corporation mega station was done using Leopold matrix and other environmental assessment techniques to find out the impact of interactions between the station developmental activities like temperature, rainfall, soil, water and air qualities (Akintunde and Olajide, 2011). Impact Significance Determination (ISD) which is one of the most important tasks in EIA activity of IMPERIA project using Leopold matrix (Marttunen, *et al.*, 2013). According to (Petra, 2009), the Leopold matrix method helps to represent the interactions between project activities and environmental components and also identify the environmental effects and impacts. Environmental impact of Uakari Floating Lodge, through an adaptation of the Leopold Matrix, evaluates the magnitude and importance of their environmental impacts (Pedro, 2012). It was found that 28 environmental aspects in Uakari Lodge, being 'generation of domestic wastewater' and 'accumulation of used batteries' are the most important internal aspects, and 'consumption of lubricating oil and fuel in motor boats rides' and 'production of gases from fuel combustion in boat rides' are the most important external aspects. All of them were recognized as environmental aspects with potential for Direct 84.6%, Reversible 76.9%, Insignificant 46.2% or Moderated 53.8%, and Local 100% impacts. The results specify the environmental aspects raised have low impact to the natural environment, considering the enterprise scale. Evaluation of possible environmental impacts for Barapukuria thermal power plant and coal mine was done using Leopold matrix (Alam, *et al.,* 2011). Graded matrix system was used to indicate the magnitude and importance of the impacts by numerical values (Leopold *et al.*, 1971). The Leopold matrix depicted a result of totaling +950 positive scores, definitely favors to environment. It is clear from the analysis that the Mn concentration was found in the acceptable range. The pH was found slightly alkaline and surface water was bacteria infected. SO_4^{2-} concentration was in the range of WHO standard. Calculated SOx loading was almost

same of monitored release. Corresponding estimated concentration of SOx was in satisfactory range, which may not bring any matter of concern. In the study, an attempt was also made to assess the health impacts of SPM suspended particulate matter emitted from the combustion of coal in the power plant. The socio economic situation was also considered a dominating factor, for the EIA along with the chemical parameters since increased employment for the project. Kaur and Arora (2012) studied the importance of EIA in the sustainable development of a construction project with a case study of an upcoming Multiplex in Ballo, Majra near Mohali Punjab using leopold matrix method and The project scored -350 points with mitigation measure. This indicates that there would not be significant impact on the environment with suitable environmental control measures.

3. Study Area

The present study has been carried out with reference to a rapidly growing city – Lucknow, which is the capital city of India's biggest and fastest growing State – Uttar Pradesh. Among its vastly populated world of towns and cities the state of Uttar Pradesh is most populous, having a population of 199.6 million as per the Census of India, 2011. It is the second largest state-economy in India contributing 8.17% to India's total GDP between 2004 and 2009. Lucknowhas a population of 4.5 million and a geographical area of about 3100 sq. km out of which the city occupies about 300 sq. km. It is surrounded on the eastern side by district Barabanki, on the western side by the district Unnao, on the southern side by Raebareli and on the northern side by Sitapur and Hardoi districts. The city is on the north western shore of Gomti river, which flows through it. The city has seen a steady increase in population arising from natural growth, incorporation of peri-urban areas in 1980's and large-scale migration. The population growth projected in the Master Plan 2021 varies between 3.51 to 4.37 per cent per year over different 5-year periods until 2021, somewhat higher than the average growth rate of cities of similar size in the country and state. As any other fast growing developing Indian mega city, Lucknow faces an uncontrolled urban sprawl. The rapidly growing urban population in the city and high rate of migration spills into the peri-urban and rural areas surrounding the city boundaries. The selected study area includes four different sites of housing projects of Lucknow city namely Parsvnath City, LDA Gomti Nagar Extension scheme, DLF Garden City, and Omaxe residency (Figure 1). A short description about the housing projects are provided below:
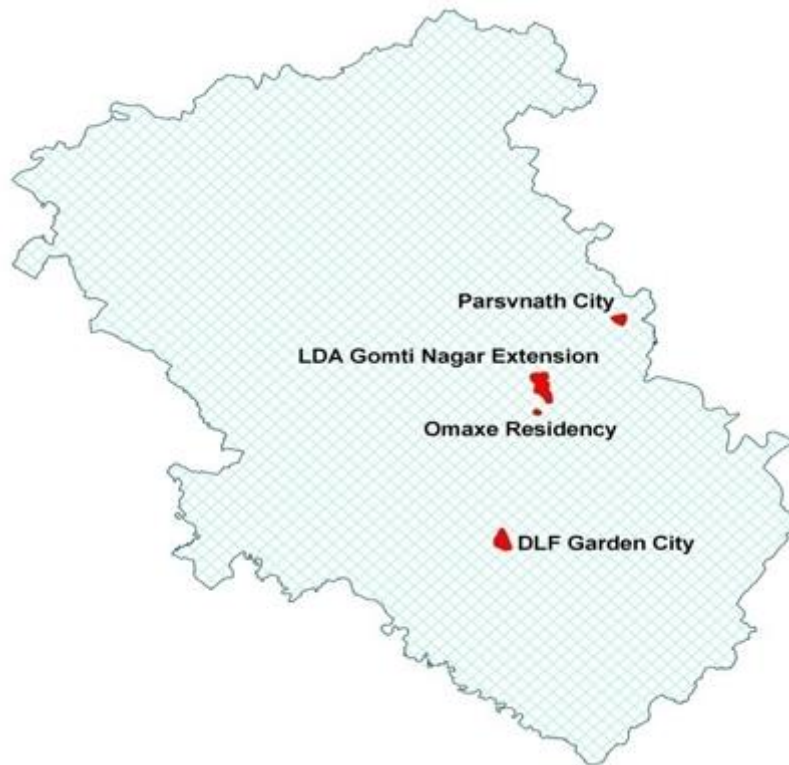
Figure. 1 Location map of the study area of housing projectsinLucknow

*1. Parsvnath (Township):*This site is located on Faizabad road near village Uttardhanua. The township spreads over an area of 34.8 acres, adjacent to NH-28 which connects Lucknow to Barabanki.

2. LDA Gomti Nagar extension: This site is located towards the east of the existing city at a distance of about 6 Km. from the central business district Hazratganj. The "East West Corridor" (Connecting Lucknow-Kanpur Highway, Lucknow-Raibareli Highway, Lucknow-Sultanpur Highway &Lucknow-Faizabad Highway) passes through the township.

3. *DLF Garden City:* It is located on Raebareli Road near Purseni village, Mohanlalganj. This site is totally open area in which the construction is in process. It poses sensitive area SGPGI on Raebareli Road.

4. Omaxe Residency: It is situated near Sarsawan village near Arjunganj. The proposed site for group housing is well connected to surrounding areas through national highway, namely NH-56 connecting Lucknow to Gosaiganj, NH-25 connecting Lucknow to Kanpur, NH-24B connecting Gosaiganj to Barabanki.

4. Methodology

The activities (project attributes) linked to the housing project are listed on one axis while, the environmental and social conditions are listed on the other axis as shown in the Figure-2 given below:
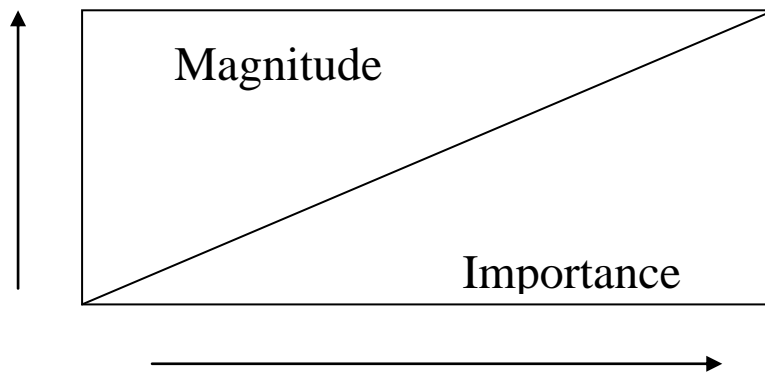
Figure 2. Illustration showing matrix bearing magnitude and importance

For the evaluation of these projects, each action checked was evaluated in terms of magnitude of effect on environment characteristics and conditions [on the vertical axis]. From upper right to lower left across each block where significant interaction is expected slash \ was placed diagonally. The most important blocks marked are evaluated individually, and a number between 1to10 is placed in the upper left-hand corner to indicate the relative magnitude of the impact 1is the best magnitude, and 10 the greatest magnitude. In the same way, a number between 1 and 10 in the lower right-hand corner to indicate the relative importance of the impact again,1 is the magnitude, and 10 the greatest. The next step is to evaluate the numbers which have been in the slashed boxes. The high or low numbers on any one box indicates the degree of impact of the appropriate action on the given characteristic of the environment. The assignment of magnitude and importance numbers is based, to the extent possible, on factual data rather than on the evaluator's preference. For the rating design regarding the probable impacts requires the evaluator to quantify his\her judgment. The rating scheme\scheme allows the reviewers to thoroughly follow the evaluator's line of reasoning, to aid in identifying points of agreement and disagreement. In fact, matrix is the abstract for the text of the environmental impact assessment.

Table 1. Type of impacts and their scale of importance and magnitude

Sl. No.	Types of impacts	Scale of magnitude 1-10	Scale of importance 1-10
1.	No impact	1	1
2.	Low impact	2-4	2-4
3.	Medium impact	5-6	5-6
4.	High impact	7-10	7-10

Mark the boxes in the matrix with diagonal line slashed\is placed

↓

Evaluate the magnitude scale of action by applying a number from 1 to10 to the upper left hand corner

↓

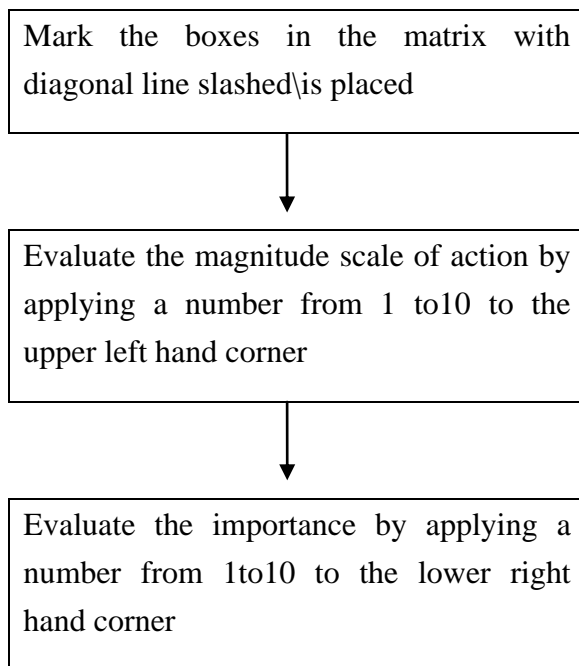| Evaluate the importance by applying a number from 1to10 to the lower right hand corner |
|---|

Figure 3. Flow diagram of methodology of Leopold matrix for Identification of Impacts

5. Results

Table 2. Comparative checklists for EIA of Housing Projects in the Study area (as per the form − 1 A for construction projects listed under item 8 of the EIA schedule)

2.1 Air Environment: Release of Pollutants or Any Hazardous, Toxic Substances to Air Kg/Hr

SL.NO.	Information/checklist confirmation	Omaxe Residency, Gomti Nagar	Parsvanath Developers, Faizabad Road	LDA Gomti Nagar Extension Scheme	DLF Garden City, Raibareli Road	Total score of impact	Average of impact
1.	Emissions from combustion of fossil fuels from stationary of mobile sources.	4/6	6/7	9/9	7/8	26/30	6/7.5=6/7
2.	Emission from construction activites including plant & equipment	7/7	5/6	9/8	8/7	29/28	7.2/7=7/7
3.	Dust or odours from handling of materials including construction materials, sewage & waste.	7/7	7/7	8/9	7/8	29/31	7.2/7.7=7/8
	Total score of impact	18/20	18/20	26/26	22/23		
	Average score of impact	6/6.6=6/7	6/7	8.6/8.6=9/9	7.3/7.6=7/8		

2.2 Noise Environment: Generation of Noise & Vibration. & Emission of Hazardous Materials

SLNO.	Information/checklist confirmation	Omaxe Residency, Gomti Nagar	Parsvanath Developers, Faizabad Road	LDA Gomti Nagar Extension Scheme	DLF Garden City Raibareli Road	Total score of impact	Average score of Impact
1.	From operation of equipment e.g. engines, ventilation plant, crushers.	7/6	7/7	8/9	8/8	30/30	7.5/7.5
2.	From industrial or similar processes.	1/1	1/1	1/1	1/1	4/4	1/1
3.	From construction or demolition	6/6	7/6	9/9	8/7	30/28	7.5/7
4.	From blasting or pilling	1/1	1/1	1/1	1/1	4/4	1/1
5.	From construction or operational Traffic	5/6	6/7	9/9	7/8	27/30	6.7/7.5
6.	From lighting or cooling system	1/1	1/1	1/1	1/1	4/4	1/1
	Total score of impact	21/21	23/23	29/21	26/26		
	Average score of impact	3.5/3.5	3.8/3.8	4.8/3.5	4.3/4.3		

2.3 Water and Land Environment: Risks of Contamination of Land Water from Release of Pollutants

SL.NO.	Information/checklist confirmation	Omaxe Residency, Gomti Nagar	Parsvanath Developers Faizabad Road	LDA Gomti Nagar Extension Scheme	DLF Garden City, Raibareli Road	Total score of impact	Average score of impact
1.	From handling storage use of hazardous materials	7/6	8/7	9/9	8/9	32/31	8/7.7
2.	From discharge of sewage or other effuents to water or the land	7/7	7/8	9/9	8/8	31/32	8/7.7
3.	By deposition of pollutants emitted to air into the land or into water	6/7	7/8	8/9	8/7	29/31	7.2/7.7
	Total score of impact	20/20	22/23	26/27	24/24		
	Average score of impact	6.6/6.6	7.3/7.6	8.6/9	8/8		

2.4 Environmental Sensitivity

SL.NO.	Information/checklist confirmation	Omaxe Residency, Gomti Nagar	Parsvanath Developers, Faizabad Road	LDA Gomti Nagar Extension Scheme	DLF Garden City, Raibareli Road	Total score of impact	Average score of impact approximately
1.	Areas protected under international conventions national or local legislation for their ecological value.	1/1	3/5	1/1	1/1	6/8	4.5/2
2.	Ares which are important or sensitive for ecological reasons wetlands, water courses or other water bodies, coastal zone biosphere, mountains forests	1/5	3/7	6/7	1/1	11/20	1.1/2
3.	Ares used by protected important or sensitive species of flora and fauna for breeding, nesting, foraging, resiling over wintering migration	1/1	1/1	1/1	1/1	4/4	1/1
4.	Inland coastal marine or underground waters	1/1	6/7	1/1	1/3	9/12	2.2/3
5.	State national boundaries	1/1	1/1	1/1	1/1	4/4	1/1
6.	Densely populated area	4/7	4/7	1/3	1/2	10/19	2.5/1.9
7.	Ares occupied by sensitive man made land uses .	4/5	6/8	3/7	3/6	16/26	4/6.5
8.	Ares already; subjected to pollution or environmental damage.	1/1	3/2	1/1	1/1	6/5	1.5/1.2
9.	Areas susceptible to natural hazard which could cause the project to present environmental problems.	1/1	3/2	1/1	1/1	6/5	1.5/1.2
10.	Defence installations.	1/1	1/1	1/1	1/1	4/4	1/1
	Total score of impact	16/27	29/40	17/24	12/18		
	Average score of impact	1.6/2.7	2.9/4	1.7/2.4	1.2/1.8		

2.5 Fauna

SL.NO	Information/checklist confirmation	Omaxe Residency, Gomti Nagar	Parsvanath Developers, Faizabad Road	LDA Gomti Nagar Extension Scheme	DLF Garden City, Raibareli Road	Total Score of impact	Average score of impact
1.	Is there likely to be any displacement of fauna-both terrestrial and aquatic or creation of barrier for there movement?	2/6	3/7	5/9	4/8	14/30	3.5/7.5
2.	Are there any direct or indirect impacts on avifauna of the area?	3/6	4/7	6/9	5/8	18/30	4.5/7.5
	Total score of impact	5/12	7/14	11/18	6/16		
	Average score of impact	2.5/6	3.5/7	5.5/9	4.5/8		

2.6 Vegetation

SL.NO.	Information\checklist confirmation	Omaxe Residency, Gomti Nagar	Parsvanth Developers Faizabad Road	LDA Gomti Nagar Extension Scheme	DLF Graden City, Raibareli Road	Total score of impact	Average score of impact
1.	Is there any threat to of project to the biodiversity?	2\5	2\6	4\8	3\7	11\26	2.7\6.5
2.	Will the construction involve extensive clearing or modification of vegetation?	2\5	3\6	5\9	4\7	14\27	3.5\6.7
	Total score of impact	4\10	5\12	9\17	7\14		
	Average score of impact	2\5	2.5\6	4.5\8.5	3.5\7		

2.7 Risk Assessment Risk of Accidents during Construction or Operation of Project Which Could Affect Human Health or the Environment

SL.No.	Information\checklist confirmation	Omaxe Residency, Gomti Nagar	Parsvanath Developers, Faizabad Road	LDA Gomti Nagar Extension Scheme	DLF Graden City, Raibareli Road	Total score of impact	Average score of impact
1.	From explosions and spillages, fires etc, from storage handling, use of production of hazardous substances From any other causes	4\5	5\6	8\9	7\8	24\28	6\7
2.	From any other causes	1\1	1\1	1\1	1\1	4\4	1\1
3.	Could the projects affected by natural disasters causing, environmental damage e.g; floods, earthquakes, landslides, cloud burst etc.	6\5	6\5	8\7	7\6	27\23	6.7\5.7
	Total score of impact	11\11	12\12	17\17	15\15		
	Average score of impact	3.6\3.6	4\4	5.6\5.6	5\5		

2.8 Solid Waste Management Production of Solid Waste during Construction or Operation or Decommissioning

SL.NO.	Information/checklist confirmation	Omaxe Residency, Gomti Nagar	Parsvanath Developers, Faizabad Road	LDA Gomti Nagar Extension Scheme	DLF Garden City Raibareli Road	Total score of impact	Average score of impact
1.	Municipal waste domestic orcommercial wastage	4/6	5/7	8/9	6/8	23/30	5.7/7.5
2.	Hazardous wastage	5/7	6/8	7/8	8/9	26/22	6.5/5.5
3.	Other industrial processes wastes	1/1	1/1	1/1	1/1	4/4	1/1
4.	Sewage sludge or other sludge from effluent Treatment	4/6	5/7	8/9	7/8	24/30	6/7.5
5.	Construction of demolition wastes	5/6	6/7	9/9	7/8	27/30	6.7/7.5
	Total score of impact	19/26	23/30	33/36	29/32		
	Average score of impact	3.2/5.2	4.6/6	6.6/7.2	5.8/6.4		

2.9 Socio-Economic Status.

SL.No.	Information\checklist confirmation	Omaxe Residency, Gomti Nagar, Lucknow	Parsvanath Developers, Faizabad Road	LDA Gomti Nagar Extension Scheme	DLF Garden City, Raibareli Road	Total score of impact	Average score of impact
1.	Will the proposal results in any change to the demographic structure of local population?	1/5	1/6	1/8	1/7	4/26	1/6.5
2.	Will the project cause adverse effects on local communities, disturbance to sacred sites or other cultural values?	1/1	1/1	2/2	1/1	4/4	1/1
	Total score of impact	2/6	2/7	3/10	2/8		
	Average score of impact	1/3	1/3.5	1.5/5	1/4		

2.10 Overall Results of Four Housing Projects

| SL.NO.	Information\checklist confirmation	Omaxe Residency, Gomti Nagar	ParsvanathDevelopers,Faizabad Road	LDA Gomti Nagar Extension Scheme	DLF Garden City, Raibareli Road
1.	Air Environment	6/6.6	6/7	8.6/8.6	7.3/7.6
2.	Noise Environment	3.5/3.5	3.8/3.8	4.8/3.5	4.3/4.3
3.	Water and Land Environment	6.6/6.6	7.3/7.6	8.6/9	8/8
4.	EnironmentalSenstivity	1.6/2.7	2.9/4	1.7/2.4	1.2/1.8
5.	Fauna	2.5/6	3.5/7	5.5/9	4.5/8
6.	Vegetation	2/5	2.5/6	4.5/8.5	3.5/7
7.	Risk Assiessment	3.6/3.6	4/4	5.6/5.6	5/5
8.	Solid Waste Management	3.2/5.2	4.6/6	6.6/7.2	5.8/6.4
9.	Socio-Economic Status	1/3	1/3.5	1.5/5	1/4
	Total	29.9/42.2=3.2/4.4	32.6/47.9=3.5/5.2	47.4/56.8=5.2/6.2	40.6/52.1=4.4/5.7
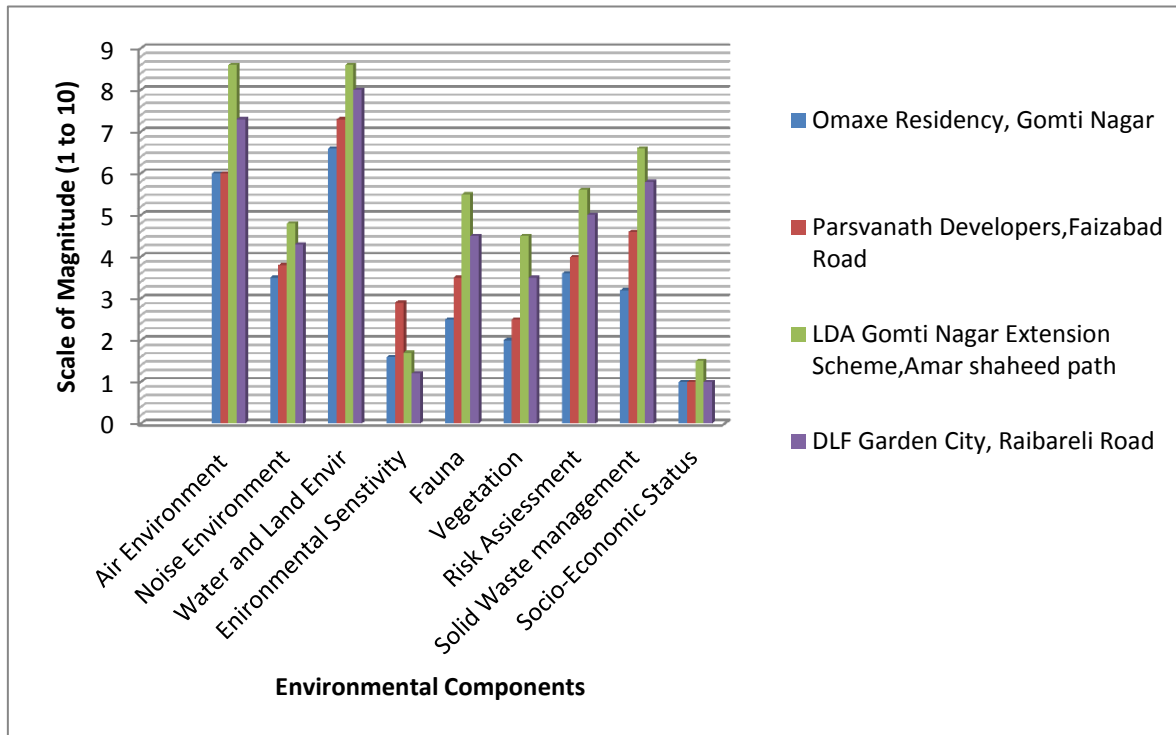
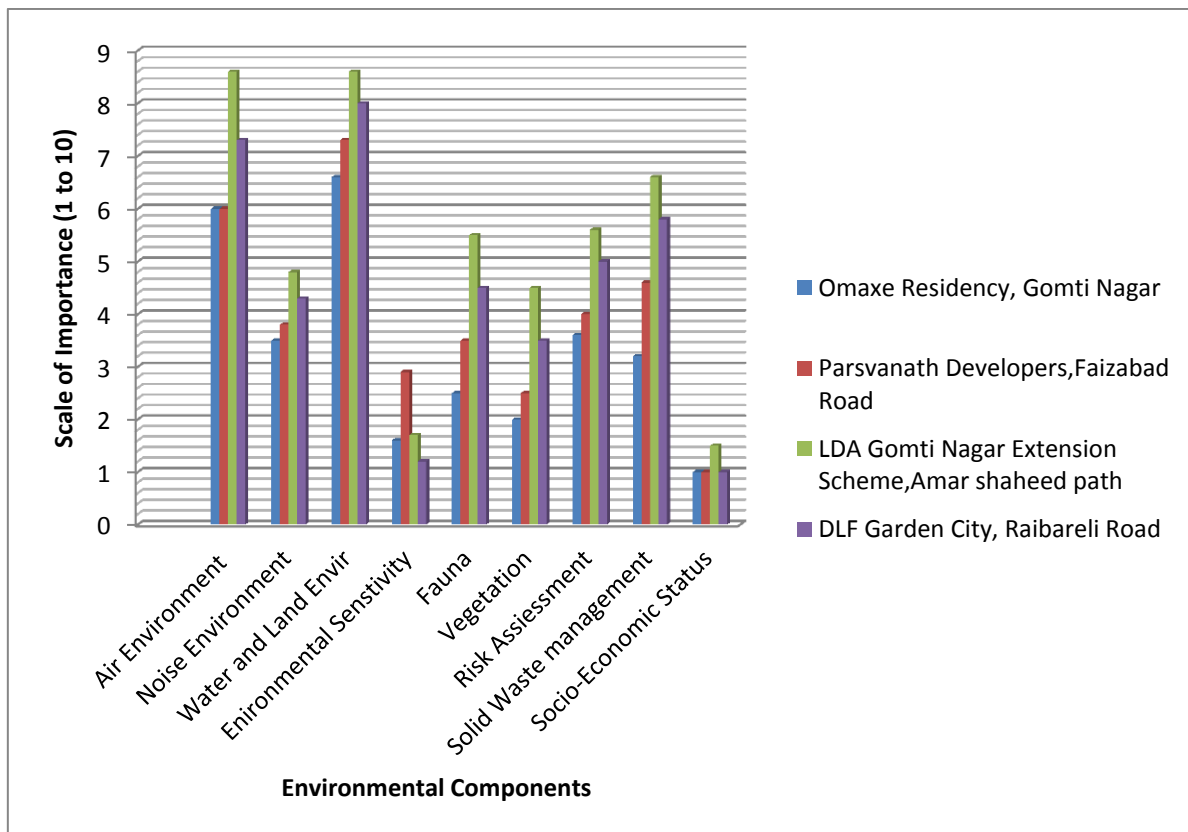Figure 4. Scale of Magnitude for various components for different housing colonies

Figure 5. Scale of Importance for various components of different housing colonies

6. Discussion

- ✓ With respect to air quality the magnitude and importance of LDA Gomti Nagar Extension Scheme and DLF Garden City was high whereas Omaxe Residency and Parsvnath City was observed medium. But, in case of noise quality and environmental sensitivitythe magnitude and importance of all four housing projects (LDA Gomti Nagar Extension Scheme, Parsvnath City, DLF Garden City and OmaxeResidency) was observed to be low.

- ✓ With respect to water and land environment magnitude and importance of LDA Gomti Nagar Extension Scheme, Parsvnath City and DLF Garden City was observed to behigh except Omaxe Residency whose magnitude and importance have medium impact on environment.

- ✓ With respect to fauna the magnitude of LDA Gomti Nagar Extension Scheme was observed to be medium and the magnitude of other three housing projects (Parsvnath City, DLF Garden City and OmaxeResidency) are observed to be low whereas, the importance of LDA Gomti Nagar Extension Scheme, Parsvnath City and DLF Garden city was observed to behigh except Omaxe Residency which have medium impact on environment.

- ✓ With respect to risk assessment the magnitude and importance of LDA Gomti Nagar Extension Scheme and DLF Garden City was observed medium butParsvnath City and DLF Garden City having low magnitude.

- ✓ With respect to vegetation all four housing projects (LDA Gomti Nagar Extension Scheme, Parsvnath City, DLF Garden City and Omaxe Residency)shows low magnitude whereas the importance ofLDA Gomti Nagar Extension Scheme and DLF Garden City was observed to be high in comparision to Parsvnath City and DLF Garden City (medium impact)

- ✓ With respect to socio-economic status all four housing projects (LDA Gomti Nagar Extension Scheme, Parsvnath City, DLF Garden City and Omaxe Residency)have low magnitude and but the importance of all the three projects (Parsvnath City, DLF Garden City and Omaxe Residency) are observed to be low except LDA Gomti Nagar Extension Scheme.

- ✓ With respect to Solid Waste Management the magnitude of LDA Gomti Nagar Extension Scheme and DLF Garden City was observed medium but the other two projects (Parsvnath City and OmaxeResidency)have low magnitude whereas the importance of Parsvnath City, DLF Garden City and Omaxe Residency was observed to be medium except theLDA Gomti Nagar Extension Scheme which was observed to behigh.

7. Conclusion

This comparative study of housing projects was administered via personal surveys, and details study of all EIA reports of selected study area was made to prepare a comparative table of responses in a standard format covering various parameters of housing projects as shown intable 1. All housing projects sites have a green belt area and parking area. They have also installed sewage-treatment plants which are in operation except DLF and Parsvnathcity,

rain water harvesting system (ground based) and none of the projects have a basement parking system. All the projects have ground water as a source of water and the water table of all the projects sites lies average over the range of 20-25 feet from the ground surface, and among all the housing projects sites, two sites viz. DLF Garden city and Parsvnath city is currently unoccupied and proposed to be habitated.

It was observed that building bye-laws relating to the provisions of vacant areas/spaces as outlined in clause 1.3 of the building bye-laws, 2008 of UP were not adhered to.There is also non-compliance to the norm of open spaces, as the space for parks and recreational areas are limited.As per the government order in November 1999, regarding model costing plan for housing development by the land development authorities and housing boards, cost would include external development including construction of STPs and garbage disposal places. Garbage generated by these colonies is collected by private and informal groups, who ultimately dispose them in open and vacant land due to the absence of any landfills. Similarly LDA has not developed common rain water harvesting (RWH) system which is required for plots of less than 300 square meter area.

Leopold matrix is a significant methods used in EIA process and provides a format for comprehensive review of the interactions between proposed anthropogenic actions and environmental factors including its characteristics and conditions. It was applied for the evaluation of impacts of housing projects in Lucknow city. The conclusions drawn from the evaluation of impacts is magnitude of LDA Gomti Nagar Extension Scheme and DLF garden city was observed medium whereas the other three housing projects have low magnitude. Similarly, the importance of all the three housing projects was observd to be medium except Omaxe Residency. The site visits also revealed that actual plantation in the parks do not match with the plan as per the environmental clearance report and the schedule of the compliance criteria. Some of the housing projects began their construction activities before getting their prior stipulated environmental clearance.

Planned approach is essential for integration between urban development, environmental conservation and overall wellbeing of people. Thus, creation and maintenance of housing projects that are in tune with the natural environment and resource use is an important component of sustainable urban systems. The comparative study of this paper shows the ground reality of various parameters in the selected housing projects. The housing project should have rainwater harvesting system, proper parking facilities, adequate green area and contain the plants/trees that absorb the high level sound/noise, wastewater treatment facility and sound waste management facility.

7. Acknowledgement

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