CHAPTER 4
IMPLICATIONS OF URBAN SPRAWL

4.1. Implications of Urban Sprawl

The town or the city truly bears the consequences of urban growth in the form of both positive and negative impacts. It has been observed that negative impacts override the positive sides of urban growth as these generally get more highlighted because of its uncontrolled or uncoordinated nature of developments. Positive implications of urban growth include higher economic production, opportunities for the underemployed and unemployed, better life because of better opportunities and better services, and better lifestyles. However, in many instances, urban growth is uncontrolled and uncoordinated resulting in a sprawl. As a result, the upside impacts vanish inviting the downsides (Bhatta, 2010).

It has been realized that in order to address the problems that are caused by urban development, and for the limitation of urban sprawl, a wide range of policy instruments are required. Unfortunately, the policies for restriction of urban sprawl are very difficult to implement as there are factors which affect implementation and effectiveness of policy (Vasili, 2013). The impact of urban growth on space, environment and quality of life will be, to say the least, is tremendous. The provision of infrastructural facilities required to support such large concentration of population is lagging far behind the pace of urbanization. The urban expansion that tends to sprawl away from the center of urban hub deteriorates the level, quality and distribution of services like water supply, sewerage, developed land, housing, transportation and other facilities (Sivaramakrishnan et al., 2003).

The inability of the smaller towns and cities to cope up with the growing population has further been influenced by the impacts of climate change. The changes in the
patterns and the intense variations in the climatic characteristics has resulted frequent environmental problems in the urban areas and which are projected to be further aggravated by increased rate of urbanization. The urban dwellers are either adapting or bearing the brunt of the effects by responding to the implications evolved out of climate change.

It is therefore, essential to understand the implications of urban sprawl so as to introduce policies or regulations at the local governance level for restriction of urban sprawl and thereby limiting the negative impacts.

4.1.1. Implication of urban growth on the land use/ land cover of Jorhat Town

It has been observed that the existing land use / land cover (LULC) of Jorhat town and its surrounding areas has been under tremendous influence from the varied dimensions of the causes of urban sprawl. Therefore, an understanding and assessment of it in the face of urbanization is significant.

The LULC of the study area which has been mapped and classified under sixteen smaller classes are grouped under five major categories viz. Agri-Land, Built up area mixed with rural built up and household plantations, Waterbody, Tea Garden and Wetland (Fig-4.1).
The land cover of the Jorhat Town has been under constant pressure in fulfilling the various and innumerable socio-economic demands of the rising numbers of population. The increase in population subsequently led to an expansion of residential, industrial and commercial areas in a haphazard way. This made the earlier planned city, Jorhat town, to turn out to be a haphazard mix of built-up areas which merged into one another without leaving the scope of demarcation. Here, an analysis of the existing land use/land cover has been made taking into consideration four (4) areas (Fig-4.2) so as to get an insight to the pattern and magnitude of urban expansion. The four areas that have been considered for the land use land cover study are:

**Fig-4.1: Land Use/ Land Cover of the Study area**
1. Existing Municipality Boundary

2. 1 km buffer area of the Municipality boundary

3. Master plan boundary

4. 6 km buffer area of the Municipality boundary

Fig-4.2: Four categories of area considered for LULC analysis in the study area

4.1.1.1. Land Use/Land Cover in the Municipality Area: An analysis of the land use land cover of the existing Municipality boundary shows that 84.79 per cent of the land is under built-up consisting of residences, retail establishments, educational institutes, public places and roads. The expansion is quite likely with the growth of population in the urban hub of Jorhat town. Agricultural land occupied only 13.80 per cent of the land and waterbody constituted 1.45 per cent keeping little or no scope for preserving green zone (Fig-4.1& Table-4.1).
Table-4.1: LULC Categories covered by existing Municipality Area

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>LULC Categories</th>
<th>Area Covered (sq. km.)</th>
<th>Area Covered (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agri-Land</td>
<td>1.43</td>
<td>13.80</td>
</tr>
<tr>
<td>2</td>
<td>Built up area mixed with rural built up and household plantations</td>
<td>8.78</td>
<td>84.79</td>
</tr>
<tr>
<td>3</td>
<td>Waterbody</td>
<td>0.15</td>
<td>1.45</td>
</tr>
<tr>
<td></td>
<td><strong>Total Area</strong></td>
<td><strong>10.36</strong></td>
<td><strong>100.04</strong></td>
</tr>
</tbody>
</table>

Source: Visual Interpretation of Satellite image LISS IV MX (5.8 m), 2009

This scenario clears the picture of an overcrowded municipality area with 17003 households giving shelter to 71782 populations and with a density of 7760 persons and 1838 households per sq. km. area (Census, 2011). Moreover a total of 5750 shops with a density of 622 shops or more per sq. km. area of diversified trades constituted the commercial hub of the municipality area (Jorhat Municipality Board, 2011). It can be observed that the township has crossed the existing boundary of 9.25 sq.km area with 19 wards demarcated by the Municipality in 1989. The existing boundary of local governance structure i.e the Municipality boundary is totally exhausted to regulate the expansion of development activities of the town.

4.1.1.2. Land Use/Land Cover in one (1) km buffer area of the Municipality boundary: To get a picture by adding more area to the Municipality area, an analysis is attempted by taking into account 1 km buffer of the Municipality boundary. In that case, it is seen that built up area mixed with rural built up and household plantations constituted 71.38 per cent thus leaving 26.90 per cent for agricultural crop land, 1.11 per cent for waterbody and 0.60 per cent to tea plantations (Fig-4.1 & Table-4.2).

Table-4.2: LULC Categories covered by 1 km buffer area of existing Municipality Boundary

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>LULC Categories</th>
<th>Area Covered (sq km)</th>
<th>Area Covered (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agri-Land</td>
<td>7.87</td>
<td>26.90</td>
</tr>
<tr>
<td>2</td>
<td>Built up area mixed with rural built up and household plantations</td>
<td>20.88</td>
<td>71.38</td>
</tr>
<tr>
<td>3</td>
<td>Waterbody</td>
<td>0.33</td>
<td>1.11</td>
</tr>
<tr>
<td>4</td>
<td>Tea Garden</td>
<td>0.18</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td><strong>Total Area</strong></td>
<td><strong>29.25</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Source: Visual Interpretation of Satellite image LISS IV MX (5.8 m), 2009
4.1.1.3. Land Use/Land Cover in the Master Plan boundary: Again, to get a much broader picture of the built-up expansion, the first master plan of the district with an area of 75.52 sq.km, prepared in 1978 through a thorough survey by Town & Country Planning Department that has not been implemented at all and expired in 1991, has been taken into consideration. The Master Plan boundary, which surpassed more than 1 km area of the existing Municipality boundary, has been found to be exhausted with urban expansion. The master plan boundary (75.52 sq. km) itself exhibited devoid of proper zoning with ever expanding town where built up area mixed with rural built up and household plantations is 63.46 per cent (Fig-4.1& Table-4.3). In absence of the Master Plan which provides guidelines in carrying out the developmental activities, earlier demarcation has been crossed with expansion of commercial and residential areas into the adjacent countryside. This has caused once a planned town turned out to be a mix of residential, industrial and commercial zones. And green zone of the town almost lost its identity.

Table-4.3: LULC Categories covered by Jorhat Master Plan Area

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>LULC Categories</th>
<th>Area Covered (sq km)</th>
<th>Area Covered (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agri-Land</td>
<td>21.38</td>
<td>28.31</td>
</tr>
<tr>
<td>2</td>
<td>Built up area mixed with rural built up and household plantations</td>
<td>47.93</td>
<td>63.46</td>
</tr>
<tr>
<td>3</td>
<td>Waterbody</td>
<td>0.64</td>
<td>0.85</td>
</tr>
<tr>
<td>4</td>
<td>Tea Garden</td>
<td>5.58</td>
<td>7.39</td>
</tr>
<tr>
<td><strong>Total Area</strong></td>
<td></td>
<td><strong>75.53</strong></td>
<td><strong>100.01</strong></td>
</tr>
</tbody>
</table>

Source: Visual Interpretation of Satellite image LISS IV MX (5.8 m) Area, 2009

4.1.1.4. Land Use/Land Cover in the six (6) km buffer area of the Municipality boundary: Further in the analysis, another 5 km was added to the one (1) km buffer area of the existing Municipality Boundary and which comes to a total of 6 km buffer area. The purpose of taking this buffer area is to take into account and cover the Master Plan Area within it. However, if the buffer area is taken more than 6 km, it touches the Brahmaputra River boundary in the North. So, it has been discarded and 6 km was taken
into consideration for the proposed study. Here, the study area with the buffer accounts for 209.19 sq. km. Of the total, 46.66 per cent is the built up area mixed with rural built up and household plantations and 40.13 per cent is agri-land. (Fig-4.1& Table-4.4)

Patches of tea gardens are situated to the south east, south west and eastern periphery of the study area.

Table 4.4: LULC categories covered by 6 km buffer area of Jorhat municipality area

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>LULC Categories</th>
<th>Area Covered (sq. km.)</th>
<th>Area Covered (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agri-Land</td>
<td>83.94</td>
<td>40.13</td>
</tr>
<tr>
<td>2</td>
<td>Built up area mixed with rural built up and household plantations</td>
<td>97.62</td>
<td>46.66</td>
</tr>
<tr>
<td>3</td>
<td>Waterbody</td>
<td>1.39</td>
<td>0.67</td>
</tr>
<tr>
<td>4</td>
<td>Tea Garden</td>
<td>25.93</td>
<td>12.40</td>
</tr>
<tr>
<td>5</td>
<td>Wetland</td>
<td>0.31</td>
<td>0.15</td>
</tr>
<tr>
<td><strong>Total Area</strong></td>
<td></td>
<td><strong>209.19</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Source: Visual Interpretation of Satellite image LISS IV MX (5.8 m), 2009

The entire area covered about 93 revenue villages with a population of about 300599 and 69191 households. It has been observed that the road network has facilitated growth of the built up areas alongside and an arterial pattern of settlement has been observed. Of the 46.66 per cent built up area (mixed with rural built up and household plantations) in the entire study area, 15.64 per cent built up area is covered by the urban hub area of 2010.

4.1.2. Availability of Green Belt

When an attempt has been made to look into the availability of green belt in the analyzed four areas viz. existing Municipality Boundary; 1 km buffer area of the municipality boundary; master plan boundary and 6 km buffer area of the municipality area, it showed how that all the areas have been affected by the expansion of built-up area in the face of urban growth. The open and green areas are losing their identity with the takeover of land by the built-up area in the course of urban expansion. The three areas viz. existing Municipality Boundary; 1 km buffer area of the municipality
boundary; and master plan boundary under consideration for the study leaves no or less than 30 per cent of agricultural lands which could have served the purpose of green belt contributing to the sustained urban development. Only the 6 km buffer area of the municipality boundary leaves some scope for preserving the green belt as this area has an area of more than 40 per cent agricultural land (Fig-4.3).

![Availability of Green Belt](image)

*Source: Visual Interpretation of Satellite image LISS IV MX (5.8 m), 2009*

**Fig-4.3: Availability of Green Belt in the study area**

It has been observed that the earlier demarcations done decades ago has lost its importance and gradually becoming meaningless. In the recent past, it has been observed that over a period of time, the adverse effects of haphazard urban expansion of the town have already started to create a bane to the dwellers of the city in the form of waterlogging problems, drinking water scarcity, sewerage problem, forming of heat-islands, waste disposal, traffic congestion etc. Most of the problems roots out from the gradual impacts of climate change which are caused by the change in pattern of rainfalls, temperatures and extreme events of rainfall. It is the need of the hour to redefine the areas of the town to avoid confusion and to retain its capability to face the challenges of the impacts of climate change.
In a nutshell, the analyses of land use/land cover considering the four categories of areas reflected the following implications:

- The built-up land is expanding in a highly unplanned and haphazard manner to accommodate the growing population and their socio-economic needs at the cost of the open agricultural and green areas. This has led to haphazard mix of residential, industrial and commercial zones.

- Green belt is being consumed up at the cost of expansion of urban activities in the study area.

- The study area has been under the pressure of the gradual impacts of climate change like change in pattern of rainfalls, change in temperatures and extreme events of rainfall. These impacts have been slowly casting its negative effects on the existing urban system of the historic town. In the recent time these effects can be seen in the town in the form of waterlogging problems, drinking water scarcity, lack of sewerage, forming of heat-islands, creating a bane to the dwellers of the city. Illustrations of these problems have been given in the subsequent paragraphs.

4.1.3. Water Logging and reasons of its proliferation

Jorhat Town area has witnessed artificial flood in recent times. It has been observed that the terrain feature of the study area largely exhibit between 80-100 m height above mean sea level. As the eastern part of the district exhibits elevations ranging from 120 to 200+ m above MSL and have moderately to steeply sloping lands, the accumulated rain water makes its way to the north east, south west and the south which exhibits level to nearly level slope with 0-1 %. Now, as that the low-lying areas and former open fields in both the northern and southern parts were turned into residential areas with haphazard
construction of buildings, the natural run-off do not have the sufficient place to accumulate and this leads water logging in the study area.

Moreover, total length of storm water drainage in the town is only about 200 km. out of which 10% is *pucca* and balance is *kutcha* drain. Due to lack of permanent drains in several residential colonies aggravates the water logging problem. The unplanned drainage system added by the non-existence of the original outlets through which the earlier water passed to the Tarajan River cannot cross the A.T. Road to flow towards the low northern part. Now there is no provision to let out the logged water to nearby Tarajan River too. To name a few, the entire area of Tarajan, Brahmingaon, Sonarigaon and Kakotigaon was severely hit by artificial flood due to continuous showers recently. Chandan Nagar, Suruj Nagar, Club Road and all the by-lanes between Na-Ali and Club Road, also remain submerged under artificial flood.

As per the census data, 2011, waste water connected to closed drainage in the study area comprising the Jorhat town and its surrounding areas is only 5.50 per cent, while that connected to open drainage is 33.45 per cent. Most of the waste water finds no outlet to flow out as about 60.06 per cent of the wastewater is not connected to any drainage.

As can be observed from Fig-4.4, over a period of ten years(2001-2011), the figures are showing disappointing picture with rising percentage of open drainage in the district. Although closed drainage connectivity has shown a higher rate over a decade, more than 75 percent of the households have no drainage connectivity for waste water outlet.
Unscientific disposal of waste in residential and commercial areas eventually leads to the blockage of existing drains resulting in artificial water logging. Moreover, the most awful fact is that the water coming from the direction of the JDS Civil Hospital and logged in the area is so filthy that it will be a transporter of germs of various diseases.

As has been observed from the climatic background of the study area, for the last 30 years the decrease in rainfall has been at a higher rate, but with more abrasive trends. The years 2009 and 2010 have extreme contrasting trends. At Toklai, Jorhat the total rainfall in the year 2009 was 1184.4 mm whereas in 2010, it almost doubled to 2299.7 mm. This type of variations makes towns like Jorhat reel under waterlogging and flood like situation. Moreover, the months with high rainfall have been observed to have more number of thunderstorms as per the draft report on Assam State Action Plan on Climate Change.

4.1.4. Garbage Disposal

Garbage disposal has been one of the acute problems in the town, owing to the sheer lack of house to house collection of waste, secondary collection and most importantly the absence of permanent scientific dumping ground. As per the report on
Assam State Action Plan on Climate Change 2012 – 2017, this is by and large the scenario for all urban areas in Assam. It is a discouraging sight that none of the cities and townships in the state of Assam have appropriate infrastructure for sewage treatment. But, most importantly, this has been a key issue for the sustainability of water resources and their origin on which the urban areas are dependent.

As a matter of fact, Jorhat Town does not have a proper waste disposal site to dump the tons of garbage that it produces everyday (Table-4.5). According to the reports of Jorhat Municipality Board, the garbage generated per day is 35 MT of which 31-33 MT can be disposed. The remaining is left out to create health hazard to the people.

Table-4.5: Generation and disposal of Garbage

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Particulars</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Garbage Generation/day in the town</td>
<td>35 MT</td>
</tr>
<tr>
<td>2</td>
<td>Garbage dispose/day</td>
<td>31-33 MT/day</td>
</tr>
</tbody>
</table>

Source: Jorhat Municipality Board

The refuge is generally kept in the dustbins on the roadsides. Concrete dustbins have been built from place to place. From these the Municipal authority takes away the refuge to throw on the banks of Toklai River near Engineering College at Garmur, 3 km away from the city, but the ground has got overfull.

The solid waste management scenario of the Jorhat town reflected that (Fig-4.5) the major part of the garbage are organic substances, ash etc. Garbage i.e. paper etc. and textiles covers about 13.73 percent and 12.4 per cent respectively. Plastics form the fourth large part of garbage with its share of about 9.8 per cent. Small parts of glass (1.8 per cent), wooden matter (1.1 per cent) and metals (0.1) constitute the garbage that is generated in the Jorhat Town.
In addition to that, the absence of proper residential and commercial waste disposal mechanism most of the waste never find its way to disposal site. The Garbage has especially been dumped over the Toklai River at Marwaripatty site and in certain areas in the A.T. Road and Garali huge waste are dumped causing traffic problems and unclear conditions in and around. This eventually manifested to several common urban woes.

4.1.5. Traffic Congestion and Air Pollution

Keeping a pace with the recent trends of developmental growth, population growth and urbanization, there has been an increased demand in the transportation services. In the absence of efficient public transport system, private vehicles have grown at a rapid pace in the state. Total number of vehicles in the state increased about 120% during 2001-09 while only during 2008-09 registration of vehicles recorded 23% increase.

As per the Municipality Board, Jorhat the total road length within the Municipal limit is 87 km out of which 39 km is Municipal Road and the rest 48 km is PWD Road. It has been observed that Jorhat Municipal Board has paved 11 km of road and balance
is remaining unpaved. The rising number of vehicles as can be observed from the period of 1999-2000 where the number of registered motor vehicles was 2608 rose to 8568 in 2009-2010 indicating more than 3 times rise in rate of vehicles and corresponding rate of emission (Fig-4.3).

Moreover, the vehicles mainly consume non-renewable fossil fuels, and are a major contributor of greenhouse gases, particularly CO2 emission. Such trends are indicative of increased fuel demand and vehicular emissions. The total commercial energy consumption in the transport sector is estimated to be huge and includes fuel such as diesel, petrol, CNG, LPG etc.

It has been found from the Census of India, 2011 that about 43.62 per cent of the villages/urban area of the study area have more than 20 per cent of the households who have vehicles (scooter/motorcycle/moped or car/jeep/van). With no real increase in the length and size of the roads in the study area, the eventual traffic congestion is imminent. In the backdrop of the increase in population and increase in number of vehicles, the existing nature of the roads seemed to be incapable to provide ample service to the commuters. It has been, thus, realized that an additional load on the existing infrastructure has been created in accommodating the increasing number of vehicles added every year. And this has led to acute traffic congestion during the peak hours of the day.
4.1.6. Water Scarcity

A number of habitations with 100 percent population coverage for safe drinking water are 46262 out of total number of 86976 habitations in the state of Assam. This gives an impression that only 53 per cent of the population of the State has the accessibility to safe drinking water.

With the increase of population in the town, the supply of water from the existing water supply projects is not sufficient to meet the present demands of the people. It has been found from Census of India, 2011, that only 28 per cent of the households in the study area get tap water from treated sources. So, about 70 per cent of the household have to depend on hand pumps, tap water from un-treated source, un-covered well, tank/pond/lake, and tube well/borehole for drinking water. A small percentage of about 2 per cent are found to depend on spring, river, etc.

The existing water supply projects are old enough and need immediate up-gradation to fulfill the demands of the growing population. Moreover, as water is the main source of epidemics since it is universally used and supplied to a large population from a few centralized sources, there is a dire necessity of upgrading and renewing the water supply.
system. As majority of the people who do not have piped water supply, and have to depend upon other sources like pond, dug well, hand pump etc. which are not safe for health often causes water borne diseases like diarrhoea, jaundice etc. (Bhuyan et al., 2013).

A survey carried out by Dr. R. Barua et al. in the Jorhat Town area revealed that water from surface sources were found to be more polluted than ground sources. Of the surface sources, those in the deep category had low level of pollution. More than 91 per cent samples from ground sources fall within non-polluted category while in the case of surface sources, 70 per cent samples only were in this category. Water sources owned and maintained by private individuals are far safer than public sources (Thakur, et. Al., 2004).

However, as stated in the report on Assam State Action Plan on Climate Change 2012 – 2017, it has been found that with the disappearance of surface drinking water, people of the state are depending more upon deep tube well water.

Barring some small parts in the study area, that the entire study covers unconfined to semi confined aquifer as depicted by the ground water prospect map (Fig-2.6: Map showing ground water prospects of the Jorhat district along with the study area, Chapter-II). The ground water quality is found to be well within the permissible limit of drinking, irrigation and industrial purposes except high iron concentration which can be removed through proper measures. As per the Ground Water Information Booklet, Jorhat District prepared by Central Ground Water Board, North Eastern Region, Ministry of Water Resources, 2008, that as the district is underlain by approximately 30 to 50 meters of clayey formation, construction of shallow tube well poses problems.
4.1.7. Heat Wave

As has been observed from the trend of minimum temperature recorded at Tocklai, Jorhat, it has been found that over about 88 years, there has been a significant increase of the same. And there is more than $1.4^\circ\text{C}$ increase in minimum temperature. Moreover the number of days having temperature $> 30^\circ\text{C}$ or even $35^\circ\text{C}$ is generally increasing with the increase in minimum temperature.

Further analysis of the extreme events shows that the number of days having temperature less than or equal to $6^\circ\text{C}$ and $8^\circ\text{C}$ have decreased recently especially during the last 30 decades, thus, indicating that the minimum temperature is increasing and more number of days are with higher minimum temperature compared to earlier years, indicating a warmer trend.

There have been instances of heat wave in the recent years severely affecting all section of people in the district along with the state. It has been reported that the heat wave has severely affected the tea industry in the district and has been a major concern as the shade tree status in most tea gardens are poor; only about 30 per cent of the area of the plantations gets adequate shade required for the tea to grow.

Incessant urbanization increases land surface temperatures and, over time, the city ends up as an island of heat. Delhi, Mumbai and their residents have been facing this onslaught [of heat] for 20 years. It may eventually result in unprecedented repercussions such as heat waves, health impacts, human discomfort and increased mortality among the elderly," Scientists expect urban heat waves to increase in both frequency and intensity as cities in developing countries grow. A study of 30 years' weather records by the Shanghai Urban Environmental Meteorology Centre shows that warming differs according to the degree of urbanization, and that many more people die from extreme heat in built-up areas than in areas surrounding a city.
As studied by S. Stapleton, in 2013 on Simple Climate Change Projections by the 2030s, Jorhat, it has been stated that the process of urbanization has been altering the landscape of the town, making it more prone to flooding and putting the residents’ and their livelihoods at risk of suffering damage during climate-related hazards.

Now, with regard to the study area, it has been found that Jorhat Municipality area and its immediate surrounding areas comprise the urban hub covering the maximum built-up area. About 97.42 per cent of the households in the Municipality area of Jorhat have houses with roofs made up of G.I./Metal/Asbestos sheets, Concrete, Stone/Slate and Burnt Brick. The increasing trend of both maximum and minimum temperatures in the study area in association with loss of trees and other types of vegetation for buildings, roads, and other urban or social infrastructure, increases the rate and extent of local warming of the town. Air pollution with the increase of emissions as a result of increase in number of vehicles is contributing to the increased heat in the town.

The Urban Heat Islands which refers to the generally warm urban temperatures compared to those over surrounding, non-urban, areas (Mills, 2004). The phenomenon of urban heat islands has been recognized as a direct consequence of urbanization. The artificial urban surfaces such as concrete and asphalt act as a giant reservoir of heat, absorbing it in the day and releasing it at night. Pollutants from nose-to-tail traffic add to the heat and, in a vicious cycle, people turn to air conditioning, which pumps out yet more heat and pollutants, so increasing climate-changing emissions, which lead to warmer global conditions.

Many different types of surfaces that make up an urban environment affect the heat balance of cities. Roof surfaces are key interfaces in the volumetric exchange of energy because they constitute a large fraction of urban surface areas, and due to their
exposure, they receive considerable solar radiation (Wijerathne, et al.). Moreover dark horizontal surfaces absorb most of the sunlight falling on them and consequently dark surfaces run hotter than light ones. This is the main cause of urban heat island effect (Killingsworth et al., 2011). The effects of urban heat island are directly related to and worsened by climate change, where it is expected that an increase in the average temperature will have a stronger effect on the health of people living in cities, and particularly of the vulnerable groups like the sick and elderly.

As per the Census of India, 2011, more houses with mosaic/ tiles or stone floored houses are found in the urban areas, while it is negligible in the rural areas. The predominance of houses with concrete roof, wall and floors in the urban areas hence make the hub of the town feel the brunt of heat waves.

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