Planning for water and sanitation in the residential suburbs: the case of Aligarh City, India

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ABSTRACT

This paper examines the status of water and sanitation conditions in the residential suburbs of Aligarh city. The study is mainly based on primary sources of data collected through field/household surveys with the help of questionnaire interviews. Data was collected from 996 households living in 66 developed residential colonies. The services were categorized into three levels (standards), level 1 (basic), level 2 (intermediate) and level 3 (higher), to assess their standard. The standard score additive model has been used to arrive at a Composite Mean Standard Index (CMSI). The average value of CMSI of water and sanitation were calculated and further categorized into four levels, high, moderate, low and very low, for the purpose of planning. Maps were prepared accordingly. Results have shown that colonies located along the main roads have a high level of water and sanitation facilities compared with the colonies located along the wedges of two roads.

Key words | levels, residential colonies, sanitation, suburbs, water

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INTRODUCTION

Managing urban growth has become one of the most important challenges of the 21st century (Cohen 2006). India is urbanizing rapidly and this trend is certain to gather pace in the next 20–30 years. It is anticipated that by 2030, 350 million people will have moved from the countryside to urban centres and by 2050, 700 million people will have done so (Sabikhi 2012). The last two censuses (Census of India 2001, 2011) show that there has been a steady rise in the number of new census towns (towns that have a population of over 5,000) over the years and in due course many of these towns will grow in size and become cities. There are no plans for these new settlements as well as for the existing cities that are witnessing massive expansion. The population outside the cities has grown faster indicating a strong tendency for outward expansion of urban areas over their fringes, engulfing villages and farmlands and transforming them into dense commercial, industrial and residential areas resulting in the development of suburbs (Angel *et al*. 2005).

The occurrence of suburbs around Indian cities is a rather recent phenomenon. The main reason for the absence of suburbs was the slow growth of cities. Any small increase in the population (the population of Aligarh city grew from 669,087 in 2001 to 872,500 in 2011; Census of India 2001, 2011; Aligarh Nagar Nigam 2011) of a city was generally absorbed within the existing residential areas. It was only with the flow of new migrants into the city, that the city's residential areas could no longer absorb the growth, and the city began to expand physically, first through the development of vacant land within the city itself, later by the slow encroachment of land in areas lying outside the city limits. The uncontrolled and unplanned expansion in the spatial extent of the cities creates residential hubs (concentration of residential areas) where many residential colonies develop without any basic amenities and facilities. In India these are basically poor areas inhabited by poor, low skilled migrant workers, who cannot afford the higher cost of living in the city. Presently this trend is changing. Nowadays, the land at edges not only provides housing but is also being converted into property for commercial and industrial factories and for middle and high income residential housing (Singh & Abbas 2011). Primary urban facilities, such as

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water supply and sewerage, are for the most part not available because the city provides these services to places within the municipal limits; outside the municipal limits in the residential suburbs, lack of necessary administrative infrastructure and lack of finances mean that these services are not provided by the municipality (Ramachandran 2001). In order to understand the needs of people and provide a livable environment in the residential suburbs, in-depth surveys have to be conducted to find a solution.

Keeping these aspects in mind, Aligarh (27°53′N latitude and 78°4′E longitude), a medium-sized city located about 133 km away from the country's capital, New Delhi, in the western part of the state of the Uttar Pradesh, in the fertile Gangetic plain of North India, was selected as the study area (Figure 1). In this paper, an attempt has been made to assess the state of water supply and sanitation and to suggest suitable measures for providing a livable environment in the residential suburbs.

DATABASE AND METHODOLOGY

The present study is mainly based on primary sources of data which has been collected through an in-depth survey of the residential suburbs and households living in the developed residential colonies. The following methods were used:

1. The suburban residential colonies were identified with the help of satellite imagery IRS-P6, March 2007 and extensive field surveys which were conducted during 2009 and 2010. Ninety-four colonies were identified, 66 developed (colonies which were sold off by the

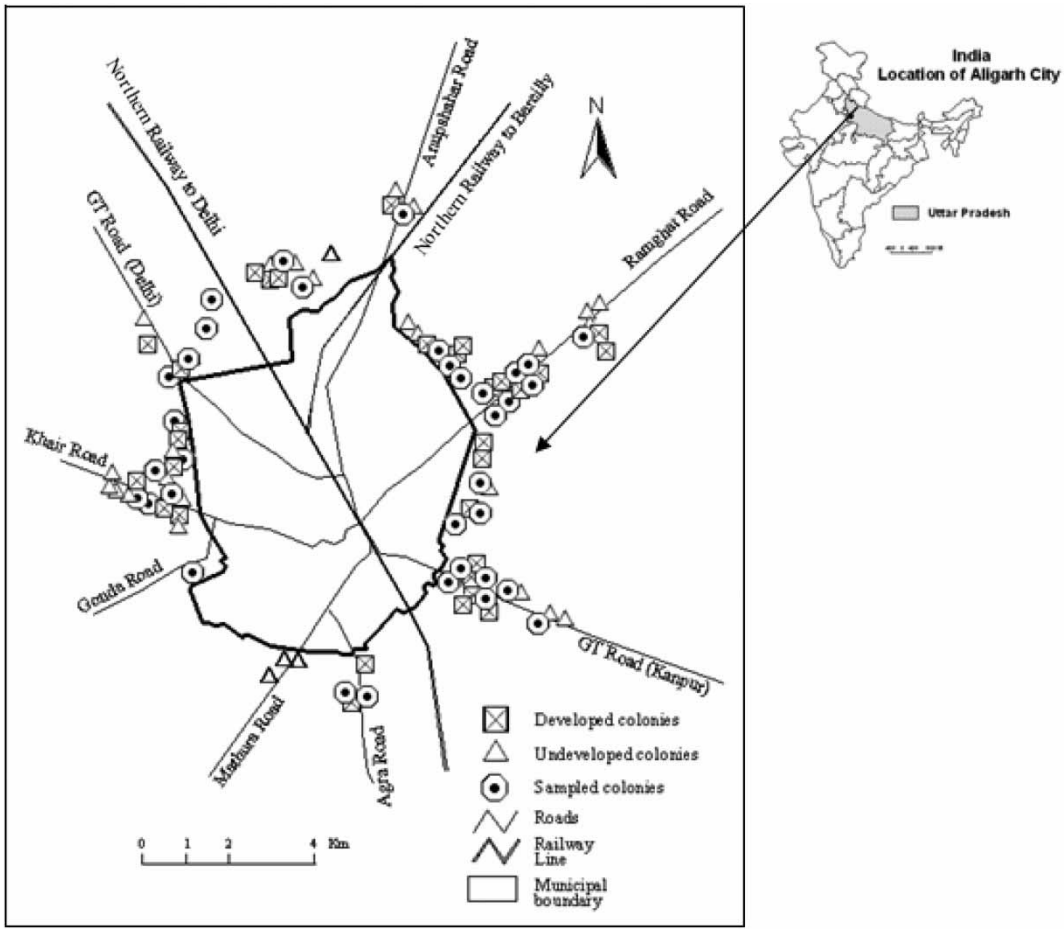

Figure 1 | Aligarh city: Residential colonies in the suburbs (2009–2010). *Source*: IRS-P6, satellite imagery, March 2007; Based on field survey, 2009–2010.

colonizers and were occupied by people) and 28 undeveloped (colonies in which only plots have been demarcated, no or little construction work has been started and no one lives there; Table 1 and Figure 1).

2. To gather relevant information about the state of water supply and sanitation in the residential colonies, a questionnaire was prepared with the help of questionnaires used in similar studies (MaGranahan 1993; Mitra 1993; Sharma & Sharma 1994; Rahman 1998; Singh & Rahman 1998; Khan 2005). For in-depth investigation, 35 developed residential colonies (>50% of the developed residential colonies) were selected and from each colony up to 29 households were sampled. The total sample size consisted of 996 households.
3. To examine the level (standard) of services, the data collected regarding the state of water supply and sanitation has been categorized into three service levels – level 1 (basic), level 2 (intermediate) and level 3 (higher) – to show the present quality of the services. The choice of the level of a particular service is influenced by affordability as well as need. The quality of service decreases from level – 1.
4. The standard score additive model has been used to arrive at a composite standard index (Smith 1973; Bishnoi & Aneja 2008). Standard scores have been used to develop a composite score availability of water supply and sanitation services in the residential suburbs. The standard score measures the departure of individual observations from the maximum and minimum values of all observations in a comparable form.

$$Si = (Xi - \min)/(\max - \min) \quad (1)$$

where Si = standard index of the ith variable, Xi = original value of the individual observation, min = minimum value of the variable, max = maximum value of the variable.

The values of standard scores are added and their average is taken to obtain the composite mean standard index and algebraically expressed as:

$$\text{CMSI} = \sum Si/N \quad (2)$$

where CMSI = composite mean standard index, $\sum Si$ = sum of standard index of variable j in observation i, N = number of variables.

5. For demarcation and mapping of different levels of water supply and sanitation services in the residential colonies for the purpose of planning, a total of eight indicators under two subheads were taken into consideration:
   (i) For the state of water supply, two indicators (availability of submersible/tubewells inside the premises, good quality of water supply).
   (ii) For the state of sanitation, six indicators (flush latrines inside the house; disposal of excreta from flush latrines into soak pits; *pucca nali* (cemented drains) in the premises; disposal of wastewater/waterlogging in open plots/fields; disposal of household/commercial/industrial waste in collection points; and frequency of garbage collection by private agency twice a week) were considered.

Table 1 | Overall levels of state of water supply in the residential suburbs of Aligarh city (2009–2010)

	Overall levels of water supply condition[a]		
Name of the roads/bypasses	**Level 1**	**Level 2**	**Level 3**
1. Anupshahar Road	–	16.67	83.33
(1). Anupshahar Road to Ramghat Road bypass	8.33	64.44	27.22
2. Ramghat Road	0.78	5.99	93.23
(2). Ramghat Road to GT Road (Kanpur) bypass	2.22	34.45	63.33
3. GT Road (Kanpur)	–	4.88	95.12
4. Agra Road	3.33	24.17	72.50
(3). Mathura Road to Khair Road bypass	13.33	65	21.67
5. Khair Road	1.85	24.07	74.07
(4). Khair Road to GT Road (Delhi) bypass	3.33	37.78	58.89
6. GT Road (Delhi)	2.50	20.83	76.67
(5). GT Road (Delhi) to Anupshahar Road bypass	4.13	43.12	52.75
Total sampled households 996	**2.76**	**26.15**	**71.09**

Note: [a]Averages (in per cent) of two important factors considered for water supply condition under each level.
Level 1 – roadside handpumps, poor quality of water supply.
Level 2 – handpumps inside premises, average quality of water supply.
Level 3 – submersible/tubewells inside premises, good quality of water supply.
Source: Based on field survey, 2009–2010.

The average values of CMSI of water supply and sanitation were calculated and further categorized into four levels for the purpose of planning – high, moderate, low and very low levels – with the help of mean and standard deviation methods (standard grading system) and were mapped with the help of GIS Arc view 3.1.

RESULTS AND DISCUSSION

Background of the study area

Cities get their water supply from surface sources (rivers, lakes, ponds) and from groundwater sources. Aligarh city depends on groundwater sources for its water. The water from the two rivers, Ganga (in the north-east) and Yamuna (in the north-west), which form the highland peripheries and flow 50 – 60 km away from the city, cannot be tapped (owing to the saucepan-shaped topography of the city and district). The other two rivers of some importance are the Kali and Sengar (downstream) but both are seasonal rivers and dry up during the summer season, and the city drains (carrying wastewater) open into the Kali Nadi (river), so the water is not potable. Therefore, the city and its peripheral areas fully depend upon the groundwater. The alluvial terrain of the Ganga plain forms one of the richest water-bearing formations. The Pleistocene and recent deposits which are composed of sands and gravel constitute the aquifers. These plains are immense reservoirs of fresh, sweet water stored in more porous, coarser strata, beneath the level of saturation, and they are easily accessible by means of ordinary boring. The underground aquifers are supplemented by rain water which sinks easily into the ground. The percolation from major rivers and their tributaries also contributes to maintaining groundwater level. The physical setting therefore provides every facility for the boring of tubewells (Azam 1998).

Topographically, Aligarh district represents a shallow trough, in a saucepan shape, with the city lying in the centre of the low-lying tract. Because of the saucepan-shaped topography, not only does the dirty water from the city collect here but so does water from peripheral areas, and there is no outlet. The poor natural drainage is responsible for the peculiar drainage and sewerage problems faced by the city and its periphery. It is a very difficult task to improve the natural drainage. Water remains stagnant in the open drains because of the absence of an outlet. So the city and its peripheral areas not only become submerged during the rainy season but also remain submerged all year round because of poor natural drainage. The waterlogged areas become breeding grounds for mosquitoes and other pests. Therefore, the city and its peripheral areas need proper laying and management of a drainage system to avoid overflowing, flooding and waterlogging (Singh & Rahman 1998).

Satellite imagery (IRS-P6) and field surveys helped in identifying 94 suburban residential colonies. Of these, 66 were developed and 28 undeveloped. Out of the 66 developed colonies, 39 (60%) were located along the main roads and 27 (40%) along the wedges (connecting two main roads). Of the total developed colonies, most were located along Ramghat Road (13), GT Road (Kanpur, 11) and Khair Road (5). While along other roads such as GT Road (Delhi, 4), Agra Road (4) and Anupshahar Road (2) there were only a few developed colonies. Along the bypasses most of the developed colonies were located along GT Road (Delhi) to Anupshahar Road (7), Anupshahar Road to Ramghat Road (6), Khair Road to GT Road (Delhi) (6) and Ramghat Road to GT Road (Kanpur) (6), while Mathura Road to Khair Road bypass had only 2 developed colonies (Figure 1).

Status of water supply in the residential suburbs

During field surveys it was observed that the suburbs were dotted by handpumps and submersible tubewells which were the main source of water supply in these areas. Handpumps were routinely installed, wherever they were required inside the homes of original dwellers in the core villages and by the migrants from the nearby villages who had settled in the poorer areas of the residential suburbs. So the original dwellers either manage to live without most services or try to have the basic/lower order services. They obtain water from ordinary wells and handpumps while the new suburban residents have better options, i.e. submersible/tubewells inside their premises, for obtaining water. Colonizers and private developers at times provide better water facilities so that their flats/apartments are sold off at better prices. The submersible/tubewells were installed by the rich farmers in

the core villages and by the colonizers and flat/apartment owners. Regarding the status of water supply, the residents reported that the supply was regular and they were getting an adequate amount of water. This was because they were getting the supply either from handpumps or from submersible/tubewells from which water is available 24 hours.

The state of water supply in the residential suburbs was assessed and categorized according to its standard or levels. Two important factors (i) source of water supply (level 1, roadside handpumps; level 2, handpumps inside premises; and level 3, submersible/tubewells inside premises) and (ii) quality of water supply (level 1, poor; level 2, average; and level 3, good) were taken into consideration. Table 1 shows the overall levels of state of water supply along the main roads and bypasses in the residential suburbs of Aligarh city. The averages of the two important factors were taken to assess the overall water supply at various levels in the residential suburbs. Table 1 shows that in most of the cases the residential suburbs of Aligarh city have a higher level of water supply (i.e. residents depended upon submersible/tubewells inside premises and reported good quality of water) especially along the main routes (i.e. GT Road (Kanpur), Ramghat Road, Anupshahar Road, GT Road (Delhi), Khair Road and Agra Road). Poor level of water supply (i.e. residents depended on handpumps as a source of water and reported poor quality of water) existed along the Anupshahar Road to Ramghat Road bypass and Mathura Road to Khair Road bypass.

This area (located along the Anupshahar Road to Ramghat Road bypass and Mathura Road to Khair Road bypass) was dominated by poor Muslim migrants belonging to the lower socio-economic strata; they were mostly involved in informal sectors as petty shopkeepers, petty shop owners, rickshaw pullers, labourers etc. and had large families (>6 members) so they could only afford shallow bored handpumps only 6–8 metres deep. The upper stratum of the earth absorbs the wastewater from garbage dumps, collection points and soak pits and thus pollutes the groundwater. Boiling water for drinking purposes is not practised in these households because of poverty, illiteracy and also because of the popular perception that the overall quality of water is tolerable. Field observations have also revealed that the surroundings of these sources (handpumps) are generally very unclean. Handpumps have been installed in areas with soak pits, heaps of garbage, waterlogging and marshy conditions so the seepage of contaminants takes place easily and hence the water becomes contaminated.

Status of sanitation in the residential suburbs

During field surveys it was observed that the sanitation condition in the residential suburbs was very poor. It was seen that people were defecating in the open and few had either flush or manual latrines in their courtyards or inside their homes. The excreta was disposed either in drains/along roads/in fields or in soak pits. It was observed that the residential suburbs had very poor drainage conditions. Wastewater was disposed either in *kutcha nali* (uncemented drains) or in a *pucca nali* which opened around the house or onto the roads/streets and/or in open plots/fields. Household/commercial/industrial solid waste was disposed of either along road/street sides or in open fields and at collection points. The residents reported hiring persons themselves for disposal of garbage. At most of the places garbage remained uncollected.

The state of sanitation conditions in the residential suburbs has been assessed by examining the different levels of its availability. Six important factors (i) toilet facilities (level 1 open defecation, level 2 flush/manual latrines in the courtyard and level 3 flush latrines inside the house); (ii) disposal of excreta (level 1 no disposal, level 2 disposal of excreta from manual latrines in drains/along roads/in fields and level 3 disposal of excreta from flush latrines into soak pits); (iii) type of drainage (level 1 no drainage, level 2 *kutcha nali* and level 3 *pucca nali*); (iv) disposal of wastewater/waterlogging (level 1 around the house, level 2 on the roads/streets and level 3 in open plots/fields); (v) disposal of household/commercial/industrial waste (level 1 disposal on road/street sides, level 2 disposal in open fields, level 3 disposal in collection points); and (vi) frequency of garbage collection by private agencies (level 1 uncollected, level 2 collected fortnightly, level 3 collected twice a week) were taken into consideration. Table 2 shows the overall levels of sanitation along the main roads and bypasses in the residential suburbs of Aligarh city. The averages of the six important factors of sanitation were taken to assess the overall sanitation at various levels in the residential suburbs. Table 2 shows that in most of the

Table 2 | Overall levels of state of sanitation in the residential suburbs of Aligarh city (2009–2010)

Name of the roads/bypasses	Overall levels of sanitation condition[a]		
	Level 1	Level 2	Level 3
1. Anupshahar Road	10.56	35.55	53.89
(1). Anupshahar Road to Ramghat Road bypass	42.96	37.78	19.26
2. Ramghat Road	14.84	25.35	59.81
(2). Ramghat Road to GT Road (Kanpur) bypass	23.52	26.48	50
3. GT Road (Kanpur)	16.36	24.29	59.35
4. Agra Road	10	16.67	73.33
(3). Mathura Road to Khair Road bypass	61.11	25	13.89
5. Khair Road	26.34	29.83	43.83
(4). Khair Road to GT Road (Delhi) bypass	32.22	30.37	37.41
6. GT Road (Delhi)	16.11	15.83	68.06
(5). GT Road (Delhi) to Anupshahar Road bypass	32.57	27.83	39.60
Total sampled households 996	**23.91**	**26.69**	**49.40**

Note: [a]Averages (in per cent) of six important factors considered for sanitation condition under each level.
Level 1 – open defecation, no disposal of excreta, drainage, disposal of wastewater/waterlogging around the house, disposal of household/commercial/industrial waste on road/street sides, garbage uncollected.
Level 2 – flush/manual latrines in the courtyard, disposal of excreta from manual latrines in drains/along roads/in fields, *kutcha nali*, disposal of wastewater/waterlogging on the roads/streets, disposal of household/commercial/industrial waste in open fields, garbage collected fortnightly.
Level 3 – flush latrines inside the house, disposal of excreta from flush latrines into soak pits, *pucca nali*, disposal of wastewater/waterlogging in open plots/fields, disposal of household/commercial/industrial waste in collection points, garbage collected twice a week.
Source: Based on field survey, 2009–2010.

cases the residential suburbs of Aligarh city have high to low levels of sanitation. A good (level 3) state of sanitation (i.e. flush latrines inside the house, disposal of excreta from flush latrines into soak pits, *pucca nali*, disposal of wastewater/waterlogging in open plots/fields, disposal of waste in collection points, garbage collected by private agencies fortnightly/twice a week) prevails in the residential suburbs along the main roads, i.e. Agra Road and GT Road (Delhi), Ramghat Road, GT Road (Kanpur) and Anupshahar Road. A poor (level 1) state of sanitation (no toilet facility in the house/open defecation practised, no disposal of excreta, no drainage facilities in the premises, disposal of wastewater/waterlogging around the house, disposal of waste on road/street sides, uncollected garbage) existed in the suburbs along Mathura Road to Khair Road bypass and Anupshahar Road to Ramghat Road bypass. These two bypasses are occupied by the Muslim migrants belonging to low socio-economic strata with large family size (>6 members) and are engaged in informal sectors characterized by insecurity of work, low wages, long working hours, etc.

Planning for water and sanitation in the residential suburbs

The proper planning for water supply and sanitation in the residential suburbs requires the preparation of a detailed plan, for which (1) field/household surveys have been conducted to collect information regarding the state of water and sanitation (Tables 1 and 2); (2) on this basis, the residential suburbs could be demarcated and mapped showing the different areas with different levels of state of water and sanitation services; and (3) then plans could be prepared for different areas according to their requirements. The provision of services, especially water and sanitation, plays an important role in the processes of growth and development of the residential suburbs. The residential suburbs with better provision of water and sanitation will be more developed than other areas. People will be attracted to settle in these suburbs and this area will be a hub of activities. An attempt has been made to assess the levels of water and sanitation in the residential suburbs with the help of eight indicators:

1. Two indicators of water supply condition:
   X_1 – availability of submersible/tubewells inside the premises
   X_2 – good quality of water supply
2. Six indicators of sanitation condition:
   X_3 – flush latrines inside the house
   X_4 – disposal of excreta from flush latrine into soak pits
   X_5 – *pucca nali* in the premises
   X_6 – disposal of wastewater/waterlogging in open plots/fields
   X_7 – disposal of household/commercial/industrial waste in collection points
   X_8 – frequency of garbage collection by private agency twice a week.

The development index (DI) of water supply and sanitation was calculated with the help of the standard index

method taken of the respective indicators. Finally, the composite mean standard index (CMSI) was calculated through the standard index (SI)/aggregate score model.

Road-wise levels of development of water supply and sanitation services in the residential suburbs of Aligarh city are presented in Tables 3, 4 and 5. A maximum value of CMSI of water supply was observed along GT Road (Kanpur) (0.993), followed by Ramghat Road (0.973), Anupshahar Road (0.870) and GT Road (Delhi) (0.800), and minimum values were observed along Mathura Road (0.000), Mathura Road to Khair Road bypass (0.226) and Anupshahar Road to Ramghat Road bypass (0.284). A maximum value of CMSI of sanitation was observed along Agra Road (0.955) followed by GT Road (Delhi) (0.893) and minimum values of CMSI of sanitation were observed along Mathura Road (0.000), Mathura Road to Khair Road bypass (0.158) and Anupshahar Road to Ramghat Road bypass (0.227). In each case of water supply and sanitation services the value of CMSI was at a minimum along Mathura Road because along this road there were no developed residential colonies. Only demarcation of plots could be seen.

For the purpose of demarcating the residential suburban areas on the basis of different levels of water supply and sanitation services, the average value of CMSI of water supply (with the help of two indicators) and sanitation (with the help of six indicators) were calculated and categorized into four levels – high, moderate, low and very low level of development – with the help of mean and standard deviation methods (standard grading system) (Tables 5 and 6) and were mapped (Figure 2).

Field surveys have also revealed the same picture in all the residential colonies. Tables 5 and 6 and Figure 2 reveals that 18 residential colonies located along Agra Road (0.856), GT Road (Delhi) (0.847), GT Road (Kanpur) (0.821), Ramghat Road (0.814) and Anupshahar Road (0.729) had high levels of development of water supply and sanitation services (>0.709). Whereas, 13 residential colonies located along Ramghat Road to GT Road (Kanpur) bypass (0.654), Khair Road (0.626), Khair Road to GT Road (Delhi) bypass (0.509) and GT Road (Delhi) to Anupshahar Road bypass (0.492) had moderate levels of development of water supply and sanitation services (0.709–0.424). Four residential colonies located along Anupshahar Road to Ramghat Road bypass (0.256) and Mathura Road to Khair Road bypass (0.192) had low levels of water supply and sanitation services (0.424–0.139). A few residential colonies located along Ramghat Road (Lucky Compound, Railway and

Table 3 | Road-wise levels of development of water supply in residential suburbs of Aligarh city (2009–2010) (Based on Standard Index)

	Two indicators of water supply conditions			
Name of the roads/bypasses	**Availability of submersible/ tubewells inside the premises**	**Good quality of water supply**	**CMSI of water supply conditions**	***R***
1. Anupshahar Road	0.801	0.939	0.870	3
(1). Anupshahar Road to Ramghat Road bypass	0.000	0.568	0.284	10
2. Ramghat Road	0.947	1.000	0.973	2
(2). Ramghat Road to GT Road (Kanpur) bypass	0.441	0.881	0.661	7
3. GT Road (Kanpur)	1.000	0.986	0.993	1
4. Agra Road	0.644	0.870	0.757	5
(3). Mathura Road to Khair Road bypass	0.000	0.452	0.226	11
5. Khair Road	0.593	0.953	0.773	6
(4). Khair Road to GT Road (Delhi) bypass	0.302	0.927	0.615	8
6. GT Road (Delhi)	0.662	0.939	0.800	4
(5). GT Road (Delhi) to Anupshahar Road bypass	0.288	0.814	0.551	9
7. Mathura Road	0.000	0.000	0.000	12

Note: CMSI – Composite Mean Standard Index; *R* – Rank.

Table 4 | Road-wise levels of development of sanitation in residential suburbs of Aligarh city (2009–2010) (Based on Standard Index)

	Six indicators of sanitation conditions							
Name of the roads/bypasses	**Flush latrines inside the house**	**Disposal of excreta from flush latrine into soak pits**	***Pucca nali* in the premises**	**Disposal of wastewater/ waterlogging in open plots/fields**	**Disposal of household/ commercial/ industrial waste in collection points**	**Frequency of garbage collection by private agency twice a week**	**CMSI of sanitation conditions**	***R***
1. Anupshahar Road	0.904	0.944	0.830	0.851	0.000	0.000	0.588	3
(1). Anupshahar Road to Ramghat Road bypass	0.186	0.186	0.127	0.865	0.000	0.000	0.227	10
2. Ramghat Road	1.000	1.010	0.935	0.977	0.000	0.000	0.654	4
(2). Ramghat Road to GT Road (Kanpur) bypass	0.626	0.653	0.623	0.653	0.667	0.667	0.648	6
3. GT Road (Kanpur)	0.948	0.972	1.000	0.973	0.000	0.000	0.649	5
4. Agra Road	0.870	0.909	0.951	1.000	1.000	1.000	0.955	1
(3). Mathura Road to Khair Road bypass	0.174	0.175	0.173	0.426	0.000	0.000	0.158	11
5. Khair Road	0.657	0.699	0.807	0.709	0.000	0.000	0.479	7
(4). Khair Road to GT Road (Delhi) bypass	0.580	0.583	0.819	0.440	0.000	0.000	0.404	9
6. GT Road (Delhi)	0.835	0.839	0.917	0.766	1.000	1.000	0.893	2
(5). GT Road (Delhi) to Anupshahar Road bypass	0.651	0.654	0.638	0.656	0.000	0.000	0.433	8
7. Mathura Road	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12

CMSI – Composite Mean Standard Index; *R* – Rank.
Source: Based on field survey, 2009–2010.

Table 5 | Road-wise overall levels of development of water supply and sanitation services in residential suburbs of Aligarh city (2009–2010) (Based on Standard Index)

Name of the roads/bypasses	**Water supply conditions**	**Sanitation conditions**	**CMSI of water supply and sanitation services**	***R***
1. Anupshahar Road	0.870	0.588	0.729	5
(1). Anupshahar Road to Ramghat Road bypass	0.284	0.227	0.256	10
2. Ramghat Road	0.973	0.654	0.814	4
(2). Ramghat Road to GT Road (Kanpur) bypass	0.661	0.648	0.654	6
3. GT Road (Kanpur)	0.993	0.649	0.821	3
4. Agra Road	0.757	0.955	0.856	1
(3). Mathura Road to Khair Road bypass	0.226	0.158	0.192	11
5. Khair Road	0.773	0.479	0.626	7
(4). Khair Road to GT Road (Delhi) bypass	0.615	0.404	0.509	8
6. GT Road (Delhi)	0.800	0.893	0.847	2
(5). GT Road (Delhi) to Anupshahar Road bypass	0.551	0.433	0.492	9
7. Mathura Road	0.000	0.000	0.000	12

CMSI – Composite Mean Standard Index; *R* – Rank.
Source: Based on field survey, 2009–2010.

Table 6 | Assessment of levels of development of water supply and sanitation services in residential suburbs of Aligarh city (2009–2010) for the purpose of future planning

Overall levels of urban basic services	Location and names of the colonies located in the residential suburbs
1. High level of development (>0.709) **18 residential colonies** (51.43%)	**1. Anupshahar Road (1 residential colony)** (Sagar Housing Complex) **2. Ramghat Road (7 residential colonies)** (Raj Vihar, Chaudhary Vihar, Lucky Compound, Shankar Vihar, Mukund Vihar, Railway, Harizon Basti colony) **3. GT Road (Kanpur) (6 residential colonies)** (Vishnu Dham, Basant Vihar, Prabhat Nagar, Shiva, Keshav Vihar, Hydel colony) **4. Agra Road (2 residential colonies)** (Damodar Apartment, Neem Karoli colony) **5. GT Road (Delhi) (2 residential colonies)** (Nai, Guru Ramdas Nagar)
2. Moderate level of development (0.709–0.424) **13 residential colonies** (37.14%)	**1. Ramghat Road to GT Road (Kanpur) bypass (3 residential colonies)** (Engineer's, Kuldeep Vihar, Brij Vihar colony) **2. Khair Road (3 residential colonies)** (Shiv Dham, Nada Bajitpur Nayaabadi, Singh Vihar) **3. Khair Road to GT Road (Delhi) bypass (3 residential colonies)** (Ashok Vihar, Baghel, Bank colony) **4. GT Road (Delhi) to Anupshahar Road bypass (4 residential colonies)** (Dev Nagar, Ganesh Nagar, Riyaz, Islam Nagar colony)
3. Low level of development (0.424–0.139) **4 residential colonies** (11.43%)	**1. Anupshahar Road to Ramghat Road bypass (3 residential colonies)** (Nishad Bagh, Bihari, Raza Nagar) **2. Mathura Road to Khair Road bypass (1 residential colony)** (Sadbhavana Nagar)
4. **Very low level of development (<0.139)** No developed residential colony	**1. Mathura Road**

Source: Based on field survey, 2009–2010.

Shankar Vihar), along GT Road (Delhi) (Guru Ramdas Nagar, Sai Vihar), along Anupshahar Road (Sagar Housing Complex), along GT Road (Kanpur) (Vishnu Dham, Basant Vihar, Prabhat Nagar, Vidyut Nagar), and along Agra Road (Damodar Apartment, Neem Karoli) have well developed water supply and sanitation either provided by the colonizers or arranged by the residents themselves. Residents living in these colonies belong to the high income strata so they have equipped their homes with all the modern urban services. Colonies located along the city margins such as along Anupshahar Road to Ramghat Road bypass are an extension of the Jeewangarh colony which is mainly occupied by poor Muslim migrants who are engaged in informal sectors, have large family size (>6 members) and belong to lower socio-economic strata. The same situation prevails in the extended colonies located along the GT Road (Delhi) to Anupshahar Road bypass and Mathura Road to Khair Road bypass. So the residents living in these colonies could not cope with these problems by themselves.

It was observed that the level of development of water supply and sanitation was good in the suburban residential colonies developed along the main roads such as Agra Road, GT Road (Delhi), GT Road (Kanpur), Ramghat Road and Anupshahar Road. This is because the land prices are much higher here and only the bigger colonizers purchase these lands, sell it off at higher prices and provide all the urban basic services. People who purchase these lands are economically prosperous, so they also develop basic services according to their needs. Living near the main roads means an easy access to transport, marketing, health education facilities and so on. Availability of urban basic services in the developed colonies located along the wedges of the main roads was low to very low because these wedges have been garbage and wastewater dumping grounds. So this area has not developed. Another reason which emerged during the field investigation was that these were poor areas, occupied by people belonging to lower socio-economic strata. The colonizers did not provide

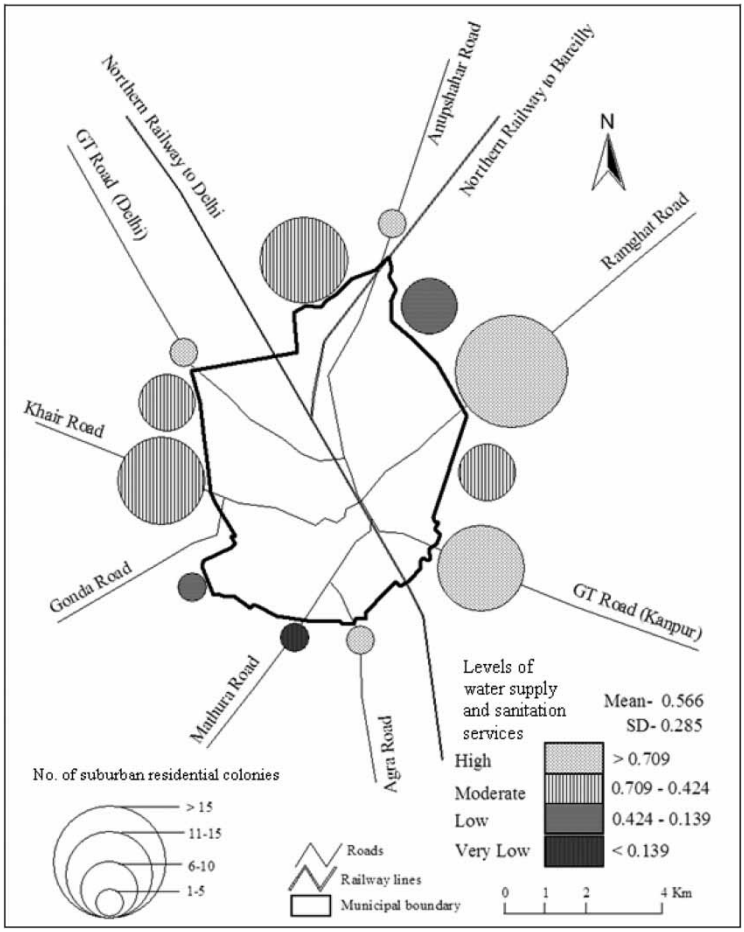

Figure 2 | Aligarh city: Assessment of levels of water supply and sanitation services in residential suburbs for the purpose of planning (2009–2010). *Source*: Based on field survey, 2009–2010.

the basic facilities and the residents did not have sufficient money to develop the facilities by themselves.

CONCLUSIONS

The main conclusion which derived from the present study is that colonies located along the main roads have a high level of water and sanitation facilities compared with the colonies located along the wedges of two roads, and the services are mostly arranged by the residents themselves. But city populations will keep on growing, the urban expansion will keep on increasing and the suburban residential colonies will also keep on developing. So what can be done? The colonizers will purchase the agricultural lands at low prices from the farmers in anticipation of the city's growth (i.e. increase in population and land area) and sell it off at higher prices to the colony developers; they in turn will or will not provide the urban basic services. So there is a need for better urban governance. The municipal authority should pay attention and consider the suburbs as being within city limits and in turn should collect taxes for their convenience to provide all the basic services. So the residents living in the residential suburbs get equal advantages of all services.

A number of action programmes have been suggested which should be implemented in a comprehensive manner:

- Managing residential suburbs requires local solutions rather than state, national ones. There is an urgent need to build and support the capacity of local/municipal bodies to manage the problems of rapidly growing residential suburbs.

- Local municipal authorities need to be empowered with financial and human resources to develop the required infrastructure and deliver the services in the residential suburbs.
- Large investment is needed for the creation, expansion and maintenance of water supplies, systems for collection and disposal of waste, both garbage and wastewater, electricity, roads, houses etc.
- People living in the residential suburbs should pay taxes so that they are also provided with these services. These services must reach all sections of the people living in the residential suburbs.
- Policies should be framed so that the colonizers and land developers develop the area properly and provide all the urban basic services in the individual houses and apartments before selling them for residential purposes.
- Every city should have a master plan, not only for the city but also for the suburban areas, and planning should not be entrusted to the state town planning department but to the city town planning department; plans should be implemented properly.

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