Impact of Built Environment on Health in Kanpur City, India

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Abstract

This paper attempts to study the impact of built environment on the immediate surroundings and nearby places in a metropolitan city of North India. The relationship of built environment with travel behaviour is studied on the basis of empirical studies. Impact of treatment plants, emissions from domestic and industrial sources, vehicles and sewerage, etc., has been studied in the study area. The consequences and ill-effects in nearby places have also been studied, based on secondary data. Various development and planning issues are discussed. There is an immediate need to adopt the concept of ecological city and to take appropriate remedial measures to achieve sustainability.

Keywords: Built environment, Travel behaviour, Ecological city, Sustainability

Introduction

Built environment encompasses all of the physical parts where people live and work like homes, buildings, streets, open spaces, infrastructure, etc. The built environment has a direct impact on a person's level of physical activity and overall health. A good built environment results in better productivity of people economically, socially and physically.

The concept of land-use planning, zoning and master plans started to ensure a healthy city. World Health Organization (WHO) defines "health as a state of complete physical, mental, and social well-being and not just the absence of diseases or infirmity". Urban centers are considered to be engines of economic development and attract a lot of people for employment from nearby and far off places. This often results in an accelerated pressure on the various infrastructure demands, including water supply, housing, sewerage and waste management. The increase in population results in a mix of planned and unplanned development of cities with a resultant built environment which is often not conducive to general well-being of people and environment. Indian cities are increasingly facing this problem of ill-effects of built environment on public health and environment. This paper attempts to look at the impact of built environment such as treatment plants, inefficient drainage, sewerage and waste management, transportation, land use and industries on the well-being of people in a big metropolitan city of Uttar Pradesh State of India.

Study area: Kanpur City

The district of Kanpur is situated in the lower section of the Ganga and Yamuna *doab*, between the parallels of 25° 26′ and 26° 58′ North latitude and 79° 31′ and 80° 34′ East meridians of longitude in an irregular quadrilateral shape. The creation of the district Kanpur Nagar has taken place after 1981 Census and was earlier a part of Kanpur district.

On its South-east is the district of Fatehpur, to the North-east lie the districts of Hardoi and Unnao and surrounded by the district of Kanpur-rural (Kanpur-Dehat) in the west. The Ganga river forms the north-eastern boundary. The area is a very fertile well-cultivated area and lies at an altitude of 126 m above sea level.

The study area of Kanpur Urban Agglomeration lies towards the North-eastern part of District Kanpur Nagar. It has a total area of 298.98 sq km. It is the most populated metropolitan city of Uttar Pradesh State and the State's chief industrial city. It is located on the right bank of the river Ganga. It enjoys a central position in Uttar Pradesh and is at a distance of 63 km from Lucknow and 425 km from the national capital Delhi. The location of the city is presented in Fig. 1 and 2.

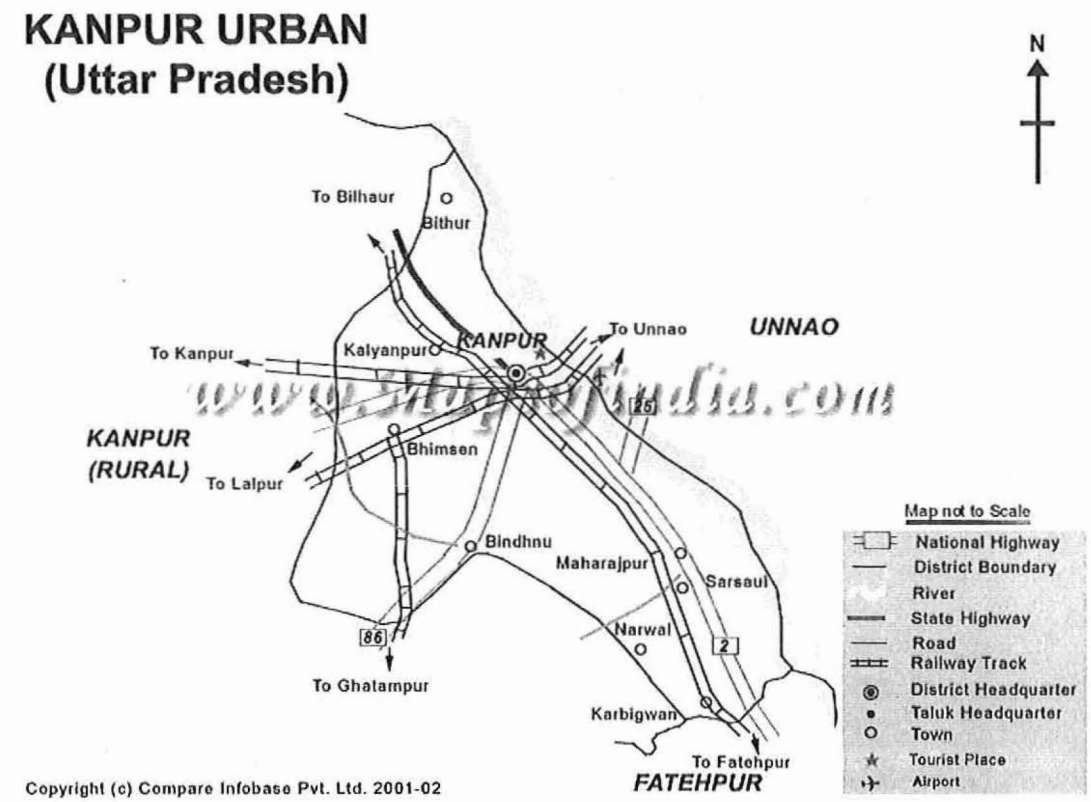
Built environment and travel behaviour

Built environment is a multi-dimensional concept. Some of the dimensions of the built environment are given as under:

1. Density and Intensity: This gives the amount of activity in a given area.
2. Land use mix: This is defined by the proximity of different land uses.
3. Street connectivity: This is indicated by the directness and availability of alternative routes through the network and can be measured by number of intersections per square kilometer of area.
4. Aesthetic qualities: This is given by attractiveness and appeal of a place.
5. Regional structure: Distribution of activities and transportation facilities across the region
6. Travel behaviour: this is indicated by the distance traveled to workplace, shopping, etc., kind of transport used (public/private), ownership of personalized vehicles, etc.
7. Quality of life: this is given by various parameters like economic well-being, assess to quality health care, life style, educational and employment opportunities, etc.

There is a strong association observed between built environment and travel behaviour (Handy, S.L. et al, 2002), and has a direct bearing on human behaviour. Currently, direct assessment of impacts of built environment on health, ecology and environment is not done by the urban planners. The Master plans prepared in India are limited to assigning land use, zoning and road network plan.

The travel behaviour reflects a lot about the built-environment and has implications on public health and environment. The investigators conducted a small sample survey of 300 households taken from six different income-groups, to study the travel behaviour of the people of Kanpur city. Table 1 presents the use of mode of transportation for trips.



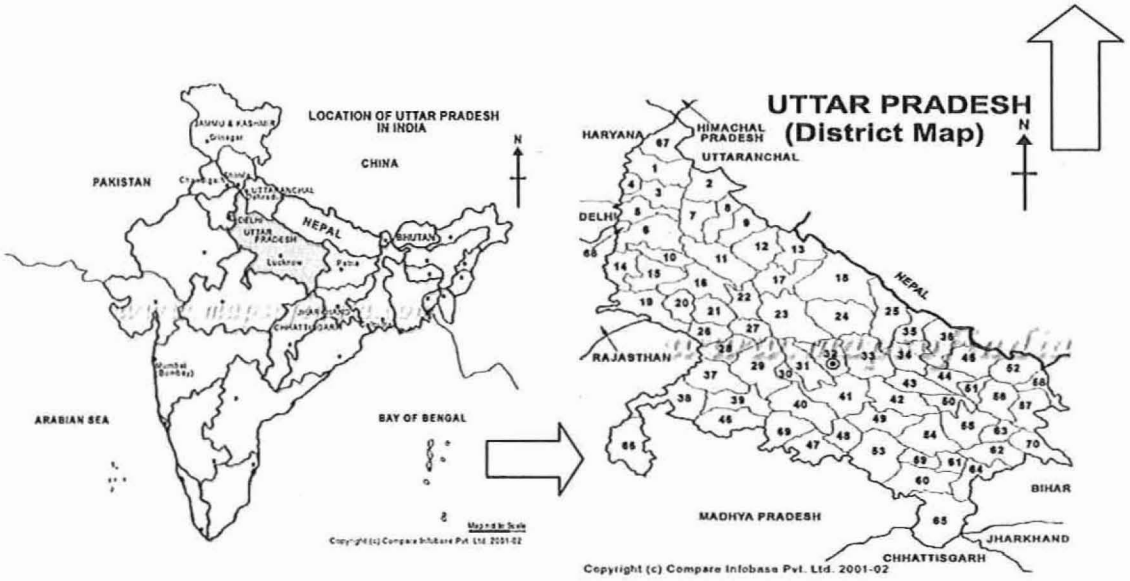


Fig. 1: Location of Study Area: Kanpur

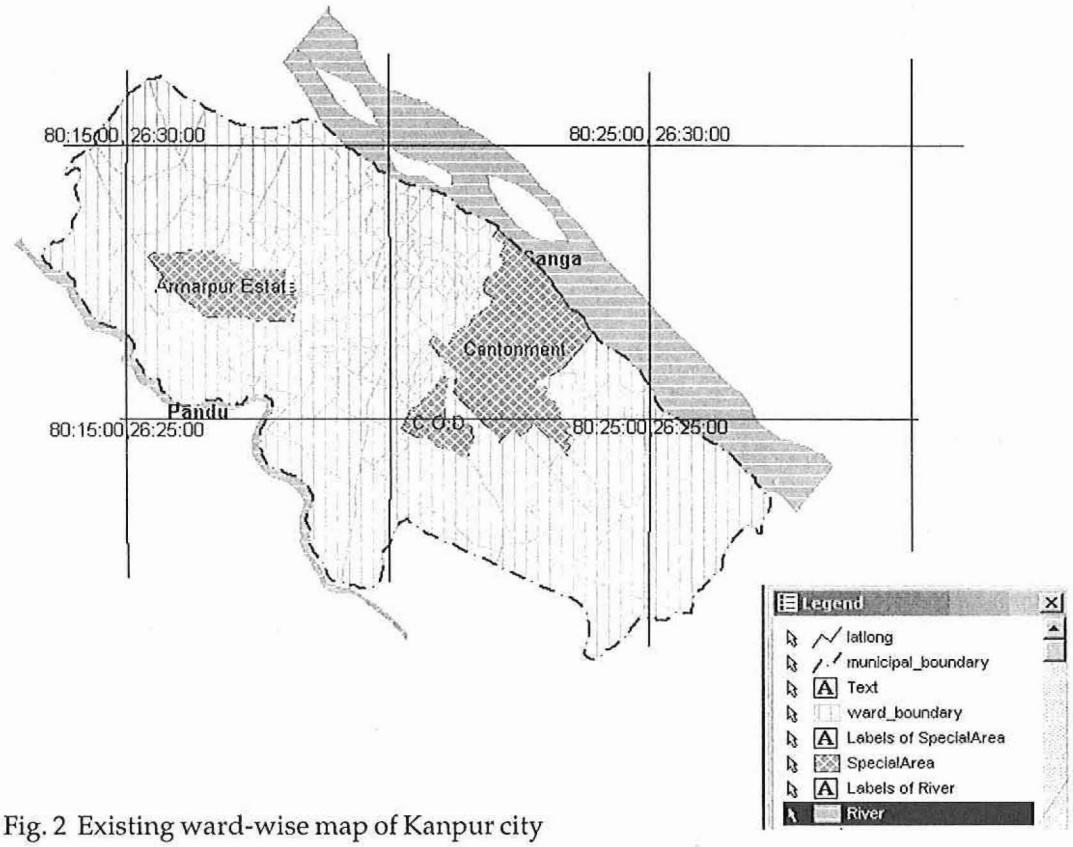


Fig. 2 Existing ward-wise map of Kanpur city

Table 1: Mode of transportation in Kanpur (disaggregate data)(Income/annum in Indian rupees)

S. No.	Income-group	Bus	Per cent	Tempo	Per cent	Own vehicle	Per cent	On foot	Per cent	Combi nation	Per cent	Total
1	<50,000	0	0	11	37	23	9	1	33	0	0	35
2	50-1,00,000	1	100	16	53	121	46	0	0	1	25	139
3	1,00-1,50,000	0	0	0	0	80	31	2	67	2	50	84
4	1,50-2,00,000	0	0	2	7	24	9	0	0	1	25	27
5	2,00-2,50,000	0	0	0	0	8	3	0	0	0	0	8
6	>2,50,000	0	0	1	3	6	2	0	0	0	0	7
	Total	1	100	30	100	262	100	3	100	4	100	300
	Per cent	0.3		10.0		87.3		1.0		1.3		100.0

Source: Based on field survey by investigators in 2004

The table shows that only 10.3 per cent people use public transportation for travel to place of work, shopping, and other purposes. This percentage is abysmally low compared to the metropolitan status of the city. Whereas, 87.3 per cent of the surveyed households use their own personal vehicles for travel. The existing public transport system for travel within the city comprises of Bus, tempo (popularly known as Vikrams and are highly polluting) and Auto rickshaw. The human-driven rickshaw is also popular for intermediate distances. The city bus service is very poor characterized by high congestion and poor frequency. Vikrams ply on major roads and are the most popular among the motorized public transport system. They are, however, highly polluting and, in place of 6 persons, carry 10-12 persons.

Place of work and the distance travelled from place of residence to work is guided by factors like land-use mix, type of public transport facility, etc. Table 2 presents the distribution of distance of place of work among different income-groups in Kanpur city.

Table 2: Place of work (distance in km) (Income/annum in Indian Rupees)

S. No.	Income-group	<2	2-4	4-6	6-8	8-10	>10	Total HHs
1	<50,000	15	5	9	3	2	1	35
2	50-1,00,000	35	47	18	12	13	14	139
3	1,00-1,50,000	25	17	5	13	14	10	84
4	1,50-2,00,000	10	7	1	3	4	2	27
5	2,00-2,50,000	3	0	0	3	0	2	8
6	>2,50,000	1	4	1	0	1	0	7
	Total	89	80	34	34	34	29	300
	Percentage	29.7	26.7	11.3	11.3	11.3	9.7	100.0

Source: Based on field survey by investigators in 2004

The table clearly shows that the place of work of 56.4 per cent of the total surveyed households were upto 4 km, whereas 9.7 per cent working people had to go more than 10 km away for work. This reflects that mixed-land use is followed in most parts of the city and/or people prefer to live in close proximity to their places of work. This ,however, came intuitively to the people and is not a result of planned interventions (in the form of Master Plans).

Ownership of vehicles in a place reflects the status and quality of public transport available and also attitude of people to some extent. In the absence of a good public transport system, the city is undergoing a tremendous vehicle growth like most of the other metropolitan cities in the country. The city has more than 5 lakh vehicles plying on its roads, and almost 50,000 new vehicles are added every year. The pollution load due to these vehicles is 3350 kg/hr. Table 3 presents the break-up details of distribution of vehicular pollution load while Table 4 and 5 present the vehicle ownership (cars and two-wheelers) among the surveyed households.

Table 3: Vehicular pollution load in Kanpur

S. No.	Parameter	Load in kg/hour
1.	SO_2	33.7
2.	PM	42.2
3.	NO_x	408
4.	CO	2307
5.	HC	757

Source: Environment Management Plan for Kanpur city, CPCB,2001

Table 4: Number of Households having Car (Income/annum in Indian Rupees)

S. No.	Income-group	One	Two	>2	Total
1	<50,000	-	-	-	-
2	50-1,00,000	4	2	-	6
3	1,00-1,50,000	28	2	-	30
4	1,50-2,00,000	5	2	2	9
5	2,00-2,50,000	4	1	-	5
6	>2,50,000	4	0	2	6
	Total	45	7	4	56

Source: Based on field survey by investigators in 2004

Table 5: Number of households having two-wheelers (Income/annum in Indian Rupees)

S. No.	Income-group	One	Two	>2	Total
1	<50,000	14	-	-	14
2	50-1,00,000	102	4	-	106
3	1,00-1,50,000	51	26	1	78
4	1,50-2,00,000	18	5	-	23
5	2,00-2,50,000	5	-	3	8
6	>2,50,000	1	6	-	7
	Total	191	41	4	236

Source: Based on field survey by investigators in 2004

It is observed that only 18.6 per cent of the surveyed households had one or more cars. More than 85 per cent of the surveyed households depend on personalized vehicles (two-wheelers) for daily transport. It is also observed that 63.6 per cent were found to have one two-wheeler while 13.6 per cent had two two-wheelers.

There is no effort seen whatsoever on the part of citizens or the local government to improve mobility and the quality of life for the elderly and disabled (differently able)

Table 6: Ambient air quality in Kanpur

Ambient Air Quality in Kanpur			
S.No.	**Area in the city limits**	**SPM in ug/m3**	**Factors effecting air quality**
1	Central Business District area comprising commercial areas like of Deputy kaPadao,General Ganj,Parade, Gwaltoli etc. Panki Industial area, Power house and the immediate adjoining areas including ash pond.	501 to 800 (occasionally exceeding 800)	• The commercial areas are characterised by unclean roads and traffic congestions. • In industrial areas low level emission from DG sets. Small boiler emissions, small foundries • Fly ash from ash pond and operation of small boilers in Panki Power plant also affects air quality of adjoining areas
2	Mixed use areas in the south,south west and east side of CBD area covering Dada nagar ,Govind Nagar,Industrial state etc. Areas adjoining to power house	350-500	• Impact of adjacent industrial emissions· • Impact of power house fly ash
3	Areas in the south-east,south and south-west side to CBD area like Naubasta ,Ratanlal Nagar, Barra, Lalbangla etc.	250-350	• Commercial and residential areas being effected by industrial areas during lea-ward wind flow. • Most of the areas are under developing stage with uncovered open areas, leading to dust problem. • Vehicular emissions
4	Jajmau Industrial area	350-500	• Emissions from small boilers being liberated through stacks of height 15 to 30m.height
5	Area to the left of CBD consisting Rawatpur village,around the allen forest, Swaroop Nagar ,Vikas Nagar and Sharda Nagar etc.	250-300	• Natural sources of dust,dust due to vehicular movement , use of coal/cow dung in adjoining slum areas if any
6	Areas with more vegetation and low population density like Cantonment, IIT, villages and agricultural land along the westem periphery of the city	200-300	• Natural source of dust • Industrial influence during lea ward wind direction and other favourable meteorological conditions.
7	Agricultural land along the eastem boundary of the city	<200	• Natural source • Distant traces of emissions from main city.

Source: Environment Management Plan for Kanpur city, CPCB

citizens. Urban design components which mainly concentrates on how the built environment looks and design of public spaces is mostly absent in the study area.

Air Pollution

Kanpur is one of the major polluted cities in India. The estimated air pollution loads in Kanpur is 5500 kg/d from domestic sources, 2550 kg/h (142 t/d) from vehicular sources and 12,000 kg/hr from industrial sources (CPCB, 2001). The major problem in case of air pollutants in the city is due to high levels of SPM, which is exceeding the prescribed norms in most places in the city. Respirable dust concentrations are alarmingly high in many locations in the city due to loose surface soil and lack of vegetation in most parts of the city. The SPM levels in different parts of the city and the generators of such pollutants are presented in Table 6.

The table illustrates that the Central Business District area and Panki industrial area has the highest SPM level of 501 to 800 μm^3 followed by Dadanagar and Govindnagar industrial area where SPM level of 350 to 500 μm^3 were recorded. Jajmau area also has high SPM levels due to stack emissions form the numerous tanneries.

Vehicular pollution loads

In the absence of a good public transport system, the city is undergoing a tremendous vehicle growth like most of the other metropolitan cities. The city has more than 5 lakh vehicles plying on its roads, and almost 50,000 new vehicles are added every year. The pollution load due to these vehicles is 3350 kg/hr. Table 7 presents the break-up details of distribution of vehicular pollution load.

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Source: Environment Management Plan for Kanpur city, CPCB,2001

Impact of Air pollution in Kanpur city

There are numerous ill-effects of air pollution on the flora, fauna and the human beings. Kanpur, also known as "Capital of Tuberculosis", is also turning out to be a high-risk city for asthma. The city had the highest count of respirable suspended particulate matter (RSPM) in the country as per CPCB survey, January to April 2002. The RSPM levels varied from 119 to 257 micrograms per cubic metre as against the National Ambient Air Quality Standard (NAAQS) of 60 micrograms per cubic metre. The pollutant triggers a lot of respiratory ailments like, asthma. Currently, the number of asthma patients exceeds 10 per cent of the total population against the norm of two to five per cent for a normal city. According to a World Bank Study in 1995, the annual environmental health cost for every citizen in Kanpur owing to ambient air pollution is US$ 50. Thus the total annual environmental health cost due to air pollution for Kanpur is approximately Rs 600 crore (http://www.ganga-icdp.org/reports.php). An estimated annual health incidence due to ambient air pollution in major cities of India is presented in Table 8.

Table 8: Estimates of annual health incidences in India cities due to ambient air pollution levels

S. No.	Cities	Premature death	Hospital admissionsand sickness requiring medical treatment	Incidence of minor sickness
1.	Ahmedabad	2979	1,183,033	72,177,644
2.	Bangalore	254	135,887	8,326,282
3.	Calcutta	5726	2,022,786	179,479,908
4.	Delhi	7491	2,990,012	241,958,219
5.	Hyderabad	768	420,947	31,708,958
6.	Jaipur	1145	520,947	31,708,958
7.	Kanpur	1894	812,381	49,247,224
8.	Madras	863	416,966	27,859,485
9.	Mumbai	4477	2,57,210	156,452,916
10.	Patna	725	319,242	19,561,109

Source: Gadhok, T.K., Risks in Delhi: Environmental concerns, HSMI, HUDCO, New Delhi

The table clearly illustrates that the incidence of premature death due to ambient air pollution levels is very high in Kanpur city as compared to other cities of similar and bigger size like Bangalore, Madras, Hyderabad, etc. The number of hospital admissions and sickness requiring medical treatment is very high at 8.1 lakh cases in a year, while 492 lakh cases of minor sickness are reported annually. This figure is growing drastically due to increasing air pollution and lack of proper remedial measures to check the root cause of this problem.

Water pollution

Kanpur gets 64 per cent of its water supply from Ganga river and the rest 34 per cent from tube wells. Both surface water and ground water is severely polluted and not fit for consumption without thorough treatment. Escheerichia Coliform and faecal coliform were found in water samples collected in the city and its suburbs. The water samples from Bhairon ghat pumping station (the primary source of drinking water) and Motijheel raw intake point were found to be highly contaminated (www.ecofriends.org).

Samples collected by the State Pollution Control Board at Bithoor, Ranighat and Jajmau pumping station with their observed ph value and coliform count are presented in Table 9.

Table 9: Characteristics of Water samples in Kanpur

	Sampling Points	Sampling Date	Total Coliform	pH	Faecal Coliform	BOD	Use Based Class
1	BITHOOR	04/01/2005	7500	8	3900	2.2	B
2	RANIGHAT	09/11/2005	4300	8	900	1.6	B
3	JAJMAU PUMPING STATION	04/01/2005	93000	8.1	28000	8.6	B
4	JAJMAU PUMPING STATION	06/05/2005	43000	8.6	15000	6.9	B
5	JAJMAU PUMPING STATION	09/11/2005	46000	8.2	23000	4.3	B

Source: Prepared by Investigators based on results by State Pollution Control Board

The defined use is B type use based class as observed in the Table. For B type, the criterion is that total coliform count should be less than 500. In all the above cases however, it is far exceeding. Even for C type usage (drinking water source after conventional treatment and disinfection), the defined total coliforms count is less than 5000 (Ministry of Environment and Forests). It has been observed that in many places in the city, electroplating and bleaching waste contaminates the ground water, rendering it unfit for drinking and cooking. Improper disposal of municipal solid waste, biomedical and industrial waste is also contaminating the ground and surface water in the city.

Status of Domestic Sewage

Domestic sewage with or without treatment is usually disposed off in the available surface water in Kanpur city, which has a direct impact on the pollution load of the surface water. The status of drains carrying domestic sewage in Kanpur is presented in Table 10 and Fig 3.

Fig. 3 Location of various Nalas and sewage treatment plants in Kanpur City

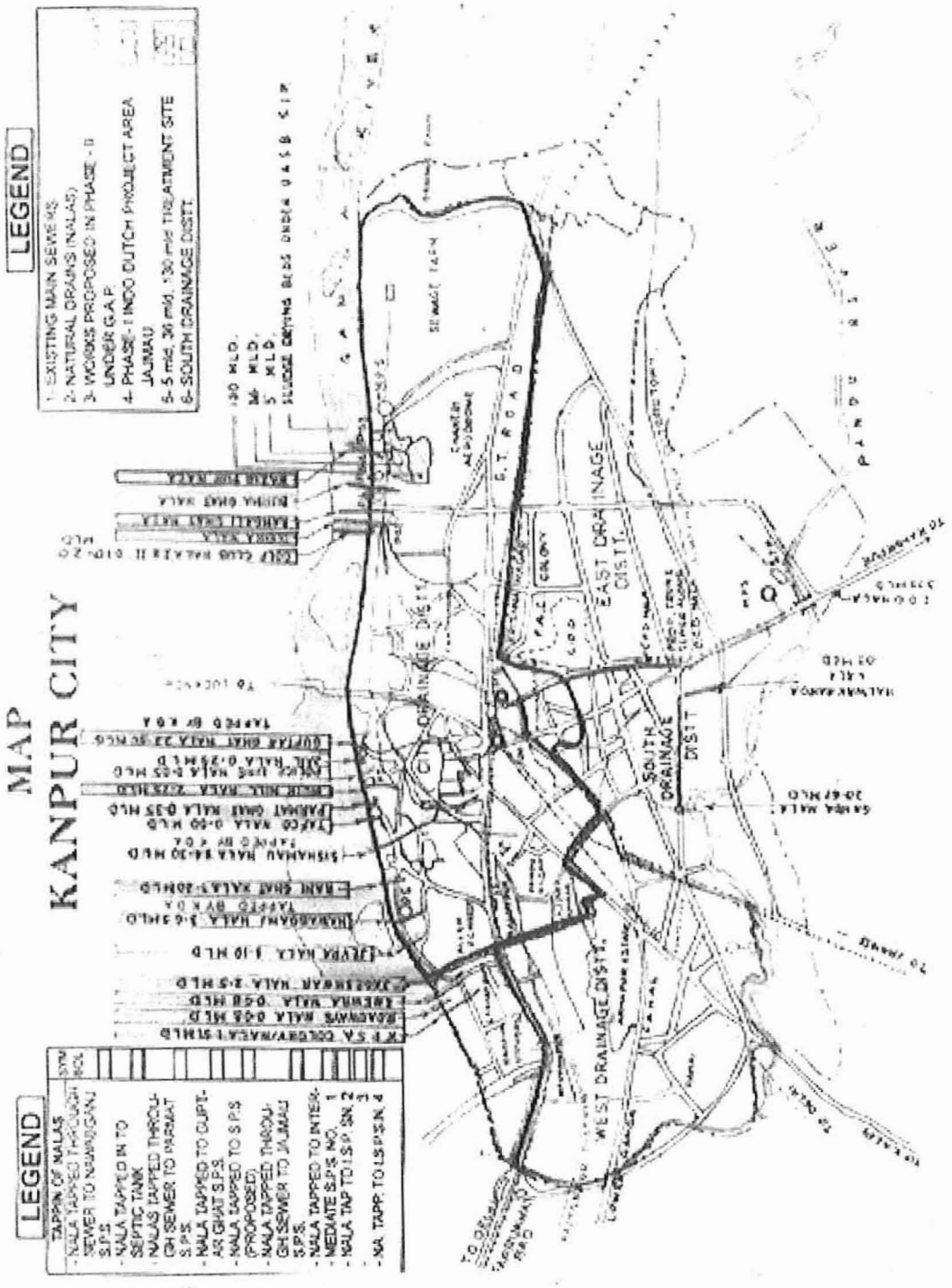

Table 10: Status Report of Drains (nalas) carrying domestic sewage

Name of the drain (name given according to the place of discharge)	Actual status as on June, 2003
Bhaironghat- Raw water source for kanpur	Bhaironghat raw water intake point, which is the primary source of drinking water for at least 60 % of the population of Kanpur, is no suffering from severe contamination from at least 15-20 drains in the upstream of water intake point. Azadnagar, Dandiwada, Pehalwaan purwa, KDA colony Malin Basti and a TB hospital drain, instead of being diverted to Nawabganj IPS, are being allowed to flow in Binda Shiwala (new basti) nala which finally reaches Intake point. Similarly Mainawati Marg, Shivadeen purwa, Rani ghat, Machuwa Nagar drains also reach raw water intake point. **Besides, open defecation, washing of clothes, bathing, use of detergents etc. at raw water intake point go on unabated.**
Sisamau nal	It's like a tributary meeting Ganga. It discharges more than 100 MLD of raw sewage directly into river Ganga.
Parmath Ghat nala	Parmat ghat nala is situated just along the Parmat temple. It receives some sewage from Sisamau Nala, sewage from Jail, Parmat colony, Khalasi line and Gwal Toli area. It still discharges sewage directly into Ganga. The capacity of the Parmat IPS is 18 MLD and it receives around 20 MLD of sewage from Sisamau nala, around 8-10 MLD from Jail, Parmat colony, Khalasi Line and Gwal Toli area.Parmat ghat area is highly polluted and completely filled with dirt and filth along Ganga side. No measures have been taken to collect the waste produced from the temple and also to stop the drain carrying raw sewage directly into Ganga.
Jail nalas	Small drains carrying sewage from the Jail premises find its way to Ganga. These drains are along Sarsaiya ghat area. Beside these drains, also the sewer lines of this locality remain choked most of the time, as a result of which all the sewage overflows and bypasses into Ganga.
Police Lines nala	Police personnel who are living in barracks have constructed toilets on these drains which are carrying all the sewage to Ganga. Also their backyard has become a dumping ground for their garbage and a huge volume of garbage can be seen littered in the backyard.
Bhagwat Das Ghat nala	Bhagwat Das Ghat nala receives maximum sewage from the Guptar ghat IPS. The capacity of this IPS is 3 MLD but the waste which reaches here is approximately double Thus around 3-4 MLD of raw sewage is being bypassed directly into Ganga.
OEF nala	There are two drains from OEF, which are discharging their waste into Ganga. One carries industrial effluent and the other one sewage from their colonies. The industrial effluent is treated and then bypassed into the river, say OEF officials.
Gola Ghat nala	This is in the Cantonment area. The drain discharges its load of raw sewage into the Ganga. People have made house connections directly into this nala. There is a big dhobi (washing) ghat functioning here.
Massacre ghat nala	No sewage flows through this drain.
Dabka nala	There are two drains, one carries domestic waste and the other one industrial effluent. These nalas discharge their load of raw sewage and effluent into the Ganga.
Nalas in Jajmau Many small nalas from	the settlements on the edge of the river discharge raw sewage into the Ganga. These settlements also dump their solid waste into Ganga.

Source: www.ecofriends.org

Status of Tannery Sewage

Reports by an NGO Ecofriends' state that some tanneries situated at some height along Ganga have constructed underground drains from their factory to the Ganga. They are fearlessly discharging their hazardous waste directly into Ganga and as a result, the colour of the water in that stretch looks dark brown.

Status of Intermediate pumping Station, Tannery effluents

There is power breakdown on an average for 7 hours every day. The supply of diesel remains irregular, erratic, and insufficient which hampers the efficient functioning of the pumping station. This ultimately leads to bypassing of the raw sewage and tannery effluent to the river. During monsoon the IPS become dysfunctional and the entire sewage and tannery effluent is allowed to flow directly into the river Ganga.

Besides Ganga, Pandu river is also severely contaminated with domestic and industrial effluents. Some of the drains such as COD, Ganda Nala, Halwa Khanda ,etc., falling into the river Pandu carry effluent from industries in the Panki and Dadanagar industrial areas and pollute the river Pandu.

One of the biggest woes of the city is its underground aquifers are getting extremely polluted due to the pollution of river Ganga and leachate penetration from numerous legal and illegal dump sites. A four-member team of scientists from the National Environmental Engineering Research Institute (NEERI) has found the quality of underground water in many of the localities of the city and suburbs totally unfit for domestic use (www.HindustanTimes.com).Water samples were collected from two classes of respondents (higher and lower income groups) from different parts of the city, analyzed and found that the water samples collected from the higher income groups in the city and suburb areas for the pre monsoon and winter seasons contained faecal coliform. The water samples of tubewells collected from the people belonging to the lower income group had faecal coliform and Escheerichia Coliform contamination. The water samples collected from the Bhairon Ghat pumping station and the Motijheel raw water intake point were found grossly contaminated. Similarly, all water samples collected in winter months from the highest income group indicated high rate of contamination. The report suggested that raw water resources needed thorough treatment before being consumed. The ground water of Panki industrial area has been found to be contaminated with alarming levels of ammonia due to contamination from Duncans Fertliser factory. The underground water in areas such as Baburia, Rakhimandi, Nauriyya Khera, Fazalganj, Juhi and Jajmau is highly contaminated. The chromium level in the groundwater of these places was between 0.132 and 10 miligram per litre, which is far beyond the permissible level of 0.05 miligram per litre.

Solid Waste Management

Kanpur generates approximately 1500 tonnes/day of solid waste from domestic and commercial sources, apart from 250 to 350 tonnes/day of industrial waste. The responsibility of solid waste management is entrusted to Kanpur Nagar Mahapalika (Municipal Corporation). Collection efficiency varies from very poor to poor all over the city. Areas owned by other agencies like Cantonment, HAL colony, Armapur, IIT, etc., have efficient waste collection. Peripheral areas, newly developed colonies and slums have very poor waste collection. The city, however, lacks an integrated approach to manage waste. There is no treatment of municipal waste and the collected waste continue to be dumped unscientifically at legal and illegal sites, leading to water pollution, air pollution, land degradation, spread of diseases, etc.

Impact of urban activities on fringe villages and suburbs

The built environment has its spread effect. In Kanpur, the ill-effects of various activities like industries, treatment plants, air and water pollution are not limited to the city limits. The impacts have started to appear in the suburbs and villages nearby. In Motipur village, the use of irrigation water (which gets a residue from the CETP) has caused abortions, skin diseases in humans and cattle. The agricultural yield has gone down drastically.

In Wajidpur and Sheikhpur villages, the tests conducted on ground water (the only source of water) by the Facility for Ecological and Analytical Testing, Indian Institute of Technology, Kanpur in 2002 on request by an NGO 'Ecofriends', showed the following results (Table 11):

Formation of heat islands

The city lacks green spaces, especially in the central core area. Even in the areas surrounding the city, the green spaces available near Unnao are highly polluted due to the contaminated discharges from leather tanneries. This leads to creation of heat islands as natural vegetation is sparse in the city. Studies of estimation about the increase in temperature due to heat islands in Kanpur, is not available. This phenomenon is however, believed to raise air temperature in a city by 2-8^{0}F (Gorsevski et al, 2001).

Issues

Urban development in India is usually guided by the Master Plan. It is observed however, that the current practices of Master Plan preparation are guided primarily by spatial planning and land use allocation, followed by a road network plan. Universal design concept with an understanding of implications of various land-use and development decisions on public health is not visible. The first Master Plan for Kanpur was done in 1962 with an envisaged development plan up to the year 1991. The growth patterns achieved were however, contrary to the expected and forecasted results of the plan. The Master Plan was revised in 2001 and a new draft Master Plan for 2021 was proposed. The following are observed in the new plan:

- The revised plan still adopts conventional techniques for forecasting. Infact, aspects like Solid Waste Management have been altogether left out in spite of the fact that the city is one of the dirtiest cities in North India and has an alarming rate of broncho-respiratory problems. There is no land identification for landfills and/or solid waste treatment facilities.
- The dynamics of the city has not been dealt with in a scientific way.
- Regional perspective is lacking in the current plan.
- The Master Plan does not discuss about sustainability.
- All stakeholders have not been involved.
- Sewage problem has not been dealt with at its route. Kanpur is a witness to sewers blockage, which result into sewage backflows. The situation worsens in monsoons and the city is often flooded even with little downpours. The harmful pathogens get back in the humans through food and water resulting in poor health, spread of diseases and economic losses.
- No efforts, whatsoever, has been taken to assimilate the waste generated in a cyclic flow
- Kanpur city with rivers on north and southern part is paradoxically a water starved city. No effort to stop wastage of water, prevent excessive pollution of surface and underground water is seen. Overall, there is a complete dearth of an integrated approach to water management.
- The city is an energy starved city bearing full impacts of the poor power crisis of Uttar Pradesh state. On an average, the city faces power cuts of 8 hours which increases during peak summers. There are no steps taken at city level to manage the energy scenario in a better way and to focus on steps like demand-side management and conservation.

Table 11: Test results of Ground Water meant for Drinking at Wajidpur, Sheikhpur villages at Jajmau

Sl No.	Parameters (Heavy Metals / Pesticides)	Wajidpur (mg/L) ***	Sheikhpur (mg/L)	WHO* Standards (mg/L)	No of times greater/less than WHO Standards for Wajidpur	No of times greater/less than WHO Standards for Sheikhpur	Selective Potential impact from ingestion health of water
1.	Arsenic	Absent	0.64	0.01	NA**	64 Times	Skin damage or problems with circula-tory systems and increased risk of cancer
2.	Cadmium	1.56	Absent	0.003	520 Times	NA	Kidney damage
3.	Mercury	0.11	0.12	0.001	110 Times	120 Times	Neuro-logical toxicant
4.	Nickel	1.45	0.01	.05	72.5 Times Limits	Below WHO	Increased risk of cancer
5.	ChromiumVI	39.52	37.57	.05	790 Times	751 Times	Increased risk of cancer
6.	Alpha, Beta, Gamma BHC	0.013 Micro grams / Litre (Beta BHC only)	1.69Micro grams/ Litre (Alpha, Beta, Gamma BHC)	2 Micro grams/ Litre	Below WHO Limits	Below WHO Limits	Liver or Kidney problems
	Endosulphane	Absent	0.22 Micro grams/ Litre	Banned	NA	NA	Liver or Kidney problems
	Dieldrin	Absent	0.78 Micro grams/ Litre	0.03 Micro grams/ Litre	NA	26 Times	Liver or Kidney problems
7.	Sulphate	1327	1573.6	400****	3.3 Times	3.9 Times	Liver or Kidney problems
8.	Nitrate	1200	6400	50 (Acute)	24 Times	128 Times	Increased infant mortality (blue baby syndrome)
9.	Chloride	1285.4	595.56	1000***	1.28 Times	Below WHO limits	Liver or Kidney problems

*WHO: World Health Organisation; **NA: Not Applicable
*** mg/L: Milligram Per Litre; **** Indian Standards

Source: www.ecofriends.org

Similarly in Noraiakheda, the concentrations of Chromium, Iron, Fluorides and Pesticides were 125 times, more than 1000 times, 4-5 times and more than hundred times respectively than the desirable limits for drinking water (CPCB, 1997).

For the sake of sustainable development in the city and to promote a healthy built environment, the following issues come up:

i. A strategy for operation and maintenance of sewerage and pump stations, the current state of which presents a picture of neglect and disrepair for the flows along with waste collection and segregation at source at the ward level.
ii. Treating wastewater requires provision of costly infrastructure and its continuing operation and maintenance, but if the "problem" is moved downstream of the city then the polluters make the non-polluters suffer as also the case with solid waste the people living in the vicinity of dumpsites have to breathe and access contaminated air and water.
iii. There appears to be demand for improving sanitation services but policy makers are being misled by unsustainable solutions. So if communities are the final owner of the sanitation as they should be they must have a collective stake in determining the shape of the project and a commitment to and understanding of their future responsibilities.
iv. The primary stakeholders' perspective at the household level has to be taken cognizance of and their participation can bring in real change.
v. There is an immediate need to change our approach from inefficient and resource consuming sewerage system to the sustainable ecosan approach. It is a sustainable, closed-loop system, which closes the gap between sanitation and agriculture. The underlying aim is to close (local) nutrient and water cycles with as less expenditure on material and energy as possible to contribute to a sustainable development.
vi. The existing built-environment of the city is not promoting a healthy environment. The increasing rate of broncho-respiratory diseases and stress related problems is a testimony to this.
vii. There is a dearth of green spaces with a resultant increase in heat-islands. Traffic is in complete disarray at most parts of the city, showing an absence of a technically sound transport plan.

Discussion

- The Master Plan or the Development Plan must be integrated in approach, and must be economically feasible, technically viable, socially acceptable and practically implementable. It should be based on the concepts of sustainable development.
- Key planning tools and techniques such as, information system, statistics, operations research, system dynamics, discounted cash-flow techniques, etc., should be employed while preparing integrated Development Plan, in addition to employing the required planning theories. However, it has been observed that the present Master Plans never consider all these aspects, and the plans are prepared in the air without scientific backing.
- Due weightage should be given to infrastructure development, energy-management (at built environment level) and a transport network plan with appropriate modal mix should be developed in accordance with requirements.
- The existing practice of water and energy consuming sewerage system is proving to be highly unhealthy and resource consuming in our Indian context.
- The existing practice of waste collection and land disposal is least environment and human friendly. There is hardly any treatment facility except for in few metropolitan cities and that too is not conducive to our waste characteristics.
- Under uncontrolled urbanization of cities, the possibility of availability of suitable land for waste disposal will eventually become very scarce in future.
- There is a need to evolve a sustainable and socio-economically viable solution

for municipal and hazardous (industrial and bio-medical) waste management. Appropriate technology should be employed in the system. There is an urgent need to look for optimal alternative solutions to reduce the amount of wastes finally going for disposal. There is a need to check the current practice of ad hoc selection of site for open dumps and instead pave the way for sanitary landfills.

- Stricter implementation of the rules and regulations and to catch hold of the law-breakers especially the rich industrialist; adoption of 'polluter pay' which will eventually give the right signal.
- Need to adopt Ecosan approach for sanitation because clean and healthy cities are the basic requirements for a sustainable community and a healthy built enviornment.

Future cities based on ecological approach

A city should be a replica of a natural system. It should recycle all the resources and there should be zero waste production. It should be a people friendly city with the entire infrastructure including transportation as people friendly and not vehicles friendly. People need to voluntary adopt simpler lifestyles, use more energy-efficient technologies. Power production should be based on non-conventional and renewable resources. A decentralized concept should be adopted for developmental activities, including sanitation and waste management. It should be a top-down and bottom-up approach, as we need to change the mindset of the users and consumers as well as the policy makers and planners. There is an urgent need to change the existing planning process followed in Indian urban centers. People participation should be sought in real sense. Education and media can play a very strong positive role in sensitizing people. Once there is a change in the attitude and mindset of all the stakeholders, implementation of various eco-friendly schemes and development plans would not be a problem as there will be a good public support.

Index card

There is a need to prepare an Index card based on principal sustainability indicators on an annual basis in order to check the progress/decline a city has made. These indicators should encompass the socio-economic and environmental issues. Some of the indicators are discussed as under:

- Birth weight: Birth weight is a strong indicator of the overall socio-economic status of the reproducing population within an area
- Rate of diseases like diabetes, heart-diseases, hypertension, strokes, skin ailments, broncho-respiratory diseases, etc.
- Quality of air: An increase in hospital admissions due to broncho-respiratory diseases are strong indicators of the degrading quality of air in a place
- Transportation related indicators:
- Number of personalized vehicles
- Availability and level of service of public transport
- Accident rate
- Area under Green cover
- Extent of planned public spaces
- Shelter occupancy rates and presence of slums
- Housing conditions
- Voter turnout
- Employment rate
- Education level
- Consumption of energy in all major sectors like domestic, commercial, industrial, transport, etc (qualitative and quantitative data).
- Status of Solid Waste Management
- Status of water supply, sewerage and drainage
- Quality of surface and underground water

The above list is not comprehensive and can be further extended depending on the city specific requirements.

Conclusion

With fast depleting resources and increasing man-made pressure on the natural systems, there is an urgent need to bring a holistic change in the way one thinks, acts and consumes. The existing status of built environment in urban centers, as observed in the study area of Kanpur, creates numerous environmental problems and pose health threats to resident population. This ill-effect of built environment is not limited to the concerned city but its effects trickle down to adjacent areas. Water and sanitation are one of the biggest challenges of the urban systems. There is need to adopt a closed loop cycle for both solid wastes and liquid wastes treatment and disposal. However, one needs to make the system affordable, acceptable, aesthetically inoffensive and consistent with cultural and social values, and as comfortable as conventional systems. An ecological city rightly serves our objectives to achieve sustainability in all aspects. At this juncture, it is an inevitable requirement to bring remedial measures in all Indian cities to make a successful march towards sustainability. To achieve sustainability, required reforms must be adopted and implemented; otherwise the cities are bound to perish, definitely.

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