I Issues & Themes

Vulnerability to Climate change is the degree to which a system is affected by adverse effects of climate change. Human vulnerability thus includes the vulnerability of social and economic systems, health status, physical infrastructure and environmental assets.[[1]](#endnote-2)

The IPCC defines it as “the degree, to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. The term ‘vulnerability’ may therefore refer to the vulnerable system itself, e.g., low-lying islands or coastal cities; the impact to this system, e.g., flooding of coastal cities and agricultural lands or forced migration; or the mechanism causing these impacts, e.g., disintegration of the West Antarctic ice sheet”[[2]](#endnote-3).

Thus Vulnerability to Climate Change has to be looked at three levels:

**Direct impacts** are the system’s exposure to crises, stresses and shocks. There is the direct impact due to rise in sea level and increase in sea temperatures that may inundate low lying areas or result in depletion of fish stock. Sea level rise will have multiple impacts. It will inundate coastal settlements, aggravate flood situations, erode beaches, further impacting settlements, and will leave vast swathes of land and water sources saline. The net result will be the displacement of people from these densely populated areas. There are also the impacts of extreme weather events like flash floods, heat waves, droughts and other impacts of rise in temperature of vectors.

**Sensitivity of the system:** At the next level is the sensitivity of the system already impacted by environmental degradation - changes brought about by dumping of industrial waste or reduction of mangroves, deforestation, depletion of ground water, poor quality of amenities like sewerage etc.

**Adaptive capacity & long term recovery:** The ability of the system to attenuate stresses or cope with the consequences is critical. We need a clearer understanding of coping strategies or mechanisms, of who are at risk, from what. Which are the specific stresses and perturbations which have higher risk and major impacts? This includes the consequences and attendant risks of slow (or poor) system recovery. This perspective suggests that the most vulnerable individuals, groups, classes and regions and the most sensitive to perturbations or stresses have the weakest capacity to respond and ability to recover.

When stresses or perturbations emanating from the environment coalesce with those arising from society, significant consequences can result. For example, economic depression reduces society's capability to develop or maintain pre-emptive coping measures to reduce the impacts of drought, such that the co-occurrence of drought and economic depression synergistically enlarges the vulnerability of the system”.[[3]](#endnote-4)

I.1 Vulnerability to Climate Change in the urban context

Less than two percent of the global population resided in “megacities” of 10 million or more inhabitants about 25 years ago. Today the proportion exceeds four percent.

In India, according to the 2011 census, 31.2% of the total population lives in urban centres compared with 27.8% in 2001 and 25.5% in 1991. For the first time since Independence that the absolute increase in population between 2001 & 2011 in urban areas (at 91 million) was more than in rural areas at (90.4 million). The biggest trend towards urbanization is in southern India, where all states except Andhra Pradesh have more than 35% of the population in urban centres. In Karnataka the level of urbanization has increased from 33.9 percent in the 2001 Census, to 38.57 percent in 2011. Bangalore has a population of 87.1 lakhs (provisional population figures 2011).[[4]](#endnote-5)

I. 2 Areas of Urban Vulnerability and Indicators

Every city is marked by informal settlements where the poor are forced to live without access to basic services like water and sanitation. In some cities like Mumbai, for instance, half of the population (49 percent according to Census 2001) lives in slums. They are forced to accept dangerous and inhuman living conditions, in which any untoward natural event is likely to become a disaster. Vulnerability to Climate Change sits on top of, and is exacerbated by other vulnerabilities created by poor access to land, overcrowding and low-quality housing and a complex set of social, institutional and economic processes.

Environmentally too the city is precariously poised. Contaminants and gases in an urban setting are 5-25 times more than that of a rural environment; rainfall and cloudiness 5-10% more; fog as much as twice as frequent (especially in winter); temperature 0.5-2°C higher; relative humidity about 2% less; radiation 15-20% less and winds 20-30% less[[5]](#endnote-6). Due to climate change the frequency of warm spells and heat waves are likely to increase, exacerbating the heat island effect in cities where temperatures may go up to 10 degrees higher in densely populated areas. Air pollutions would also worsen in these conditions. Thus there is increased risk of heat related mortality, increase in vector borne diseases, respiratory diseases.

Following heavy precipitation events and increased cyclonic activity predicted following global warming, there is an increased risk of floods and landslides, damage to homes and business, loss of income and property. Low lying areas are susceptible to water borne diseases, increased breeding of vectors, water related diseases. The cities along the coast, and there are many of them, suffer loss of property, damage to shelters, salination of water, coastal flooding etc due to the projected sea level rise.

Drought in the hinterland, creates food shortages, where poorer people are unable to cope with increased prices of food, leading to massive malnutrition among children and women particularly. Further these urban spaces are subject to increase distress migration from rural areas.

I.3 Features of Bangalore with relation to areas of Urban Vulnerability

A tiny village in the 12th century, Bangalore grew to a cantonment township and from there to one of the fastest growing cities in the world. In the Nehruvian era, the 60s and 70s Bangalore became the hub of some of the biggest public sector undertakings, like BHEL, BEML, HAL. It houses industries like textiles, aviation, space as well as numerous commercial and educational institutions. Major IT companies and biotechnology firms have a prominent base within this city – all contributing to the growing economy of the city[[6]](#endnote-7). As of 2001, the city had an economy of US$ 47.2b.[[7]](#endnote-8) Its share of US$3.7b in Foreign Direct Investment was the third highest for an Indian city. As of 2009, Bangalore was inducted in the list of global cities and ranked as a “Beta World City” along with cities such as Miami, Boston, Kuwait[[8]](#endnote-9). The city now has a population of over 6 million and has achieved a decadal growth rate of 47% between 2001 and 2011.[[9]](#endnote-10)

Table 1: Demography of the Bangalore Urban agglomeration:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Bangalore UA** | 1971 | 1981 | 1991 | 2001 | 2011 |
| Population (000s) | 1654 | 2922 | 4130 | 5701 | 9588 |
| Decadal growth | - | 76.67% | 41.30% | 38.04% | 46.68% |
| Area sq km | 174.71 | 365.65 | 413.03 | 492.55 | - |
| Sex ratio | 874.39 | 895.52 | 903.52 | 907.76 | 908 |

Bangalore provides a classic example of the impacts of city growth, where urban landscapes have shown unprecedented growth rates, and how a predominantly rural population converts to an urban one[[10]](#endnote-11). The rapid expansions of the city have also taken place at the expense of natural ecosystems[[11]](#endnote-12).

**Overview of slums and fringes in Bangalore**

The slum population in metropolitan slums has been growing at a faster rate than the metro as a whole. In Bangalore the number of slum dwellers in a decade has risen from 23% in 2001 to nearly 30-40% of the city's current population. The city attracts large numbers of migrants in search of employment from other states most notably Tamil Nadu, Kerala and the backward districts within Karnataka. Many have been brought in as labour for construction. So, as the economy grows, more and more slums are also needed to house the people providing services. The service work force thus includes transport workers, masons, plumbers, electricians, sweepers, dhobis, peddlers, hawkers, cobblers, daily wage workers, labourers, dhobis etc. Most women folk engage themselves as domestic or office helps, or else generate a source of income from some cottage industry like making of incense sticks or Agarbathis.[[12]](#endnote-13)

Thus nearly 1.7 lakh households crowd into more than 400 slums in the city[[13]](#endnote-14). There is ambiguity regarding the number of slums in the city. While the KSCB places the number of slums in the city at 473, other sources place it at 450[[14]](#endnote-15) , 733[[15]](#endnote-16) and 569[[16]](#endnote-17). According to the BBMP, city hosts 569 slums — of these, 228 are notified and 341 unauthorized.

The locations of slums are least desirable from the habitat point of view – low lying areas that are susceptible to inundation, quarry pits, tank beds, along railway lines, near cemeteries, slaughter houses, etc. According to a project report prepared for the Karnataka Slum Clearance Board by the Center for Symbiosis of Technology, Environment and Management (STEM), 1/3rd of slums in the city are located in environmentally sensitive and filthy areas, where water stagnation breeds mosquitoes and other health hazards. Almost 90% of all slum houses are *kutcha* and *semi pucca* shabby dwellings.[[17]](#endnote-18) The Bruhat Bengaluru Mahanagara Palike has recently expanded to incorporate fringe areas of the city[[18]](#endnote-19). These fringe areas are predominately rural in their environs. According to Mr. Issac Amruthraj, an activist working in these areas, 85 zones with area characteristics of a village have already been considered as slums.

I.4 Development and Governance of Slums in Bangalore

The nodal agency that deals with the slums of Bangalore is the Karnataka Slum Development Board, formerly, the Karnataka Slum Clearance Board. The Karnataka Slum Clearance Board was constituted during July 1975 under the provisions of the Karnataka Slum Areas (Improvement and Clearance) Act 1973[[19]](#endnote-20). Other nodal agencies that partially look into the slum affairs include the erstwhile Bangalore City Corporation and the Bangalore Development Authority.

**Improvement of Slums:**

Declared slums[[20]](#endnote-21) are entitled to land rights and certain benefits, including infrastructure services like water and electricity toilets, street lighting, drains, storm water channels, and community bathrooms. Thus slum dwellers covet declared slum status. Even if such a status does not bring in any real development, it provides a security from being evicted. However the process of declaration is a lengthy and byzantinemechanism which can take years, if not decades. Thus all infrastructure improvement by the communities themselves are in limbo as the conditions of declaration of slums (see box), in a way, encourage insanitary conditions.

The Mysore slum areas (Improvement and clearance) Act, 1973

..the government may declare an area a slum if

a) any area is likely to be a source of danger to health, safety or convenience of the public of that area or of its neighborhood, by reason of the area being low-lying, insanitary, squalid, overcrowded or otherwise; or

b) the buildings in that area, used or intended to be used for human habitation are-

1. in any respect, unfit for human habitation; or
2. by reason of dilapidation, over-crowding, faulty arrangement and design of such buildings, narrowness or faulty arrangement of streets, lack of ventilation, light or sanitation facilities, or any combination of these factors, detrimental to safety, health or morals.

In 2010, the state government has made it mandatory for deputy commissioners to take approval from the secretary of the housing department before declaring any habitation as a slum in their jurisdiction. This new hurdle in obtaining slum declarations has made it more difficult for the people to access the subsidies to which they become entitled once the status is achieved[[21]](#endnote-22).

There is also a move to replace all slums in the city with pucca apartment blocks, construction of which has already begun in many places. The Board also undertakes construction of houses for the Economically Weaker Sections (EWS) of the society at a subsidized rate that provides them with the basic amenities. This program is currently being implemented in the slums by replacing the existing shanties, sheds and huts with apartment blocks in which the residents can live comfortably[[22]](#endnote-23).

A major problem of governance is that there are multiple agencies concerned with slums in Bangalore. The following table indicates the functions of each of these agencies, their functions and functional overlaps, which often make them dysfunctional.[[23]](#endnote-24)

|  |  |  |
| --- | --- | --- |
| **Agency** | **Functions** | **Functional Overlap** |
| BDA | Responsible for land use zoning, regulation  and planning of land, providing sites, creating  urban infrastructure and improving urban  environment | A function of BBMP under the Constitution which is also partly carried out by BMRDA  and ABIDe |
| BMRDA | Responsible for planning, coordinating, and  supervising the orderly development of land in  the larger Bangalore Metropolitan Region | A Municipal Corporation function mainly carried by BDA in city limits |
| KUIDFC | Provides assistance for urban agencies in  planning, financing, and providing expertise to  develop urban infrastructure | A Municipal Corporation function; similar tasks also carried out by ABIDe |
| KSCB | Performs rehabilitation of all declared slum  areas in the city | A Municipal Corporation function also performed by BDA and BBMP |
| BWSSB | Responsible for the pumping and distribution  of drinking water, sewerage collection, water  and waste water treatment and disposal | A Municipal Corporation function; some aspects like waste water disposal also  carried out by BBMP |

**Infrastructure of Bangalore:**

**Water:**

The Bangalore Water Supply and Sewerage Board (BWSSB) is the nodal agency that deals with water supply and drainage in the city. Earlier Bangalore depended on its lakes and local wells. The city began to import water from the Cauvery river in the early 20th century. The Cauvery water supply scheme today has reached its 2nd phase of the 4th stage and is steadily expanding.

Recently, a random test of Cauvery water conducted by a City-based laboratory found high levels of bacteria in the form of faecal coliforms and total coliforms and increased pH levels (the acidity or alkaline level of water). The water tested was collected at the source of pipelines supplying water to houses. According to Indian Standard Specifications for Drinking Water, potable water must have ‘nil’ coliforms, but the study showed more than 1,600 (most probable number) MPN/10 ml of faecal and total coliforms. Most of the water pipelines in the city are as old as 50 years. These pipelines have either become corroded or cracked making them susceptible to various contaminants..[[24]](#endnote-25) Further, since the supply is irregular, moist surface and air within the pipelines provide breeding space for the various microbes that enter the system through contact with stagnating water sources such as puddles or ditches, most frequently in the monsoon seasons.

**Drainage and Sanitation:**

Bangalore's original sewerage system was built in 1922. It covered only the heart of the city. Programmes to expand the system to unsewered areas were undertaken in 1950, and after 1960 when the BWSSB was formed[[25]](#endnote-26). The system uses a network of pipes, underground ducts and drains to tackle the sewage and in most cases the flow is gravitational. The drainage system of the city was never planned, and it grew haphazardly just like the city. Site allotments by the erstwhile corporation, the Bangalore Development Authority and the Slum Clearance Board have been made without providing adequate consideration to drainage channels. People have also in the past been dumped into flood zones without being warned[[26]](#endnote-27). The city's many interconnected and fast disappearing lakes are also used as dumping grounds for partly treated or, for the most part untreated sewage from the neighbourhoods.

**Climate of Bangalore**

The city of Bangalore lies in the center of the Mysore Plateau, which is part of the precambrian Deccan Plateau. The city is at an elevation of 3,018sq feet (920m). Its lush greenery with numerous gardens and open spaces had led to it being called the `Garden City’ of India, a term which has given way to “silicon valley of India”.

According to Kopper's broad climate classification, the climate of the city can be broadly classed as the tropical monsoon Plateau type[[27]](#endnote-28). The four main seasons that the city experiences are[[28]](#endnote-29):

a) The cold weather season (December to February) – Characterized by a period of cool weather, clear skies and a diurnal temperature range of 10-14°C. This season also is a period of little or no rainfall.

b) The hot weather season (March to May) – The temperature in this season rapidly rises to a maximum of 33.5°C. March is typically a dry month with low humidity. April and May are months characterized by considerable rainfall and thunder. An average rainfall of 160mm occurs during this period most of which occurs in May.

c) The South West Monsoon Season (June to September): Is a moist, cloudy and rainy period with a total seasonal rainfall of about 490mm. September is the month of maximum rainfall with ~143mm of recorded rainfall. This is also a period of strong and steady winds blowing from the South West to the West.

d) The North East monsoon Season (October to November): Also is a moist, cloudy and rainy period with a lesser cloud cover. Winds are weaker and blow from the ENE to NE. The change in wind direction from WSW to ENE[[29]](#endnote-30) is very characteristic.

Bangalore has seen a rapid replacement of its lush greenery with concrete and asphalt roads and numerous high rises. It has also received the dubious distinction of being the third most polluted city in the country and has loads of nitrous oxides and other particulate matter in its atmosphere, which are trapping the heat and contributing to an increase in temperature.[[30]](#endnote-31)

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