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Delineation of rural-urban fringe of Indian town: a case study of Uluberia Municipality, Haora

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Abstract

In India, most urban centres are expanding very rapidly both spatially and demographically. This expansion refuels the process of urbanization and spreads urban characteristics to peripheral regions. As a result, the rapid growth and expansion of urban areas to its surrounding rural hinterlands fosters unplanned and haphazard development and makes the area even more complex. Over time, the distinction between rural and urban gradually disappears, so that a new type of structure would emerge in city outskirts which is characterized by mixed forms of land-use, socio-economic activities and termed as rural-urban fringe. The paper delineates rural-urban fringe of Uluberia municipality based on selected indicators of demographic structure and economic services. Urbanity Index and Composite Urbanity Index have been used for the delineation of rural-urban fringe. Four fringe zones of Uluberia municipality have been identified and termed by applying the Mean±Standard Deviation technique.

Keywords: *rural-urban fringe, delineation, urbanity index, composite urbanity index.*

Rezumat. Delimitarea franjei rururbane: municipalitatea Uluberia, districtul Haora, India ca studiu de caz

În India, majoritatea centrelor urbane cresc foarte rapid atât spațial, cât și demografic. Această extindere alimentează procesul de urbanizare și disemnează caracteristicile urbane către regiunile periferice. Ca urmare, creșterea și extinderea rapidă a zonelor urbane către cele rurale înconjurătoare favorizează dezvoltarea neplanificată și întâmplătoare și transformă arealul într-unul cu atât mai complex. De-a lungul timpului, distincția dintre rural și urban se atenuează treptat, astfel că un nou tip de structură apare la marginea orașelor, caracterizată prin forme mixte de utilizare a terenului, activități socio-economice și denumită franja rururbană. Lucrarea delimitează franja rururbană a municipalității Uluberia pe baza unor indicatori selectați de structură demografică și servicii economice. Indicele de urbanitate și Indicele de urbanitate compus au fost utilizați pentru delimitarea franjei rururbane. Au fost identificate și denumite patru componente ale franjei municipalității Uluberia utilizând Media±Deviația Standard.

Cuvinte-cheie: *franjă rururbană, delimitare, indicele de urbanitate, indicele de urbanitate compus.*

Introduction

Nowadays, Rural-Urban Fringe (henceforth RUF) is one of the most demanding and debatable contexts in the field of urban geography (Pryor, 1968; Scott et al., 2013). A developing country like India possesses one of the largest urban systems in the world. The total urban population in the country is more than 377 million persons, constituting 31.2 percent of the total population, with a growth rate of 2.76 percent/year in the last decade (Census of India, 2011; Kolhe and Dhote, 2016). The present trend of rapid urbanization process immensely influences the socio-economic as well as spatial development of an urban centre and its peripheral regions.

The fringe area represents the transition zone where rural is sequentially transformed into rurban, next to urban areas. The word RUF is combined with two different terminologies i.e. 'rural fringe' and 'urban fringe'. In 1937, T. L. Smith first used the term 'urban fringe' to describe "the built-up area outside the corporation limits of the city" but the concept of RUF was developed and popularised by R. J. Pryor in 1968. RUF is a frontier rather than a boundary which lies between urban and rural land-use where spread effect or centrifugal force plays an important role for landscape development (Marchand and Charland, 1992; Pryor, 1968). It is a transitional and dynamic zone located beyond the corporate limits of a legal city, sometimes exterior to suburban area. Several authors have discussed the characteristics of RUF includes mixed land use, low taxation, inhabitants engaged both in rural and urban occupations, lack of urban utilities, high population growth and density but less than in central city (Andrews, 1942; Kurtz and Eacher 1958). The proper taxonomy of RUF is very complicated, although many urban researchers have classified RUF into various zones such as suburb fringe, urban fringe, rural fringe and urban shadow. Suburb fringe is a contagious area to the central city with high proportion of non-farm land use; maximum residents engaged in city occupation and provide a few municipal services (Jindrich, 2010; Kurtz and Eacher, 1958). Urban fringe includes the low rurality in nature and high urbanity in approach, intermediated between the suburb and rural fringe (Lal, 1973; Mukherjee, 1963; Myers and Beegle, 1947; Sharp and Clark 2008) whereas rural fringe includes high rurality and maximum lands occupied by farm activities with a

lower rate of land conversion (Pryor, 1968; Sinclair, 1967; Singh, 1967). Urban shadow is somehow similar to the rural area and is known as 'rural hinterland' (Piorr, 2011).

The indicators and methods used for fringe delineation are very much diversified just as the multiplicity of fringe definitions (Mustak et al., 2018; Pryor, 1968). The indicators used for the delineation of fringe not only vary from developed to developing nations but also vary from city to city in the same country. Variables for the delineation of rural-urban fringe are usually based upon functional linkage of the city with its surrounding area. Several authors have worked on the rural-urban fringe delimitation taking a variety of indicators (Table 1). Non-village population, rural non-farm population (Myers and Beagle, 1947), farm size, internal migration, public utilities, land value (Golledge, 1960), population density (Fesenmaire et al., 1979; Sharp and Clark, 2008) etc. are used for fringe delimitation in developed countries. Along with India, most of the developing countries have used built-up area, house type, pattern of streets (Singh, 1966), children school, population density, population growth rate, gender ratio, electricity consumption, water supply (Alam and Khan, 1972), isochrones, urban influence (Sinha, 1974), milk supply and vegetable supply (Nisha, 2015) and bus service (Arif and Gupta, 2018) etc. for fringe delineation. In developing countries, delineation of RUF depends on census data and functional relationship between the city centre and its rural hinterland (Doan and Oduro, 2012; Khan and Munir, 2017). Detroit fringe was delineated and classified into two groups based on NV-RNF (non-village, rural non-farm) population (Myers and Beegle, 1947). Land use data (from aerial photos) and census data (1951 and 1966) used for delineation of Melbourne urban fringe and also delineated outer suburb from the urban fringe (Pryor, 1969).

The RUF of Patna city in Bihar and Indore in Madhya Pradesh were delineated by using 'Urbanity Index' and 'Scale of Urbanity'. Accordingly, the RUF was classified into two groups, i.e. inner fringe and outer fringe by applying upper quartile (Q3), median quartile (Q2) and lower quartile (Q1) (Saxena and Vyas, 2016; Singh and Vyas 2014; Sinha, 1980). Superimposing of a series of maps based on several indicators is used to delineate the fringe region of KAVAL towns and Hyderabad metropolitan (Alam and Khan, 1972; Dube, 1976; Singh, 1966). Fringe areas of Delhi metropolitan were demarcated by using various heterogeneous factors and a 'stage model' also prepared to show the transformation of village into a metropolis (Nangai, 1976; Srivastav and Ramachandran, 1974). Based on the administrative unit, five fringe zones of Calcutta Metropolitan (now Kolkata Metropolitan; 1st of January, 2001) are delineated (Ganguli, 1967). The primary and secondary fringe of Jammu city has been delineated by applying Mean±Standard Deviation (SD) method (Nisha, 2015). Occupational, socio-cultural, spatial, structural and ecological characteristics of sub-urban, fringe area and rural area are examined to distinguish the inner and outer portions of the RUF (Carter, 1972; Newman and Applebaum, 1989; Sharp and Clark, 2008). Economic and social characteristics in the fringe zone were also considered adequate indicators for delineating the RUF (Duncan and Resse, 1956; Rao, 1982). Moreover, urban demand for agricultural land of RUF is an important criterion for fringe delineation (Hady, 1970; Hushak, 1975; Kumar, 1980; Relph and William, 2001; Sullivan et al., 2003; Zasada, 2011). Land use structure and land use policy in the RUF are examined in order to delineate the fringe zone and also considered as having particular importance for urban morphological planning, urban land use planning and sustainable management of land resources (Ban and Hu, 2007; Lawrence and Jeff, 2003; Wehrwein, 1942). Arif and Gupta (2018), Khan and Munir (2017), Mustak et al. (2018), Saradar and Hazra (2014) etc. also delineated the fringe region of different non-primate urban settlements such as: Aligarh, Raipur, Burdwan in India. In this regard, internet cafe services, market availability, accessibility of metalled road are recently taken into consideration as useful indicators in delineating non-primate cities' fringe. As a result, these indicators have been used in this paper along with Uluberia municipality's sphere of influence, which determined the exterior boundary of its RUF.

In addition to these indicators, a variety of methods for RUF delineation were also carried out. Most of the earlier studies in developed countries used statistical techniques (Fuzzy analysis, Cluster analysis etc.). The applicability of this method is very complicated for developing countries and needs enormous statistical knowledge and expertise. But most studies in developing and underdeveloped nations applied two methods, i.e. superimposed maps one over other (sieve method) and the urbanity index method. The significant drawback of the sieve method is the fact that the external fringe boundary is not fixed; it varies from researchers to researchers by using the same set of indicators and study area (Singh, 1980). On the other side, the urbanity index and composite urbanity index have the convenience of easily identifying the intensity of urban way of life around the urban area, cultural dimension and infrastructural growth of the cities (Mustak et al., 2016; Singh, 1980). The term 'urbanity' is understood as degree of urbanization, mostly used to measure the relative urban nature of a place (Karg et al., 2019; Saksena et al., 2014). This method also accurately identified the proper rural-urban gradation. The parameters of urbanity index are usually related to demographic data, socio-economic data and different rural-urban services, although country-specific diversification may also exist.

Table 1 List of indicators used for fringe delineation in different countries

Types of Country	Author(s)	Study area	Criteria used for fringe delineation
Developed countries	Myers and Beagle (1947)	Detroit, USA	Non-Village population, Rural Non-Farm population (NV-RNF) and earlier minor civil division units
	Golledge (1960)	Sydney, Australia	Farm sizes, population density, internal migration from inner city areas to the outer suburbs, housing density, non-urban land, provision of public utilities (water, gas, electricity, sewerage, public transport, paved roads, footpaths and street lighting), land values
	Mukherjee (1963)	Orlando, Florida, USA	Intensity of urban land use
	Pryor (1969)	Melbourne Metropolitan, Australia	Build-up area & density (collected from aerial photographs, 1951-1966), the construction of radial lines or vectors originating from the C.B. D
	Fesenmaire, Goodchild and Morrison (1979)	City of London, Ontario, Canada	Population density, proportion of non-farm residents, percentage of land in non-farm ownership, accessibility to the central city
	Sharp and Clark (2008)	Ohio, USA	Demographic indicators: population, density, population change, housing value, age of population, poverty, education, and income attributes; Occupational structure: employment in industries such as construction, manufacturing, agriculture, or professions
Developing countries	Hart and Partridge (1966)	Johannesburg (South Africa)	Land value, land utilisation, size of land, pattern of residential land development and its availability, accessibility of the land, household density, transportation facility
	Browder a, Bohland and Scarpaci (1995)	Bangkok (Thailand), Jakarta (Indonesia), and Santiago (Chile)	Basic migratory flows: direct rural to-peri-urban migration, step-wise interurban migration and intra-metropolitan migration; Employment Characteristics: sector of employment (agriculture, industry, construction etc.), gender of workers; Income generation: average monthly income, workplace location; land use data
	Zhao (2012)	Beijing, China	Migrant patterns, percentage of non-built-up area, growth rate of the population, transport and communication, growth rates in employment, housing price
	Yuhong (2016)	China	Non-agricultural households, quantity of industrial employees, non-agricultural permanent population, identify the village type, industrial enterprises.
	Singh (1966)	KAVAL towns, India	Built-up area and house types, types and patterns of streets, occupational structure of the inhabitants, site for large institutions and industrial establishments, presence of lime and brick-kilns, limit of essential services and distribution of children schools.
	Alam and Khan (1972)	Hyderabad metropolitan, India	Population density, population growth rate, gender-ratio, ratio of working population, electricity consumption, transport service, water supply, retailing, telephone and postal service.
	Sinha (1974)	Patna, India	Isochrones (time taken to reach corporation boundary of Patna), urban influence, Public utility services, land value, non-agricultural activities, number of families per house, population density, gender ratio, daily commuter, literacy, primary activities, agriculture activities, built-up area.
	Srivastav and Ramacharadran (1974)	Delhi Metropolis	Occupational structure, land-use pattern, interaction with the city, urban amenities and location characteristics.
	Lal, 1987	Bareilly, India	Ratio of non-agricultural workers, population density, rate of change in density, population growth, gender structure, literacy
	Singh and Vyas (2014); Saxena and Vyas (2016)	Chennai metropolitan, India; Indore City, India	Density, gender ratio, literacy rate, decadal growth, percentage of working population, percentage of main worker, percentage of marginal worker, percentage of cultivators, percentage of agricultural labour, percentage of other worker, number of household, size of household, distance from city centre, percentage of agricultural land, average land value, number of BPL families.
	Nisha (2015)	Jammu City, India	Economic Services: milk supply zone, the vegetable supply zone, mini bus service zone, commuters' zone, brick kilns zone; Demographic determinants: density of population, gender ratio, literacy rate; Occupational structure: ratio of non-agricultural workers.
	Mustak et al. (2016)	Raipur, India	Socio-economic data: population density, population growth, literacy, gender ratio; Occupational
			structure: non-agricultural workers; percent of urban land, accessibility (bicycle, auto, motorbike and city busses)
	Khan and Munir (2017)	Aligarh city, India	Economic determinants: milk supply, vegetable and fruit supply, daily commuters, transport services, educational services, medical services; Occupational structure: ratio of non-agricultural workers; Demographic determinants: population growth, population density, literacy, gender ratio, household density, pucca houses.
	Arif and Gupta (2018)	Burdwan city, India	Population density, decadal growth rate, literacy rate, female workers, non-agricultural workers, market availability, black topped road, bus services
Underdeveloped countries	Tabor (2013)	Finfine (Addis Ababa), Ethiopia	Population growth, net migration, housing density, land use, value of land, transport routes
	Karg et al. 2019	Tamale, Ghana	Urban built-up area, urban land use change, frequency of visits to city centre, non-farm employment, services: electricity, water, sanitation; Access: public transport, road density, distance to roads.

Source: author's processing from various literatures

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Study area

Uluberia municipality is a part of Kolkata Metropolitan Development Authority (KMDA) and is closer to Howrah Municipal Corporation. The municipality is located on the left bank of the river Hooghly (Fig. 1). Since 1982, it is the head-quarter of Uluberia subdivision and Uluberia C.D. block. The total geographical area of the Uluberia municipality is 33.72 square kilometers with a population of 230,000 inh. in 2011 (District census handbook, 2011). National Highway-6, railway lines (South-Eastern Railway) and state highway go through the municipality.

The fringe area of the municipality which covers a geographical area of 274.22 square kilometers and serves about 780,000 inhabitants is extended from 22º22′30″N to 22º36′30″N latitude and 88º0′0″E to 88º14′30″E longitude. The present study analizes 111 fringe villages and 44 census towns along the fringe area.

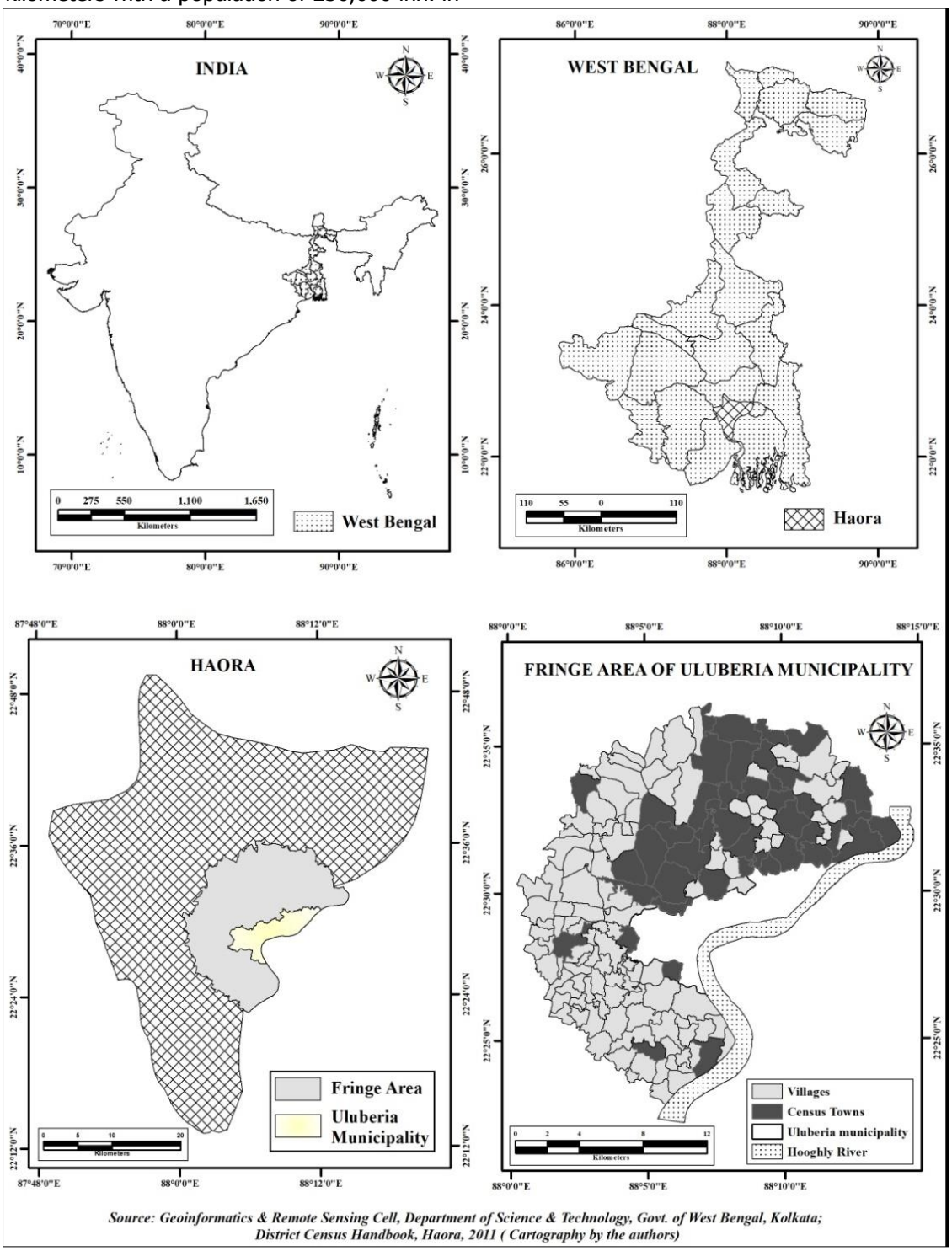

Fig. 1: Location of the study area

The studied municipality provides administrative, medical as well as educational services to its neighbouring region. Due to its contiguousness to Kolkata conurbation and Howrah municipality as well as Santragachi Railway junction, the municipality attracts important flows of migrants from different districts of West Bengal, Odisha, Bihar and Jharkhand fostering rapid growth of medium and small-scale industries. This huge influx of migrants from different parts of the nation significantly refuels the unorganised urbanisation process in the peripheral area with their heterogeneous socio-cultural traits. Without an appropriate infrastructural development and planning, the fringe area became ground of constant problems such as traffic congestion, land use, pollution, high population density etc. This persistent slum development impedes the progress of the settlement. To solve all those aforesaid problems, Uluberia municipality has immense responsability in delineating the rural-urban fringe (RUF) which could help the policymakers and urban planners for planning a smart urban growth and development in a more organised manner.

Data base and methodology

Socio-economic and demographic data were collected from District Census Handbook-Haora, District Statistical Handbook-Haora, Uluberia Municipality office and concern Block Development Authorities of Haora for the delineation of the sphere of influence and RUF zones of Uluberia municipality. Also, several essential thematic maps were obtained using Remote Sensing data and GIS tools.

a) The zone of influence or intermediate point between two cities i.e. Uluberia municipality and Howrah Municipal Corporation was demarcated by applying Converse's 'breaking point model'.

b) In order to delineate the RUF of Uluberia municipality the following methods were used:

- *Urbanity Index* (UI) - calculated for all sample villages and census towns, based on 11 variables. The value of the indicators decreases with the increasing distance from the central point of municipality as well as from fringe to the villages. Given these conditions, the formula of the urbanity index is:

UI = (F-V)/(T-V) ×100 (.....ii)

The calculated indicators' value increases as we move towards the villages and the index value also increases from fringe to village. In this situation, the formula of urbanity index stated as:

UI=(V-F)/(T-V)×100 (.....iii) where T, V and F are index value of factor for sample towns, villages and fringe, respectively.

- *Composite Urbanity Index* (CUI):

$$Composite\ Urbanity\ Index = \sum_{i=1}^{n} UI$$

(.....iv), where: n = number of variables and UI = Urbanity index.

Results and discussion

Identification of Uluberia municipality's sphere of influence

The sphere of influence of Uluberia municipality has been delineated by using P. D. Converse's 'breaking point model' (1949). By applying this model, 11 kilometers influence area of Uluberia municipality has been considered as study area. Total 111 villages and 44 census towns from seven blocks (Uluberia-I, Uluberia-II, Panchla, Sankrail, Amta-I, Jagatballavpur and Shyampur) are considered for the present analysis of RUF within 11 kilometers radial buffer zone from the central point of the municipality (Fig. 2).

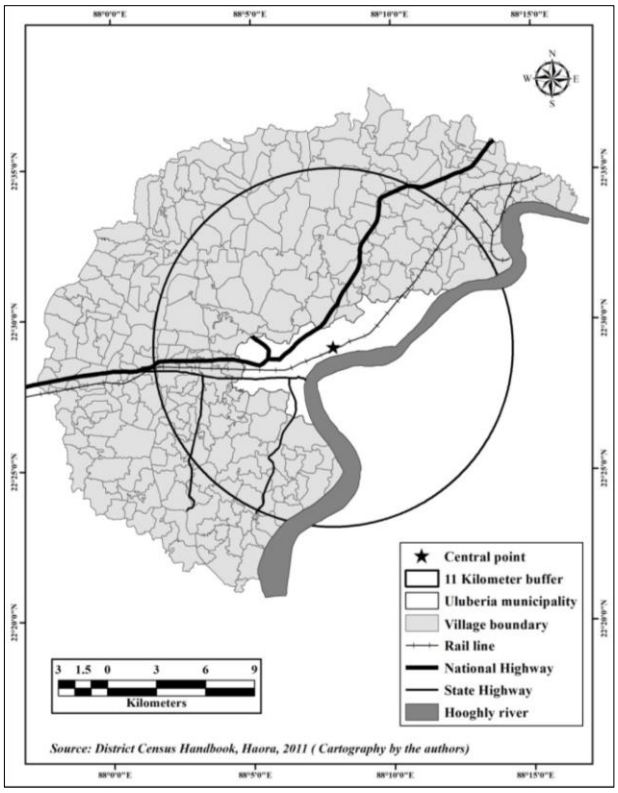

Fig. 2: Delineation of Uluberia municipality's sphere of influence (Source: District Census Handbook, Haora, 2011)

Delineation of Rural-Urban Fringe of Uluberia municipality

Considering the vast literature review, it is obvious that the indicators used for rural urban fringe delineation vary from developed nations to underdeveloped nations. Moreover, there are some common indicators

used for the fringe delineation within the same country. But the nature and patterns of urbanisation are not the same for all. So, it was considered better not to tackle the indicators which were used to delineate the urban fringe of developed countries such as the western urban centres. Unlike developed countries, the land use pattern of developing countries is highly mixed in nature. Just as in India, most developing countries have used: land value, land use, plot size, household density, transport, migration, income etc. as indicators for fringe delimitation. The indicators should be based on the functional interaction of urban centres with their countryside and of course, the availability of data. A pilot survey in the study area helped us understand the functional interaction of Uluberia municipality with its surrounding villages and census towns. In fact, this helped out to set the indicators for delineation of rural-urban fringe of the study area. These indicators have been categorized into two groups, as following:

A. *Demographic determinants:*

i. Population density (persons per square kilometer)
ii. Population growth rate (percent)
iii. Household density (number of houses per square km)
iv. Gender ratio (number of females to 1000 males)
v. Literacy rate (percent)

B. *Occupation structure and economic services:*

i. Number of non-agricultural workers to the total workers (percent)
ii. Number of female workers to the total number of workers (percent)
iii. Availability of bus service (within 1 kilometer)
iv. Metalled road availability (within 1 kilometer)
v. Market availability (within 1 kilometer)
vi. Availability of internet cafes (within 1 km).

The Urbanity Index (UI) was calculated for all sample villages and census towns within the identified influence zone. Based on the UI value of eleven variables, four zones of the rural-urban fringe were identified for each variable by applying the mean ± standard deviation (SD) techniques i.e. suburb fringe (above mean + 1 SD), urban-fringe (mean + 1 SD), rural-fringe (mean - 1 SD) and urban shadow (below mean - 1 SD). A Composite Urbanity Index (CUI) has been estimated using the composite value of each variable to delineate the final fringe zones of Uluberia municipality.

A. Demographic determinants

Demographic indicators are very much useful for the delineation of rural-urban fringe. The following demographic determinants were selected to delineate the rural-urban fringe of Uluberia municipality:

i. Population density

Population density is one of the most valuable factors to determine the city's sphere of influence. Uluberia Municipality acts as a pull factor for both skilled and unskilled rural population due to its self-generating employment opportunities, education and other utility services. Immigrants from the remote corners of the municipality are unable to afford the higher house rent within the municipal area. Under these circumstances, the centrifugal force of urbanization plays a great role to force people reside outside the municipality's boundaries within a commutable distance and increases the pressure of population density.

The average population density in the fringe belt is 2956 persons per sq. km. Villages and census towns having the UI value above mean + 1 SD (> 47.09) and mean to mean + 1SD (29.27 to 47.09) are considered as the suburb fringe and urban fringe respectively. These two zones are mainly extended towards north-east due to the influence of Kolkata conurbation. Villages and census towns with UI value of mean to mean - 1 SD (29.26 to 11.43) and below mean – 1SD (<11.43) are termed as rural fringe and urban shadow respectively. Maximum villages of the south-west and north-west part of the study area come under the rural fringe and urban shadow zone due to its lower degree of urban influence.

ii. Decadal population growth

The population growth rate is a combined function influenced by fertility, mortality and migration. In Uluberia municipality's case, migration is the most significant factor for the population growth. Growth of the population in the Uluberia municipality and its surrounding areas follow the Ravenstein distance decay law (Ravenstein, 1889; Tobler, 1995) i.e. decrease of population growth with increasing distance.

It is obvious that the population growth rate is very unevenly distributed (Fig. 3); three villages within suburb region have a growth rate of above 56.32 percent and UI of 26.27 (Table 2). The high growth rate of population from 2001 to 2011 is registered towards north, west, south-west part of the fringe zone and fall into the urban fringe (UI, 18.49 to 26.27) (Fig. 4). Besides migration, illiteracy, poverty and traditional beliefs are also key determinant factors for the higher natural growth of the population. The north-eastern part of the fringe belt has been considered as rural fringe due to the minimum population growth, i.e. - 13.57 to 21.37 percent.

iii. Household density

A household is a fundamental unit of a settlement where persons are ties with a co-residential relationship regardless of kinship bonds. Demographic factors, kinship rules and socio-economic conditions of a

society play an influential role in an individual household. Household density and size not only change with the urbanization process but also change the design and architectural pattern of the buildings. The population of the city's peripheral zone continuously increased due to the huge number of migrants. As a result, new buildings are constructed to accommodate the new migrants. Thus, there is a clear gradation of household density from the immediate surrounding fringe area to the rural area (Table 2) and household density gradually increased in every zone of RUF in the course of time.

Maximum villages and census towns of the north-eastern part fall within the suburb and urban fringe due to the tremendous concentration of households. Rural fringe (mean to mean – 1 SD) and urban shadow (below mean – 1 SD) are extended towards the north-west and south-west portion of the municipality's fringe where household density is below 615. The built-up area has been increased over a comparatively small space in the western part of the fringe area. In this zone, households are extended parallel to the railway and national highway. As a result, a few census towns (Kendua, Osmanpur, Basudebpur and Brindahanpur) and villages (Gudar, Kasipur, Gauripur, Kajiakhali) are fallen under the urban fringe, having household density 616 to 961 household per sq. kilometer.

iv. Gender ratio

The gender ratio is a fundamental element of geographical study because it has a profound effect on other demographic criteria like population growth, age of marriage, migration rate, occupational structure etc.

A large number of male workers migrated to Uluberia municipality from the countryside to get better jobs. Gender ratio increases from city centre to the rural area and vice versa. Low paid unskilled and semi-skilled migrants prefer to live in the peripheral areas of Uluberia municipality due to cheaper residential rent and availability of other urban facilities and services.

The huge influx of male migrants into the fringe area creates disparity of gender structure. The villages and census towns having low gender ratio (below 920) are found in northern, western and south-western parts of the RUF which are termed as suburb fringe and urban fringe. The female population exceeded the male population in the north-western part of the fringe (Fig. 3) which integrated them in the rural fringe and urban shadow category.

v. Literacy rate

Literacy is a significant determinant of social well-being as well as human development. The present study reveals that literacy rate decreases from suburb fringe to rural fringe (Table 2) and based on literacy rate, the maximum villages and census towns of suburb fringe and urban fringe are located in the periphery of RUF.

So, the relationship between the distance from the city centre and literacy is positive i.e. 0.44 (Table 3). The literacy map (Fig. 3) proved that people living in the north-eastern and south-western part have higher literacy rates (> 67.78 percent), termed as suburb fringe and urban fringe. In these parts, some of the scattered villages also fall under rural fringe and urban shadow group. From the northern to the western part of the fringe, villages are considered as part of the rural fringe and urban shadow because of the lower literacy rates (less than 67.77 percent).

B. Determinants of economic structure and economic services

Economic structure and services are important attributes taken into consideration in order to find out the degree of urban influence in peripheral regions.

i. Ratio of non-agricultural workers

The villages closer to the city change their rural character more than those situated farther from it. The higher percentage of non-agricultural workers to the total workers is an important feature of the fringe population. Increasing of non-agricultural workers is a remarkable changing phenomenon in the rural-urban fringe zones.

Uluberia municipality offers multifarious employment opportunities to its rural hinterlands. Surplus labour, low paid workers and unemployed persons of the surrounding villages migrate towards the city centre to get these diversified opportunities. The workers engaged themselves in the various secondary and tertiary economic activities like household and manufacturing industry, construction, trade and commerce, storage, communications and other services.

Rural-non-agricultural workers are concentrated in the north-eastern fringe zone (Fig. 3) because of the nearness to the Howrah-Hugli industrial zone, Kolkata metropolis and easy accessibility of transport for various purposes term as suburb fringe. North-western and south-western part of the rural-urban fringe lies in the urban shadow and rural fringe zone because of its higher rural character (UI is below 71.74) (Fig. 4). In these zones, almost 45 percent of the people are working on different primary activities such as agriculture, fishing, which are located far away from the city centre.

Table 2 Categories of rural-urban fringe based on urbanity index of selected indicators

Indicators	Categories of Rural-urban Fringe	Range of the Urbanity Index	Range of the indicators	Number of villages	Number of census towns	Total number of villages and census towns
Population density	Suburb fringe	Above Mean + 1 SD (> 47.09)	>4643	8	17	25
	Urban fringe	Mean + 1SD to Mean (47.09 - 29.27)	4643 to 2956	23	16	39
	Rural fringe	Mean to Mean - 1SD (29.26 - 11.43)	2955 to 1268	62	11	73
	Urban shadow	Below Mean - 1SD (< 11.43)	<1268	18	0	18
Population growth rate	Suburb	Above Mean + 1 SD (> 26.27)	> 56.32	3	0	3
	Urban fringe	Mean + 1SD to Mean (26.27 - 18.49)	56.32 to 21.38	34	15	49
	Rural fringe	Mean to Mean - 1SD (18.48 - 10.70)	21.37 to - 13.57	71	29	100
	Urban shadow	Below Mean - 1SD (< 10.70)	< -13.57	3	0	3
Household density	Suburb fringe	Above Mean + 1 SD (> 50.89)	> 961	6	15	21
	Urban fringe	Mean + 1SD to Mean (50.89 - 32.02)	961 to 616	23	17	40
	Rural fringe	Mean to Mean - 1SD (32.01 - 13.13)	615 to 271	64	12	76
	Urban shadow	Below Mean - 1SD (< 13.13)	< 271	18	0	18
Gender ratio	Suburb fringe	Below Mean - 1SD (< 39.53)	< 920	19	3	22
	Urban fringe	Mean to Mean - 1SD (39.53 to 52.58)	920 to 954	40	20	60
	Rural fringe	Mean + 1SD to Mean (52.59 to 65.64)	955 to 9989	34	20	54
	Urban shadow	Above Mean + 1 SD (> 65.64)	> 989	18	1	19
Literacy rate	Suburb fringe	Above Mean + 1 SD (> 77.64)	> 74.48	16	3	19
	Urban fringe	Mean + 1SD to Mean (77.64 to 63.75)	74.48 to 67.78	42	22	64
	Rural fringe	Mean to Mean - 1SD (63.74 to 49.85)	67.77 to 61.07	39	14	53
	Urban shadow	Below Mean - 1SD (< 49.85)	< 61.07	14	5	19
Non-agricultural workers	Suburb fringe	Above Mean + 1 SD (> 94.12)	> 94.54	9	20	29
	Urban fringe	Mean + 1SD to Mean (94.12 to 71.75)	94.54 to 75.40	36	22	58
	Rural fringe	Mean to Mean - 1SD (71.74 to 49.37)	75.39 to 56.25	38	2	40
	Urban shadow	Below Mean - 1SD (<49.37)	< 56.25	28	0	28
Female workers	Suburb fringe	Above Mean + 1 SD (>50.80)	> 25.90	17	6	23
	Urban fringe	Mean + 1SD to Mean (50.80 to 35.26)	25.90 to 18.65	32	24	56
	Rural fringe	Mean to Mean - 1SD (35.25 to 19.73)	18.64 to 11.39	42	12	54
	Urban shadow	Below Mean - 1SD (< 19.73)	< 11.39	20	2	22
Availability of bus service	Urban fringe	Above Mean (> 62.52)	2	73	27	100
	Rural fringe	Mean to Mean - 1SD (≤ 62.52)	1	38	17	55
Metalled road availability	Urban fringe	Above Mean (> 70.32)	2	77	32	109
	Rural fringe	Mean to Mean - 1SD (≤ 70.32)	1	34	12	46
Market availability	Urban fringe	Above Mean (> 62.52)	2	68	32	100
	Rural fringe	Mean to Mean - 1SD (≤ 62.52)	1	43	12	55
Availability of internet cafes	Urban fringe	Above Mean (> 57.42)	2	61	28	89
	Rural fringe	Mean to Mean - 1SD (≤ 57.42)	1	50	16	66

(Source: Computed from District Census Handbook, Haora, 2011)

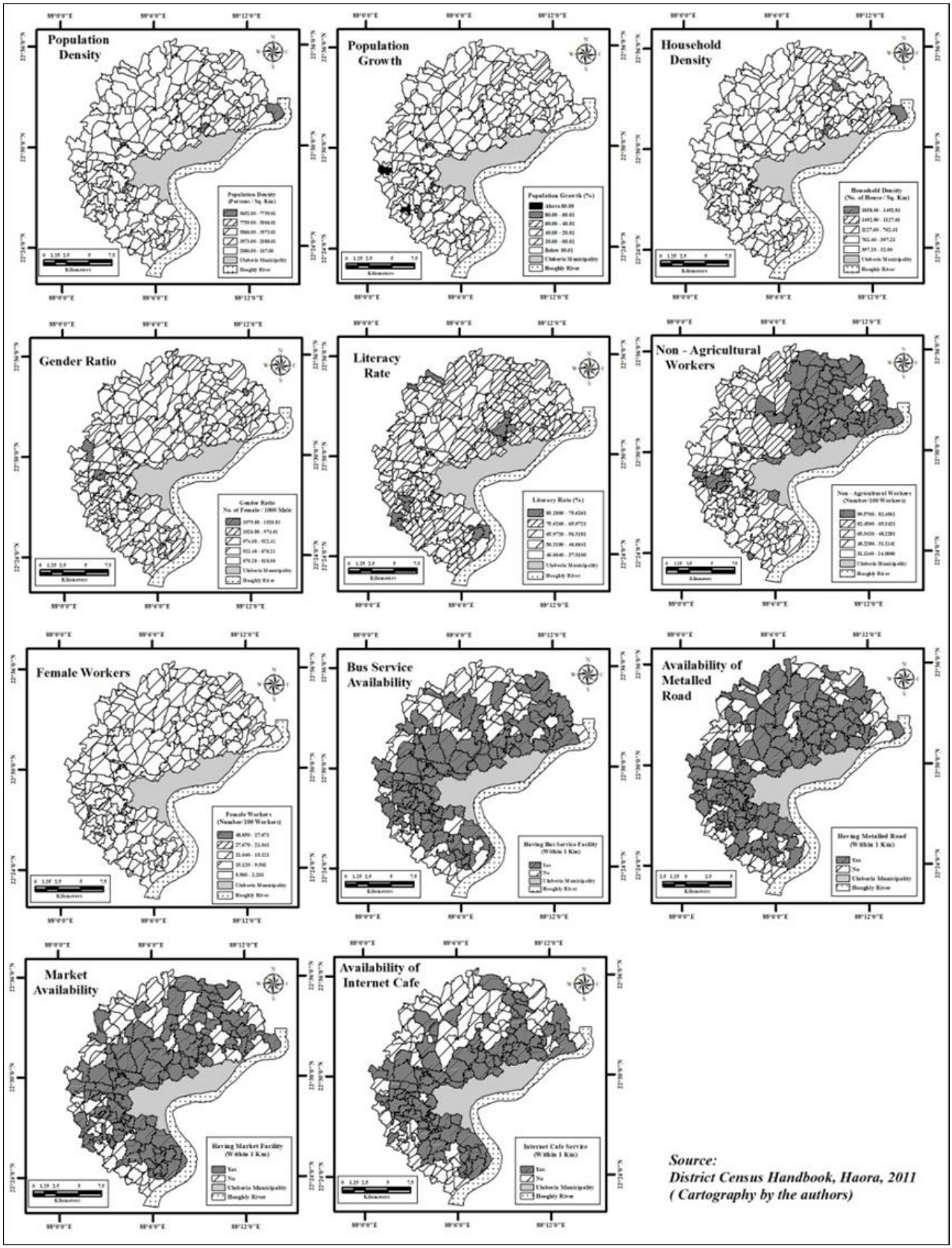

Fig. 3: Spatial distribution pattern of selected indicators, 2011

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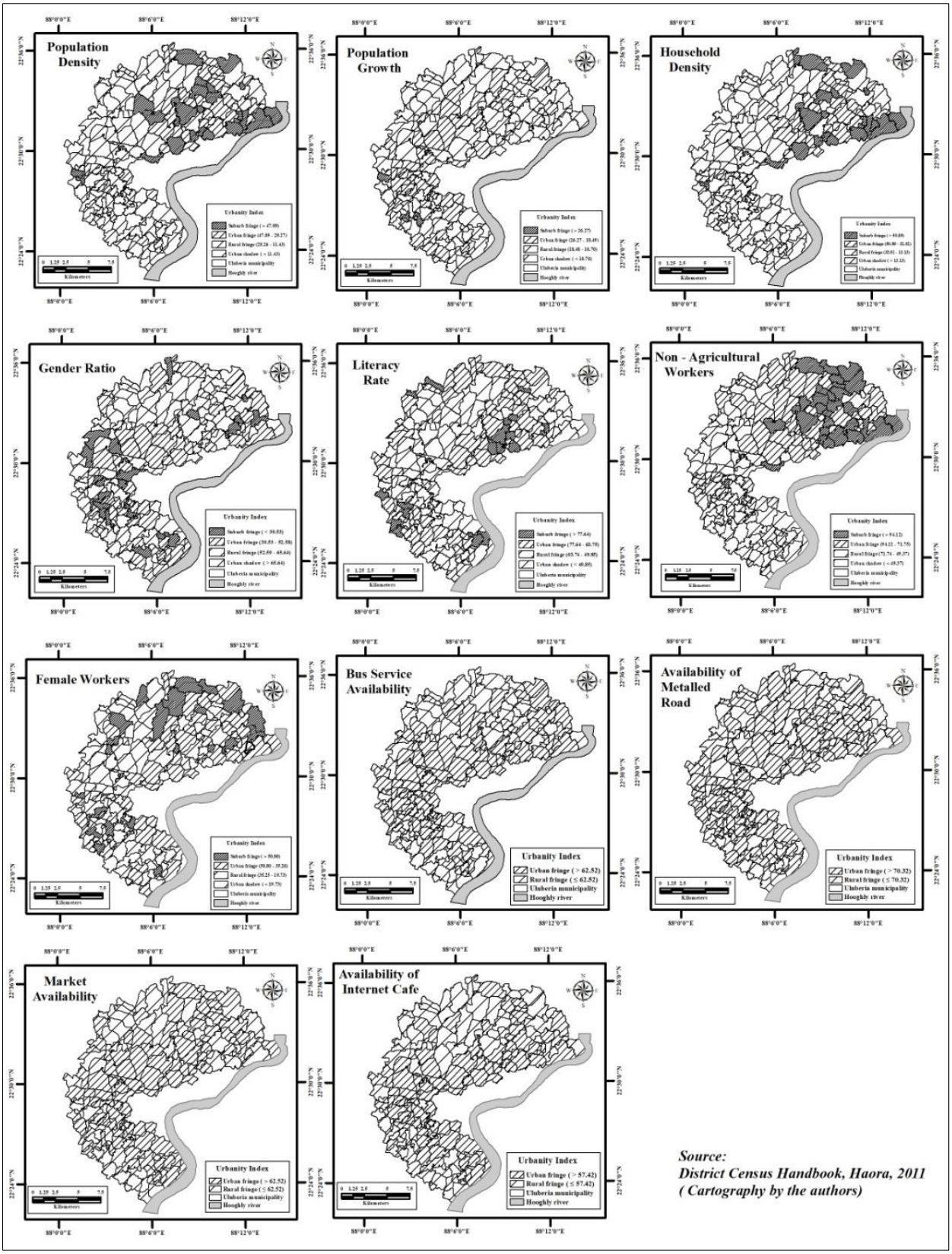

Fig. 4: Urbanity index of selected indicators used to delineate RUF

ii. Female workers

The number of female workers is one of the key determinants to delineate the rural-urban fringe area of Uluberia municipality. Female participation in the workforce creates a better economic environment for the individual family and village as a whole because

women are socio-economically and politically empowered. Villages and census towns having high literacy rate may engage more females to the workforce.

Urbanity Index based on female workers' percent have the most peculiarity in terms of the spatial distribution of Uluberia municipality's RUF. The distribution of female workers to the total population are maximum towards the peripheral zone of north-east and west, considered as the suburb fringe (above 25.90 percent) and urban fringe (18.65 to 25.90 percent) (Fig. 3). A large number of villages and census towns in the north-western and south-western part of the fringe belt integrate in the rural fringe and urban shadow zone due to the higher assemblage of male workers. Thus, a total of 23 villages and census towns are part of the suburb fringe, 56 of the urban fringe, 54 of the rural fringe and 22 of the urban shadow zone (Table 2).

iii. Availability of bus service

Rapid urbanization with the increasing trends of administrative, business and commercial activities demand a high mass transit system of Uluberia municipality. Uluberia-Howrah-Kolkata, Uluberia-Jagatvallavpur-Arambag, Uluberia-Shyampur, Uluberia-Amta, Uluberia-Panchala, Uluberia-Bagnan-Mecheda are the important bus routes which radiate from Uluberia bus terminal. The studied administrative units possessing bus services (within one kilometer) are found along the inner crescent of the municipality which denotes the urban fringe zone. The radial distributional pattern of the road network is responsible for the development of the urban fringe. Peoples living in the villages and census towns adjacent to the boundary of the municipality are daily commuters and regularly cross the distance from their place of residence to the urban centre.

iv. Availability metalled road

The patterns of city development are greatly influenced by its transportation system. It actually bridges between the urban and the rural community. There is a positive correlation between levels of connectivity and suburbanization development. The connectivity through the metalled roads is important for the daily movement of people to the city centre. New residential colonies developed along the metalled road. So, transportation development intensified the suburbanization process and became a larger exterior frontier to the urban system of Uluberia municipality. Maximum villages and census towns have effective facilities of the metalled road within one-kilometer radius. Metalled roads of Uluberia municipality are extended parallel to the railway track, state highway and National Highway-6. Very few villages are settled without metalled road access around the end limit of rural-urban fringe.

v. Market availability

Markets play an important role in the formation of the urban fabric. Market centres are always a focal point for the economic activities which act as the central place for services and functions. Through employment generation, markets create a variety of ancillary jobs (suppliers, hospitality, security, delivery vehicles) and empowered low-income peoples. The characteristics of these markets are hierarchically lower order and retail in nature within communicable distance. A good transportation facility, agricultural and industrial development helps to increase the size and number of markets nearer the city centre. Fringe villages and census towns with a higher percentage of non-agricultural dwellers are economically capable to buy a variety of commodities. To serve the dwellers, different kind of shopping centres and higher-order markets are developed in the rural-urban fringe of Uluberia municipality. From an economic point of view, market availability denotes opulence to both sellers and buyers as well as the consumption level of the dependent population.

vi. Internet café availability

The internet café, commonly known as the cyber café, is a place where people can use a computer with internet access at a minimum cost per hour. The villages and census towns which have at least one internet cafe within one-kilometer distance is termed as urban fringe. Villages which do not have any internet cafes within one-kilometer radius are considered part of the rural fringe, being located at the extreme boundary of the urban fringe. At the edge of the fringe area, lagging economic and infrastructural services discourage the development of internet cafe facilities. The distance from the urban centre also plays a significant role in the availability of internet cafes among the villages and census towns.

Correlation analysis

In order to measure the intensity of relationship degree between distance from the city centre and selected variables, the Pearson product movement correlation coefficient (r) method has been used in this study. This correlation coefficient value has an immense significance to the application of UI formulas (Table 3). Equation-2 has been applied, for the negative correlation between two variables and equation-3 is used for the positive correlation. Thus, UI of the selected variables like population density, population growth, household density, non-agricultural workers, availability of bus service, metalled road availability, market availability and availability of internet cafe are calculated by using equation-2 whereas equation-3 has been taken for gender ratio, literacy rate and female workers.

Table 3 Relationship between the distance from central point of Uluberia municipality and selected indicators

No.	Name of the indicators	Value of Correlation Coefficient
1	Population density	-0.81
2	Population growth rate	-0.53
3	Household density	-0.78
4	Gender ratio	0.23
5	Literacy rate	0.44
6	Non-agricultural workers	-0.56
7	Female workers	0.26
8	Availability of bus service	-0.92
9	Metalled road availability	-0.86
10	Market availability	-0.94
11	Availability of internet cafes	-0.89

Composite Urbanity Index for the delineation and classification of Uluberia municipality's rural-urban fringe

The crescent-shaped fringe area of the Uluberia municipality is extended up-to 11 kilometers radius from the central point. Based on the eleven selected variables, the Composite Urbanity Index (CUI) has been calculated for the entire study area and plotted on the map (Fig. 5) for the delineation of rural-urban fringe. Finally, four zones of the RUF have been identified based on Mean ± Standard Deviation of CUI, described in Table 4.

Suburb fringe

The suburb fringe is placed just beyond the municipality boundary of Uluberia. This zone has a more pronounced urban character (> 63.43 CUI) with the higher concentration of non-farm dwellings, possessing better municipal facilities in comparison to the other three zones. The suburb fringe comprises 12 villages and 11 census towns within an area of 32.87 sq. km (11.99 percent of the total fringe area) (Table 4). Land-use is corporate in nature and exclusively urban. Both demographic and household density are very high. People who reside in the suburb fringe are migrating to the urban centre and engaged in different factories, offices and commercial centres. Land value is very high and most of its territory is occupied by industries, large residential apartments and multi-storied houses. In this zone, vertical expansion of the houses is preferable to the horizontal one. Due to the favourable location, this zone is continuously expanding to the north-east and west direction along the axial transportation network.

Table 4 Categories of rural-urban fringe based on Composite Urbanity Index (CUI)

Categories of rural-urban fringe	Ranges of CUI	No. of villages	No. of census towns	Total number of census towns and villages	Area (sq. Km)	Population (2011)
Suburb fringe	Above Mean + 1 SD (> 63.43)	12	11	23	32.87	134414
Urban fringe	1SD + Mean to Mean (63.43 to 50.91)	39	22	61	106.32	383268
Rural fringe	Mean to Mean - 1SD (50.90 - 38.37)	37	9	46	89.4	184878
Urban shadow	Below Mean - 1SD (< 38.37)	23	2	25	45.63	81458
Total		**111**	**44**	**155**	**274.22**	**784018**

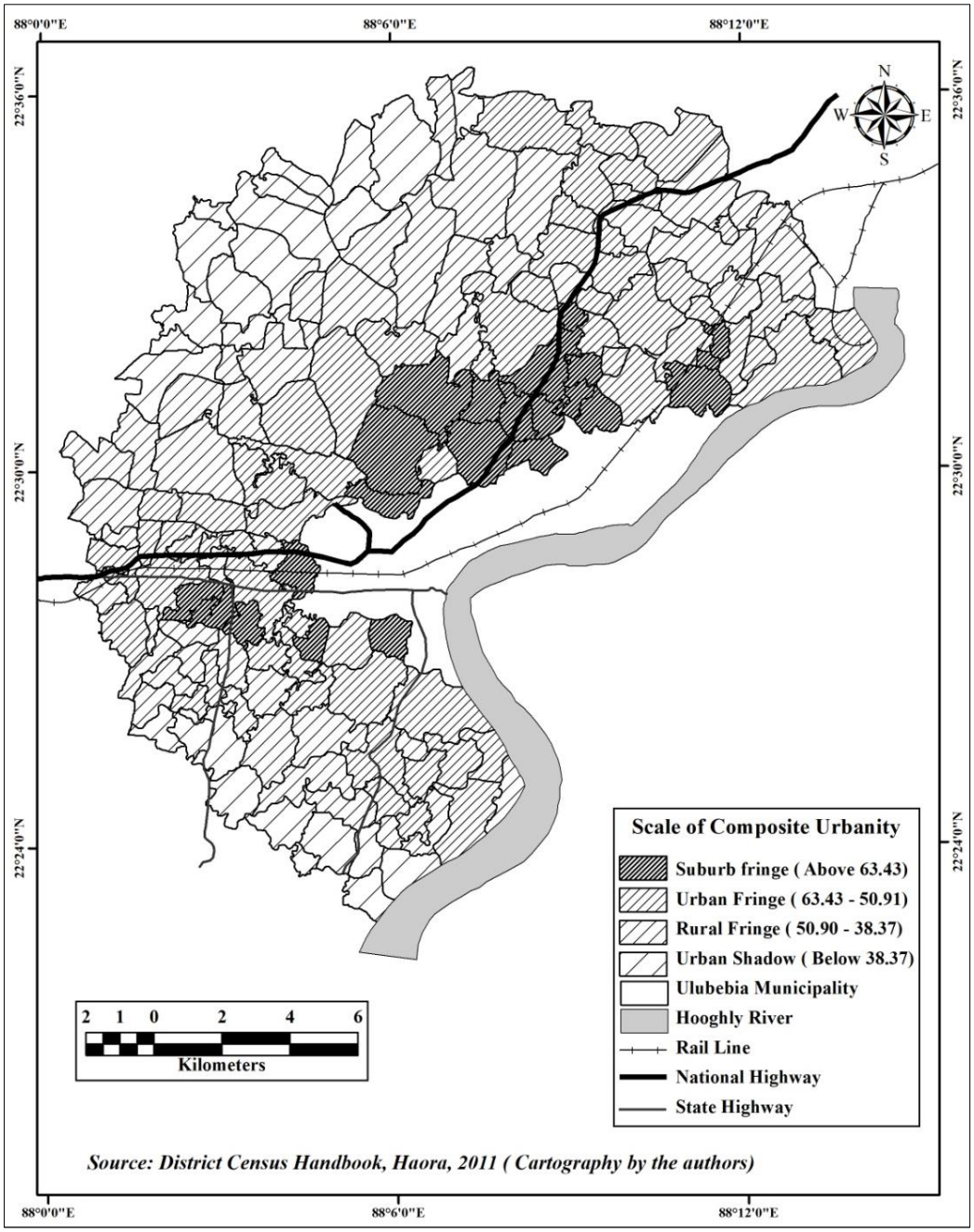

Fig. 5: Delineation of RUF, Uluberia municipality, 2011 (based on Composite Urbanity Index)

Urban fringe

Urban fringe is located beyond the suburb fringe boundary and surrounded by the rural fringe in all directions except for the north-east and west. This zone consists of 34 villages and 22 census towns with an area 106.32 sq. km. (33.77 percent of the total fringe area) (Table 4). The urban fringe is an area having a higher population growth rate due to the huge influx of rural migrants. There are still some open places owned by the farmers but they want to sell it at higher prices. The settlements are semi-urban in nature and urban land uses dominate. The workers within the urban fringe are engaged in the non-agricultural activities and most of them are employed in different industries. Presence of Howrah-Hugli industrial zone, national highway and railway track affect the shape of the urban fringe zone with a clear elongation in north-east and west directions. The high concentration of population density, non-agricultural workers, bus service and high growth rate of population characterize this zone. The villages and census towns in the urban fringe underwent tremendous transformation in terms of demographic and economic structure. Unplanned and haphazard growth of built-up area creates problems of traffic congestion, sewerage etc.

Rural fringe

The boundary of rural fringe starts from the outward side of the urban fringe. Rural fringe covers 89.40 sq. km area (32.60 percent of the total fringe area) with 37 villages and 9 census towns. This area acts as an agricultural hinterland (38.37 to 50.90 CUI value) (Fig. 5) and has strong linkage with the Uluberia municipality in terms of supply of labourers, vegetables, milk and other daily commodities for the urban dwellers. A mixed rural-urban character prevails and most of the area is dominated by agricultural activities. The percentage of agricultural land and open space are relatively higher than in the suburb and urban fringe. Only a few urban amenities such as water supply, transportation, sewerage, markets and internet cafes are available in this zone. The percentage of farmers is very high, followed by a part-time-farmers, agricultural labours and non-farmers. Restaurants, gas-stations and cottage-based industries are randomly distributed along the major arterial roads.

Urban shadow

This zone is located far away from the centre of Uluberia municipality and it actually begins from the outer edge of the rural-urban fringe belt. A total 25 villages and census towns belong to the urban shadow zone with an extension of 45.63 sq. km geographical area (16.64 percent of the total fringe area). The urban encroachment into rural land is the dominant characteristic of this region. Presence of urban characteristics is very low in the area with <38.37 CUI value (Fig. 5). This zone experiences low population density with a lower rate of migration which indirectly establishes greater availability of open space. Unplanned commercial establishment and residences are common and of course, the mixture characteristics of rural-urban land uses. Dwellers are mainly engaged in different primary activities like farming, fishing, forestry etc. The residential form of the urban shadow is isolated and developed as interstitial growth.

Conclusion

The rapid expansion urban areas act as powerful centres having economic opportunities with high potential to multiply various economic activities beyond the municipal boundary. Uluberia municipality could not support itself without interaction to its surrounding fringe; there is actually a strong interdependence between the two areas. Furthermore, complex relationships between the urban centre and its surroundings are established based on several criteria such as: supply of vegetables, food-grains, fruits, milk or facilities such as: banking, education, medical and bus services etc. The centre and its periphery interact with each other by extensive transport and communication network. The industrial (rice and jute mills, biscuits and cakes industry, light vehicle production centres, furniture industry, etc.), commercial expansion (retail and market centres), the growth of manufacturing and service activities, the increasing number of educational institutions (Uluberia College, Tata Institute of Social Sciences, Calcutta Institute of Technology, Fuleswar Paramedical College, etc.) and healthcare facilities (sub divisional hospital, ESI hospital, Sanjibani Multi-specialty hospital and other private nursing home) have also made a significant contribution for the economic and fringe development of the town. The urban area performs as administrative headquarter, the extension of brick kilns in the fringe region, rapid construction of housing complexes along transportation routes, the establishment of recreation and local tourist centres on the bank of the river Hooghly and in the proximity of Kolkata metropolitan area contributed to the process of urbanization in case of Uluberia municipality and the suburbanization in its fringe zone. Along with these, the Hooghly river has an imprint on the shaping and development of Uluberia municipality's RUF. It also fulfilled the recreational and water demands of the city's inhabitants and entrepreneurs.

The RUF of Uluberia is a mixed zone situated at the municipal boundary exerting a strong urban influence on its periphery. All selected indicators have individually delineated different extensions of the rural-urban fringe zone and were superimposed into one to find out the combined effects of these indicators. Thus, the limit of the rural-urban fringe extended 9 kilometers in the north, 7 kilometers in the north-east, 6 kilometers in the south-west and west of the municipality boundary of Uluberia. Built-up area in the fringe zone is discontinuous and haphazardly located over agricultural land. There is no distinct physical boundary between fringe zones of Uluberia municipality, but all are interrelated and interconnected. In fact, the levels of socio-economic development have developed the gradation of fringe villages and census towns.

The north-eastern and western part of the fringe belt has a greater urban character due to the location of small and medium scale industries along the transportation route. Land-use transformation is very rapid in this part and mainly engulfed by administrative headquarters, residential and commercial buildings, educational and health centres and industries. Maximum rural characteristics have been found in the south-western and northern part of the RUF. This sector is mainly used for agricultural purposes, but also consists in unproductive fallow land. Farmers are usually ready to sell these lands

with higher prices to businessman, industrialists and stockholders. Uluberia municipality's fringe has a crescent spatial pattern. The fringe belt has not expanded towards the east and southeast because of the barrier the Hooghly river represented. If only a bridge is built over the Hooghly river near the municipality, this barrier would be alleviated and it may have a great impact on the physical shape of the fringe area in the near future.

The RUF areas of growing cities in developing countries are experiencing a rapid urbanization process which has improved the quality of life, developed mixed communities and a pluralist culture. But this rapid urbanization process may have also determined a complex socio-economic and environmental development. Urban sprawl in the RUF region, dynamic land use patterns and urban demands for agricultural land are important issues which need further detailed research. Until then, the appropriate socio-economic and demographic variables used to scientifically delineate the RUF, but also the spatial extension of Uluberia municipality's fringe zones may provide useful information to policy-makers, urban and regional planners for city planning and smart design of urban growth.

References

Alam, S.M., & Khan, W. (1972). Metropolitan Hyderabad and Secunderabad: A Strategy for Development, Asia Publishing House, London.

Andrews, R.B. (1942). Elements in the Urban-Fringe Pattern, The Journal of Land & Public Utility Economics, 18, 169-183.

Arif, M., & Gupta, K. (2018). Mapping Peri-Urbanization in a Non-Primate City: A Case Study of Burdwan, India. European Academic Research, 5(11), 6065-6081.

Ban, Y., & Hu, H. (2007). RADARSAT fine-beam SAR data for land-cover mapping and change detection in the rural-urban fringe of the Greater Toronto Area. Urban Remote Sensing Joint Event.

Bengal, G.O. (2011). District Statistical Handbook. Haora: Bureau of Applied Economics and Statistics.

Carter, H. (1972). The Study of Urban Geography. London: Arnold.

Converse, P.D. (1948). New Law of Retail Gravitation. Journal of Marketing, 14(3), 379-384.

District Census Handbook. (2011). Haora: Census of India.

Doan, P., & Oduro, C.Y. (2012). Patterns of Population Growth in Peri-Urban Accra, Ghana. International Journal of Urban and Regional Research, 36(6), 1306-1325.

Dube, K.K. (1976). Use and Misuse of Land in the Kaval Towns. Varanasi: National Geographical Society of India.

Duncan, O.D., & Reiss, A.J. (1956). Social Characteristics of Urban and Rural Communities. John Wiley, 372.

Fesenmaier, D.R., Goodchild, M.F., Morrison, S. (1979). The Spatial Structure of the Rural-Urban Fringe: a Multivariate Approach. Canadian Geographer, 23(3), 255–265. https://doi.org/10.1111/j.1541-0064.1979.tb00661.x

Ganguly, M. (1967). The Nature of Fringe Area of Calcutta. Geographical Review of India, 29, 53–59.

Golledge, R.G. (1960). Sydney's metropolitan fringe: a study in urban - rural relations. Australian Geographer, 7(6), 243–255. https://doi.org/10.1080/00049186008702353

Hady, T.F. (1970). Differential Assessment of Farmland on the Rural-Urban Fringe. American Journal of Agricultural Economics, 52(1), 25–32. doi:10.2307/1238159

Hart, G.H.T., & Partridge, T.C. (1966). Factors in the Development of the Urban Fringe North-West of Johannesburg. South African Geographical Journal, 48(1), 32–44. https://doi.org/10.1080/03736245.1966.10559408

Hushak, L.J. (1975). The Urban Demand for Urban-Rural Land. Land Economics, 51(2), 112–123.

Jindrich, J. (2010). When the Urban Fringe is not Suburban. Geographical Review, 100(1), 35–55. doi:10.1111/j.1931-0846.2010.00005.x

Karg, H., Hologa, R., Schlesinger, J., Drescher, A., Kranjac-berisavljevic, G., Glaser, R. (2019). Classifying and Mapping Periurban Areas of Rapidly growing medium-sized Sub-Saharan African cities: A Multi-Method Approach Applied to Tamale, Ghana. Land, 8(40), 1–22. https://doi.org/10.3390/land8030040

Khan, K., & Munir, A. (2017). Delineation of Rural-Urban Fringe: A Case Study of Aligarh City. Forum Geografic, 16, 70–79. doi:10.5775/fg.2017.021.i

Kolhe, N.P., & Dhote, K.R. (2016). Rurban Centres: The New Dimension of Urbanism. Procedia Technology, 24, 1699–1705. 10.1016/j.protcy.2016.05.198

Kumar, P. (1980). Agricultural Changes in Urban Fringe. New Delhi: Rajesh Publication.

Kurtz, R.A., & Eicher, J.B. (1958). Fringe and Suburb: A Confusion of Concepts. Social Forces, 37, 32–37.

Lal, H. (1973). Urban Fringe: An Analysis of Concept. Uttar Bharat BhoogolPatrika, 9(2), 71.

Lal, H. (1987). City and Urban Fringe: A Case Study of Bareilly. New Delhi: Concept Publishing Company.

Lawrene, W.L., & Jeff, S.S. (2003). Land-Use Compatibility, Change and Policy at the Rural-

Urban Fringe: Insights from Social Capital. Am J Agr Econ, 85, 194–200.

Marchand, C., & Charland, J. (1992). The Rural Urban Fringe: A Review of Patterns and Development Costs. Toronto: Intergovernmental Committee on Urban and Regional Research.

Mukherjee, D. (1963). The Concept of Fringe and Its Delimitation – the Case Study of Orland, Florida, U.S.A. Geographical Review of India, 25, 45–55.

Mustak, S., Baghmar, N.K. Srivastava, P.K., Singh, S.K., Binolakar, B. (2018). Delineation and Classification of Rural–Urban Fringe Using Geospatial Technique and Onboard DMSP–Operational Linescan System. Geocarto International, 33(4), 375–396. doi:10.1080/10106049.2016.1265594

Myers, R.R., & Beegle, J.A. (1947). Delineation and Analysis of the Rural-Urban Fringe. Applied Anthropology, 6, 14–22. doi:10.17730/humo.6.2.q6114010757w80t0.

Nangaia, S. (1976). Delhi Metropolitan Region: A study in Settlement Geography. New Delhi: K.B. Publications.

Newman, D., & Applebaum, L. (1989). Defining the Rurban Settlement: Planning Models and Functional Realities in Israel. Urban Geography, 10(3), 281–295. doi: 10.2747/0272-3638.10.3.281

Nisha (2015). Delineation of Rural Urban Fringe of Indian Cities: A Case Study of Jammu City. IOSR Journal of Humanities and Social Science (IOSR-JHSS), 20(4), 105–115. doi: 10.9790/0837-2041105115

Piorr, A. (2011). Peri-Urbanisation in Europe: Towards European Policies to Sustain Urban-Rural Futures; Synthesis Report; PLUREL [sixth framework programme]. Copenhagen, Denmark: Forest&Landscape, University of Copenhagen.

Pryor, R.J. (1968). A Sampling Frame for the Rural-Urban Fringe. The Professional Geographer, 20(4), 257–261. doi:10.1111/j.0033-0124.1968.00257.x

Pryor, R.J. (1968). Defining the Rural-Urban Fringe. Social Forces, 47, 201–215. doi:10.1093/sf/47.2.202

Pryor, R.J. (1969). Delineating Outer Suburbs and the Urban Fringe. Geografiska Annaler Series, 51(1), 33–38. doi:10.2307/490648

Rao, B.P. (1982). Urban Fringe in German Towns: A Case Study of Wolfsburg and Marls-Huls. Uttar Bharat BhoogolPatrika, 18(2), 132–139.

Ravenstein, E.G. (1889). The Law of Migration. Journal of the Royal Statistical Society, 52(2), 241–305. doi:10.2307/2979333

Heimlich R.E., & Anderson W.D. (2001). Development at the Urban Fringe and Beyond: Impacts on Agriculture and Rural Land. Economic Research Service, 803, 11–14.

Saradar, J., & Hazra, S. (2014). Delineation of Peri-Urban Area Using Modern Techniques a Case Study of North 24 Parganas District, West Bengal, India. The Indian Journal of Spatial Science, 5, 62–69.

ADDIN Mendeley Bibliography CSL_BIBLIOGRAPHY Saksena, S., Fox, J., Spencer, J., Castrence, M., Digregorio, M., Epprecht, M., Vien, T. D. (2014). Classifying and mapping the urban transition in Vietnam. Applied Geography, 50, 80–89. https://doi.org/10.1016/j.apgeog.2014.02.010

Saxena, A.M., & Vyas, S. (2016). Delimitation of peri-urban area: Various approaches. International Journal of Combined Research & Development (IJCRD), 5(9), 691–698.

Scott, A., Carter, C., Reed, M., Larkham, P., Adams, D., Morton, V., Curzon, R. (2013). Disintegrated Development at the Rural–Urban Fringe: Re-connecting Spatial Planning Theory and Practice. Prog Planning, 83, 1–52. doi:10.1016/j.progress.2012.09.001

Sharp, J.S., & Clark, J.K. (2008). Between the Country and the Concrete: Rediscovering the Rural-Urban fringe. City and Community, 7(1), 61–79. doi:10.1111/j.1540-6040.2007.00241.x

Sinclair, R. (1967). Von Thunen and Urban Sprawl. Annals of the Association of American Geographers, 57, 72–87. doi:10.1111/j.1467-8306.1967.tb00591.x

Singh, D., & Vyas, A. (2014). Planning Strategies for the Development of Peri-Urban Area, The Case of Indore Peri-urban Area. International Journal of Scientific&Engineering Research, 5 (7), 27–32.

Singh, R.L. (1967). The Rural Urban Fringe Studies. The Geographer, 14, 9–22.

Singh, U. (1966). Urban Fringe of KAVAL Towns: A Study in their Delineation and Land-Use Change. Applied Geography, NGSI Varanasi, 42.

Sinha, M.P. (1974). Rural-Urban Fringe of Patna. Indian Geographical Study (Research Bulletin), 3, 28–32.

Sinha, M.P. (1980). The Impact of Urbanization on Land Use in the Rural Urban Fringe: A Case Study of Patna. New Delhi: Concept Publishing Company.

Ramachandran, R., Srivastava, B. (1974). The Rural-Urban Fringe: A Conceptual Frame for the Study of the Transformation of the Rural-Urban Fringe with Particular Reference to the Delhi Metropolitan Area. The Indian Geographical Journal 49, 1–9.

Sullivan, W.C., Anderson, O.M., Lovell, S.T. (2003). Agricultural Buffers at the Rural–Urban Fringe: An Examination of Approval by Farmers, Residents, and Academics in the Midwestern United States. Landscape and Urban Planning, 69, 299–313. doi:10.1016/j.landurbplan.2003.10.036

Tabor, K.W. (2013). Land use/cover dynamic, socio-economic and environmental transformations and implications: A geographical study of the fringe of

Finfine (Addis Ababa) city, Ethiopia. Ph.D. Thesis, Osmania University, Hyderbad, India, 2013.

Tobler, W. (1995). Migration: Ravenstein, Thorntwaite and Beyond. Urban Geography, 16(4), 327–343. doi:10.2747/0272-3638.16.4.327

Wehrwein, G.S. (1942). The Rural-Urban Fringe. Economic Geography, 18, 217–228. doi:10.2307/141123

Yuhong, L. (2016). Identifying the Peri-Urbanized Rural Areas in China: Estimation Based on Firm-level Data of the First and Second National Economic Censuses. Chinese Journal of Urban and Environmental Studies, 4(3), 1–16. https://doi.org/10.1142/S2345748116500238

Zasada, I. (2011). Multifunctional Peri-Urban Agriculture – A Review of Social Demands and Provision of Goods and Services by Farming. Land Use Policy, 28, 639–648. doi:10.1016/j.landusepol.2011.01.008

Zhao, P. (2012). Urban – rural transition in China's metropolises : new trends in peri-urbanisation. InternatIonal Development PlannIng RevIew, 34(3), 269–294. https://doi.org/10.3828/idpr.2012.20