



Spatial development planning in peri-urban space of Burdwan City, West Bengal, India: statutory infrastructure as mediating factors

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Abstract

Population growth, economic development, and rural–urban migration have contributed to the rapid growth of peripheral areas in Indian cities. The immigration of population and emergence of new activities are changing these areas, as seen in changes in land use and occupational structures, reduced agricultural activities, and built-up structural development. The city of Burdwan is no exception to this phenomenon of accelerated population growth. With the passage of time, this city is expanding towards peri-urban villages, thereby strongly influencing the peripheral rural settlements in the dimensions of both natural and social resource. Thus, advance spatial development planning of land use and infrastructure for a speedily growing population that is projected is highly important. In the current decade, the use of an environmental approach in the planning of peri-urban areas has gained significant recognition. However, desegregation of socio-economic sectors has been mentioned very loosely. This paper seeks to achieve spatial development in peri-urban areas by taking into account socio-economic and demographic factors along with environmental principles. Hence, the objective for the study is based on a mixed-method approach to assess major problems of a peri-urban space. We applied an interdisciplinary approach which merged household survey and temporal change analysis over three time periods (1991, 2001, and 2011) based on geographical information systems. Results show substantial built-up growth and that agricultural workers drastically decreased in the last twenty years. Finally, considering the structural and functional potential of peri-urban areas, land use zoning plan was prepared. Further, zone-wise development plan was designed for sustainable and intensive development of the city. This study has explicitly focused on quantifying physical and social infrastructure at various spatial scales, which can be implemented in other cities for balanced regional development and in identifying and mitigating disparities for balanced regional development.

Keywords Peri-urban · Spatial development · Planning · Infrastructure · Burdwan

Abbreviations

SOI	Survey of India
Toposheet	Topographical sheet
LANDSAT	Land satellite
USGS	United States Geological Survey
AMSL	Above mean sea level
C.D. Block	Community development block

1 Introduction

Turning villages into cities and later into megacities is one of the biggest challenges for our civilization, because of massive consequences connected with the impact that such rapid urbanization causes [1, 2]. It is empirically evident that, as a corollary to the steep growth in population, development of urban settlements is taking place rapidly over the last few decades [3]. Smaller villages are becoming larger, and their status of administration changes with

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a wink from village council to city council and beyond. Identically, smaller towns are acquiring the character of large urban centres, more prominently so in the global south urban scenario [4].

The post-independence period has witnessed a radical transformation of the urban landscape [5]. During this time in particular, one lakh cities started to develop rapidly [6]. This rapid rate of growth of cities could not be entirely accommodated within the limits of the existing cities [7]. Most rapidly developing cities over India are encompassed by thick and large, devastated, shanty towns [8] or different types of casual as well as sporadic housing, portrayed by insufficient framework, administration arrangement, and security of safe houses. These frequently spread into beforehand provincial and peri-urban land, regularly encompassing or converging with existing towns of differing period, size, and physical and useful structure [9]. This procedure makes complex zones regarding land residency, land use, access to administrations, and different proportions of social, financial, and political joining [10]. These complexities and related strains and clashes in this manner present imposing difficulties to organizers, governments, non-legislative associations, and inhabitants, as far as improving security of residency, overhauling settlements, administration arrangement, reconciliation with the urban areas, and related administration issues is concerned [11]. This clarifies the ongoing increment in globally subsidized investigation into, and worry with, peri-urban territories [12].

The peripheral areas around Indian cities undergo physical and morphological changes furthermore, in socio-economic terms [13]. The physical enlargement of a city inevitably brings in concomitant changes in peri-urban villagers. Industry, trade, government, schools, and healthcare development create employment for the rural population. It is pertinent to attempt a clear definition, before various aspects of a peri-urban space may be examined [14]. There is no generally acknowledged meaning of 'peri-urban' despite the fact that, in basic terms, it very well may be characterized as the territories around urban areas and towns described by rapid demographic, environmental, economic, social, and cultural interactions and changes [15]. Peri-urban area is considered as a transitional zone where the city and the countryside interact with each other [16]. In other words, peri-urban is a direct result of expansion. It results in population and economic growth which asks for housing and commercial areas. The residential location is ascertained by transport accessibility as well as cheap land values. All these factors mutually interact for urban expansion [17, 18]. The main cause of peri-urban population growth is migration and infrastructure. The general trend among people from rural households is to

sell labour and remit their income to families for survival. The pattern of migration may vary across different parts of India according to socio-economic and cultural setup [19]. Remittance income plays an important role in raising education, health, and living standards for the resident population. It is only for the better income that people come to the city. On the other hand, these cities create potential for economic growth of rural areas, as farmers can readily sell their commodities to a nearby city [20]. With time, economic structure and employment activities shift to peri-urban areas and secondary and tertiary activities move away from the volatile urban centres. Infrastructure is one of the important components of peri-urbanization [21]. The rapid growth of infrastructure helps to create an expanding market for vegetables, fruits, milk, etc. Primary urban infrastructures like road, water, and electricity are available in proximity to the city; thus, people prefer to live near the boundary of the city [22].

Urban growth in Indian cities has increased at an incomparable scale. The level of urbanization in a state is measured by the percentage of urban population. The state of West Bengal has experienced gradual increase of urbanization since 1971 until now [23]. The following table clearly depicts that the percentage of urban population increased in the state as well as the Barddhaman district [24]. Growing cities are constantly in need of space, the inadequacy of which makes people shift towards the peri-urban area [25, 26].

Burdwan is one of the oldest cities of West Bengal state in the eastern part of India [27]. Since its emergence, the pull factors of urbanization of this city are education, health, transportation, and market facilities along with agro-based industries such as rice manufacturing factories. This assemblage of socio-economic amenities has attracted immigrants from surrounding areas to this city [28]. The exorbitant population growth accompanied by the rapid expansion of built-up areas in the outskirts of the city of Burdwan is an important advancement noted in recent decades. Consequently, the city is expanding in a haphazard, unplanned manner and beyond its administrative boundaries into the surrounding rural areas [29]. At times, built-up growth in the periphery of the city takes place along roads with good transport network and public amenities, thereby giving it a longitudinal shape. It gets more prominent along the roads connecting to the city and its hinterland settlements. The development of these settlements is demarcated as city outgrowths, extending beyond the defined urban limits [30]. In other words, it is the built-up growth beyond existing settlements on to the vacant lands in adjacent locales. These settlements habitually acquire pseudo-urban character particularly in case of social and economic issues, while simultaneously being

functionally dependent on the main city. However, they grossly lack proper urban infrastructure and amenities [31, 32]. In recent years, the peri-urban space has seen a dramatic increase in the intensity of environmental degradation. Problems of inadequate access to basic amenities are further amplified by an expanding population which places enormous pressure on existing civic infrastructure, in particular for drinking water, sanitation, drainage, and solid waste management.

Class I towns in India have an increasing trend towards concentration of urban population [6, 33]. Table 1 clearly indicates that these towns are becoming places for larger number of people. The increasing population and rapid urban growth process of class 1 cities have also some important implications towards the peri-urban space. Like other Class I towns, Burdwan has developed in terms of population and urban growth is spreading to peri-urban spaces that have undergone significant changes [24]. This study investigates a number of problems associated with peri-urban areas in Burdwan city that faces several environmental, socio-economic, and administrative issues due to the rapid development of its periphery and human intervention. In this research, the authors identify the major issues and problems of peri-urbanization. Consequently, based on the problems, some recommendations are proposed to improve the study area. Finally, a spatial development plan was prepared to formulate recommendations for future growth of the peri-urban area of Burdwan city. The land use zoning map is designed for better comprehension within the broader corpus of planning law [34]. However, the broad objective of this plan is to include socio-economic development, overall improvement in physical and social infrastructure, growth management, and environmental quality in order to achieve a balanced growth in future. This article also helps to broaden the scientific understanding of the complex relationships between demographic, societal, and environmental impacts of land use and spatial development planning responses.

2 Literature review

Peri-urban space, which is placed on the periphery of a city boundary, presents many challenges as a complex interface between urban and rural parts of the land and influx of people into it. The literature on regional development suggests that major metropolises or primary cities continue to affect the growth of their peripheries [35]. Infrastructure is considered to be the key sector that supports all sorts of developments like social, economic, and others [36, 37]. Some researchers have tried to identify the relationship between infrastructure and development [38–40]. Several studies have clearly shown that local and regional authorities are neglecting the urban fringe in terms of infrastructure facilities, planned development, economic opportunities, and environmental pollution [41, 42]. According to the United Nations Human Settlements Programme, excess of 3 billion people will live and work in urban territories during the twenty-first century [43]. Among the primary issues that should be confronted are unemployment, increased poverty, unscientific land use, inadequate water supply, rising traffic clog, expanding pollution, and uncoordinated urban development [44]. Based on the scientific literature, this article condenses the social and environmental effects of land use change expected to happen in peri-urban zones, including specifically, the impacts of land development on agriculture, landscape character, and social factors. Peri-urban areas are not just sites of chaos; they are also areas of creativity [45]. These areas have rapidly expanding infrastructure services, large green areas, and lower land values relative to the city, creating potential for future multifunctional growth [46]. There is also increasing connectivity between peri-urban areas, bypassing the city centres, which demonstrates the growing importance of these locations. [47]. Peri-urban areas are described by quickly changing relationships between the uses and activities of rural and urban land and pose problems of both conceptual and realistic policy. Ramifications for peri-urban scenes are examined,

Table 1 Class I towns, percentage of urban population in India, West Bengal state, and Barddhaman district from 1971–2011. *Source:* Data from different census years

Census years	Number of Class I towns in India	Percentage of urban population in India	Percentage of urban population in West Bengal	Percentage of urban population in Barddhaman district
1971	148	19.91	24.7	22.78
1981	218	23.34	26.5	29.4
1991	300	25.72	27.5	35.08
2001	393	27.78	28.05	37.18
2011	468	31.16	31.9	39.87

Class I towns mean cities with 100,000 or more people

and suggestions for other created nations trying to change their arranging frameworks are talked about [48].

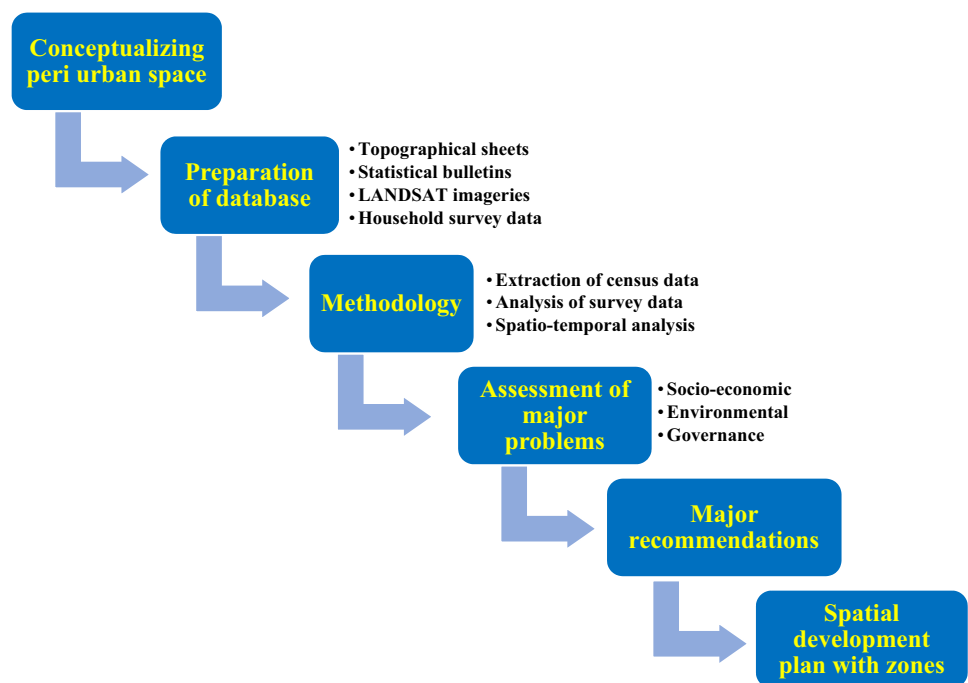
To identify the major problems, some researchers used different indicators for land use management, especially in the context of spatial urban development [49]. The main purposes of development planning indicators are identification and analysis of relevant issues, setting priorities according to objectives, and directing to evaluation of the development plan [50]. Some studies also suggest that there is close association between sustainable development and socio-economic components along with environmental issues [51]. Spatial planners and policy makers at present struggle to comprehend the peri-urban territory, with its blend of land uses and its transitional status between the urban and the provincial [52, 53]. Allen (2003) argues that a specific approach should be established to manage the peri-urban area, integrating attributes from urban, rural, and regional planning [54]. The expanding complexity of rural–urban interactions in the peri-urban area also means that policy makers are not properly prepared to comprehend and cope with the resulting combination of processes [55]. Continuous planning efforts are needed to balance conflicts of interest, overlapping demands and uneven growth of the urban fabric. The fractured and changing ecosystem is a particular problem [56]. While trying to reinforce the conceivable outcomes of peri-urban development planning with the help of different stakeholders [57], some other researchers have just contended that organizers need to relinquish their urban or rural inclination [58, 59]. Several studies have been conducted to analyse land use development planning

scenarios in and around the periphery area. However, there is limited literature addressing the environmental issues with socio-economic metrics for land use management. This study provides spatial development plan for future prospect of the peri-urban space of Burdwan city.

3 Database and methodology

The present study requires detailed information on problems and perspective development planning in the peri-urban area of Burdwan city. The study makes use of a variety of tools and methods to draw upon a comprehensive array of knowledge. To meet this end, a wide range of data was collected from different sources like Survey of India Toposheet No. 73 M/15 and M/16, census data of different years, LANDSAT series data from United States of Geological Survey, village revenue records, and the Indian Meteorological Department [60–63]. The village-wise population data were collected from Census of India 1991, 2001, and 2011. Census data provided valuable information at the village level and more broadly, the economic activities. The selected research area encompasses a wide range of villages which are located within 10 kms from the centre of the city. Primary information regarding social, economic, and environmental structure was collected from respondents using a well-structured questionnaire. A total of 250 households were sampled in peri-urban villages. Secondary data include general information on the villages and various settlement norms and their expansion in the concerned regions and field areas. Additional data for the study area

Fig. 1 Methodological framework of the study



were procured from various statistical bulletins and government publications [63–65]. The study generally integrated the primary and secondary data to assess the impact of urbanization processes on land use, demographics, occupation, and socio-economic issues of peri-urban villagers. The data thus collected from various primary and secondary sources to assess the peri-urbanization, demographic, and public amenities have been calculated and represented in Microsoft Excel software. A comparative study has been conducted over three time periods [1991 (TM), 2001 (TM), and 2011 (ETM+)] to evaluate built-up level of development in the peri-urban space of Burdwan city by using digital cartographic techniques. The Earth Resources Observation and Science (EROS) Data Center of the US Geological Survey (USGS) (<https://earthexplorer.usgs.gov>) was the primary source to procure the radiometrically as well as geometrically corrected images. The spatial analysis of built-up expansion was carried out on ArcGIS (v. 10.2.1) software [66]. A series of data indicators were used to emulate the best possible depiction of a development plan in the peri-urban space. On the basis of synthesis of analysed data and with the help of SOI Toposheet no 73 M/15 and 73 M/16, and all recommendations on major problems, this study suggests meaningful plan in a GIS environment for spatial development of peri-urban area (Fig. 1). Finally, a zoning plan was prepared which addresses issues of socio-economic and environmental problems and should help to mitigate the effects of declining quality of the peri-urban space.

3.1 Indicators and analytical methods

The development plan of the study area was examined through a quantitative and comparative approach. Initially, a comprehensive list of environmental, socio-economic, and administrative indicators was drawn up from the compilation of relevant articles, reports, and websites. A review of the indicators was performed based on the importance and contextual significance of each indicator to the study area. Indicators are being used to find out to what extent the processes of peri-urban growth comply with the envisaged spatial development. An indicator can be summarized as a modulated measure that indicates the performance of a system [67]. There are some indicators which are taken into consideration in preparing the development plan. A set of data indicators were used where the choice of components was primarily based totally to imitate the most effective probable depiction of development plan within the peri-urban space during 1991, 2001, and 2011. The time-series data were extracted from the District Census Handbook and District Statistical Handbook collected from the Census of India. A total of 13 components were used: five to develop an indicator to measure environmental problems, seven to develop an indicator to quantify socio-economic development and one to access capacity of governance (Table 2).

Table 2 Indicators selected for the spatial development planning

Indicators	Components	Definition	Data sources
Environmental	Potable drinking water	Water fit for drinking, being free from contamination	SHS
	Sanitation	Facilities and utilities for the safe management of human excreta from the toilet to containment, storage, and treatment on site or transportation	SHS
	Sewage system	Networks for the collection of waste water	SHS
	Waste disposal	Control of storage, collection, transfer, processing, and disposal of solid waste materials	SHS
	Change of built-up area	Increase or decrease of settlement area	LANDSAT imageries
Socio-economic	Agricultural workers	A person who is employed in agriculture	DCHB
	Monthly income per household	Amount of income for a whole family	SHS
	Working population per sector	Population employed in different economic sectors	SHS
	Healthcare	Preventative or necessary medical procedures to improve a person's well-being	SHS
	Educational facilities	Different types of educational institution from school and onwards	DCHB and SHS
	Small-scale industry	Industries in which manufacturing, service delivery and production are carried out on a limited scale	DCHB and SHS
	Transport facilities	Facility containing the required means and infrastructure for the transportation of passengers or goods	DCHB and RTO
Governance	Administrative boundary	Areas defined for the purpose of administration by a (local) government	DCHB

SHS Sample household survey, DCHB district census handbook, LANDSAT land satellite and RTO Regional transport office

4 Description of study area

Peri-urban area of Burdwan city is located in the moribund delta of Bengal plain [68] on the northern bank of River Damodar. The study area has an elevation of 31 metres

AMSL (SOI Toposheet: 73 M/15 and M/16, 1974, 1975). River Damodar forms the southern boundary, while river Banka flows from west to east through the city. Therefore, the relative relief is little higher in the western portion vis-à-vis the north-eastern part. However, the slope is gentle

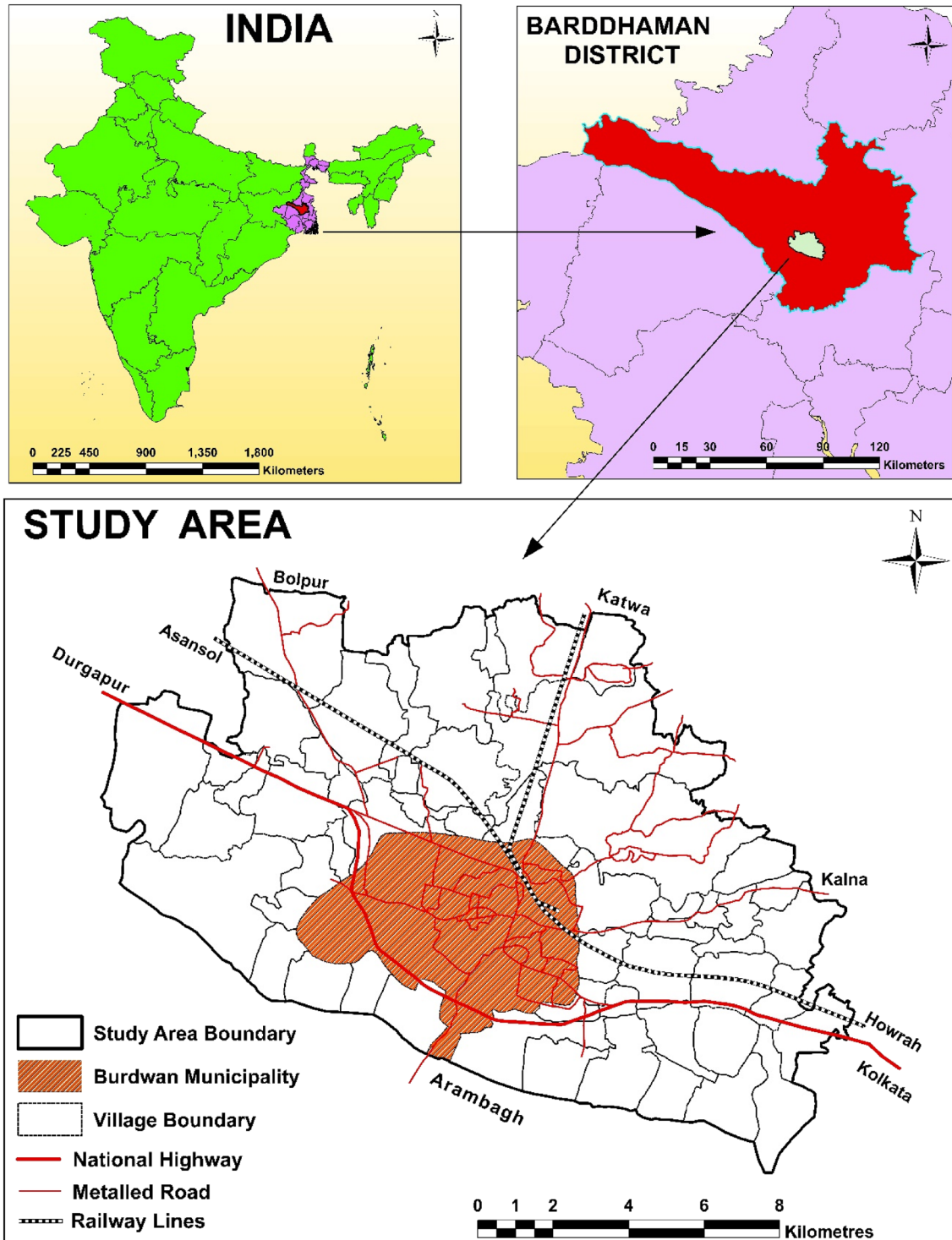


Fig. 2 Location map of the study area

from west to east. Boundary of the study area extends from 23° 10' N to 23° 20' N latitudes and 87° 46' E to 87° 58' E longitudes, comprising of 57 villages in 7 g panchayats (village council) spread across two community development blocks (C.D. Block), i.e. Burdwan I and Burdwan II. Within Burdwan I C.D. Block, there are 34 villages covering a 126 sq. km area and 23 villages within an area of 44 sq. km. in Burdwan II C.D. Block. Figure 2 shows that the study area has an extent of over to 170 sq.km. accommodating about 1,58,504 persons [63].

Recent decadal growth rates of the study area from 1991–2001 and 2001–2011 have been 32.2% and 28.3%, respectively. This indicates a rapid but decreasing rate of growth in the region. This is due to the tertiary economic activities having increased in recent times and the simultaneous increase in intra-district and interstate migration within the peri-urban villages of Burdwan city (Sample survey 2018). The population was 91,369 in 1991, and 158,504 in 2011 as per census of India [63]. In the last two decades, population has increased by 73.5% in the peri-urban area. Villages near the city limits have an influx of population. People migrated from other districts for government and private jobs, businesses, and educational purposes. This inflow into the city induced residential population growth and the city expanded physically to accommodate, first through the development of vacant land within the city itself and then through encroachment on land in areas lying outside the city limits [69]. The net result has been the intrusion of urban land uses into rural areas surrounding the rapidly growing Burdwan city [29]. The average population density of the study area is 1271 persons per sq.km which is higher than the Barddhaman district population density of 1099 persons per sq.km (Table 3). Therefore, population density is also one of the important discernible demographic factors.

There is no doubt that Burdwan city benefits from its prime location, situated in the lower gangetic plain of India, about 100 km from Kolkata, the capital city of the state. This city have advantages from being strategically located along the age-old Grand Trunk Road, an exceptionally busy route of over 2400 km length that connects Kabul in Afghanistan in the west with Chittagong in Bangladesh in the east [70] and National Highway 2, which is stretched over 1465 km and connects New Delhi to Kolkata. Besides that, the whole area is well connected by state highways (like Katwa road, Kalna road, Bolpur road, and Arambagh road) and railway network towards Howrah and New Delhi division. This zone also circumvents the district headquarter related to administration, transportation, and education. Therefore, the assemblage of educational, medical, and administrative services, expanding consumer market, and good transport network created strong magnetic pull factors and draws the attention of new residents

Table 3 Characteristics of the study area

Administrative unit	Village and census towns
Area in sq. km	144
Total population	158,504
Urban population (Census town)	73,450
Rural population	84,494
Share of population in the Barddhaman district	2.05%
Average household size (persons)	4.16

Census towns are not administered as a town but normally a whole village with minimum population of 5000, population density of at least 400 persons per sq. km. and 75% of the male main working population engaged in non-agricultural sector

as well as industrial investment in the peri-urban space of Burdwan city.

5 Spatial development planning in the peri-urban space

Development is a dynamic concept, and its basic aim is to raise the quality of living of people through various interventions in economic, social, political, and cultural dimensions [71, 72]. Development agenda's main motto is to reduce poverty, inequality, unemployment, illiteracy, poor health, and unsanitary conditions and provide access to portable drinking water, sanitation, sewage, and other basic amenities for each family. In a gist, development is a quantitative and qualitative change in various socio-economic indicators [73]. Planning is defined as a process of setting goals, formulation of objectives, development of strategies, and sector-wise allocation of resources in order to accomplish the development goals and objectives within a particular period. Another social scientist viewed preparation as encompassing all the events contributing to the setting of priorities and the correct course of action leading to their achievements [74, 75]. A development plan has to be simple, logical, and internally consistent and should provide information on development indicators, tasks, activities, and targeted output and outcome. The plan needs to put an emphasis on both spatial and intensive development of the peri-urban space of the city [73]. Development planning usually follows a set of distinct phases like.

- i. Identification of key issues and problems of the indicators
- ii. Developing recommendation and
- iii. Preparing development plan to address the objectives

5.1 Problems of indicators

5.1.1 Environmental indicator

Burdwan has seen a tremendous growth of population in the last two decades. This unprecedented growth of population created environmental problems of haphazard and imbalanced development in the peri-urban area of the city. The exceeding population started sprawling beyond the city limit into the peripheral areas [63]. A number of problems related to water supply, sanitation, drainage, and solid waste have cropped up with the growth of peri-urban in the Burdwan city (Sample survey 2018). Following are the major issues.

5.1.1.1 Potable drinking water Water is one of the basic needs for all forms of life. The major sources of potable water are tap water, tube wells, and wells (both personally and community owned). Residential areas in the peri-urban villages and colonies are not provided with water by the municipality because it falls outside the municipal limits. It is learned that majority of the households are depending on groundwater extracted through their own tube wells for drinking. On the face of increased demand for piped water facility, there is a huge surge in the use of submersible pumps in these areas (Fig. 3). Villages mainly located adjacent to municipal boundary are availing both submersible and tap water. However, villages located on the bank of river Damodar have no water supply from the village administration and on top of that, the water level goes down in the summer season. Keeping in mind the low water level at villages, there is a need to develop an alternative source of potable water.

5.1.1.2 Sanitation The most crucial problem in the peri-urban area is poor sanitation facilities. As the population of the peri-urban area grows, the sanitation problems also escalate day by day. Very unhealthy sanitation and waste-

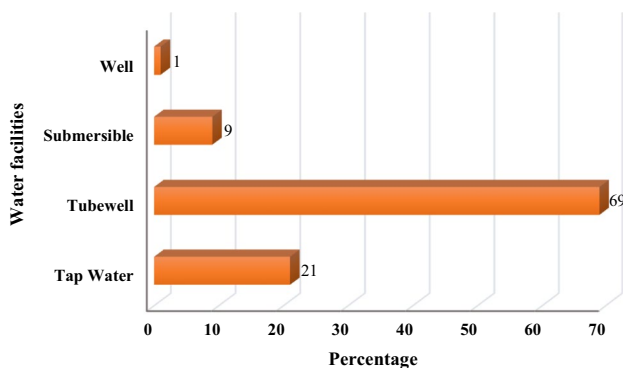


Fig. 3 Sources of drinking water in peri-urban area. *Source:* Sample survey 2018 and Census of India 2011

water disposal system has contaminated the groundwater and converted rivers into sewers. Poor sanitation condition has also created different diseases in households especially for children. Besides, people are using open land, embankments of Damodar Valley Corporation (DVC) canal, ponds, riversides, roadsides, and rail lines for open defecation. Villages located in south-west and west direction are facing unsanitary and unhygienic conditions due to this problem. About 52 percent of households have septic tanks in their premises (Fig. 4). However, people living adjacent to the city boundary have better hygienic and sanitation conditions. Villages, mainly Krishnapur, Goda, Sadhanpur, Mirzapur, Gopalnagar, and Alisha, have good sanitation condition, where some households are even using flush latrines with a concrete drainage system.

5.1.1.3 Sewage system Peri-urban area has no planned sewage system. The drainage condition is categorized under three heads which include no drainage, mud drainage, and concrete drainage. On an average, 52.6% and 89.5% of households have 'open pucca' (open concretized) and 'open kuccha' (open dirt and mud based) drain, respectively (Fig. 5). In many areas, even outlets of septic tanks are connected to the open drainage channels making the environment unhygienic. Villages located in the north-west side have very good drainage conditions. Besides this, villages that are located far from the city boundary have relatively poor drainage conditions. However, some residents used two types of drain for dirty water.

5.1.1.4 Waste disposal The major sources of solid waste generation in the peri-urban area are households, cow dung, agricultural wastes and industries. There is no systematic arrangement for the collection and treatment of solid waste. It is observed that people tend to throw the wastes on to the streets, or some unoccupied land, or directly to the drains. Waste disposal is analysed into four categories, i.e. category 1 which includes 54% disposal of

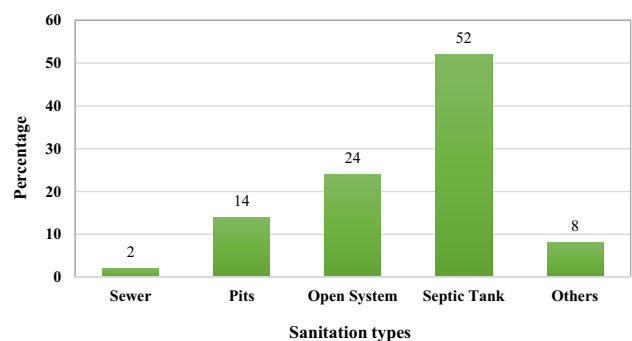
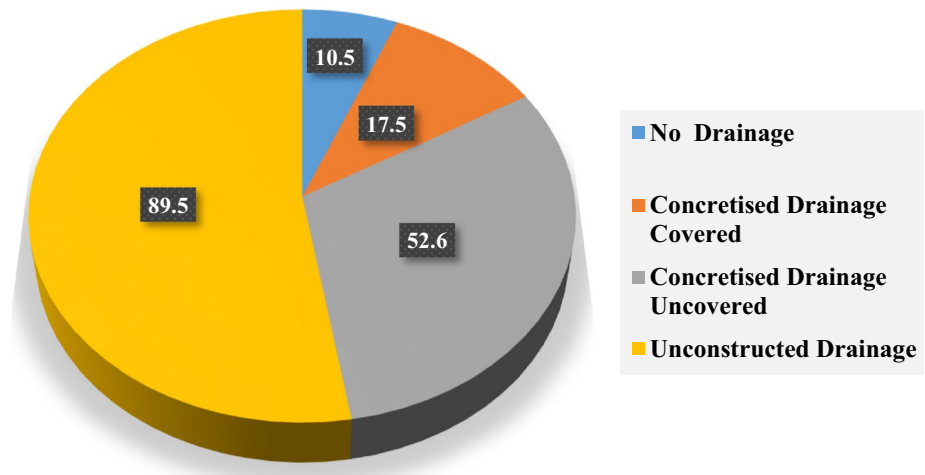


Fig. 4 Percentage of sanitation types in peri-urban area. *Source:* Sample survey 2018 and Census of India 2011

Fig. 5 Percentage of sewage status in peri-urban area.
 Source: Sample survey 2018 and Census of India 2011



waste along road/street sides, category 2 which includes 22% disposal of waste in drains, category 3 which includes 32% disposal at defined points and category 4 which includes 24% waste disposal at no particular place (Fig. 6). With no dumping points and segregation site servicing the villages, most of the garbage is left on the roads to rot and cause unhygienic conditions.

5.1.1.5 Change of built-up area The fundamental is that urban development is a cumulative result of population growth and built-up area expansion. In the case of peri-urban space of Burdwan city, these changes lead to an increase in environmental problems. By spatial analysis, it is found that built-up area was about 14.26 sq. km. in 1991, which increased to 21.6 sq. km in 2002 and 36.58 sq. km in 2011 (Fig. 7). Therefore, the net built-up area rises about 156% in twenty years. The villages of the peri-urban area show great variation in the density of population. There is an increasing trend in density

from 1991, 2001 and 2011 with 686 and 949 and 1265 persons per square kilometre, respectively. The areas with increasing population density and built-up areas exist near the city in the north-east and north-west directions (Fig. 8). These places are located along viable transport routes. The constricting nature of topography between the Eastern Railway line and Damodar river is mainly responsible for extending growth in the east-west directions.

5.1.2 Socio-economic indicator

Socio-economic indicator in the peri-urban area is very much important as this zone is interlacing both urban and rural ways of living. The major components of this indicator are income, working sector, work place, agricultural workers, small-scale industries, and transport facilities.

Fig. 6 Percentage of waste disposal site in peri-urban area.
 Source: Sample survey 2018 and Census of India 2011

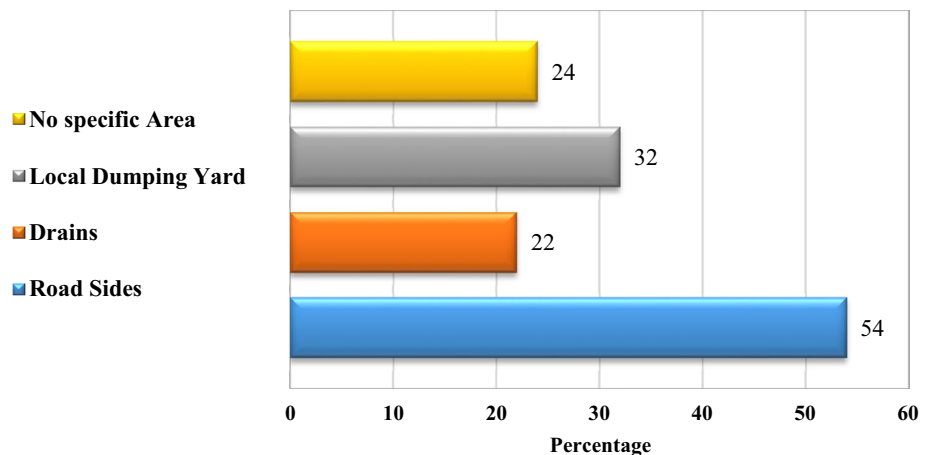


Fig. 7 Development of built-up areas with population density in peri-urban area. Source: Census of India 1991, 2001, 2011

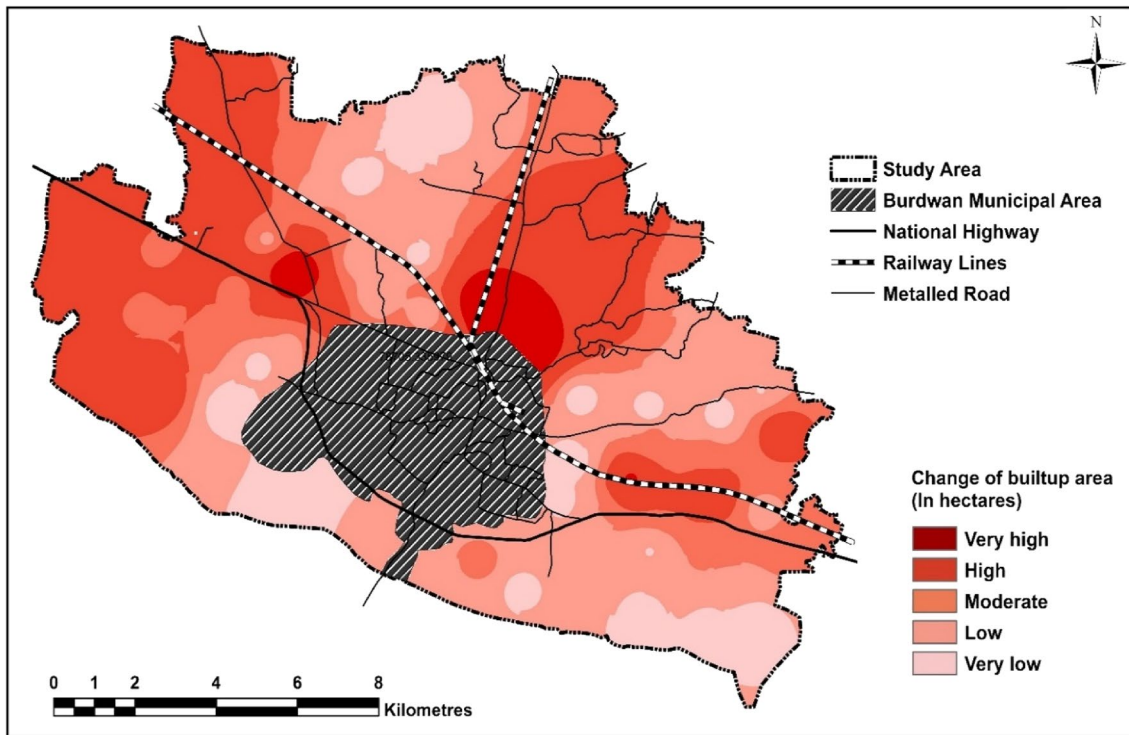
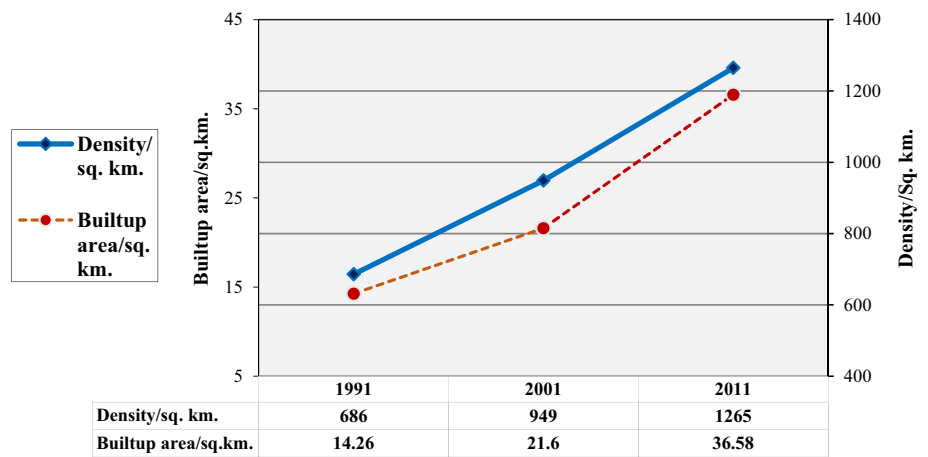


Fig. 8 Change of built-up area in peri-urban space of Burdwan city from 1991 to 2011

5.1.2.1 Loss of agricultural workers Transformation of agricultural land to commercial use creates lack of productive land, as non-farm operations raise land values leading to high demand for space, degradation of the landscape, overlapping disputes, and environmental pollution [76]. A distinctive feature of the peri-urban area is that land is often under intense pressure due to various usage conversion processes and increased marketing. Therefore, the peri-urban area is regularly described by an

interwoven mosaic of different developments, incorporating residential areas mixed with vacant land and agricultural land switching from agriculture to industrial use [77]. The agricultural land conversion to urban uses is one of the most prominent changes that result from economic development [78]. With the loss of agricultural land, there is also a decrease in the number of agricultural workers in the peri-urban area of Burdwan city. It is seen that the number of agricultural workers has decreased from 72.9%

Table 4 Rate of change in agricultural workers within 57 villages *Source:* Census of India 1991, 2011

Agricultural workers (in %)	Number of villages	
	1991	2011
<40%	4	13
40–60%	6	20
60–80%	25	21
>80%	22	3

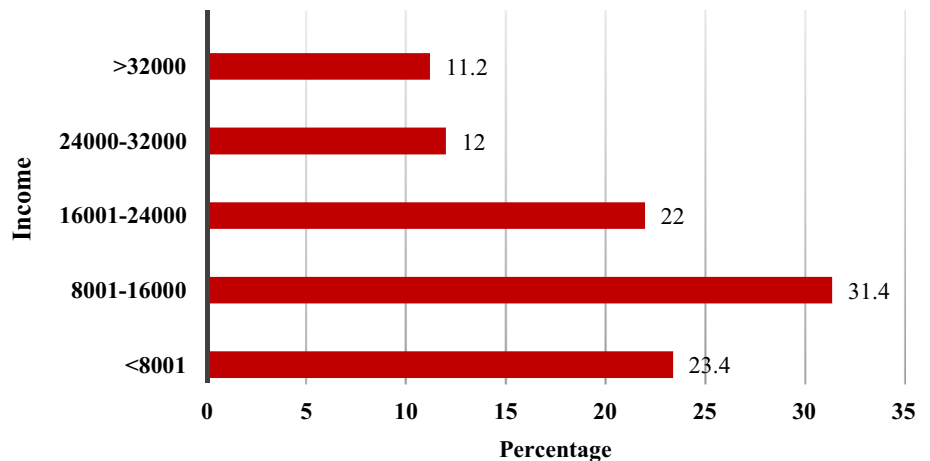
in 1991 to about 54.6% in 2011, a decrease of around 18% in 20 years (Table 4). Sample survey observed that workers have shifted to different works in the informal sector. Villages located on the bank of Damodar river have seen a decrease of more than 50% in agricultural workers population in the last two decades. The percentage of agricultural workers was above 80% in 22 villages in 1991, whereas it is only in 3 villages in 2011.

5.1.2.2 Monthly income per household Analysis of data shows that there are great variations in the income level among the population in the peri-urban area. It ranges between 8000 rupees per household (monthly) and 32,000 rupees and above per household (monthly). To depict the distribution of average monthly per capita income in the sample areas, data are grouped into five income classes. The lowest class is prepared on the basis of Ministry of Labour and Employment wage structure to unskilled and skilled labourers. The analysis shows that the highest percentage of households in the peri-urban area fall into two income groups like below 8000 and 8000–16,000 rupees. Income varies with the diversification of economic activities, which is highest in the high density and least distant villages. Following Fig. 9 clearly depicts that about 11.2 percent of the people have a high income in the peri-urban villages.

5.1.2.3 Working population per sector Distribution of occupation type is not uniform all over the peri-urban villages. Villages near the Burdwan city have higher urban influence and prototypical urban land use than the areas farther away from the city, which influences the occupation structure. A sectoral analysis of the economy indicates a presence of diverse economic activities, with a predominance of tertiary sector activities. At present, 74 percent workers are engaged in tertiary activities, 22 percent workers are engaged in primary activities and 4 percent are involved in secondary activities (Sample survey and Census of India, 2011). Primary activities, particularly agriculture and fishing, are the dominant source of income and employment (Fig. 10). Diverse types of tertiary activities are found in the peri-urban area. A good number of people have shops in the village and many of them worked in the fields. Besides, a significant proportion of them work in public and private sector. In addition, many people come to the city for work in various outlets and shops.

5.1.2.4 Healthcare facilities Another prime component of socio-economic indicator is the healthcare system. A proper healthcare system in an area ensures the prosperity of health for its residents. With the increase in population, demand for healthcare facility has also increased. There is only one government hospital in Burdwan city. Most of the villages have very poor healthcare facilities with only a few villages having a primary healthcare centre. Consequently, the majority of people come to Burdwan Hospital for treatment which is at a distance of 5 km on average. In 2003, Anamoy Superspeciality Hospital was established in Bamachandaipur village of Burdwan II Block, but it is yet to start its journey properly. In last ten years, some private hospitals have been built along the road. Hospitals named Sharanya, Camri, KIMS, and Medica are located along the National Highway 2 (NH-2). In addi-

Fig. 9 Percentage of monthly income per household in peri-urban area (1 US Dollar = 64 rupees in 2018). *Source:* Sample survey 2018



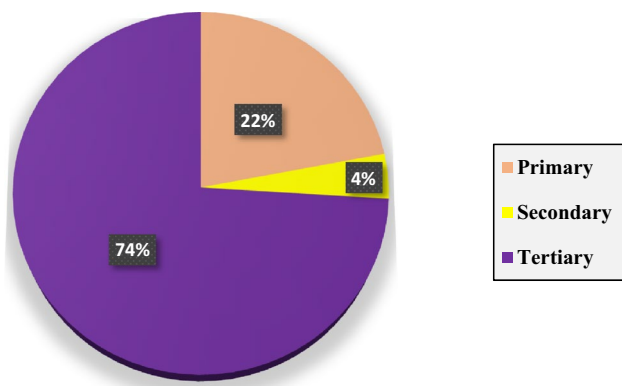


Fig. 10 Percentage of working sector for households in peri-urban villages. *Source:* Census of India 2011 and Sample survey (2018)

tion, 17 nursing homes are located in different villages of the peri-urban area. Notwithstanding, it is very unfortunate that there is no trauma care centre along the high-ways or some other critical junctures.

5.1.2.5 Educational facilities One of the prime components of socio-economic indicator is education. Burdwan city stands second in the state after Kolkata considering the educational facilities that already exist. With the passage of time, newly developed residential areas have surged demand, leading to mushrooming of schools and colleges. Peri-urban area has a significant number of schools. Field survey has shown that peri-urban areas have significant types of educational services like primary schools, junior high schools, high schools, technical colleges. However, most of the schools are up to primary level. From the survey, it is found that there are 70 schools up to primary and middle level, 9 schools up to secondary level and 1 school up to higher secondary level (Fig. 11). Apart from schools, peri-urban area has 4 technical educational institutes. The educational institutions for

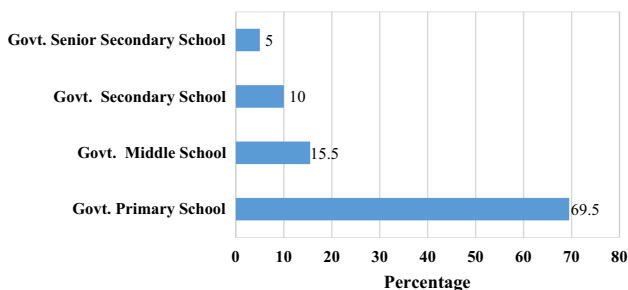


Fig. 11 Percentage of availability of schools in peri-urban area (primary school up to class 4, middle school up to class 8, secondary school up to class 10 and senior secondary school up to class 12). *Source:* Sample survey 2018 and District statistical handbook 2014

higher secondary education and beyond in the peri-urban area are also inadequate in number.

5.1.2.6 Small-scale industries The land is fertile and has access to irrigation facilities that helps to grow paddy. Rice mills and processing units are the major small industries prevalent in this area. Apart from rice mill units, there are rot iron manufacturing units, PVC pipe factories, purified water manufacturing units, puffed rice, and some brick kiln units located. In addition to the rice processing factories, there is rapid increase in building materials manufacturing units such as brick kilns, tiles, cement and concrete, pre-manufacturing units and related activities. Such activities will be further pushed in the future by steady growth of construction activities along with the recent boom in real estate investments.

5.1.2.7 Transport facilities The growing population of peri-urban areas has put a burden on its transport network and infrastructure. Peri-urban villages have improved accessibility especially in terms of road transport. A large number of people could come to the city for different purposes due to the good accessibility by road. The improvement in roads has significantly helped the expansion as well as development of the peri-urban space. In this area, the total length of bitumen road is 39 km and concrete road is about 85 km (data collected from village council). Most of the people come to the city by cycle and bus, while some also come by motorcycle and electric rickshaws. It is also found that about 54% villages accessed bus service within 1 km and 40% villages have accessibility within 1 to 5 km distance (Fig. 12). In the north-east, north-west, and south-east direction, villages have good transportation facilities as against the villages in other directions having very poor transportation facilities because of unmetalled roads. Overall good connectivity is available in the peri-urban space of Burdwan city.

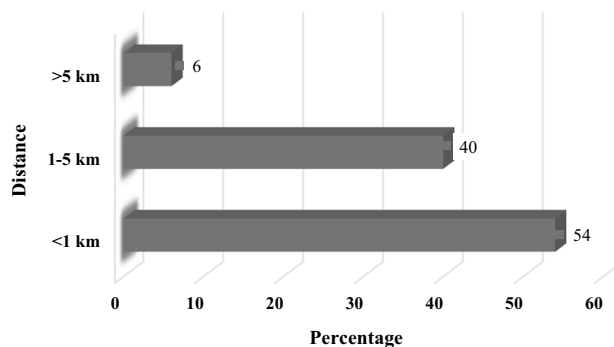


Fig. 12 Percentage of villages for bus service with different distances in peri-urban space. *Source:* Census of India 2011

5.1.3 Governance indicator

A significant part of India's peri-urban area is not governed by municipal administration but by rural bodies. Public amenities, such as water supply, sanitation, waste collection and disposal, street sweeping and lighting, are not part of rural authority's responsibilities [21]. The peri-urban area is a concern for the administration. The study area comprises 57 revenue villages. The de facto administration of these villages is run by the local self-government who are administratively and financially powerless. It is no wonder that the peri-urban area remains a zone with no responsible authority to look after. The gram panchayat, coupled with their little knowledge to deal with urban affairs, seldom gets the wholehearted support from the administrative personnel. Village representative, known as Pradhan, sorts any problems concerning land use. Besides, since the peri-urban villages are under the control of more than one administration there are many places with gaps and overlapping responsibilities. Moreover, there is inadequate understanding of city administration in the panchayat personnel. All these lead to haphazard development in the peri-urban areas.

5.2 Major recommendation

The peri-urban area has suffered a neglect from both rural and urban ends with regard to policy and decision-making. The problems of the peri-urban area are indeed many and varied. In particular, they can be categorized into three major areas: (i) environmental issues, (ii) socio-economic issues, and (iii) the problem of governance. Above all, the problem of the peri-urban area is a human problem in which residents of the peri-urban villages give up rural life due to inducing circumstances [14]. Effective planning of the development trajectory requires careful attention towards the following aspects (Table 5):

5.3 Preparing spatial development plan

Identification of various issues and challenges due to development is an arduous task. However, it is a matter of fact that the peri-urban area is confronting various issues and challenges in the last two decades. For a holistic and an all-round development, it is imperative to prepare an integrated plan which would not lead to a skewed development [54]. Burdwan is experiencing high population growth in recent decades [63]. Taking a cue from this trend it can be naturally concluded that residential areas will see high intensive growth in near future. As a consequence of this gestation period, the intensity of growth within a definite time frame will be moderate for this zone. The industrial growth has not shown any considerable trend, which is expected to tread the same line in the near future, thus

this zone will experience low-intensity growth. However, all these propositions hold ground on a condition that status quo in land use characteristics will be maintained. The comprehensive development plan provides a strategic framework for land use planning in the peri-urban area of Burdwan city for shaping its future. It is observed while analysing the different indicators involved in the dynamic process of urban development that a unique pattern of planning zones has evolved.

The development of assorted activities in the ever-changing environmental, social, and economic scenario of the peri-urban area is an ongoing process. The zoning regulations allow for the approval of different activities in the key land use areas in order to simplify planning procedures and satisfy development criteria. In order to facilitate public health and welfare of the community, it is necessary to apply reasonable limitations in land use. The study area is divided into a number of zones for this reason. Zoning is not retrospective. It does not restrict land uses which are legally used until the zoning regulations come into effect. The zoning law and its implementation are a big tool for maintaining the spatial development plan pattern of land uses. It has been stated that researchers have adopted the West Bengal Town and Country (Planning & Development) Act 1996 guidelines with minor modifications. The purpose of zoning this spatial structure is to provide a scientifically designed framework for the analysis of existing land use and landform, future population distribution, changing the occupational structure, possible industrial locations, traffic alignments and the distribution of social and physical infrastructure to accommodate the future population. Thus, a series of zones based on intensiveness are scientifically demarcated in the peri-urban area (Fig. 13). This region is delineated into six different types of potential development zones. These zones are as follows:

- Residential zone
- Institutional zone
- Industrial zone
- Transportation zone
- Healthcare zone
- Restricted zone

5.3.1 Residential zone

The purpose of this zone is to provide a scientifically designed frame based on an analysis of existing built-up area, population density, changing occupational structure, possible industrial corridor, road network, and the level of social and physical infrastructure to accommodate the future population. The proposed residential corridor is scheduled to prosper in this area. Due to rising population

Table 5 Major recommendation of indicators for spatial development *Source:* Prepared by authors and based on Sample survey 2018

Indicators	Area of intervention	Recommendations
Environment	Water supply	Very necessary to establish pumping stations on both sides of the peri-urban area, so that water can be distributed to all households with a nominal rate A 30 million-gallon water treatment plant needs to be constructed and treated water be distributed to the villages after chlorination process Appropriate water pricing to cover cost of delivering potable drinking water
	Sanitation	To implement rules for individual households, flushing type of latrine with septic tank is to be made compulsory Build community toilet in every village Construct a sewerage treatment plant
	Sewage	Identify the water accumulation areas due to lack of adequate drainage A detailed drainage channel layout needs to be prepared at a convenient scale on the basis of a topographical survey All the villages should have a proper drainage system
	Waste disposal	Provision of covered community waste bins at proper distances for the people to deposit domestic wastes Should have door-to-door waste collection system Prepare a biomedical waste disposal and segregation system in two blocks of the peri-urban area
	Change in built-up area	A spatial infrastructure plan should be prepared by observing such factors as land use and land form, population density, changing occupational structure, and traffic alignments to accommodate the future population [79] New settlement areas will grow in low built-up villages, i.e. Chandul, Goda, Kamnara, Rayan, Nari, Alisha, Bamchandaipur
Socio-economic	Loss of agricultural workers	To increase the production of agricultural products as well as income Generating employment opportunities by aggregating raw and processed products Reducing production and price risk by implementing agriculture insurance scheme. This scheme should give compensation for any kind of loss Agri-infrastructure including agricultural markets, cold storage, warehouses, and agro-processing should expand at the required pace with that of agricultural production
	Household income	Should increase the income in agricultural sector by giving fixed amount for major agricultural products Villagers should be involved in regular work rather than part time work More female work participation
	Healthcare	Make Anamay hospital a full-fledged hospital rather than an extension of Burdwan Hospital Should construct health corridor in peri-urban area. Open more fair price medicine outlets in each village Each village council should have an ambulance
	Education	Very necessary to establish senior secondary schools with all facilities like text books, furniture, storage in classrooms, playgrounds, libraries, laboratories, etc. Upgradation of middle school to higher secondary school
	Small-scale industry	To reduce pollution in nearby villages Need to upgrade to modern technology and increase productivity Develop strong marketing network
	Transport facilities	All earthen roads to convert to black topped roads Improvement of road geometry by correction of alignment, segregation of pedestrian walkways, appropriate location of road dividers [80] Construct a bypass for heavy loaded trucks and also go downs in this road
	Governance	Development of an efficient regulatory framework and the establishment of city planning committees is very important Taking necessary measures to merge peri-urban areas with local urban authorities Strengthening regulatory framework of local body ombudsman Unified command under an empowered and accountable Mayor

pressure, new settlements will come up in this corridor with all the public amenities. This zone provides a mix of housing types, including single-family detached, single-family attached, townhouses, and multi-family residences,

with the simultaneity of a number of offices and convenient commercial places within the primarily residential areas. Accordingly, for future population growth, this zone

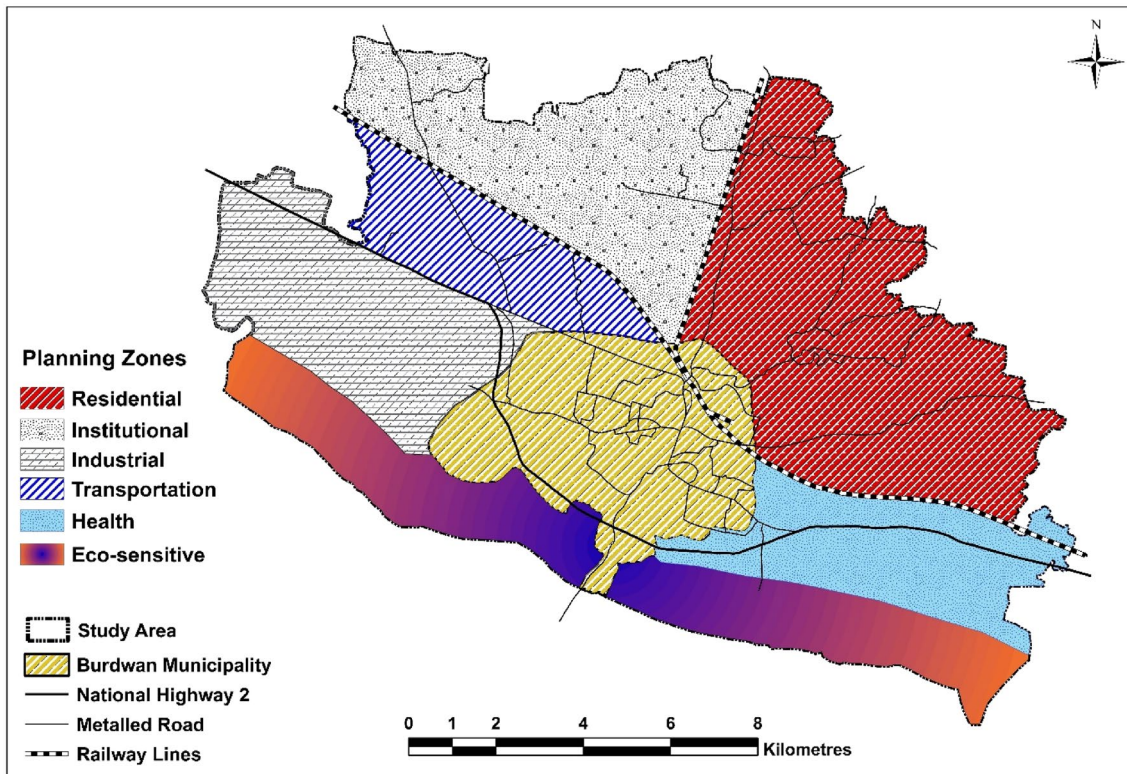


Fig. 13 Future planning zones of peri-urban area of Burdwan city. Source: Prepared by authors

has been proposed through greater densification in the north-eastern part of the existing city.

5.3.2 Institutional zone

This zone is a new development of varying density establishing upon vacant land, agricultural land and government land. Within this zone, institutional hubs are located keeping in view future developments. The institutional zone has been conceptualized for regional and national level institutes. Furthermore, this hub is mostly located between the railway tract of Asansol and Katwa. So, there is a higher need for creation of high school, higher secondary school in future. Private sector should be encouraged in to the main stream of the education system.

5.3.3 Industrial zone

The concept of industrial zone basically developed along the major linear transportation area. This zone will consist mainly of low-density areas and where infrastructure capacity is sufficient and places that have experienced unplanned development, and also those with the intrinsic potential to develop as future industrial hub. This zone is basically demarcated for industrial development. So, this corridor accommodates a range of non-polluting industrial

enterprises, including those with significant external linkages like milk industry, food processing, automobile complex, cold storage, ice factory, and agro-based industries. Industrial zone is located entirely along the national highway which facilitates easy loading and unloading of goods.

5.3.4 Transportation zone

The peri-urban space has been physically divided into two halves, bigger and denser half lying north of the railway tracks and smaller half lying south of the railway tracks. The roadways and railways constitute major transportation zone in the peri-urban area. This proposed transport hub is very near to Kazi Nazrul Islam Airport. So, the existing wholesale activities should be shifted along the national highway in the western part of peri-urban Burdwan. This will ease transportation of goods like agricultural products from the adjoining hinterlands. Besides this, it is very necessary to expand newly built Nababhat bus stand to an interstate bus terminal.

5.3.5 Healthcare zone

It is very necessary to develop healthcare facilities in a zone where all kinds of facilities will be available including good connectivity to all locations. There is an urgent need

to increase government healthcare facilities in peri-urban areas with more sophisticated medical equipments, developing autoclaves for waste disposal, setting up a drug store, and purchasing more ambulances with a single dial number for emergency. Government should establish new hospitals with the public private partnership model. There is lack of healthcare facilities like doctors, dispensaries, and diagnostic centres in the peri-urban area. So, the proposed zone will give all the healthcare facilities under one umbrella. A coordinating system will provide solutions to hospitals, physician practices, through a robust medical information system.

5.3.6 Eco-sensitive zone

It is an eco-sensitive zone as it is located on the banks of Damodar river. The entire area is gifted with tremendous natural resources in the form of a riverine ecosystem. Here, land will not be available for urban development in the foreseeable future and would continue to cultivate cash crops and medicinal plants. The entire river belt region on the right side of the peri-urban area has been proposed for recreational land use with green buffers all along the river embankment. Besides that, botanical and zoological garden, water retention basins, cottage industries with related training facilities, nature tourism with camping sites, and nature observation parks will be encouraged here.

The different sectoral plans that have been drawn up for development over the period of 20 years have given a general idea of an investment that needs to be undertaken. Public sector agencies alone would not be able to arrange all the required investment. As a result, there is the need of the hour to strike a partnership between the public sector and the private sector.

6 Conclusion

Peri-urban spaces are highly dynamic [81]. Internal migration processes in many peri-urban areas around the Burdwan city are inducing rapid changes. The future impacts of these changes on rural landscapes must be identified and the problems and prospects evaluated in order to anticipate or adapt to the combined impacts of urban growth. This article examined the need for a system for spatial development planning to overcome foreseeable issues for preserving existing landscapes in fifty-seven villages of the peri-urban area. To assess the problems of peri-urban space, different indicators were developed regarding changes of physical and economic landscapes. For spatial development planning, the indicators chosen in this study represented, e.g. environment,

socio-economic infrastructure, and governance. In this case study, by using specific indicators, the evaluation of progress towards development planning in the peri-urban area was facilitated. The resulting set of indicators examines environmental issues like water supply, sanitation, sewage, solid waste management, and built-up areas. It is found that most of the villages face serious problems in these areas. An appraisal of socio-economic indicators reveal that villages located far away from the city boundary have lesser number of schools, healthcare centres, poor transport facilities, and average income per household. Continuous growth of built structures over rural jurisdictions created haphazard development. Third area of concern relates to governance issues which are inefficient in the peri-urban space. The capacity of current governance structures to address the instability arising from the complexity of these spaces is a major problem in governing peri-urban spaces. Therefore, a set of recommendations are given to address all the issues concerning these indicators. In view of these emerging problems and to address the recommendations, it is necessary to formulate a spatial development plan for the planned growth of peri-urban spaces around Burdwan city. So, we need a more holistic, territorially oriented perspective to shape policies in the peri-urban area of Burdwan city.

Batty (2008) contends that urban areas, for the most part, develop from the bottom up, where economy and transport go about as the key components, while spatial arranging and urban structure assumes an optional job [82]. The examination of administration forms in the investigation region has demonstrated that they can be successful just in the event that they depend on a trained conventional administration and arranging framework; else, they have almost no possibility to control factors that play over spatial procedures in the peri-urban region. Thus, the proper setting up of formal institutional systems, policies, and regulations is of paramount importance in resisting disordered peripheral settlement growth. However, both urban and rural governance ignores the problems of peri-urban areas because they fall outside their *de jure* limits. Thus, an independent separate authority should be established to solve the trivial problems of the peri-urban area. Future research on spatial development planning in India can complement development planning processes in rural areas and investigate less spectacular urban and peri-urban development planning in medium and small cities.

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Compliance with ethical standards

Conflicts of interest The authors declare no conflict of interest.

Appendix

See Fig. 14.



Dumping solid waste beside house



Solid waste dumping ground



Poor drainage system



Mud road with improper drainage



New settlement in agricultural land



High rise apartment in progress



Rot iron industry in village



Brick kiln factory in agricultural field

Fig. 14 Photographs of the different indicators in peri-urban space of Burdwan city. *Source:* Captured by authors

References

- Jaysawal D, Saha S (2014) Urbanization in India: An impact assessment. *Int J Appl Sociol* 4(2):60–65
- Vishwanath T, Lall SV, Dowall D, Lozano-Gracia N, Sharma S, Gun WH (2013) Urbanization beyond municipal boundaries: nurturing metropolitan economies and connecting peri-urban areas in India (English). *Directions in development; countries and regions*. Washington D.C.: The Worldbank. <https://documents.worldbank.org/curated/en/373731468268485378/Urbanization-beyond-municipal-boundaries-nurturing-metropolitan-economies-and-connecting-peri-urban-areas-in-India>
- Pradhan KC (2017) Unacknowledged Urbanisation: the new census towns in India. In: Denis E, Zérah MH (eds) *Subaltern urbanisation in India*. Springer, New Delhi, pp 39–66
- Narain V (2009) Growing city, shrinking hinterland: land acquisition, transition and conflict in peri-urban Gurgaon. *India Environ Urban* 21(2):501–512
- Kumar J (2015) Metropolises in Indian urban system: 1901–2011. *Eur J Geogr* 6(3):41–51
- Nallathiga R, Taneja S, Gupta A, Gangal B (2017) sustainability of urban fringe development and management in NCT-Delhi: a case study. In: Mukherjee J (ed) *Sustainable urbanization in India*. Springer, Singapore, pp 109–133
- Roy A (2009) Why India cannot plan its cities: informality, insurgency and the idiom of urbanization. *Plan Theory* 8(1):76–87. <https://doi.org/10.1177/1473095208099299>
- Mishra SV (2018) Dispossession by appropriation in a global south city: geography, cartography and statutory regime as mediating factors. *Int J Urban Sci* 23(1):105–121. <https://doi.org/10.1080/12265934.2018.1443397>
- Allen A, da Silva N, Corubolo E (1999) Environmental problems and opportunities of the peri-urban interface and their impact upon the poor, Research paper, Strategic Environmental Planning and Management for the Peri- Urban Interface project, Development Planning Unit, London, www.ucl.ac.uk/dpu/pui
- Palmer D, Friczka S, Wehrmann B (2009) Towards improved land governance. Food and Agriculture Organization of the United Nations, Rome
- Simon D, McGregor D, Nsiah-Gyabaah K (2004) The changing urban-rural interface of African cities: definitional issues and an application to Kumasi. *Ghana Environ Urban* 16(2):235–248
- Mayer H, Knox P (2010) Small-town sustainability: Prospects in the second modernity. *Eur Plan Stud* 18(10):1545–1565
- Dupont V (2017) Urban development and population redistribution in Delhi: implications for categorizing population. In: Champion T, Hugo G (eds) *New forms of urbanization: beyond the urban-rural dichotomy*. Ashgate, Aldershot, pp 171–190
- Ramachandran R (1992) *Urbanization and urban systems in India*. Oxford University Press, New Delhi
- Birley MH, Lock K (1998) Health and peri-urban natural resource production. *Environ Urban* 10(1):89–106
- Shukla A, Jain K (2019) Critical analysis of rural-urban transitions and transformations in Lucknow city, India. *Remote Sens Appl Soc Environ* 13:445–456
- Briggs J, Mwamfupe D (2000) Peri-urban development in an era of structural adjustment in Africa: the city of Dar es Salaam. *Tanzania Urban Stud* 37(4):797–809
- Abass K, Adanu SK, Agyemang S (2018) Peri-urbanisation and loss of arable land in Kumasi Metropolis in three decades: Evidence from remote sensing image analysis. *Land Use Policy* 72:470–479
- De Haan A (1999) Livelihoods and poverty: The role of migration - a critical review of the migration literature. *J Dev Stud* 36(2):1–47
- Brook R, Dávila J (2000) *The peri-urban interface: a tale of two cities*. School of Agricultural and Forest Sciences, and Development Planning Unit, University College London, Bangor
- Shaw A (2005) Peri-urban interface of Indian cities: growth, governance and local initiatives. *Econ. Political Wkly*. 129–136.
- Webster D (2002) *On the edge: shaping the future of peri-urban East Asia*. Asia/Pacific Research Center, Stanford
- Samanta G (2012) In between rural and urban: Challenges for governance of non-recognized urban territories in West Bengal. In: Jana NC, et al. (eds) *Geo-Spatial Issues*. Department of Geography, The University of Burdwan, West Bengal, pp 44–57
- Office of the Registrar General and Census Commissioner (2011). *District statistical handbook, Barddhaman, Part XII A-B. Directorate of Census Operations, Government of West Bengal*. https://censusindia.gov.in/2011census/dchb/1909_PART_B_DCHB_BARDDHAMAN.pdf on 17 December 2017. Accessed 15 November 2018.
- Drakakis-Smith D (1995) Third world cities: sustainable urban development. *Urban Stud* 32(4–5):659–677
- Wang MY (1997) The disappearing rural-urban boundary: rural socioeconomic transformation in the Shenyang-Dalian region of China. *Third World Plan Rev* 19(3):229
- Marshall PJ (2006) *Bengal: The British Bridgehead: Eastern India 1740–1828, vol 2*. Cambridge University Press, Cambridge
- Laha M (2019) Centripetal Forces Of Urbanization In Barddhaman Municipality. *West Bengal Trans Inst Indian Geograph* 41(1):33–50
- Arif M, Gupta K (2018) Mapping peri-urbanization in a non-primate city: a case study of Burdwan. *India Eur Acad Res* 5(11):6065–6081
- Nilsson K, Pauleit S, Bell S, Aalbers C, Nielsen TAS (eds) (2013) *Peri-urban futures: scenarios and models for land use change in Europe*. Springer Science & Business Media, Berlin
- Herrschel T (2010) Cities, suburbs and metropolitan areas—governing the regionalised city. *Res Urban Sociol* 10:107–130
- Halkatti M, Purushothaman S, Brook R (2003) Participatory action planning in the peri-urban interface: the twin city experience, Hubli-Dharwad. *India Environ Urban* 15(1):149–158
- Samanta G (2017) New urban territories in West Bengal: Transition, transformation and governance. In: Denis E, Zérah MH (eds) *Subaltern Urbanisation in India. Exploring Urban Change in South Asia*, Springer, New Delhi, pp 421–441
- Otubu AK (2012) Conceptualizing zoning within the lagos megacity project: a prognosis. *J Environ Earth Sci* 2(10):1–9
- Roberts BH (2014) Managing systems of secondary cities: Policy responses in international development. Brussels: Cities Alliance: Cities without Slums. <https://www.citiesalliance.org/node/4978>. Accessed 15 November 2018.
- Holtz-Eakin D, Schwartz AE (1995) Infrastructure in a structural model of economic growth. *Reg Sci Urban Econ* 25(2):131–151. [https://doi.org/10.1016/0166-0462\(94\)02080-Z](https://doi.org/10.1016/0166-0462(94)02080-Z)
- Kessides C (1993) In Kessides C (ed) *The contributions of infrastructure to economic development: A review of experience and policy implications*. World Bank Publications, Washington D.C
- Saxena A (2001) Monitoring of urban infrastructure in cities and its fringe areas through remote sensing. Paper presented at Asian conference on remote sensing, November 5–9, 2001. Singapore.
- Rana IA, Bhatti SS, Arshad HSH (2017) Assessing the socio-economic and infrastructure development disparity – a case study of city districts of Punjab. *Pakistan Int J Urban Sust Dev* 9(3):346–358. <https://doi.org/10.1080/19463138.2017.1320286>
- Abbas S, Hussain MS, Im S, Lee S, Shirazi SA (2018) Urban Growth and Its effect on temperature trends of Lahore City. *Pakistan J Clim Res* 13(3):231–245

41. Dupont V (2005) Peri-urban dynamics: Population, habitat, and environment on the peripheries of large metropolitan cities. CSH Occasional Paper (15). Centre Pour Sciences Humaines (CSH), New Delhi
42. Zérah MH (2005) Towards an improved urban governance of public services: Water supply and sanitation. In: Evelyn H, Michael M (eds) *Urbanization and governance in India*. Manohar Publishers, New Delhi, pp 127–150
43. UNCHS (2000) *The Habitat Agenda*, United Nations Centre for Human Settlements, <https://www.unchsh.org/unchsh/english/hagenda/ch-1a.htm>, Accessed 10 June 2019.
44. Burgess R, Carmona M, Kolstee T (eds) (1997) *The challenge of sustainable cities: neoliberalism and urban strategies in developing countries*. Zed Books, London
45. Foot J (2000) The urban periphery, myth and reality: Milan, 1950–1990. *City* 4(1):7–26
46. Ravetz J, Fertner C, Nielsen TS (2012) The dynamics of peri-urbanization. In: Nilsson K, et al. (eds) *Peri-urban futures: scenarios and models for land use change in Europe*. Springer, Berlin, pp 13–44
47. Tacoli C (1998) Rural-urban interactions: a guide to the literature. *Environ Urban* 10(1):147–166
48. Swaffield SR (2012) Reinventing spatial planning at the urban rural interface: a Christchurch, New Zealand case study. *Plann Pract Res* 27(4):405–422
49. Weiland U, Kindler A, Banzhaf E, Ebert A, Reyes-Paecke S (2011) Indicators for sustainable land use management in Santiago de Chile. *Ecol Indic* 11(5):1074–1083
50. Fraser EDG, Dougill AJ, Mabee WE, Reed M, McAlpine P (2006) Bottom up and top down: analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environmental management. *J Environ Manage* 78(2):114–127. <https://doi.org/10.1016/j.jenvman.2005.04.009>
51. Goodarzi M, Haghtalab N, Saedi I, Moore NJ (2019) Structural and functional improvement of urban fringe areas: toward achieving sustainable built–natural environment interactions. *Environ Dev Sustain*. <https://doi.org/10.1007/s10668-019-00511-4>
52. Szulczewska B, Kaliszuk E (2003) Challenges in the planning and management of 'green structure in Warsaw. Poland, *Built Environ* 29(2):144–156
53. Abbas S, Shirazi SA, Qureshi S (2018) SWOT analysis for socio-ecological landscape variation as a precursor to the management of the mountainous Kanshi watershed, Salt Range of Pakistan. *Int J Sustainable Dev World Ecol* 25(4):351–361
54. Allen A (2003) Environmental planning and management of the peri-urban interface: perspectives on an emerging field. *Environ Urban* 15(1):135–148
55. Hudalah D, Woltjer J (2007) Spatial planning system in transitional Indonesia. *Int Plan Stud* 12(3):291–303
56. Mattingly M (1999) Institutional structures and processes for environmental planning and management of the peri-urban interface. Development Planning Unit University College London, London
57. Al Mamun MM, Kim SM (2019) Stakeholder analysis matrix for buffer zone management in the peri-urban area of Chittagong. Bangladesh *Environ Dev Sustain*. <https://doi.org/10.1007/s10668-019-00435-z>
58. Sieverts T (2003) *Cities without cities: An interpretation of the Zwischenstadt*. Routledge, New York, pp 48–68
59. Feng S, Patton M (2017) Empirical analysis of differential spill over effects within a growth equilibrium framework: Urban–rural versus rural–rural linkages. *Pap Reg Sci* 96(4):743–758
60. Survey of India (1974) Barddhaman District, West Bengal, (sheet 73M/16, 1:50,000). Government of India, Kolkata
61. Survey of India (1975) Barddhaman District, West Bengal, (sheet 73M/15, 1:50,000). Government of India, Kolkata
62. U.S. Geological Survey (2017) USGS Earth Explorer. <https://earthexplorer.usgs.gov>. Accessed 18 August 2017.
63. Registrar General and Census Commissioner (2013) *Census of India 2001, 1991, 1981, 1971: District Census Handbook, Barddhaman*. Directorate of Census Operations, West Bengal
64. Regional Transport Office (RTO), Registration of Vehicle in Barddhaman district, Barddhaman (M. Arif, Interviewer) (2018)
65. Peterson JCK (1910) *Bengal district gazetteers: Burdwan*. Bengal Secretariat Book Depot, Calcutta
66. Environmental Systems Research Institute (ESRI) (2017) *ArcGIS Release 10.2.1*. ESRI, Redlands, CA
67. Flowers J, Hall P, Pencheon D (2005) Mini-symposium—public health observatories. *Public Health* 119(4):239–245. <https://doi.org/10.1016/j.puhe.2005.01.003>
68. Spate OHK: *India and Pakistan*, (Methuen & Co. Ltd, London) 1954, 827p. *Jpn. J. Hum. Geogr.* 6(4), 315–316.
69. Gupta S, Roy M, Sarkar A (2013) Identification of urban sprawl dynamics in a rapid growing city using GIS. *Int J Geom Geosci* 3(3):486–499
70. Arden H (1990) Searching for India: along the Grand Trunk road. *Natl Geogr* 177(5):118–138
71. Thahane TT (1974) Planning for development. Accelerated development in Southern Africa. Palgrave Macmillan, London, pp 447–459
72. Kohsaka H (2000) Applications of GIS to urban planning and management: Problems facing Japanese local governments. *GeoJournal* 52(3):271–280
73. Pattanaik BK (2016). *Introduction to Development Studies*. SAGE/TEXTS.
74. Mycoo M (2005) Sustainable livelihoods in the peri-urban interface: Anse La Raye, St Lucia. In: McGregor D, et al. (eds) *The periurban interface: approaches to sustainable natural and human resource use*. Earthscan, London, pp 134–148
75. Diaz-Chavez R (2005) Measuring sustainability in peri-urban areas: case study of Mexico City. In: McGregor D, et al. (eds) *The peri-urban interface Approaches to Sustainable Natural and Human Resource Use*. Earthscan, London, pp 246–261
76. Clark JK, Jackson-Smith D, Sharp J, Munroe D (2007) The geography of US periurban agricultural adaptation. In: *TransAtlantic Land Use Conference*, Washington, DC. <https://cffpi.osu.edu/agadapt.htm>.
77. Atkinson A, Dávila JD (2019) The challenge of environmental management in urban areas. Routledge. <https://doi.org/10.4324/9780429439094-1>
78. Yeh AGO, Li X (1999) Economic development and agricultural land loss in the Pearl River Delta. *China Habitat Int* 23(3):373–390
79. Llausàs A, Buxton M, Beilin R (2016) Spatial planning and changing landscapes: a failure of policy in peri-urban Victoria. *Australia J Environ Plann Man* 59(7):1304–1322
80. Arif M, Gupta K (2019) Application of graph-based model for the quantification of transport network in peri-urban interface of Burdwan City. *India Spat Inf Res* 28(4):447–457. <https://doi.org/10.1007/s41324-019-00305-w>
81. Geneletti D, La Rosa D, Spyra M, Cortinovis C (2017) A review of approaches and challenges for sustainable planning in urban peripheries. *Landsc Urban Plan* 165:231–243. <https://doi.org/10.1016/j.landurbplan.2017.01.013>
82. Batty M (2008) The size, scale, and shape of cities. *Science* 319(5864):769–771

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