EFFECTIVENESS OF EIA FOR HOUSING PROJECTS IN LUCKNOW, UTTAR PRADESH

SUMMARY AND CONCLUSION OF THESIS

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SUMMARY AND CONCLUSIONS

Rapid urbanization, environmental pollution and resources scarcity greatly influence the ability of town planners to deliver sustainable housing to citizens in developing countries. This has resulted in development of housing colonies that are unsuitable for occupancy generating negative consequences to the surrounding communities and the environment in the long run (Moja and Mnguni, 2014; Poom *et al.,* 2014; Dutta, 2012). Developing more resilient and sustainable settlements requires planners to anticipate and take account of changing socio-ecological and physical conditions (Fitzgerald *et al.,* 2015). Understanding the complex interactions between dynamic environmental, technological, infrastructural and governance systems in relation to housing provisions forms the starting point for impact assessment within the framework of Environmental Impact Assessment (EIA). EIA is the process used to identify, predict, evaluate and mitigate the environmental, social, and other potential impacts and consequences of developmental projects prior to major decisions being taken and commitments made to recommend suitable mitigation measures and to decrease possible adverse impacts (International Association for Impact Assessment (IAIA), 1999; Kaya and Kahraman, 2011). Human activities are both beneficial and harmful for environment such as biological, cultural, social, economic impacts and so on and they must be taken into consideration when the development projects or plans are evaluated (Puri *et al.,* 2015; Deng, et *al.,* 2014). The rapid growth in the population in urban areas has increased the demand of land and cost of living, and it has also increased the housing load and housing projects activities (Jiao, 2015). This high demand of urban land and housing is often in short supply and out of the economic reach of the majority of the urban households (Oladapo and olotuah, 2007; Olotuah, 2010).

The urban areas in developing countries are crowded by a large mushrooming growth of settlements. These parts of the urban population needs special attention and is constrained with limited services, insufficient resources, crowded and squatter settlements and a generally poor environmental quality (McGranahan, 2015; Galbraith, 1968). These are the urban poor that are subjected to a life characterized by precarious conditions of housing, nutrition and health, little or poor material possessions (Walter *et al.,* 2015; Mabogunje, 1975). In India, urbanization trend shows a dramatic shift. Total population has increased from 23.84 crores in 1901 to 102.7 crores in 2001, and number of town has grown from 1827 in 1901 to 7935 in 2011 (Census of India, 2011). The number of urban agglomerations has increased from 384 in 2001 to 475 in 2011, whereas the number of population living in urban areas has increased from 2.58 crores in 1901 to 28.53 crore in 2001.

1.1 EIA for Housing projects

The Environmental Impact Assessment comes from Sec. 102 (2) of the National Environmental Policy Act (NEPA), 1969, USA. In many European

countries, it came into trend with the introduction to the concept of sustainable development after the report of World Commission on Environment and Development (WCED) came in 1987. In India, EIA came into existence informally through isolated project assessment on environmental criteria around 1978-79, it was made a mandatory provision in 1994.

The vast majority of urban residents in India continue to live in sub-standard or informal housing, with few basic amenities (Tiwari and Hingorani, 2014). 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 during the early stage of project development. The primary goal of EIA is ensuring environmental protection and management (Bailey, 1997; Morrison and Bailery, 1999). EIA is generally 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 post project monitoring and auditing (Art *et al.*, 2001; Glasson, 1994; Petts and Eduljee, 1993). Moreover, the procedural emphasis of EIA upon the pre-decision investigation keeps it isolated from its final 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, 1989; Dipper *et al.,* 1998; Glasson *et al*., 1994; Ortolano and Shepherded, 1995; Sadler, 1996; Wood, 2003).

The living space becomes the centre and instrument for mankind's socio-economic and moral well being (Wang *et al.,* 2015). Since living space affects the very foundation of an individual's life, the house becomes an integral part of it. Besides it is fundamental to people's physical, physiological, social and economic well-being (Kraatz *et al.,* 2015). Housing is the physical structure that man uses for shelter. The quality of life of human being can not be fulfilled without safe, secure and comfortable housing. But, in most of India's towns and growing cities, people are not fortunate to have housing of their own which is safe, sustainable and comfortable. Housing is the biggest challenge associated with urbanization in India. In the absence of proper assessment of environmental significance of ongoing housing projects, the living standards of urban as well as rural area are deteriorating. Thus, the sustainable human settlement and construction of eco-cities or green housing can be achieved by implementing the policies of EIA in housing and construction projects (Kulkarni *et al.*, 2014).

1.2 Research Objectives

EIA has been used as a practical and effective tool in decision making process to identify environmental factors, and consequences for a proposed development project needed to arrive at socio-economic development. This study uses the EIA framework as a lens to evaluate current and future environmental impacts in developing housing projects by both public and private agencies and also evaluates the post-project conflicts through primary and secondary data. This research work quantitatively explores the spatio-temporal patterns of land use/land cover transformations in the core and along the city periphery of Lucknow city, the capital of India's largest state, in addition to observing nature and form of urban expansion resulting in a complicated urban landscape. Conflict analysis is carried out to explore disagreements between urban suitability, enabling infrastructure and Master plan 2021 proposed by the land authorities using satellite imageries, Fuzzy AHP and sub-models within a framework of environmental assessment. The methodology provides a cost effective and rapid land evaluation framework for EIA which may help policy makers, urban and regional planners and researchers working in developing countries to understand the dynamics of urban growth and impacts of housing projects on the environment.

There are three main research objectives which are formulated as follows:-

- To assess the baseline and current environmental status (such as air, water, noise, and socio-economic parameters) for housing projects in Lucknow.
- To do a comparative study of the housing projects in the study area on different parameters using Leopold Matrix method.
- To review the effectiveness of EIA systems implemented in housing projects through conflict analysis and post-project monitoring using Fuzzy AHP models and GIS.

The study was used to observe the effectiveness of EIA for housing projects in Lucknow by studying and reviewing the Government of India EIA notifications, with the help of spatial and non-spatial data, use of Fuzzy – AHP modelling techniques, Leopold interaction matrix, land use/cover change detection, and conflict analysis. The methodological framework is schematically outlined below in the figure 1.1

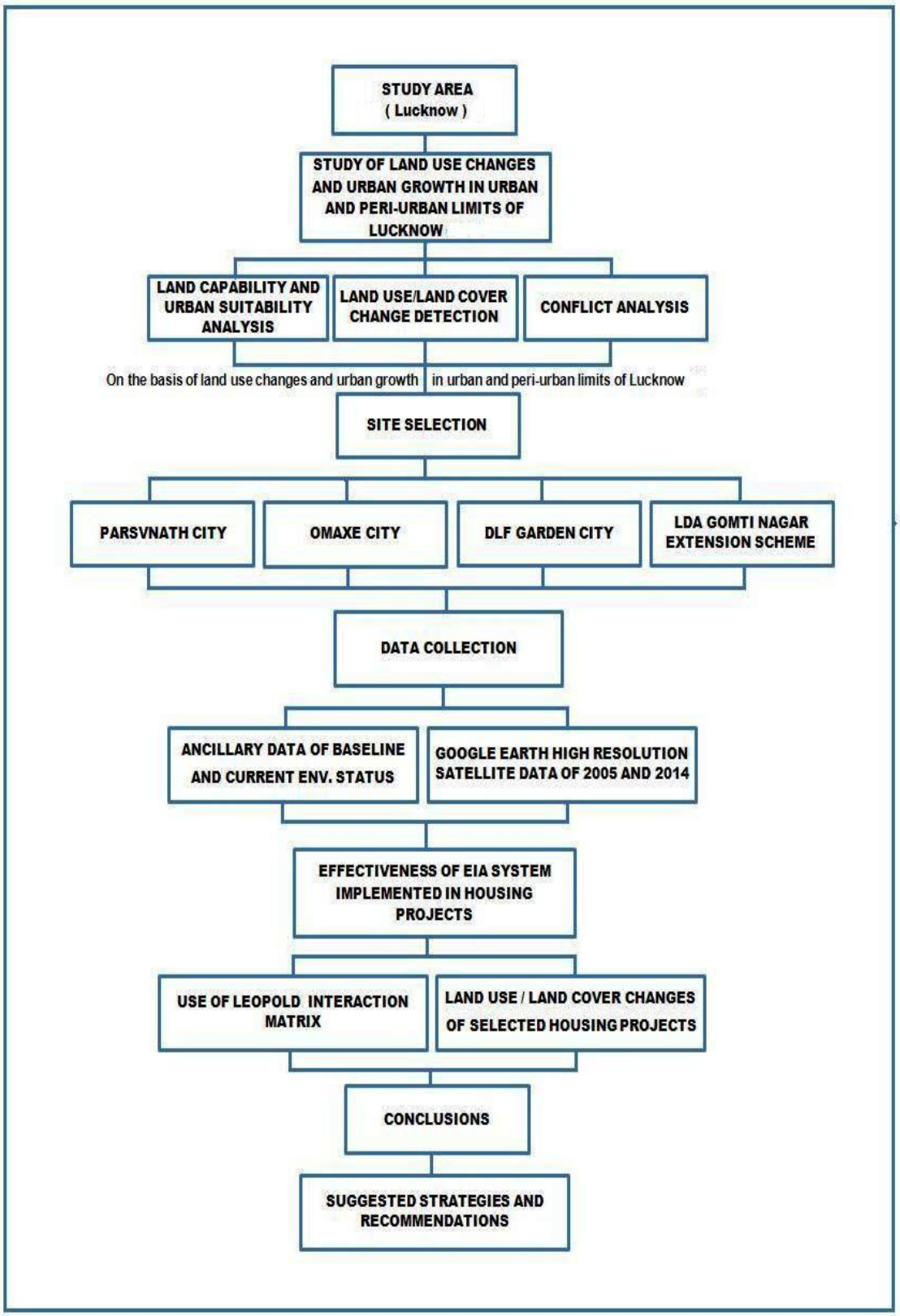

Figure 1.1 Methodological framework adopted for the study

1.3 Summary and Conclusion of the Study

In India's growing towns and cities, unplanned sprawled development due to public and private housing projects is leading to use of more resources like land, water, energy etc. which puts enormous pressure on physical infrastructure as well as on environmental quality. There is a need of an integrated approach that could assist housing and settlement planning while preparing the EIA of new and upcoming colonies. Although ElAs can certainly improve housing projects, there are still several limitations to what they can achieve.

The upcoming housing projects in the city of Lucknow during the EIA process state that the projects would contribute to development of green spaces, gardens, constructed wetlands, permeable pavement, and integrated rainwater harvesting systems, however, the situation on the ground depicts a different picture. The review of the EIA of housing projects reveal 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.The land developers tend to be disconnected from the realities of resource limitations and largely inattentive to the long-term environmental impacts of land use modifications. This process will continue with time if not checked through proper intervention and strict planning measures and can adversely impact the quality of life of urban and peri urban dwellers. The research outcome is summarised under the following sections:

1.3.1 Spatio-temporal patterns of land transformations

Pattern of urban growth in Lucknow city as explored by the study is not linear or nodal. Urbanization seems to spread radially in all the directions and influence of transport infrastructure is minimal. Drivers of such changes are many and very site specific. Some areas have developed out of older city core, but others developed out of new industrial zones. In the latter case, the lack of reliable transport infrastructure has not inhibited the development and nor is the direction of development controlled by presence of transport routes as observed in earlier studies (Taragi, 1997). A large chunk of urban middle class prefer cheap housing in the suburbs even when there is not enough transportation infrastructure. Many people buy land in such areas from investment point of view as they know that land price would go up substantially once the area is earmarked for housing in the future. As a result, peri-urban locations look increasingly investment attractive, which leads to spatial growth of the city.

In the study area two major land use/cover trends between 1997 and 2010 can be discerned: (i) Intensification of urbanization in central/core areas where a few remaining open areas and water bodies were occupied and landfilled to accommodate residential developments; (ii) Urban expansion in peri-urban/ suburban areas, where the extension of urban core increased at the cost of permanent crops and pastures. As is revealed from the statistics, there are four classes displaying significant land transformation; *Agricultural cropland shows major decrease, urban built-up shows major increase, wasteland shows moderate decrease and area under construction*

shows significant increase; all other land use classes exhibit relatively insignificant change.

Peri-urban areas are currently experiencing the most active urbanization. Results indicated that the prominent urban growth in such areas follows two main physical processes:

- Urban growth in three peripheral sites (N, NW and S) is occurring through '*Edge expansion and Envelopment'* i.e., annexation of surrounding landscape through the growth of existing urban areas (Seto & Fragkias, 2005). *Since the study area is primarily dominated by agricultural land, urban growth through 'edge expansion and envelopment' is happening mostly at the expense of such cultivable lands.*

- Urban growth in North Eastern site is occurring through '*Attainment*' – occupation of small built-up clusters (mostly rural) dispersed in landscape by extending urban areas. Attainment seems to be the direct result of improvement in accessibility due to development of transport infrastructure. Rural settlements located amidst predominantly agrarian areas are urbanized when major roads pass through them and the urban development along these routes intensifies to engulf them. Along with the economic development and ensuing urbanization, an impetus on improvement of major transport routes is obvious. Accessibility to the far flung townships and villages have led to development of hitherto underdeveloped areas on fringes of the city, which welcome the conversion of rural land for upcoming industries and educational institutions requiring vast unutilized land resources and spelling major financial gain to marginal farmers.

Furthermore, multi-temporal land use change statistics showed that substantial class I agricultural land was lost by urban growth during 1997 – 2010, with an average annual rate being 13%. The major land use transformations class is – *Rural to Urban* being 41.91% of the total change (Table 1.1). Of importance to the study are *other* categories, specifically the *rural to transitional* and *natural to transitional* which together contribute a fair 16.84% to the LULC change and are placed in the transformation category of *Critical*. This *Critical* category is generally the result of land cover degradation and is prevalent in peri-urban areas on brink of being urbanized. *Although the allocation of land is governed by competition between urban and agricultural uses, the outcome has increasingly tipped in favor of urban use, leading to substantial spatial growth in peri-urban areas.* Also important is the observation of a small but significant amount of change (7.64%) from *transitional to natural* and *transitional to rural*, mostly observed in the study as conversion of wastelands into croplands, which confirms that above reconversion is possible and takes place naturally also, although at much smaller percentage than required.

Table 1.1: Landtransformation from 1997 to 2010 at four peri-urban sites showing transformation classes

"From" Class	"To" class	Change (2002-2010)	
		Area	%
Natural	Rural	0.22	*0.63*
	Transitional	1.46	*4.24*
	Urban	1.43	4.16
Rural	Urban	14.46	41.91
	Transitional	4.36	*12.64*
	Natural	0.29	0.84
Transitional	Urban	9.47	27.45
	Natural	1.29	3.74
	Rural	1.35	3.90
Urban	Rural	0.02	0.07
	Transitional	0	0
	Natural	0.14	0.42

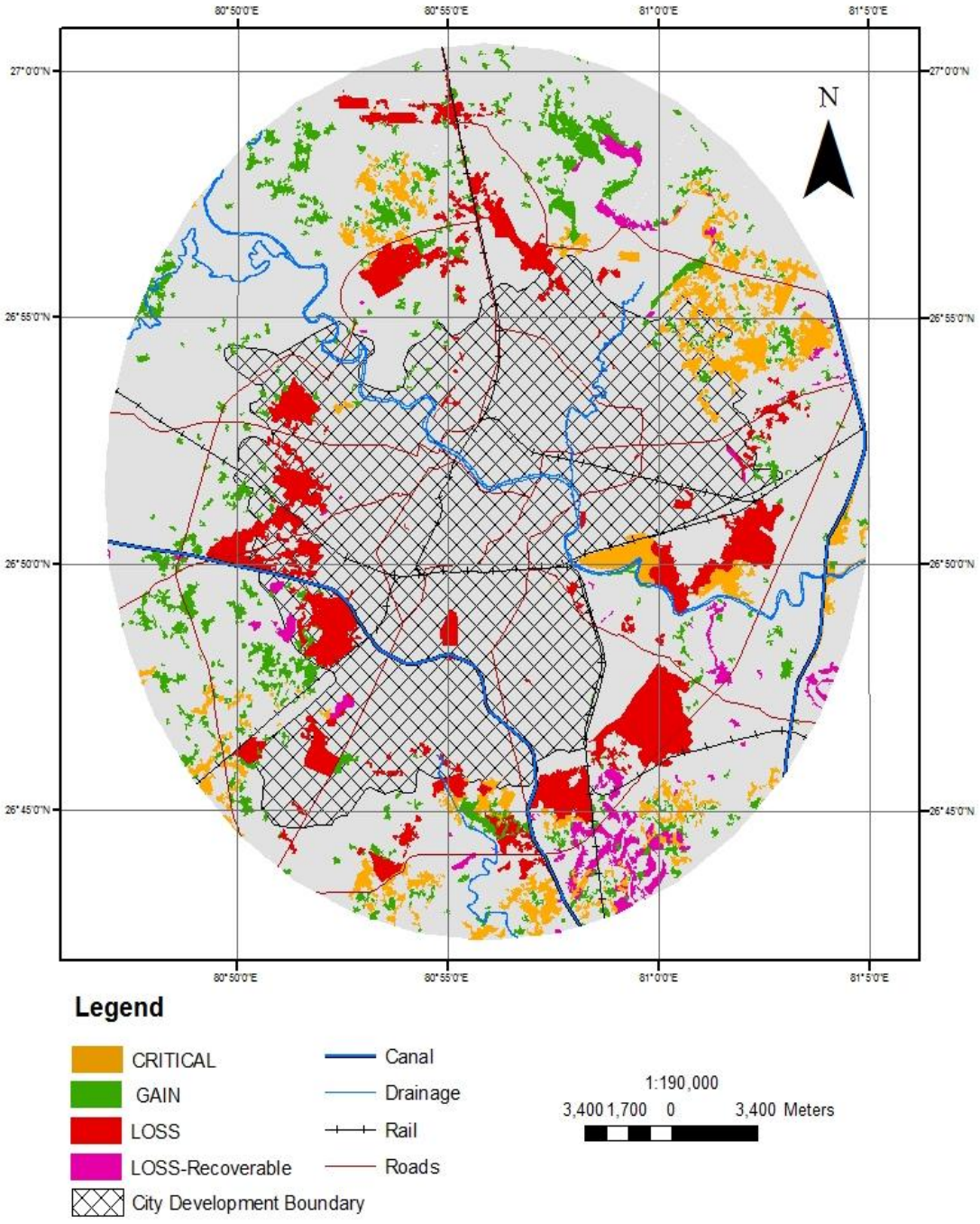

Figure 1.2: Spatial occurrence of land use transformations in the peri-urban areas.

Detailed results from the study reveal that urban land use for all four sites has increased over the study period (year 1997 to 2010) with the largest growth of 17.5 % being observed for Northern site and lowest of 10% for Southern site (Figure 1.3). On an average, more than 70% of the total land use /land cover change has been towards the transformation category of *Loss* towards urban land use, there has been practically negligible amount of *Gain* and an insignificant amount of *Loss-recoverable*. Only the *Critical* class holds some hope especially for Northern and North Eastern sites where more than 20% of the total land use is in *Critical* stage. Also observed is an insignificant for now (0.04%) conversion of forest into urban vegetated wherein *open forest patches on city fringes degrade rapidly as expanding settlement approaches them.* These open forests are soon converted into urban-vegetated class which is vegetation interspersed with urban built-up, feared to be quickly engulfed by densification of the city. Also, 75 % of *Loss-recoverable* category accounts for change of lakes into cropland and horticulture, wherein water bodies have been landfilled and are being used for agriculture or plantations. Loss of water bodies in Southern site is also alarming, making it a fragile area as well. North Eastern area exhibits the change of maximum amount of cropland into transitional category. Site specific observation of *Critical* land transformation category, reveals that at Northern site, *Critical* category is being formed by conversion of four rural land use classes, out of which conversion from cropland is maximum (63%), followed by a substantial 28% being formed by conversion of forest to urban-vegetated. *This observation is alarming, making this site fragile, since presence of forest on a city periphery is already rare and its being lost to urban land use means extensive loss of natural habitation with severe threat to the remaining areas of core natural forest.*

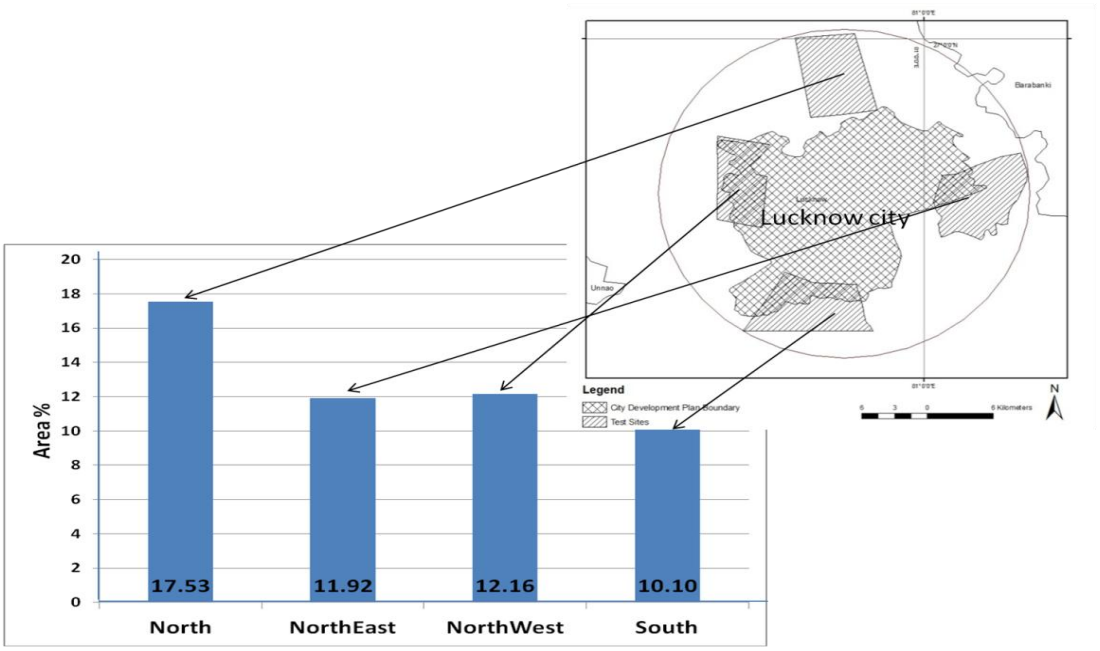

Figure 1.3: Growth rate of urban land use in peri-urban areas between 1997 and 2010

Due to peri-urban land takeover by urban development agency, competition for land between real estate developers and nonurban users, mainly farmers and other agricultural users, have increased tremendously in the last decade. For the city to grow spatially, public and private developers bid away additional land from agricultural users in the peri-urban areas. Increased demand for housing and commercial space means that land is worth more in urban use than in agriculture, thus reflecting greater economic benefits in its developed state. According to ***Brueckner***(2000), land conversion in such situations is guided by the 'economist's "invisible hand", which directs resources to their highest and best use'. In this process productive agricultural land is often converted into urban land use. As the value of agriculture output is fully reflected in the amount that agricultural users are willing to pay for the land, a successful bid by public and private developers means that society values the houses and other structures built on the land more than the agriculture output that is forgone.

It is observed that site along the North western direction (enroute to suburban Malihabad town) has experienced maximum amount of relative increase in urban built-up (17.18%), with a simultaneous decrease in rural built-up (4.71%), wherein the latter seems to have merged with extending urban land use. This finding is unexpected, as it was anticipated that this area would experience least urban growth due to its location along state highways, as opposed to location of other sites along national highways and absence of adjacent major industrial town as opposed to North east (adjacent to Barabanki) and South (adjacent to Kanpur). The site also shows a significant decrease in cropland (9.68%) and wasteland (2.82%), indicating the conversion from these classes to urban land use. Surprisingly, this site displays minimum area under construction (3.04%) amongst the study sites; indicating a reduction in rate of future urbanization and pointing towards occurrence of a probable land speculation prevalent in recent past which may have spurred the observed urbanization.

Decrease in cropland area (18.25%) is observed to be maximum in North-eastern site, which falls along the Lucknow-Barabanki national highway. The area is intensely industrialized, with increasing number of unplanned factories/industries. Capacity of existing environmental infrastructure in the area for sewage, industrial and solid waste management is inadequate, spelling serious environmental deterioration. The site displays maximum amount of area under construction (7.72%), a significant increase in urban built-up (11.02%) and fair decrease in cropland. The area also shows a significant amount of area under long fallow (3.15%), indicative of a trend where farmers leave their cultivable land fallow, waiting for urban development opportunities and in event of selling their land towards urban development, gain compensation used to develop farmlands further from city. For these farmers, the uncertainty of when exactly the land might be taken over by urban structures is too great to make it worthwhile continuing with serious, intensive agricultural production. This explains the widespread abandoned fallow or unutilized land found around many expanding cities (Van den Berg *et al.*, 2003).

Southern site, falling on Lucknow-Kanpur route, displays a marked decrease in wasteland (5.59%) and cropland (8.08%), with a simultaneous increase in area under construction (7.51%) indicating an increased rate of future urbanization. A careful observation of initial (1997) and final (2009) images of the site, reveals that most of the defined wastelands are being used for real-estate development. *Southern site alone shows a decrease in water bodies, owing to the fact that this area was marked by presence of numerous big and small water bodies in past, which have been transformed to agricultural uses or land filled for real estate development.*

Northern test site displays significant decrease in most rural land use classes; Cropland (12.50%), Wasteland (2.07%) and Open Forest (1.28%) with a simultaneous increase in urban built-up (9.17%) which is understandably due to urbanization (Figure 1.5). *The transformation class of area under construction (5.21%) also shows significant increase indicating a continuous urbanization in future.*

As the city's population expands, it must grow spatially to accommodate more people. In addition, people's rising incomes and quality of life concerns affect urban growth because residents demand better housing conditions and more living space as they become richer over time. The greater demand for space causes the city to expand spatially as the population increase. This effect is further reinforced by the 'urban-social-aspirations' to expand and buy additional lands for their housing needs in a location where land price is cheap, mainly the peri-urban areas. Therefore, the spatial expansion due to rising incomes and quality of life concerns among the residents is strengthened by a price incentive favoring urbanization along the city's periphery.

1.3.2 Land capability and urban suitability

Poorly regulated land governance has led to unscientific urban expansions that do not conform well to the land suitability and carrying capacity of the city. Industrial areas are being built upon environmentally sensitive area; some residential areas have also encroached upon lakes and ponds and new residential areas lack open space and greenbelts. Existing infrastructure has not been integrated in the design of the layout, for eg: there is absence of logistic zones, sidewalks, bicycle lanes, parking lots, and so on. Majority of area (around 77%) in the peri-urban interface has weak or very weak suitability for future urban development primarily because of the high conservation and agriculture suitability and incompatibility of physical land use to enabling infrastructure (Figure 1.4 and Figure 1.5).

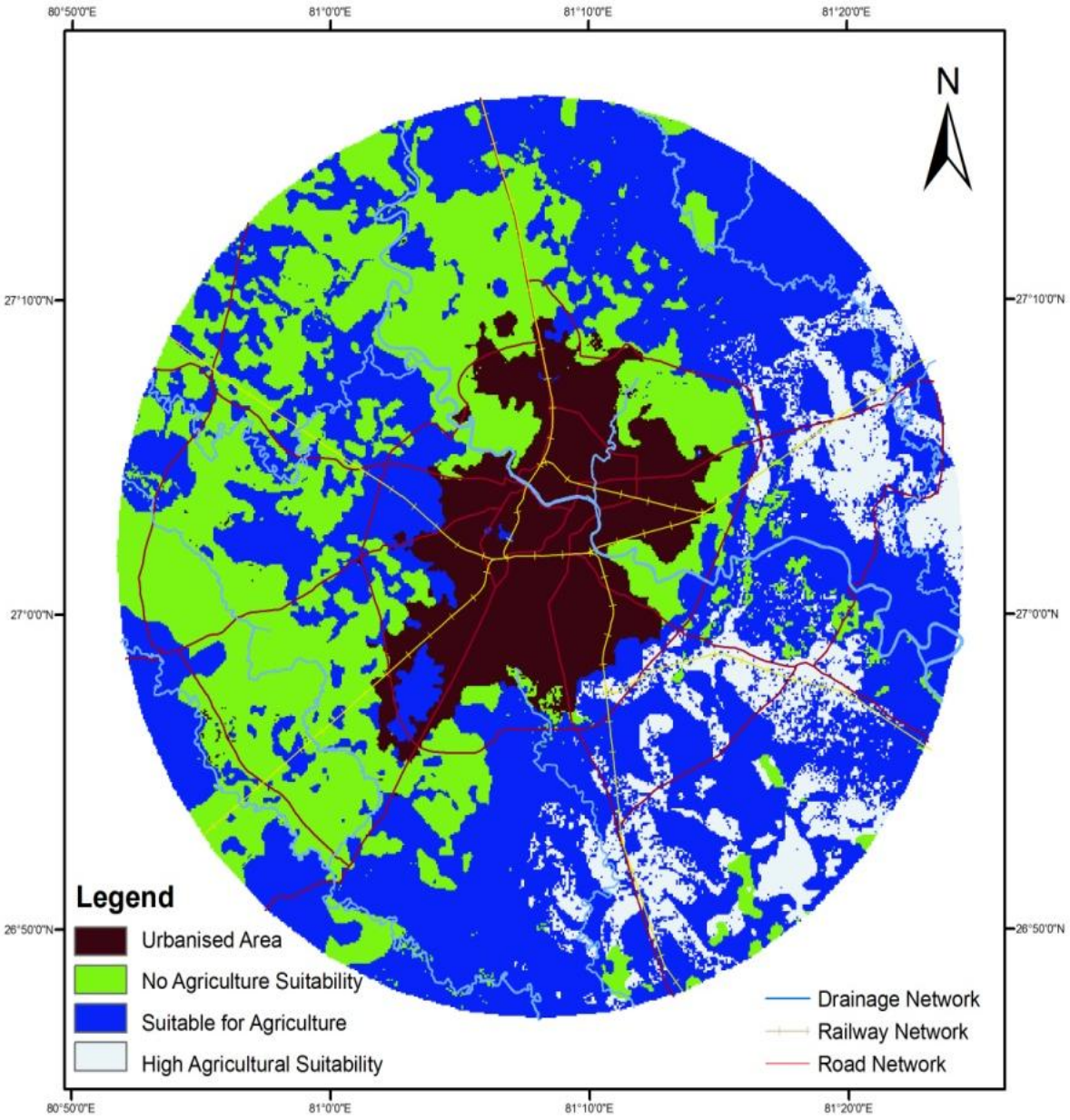

Figure 1.4: Agricultural suitability based upon Weighted Linear Combination of multiple criteria

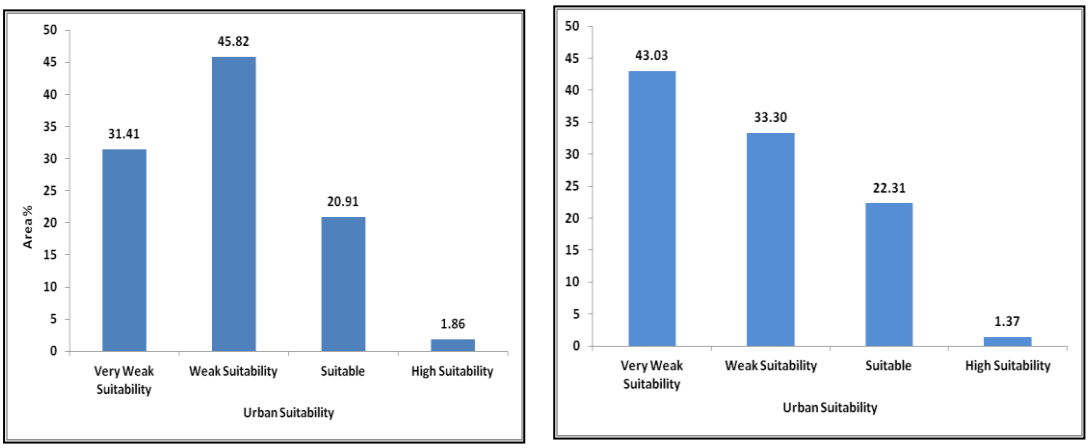

Figure 1.5: Area statistics for urban suitability using (a) traditional AHP method, and (b) Fuzzy AHP method

1.3.3 Land use conflicts

Patterns of urban growth do not follow Master Plan 2021 and even Master Plan deviate profoundly from the preferred land suitability. As per the land use statistics of 2010, high value class I agriculture land and horticulture fields constitute 57% and 15% of the area respectively. Therefore, converting them to urban land use will affect future food sustainability. Around 20% of the area, i.e. 500 sq. km. has moderate suitability whereas about 2% (50 sq. km.) of the area has high suitability for urban development. Since out of the 2500 sq. km, about 303 sq. km. has already been under active urban land use including the denser urban core, any future urban land transformation should be done very carefully taking into account the zoning regulations and importance of open space, greenbelt and class I agriculture land. It is also evident from the conflict analysis that the Master Plan 2021 is conflicting from the zoning restrictions recommended by the urban suitability analysis; the restricted/conserved areas recommended by the study are certainly in conflict with the planned future development. Of the total area of the conserved, greenbelt, reserved forests and floodplain as per the defined land suitability class, 4.18% of the area has been converted into existing built-up/settlements whereas 46.36% of the total area is proposed under residential settlements, business districts and commercial land use under the Master Plan 2021, 11.84% under transportation network and 5.11% under agriculture (Figure 1.6). Therefore, with the process of urban sprawl in the core and at the peri-urban interface, conserved area such as greenbelt, reserved forests and floodplains are threatened and will be rendered fragile.

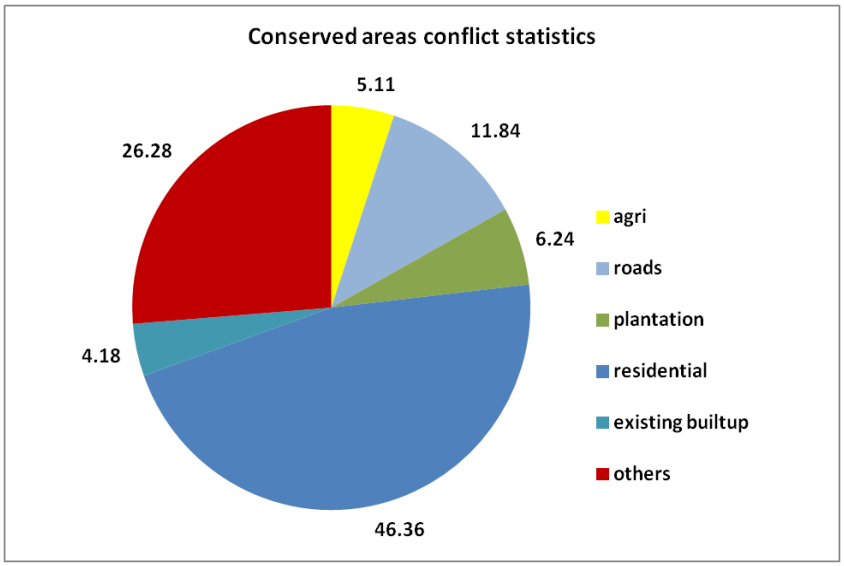

Figure 1.6: Conserved areas conflict statistics with respect to the Master Plan 2021

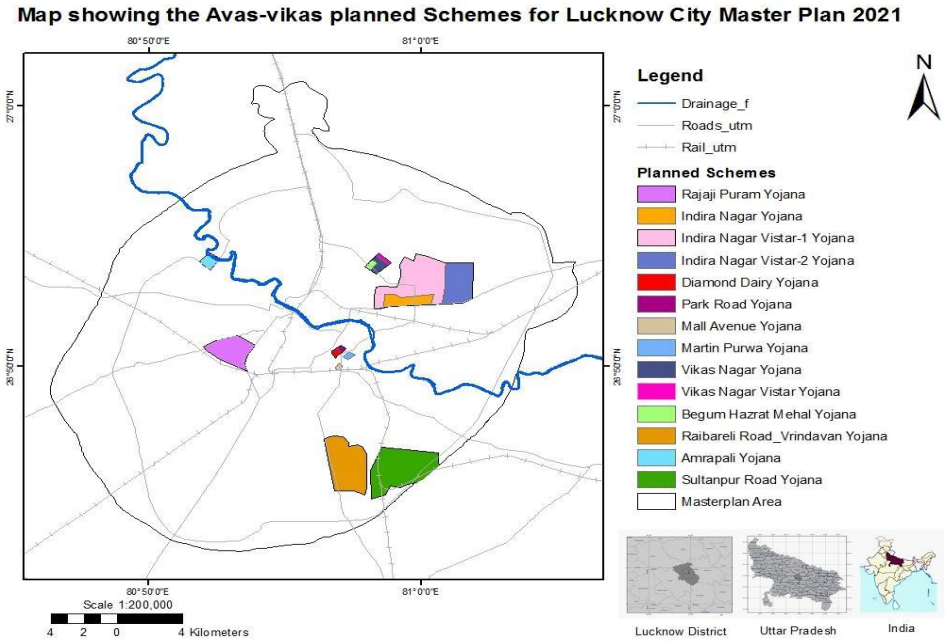

Figure 1.7: New housing schemes as planned by Avas-Vikas (Uttar Pradesh Housing Development Board) under their Master Plan 2021

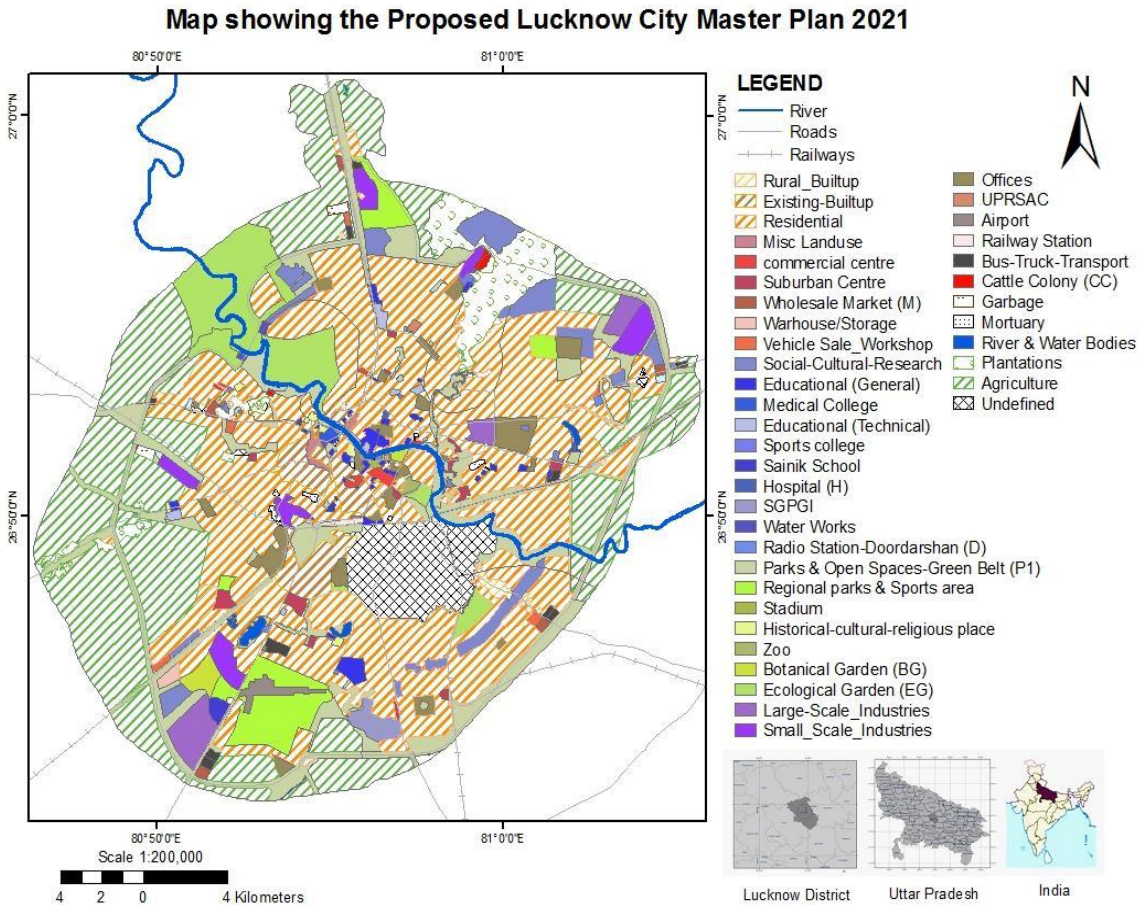

Figure 1.8: Map showing the proposed Lucknow's city Master Plan 2021

Master Plans concentrate on planning land use in isolation from other critical infrastructure and resource constraints such as water and sewerage facilities and transport network. They are not followed by local area plans and investment decisions, strategies are often inconsistent with city's spatial structure. Urban renewable schemes such as Jawaharlal Nehru National Urban Renewable Mission (JNNURM) and Rajiv Avas Yojna (RAY) are implemented as isolated projects removed from the regional policies, land use plans and their growth dynamics. Peri-urban land conversion is guided by the market's invisible hand and 'agglomeration economies' which directs resources to their highest market price ignoring the long-term environmental impacts. Multiple jurisdictions with multiple plans by the land authorities, each independent of the other, also result in fragmented development across commercial and residential areas at the micro level. Land agencies (LDA: Lucknow Development Authority and UPHDB: Uttar Pradesh Housing Development Board) do not coordinate regarding subdivision regulations creating fragmented discontinuous urban areas.

1.4 Policy implications of the study

Urban transition is a major challenge in growing cities of the developing world. Disorderly urban sprawl creates war on cities' dream to become engines of growth and threatens the future growth and vibrancy of cities' economy. Urbanization in the Indian context should be looked at beyond mega-cities like Mumbai and Delhi with a holistic view to include second-tier towns and medium size agglomerations such as Lucknow which has not been studied in detail. This paper quantitatively explores the spatio-temporal patterns of land use/land cover transformations in the core and along the city periphery of Lucknow city, the capital of India's largest state, in addition to observing nature and form of urban expansion resulting in a complicated urban landscape. Conflict analysis is carried out to explore disagreements between urban suitability, enabling infrastructure and Master plan 2021 proposed by the land authorities using satellite imageries, Fuzzy AHP and sub-models. The methodology provides a cost effective rapid land evaluation framework which may help policy makers, urban and regional planners and researchers working in developing countries to understand the dynamics of urban growth.

It is observed that due to rapid economic development, the city has expanded in size and structure, becoming increasingly more complex, heterogeneous and irregular in shape. Development has been muddled in peri-urban areas, causing natural and rural land cover to degrade over time and the trend suggests more such degradation in coming years. The land developers tend to be disconnected from the realities of resource limitations and largely inattentive to the long-term impacts of land use modifications. Natural land covers like forest and water bodies are experiencing major deterioration rendering some of the PUI sites as fragile. Each of these impacts is linked to changes in the extent of urban, agricultural, and forest lands, and (or) transportation, housing and other critical infrastructure systems. This process will continue with time if not checked through proper intervention and strict planning measures and can adversely impact the quality of life of urban and peri-urban dwellers.

Although urban sprawl cannot be stopped in a rapidly developing city, a remedy for this problem lies in strict zoning regulations based on land suitability and carrying capacity, which allow land use to be channeled toward more sustainable outcomes. Detailed observations of transformation category statistics reveal that although the pace of urbanization will grow up in the future, a significant amount of recoverable land cover presently under transformation (denoted by Critical class) can be restored and focus of development can be shifted on underutilized areas within the city development boundary. It is also suggested that older urban areas with dense horizontal urbanization can be considered for urban redevelopment using vertical urbanization methods. Primarily, unplanned and unfocussed urbanization, not considering the suitability of land cover or its environmental impacts/aesthetics should be discouraged in order to promote healthy and livable cities. Results from urban growth models can be used by land use planners and policy makers to anticipate and plan for future spatial expansion to ensure growth along the lines of city development plans and enabling infrastructure.

India's mainstream policy and planning for housing growth has been shaped to a great extent by its EIA guidelines. Mehta and Karpouzoglou (2015) note that the mainstream policy and planning for urban growth has negative implications for important natural resources like water for peri-urban areas.

It is understood that rapid, unplanned and uncontrolled urbanization is leading to disorganized growth in developing countries (Amin and Fazal, 2015). The patterns of development resulting from new urban forms are also altering natural landscapes and their dynamics in the peri-urban areas (Dutta, 2012). Unplanned urban growth is resulting in reduction in the productivity of the land and in the provision of ecosystem services (Malmir et al., 2015; Ceccarelli et al., 2015). This has necessitated understanding of spatial patterns of urbanization and their relation to post-project conflicts arising from new urban landscape. Evolution of urban land density is also a subject of great interests among researchers; however, the methodologies are arbitrary and suffer from the lack of an established foundation (Jiao, 2015; Dutta, 2012). Keeping this reality in the background, the objective of the study is to review the effectiveness of EIA systems implemented in housing projects in Lucknow city through conflict analysis based on post-project monitoring using Fuzzy AHP models and GIS. The outcome of the study would be of great importance for urban planning and decision-making communities of the city in the present and future.

Land use and land cover changes are so pervasive that, when aggregated they define the character of a city. They also define how major infrastructure such as transport, housing, commercial and market places, greenbelt etc will function in the future (Ding *et al.*, 1999). Urbanization becomes synonymous with frequent land use changes that have often negative impacts on the environment. Poorly regulated land governance which is rooted in inefficient intuitional regime leads to often unscientific urban development that do not conform well with the land suitability and carrying capacity of the region. This leads to complex policy challenges faced by planners and policymakers. Land development authorities almost always regulate land and sometimes directly provide settlement support after developing an otherwise non-urban land uses. This can also create externalities as land development agencies in the past have often neglected enabling resources and overall carrying capacity of a region in developing master plans for future growth (Frenkel & Ashkenazi, 2008).

Any future urban land transformation should be supported by a coherent urban planning policy recognizing zoning regulations and importance of open space, greenbelt, water bodies and class 1 agriculture land. Decisions made now will have a major impact on the enabling infrastructure and civic amenities. Unless more aggressive measures are taken, cities' future will be locked for decades to come. Negative externalities in terms of traffic congestion, parking, pollution, water supply and sanitation problems, solid waste disposal and lack of open space will emerge. This will also make conserved areas such as greenbelt, open spaces and floodplains fragile in times to come. Further research is required to delineate a suitable zoning development management plan to sustain a baseline for urban growth keeping in mind the carrying capacity of the city and its peri-urban areas. Furthermore, the integration of a zoning approach associated with the green belt is suggested to play a key role in a

transition to continued urbanization. The research outcome would assist planners and land developers to evaluate whether development goals are in agreement with the intended land use objectives and if yes, how the resources should best be used to optimize city's enabling infrastructure and carrying capacity.

1.4.1 EIA in housing projects

EIA certainly has a crucial role to play in addressing environmental issues surrounding project development. Most EIA processes are based on wrong assumptions and/or unclearly defined concepts, such as 'significant impacts'. There are also intractable logistical problems and challenges related to availability of resources and the necessary EIA capacities. The objective of EIA procedures, as opposed to the subjective ones that are prevalent currently, is recommended as the required first step towards addressing the challenges of EIAs. Other recommendations include making proper human resource planning and utilisation; building relevant capacity; modernizing and developing new tools and technologies; increasing budgetary allocation to the EIA function; undertaking to educate politicians and other stakeholders about the sanctity of the EIA business; communicating effectively about the EIA processes; providing the necessary political will to make the EIA administration function effectively and in a more transparent manner; and increasing investment in EIA research.

1.4.2 Assessment of Baseline (Pre-project) and Current (Post-project) environmental status

The comparative study shows the ground reality of various parameters in the selected housing projects. The housing project should have rainwater harvesting system, proper parking facilities, and adequate green area and contain the plants/trees that absorb the high level sound/noise, wastewater treatment facility and sound waste management facility.

The upcoming projects in the city of Lucknow can no doubt add to new housing areas with green spaces, gardens, constructed wetlands, permeable pavement, and integrated rainwater harvesting systems, but the situation on the ground depicts a different picture. The review of the EIA of housing projects reveal 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. These in turn result in to numerous environmental and health impacts that must be addressed. The green cover and water bodies have been destroyed to give way to the rapidly developing urban settlements at the outskirts. Urban green infrastructure comprise of all natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales. The burden of resource use in upcoming buildings or urban housing projects can be minimized in many ways. Properly designed housing projects can provide numerous services such as purification of air and water, pollution control, mitigation of floods and droughts, re-generation of soil fertility, moderation

of temperature extremes, climate change mitigation and enhancing the landscape quality.

On comparative study of ***Air Quality*** of baseline data **(Pre project)** it was found that LDA Gomti Nagar Extension Scheme possess high PM_{10} and SO_X and parsvnath city possess low PM_{10} and $SO_{X.}$ Similarly, with respect to $PM_{2.5}$ and No_X LDA Gomti Nagar Extension Scheme possess high $PM_{2.5}$ and No_X and parsvnath city possess low $PM_{2.5}$ and $NO_{X.}$ .In comparision to current environmental data **(Post project)** was found to be high with respect to $PM_{10,}$ $PM_{2.5,}$ and NOx except SOx.

On comparative study of ***Water Quality*** of baseline data **(Pre project)** it was found that all four test sites of Lucknow city indicates poor quality of ground water this is due to lack of EIA policy implementation in all these test sites.

On comparative study of ***Water Quality*** of Current **(Post project)** environmental status it was found that all four test sites of Lucknow city shows neither good nor bad quality of Ground water and used for drinking as well as other domestic purposes. Similarly if EIA policy is strictly implemented in all these sites then in future we can maintain the ground water table otherwise we will face water crisis problems in future.

The baseline data of ***Noise Quality*** of **(Pre project)** was found that DLF garden city (shows high noise level) and LDA Gomti Nagar Extension Scheme (possess low noise level) during day and night time. This is so because the area is lying near the Amar shaheed path, sultanpur road and faizabad road.it is also a poss and crowded area. Similarly The noise level recorded in 2014 after monsoon period **(Post project)** in the study area from the graph shows that LDA Gomti Nagar Extension have high level of noise and Omaxe Residency have low level of noise quality among all the housing projects of the study area during day time while during night time DLF Garden city posses low level of noise generation and LDA Gomti Nagar Extension have high level of noise.

With respect to ***Soil Quality*** of baseline data **(Pre project)** it was found that PH, Conductivity, and available phosphorous was high in DLF garden city as compared to LDA Gomti Nagar Extension Scheme. Similarly, the bulk density, available Nitrogen and Potassium was found to be high in LDA Gomti Nagar Extension Scheme as compared to DLF garden city and also, ***Soil Quality*** of current data **(Post project)** indicates that moisture content, available phosphorous, with respect to the DLF garden city was maximum and lowest in parsvnath city. Similarly, PH, bulk density was found to be maximum in Omaxe Residency and lowest in LDA Gomti Nagar Extension Scheme. The content of zince was maximum in Omaxe residency and lowest in Parsvnath city. Also, the available Nitrogen was high in DLF garden city and minimum in LDA Gomti Nagar Extension Scheme. The electrical conductivity was found to be high in DLF garden city and minimum in Omaxe residency. The quantity of Fe and Pb was costent. The available sodium was maximum in LDA Gomti Nagar Extension Scheme but minimum in parsvnath city

On comparative study of the land use/land cover change in omaxe residency it was found that there was no built up area except green area after that there was slightly increase in green area and developments of road network, built up area but no water bodies are found (figure 5.56). With respect to DLF Garden city there is loss of water bodies in 2014 (figure 5.57), increase in road network (but in 2005 according to figure no road network were found),built up area. In parsvnath city (figure 5.58) there was no loss of water body and too much growth was observed with respect to built up area,road network and green area. Similarly with respect to LDA Gomti Nagar Extension (figure 5.59) there was no loss of water body and too much growth was observed with respect to built up area,road network and green area. Overall from the land use/land cover change detection there was increase in built up area,road network and green area.There was no loss of water body and too much growth was observed with respect to built up area, road network and green area. Overall from the land use/land cover change detection there was increase in built up area,road network and green area.

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.

1.4.3 Effectiveness of EIA system: The effectiveness of EIA system implemented in the housing projects which was determined by the methods like Leopold matrix, land use / land cover change detection and conflict analysis.

The effectiveness can be checked by the use of Leopold matrix which is a significant method 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.

So, after analysing the Leopold interaction matrix it was found that EIA is highly effective in Parsvnath City (3.5/5.2=0.67308), and moderately effective in DLF Garden City (4.4/5.7=0.77193) and Omaxe Residency (3.2/4.4=0.72727). Similarly with respect to LDA Gomti Nagar Extension Scheme EIA is low/less effective (4.4/5.7=0.77193). 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.

The effectiveness of EIA was also achieved by the land use / land cover change detection. Also, analysis on the basis of land use and land cover change detection with the help of GIS and Remote Sensing from the year 2005 and 2014 it is concluded that Road network and Built up areas of the housing projects are increased. Similarly in case of Non built up areas are decreased and water bodies are lost in LDA Gomti Nagar Extension Scheme, Parsvnath City, DLF Garden City except in Omaxe Residency. Where as in the same way in case of Green areas shows increase graph in LDA Gomti Nagar Extension Scheme and Parsvnath City. Similarly with respect to Omaxe Residency green areas are decreased and in DLF garden City the green area shows no change. *The conclusion drawn with respect to Built up areas, green area and road network EIA is effective while in case of Non built up areas and water bodies, EIA is not effective. Overall EIA is effective with respect to LDA Gomti Nagar Extension Scheme and Parsvnath City while it is moderate (neither effective nor non effective) with respect to Garden City and Omaxe Residency.*

1.4.4 Effectiveness of zoning approach in EIA of housing colonies: Although urban sprawl cannot be stopped in a rapidly developing city, a remedy for this problem lies in strict zoning regulations based on land suitability and carrying capacity, which allow land use to be channelled toward more sustainable outcomes.

It is also suggested that older urban areas with dense horizontal urbanization can be considered for urban redevelopment using vertical urbanization methods. Primarily, unplanned and unfocussed urbanization, not considering the suitability of land cover or its environmental impacts/aesthetics should be discouraged in order to promote healthy and livable cities. Results from urban growth models can be used by land use planners and policy makers to anticipate and plan for future spatial expansion to ensure growth along the lines of city development plans and enabling infrastructure.

Land development authorities almost always regulate land and sometimes directly provide settlement support after developing an otherwise non-urban land uses. This can also create externalities as land development agencies in the past have often neglected enabling resources and overall carrying capacity of a region in developing master plans for future growth.Any future urban land transformation should be supported by a coherent urban planning policy recognizing zoning regulations and importance of open space, greenbelt, water bodies and class 1 agriculture land.

Further research is required to delineate a suitable zoning development management plan to sustain a baseline for urban growth keeping in mind the carrying capacity of the city and its peri-urban areas. Furthermore, the integration of a zoning approach associated with the green belt is suggested to play a key role in a transition to continued urbanization.