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Delimitation of Peri-urban Area: Various Approaches

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Abstract: Peri-urban area is the most happening are in city development cycle. These areas represent fastest transformation from rural to rurban to urban phase. It can be defined as the area of dynamic change of land use, social, environmental and infrastructural aspects. Thus delimitation of this area is very important for proper planned development. This paper present review of various approaches for delimitation of Peri-urban area. The body of knowledge available at international and domestic level is critically reviewed for appropriateness in Indian circumstances. The paper produces a list of indicators and GIS methods for delimitation of Peri-urban areas.

Keywords: Peri-urban, Delimitation, Indicator, GIS

Introduction

Delimitation of Peri-urban area has been traditionally an issue of concern for researchers. The concept of Peri-urban has been different in various parts of the world. The US City in general has extended boundaries of urban conglomerate which is inhabited by wealthy and resourceful persons. The outer city is well planned and supports best life style. On the other hand Indian subcontinent has Peri-urban areas as degenerated outer system to support city life by continuous flow of man, material, services and information. In case of South East Asian countries the Urban Agglomerate is a network of various inhabited areas linked together for survival and development. Thus the issue emerges that on what ground or basis the Peri-urban areas shall be delimited so as to reflect spatial and temporal uniqueness of India. Various scholars have addressed the issues by multiple ideas and approaches. The paper investigates an account of such ideas.

Clark and Sharp (2008), have analyzed the fringe in terms of ecological, occupational and socio-cultural aspect in order to determine the extent to which the fringe is similar to or dissimilar from the suburbs or rural areas and conclude that rural urban fringe differs from urban and suburban places, and inner portion of fringe has urban dominance than on outer portion. The delimitation of this area has three approaches GIS Approach, Indicator Based Approach and Statistical Approach.

Work done by Various Researchers using GIS -

The GIS Approach: Martin and Howarth (1989) have shown the visual interpretation of SPOT images for change detection and supervised classification of multi date images providing the best overall classification accuracy at approximately 80 per cent. The best change detection accuracy of 60 per cent was achieved with supervised classification of multi date images.

Gastellu-Etchegorry 1990; has done An assessment of SPOT XS and Land sat MSS data for digital classification of near-urban land cover with a spatial resolution of 10 m for the panchromatic band and 20 m for the XS bands, SPOT data are commonly used to produce land cover maps at the urban rural fringe.

Another interesting work done by Goong and Howarth (1990) in their study, 'the use of structural information for improving land-cover classification accuracy at rural urban fringe' is prominently placed.

Treitz et al. (1992) have studied the rural urban fringe of Toronto, Canada, took advantage of the 10 m resolution of the panchromatic band by registering it with the multi-spectral ones. An accuracy of 78 per cent was achieved in a classification of eight land covers at the urban- rural fringe of Toronto, Canada. However, no research has been carried out to comprehensively assess the factors affecting the capability of SPOT XS data and to examine the role of seasonality in mapping detailed land covers at the urban- rural periphery. To identify the growth of the urban area, Charbonneau et al. (1993) used three Landsat MSS images to monitor the urban expansion of Montreal, Canada.

The results derived from automatic classification of the data were 5- 30 per cent more accurate than governmental statistics. From Landsat TM imagery achieved an accuracy of 77 per cent in a five-category (residential, commercial, industrial, open spaces and freeways) classification for the small urban area of Beaver Dam, Wisconsin.

Urban growth also leads to the scattered growth in the surrounding areas in this context Li and Yen (1998), have studied the urban sprawl of Pearl River Delta, China. The region has witnessed wide leapfrog development due to lack of proper planning and management. TM satellite images of different dates were used to estimate the amount of urban expansion and to measure and compare the spatial pattern of urban sprawl. They have used the entropy method to measure and monitor the urban sprawl by the integration of remote sensing and GIS.

Gao and Sillcorn (1998), have studied the rural urban periphery of Auckland, New Zealand, two images were used to map ten categories of land cover at level II of the Anderson scheme, with an overall accuracy of 72.6 per cent and 81.4 per cent from the winter and summer data respectively. These images have identified the high heterogeneity of land use pattern commonly found at the urban periphery.

Nigam (2000), has studied the rural urban fringe of Enscheda City Netherland has evaluated the effectiveness of high resolution satellite data and computer aided GIS techniques in accessing the land use change dynamics from 1993 to 1998 using COSMOS data (merged with TM) of 1993 and IRS PAN Data (merged with LISS-III) development. The results have shown that during this period a high magnitude of land use was changed into residential and industrial land uses and the crop land was also changed into construction sites.

Gulch (2002) by using two types of texture analysis is at the super pixel (3 3 pixel) level. She has utilized a user-defined threshold to determine whether a super-pixel is classified build or un-build. Although she used both SPOT-PAN and Aerial photos and noticed that SPOT-PAN alone would be sufficient to distinguish built from non-built features through texture analysis.

Turker and Asik (2002), have studied the overall land use change by urban fringe through analysis of multi temporal Landsat Thematic Mapper (TM) images in Betaken, Ankara (Turkey). Seven land-use change classes were detected through a multi date classification of Landsat TM images obtained in 1985 and 1995 with an overall

accuracy of 80.9 per cent. The main aim of their study was

- To detect the overall land use change through a digital change detection technique;
- To obtain quantitative information about each land-use change type in terms of both gains of the urbanized region, specifically in urban land use categories and also loss in the natural area; and
- To identify the development trend at urban fringe in the north west of Ankara.

Epstein et al (2002) have evaluated the traditional unsupervised classification and proposed GIS buffering approach for mapping the suburban sprawl and also discussed the problems associated with the classification of urban classes (built-up) in comparison with rural and urban caters.

A sample have been proposed, automated method by Kim, Lib and Gong (2004), to detect rural urban land use change of Ho Chi Minh City in Vietnam by testing a new algorithm that provides detailed classification using SPOT-PAN images alone. They conclude that, it has a potential to be useful to researchers and policy makers in the developing world where there has been a dearth of about the rapid urban growth patterns that have developed during the last decade of the 20th century. An accuracy of 82.31 per cent was achieved for the final change map.

Another work in this regard was carried out by Kumar, Pathan, and Bhanderi (2007), Have made an attempt to monitor the urban growth over a period of time and its consequences on fringe area by employing GIS and remote sensing techniques in connection with Shannon entropy. The growth of built-up land has been divided into four zones. In each zone the percentage of density of urban built-up was calculated for different periods, later on entire study area was also divided into concentric circles of the city employing GIS technique. This was integrated with zone wise road density to study the impact of infrastructure development on the urban growth. The result has shown that the development of urban built-up land is sparse and leading to haphazard urban growth in the city particularly in the fringe area.

Jat, Garj and Khare (2008), have studied the urban sprawl of Ajmer City over the period of 25 years (1977 – 2002). The statistical approach has been used for the classification of remotely sensed images obtained from various sensors viz. Landsat MSS, TM, ETM and IRS LISS III. The **Shannon's entropy and landscape (patchiness and density) have been computed in terms of spatial phenomenon, has been used**. The results reveal that land development (160.8) per cent in the Ajmer was more than three times the population growth (50.1) per cent.

Hadeel et al (2009), have studied land use cover and land use change in southern parts if Iraq (Basrah Provinces) by using a 1:250000 mapping scale. Remote sensing and GIS software were used to classify Landsat TM in 1990 and Landsat ETM+ in 2003 imagery into five land use and land cover classes: vegetation, sand, urban area, unused land and water bodies. The results depict that large vegetation area in north and southeast were converted into urban land contraction. Rapid development of urban economy and population immigration from countryside and returning farm land to transport and huge expansion in military campus were the main causes for land use and land cover change.

Urbanization leads to the conversion of land use in the fringe area in this matter Addo (2010) has studied the farm land change in urban and Peri-urban areas of Ghana Accra region. A number of methods that differ in approach, cost and duration have used to meet the demand for high accuracy in urban

farmland mapping such as physical survey, Digitizing photogrammetric and remote sensing, and has shown an edge of GIS and remote sensing over other methods to identify the changes in farmland. He conclude that the information obtained from these methods will not only help in farmland monitoring but also in developing sustainable policies to effectively manage urban farming practices in Accra.

Saravanan and Ilangovan (2010) have studied the nature and pattern of urban expansion of Madurai City over its surrounding region during the period of 1991-2006. The satellite data Landsat-TM(1991) and Landsat ETM+ (2006) images were used to identify the expansion of urban sprawl. Rural urban fringe was fragmented into two zones namely Ring- I and Ring- II on the basis of its proximity. They have indicated that road transport was solely responsible for the rapid urban development.

The work of all the above researchers has established that GIS based calculation of Shenon's entropy is very effective delimitation method for Peri-urban areas. The data available with various planning agencies help researcher to establish sprawls of urban regions and establish boundaries of urban, Peri-urban and rural areas. Use of Shannon's entropy is one of the most accepted methods for delimitation.

Indicator based methods for identification of fringes:

OECD (Organization for Economic Co-operation and Development) based countries have established delimitation or Peri -urban areas on this basis the rural/urban classification of habitats. The area with a density threshold of 150 inhab/km^2, the OECD definition distinguishes three main categories of regions:

- **Rural regions**: more than 50% of the region's population live in rural communes;
- **Relatively rural regions**: between 15% and 50% of the population lives in rural communes;
- **Mainly urban regions:** less than 15% of the region's population lives in rural communes.

An interesting check for the delimitation of rural/urban areas is the proportion of agricultural land. In principle we would expect that urban areas have a low proportion of agricultural or arable land. We can estimate such proportion with the help of the European point survey LUCAS, -Land Use/Cover Area-frame Survey- (Bettio et al, 2002).

The definition based on the population density for the commune gives an unexpected result the average proportion of arable land in communes with a population density above 150 inh/km2 is 29%, versus 21% in communes with less than 150 inh/km2. For Utilized Agricultural Area (UAA), the proportion is 48% in "urban" communes versus 40% in "rural" communes.

'Peri-urban' or the PUI communities in socio-economic terms are those which have a dual urban-rural orientation regardless of spatial proximity (Iaquinta and Drescher, 2000). The three main aspects are the demographic, the economic and the socio-psychological component. A further approach looks at the dynamics of rural-urban links and flows. The PUI is assumed to be area where urban-rural linkages are most intense (Thirumurthy, 2005). The dynamics of this approach seems to be conceptually appealing given the rapidly changing nature of social and economic relations within PUI. This involves areas as People, Production, Commodities, Capital/income, Information, Natural resources, Waste and pollution, Non-agricultural employment Urban services

Production supplies, Non-durable and durable goods, Markets for selling rural products, Processing / manufacturing Information on employment, production, prices, welfare services, Socioeconomic structure and relations Rural economy (sectors), Rural production, Rural systems Structural changes, Urban systems Functions/role Rural – Urban Flows, Rural–urban flows (Thirumurthy, 2005).

On a more concrete level, the socio-economic driving forces are identified for PU development in India, Thirumurthy, (2005): Population growth in the cities due to migration leading to increased **land prices** in the city Settlements are then classified as urban, PU or rural if more than 75%, 25–75% or less than 25% of the criteria are fulfilled.

After a case study evaluation covering the Chennai metropolitan area, the number of indicators was produced and their threshold value is also identified. The working paper Socio-economic Conceptual Frame Work "Sustainable Settlements in Peri-urban Areas, by Anna university define indicators in three types as socio economic, agricultural and infrastructural the values of indicators are as below

1. **Socio economic indicators**

S. No	Indicators	Criteria
1.	Population	5000 or more
2.	Population density	400 persons/sq.km or less
3.	Literacy as % of total population	75% or more
4.	Work force Male	50% or more
5.	Workforce female	25% or less
6.	Dependents as % of total population	60% or more
7.	Non agricultural workforce as % of total workforce	75%
8.	Agricultural workforce as % of total workforce	Around 5%
9.	Manufacturing and house hold industry as % of total non agricultural workforce	Around 2% of non agricultural workforce
10.	Other services as % of total non agricultural workforce	Around 95%
11.	Cultivators as % of total agricultural workforce	Around 50%
12.	Agricultural labours as % of total agricultural workforce	Around 50%

2. **Agricultural Indicators**

S. No	Indicators	Criteria
1.	Agricultural land use as % of the total extent of land	Less than 10%
2.	Crops paddy/food grain	More the 100 tones
3.	Horticulture	Present
4.	SSI and Cottage industry	Preset
5.	Dairy Farms	Present
6.	Poultry farms	Present

3. Infrastructural indicators

S. No	Indicators	Criteria
1.	Distance from city center	Upto25 KM
2.	Distance from major rail corridor	More than 2 KM
3.	Availability of bus and rail transport	Yes
4.	Distance to higher education	More than 5 KM
5.	Distance of primary health center	Less than 2 KM
6.	Shopping facility	Less than 2 KM
7.	Presence of MNC	Yes
8.	Water Supply piped and house connection	Yes
9.	Latrines with septic tank	Yes
10.	Drainage	Yes

Statistical Approach: Sinha (1980) has proposed a detailed method for delimitation of fringe area the method follow following steps

1. Calculate urban index for all villages sample in fringe depending on 16 variables
2. Correlating the variables to find out relation between any two variables
3. Determining the scale of urbanization
4. Determining the suitable method (Mean, median mode) to delineate fringe

The index is to be calculated on the basis of following variables

1. Density
2. Sex ratio
3. Literacy
4. Decadal growth
5. % of working population
6. Main worker %
7. Marginal worker %
8. Cultivator %
9. Agriculture lobar %
10. % of other workers
11. House Hold No
12. Size of house hold
13. Distance from city center in KM
14. Agriculture labour %
15. Land value average in 000 per Sq KM
16. No of BPL family

The urban index (UI) Calculation: The urban index of fringe village is calculated by index value of the town, village and fringe unit for which it is to calculate. The factors decreases as we go close to the village and thus the index value will decrease. The index value is calculated as below

$$UI = \{(F-V)/ (T-V)\} \times 100$$

In case factor value increases near village then formula changes as

$$UI = \{(V-F)/ (T-V)\} \times 100$$

Where T, V & F are index value of factor for sample town. Further correlation value among all the variables is calculated to find the factors which do not exhibit distributional pattern and thus the less degree of impact. The factors which show less impact are not to be used for calculation of scale of urbanity. The scale of urbanity is defined as

Scale of urbanity= $\sum$ UI (For all values ranging from 1 to n)

Where UI is +ve when variable decreases with distance else negative.

Other Indicators of Peri urban area: Rapidly growing land cost within the city has created an enormous demand for land outside the city with a huge difference in land values. Land costs are differentiated by the distance to transport corridors. This shows that accessibility and transport

infrastructure play a role in the development of land costs. The land value and accommodation rent differentials drive especially people from the middle income group into PU areas in the search for cheaper and better accommodation (IRMA, 2005). The 'trade off' between transport and other expenditures results in a more transport-oriented lifestyles. This trend was reinforced by government policies to promote housing activity and by financial institutions which reduced the interest rates for loans.

A travel survey carried out by Thirumurthy (2005) in 16 PU settlements of the Chennai metropolitan area, covering income, transport expenditure and modal shares relating to work-trips shows that the highest level of walking and cycling occur in the settlements with the lowest transport expenditures and the lowest income. A further case study reported on working and **commuting patterns** of 11 settlements in the Chennai Metropolitan Area (CMA) major findings are as below.

1. Commuting trips in the Chennai metropolitan area are generally below 5 km.
2. Distances and modal shares are roughly the same in urban and PU settlements.
3. Only rural settlements are quite distinct, with only local employment and exclusively non-motorized modes for commuting.

Land cost (Rs per sq.ft.) Corridor Urban PUI there is significant difference of Land cost. A "high level" which recognizes that transport and land use are closely interconnected, and that solutions should reflect this interconnection.

Conclusion: The above discussion explains the three approaches for delimitation of Peri-urban boundaries of region. Each of method has got their own advantages. The GIS approach is based on extension of sprawls over a period of time. This method is fact based and scientific in nature. On the other hand the indicator based approach covers cultural and human aspects also. The statistical method offers scientific judgment criteria for assessing boundaries of Peri-urban area based on various indicators, this method resolve problem of judgment. The Indian scenario offers multiple reasons for growth of Peri-urban areas and hence it is suggested that delimitation of Peri-urban area shall be based on multiple methods.

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