CHILDREN FOCUSED CITY RESILIENCE STRATEGIC DIRECTIONS FOR VISAKHAPATNAM

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Abbreviations

ACCCRN	Asian Cities Climate Change Resilience Network
APSDMA	Andhra Pradesh State Disaster Management Authority
CC	Climate Change
CDMP	City Disaster Management Plan
CGWB	Central Ground Water Board
CPCB	Central Pollution Control Board
CLD	Causal Loop Diagram
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organisation
CRF	Climate Resilience Framework
CRZ	Coastal Regulation Zone
CSR	Corporate Social Responsibility
CSO	Civil Society Organization
DDMP	District Disaster Management Plan
DEOC	District Emergency Operation Center
DMHO	District Medical Health Officer
FGD	Focused Group Discussion
GDP	Gross Domestic Product
GoAP	Government of Andhra Pradesh
GoI	Government of India
GVMC	Greater Visakhapatnam Municipal Corporation
HRVA	Hazard Risk and Vulnerability Analysis
ICDS	Integrated Child Development Services
INR	Indian Rupee
IT	Information Technology
LED	Light Emitting Diode
NAPCC	National Action Plan on Climate Change
NGO	Non-Government Organisation
OD	Open Defecation
PMAY	Pradhan Mantri Awas Yojana
RAY	Rajiv Awas Yojana
R & D	Research and Development
SAPCC	State Action Plan on Climate Change
SBM	Swachh Bharat Mission
SC	Scheduled Caste
SCP	Smart City Proposal
SDMP	State Disaster Management Plan
SHG	Self Help Group
SOP	Standard Operating Procedure
SPCB	State Pollution Control Board
ST	Scheduled Tribe
STP	Sewerage Treatment Plant
SWM	Solid Waste Management
UCCR	Urban Climate Change Resilience
VMR	Visakhapatnam Metropolitan Region
VPT	Visakhapatnam Port Trust
VUDA	Visakhapatnam Urban Development Authority
WASH	Water, Sanitation & Hygiene
WHO	World Health Organization

1. Introduction

In today's increasingly global and inter-connected world, over half of the world's population (54 per cent) live in urban areas. The coming decades will bring further profound changes to the size and spatial distribution of the global population. The current urbanization and overall growth of the world's population is likely to add 2.5 billion people to the urban population by 2050, with nearly 90 per cent of the increase concentrated in Asia and Africa. At the same time, the proportions of the world's population living in urban areas are likely to increase, reaching 66 per cent by 2050 (UN World Urbanization Prospects, 2014). With regards to South Asia, it is estimated that almost 250 million people will be added to the existing population by 2030. A key concern for South Asia's urbanization process is the "*Messy and Hidden*" nature of urbanisation. Widespread existence of slums and sprawls leads to messy urbanization, specifically on the peripheries of major cities which is often not captured in the official statistics. Hidden urbanization can be seen as a larger proportion of population of the region is living in settlements possessing urban characteristics but do not satisfy the criterion to be officially classified as urban (Ellis and Roberts, 2016).

Likewise South Asia, a messy and hidden trend of urbanisation is observed in Indian cities with inadequate provisioning of infrastructure and basic urban services, increasing pressure on land and degradation of environment. India will contribute 404 million people to its urban population between 2014 and

2050. The annual growth in urban population in India between 2010 and 2015 was 1.1 per cent – the highest among the major economies, according to the UN World Urbanization Prospects Report, 2014. Indian cities already contribute more than 62 per cent to our national GDP.

At a time when the idea of a 'SMART City' dominates the policy discourse, India is facing with a very real urbanization challenge. The socio-spatial hierarchy in the country's ever-expanding cities is growing deeper, even as inequalities of income, access and opportunities remain unaddressed. Marginalization and ghettoization remain appallingly commonplace in Indian cities, particularly in secondary cities where rural-to-urban distress migrants end up in large numbers. Inequality in urban India is rising much faster than in rural India. The consequences are large. According to a 2014 research paper presented at a Population Association of America Conference, "poor health and inequality in urban India reduces human capital attainment and productivity, increases social fragmentation, and threatens sustainable development." The economic dimensions of India's urbanization challenge are large, but the social and cultural factors resulting from the sudden urban demographic bulge also present a daunting challenge. Nevertheless, it is believed that much of the socio-economic upheavals look potentially surmountable through poverty alleviation and job creation.

Asia is arguably among the regions of the world which are the most vulnerable to climate change. Climate change and climatic variability have affected and will continue to affect all sectors, from national and economic security to human health, food production, infrastructure, water availability and ecosystems. Rapidly developing second and third-tier Indian cities are already facing an everyday struggle to deliver infrastructure and services, given their limited institutional capacities and constrained finances. Population growth and the demographic shift from rural to urban areas are challenging the ability of urban governments/systems and other actors to provide for the basic needs of people. In particular, the urban poor living in informal settlements that are often built on marginal or dangerous land are the most impacted by climate change, with the most vulnerable being women, children and the elderly.

The hydro-meteorological risks in the cities are expected to be amplified by climate change with more and more people exposed to the additional risks. These risks have different impacts on different sections of the society where some are able to afford mitigative, coping and resilience measures, while some are exposed to higher risks with little or no protective measures (Bhat, et al., 2013). A resilient and inclusive city approach is required for Indian cities where the infrastructure and the urban systems can withstand the stresses and extreme weather events thereby, reducing vulnerabilities of men, women and children.

1.1 Andhra Pradesh and its Urbanization

The state of Andhra Pradesh has two regions: Coastal Andhra and Rayalaseema. Out of the 13 districts of the state, 9 are coastal districts and 4 are in Rayalaseema region. There are 167 Urban Local Bodies (ULBs) and 17 Municipal Corporations in the state. The urban population in the state was 33.5 per cent of the total population in 2011 and 27.3 per cent in 2001. Urban decadal population growth rate in 2011 was 36.26 per cent while on the other hand; the rural population decadal growth rate was as low as 1.64 per cent. The state has shown a large population shift to the urban areas over the last 100 years. The formation of Hyderabad Urban Development Authority (HUDA) in September 1975 also triggered the urbanization process in the state (Figure 1). As per the Census of India 2011 data, the districts of Rangareddy (70.32%), Krishna (41.01%) and Visakhapatnam (47.51%) in Andhra Pradesh have high urban population as compared to other districts of the state (SAPCC, 2012).

Increasing urbanization of the state is being accompanied by several issues linked to the provision of urban basic services. Energy consumption in the urban areas is increasing due to changing livelihood patterns. Population growth is putting immense pressure on the water supply system of the state. Large quantity of urban solid waste is being generated. The drainage systems of the cities are not adequate to accommodate the stormwater during heavy rains.

Further, Andhra Pradesh is a state which has been recently formed with a deficit budget. It faces a lot of

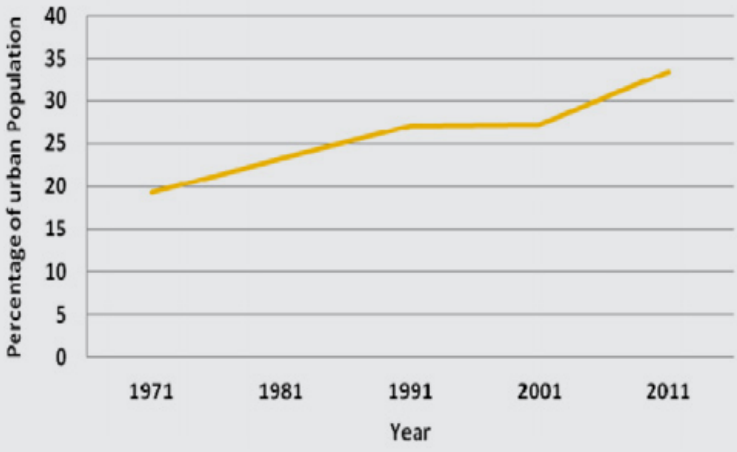


Figure 1: Trends in urban population of Andhra Pradesh

(Source: Andhra Pradesh SAPCC, 2012)

problems in the terms of allocation of financial resources to the ongoing developmental activities. This makes the state even more vulnerable to the impacts of climate change which are being observed with an increased frequency and intensity in the recent years.

1.2 Impacts of climate change and disasters in Andhra Pradesh

Available evidences indicate that there is a high possibility of an increase in the rate and intensity of climate associated natural hazards due to climate change and therefore an increase in the potential risk due to climate change-related natural disasters in India, and Andhra Pradesh is no exception to this. The state has the second largest coastline of 974 km (SDMP, 2017) in the country and major impacts of climate change are observed in the agriculture, water resources and forestry sector. Increasing variability in rainfall and temperature patters, rising sea levels and extreme events which have a marine origin such as cyclones are a serious threat for agricultural and coastal areas of the state. Godavari, Krishna and Pennar are the three major river basins in the state along with their tributaries. The impacts of climate change on the hydrological regime are being observed in the recent years due to changing precipitation and temperature patterns. The delta areas of the Godavari and Krishna rivers experience recurrent flood and drainage problem. The major industrial hubs which are concentrated in a narrow strip along the eastern coast are highly vulnerable to erosion, flood hazards and water scarcity (SAPCC, 2012).

The state is highly vulnerable to “severe cyclones” and has suffered 103 cyclones in this century, of which 31 were severe cyclones. The cyclones occur in both pre-monsoon (April-May) and post-monsoon season. The very severe cyclonic storm Hudhud in the year 2014 caused massive destruction in Visakhapatnam city and adjoining districts. Around 44 per cent of the total territory of the state is vulnerable to tropical storms and related hazards with India’s highly vulnerable coastal belt to these natural phenomenons. In terms of drought criticality, 34 Mandals of the state are severe, 353 are critical and 284 are semi-critical. The state lies in the seismic zone II and III. The coastal belt viz zone III has moderate seismic vulnerability.

In a fast urbanizing state like Andhra Pradesh, when the developmental issues are coupled with the impacts of changing climate in the form of increasing temperature and humidity, it is the urban poor population who suffer the most with this dual burden. Higher incidences of water and vector-borne diseases and increase in the food prices in urban areas are some of the most direct impacts of climate change being observed in the state. Increasing temperature (which has risen up to 45 °C in the recent past) in most of the districts of the state is posing serious health implications. Heat waves were observed in the year 2014, 2015 and 2016 causing major fatalities in the state. Around 1745 people died due to

heat wave in 2015 and 45 people died in 2016 (SDMP, 2017).

1.3 Impacts of climate change on urban poor children

Climate change has the potential to undermine human development across many countries, including India, and may even lead to a reversal of current developmental progress and will have a huge impact on the future course of human development. Though no one will be immune to the effects of climate change, children are particularly vulnerable. The types of climate risks confronting children are diverse, ranging from direct physical impacts, such as cyclones, storm surges, and extreme temperatures, to impacts on their education, psychological stress and nutritional challenges. Higher temperatures are linked to increased rates of malnutrition, cholera, diarrhoeal diseases and vector-borne diseases like dengue and malaria. Yet children's underdeveloped immune systems put them at far greater risk of contracting these diseases and succumbing to their complications. Even moderate climate change impacts could have profound long-term consequences on children's overall development, threatening the achievement of the Sustainable Development Goals.

Globally, there are 2.2 billion people under the age of 18 (2011).[1] Of these, 637 million are under 5 year old and over 1.2 billion are between 10 and 19 years old. An estimated 61 million children of primary school age and 71 million children of lower secondary school age are out of school; 53 per cent of them are girls. In conflict-affected poor countries, 28 million children of primary school age are out of school, which is 42 per cent of the world's total primary school age children.[2] In the late 1990s, the number of children affected by disasters was estimated at 66.5 million per year; climate change impacts project to increase this to as many as 175 million per year in the current decade (2010–2020).[3] Trends specify that many of the world's poorest countries and communities will face the dual threat of climate change and violent conflicts.[4] An estimated 46 developing and transition countries are considered to be at a higher risk of climate change, exacerbating the existing problems and the possibility of conflicts. Around 56 countries face a lower but still marked risk of climate-exacerbated conflicts.[5] Children and youth represent approximately one-third of the world's population. Their vulnerability, experience and ability are crucial and relevant components of the overall adaptation and mitigation capacity of a particular country or region.

Today, over half a billion children live in tremendously high flood occurrence zones; nearly 160 million live in high or extremely high drought severity zones. While climate change will eventually influence every child, these children are even now in harm's way and face some of the immediate risks. The dangers of climate change are more pronounced for children than for adults. Children are more vulnerable to vector-borne and water-borne diseases as compared to adults. They face greater dangers from undernutrition. In 2015, malaria was accountable for 438,000 deaths, of which more than two-thirds were children under 5 years of age. Diarrheal diseases are a major cause of under-five mortality and are estimated to be the cause of 530,000 deaths in 2015 alone[6].

The population of Greater Visakhapatnam Municipal Corporation (GVMC) area is steadily growing due to the migration of people from surrounding areas, especially from the nearby districts in search of livelihoods in "The City of Destiny". It is projected that the population will reach around 21 lakh in 2021. Increasing urbanization has resulted in increasing demand for land within the city and its peripheral areas. The outward expansion

1 UNICEF (2011).The State of the World's Children 2011: Adolescence – An Age of Opportunity. New York: UNICEF.

2 UNESCO (2012).Out-of-School Children. Retrieved from http://www.uis.unesco.org/Education/Pages/ out-of-school- hildren.aspx.

3 Gallegos, J., Seballos, F., Tanner, T., &Tarazona, M. (2011). Children and disasters: Understanding differentiated impacts and enabling child-centred agency (Children in a Changing Climate Research Report). Brighton: Children in a Changing Climate,
Institute of Development Studies.Retrieved from http://www.childreninachangingclimate.org/ database/CCC/Publications/IMPACTS%20and%20 AGENCY_FINAL.pdf.

4 UNICEF (2008).Climate change and children: A human security challenge, Rome: UNICEF.

5 UNICEF (2011).The State of the World's Children, 2011: Adolescence: An Age of Opportunity. New York: UNICEF.

6 Climate Change Adaptation and Disaster Risk Reduction in the Education Sector [Report]. - [s.l.] : United Nations Children's Fund, (UNICEF), 2012

of the city has caused more complex interactions with the neighbouring peri-urban and rural areas and rapid changes in the land-use have occurred in the past due to industrial development. Traditional livelihoods of the communities in peri-urban areas is changing, with more and more people migrating to urban areas to do unskilled/daily wage labour jobs as farming is being continuously affected by climate change, urbanisation and industrialisation. The lower socio-economic migrants end up settling in the high hazard risk prone locations within the city. The core city area which is around 73.7 per cent of the total city area and home to 62.8 per cent of the urban population is prone to natural calamities (CDMP, 2016).

Further, the overlapping arrangements in functions of different government line departments at local level, poor accountability and absence of an effective coordination mechanism between the city and state level agencies results in inadequate service delivery outcomes of GVMC which affects the poor and vulnerable the most. With this background, it is imperative to understand the vulnerabilities of children in this fast growing coastal city. A key requirement for Visakhapatnam's urban development process is planning for urban resilience through a climate, gender and more specifically through a child friendly lens which will ultimately reduce the social and environmental effects of urban growth.

1.4 Children in Mainstream Policies of Andhra Pradesh

State Action Plan on Climate Change for Andhra Pradesh, 2012

The State Government of Andhra Pradesh has formulated the State Action Plan on Climate Change to address the existing and future climate risks and vulnerabilities. It envisions an inclusive and sustainable development of the state with improved ecological sustainability and implementation of actions that deliver the benefits of growth and development while mitigating and adapting to climate change. An analysis of the SAPCC reveals that the state recognises the specific vulnerability of children to climate change impacts in the health and nutrition sectors but not all the strategies articulated in the plan are considering children specifically. Gender based impacts of climate change on children are not discussed in the plan. The key issues identified are high vulnerability of children to diarrhoeal diseases and micronutrient deficiency in women and children. However, the implementation of some of the sector specific key interventions of Coastal Zone Management, Energy, Industries, Health, Urban Development, and Research in Climate Change will be directly or indirectly reducing the health, WASH and physical protection related vulnerabilities of the urban poor children.

Andhra Pradesh State Disaster Management Plan, 2017

The plan identifies children (0-18 Years) as "Disadvantaged and Vulnerable" groups, especially the poor children and children belonging to SC/ST communities who are involved in child labour, forced into early marriage and have very poor nutritional status. "*One in every five children is born in the state with a low birth weight of less than 2.5 kg. One in every child (below five years) is under-weight. Two in every three children and adolescent girls are anemic*". The child sex ratio has also declined by 20 points from the last Census (964 in 2001 Census and 944 in 2011 Census). Children are identified as most vulnerable in the events of recurrent droughts, floods and cyclones. It emphasizes on child protection through disaster risk reduction strategies pertaining to floods, droughts and cyclones. A special focus is given to safety and protection of children against trafficking, comprehensive school safety and safety at Anganwadi level, child protection in emergencies and education in emergencies.

The plan has a dedicated section on "Child Rights-Disaster Management and Response" which focuses on the key aspects which can be undertaken by the state to address children's needs in disaster management and response activities. Following are the six key thematic areas relevant to children's vulnerability in the plan:

1. School Safety and Hygiene
2. Multi-Purpose Cyclone Shelter
3. WASH Program in Schools
4. School Mock Drills
5. Capacity Building for Child-Centric Departments

6. Capacity Building of Children Focused Civil Society Organizations

Child-centric basic guidelines which are required to be adhered by different departments during and post-emergency period are also provided in the plan. The key issues addressed through these guidelines are:

1. Child Protection
2. Health
3. Food and Nutrition
4. Psycho-Social Care
5. Shelter
6. Water and Sanitation
7. Education

The plan identifies that children require special protection, especially the nursing babies, infants and under-fives. Adolescent girls, women, and pregnant women in particular, bear the additional brunt of disasters.

2. Methodology for Developing City Resilience Strategy

In order to understand the existing and future climate change and disaster risk profile of the city, a methodological framework was evolved which is discussed in brief in this section. Climate and disaster related shocks and stresses being felt by the city and its population, specifically by the children and the marginalised population were identified through a detailed vulnerability analysis. Eventually, this methodological framework resulted in identifying specific resilience directions for a child friendly, climate and disaster resilient city. The methodology involved the following steps:

- Literature review of secondary data and information
- Climate data analysis
- Identification of vulnerable groups
- Field visits and community consultations

2.1 Literature review of secondary data and information

To get a brief overview of the existing policies, governance frameworks, current status of urbanization, urban poverty, impacts of climate change, history of disasters in the city, status of urban poor children and service level gaps, a review of the existing literature and the previously conducted vulnerability assessments has been done.

Key documents include the Hazard Risk Vulnerability Assessment (HRVA) report of Visakhapatnam City, District Disaster Management Plan (DDMP), State Action Plan on Climate Change (SAPCC), State Disaster Management Plan (SDMP), TERI-CRIS report, Visakhapatnam City Development Plan (CDP), VUDA Master

Plan and the City Disaster Management Plan (CDMP). An analysis of these documents and the primary data collected during vulnerability assessment, field visits and community & stakeholder consultations led to the development of Children Focused City Resilience Strategic Directions.

2.2 Climate data analysis

To understand the existing climatic conditions like temperature changes, rainfall variability and humidity, we have analyzed the past climate data: rainfall data analysis from the year 1901 to 2016, high resolution monsoonal rainfall data analysis from 1971 to 2016 and temperature data analysis from 1901 to 2002. On the basis of this data analysis, some key inferences have been identified and resilience directions were developed.

2.3 Identification of vulnerable groups

After the review of the literature and climatic data analysis, vulnerable groups were identified by doing multi-stakeholder consultations. The stakeholders were identified across various fields like Education, Nutrition, Health, WASH, Safety and Protection of children. Vulnerable groups of children were identified based on the spatial and socio-economic classification.

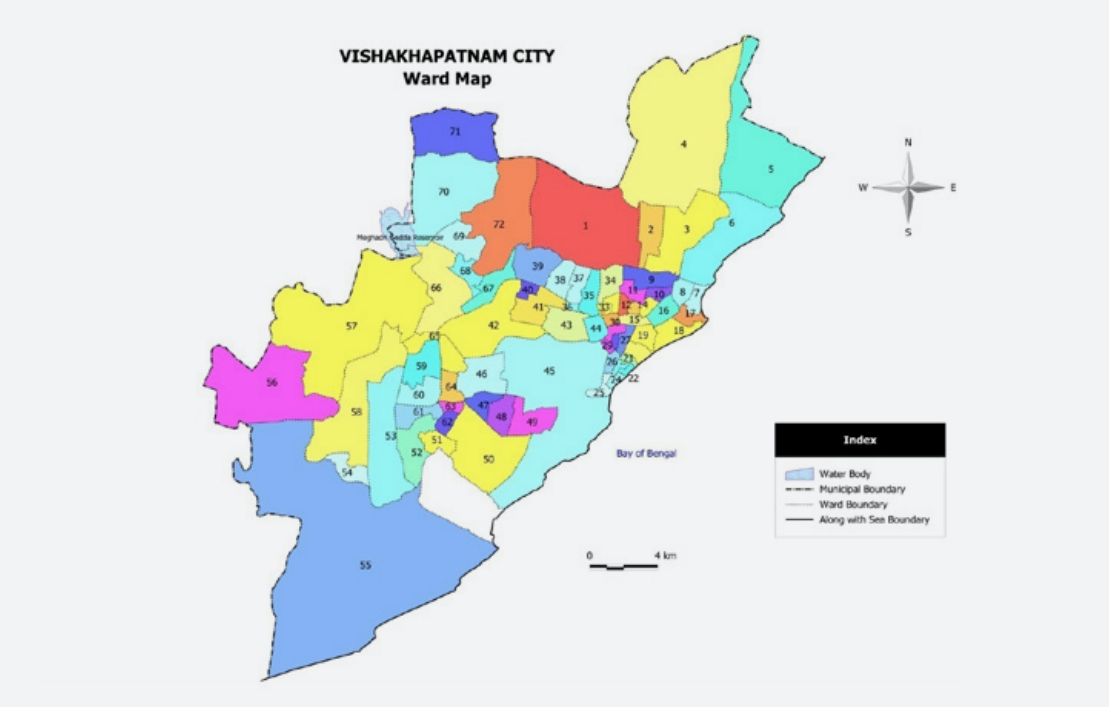
2.4 Field visit and community consultations

After the identification of the vulnerable groups, field visits were conducted to validate and substantiate the findings identified in the stakeholder meetings. Community consultations were done using Focused Group Discussions (FGDs) and Causal Loop Diagrams (CLDs).

A FGD is a qualitative research method with a particular emphasis and application in the developmental program evaluation sphere. FGDs are pre-determined and semi-structured, which are used to elicit the maximum response and generate discussion among the participants to identify the key vulnerabilities of the urban poor communities, especially vulnerable children. FGDs were conducted in the urban slums, peri-urban areas and low-income settlements where the climate change effects can be found with a maximum impact.

CLD is one of the important tools which is used to identify the inter-linkage between the two vulnerabilities and actions to be taken holistically based on the various interdependencies of the developmental stresses. CLDs are done by engaging with the community and finding out various vulnerabilities of the proposed indicator and then the inter-linkages are identified and chalked out on the paper and analyzed for the common factors that are aggravating the problems of the community.

3. Visakhapatnam City- An Overview



Map 1: **Ward Map of Visakhapatnam City**

Visakhapatnam, also popularly known as Vizag, is a rapidly developing cosmopolitan industrial coastal city fondly called, “The City of Destiny”. The picturesque Eastern Ghats along the coast adds to the natural beauty of the city. It is a unique centre of heritage and cultural values with the presence of many archaeological sites of Buddhist, Hindu and historical remains of Dutch, French, British and Indian royal families of pre-independence India. The city has good Air, Road and Water ways connectivity for goods and passengers. Along with numerous flourishing industries, the city has many R & D organizations and premier academic institutions. Vizag is a strategically important city due to the presence of Eastern Naval Command and Indian Coast Guard (CDMP, 2016).

The city spreads over an area of 620 km^2 (Map 1). It is growing continuously in terms of population due to higher in-migration rate, owing to numerous economic opportunities it offers. Securing 122nd position in the list of world’s fastest growing cities, Vizag is the largest city and the financial capital of the state of Andhra Pradesh (ibid). The southern part of the city has a strong industrial base which is further projected to grow around the Gajuwaka area. The industrial growth of the city is further supported by the good railway connectivity of two major ports: Visakhapatnam Port Trust (VPT) and the Gangavaram Port. The north coastal corridor of the city which extends up-to Bheemunipatnam (Bheemili) has long beaches, Buddhist and Dutch cultural heritage. It is becoming a centre

of several IT industries, knowledge parks and high rise residential colonies. Further, this region is also a famous tourist destination due to its scenic beauty and beaches. Every year it receives a major footfall of tourists from Odisha, West Bengal and other states during the months of October-December. Attracted by the unspoiled beauty of these beaches many tourists come here to relax and enjoy the calm ocean currents and the golden beach sand.

3.1 Topography

Situated in a low-lying basin bordered by the Kailasa Hill Range in the north (502 m) and Yarada Hill Range in the south (352 m), the city lies between Latitude 17°42' N and Longitude 82°02' E (CDMP, 2016). The city and its environs can be divided into four topographical categories which are: hilly region, upland tracks, rolling plains and plains. The two major hill ranges in the city are Kailasa hill range and Yarada hill range. On the northern side of the city, the Kailasa hill range extends from Simhachalam to MVP Colony. Surrounded by the Yarada hill which is also known as Dolphin's Nose on the side of Kailasgiri hills in the north and Bay of Bengal on the east, the city looks like a small basin

With this diverse topography, the city has got a peculiar ecosystem which needs to be observed and analyzed to address the climate change impacts and propose resilience directions. The settlements in the coastal areas face the problems of humidity, waterlogging and storm surges while the dwellers of the hilly terrain face the problems of air pollution, landslides and heat waves. Being a coastal city, the major implications found are mostly attributed to the hydro-meteorological disasters and vulnerabilities of the slums near the coasts.

3.2 Demographic Profile

The city administration GVMC serves about 3.91 per cent of the total urban population of the state. As per 2011 Census of India data, Visakhapatnam had a population of 17,28,128, of which males were 8,73,599 and females were 8,54,529. The sex ratio was 978. Currently, the population has crossed two million mark after the expansion of city limits and stands at 2,035,922 (Smart City Proposal) with a decadal growth rate of 16.7 per cent. There were 1,64,129 children in the age group of 0–6 years, with 84,298 boys and 79,831 girls.

Table 1: Demographic details

Total Population	17, 28, 128
Male Population	8, 73, 599
Female Population	8,54,529
Decadal Population Growth Rate	11.6 (2001 to 2011)
Literacy Rate	81.79 %
Floating Population	1,20,000
Population Density	3365 persons per sq km (Map 2)
Children Population (0-6 years)	1,64,129*
Boys	84,298*
Girls	79,831*
Slum Population	44.61 %

*(Source: Census of India, 2011, *Visakhapatnam Distric Health Bulletin, 2011)*

In 2013, Anakapalle and Bheemunipatnam (Bheemilli) municipalities were merged under GVMC along with 10 villages namely K.Nagarapalem, Kapuluppada, Chepaluppada, Nidigattu, JV Agraharam, Thadi, Salapuvanipale, Rajupalem, Valluru and Koppaka.

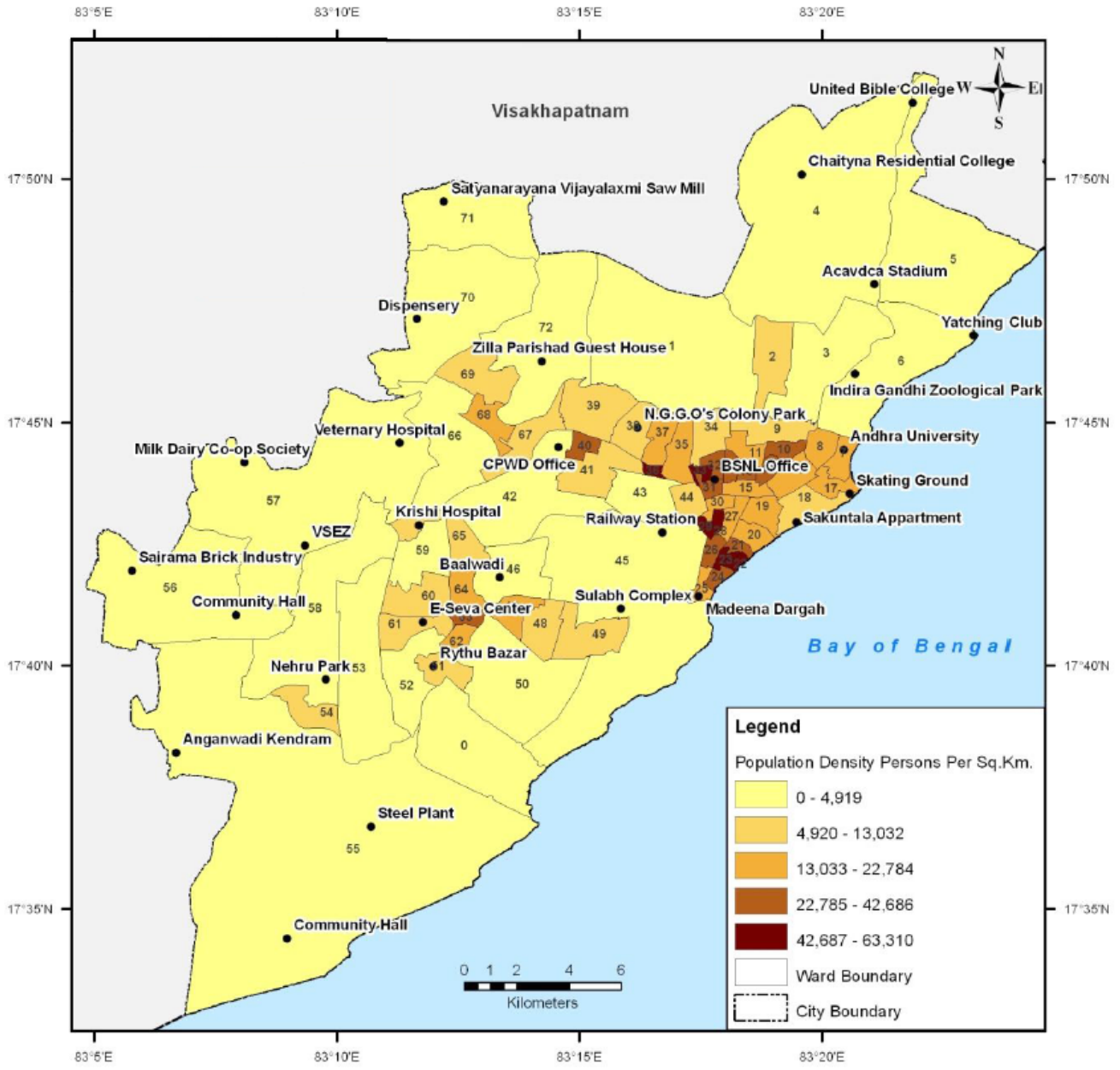
City's population is growing continuously as people living in the surrounding areas, especially from the nearby districts are migrating in search of livelihoods owing to the rapid economic growth of the city due to many flourishing industries and institutions. The projections indicate that the city population will reach 20.99 lakh by the year 2021.

3.3 Households

According to the Census 2011 data, 93.5 per cent households are permanent households by structure while 3.4 per cent are semi-permanent, 2.7 per cent are temporary, 2.3 per cent are serviceable, 0.4 per cent are non-serviceable and 0.4 per cent are unclassifiable by the type of structure.

3.4 Migration/Floating population

The employment opportunities due to the presence of major industries, availability of health facilities and educational opportunities attract migration and floating population from neighbouring districts and neighbouring states such as Orissa and Chhattisgarh (Rapid Baseline



Map 2: Population density map of Visakhapatnam city

(Source – HRVA Report, 2014)

Assessment of Visakhapatnam city, 2013, CDMP, 2016)[7]. Due to the lack of efficient public transportation in the suburban areas, people from lower socio-economic class have started moving towards the city core which is a high hazard risk-prone location within the city (CDMP, 2016).

Owing to migration from surrounding areas, especially from the nearby districts, a phenomenal decadal population growth in Visakhapatnam city was observed during 1991-2001 at 75 per cent. Decadal population growth rate in the surrounding municipalities was comparatively low at 37.2 per cent for Vizianagaram, 15 per cent for Anakapalli and 20 per cent for Bheemunipatnam (ibid). An analysis of components of population growth during 1981-1991 and 1991-2001 reveals that in-migration contributed 30 per cent and 20 per cent respectively to the population growth during these years (ibid). According to the Census of India, 2011 data, there has been an influx of 1,00,000 people into the city in the search of livelihoods and settlements in the city.

7 Capacity building for urban development, Rapid Baseline Assessment, Visakhapatnam City, Draft Report, Ministry of Urban Development, Government of India, Crisil Infrastructure Advisory, October 2013.

3.5 Literacy Rate

The average literacy rate stood at 81.79 per cent with a total of 12,79,137 literates, of which 6,88,678 were male and 5,90,459 were female. The child literacy rate was 67.7 per cent with a total of population of 1,64,129 (Census of India, 2011). There has been a huge difference in the literacy rates of children and adults because of the lack of infrastructure, interest and enforcement.

3.6 Economic profile

Visakhapatnam is the largest city of Andhra Pradesh with a GDP of 43.5 billion dollars. The fishing industry, road-rail connectivity, many heavy industries like Vizag steel, GAIL, Hindustan Shipyard etc., are the factors that made the city into an industrial hub from a small fishing hamlet. The service sector contributes 55 per cent of the total GDP of Visakhapatnam while 35 per cent comes from the industrial sector and 10 per cent from the agriculture and the allied sectors. But the people living in the slums and low-income settlements have a much diversified economic profile because of their dependence on activities like fishing, daily labour and petty jobs.

The average monthly household expenditure among the residents is INR 18,311.37. Household expenditures range from INR 1,767 to INR 142,800. About 33 per cent of the families spend between INR 10,000 and INR 15,000.

Map 3: Major slum pockets in Visakhapatnam

(Source: HRVA Report, 2014)

21.4 per cent spend below INR 10,000 per month (Smart City Report). People with such a low average income are majorly found in the slum pockets and their meager income is never sufficient to meet the daily needs of their family and basic amenities like quality housing, safe drinking water and proper sanitation facilities.

3.7 Slums

There are about 740 slum pockets in the city which are identified by the ULB (Map 3). Of them, 100 are unnotified slums and 640 are notified slums. Notified slums are the ones that are recognized by the GVMC with a provision of minimalistic basic amenities like water, electricity and housing.

3.8 Urban-peri-urban connect

The peri-urban areas like Anakapallli, Bheemili, Gangavaram, Anandapuram, Pudimadaka, Pendurthi, Sabbavaram, Chodavaram, Kothavalasa provide many services to the Visakhapatnam city in various forms. They provide agriculture products like vegetables, fruits, flowers and other perishable goods for the daily consumption. They also provide the ecosystem services in the form of wetlands, mangroves and lakes. There has been a severe neglect in the involvement of the peri-urban areas either in the developmental planning or enactment of the laws and provision of services which are making them even more vulnerable due to the increasing climate change impacts.

3.9 Multi-hazard profile of the city

The city experiences natural disasters throughout the year. Around 73.7 per cent of the city area which is the core urban part having 62.8 per cent of the population is vulnerable to natural calamities (CDMP, 2016).

As per the provisions of the CDMP, as a disaster preparedness measure, GVMC should share the information related to cyclones with vulnerable and underprivileged sections, especially including the fisherfolk population and with all the communities residing in the immediate coastal stretch of the city.

3.10 Visakhapatnam Smart City

As a destination city, Visakhapatnam has a lot to offer: beautiful beaches, friendly people and a robust economy. With a great natural harbour, this city is a natural hub for defence, shipping, trade, and manufacturing. The division of Andhra Pradesh into two states has given additional impetus to an already vibrant economic growth trend in Visakhapatnam. The advantages of living in this city as opposed to other knowledge industry capitals have not been lost on India's young professionals, who appreciate the unspoiled natural environment, affordable housing and laid-back lifestyle on offer. The challenge for

Table 2: Multi-hazard profile of Visakhapatnam city

Cyclonic wind	Storm Surge	Tsunami Hazard	Flood Hazard	Disease and Epidemics
Cyclonic wind and storm surge, Tsunami, Epidemics Cyclonic wind (entire city) 44 cyclonic disturbances passed within 150 km off Vishakhapatnam City (1877-2013) An average of 1 cyclone in 10 years Major cyclone affected the city November 1995, 1998 and December 1965, 1966 Cyclone mostly occur in the months of June and November	Storm surge Inland inundation extents are limited to areas near coast damaging coastal roads Surge influence not all along the coast. Only through the streams that are reaching the sea	Tsunami Inundation extent associated with 26 December 2004 tsunami event affect selected pockets including the stream outlets and the southern coast	The topography favours natural runoff and restrains from natural flood due to heavy rain. Waterlogging in selected pockets due to inadequate stormwater drain and choking of existing drains	Exposed to both water and vector-borne diseases Dengue incidence high during September – November Malaria incidences are rising while we consider the data for the last 5 years. Most cases reported in the northern part of the city

(Source: Compiled from Hazard Risk Vulnerability and Capacity Assessment of Visakhapatnam City (HRVA), 2014)

Visakhapatnam will be to realize its ambitious economic growth goals while preserving and enhancing livability for the benefit of local citizens. The Smart City Framework Plan lays the groundwork for the development of Visakhapatnam from a 20th Century port city into an integrated 21st Century city-region. Each of the four major centres of Visakhapatnam Metropolitan Region (VMR) will develop its own distinct urban character:

1. The city centre will raise its profile as the business and cultural centre of the region by carrying out signature development projects in the Central Business District, along the Beach Road and at the Old Town.
2. The southern industrial area will develop into smaller, mixed-use urban sub-centres that offer jobs-housing balance and improved living conditions for the local workforce.
3. Madhurawada and Rushikonda will emerge as high-end knowledge industry clusters that offer world-class educational, recreational and tourism facilities.
4. Vizag's unique selling point — its coastline — will be developed as a set of distinct recreational, ecological and livelihood destinations.

New growth areas within all four centres will locate housing near jobs, preserve ecological assets, and minimize natural hazard risk. Binding the centres into a coherent regional whole will be smart transport, water and energy infrastructure that ensures smooth and timely flows of people and resources throughout the VMR. The ICT innovations will allow infrastructure managers to anticipate stress points, take corrective actions and enhance system performance. Citizens in Smart Vizag will also gain visibility into infrastructure systems and be able to participate in decisions about future improvements. By embracing Green Living and Smart Business, VMR may become the South and Southeast Asia's Clean Commerce Capital for the 21st Century**.**

4. Impacts of Climate Change on Urban Poor Children

Children are particularly vulnerable to the effects of climate change. More specifically, urban children living in poverty face multiple deprivations rendering them vulnerable in fast urbanizing Indian cities. They are frequently exposed to physical hazards, such as polluted water; open sewer systems; inadequate public transport; lack of local safe play areas or cultural facilities; toxic local environments; and overcrowding. The dangers severely restrict children's independent mobility and opportunities for play and recreation while increasing their exposure to hazards, violence and unintentional injuries. The cumulative effect of such risks severely undermines the adaptive capacities of children to climate change. Understanding these risks is important, as policies that lessen pressures on resources, manage environmental threats and increase the welfare of the poorest members of the society can simultaneously advance sustainable development goals, enhance adaptive capacity and reduce vulnerability to climate change and other risks. Thus, it has become important for the emerging secondary cities to undertake a rapid assessment of their vulnerability, in order to understand risks, build their capacity to plan for adaptation and to develop infrastructure systems, which will not lead to cascading failures of other elements or related systems and key service deliveries.

4.1 Health

Children's health is primarily determined by the socio-economic and physical conditions of the environment in which they live and are nurtured. Climate change alters the frequency, timing,

intensity, and duration of weather events. In such situations, these children residing in the fragile fringes of the city and slums with poor basic facilities that get aggravated in times of extreme weather events become even more precarious. Climate change affects the growth and survival of disease-causing organisms related to water and food-borne illnesses. These increase when outdoor temperature increases. Immediately following storms or floods increase the incidence of water and food-borne illnesses, such as gastroenteritis and infectious diarrhoea. Extreme weather can result in the breakdown of sanitation and sewer systems, or inadequate means to cook food, increasing the likelihood of water and food-borne illness. Children are especially susceptible to water and food-borne illness due to their developing immune systems. Health is closely inter-linked with livelihoods, income, nutrition, and water and sanitation facilities. During this assessment, these aspects were closely studied in order to understand the issues of health amongst children living in different situations.

4.2 Education

Proper schooling and education are closely linked to the elusive triangle of its access, equity and quality for these urban poor children. In the wake of changing weather patterns, this is influenced by declining livelihood opportunities, migration, inaccessibility to schools, health, etc. Climate-induced disasters hit the poor communities who are then forced to discontinue their children's schooling. Displacement due to rural-urban migration leads to the problem of identity which adversely impacts education.

4.3 Child Protection

Children living in slums, city fringes and low-income settlements are devoid of basic amenities and so they grow up in a volatile environment where their safety is always in question. During extreme temperatures and rainfall, physical safety becomes a problem for the children. These slum children and those living on the streets, face extreme vulnerability and deprivation of basic entitlements. Lack of proper upbringing due to various reasons makes them vulnerable to drug abuse, sexual abuse, substance abuse, trafficking, and gambling, etc. Climate change and disasters cause large-scale dislocation of poor people from rural to urban areas or even within the urban areas. Eviction drives in the informal settlements and slums in the cities hamper the physical safety and protection of children, leaving them in a traumatic situation.

4.4 Nutrition

Though urban children are considered to have better nutritional status, several researches have evidenced that urban malnutrition is on the rise. Children, in their growth period, are vulnerable and need proper food and nutrition for their overall development. Nutritional inadequacies result in the hampering of the development of their body. If this nutritional inadequacy persists for a longer period, it results in their improper growth manifested in the form of low weight, stunted height, and low IQ, etc. Child malnutrition is the single biggest contributor to under-five mortality due to greater susceptibility to infections and slow recovery from illness. Droughts that lead to food shortages are likely to lead to malnutrition, affecting the health and development of the urban poor children.

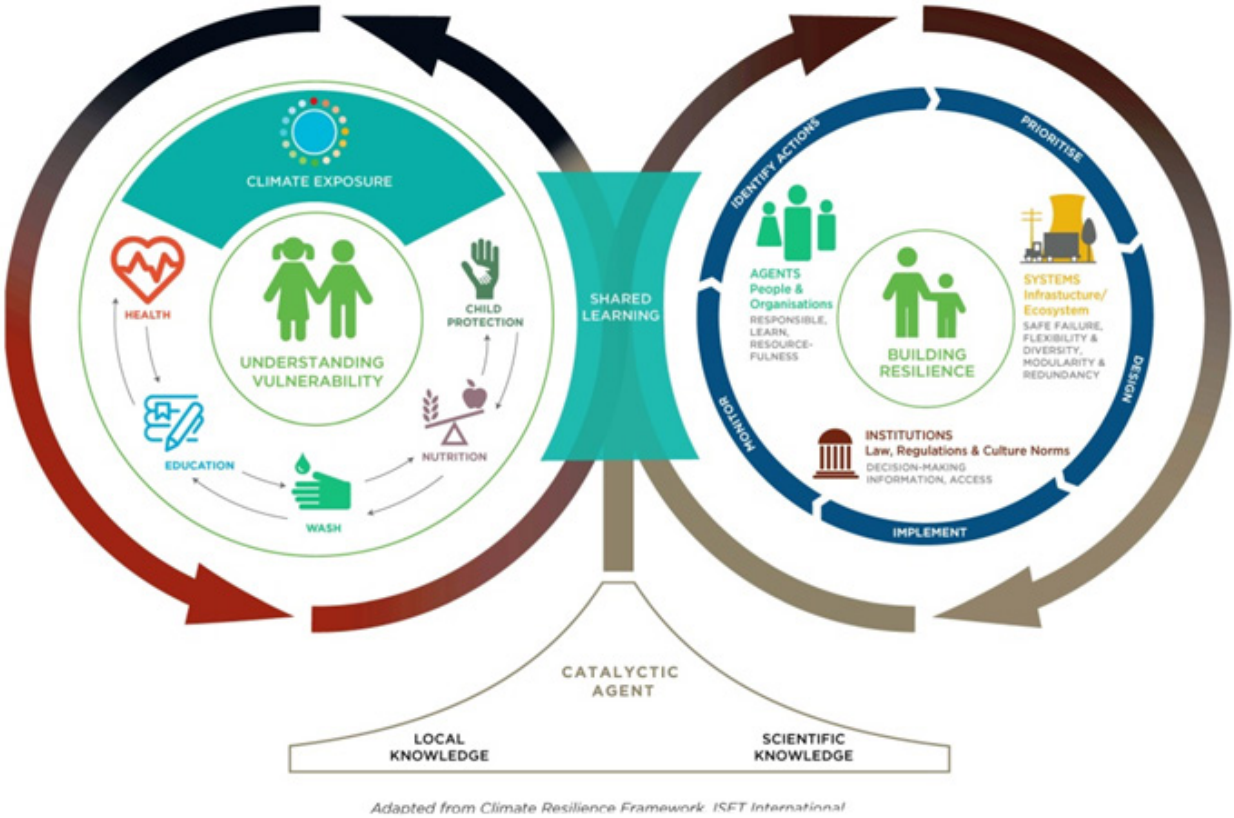
4.5 Water, Sanitation and Hygiene (WASH)

Unsafe water, poor sanitation and unhygienic conditions claim many lives each year. Poor urban areas where insufficient water supply and sanitation coverage combine with overcrowded conditions tend to maximize the possibility of faecal contamination. Open defecation in densely populated urban settlements is particularly alarming for public health. To top it all, the effects of climate change is often experienced through the water. Climate-induced disasters severely affect the infrastructure and services related to drinking water, sanitation and hygiene. Floods inundate the tube-wells, ponds and water bodies and contaminate the natural sources of fresh water thereby forcing affected communities to use unsafe water. Toilets are generally fragile and mostly unsuitable to withstand high flood or cyclone. It leaves people with no other option but to go for open defecation. Such crisis in safe water supply and sanitation service severely disrupts hygiene practices. Because of water contamination, public health situation often deteriorates spreading water-borne diseases like diarrhoea, cholera, typhoid and hepatitis.

5. Child-Centered Urban Climate Resilience Framework

The Child-Centered Urban Climate Resilience Framework (Figure 2), adapted from the internationally acclaimed Climate Resilience Framework developed by the ISET-International, is an integrated approach for understanding vulnerabilities of urban poor children, one on part, due to climate change impacts around their five key development parameters – Health, Education, Child Protection, Nutrition and Water, Sanitation and Hygiene (WASH). On the other hand, it focuses on the critical roles of Systems, Agents and Institutions across these five development parameters and the manner in which, with their own resilient characteristics, they can contribute in building urban climate change resilience for children. It also incorporates the concept of shared learning as part of an iterative process in which analysis feeds into planning, planning into actions, action into learning, learning into further cycles of analysis, and so on. This iterative, shared action-learning cycle fosters building and maintaining resilience over time, in the face of rapidly evolving contexts and high levels of uncertainty.

To explain, the left circle helps in assessing vulnerabilities due to climate change exposure on five key development parameters – Health, Education, Child Protection, WASH and Nutrition. In addition, the causes of vulnerabilities across these five thematic areas are inter-linked and inter-dependent on each other. The right circle helps in understanding the key resilience mechanisms at three levels – Agents, Systems and Institutions, across the five



Adapted from Climate Resilience Framework, ISET International

Figure 2: Child-Centered Urban Climate Resilience Framework

development parameters of children. The Framework also suggests the key characteristics of Agents (Responsible, Ability to Learn, and Resourcefulness), Systems (Flexibility, Diversity, Modularity, Redundancy and Safe Failure) and Institutions (Decision-making, Information Access). It further guides that for resilience planning, it is important to *identify actions* across key thematic sectors, *prioritize actions*, *design* resilience options/solutions, *implement* them and *monitor* them around a set of key indicators.

This framework guides efforts to build urban resilience that support children, youth, girls and boys. It integrates child and human rights into resilient urban development, enabling children to become agents of resilience.

6. Climate Scenario of Visakhapatnam

6.1 Seasonal trends

As per agro-climatic zone, the city falls in the North coastal zone, with different climatic conditions in different parts of the city, however, being constant in the same respective parts throughout the year. Visakhapatnam climate is tropical and it is the most tropical city in the country. The air is moist and relaxing near the coast, but gets warmer towards the interior and cools down in the hilly areas on account of vegetation and elevation. Typically, April, May, June are the hottest months. With temperature getting down with the onset of South-west monsoon and tumbles to a mean minimum temperature of 20.7 °C by December after which the temperature reaches an average maximum of 32.9 °C by the end of May. The mean annual rainfall of this place is 1118.8 mm. South-west monsoon contributes about 72 per cent of the annual rainfall and North-east monsoon contributes about 14 per cent of its annual rainfall.

Visakhapatnam receives the maximum amount of rainfall during the post-monsoon period (Oct-Nov) due to cyclonic activity. When compared with winter, the summers have much more rainfall. The average annual temperature is 27.8 °C. The annual mean maximum temperature of the city is 30.6 °C and the annual mean minimum temperature is 24.7 °C. The driest month is December, with 8.8 mm of rainfall. In October, the precipitation reaches its peak, with an average of 258.1 mm. The difference in precipitation between the driest month and the wettest month is 249.3 mm. The

variation in annual temperature is around 7.7 °C. The frequency of drought in Visakhapatnam is once in 5 years. Humidity is high in the coastal belt throughout the year with an average of 70 to 80 per cent in the morning. 72 per cent area is covered by red loamy soil which is poor in texture and easily drained. 45 per cent soils are low in organic content and high in phosphorus content being close to 55 per cent.

The city atmosphere is prone to pollution, greenhouse gases, dust, smoke and smog. These have the effects of changing the thermal properties of the atmosphere, cutting down the passage of sunlight and providing abundant condensation nuclei. The increase of particulate matter in the atmosphere is bound to affect the climate since particles not only scatter and absorb solar radiation but also have an effect on the outgoing radiation from the surface of the earth. Consequently, cities receive less solar radiation than rural areas. And there is yet another fact, that cities have 10 per cent or more clouds which also affect the incoming solar radiation. Urbanization is one phenomenon that may cause changes in local and even regional climate. But growing encounters with extreme events and experience of climate change by commoners, however, draws attention and need for deeper analysis and understanding of climate change phenomenon. It is for this purpose analysis of 102 years climate data has been done and inferences are drawn accordingly.

6.1.1 Rainfall

Precipitation trend analysis of both annual and seasonal rainfall has been carried out to observe temporal variations in the rainfall. Rainfall in the city varies considerably both in space and time from year to year. Analysis of rainfall for the period 1901 to 2016 (Figure 3) shows increasing, but not significant trends in annual rainfall. Monsoon rainfall departures are examined and wet and dry years are identified. The analysis of monsoon rainfall reveals that there are more wet years than dry years in Visakhapatnam. The results indicate that there is a general increasing trend in the monsoon rainfall. Trend analysis of monsoon rainfall has been carried out over a period of 46 years i.e. 1971 to 2016 (Figure 4). It is observed that there is a positive trend of rainfall with an increasing trend of 105 mm over a period of 46 years. However, 0.20 mm per year increase in rainfall is observed in the post-monsoon period, particularly in the month of October. A decrease of rainfall in winter season has been noticed insignificantly. There is no significant trend found in summer rainfall. Heavy rainfall events more than 100 mm rainfall in a day are in increasing order. Deviation from mean rainfall has been noticed more during last decade.

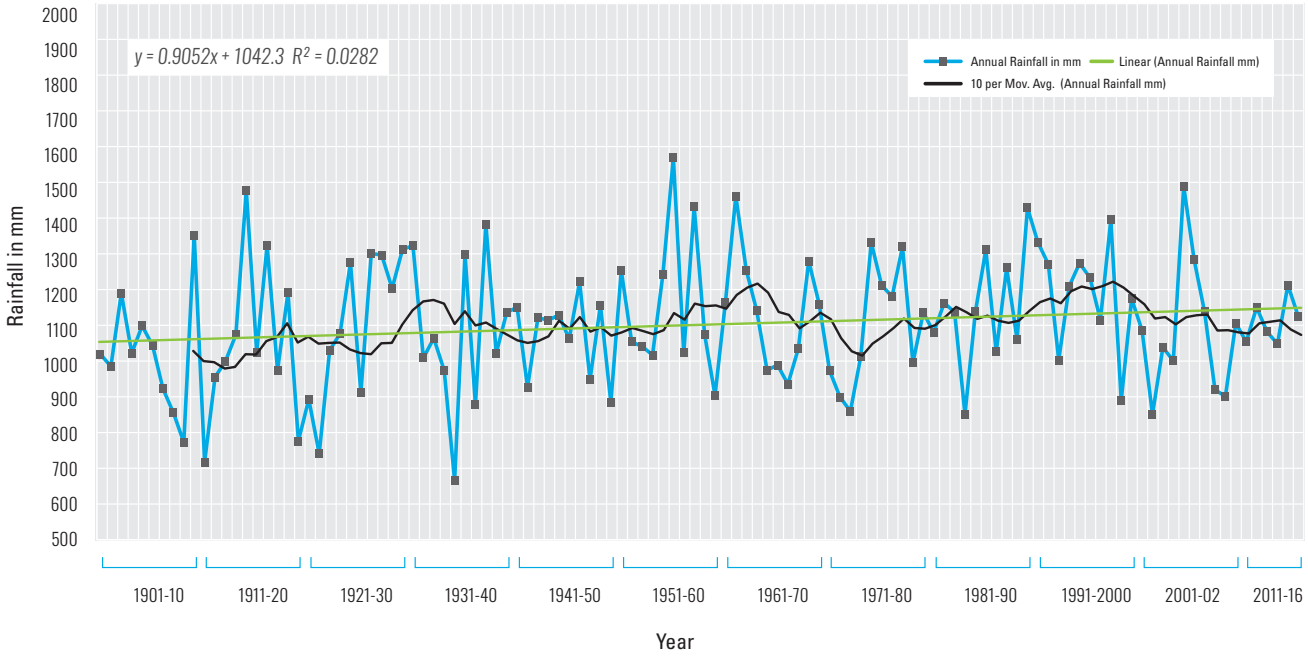


Figure 3: Annual rainfall in mm (1901–2016)

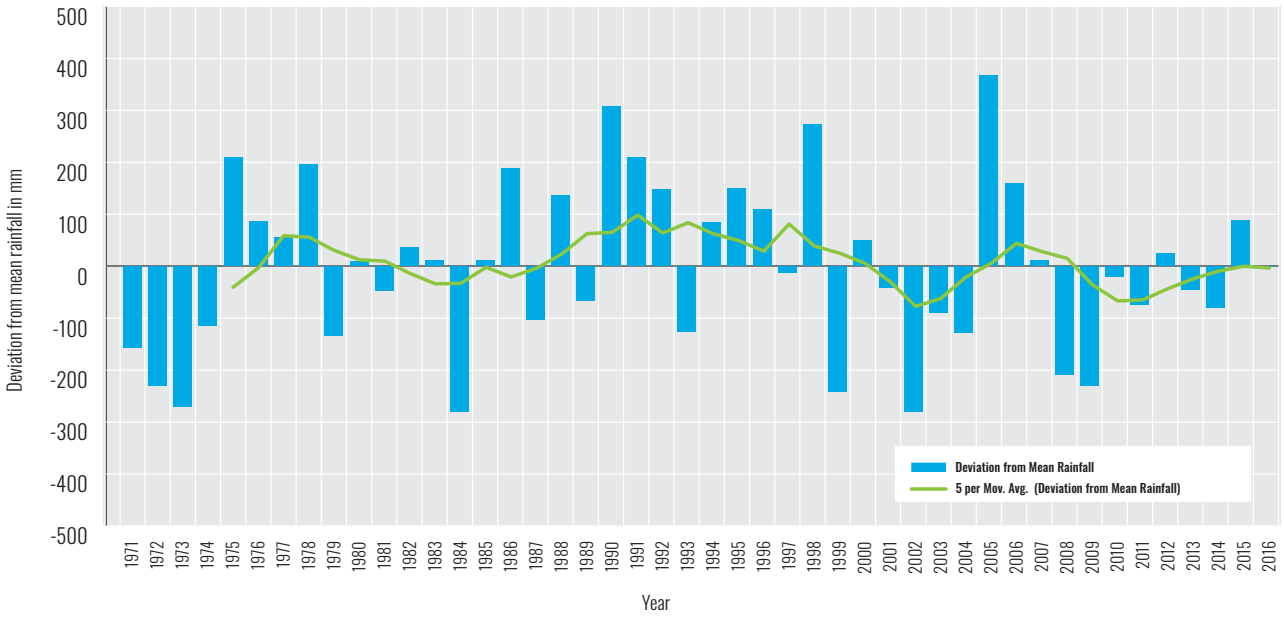


Figure 4: **Deviation from mean rainfall (1971–2016)**

6.1.2 Temperature

Among two important climate variables, the temperature is one of the key variables usually experienced by common people as climate change. Temperature variations have a deep impact on the hydrological cycle and climate of any region. Analysis and interpretation of temperature variability, therefore, constitute an important component of the analysis. Like rainfall, temperature trend too is largely fluctuating with a significant increase over Visakhapatnam. Temperature data analysis for the period 1901-2002 (Figure 5) shows an overall increasing trend for the annual mean maximum temperature by 0.01 °C /year. The rise in maximum temperature is significant during monsoon season (0.003 °C/year) and during the post-monsoon season (0.002 °C/year). A significant increasing trend is found in mean maximum temperature during winter season i.e. 0.002 °C/ year. No significant trend is found in maximum temperature in the summer season.

Annual mean minimum temperature shows a significant increasing trend of 0.009 °C /year during 1901-2002 (Figure 6). During the post-monsoon season, there is a significant rising trend of 0.004 °C/year. During the monsoon season, there is an increasing trend of 0.003 °C/year. However, minimum temperature shows increasing trend during both, the winter and summer season viz by 0.003 and 0.005 °C/ per year respectively. Meaning thereby much sharper increase in both the temperature i.e. maximum and minimum temperature has been observed post - 1970s.

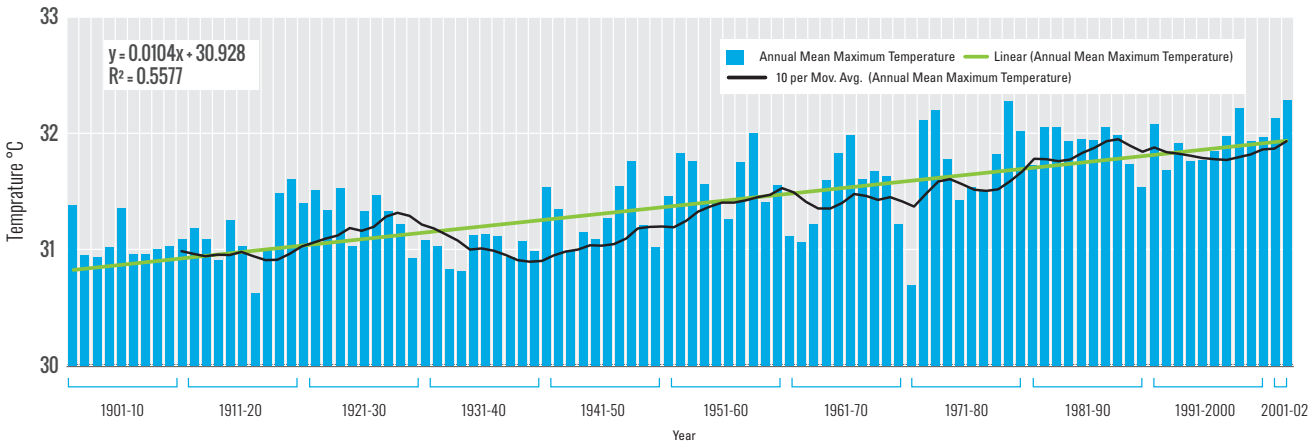


Figure 5: **Annual mean maximum temperature (1901–2002)**

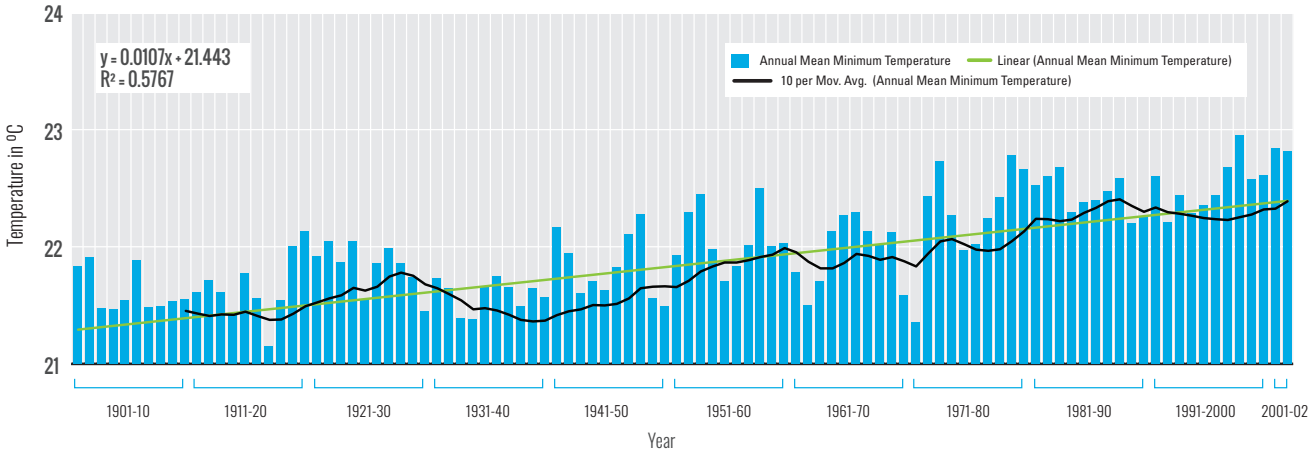


Figure 6: Annual mean minimum temperature (1901-2002)

Visakhapatnam being a tropical coastal city exhibits extreme temperatures and higher humidity, which cause distress conditions. The analysis of summer maximum temperatures shows that the city is prone to heat waves with extreme maximum temperatures with the departure of 6 °C to 8 °C from the normal and city experienced 94 heat waves, out of which 63 are moderate and 31 are severe heat waves over a period of fifty years i.e. from 1951 to 2000.

When the departure of maximum temperature is above 6.4 °C from the normal temperature then it is called severe heat wave while a departure between 4.5 to 6.4 °C is moderate heat waves.

The frequency of severe cyclonic storm over Visakhapatnam is three and medium and normal cyclone crossed Visakhapatnam coast is seven. There is a clear trend in sea level rise over Visakhapatnam coast viz 0.70 mm/year in the last 53 years.

6.2 Projected Changes

Rainfall over Visakhapatnam

The climate of India is locally driven by topography (Eastern Ghats), location and its proximity to the area to the sea. India is fully exposed to the hazards of global warming and Visakhapatnam is also not exempted. An attempt is made towards prediction of climate variables for baseline period and its future scenarios for the 2050s over Visakhapatnam, Andhra Pradesh as simulated by a PRECIS regional climate model. At present, the climate projections are based on the regional model using single socio-economic scenario A1B.

Visakhapatnam receives most of its rain during the monsoon season, which starts in mid to late June. The mean annual and seasonal precipitation amounts are simulated by PRECIS:

- Under the projected changes for 2050 considering the A1B scenario, the rainfall is projected to increase.
- Mean annual rainfall is projected to increase by 10-12 % by 2050
- Mean south-west monsoon rainfall is projected to increase by 10-15 % by 2050.

A1 Emission Scenario: The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end-use technologies.

(Source: https://www.ipcc.ch/ipccreports/tar/wg1/029.htm)

- Most of the increase is projected to occur in the monsoon period.
- Mean north-east monsoon rainfall might increase by 3-7 % by 2050.
- There is a slight decline in winter rainfall towards 2050 under the A1B scenario.
- Extreme rainfall events might increase by 10-20 % by 2050.

Considering the climate changes that could possibly occur, suitable adaptation plans need to be designed

Temperature over Visakhapatnam

The PRECIS simulation of A1B scenario is given below:

- The annual maximum temperature is projected to increase by 1.75 to 2.15 °C by 2050
- The annual minimum temperature is projected to increase by 1.6 to 2.0 °C by 2050
- The annual mean maximum temperature in post-monsoon season is likely to rise by 1.75 °C by 2050. Whereas in winter season, it is projected to change by 2.25 °C by 2050
- The annual mean minimum temperature is projected to change by 2.1 °C by 2050 during the post-monsoon season.
- The annual mean minimum temperature is likely to rise by 1.2 to 1.5 °C by 2050 during monsoon and summer season, respectively.
- Hot days and warm night might increase.

Projected change in Sea Level

- Sea level might increase by 0.21 to 0.48 meter by 2100.
- Return level estimates using storm surge model driven by RCM indicate higher flood risks associated with storm surges along the southern part of the east coast, where tidal ranges are low.

6.3 Key inferences

From the above analysis, following inferences on seasonal trend in temperature and rainfall are drawn:

- The mean maximum temperature has increased by 4 °C in the summer and monsoon seasons and the day temperatures are also gradually increasing which is also leading to increase in the humidity in the air.
- The mean minimum temperature has also been increased by 2 °C particularly in the winter season.
- The intensity of the rainfall is increased by 10 per cent but the duration of rainfall is reduced which aggravates the vulnerabilities of the low-income settlements.
- The increase in sea level of 0.21 m also leads to increasing incidence of storm surges and inundation of the low lying coastal areas.

7. Urban System Analysis and Sectoral Vulnerability

An analysis of vulnerabilities of the urban systems caters to find the stresses and precursors to the impending disasters, natural, climatic and developmental. Urban systems majorly include housing, drinking water, sanitation, drainage, sewerage, solid waste management, ecosystem services/peri-urban areas and urban governance. By analyzing these sectors and cross-sectoral issues through the climate change lens, the interdependencies of each sector and vulnerabilities of the people depending on each sector are identified.

7.1 Housing

According to the Smart City Profile of Visakhapatnam city, 44.61 per cent of the population in GVMC limits reside in settlements categorized as 'slums'.

Slum conditions are defined where residents are living with low to no access to physical and social infrastructures, socio-economic needs or sustainable livelihoods. The 32 villages recently incorporated into the GVMC are majorly poor, with low access to core trunk infrastructures.

The semi-permanent and temporary households are majorly found in the slums and slum- like settlements. Even if permanent structures are found in the slums, the standards in constructing the structures are too low that can`t withstand the withering due to high humidity. Due to the increasing temperatures, the humidity is also increasing which leads to the compromising structures thereby reducing the safety of the women and infants who are majorly found

in these homes. The slums located along the coast are particularly vulnerable to high temperature and increasing humidity.

During flash floods and storm surges, the people who get most affected are the ones residing in the poor housing structures. During the cyclone HudHud, majority of people who lost their houses are the ones residing in these slums and along the railway tracks.

7.2 Drinking Water

GVMC is responsible for the supply of potable water including planning, design, construction, implementation, maintenance, operation & management of water supply and sewerage system. The drinking water requirements of Visakhapatnam are met by the six major water sources (Figure 7, 8). They are Meghadrigedda, Tatipudi, Raiwada and Yeleru reservoirs, and Gosthani, Mudusarlova infiltration wells. Major part of the city is equipped with the pipelines to pump the water to various parts of the city. But the slums aren't connected with the pipes and are dependent on the daily supply of water provided by the GVMC.

The coverage of water supply connections in the entire city is 65 per cent (Smart City Report) and there is an 80 per cent gap in metering of water connections which is resulting in loss of ODF revenue. Water quality of the existing reservoirs is also reducing due to the construction of waste transfer stations and increased developmental activities around the water reservoirs. The Total Dissolved Solids (TDS) and the total coliform content of the drinking water are increasing (APSPCB and Smart City Report) due to leakages in the drinking water pipe connections.

The increase in sea level is leading to intrusion of sea water in the aqueducts of ground thereby polluting the groundwater which is prominently seen in the MVP Colony area. The groundwater is being contaminated by indiscriminate disposal of untreated sewage, open defecation and improper drainages causing the problem to be more widespread. The drinking water when compared with standards of WHO for drinking water quality reveals that the drinking water supplied by

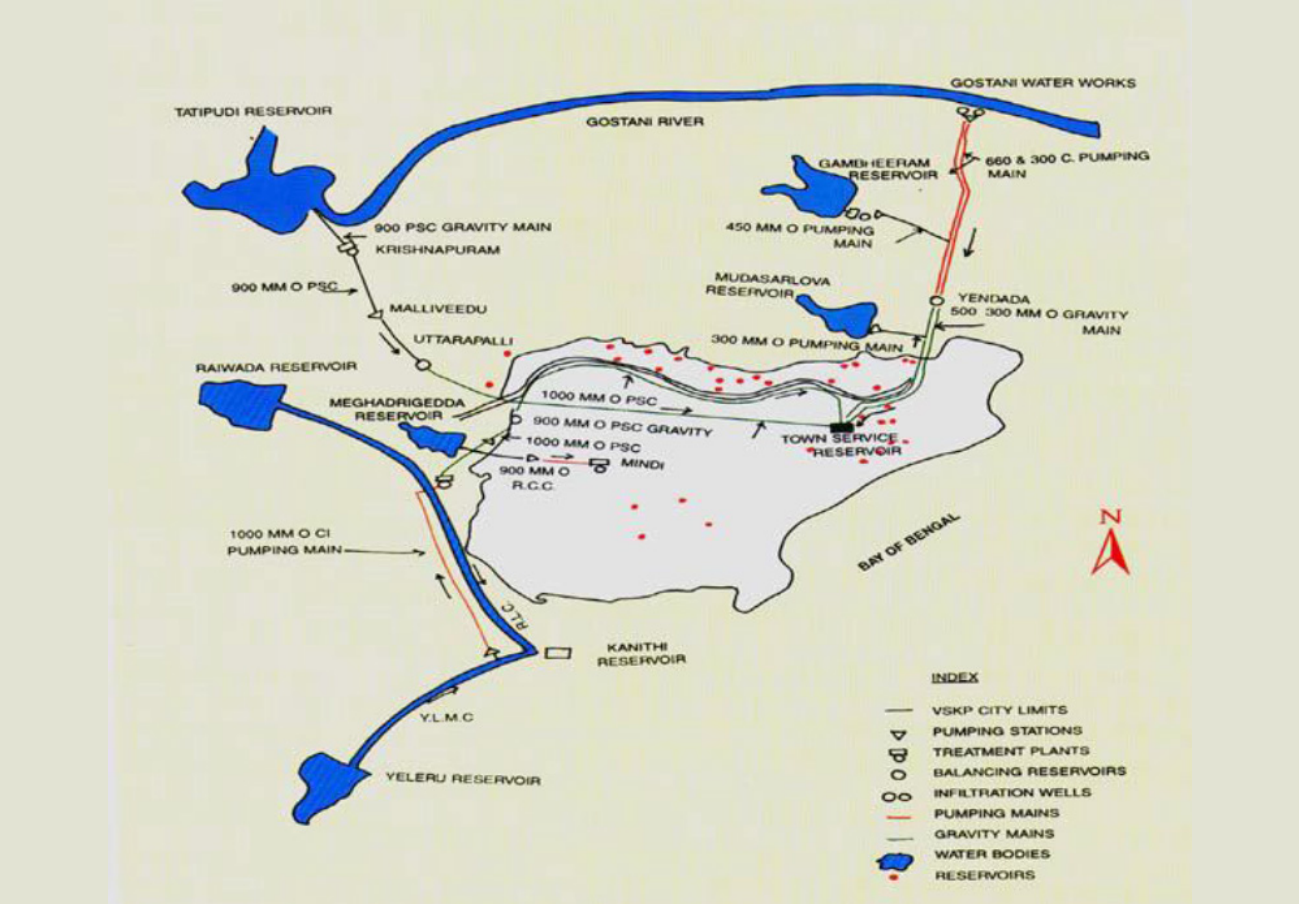


Figure 7: Major freshwater sources of Visakhapatnam City

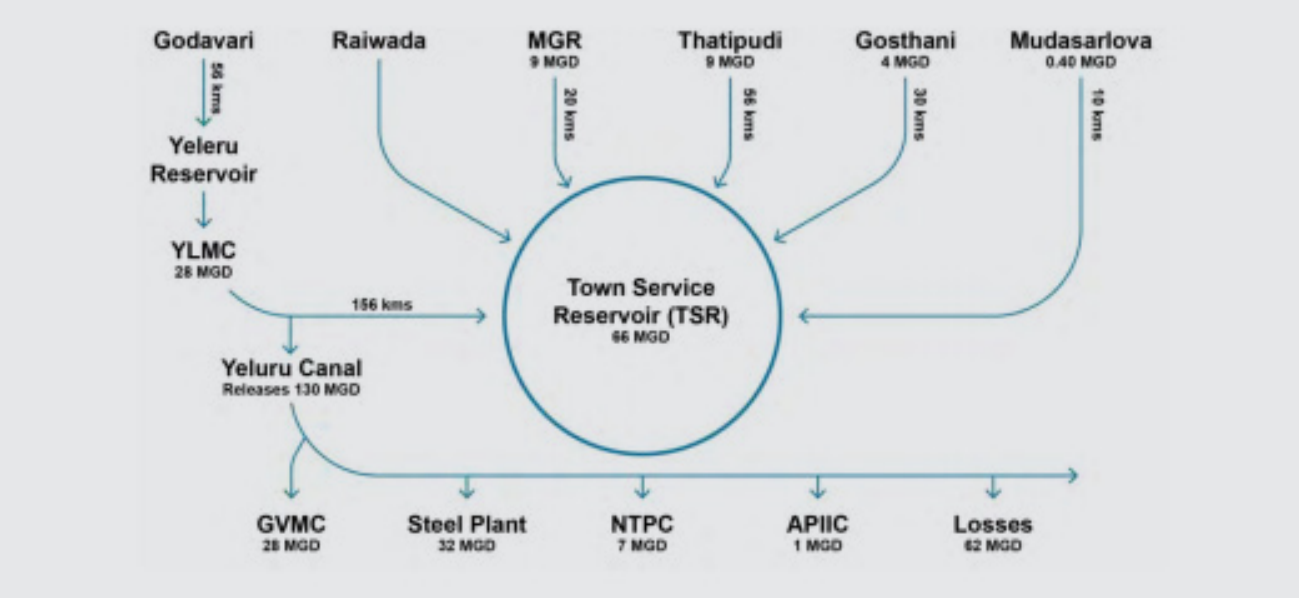


Figure 8: **Capacity of various water sources and their distribution to the city and peripheral areas**

GVMC was within the permissible limits of WHO except for turbidity, conductivity and total dissolved solids in monsoon months (Sarojini Y, et al., 2013).

Increasing temperature leads to non-availability of water because of evaporation. Due to indiscriminate disposal of stormwater and sewerage water into fresh water sources, the quality of drinking water is deteriorating. Construction of residential areas and industrial sectors in the upper catchment area is leading to the pollution of water and reduction in the water retaining capacities of the reservoirs. This may lead to the accumulation of heavy metals in humans, especially among the children which may result in deformities, stunted growth and genetic irregularities.

7.3 Drainage

There are 55 major water streams in the City. The most important tanks are Mudasarlova, Nerella Koneru and tank at Surya Bagh etc. There are about 3 tanks in the peripheral area of the city.

There are in all 22 major Geddas and 20 primary drains passing through the GVMC limits. These primary drains or nallahs carry the stormwater finally draining it either into the sea or nearby water bodies. The length of the primary drains is around 110 km.

The tertiary drains are roadside drains discharging stormwater into the primary drains and water bodies.

The total length of tertiary drains in GVMC area is about 750 km, comprising 450 km of *pucca* drains (lined with brick or stone masonry and pre-cast RCC sections) and about 300 km of *kutcha* drains (unlined).

Key Issues and Challenges:

- Inadequate drainage system, with no proper design of drainage.
- Excessive concentration of flood water due to the breaching of tanks.
- The disappearance of flood absorbing tanks.
- Dumping of debris and garbage into the open *Nallahs*.
- Illegal encroachment of natural water courses
- *Patta* lands in the natural water courses.
- Springing up of housing colonies in the foreshores of the tanks.
- Sanctioning of layouts without reference at the ground levels.
- Indiscriminate laying of service lines all along and across natural courses.
- Collection of building materials on the roadsides resulting in excessive silting of drains.
- Diversion of natural water courses to accommodate habitations.
- Increased runoff due to increase in impervious areas.

- Low Coverage
- Low Capacity
- Lack of integrated drainage plan
- Encroachments resulting in flooding and inundation.

There has been an extensive coverage of drainages in the city. Even though their capacities aren`t enough to withstand the heavy downpour that has been increasing in the recent years due to climate change. The open drains that are found extensively are attracting the solid waste and are being clogged, thereby causing inundation in the low-lying areas.

The gap of internal roadside drainage network in the city by lined/*pucca* drains is 55.50 per cent, (Smart City Plan) since the town is not fully covered. However, *kuccha*/earthen channels exist in the city area in an unregularized manner. Due to the lack of proper drains in the slums, fishermen villages and old towns, the drainage water is being openly disposed off which is leading to increased mosquito breeding thereby causing frequent malarial and diarrheal infections in the children (DMHO). Climate change is aggravating the situation in the low lying areas like Poorna market, Kurupam market, Relliveedhi area, Kobbarithota, Sebastian colony, Gnanapuram area where the maintenance of drains is a challenge.

7.4 Sewerage

In Visakhapatnam, city administration is maintaining mainly three sewage treatment plants (STPs) which are working 24X7. They are 38 MLD STP at old Lakshmi Theater, 25 MLD STP at Appughar area and 13 MLD STP at Mudasarlova area.

Key Issues and Challenges:

- Low sewerage network coverage in the whole GVMC area including core area (Map 4).
- Non-existence of comprehensive master plan for sewerage
- Data on access to sewerage connections is not available.
- No comprehensive sewerage quality studies
- Lack of effective communication strategy
- Lack of efficient energy conservation measures.
- Inadequate sewerage treatment facilities resulting in the discharge of untreated seweraage into water bodies.
- Very low recycling and reuse of wastewater.

Almost 82 per cent of the human waste is not collected by a central sewer system. Due to the hilly terrain, the construction of sewer lines across the entire city is difficult and the existing sewer lines are not well-maintained causing the contamination of the groundwater, and the spread of the water-borne diseases. The existing coverage of sewerage network services (Household services) is only 19.56 per cent (Smart City Report) with the efficiency of collection at 26.64 per cent. Only 31.79 per cent of the population is covered under the sewerage network. The STPs are not operating to their full capacity and the untreated sewer waste and municipal waste is being ejected into the Bay of Bengal and nearby open areas.

The present number of STPs and their capacities are listed below:

1. Appughar - 25 MLD (20 MLD under utilization)
2. Old city - 38 MLD (15 MLD under utilization)
3. Mudasarlova - 13 MLD (6 MLD under utilization)
4. Mini STPs - 31 MLD (16 MLD under utilization)
5. Total Capacity - 107 MLD (57 MLD under utilization)

- Current sewage being treated in the existing STPs: 57 MLD
- Total sewage generated (including Anakapalli and Bheemili): 181 MLD
- The sewage treated corresponds to 31 per cent of the total current sewage generated
- Current area covered by existing STPs: 19 sq. km
- Current population covered by existing STPs: 3.52 lakhs.

This is causing serious ecological imbalances in the ocean and nearby coastal areas. The fishermen are forced to go deep into the sea for their catch which makes them vulnerable. They are forced to change their livelihoods because of the lack of alternative livelihoods which is causing stress on children due to frequent migrations. These migrations are leading to mental stress, educational discontinuity and lack of physical safety particularly among the fisherman children in the fishing hamlets of Mangamaripeta,

Map 4: **Sewerage network of Visakhapatnam City**

(Source: HRVA Visakhapatnam, 2014)

Peddajalaripeta and Sagar Nagar beach. Majority of the slum population living on the outskirts/peri-urban areas of the city (SWM DPR, 2016) have poor access to sewerage facilities. Most of the slums have open drains for domestic sewerage (HRVA, 2014). In fishing hamlets of Peddajalaripeta and Boyaveedhi in Bheemunipatnam, the grey water from open channel drains in being directly sent to the sea. Unhygienic conditions arise near the coast because of this open sewerage drains degrading the aesthetics as well as causing mosquito breeding near their settlements which may cause disease outbreak in rainy season when these drains overflow. Some elderly people and children also defecate in open near these drains.

7.5 Sanitation and Public Health

About 19 per cent of all the deaths in children aged 0 to 4 years in Andhra Pradesh are due to diarrheoal diseases (SAPCC, 2012). It is estimated that between 8.8 and 17 million people in Andhra Pradesh are exposed to water-borne pathogens. Water-borne diseases are also linked to heavy metal contamination of water, due to industrial, agricultural and biological effluents. The city is trying to maintain proper sanitation systems and provide enough public toilets for its ever-growing population. During the morning walk, public gatherings, social events and

festivals, people can be seen urinating on the roadsides which is very disgraceful. Every day thousands of people gather at social events at the beach, market areas and without sufficient public toilets, they face numerous difficulties, especially the women and children. This problem is leading to open defecation and open urination which in turn is leading to the spread of the diseases like malaria, typhoid and diarrhoea.

Access to water supply and drainage facilities is also another problem. Under these circumstances, it is not possible to maintain water-flush toilets in the areas with lack of continuous water supply. India has been constructing 1.5 million toilets a year under its Total Sanitation Campaign (Swachh Bharat Mission). However, 50 per cent of them remain unused. Besides, manual scavenging is still widespread in India. In Visakhapatnam, there are 332 community and public toilets with 4050 seating capacity. There are 143 pay and use toilets and 54 SHGs which are catering to the needs of the daily commuters.

There have been severe sanitation issues in the schools due to lack of infrastructure, lack of awareness and lack of enforcement. The minimum provision of toilet facilities (SBM guidelines) i.e. 1 toilet for every 40 boys and 1 toilet for every 25 girls still has to be followed in many schools. And the existing toilets have to be maintained hygienically to arrest the spread of diseases. Visakhapatnam has heavily diversified industries which lead to the contamination of the seas, major water bodies and even the groundwater. This is leading to the onset of several new diseases like skin rashes, heavy metal poisoning in the area and the communities residing in peri-urban areas near the industries are the worst affected.

7.6 Solid waste management

The city administration GVMC is collecting 900 metric tons of municipal solid waste and garbage from the residential areas, bulk waste generators, community centres and market areas. Even though the city administration is doing extensive work, there has been still a menace of waste being piled upon the roads or disposed off onto the roads especially in the wholesale market areas like Poorna Market, Jagadamba, Bowdara road market area, Harbour area fish market, Malkapuram market where one can easily identify the intensity of the menace.

As most of the areas in Zone III and IV are located in low-lying areas, the indiscriminate disposal of waste is choking the stormwater drains when even a small spell of rain is leading to the spread of water and vector-borne diseases. In these areas, waterlogging is also a major problem further aggravating the challenges of proper disposal and collection of waste.

Only 62 per cent of the waste generated is collected from door to door which is segregated and sent to various facilities like Bio-gas plants, composting, piggeries, vermicomposting and rest of the 38 per cent of the mixed waste is disposed in the landfill site including the silt from drains, sludge from STPs and solid waste collected in drains. The landfill that is being used to dispose of the waste is 70 per cent filled and there is an immediate requirement for the GVMC to identify another landfill site or make proper use of the waste being generated.

Due to lack of proper containment measures in the dumpsite, erratic rainfalls are causing the leachate to reach the groundwater table which is evident by the lack of safe underground drinking water in the Kapuluppada area. Due to increase in the temperature, the waste that is being dumped is catching fires and causing serious air pollution in the Kapuluppada area. Air pollution is leading to increase in skin diseases and respiratory disease like Bronchitis, Nasal rhinitis, especially among the rag pickers and their children. There has been an attempt to generate electricity from the combustion of the waste but that is halted due to the construction of houses under PMAY and RAY schemes near the landfill site in Kapuluppada.

7.7 Waterlogging

The moist coastal areas of Visakhapatnam have a greater incidence of vector-borne diseases. The endemicity of malaria in the city is attributed to the pollution of water bodies and waterlogging. It is a climate sensitive disease and its transmission continues almost throughout the year owing to the relatively humid climate. It is also estimated that an

increase in the temperature by 2-3 °C may increase the incidence of malaria by about 3-5 per cent. There are 38 malaria hotspots (Biologist-GVMC) identified in the GVMC area where there is a constant recurrence of the disease which can be directly attributed to the waterlogging in the low-lying areas. There are more than 20 waterlogging areas in the Visakhapatnam city which are frequently flooded in the monsoon. Floods and inundation due to occurrence of significant amount of rainfall events is observed during the time period September to November. In September-October 2005, heavy rains inundated the low lying areas in the city and the Visakhapatnam airport. The low lying catchment areas of Velemapeta, Poorna Market and Kota Veedhi, ward number 1 to 10 in the old city area and some parts of ward 30 to 40 are major flood prone areas. The normal life of the city is affected due to flooding in the airport area. Ward number 45 to 50 and Gajuwaka area are commonly affected with flash floods which occur during the cyclonic rains (CDMP, 2016).

Box 1: Incidences of water and vector-borne diseases

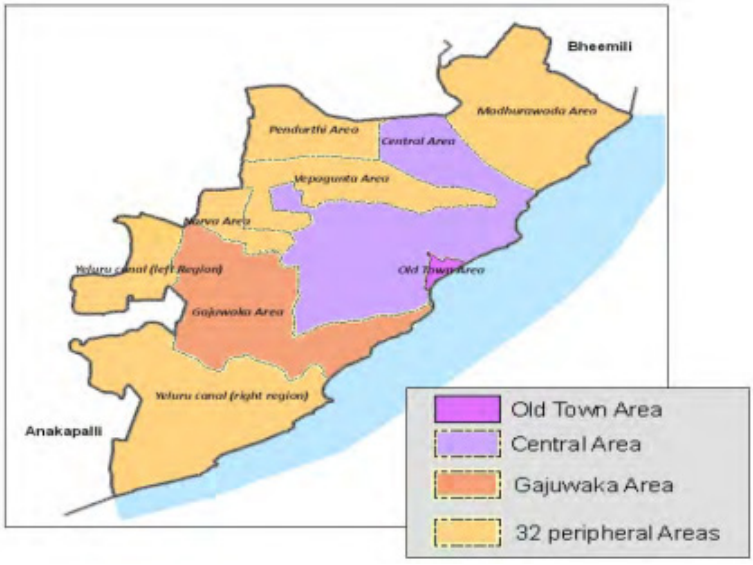
- The incidence of malaria has increased during the last 5 years
- Malaria cases are reported to be high in the northern part of the city
- Diarrhoea incidences, though showing a decreasing trend, records a high number of cases

(Source: HRVA, Visakhapatnam, 2014)

7.8 Peri-Urban Areas

The Peri-urban area includes Anakapallli, Bheemili, Gangavaram, Anandapuram, Pudimadaka, Pendurthi, Sabbavaram, Chodavaram, and Kothavalasa areas (Map 5) etc. which provides agro-products and ecosystem services. The outward expansion of the city has caused more complex interactions with the neighbouring peri-urban and rural areas and rapid changes in the land-use have occurred in the past due to industrial development.

Traditional livelihoods of the communities in the peri-urban areas are changing, with more and more people migrating to urban areas to do unskilled/daily wage labour jobs as farming is being continuously affected by urbanisation and industrialisation. This has also led to increased stress on the children and women for earning money. Increased cases of substance abuse, sexual abuse and trafficking among the children have been observed. The conversion of agricultural lands near Kurmannapalem, Steel Plant, Paravada, Madhurawada into developmental sites in the name of industrialization has led to the loss of not only livelihoods of the people residing there but also the loss of the agro-products like vegetables, fruits and flowers that are daily supplied to the core city. This is indirectly causing a burden on the urban poor in the form of commodities price hike. Common property resources like grazing lands have also decreased in the peri-urban areas, leading to fodder shortages.



Map 5: City and its peripheral areas (Before the merger of Bheemili and Anakapalli Municipalities)

The cropping pattern in the peri-urban areas is also changing from labour intensive crops to energy crops like casurina and aquaculture. According to National Family Health Survey Data, 2016 for Visakhapatnam district, 33.1% of the children under 5 years of age are underweight, 20.4% of urban children of Visakhapatnam are wasted while the rural counterpart is less at 15%. Around 10.6% of the urban women have BMI less than normal. With the replacement of food crops with plantation crops like casurina and cashew, the city will have to depend on faraway places for the supply of fresh vegetables which may increase the transportation cost, the market prices of food and ultimately the energy footprint. As livestock and poultry is an inter-dependent livelihood on agriculture, the supply of meat, milk and milk products and eggs may also be affected.

The water buffering capacity of the wetlands that are present near the port area has been reduced and may lead to increased vulnerability in the event of flash floods and storm surges. The loss of 55 hectares mangrove patches near the port area and loss of sand dunes in the beaches also lead to the increased vulnerability of the city which requires serious attention. The green cover in the peri-urban area is vanishing rapidly due to land development for construction/ developmental activities.

7.9 Governance

Visakhapatnam is administrated by GVMC and the master plan for the city is prepared by the Visakhapatnam Urban Development Authority (VUDA) which has a jurisdiction till Srikakulam. The developmental activities or projects taken up by the VUDA do not always comply with the daily functionalities or the infrastructural requirements of the GVMC which leads to a lot of mishap on the field. After the merger of Anakapalli and Bheemunipatnam municipalities with GVMC, the residents of these localities are losing their independence in the management of their towns. The municipal governance system has become more complicated where the orders are coming from distant headquarters. The availability and accountability of municipal officials to the people has been affected while the role of citizens in development activities has diminished. Neither the local people nor the officials are directly participating in the development activities planned for the town.[8]

Orderly spatial development of the city, provision of infrastructure, local economic growth, service delivery and expenditure effectiveness are affected by the absence of an effective coordination mechanism amongst city and state level agencies. Thus, to achieve better service outcomes, there is an urgent requirement of spatial and functional integration of service delivery process through innovative institutional arrangements. By the year 2021, Visakhapatnam is expected to emerge as one of the major cities in the country where maximum growth would take place in Greater Visakhapatnam area away from the city core. ”This has serious implications for the service delivery both for city core as well as peripheral areas since the traffic and population flows occur between them”. An integrated planning approach for Greater Visakhapatnam will be required with a focus on equitable service provisions to all the areas and sections of population (CDMP, 2016).

7.10 Vulnerable Groups

Based on the vulnerability assessment, the most vulnerable groups of the population have been identified. This identification has been done based on the following two criteria:

1. Spatial classification
2. Socio-economic classification

According to the spatial vulnerabilities, the following groups of people are identified-

1. People residing in the hilly terrains in the foothills of Simhachalam range, Yarada, Malkapuram, and Adavivaram, etc.
2. People residing in the high topographical areas like Seethammadhara, Hanumanthawaka, Madhavadhara, and Kailashapuram, etc.
3. People residing along the coastal region – all 18 fishing villages, Yarada, RK Beach area, Pandurangapuram, East Point Colony, Lawsons Bay Colony, Appughar, Dayal Nagar, Sagar Nagar, Rushikonda, and Bhimili, etc.

8 http://timesofindia.indiatimes.com/city/visakhapatnam/The-fifth-cleanest-Visakhapatnam-has-promises-to-keep-/articleshow/51380019.cms, Accessed 6 August 2017.

4. People living on the peri-urban plains near Anakapalle, Bheemili, Anandapuram, Pudimadaka, Pendurthi, and Kothavalasa.

Most of the people residing in the hilly areas are illegal occupants as they can`t afford the cost to purchase the land and are residing on the hills despite the area being vulnerable to landslides. Due to increase in the intensity of rainfall because of the climate change, these areas are frequently being washed off their topsoil which holds the boulders in place. This is resulting in the damage to the infrastructure and increased stress among the people particularly in children and women as they spend most of the time in the houses.

According to the socio-economic classification, people can be classified into many groups but the most vulnerable groups fall under the following categories-

- Low-income earners
- Fishermen families

A large number of people are earning a minimal amount of wages in the slums located near the coasts and same are dependent on the seasonal jobs. When there is no work to do they are left with nothing but involving their wives and children in the daily wage earning works which is leading to the increased vulnerabilities of the women and children. The children who are found in the 32 fringe villages which have been recently added are the most backward group of people as they are not provided/near to the facilities like schools, safe drinking water, enough sanitation facilities and protection against social threats like child marriages and trafficking.

7.11 Vulnerability assessment through Causal Loop Diagrams (CLDs)

After the identification of the most vulnerable groups, FGDs were conducted with the people to understand the vulnerabilities arising due to climate change and CLDs were constructed to identify the causes and sub-causes of these vulnerabilities.

The major identified vulnerabilities in the city are –

- Sanitation
- Waterlogging
- Drinking water
- Drainage/Sewerage

Sanitation (Figure 9) is one of the main concerns that is directly related to the health of the children. It needs to be addressed with prime focus because of the

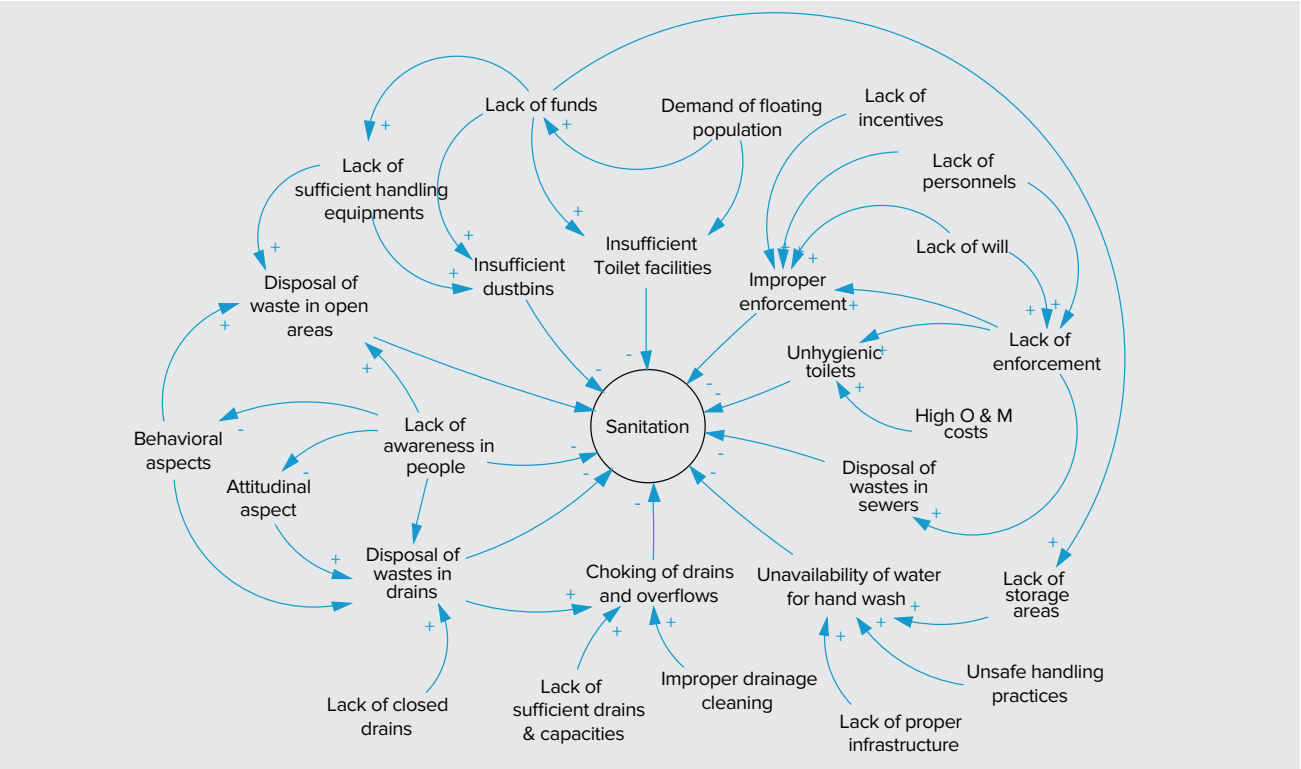


Figure 9: CLD for Sanitation Analysis

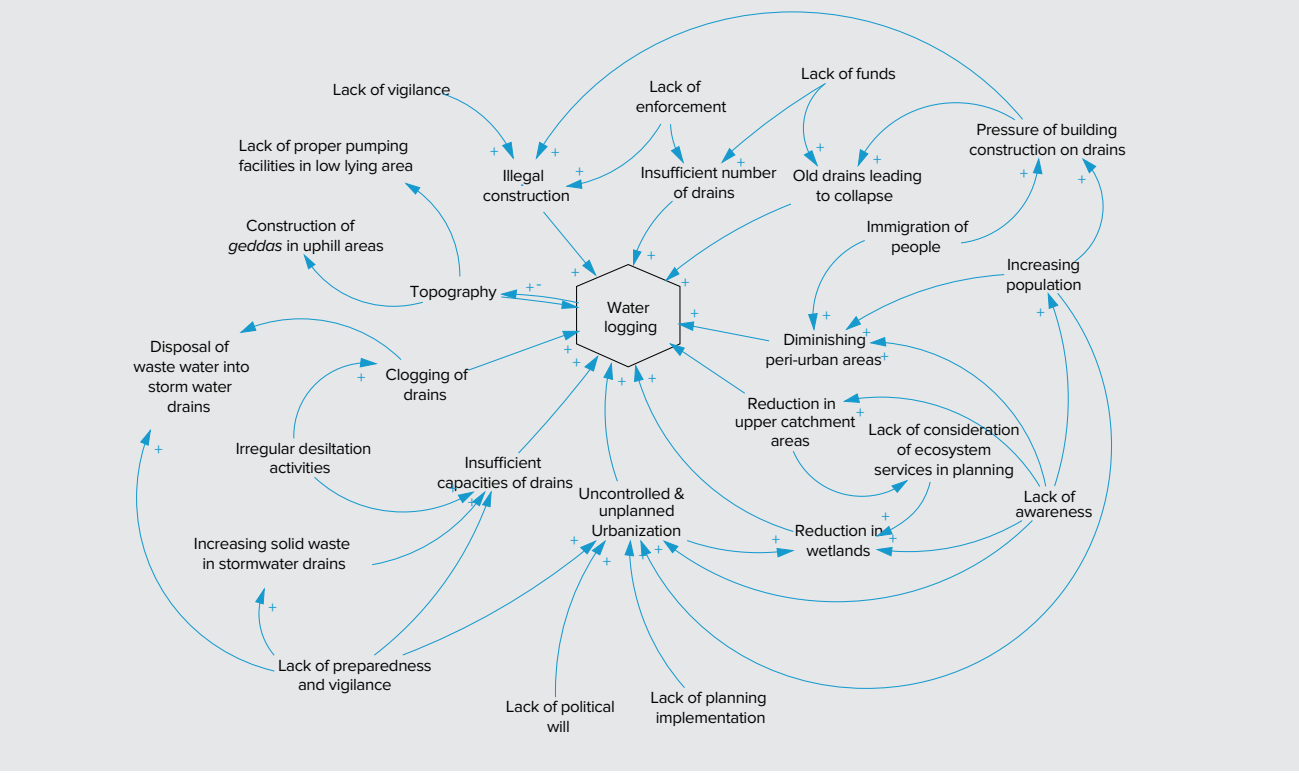


Figure 10 : CLD for Waterlogging Analysis

increased incidences of the vector and water-borne diseases. In the recent years, the risk of dengue has been increasing in the areas that are waterlogged and have poor sanitation conditions (Biologist-GVMC). Sanitation crisis in Visakhapatnam is mainly attributed to lack of proper infrastructure, lack of funds for up-gradation of the existing age-old structures and lack of supervision. All these together are aggravating the situation and the impact is clearly visible in the form of diseases among the children (UHC, GVMC).

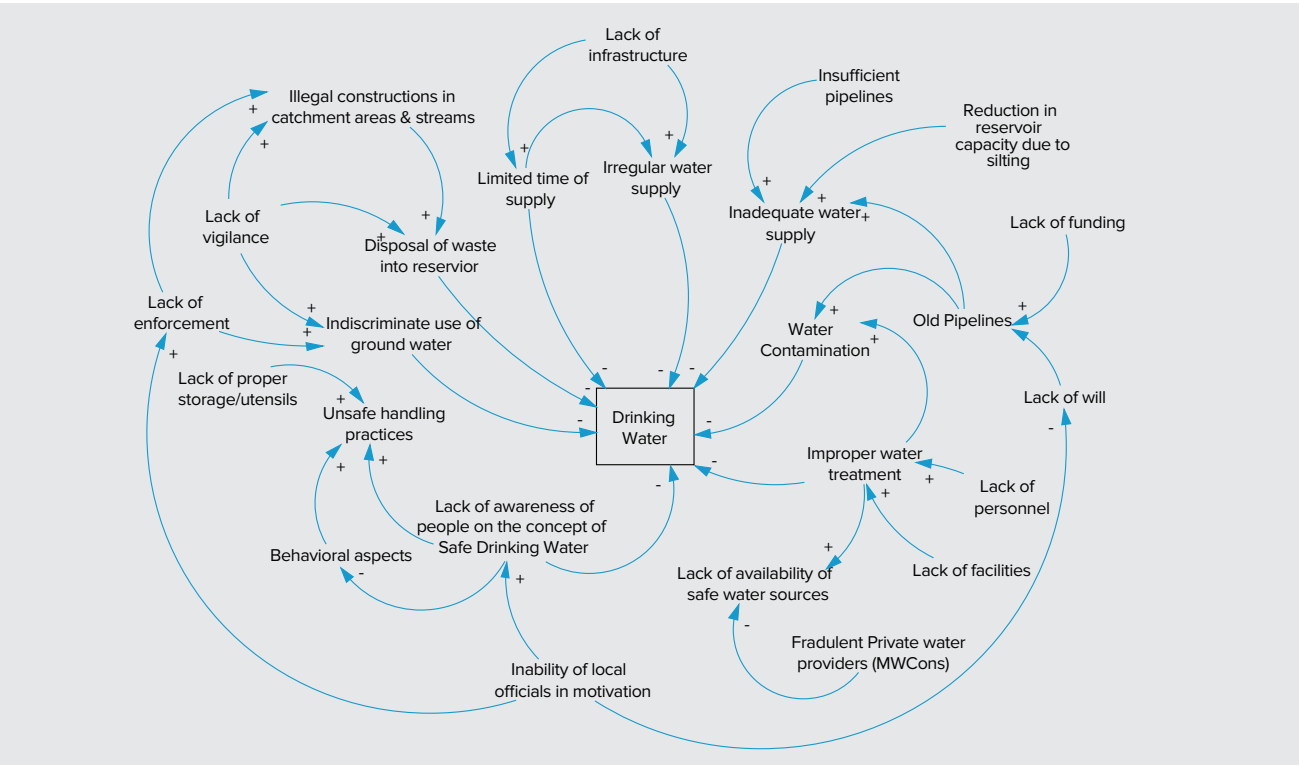


Figure 11: CLD for Drinking Water Analysis

Waterlogging is a seasonal problem that is found in the low-lying areas during the monsoon and post-monsoon seasons particularly in the months of October, November and December (Figure 10). These waterlogged areas the major hotspots for mosquito breeding where the incidences of the vector-borne diseases are high, particularly malaria. There are 38 malaria hotspots identified where there is constant recurrence of the disease. Waterlogging is majorly due to the lack of sufficient drainage infrastructure, illegal constructions over the drains, blockage of the drains due to municipal solid waste and compromising of the age-old infrastructure which are not renovated/retro-fitted to meet the needs of the growing population and increasing climate change impacts.

Hence, waterlogging is found with regular recurrence every year which needs immediate attention without which the slums in the low-lying areas, and the children in these areas, are going to face severe impacts in the form of loss of basic development parameters like education, health and safety.

Drinking water requirements are met by the Meghadrigedda, Tatipudi, Raiwada, Yeleru reservoirs and Gosthani, Mudusarlova infiltration wells which are located in the peripheries of the city. The treatment and transmission of the water is also done from the peripheries which contaminates the water during the transmission due to leakages in the pipe lines (Figure 11). Mixing of industrial pollutants in the Gajuwaka area and increased content of the coliform bacteria due to the mixing of the sewerage and drinking water further deteriorates the water quality.

This contamination is because of the insufficient pipelines and compromising of the structural integrity of the existing pipelines. This in turn is a result of increased pressure on the water supply system due to the increasing demand of growing population. Available water is also being reduced due to the increasing temperatures and illegal constructions in the catchment areas of the rivers and canals.

Sewerage / Drainage can be dealt under the same section because of the similarities in their structures and

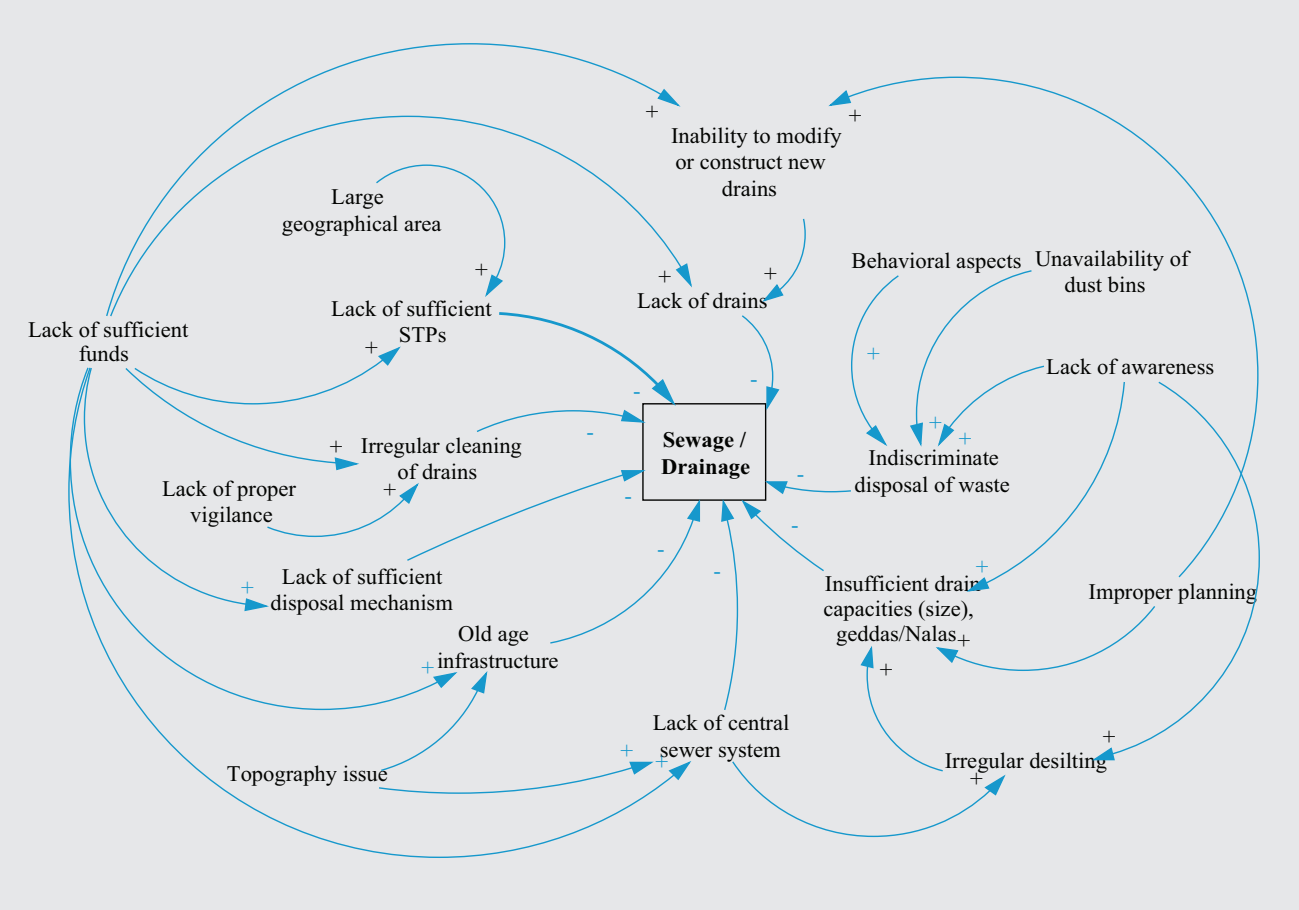


Figure 12: **CLD for Sewage/Drainage Analysis**

carrying composition. Drainage/Sewerage construction and maintenance in the Visakhapatnam city is becoming a major hindrance due to the topography of the city (Figure 12). This hindrance is majorly observed in the upland tracks, hilly areas and coastal areas.

Due to saucer shape topography of the city with hillocks on three sides and sea on one side, the rain water collected from hills and catchments flows through the untrained major drains with a high velocity before reaching to the sea. This high velocity water during heavy cyclonic rains has major devastating effects on the life of people and their properties situated all along the water course. Essentially, the population belonging to lower socio-economic groups living along the banks of the streams are prone to flooding. Storm water drains covers an area of 1400 km, most of which are encroached upon by the public narrowing down the original stream. The slum dwellers and weaker sections of the society have occupied the banks of the drains causing further obstructions to the free flow. This encroachment also hinders the process of de-silting the drains during pre-monsoon season. Due to lack of any fencing and demarcation of the storm water drains, the slum dwellers also through debris and household waste in the drains causing obstruction to the free flow of rain water and then it overflows on the roads (CDMP, 2016).

8. Vulnerability Risk Framework

Visakhapatnam is a highly dynamic area with many risks ranging from natural to anthropogenic as well as climatic stresses to developmental stresses, which lead to the increased risk of exposure of the marginal population to various vulnerabilities which may turn into disasters if proper attention is not accorded to them. The plain land around the city is under tremendous pressure of urbanization (residential development including societies, private houses and slums) and is becoming a scarce natural resource day by day. Rapid industrialization in the southern part of the city has replaced agricultural lands. Due to lack of land within the city, significant illegal constructions have occurred on the hilly regions disturbing the natural slope morphology including natural drainage, soil cover, slope vegetation and slope stability. Climatic shocks like cyclones, storm surges and extreme rainfall are increasing both in numbers and intensity. Increase in the incidence of rainfall (100 mm rainfall in a day) during both monsoon seasons and increased occurrence of cyclones have led to increased vulnerability of the city.

With breaching of coastline norms, the plantation/mangrove belt along Visakhapatnam which is a protective gear against climatic hazards like cyclones and floods is getting wiped out. The combined effect of such human, natural and development factors are resulting into the enhanced vulnerability of the city in the events of climate variability (current and projected future) leading to enhanced shocks and stresses of urban people and hence increased risks in the

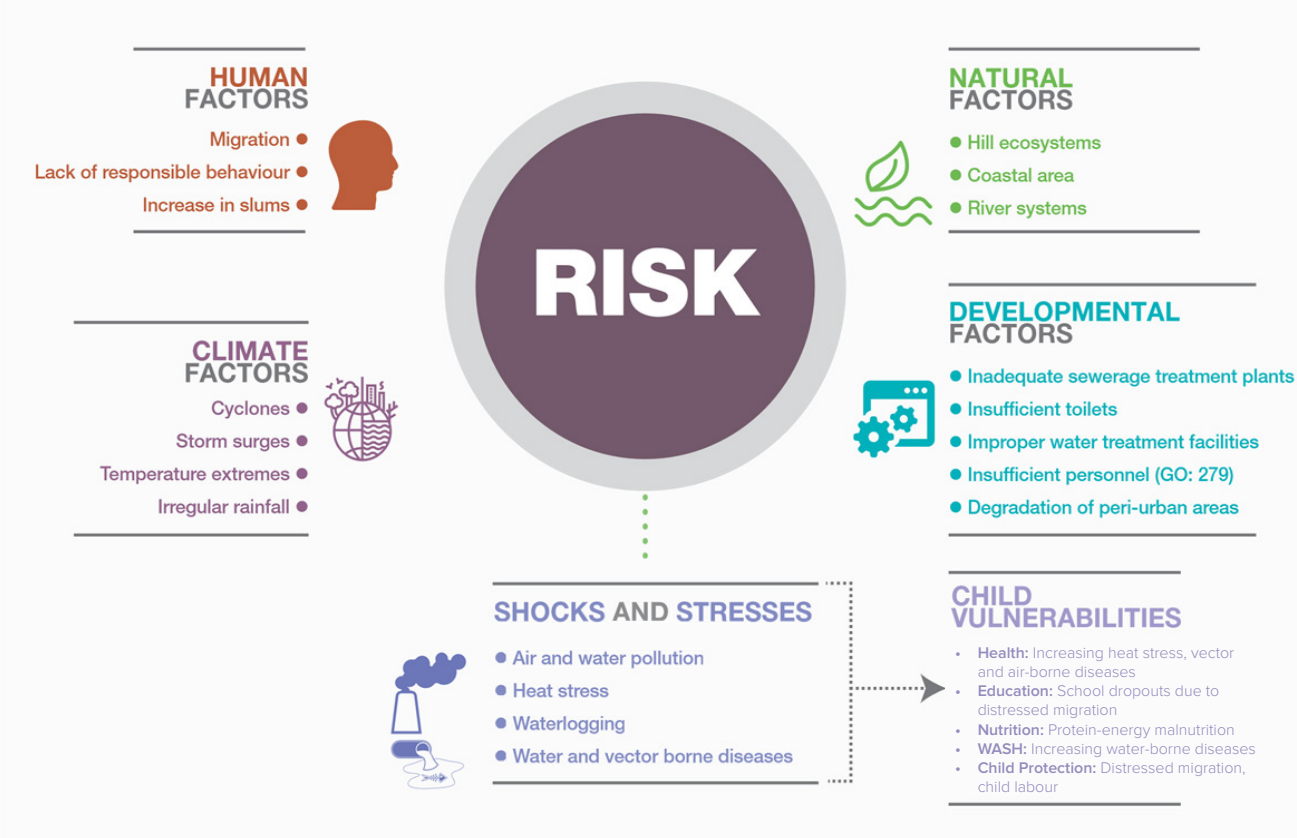


Figure 13 : Climate Risk Frame of Visakhapatnam City

city. These shocks and stresses are further aggravating poor children's vulnerabilities, adversely impacting their health, education, water & sanitation aspects, nutrition and physical protection.

8.1 Risk Factors

The risk framework (Figure 13) developed for the city indicates the major shocks and stresses which, if unattended, will turn into disasters. The risk framework is based on the following four factors:

- Human factors
- Developmental factors
- Natural factors
- Climate factors

Human factors include the migration of people, lack of responsible behavior towards both resources & services and increase in the number of slums. Migration of the people into the city from the fringe villages is leading to increased stress on the existing facilities like toilets, water consumption, food availability, and housing. These migrated people are generally found in the slums or low-income settlements found across the city.

Developmental factors include the infrastructural gaps, lack of personnel and degradation of urban and peri-urban ecosystems. The infrastructural gaps like inadequate sewerage treatment facilities, drainage and sewerage facilities lead to increase in the service level gap which increases the occurrence of both, vector-borne and water-borne diseases. During the process of industrialization, the fringe villages and the peri-urban areas were merged with the core city. These peri-urban areas which once supported the core cities are now facing serious climatic and environmental complications due to the poor planning processes and lack of proper vigilance and governance during the implementation of various developmental projects. Due to severe Coastal Regulation Zone (CRZ) violations within the city in terms of pumping of groundwater from bore wells, several groundwater resources, especially near the Lawson's Bay area, have turned saline[9]. Natural factors include the hill ecosystems that range from Upland tracks to the Eastern Ghats, extensive coastal area and small riverine systems found in the peripheries of the city.

9 http://www.thehindu.com/news/cities/Visakhapatnam/Investors-lobby-for-CRZ-relaxation-to-promote-tourism/article11419589.ece, Accessed 2 August 2017.

The bowl shaped topography of this coastal city makes it altogether more vulnerable to increasing climate change impacts. Due to the increasing temperatures and unplanned/ illegal constructions, the riverine systems are getting depleted posing a serious threat in the near future.

Climate factors include increasing temperatures, erratic rainfall, sea level rise, storm surges and increased occurrence of the cyclones. Due to the climate change, the intensity and the occurrence of cyclones is on rise which is causing serious damage to the property, and it is the poor and the marginalised that bear the maximum brunt of this damage. Increasing temperatures combined with increased pollution activities in the city has resulted in the formation of the Urban Heat Islands which is causing serious implications for the children and the elderly people. Increased intensity of rainfall with a decreased number of spells may result in the form of flash floods in the low-lying areas and outbreak of diseases in the post-monsoon season.

8.2 Major shocks and stresses

By analyzing all the vulnerabilities, the major shocks and stresses of the city are identified and the associated causes are tabulated as follows:

Table 3: Major Shocks and Stresses and their causes and sub-causes

Shocks and Stresses	Causes	Sub-causes
Air and Water Pollution	Unplanned urbanization	Lack of planning in the past
		Lack of involvement of key stakeholders like children in the decision making process
	Indiscriminate disposal of waste into the open waters	Irresponsible behaviour of the people
		Insufficient sewerage treatment facilities
		Insufficient infrastructure in transferring the waste to the treatment facility
		Illegal housing along the coast
		Lack of sanitation facilities in the households
	Rapid industrial growth	Lack of planning in the past
		Non-compliance with the CPCB standard/rules
Heat stress	Increased pollution	Illegal release of the pollutants into the air
		Topography and winds
		Rapid industrialization
		Increased number of the vehicles in the city
	Loss of green cover	Deforestation
		Rampant urbanization
		Increased temperatures
		Industrialization
		Developmental activities
		Illegal Encroachments

Shocks and Stresses	Causes	Sub-causes
Waterlogging	Low-lying areas	Topography
		Unplanned construction of colonies
		Illegal constructions in the low-lying areas
	Infrastructural gaps	Insufficient drainage and sewerage facilities
		Age old infrastructure
	Indiscriminate disposal of solid waste	Behavioural aspects of the people
		Insufficient dustbins in the slums
Water and vector-borne diseases	Increased temperatures	Climate change
		Increasing air and water pollution
		Decreased green cover
	Waterlogging	Topography
		Infrastructural gaps
		Indiscriminate disposal of solid waste
	Poor sanitation	Lack of personnel

9. Vulnerabilities of Urban Poor Children – Visakhapatnam

9.1 Health

The health issues in the city are primarily because of the poor hygienic conditions, low economic profile of the slum population, waterlogging, increasing temperature extremes, heat stress & humidity, and pollution due to industrial activities/traffic congestion. Water-borne diseases like diarrhoea and vector-borne diseases like dengue and malaria are more prevalent in the children of low-income settlements along the drains (DMHO). This can be attributed to the poor quality and quantity of drinking water, poor sanitation practices and lack of availability of proper toilet facilities in these areas (Smart City Proposal). Malaria is a climate sensitive disease which transmits more in humid climate and with increasing temperature its incidences may increase. It is projected that minimum and maximum temperature of the city is going to fluctuate significantly during different seasons which may influence the incidences of vector-borne diseases.

The groundwater is being contaminated by indiscriminate disposal of the untreated sewage and improper drainage causing the problem to be more widespread (CGWB). The Indian Network for Climate Change Assessment predicts that the state of Andhra Pradesh is going to face increased risk of severe heat stress by 2030 (SAPCC, 2012). For Visakhapatnam city specifically, evidence suggests that over the past few years, the city has been experiencing heat wave conditions in May and June. Day time summer temperatures have been

Box 2: Health: Vulnerabilities of the city

"*Summer temperatures have risen, heat waves are common. Children are frequently falling sick due to fever and diarrhoea. They suffer from skin rashes, prickly heat and often feel dehydrated*,"

– Says Suhana, mother of 5 year old Sadia from One Town area, Visakhapatnam.

observed as 3-4 °C above normal in 2017." *April and May months saw nearly 1600 people being treated for various heat related issues at various Primary and Community health care centres, including KGH Hospital. Among patients, the common issues were dehydration and viral infections".* In May 2016, the temperature recorded was 43 °C which was the highest temperature since 2011.

Children's body cannot easily acclimatize to the heat as the adult's body can do. Due to smaller bodies and higher ratio of surface area to body mass, they absorb more heat and sweat less. This increases their discomfort during heat waves and periods of high humidity.

The lack of drinking water is likely to cause heat strokes and increase mortality (SDMP, 2017, Heat Wave Action plan, GVMC). Due to the increase in temperatures as per the projections based on the Model Data, extreme weather events and the impact of coastal erosion may result in enormous economic and physical damage and is likely to be associated with severe mental distress which may arise more in the children.

The city is highly prone to air pollution. The presence of a number of low lying hills which stands more or less perpendicular to the coastline creates a number of natural topographical "bowls" which have implications for the air quality through their impact on air pollution disposal (CDMP, 2016). Due to chemical pollutants released in the air untreated, many nasal and skin diseases are rising including allergies, rashes and nasal rhinitis. Children are more vulnerable to these diseases as they have an underdeveloped immune system. Increasing temperature due to climate change has a direct impact on the air quality of the city as the concentration of pollutants may change due to changing temperature. Increasing temperature is causing higher mixing ratios of the air that is being carried by the south-westerly wind during the summers over the city. Further, the bowl shaped topography favours the settling of these pollutants. If adequate measures will not be taken to curb the air pollution in the city, the health impacts of air pollution which will be enhanced by climate change impacts are likely to increase, specifically among the children.

9.2 Education

There are adequate number of schools (>250) working under the city administration (95 schools of GVMC), state government (8 schools) and the private sector. Government is implementing many programs to encourage/attract the children towards the school. Some examples are: providing mid-day meals, waiving their school fees, and providing free uniforms etc. In most of the areas, the citizens are preferring private schools for better education. The city administration is improving infrastructure in its schools to develop them as smart schools, under the Smart City Mission.

The children from slum areas are not completing their basic high school education as they get involved in

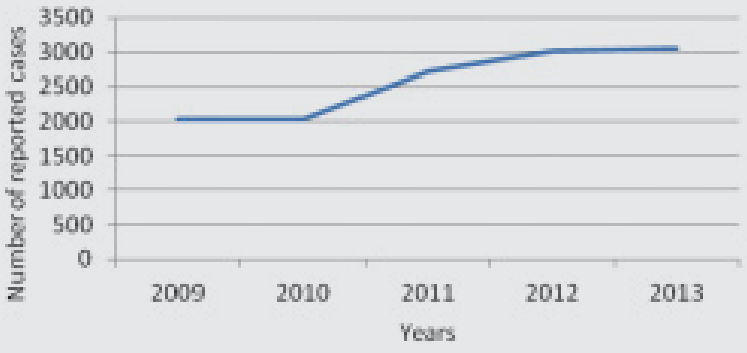


Figure 14: Malaria incidence trend in the city

Box 3: Education: Vulnerabilities of the city

"Our children are travelling 5-7 km daily to attend the government school because we can`t earn enough to send them to nearby private schools. The fish catch is reduced to a large extent due to the increasing temperatures and pollution which makes us to relocate to other locations in search of new livelihoods."

- Says Satya Narayana, a small fisherman of Peddajalaripeta hamlet, Visakhapatnam.

earning wages for their livelihoods and helping with the fish catching and selling activities among their communities. There are no proper school facilities near to some slum areas and the children have to travel pretty long distances to attend the schools. This is making them show disinterest in the education. The schools that are currently available do not have the infrastructural strength to face the impacts of the climate change like urban flooding and waterlogging.

During extreme weather conditions like excessive rainfall, heat waves, and cyclones etc. continuity of children's education is badly affected. The WASH infrastructure in GVMC schools also needs to be looked at from a climate change angle. There is a shortage of water and electricity in the toilets in some GVMC schools which needs immediate attention. This may pose health problems like malaria, typhoid, cholera, diarrhoea that are prevalent among the children. High dropout rate has been found among the children residing in the slum areas during the monsoon season.

9.3 Nutrition

Climate change affects all the three aspects of food security namely: availability, access and absorption. The susceptibility to water-borne and vector-borne diseases which are linked to climate change impacts is increasing in urban low income settlements, specifically among the children living in slums and fishermen communities. Continuous exposure to these diseases is causing higher incidences of undernutrition and poor health status. A child suffering from undernutrition in the initial years of his/her life is less likely to adapt and build resilience to climate change impacts in the long run.

Box 4: Nutrition: Vulnerabilities of the city

"The susceptibility to water-borne and vector-borne diseases which are linked to climate change impacts is increasing in urban low income settlements, specifically among the children living in slums and fishermen communities. Continuous exposure to these diseases is causing higher incidences of undernutrition and poor health status. A child suffering from undernutrition in the initial years of his/her life is less likely to adapt and build resilience to climate change impacts in the long run"

– Says Dr G Prabhakar, Health and Environment Expert, Green Vision, Visakhapatnam.

The coastal districts of Andhra Pradesh including Visakhapatnam are becoming increasingly vulnerable to reducing fish catch. Many of the tropical fishes are being displaced to the deeper waters from the pelagic realm. With this displacement many fish varieties may face extinction which in turn is a result of warming of the surface water (SAPCC, 2012). Ocean warming, increasing pollution, increasing incidences of hydro-meteorological disasters in Visakhapatnam city are the key causes of disturbed livelihood of traditional fishermen. With reducing fish catch, their family income is getting affected resulting in a lack of access to nutritionally adequate food due to low purchasing power. Micronutrients (especially iron) and energy (calories) deficiencies are increasing among their children. This is further enhancing their susceptibility to infectious diseases especially gastro-intestinal infections due to reduced immune capacities. Due to unhygienic food consumption practices, poor care environment for ill and differently abled children and poor health care seeking behaviour among the community, the absorption of nutrients from the food eaten by children is not complete. Children often suffer from skin diseases, diarrhoea and dysentery due to unhygienic food intake practices.

Protein-energy malnutrition (marasmus and kwashiorkor) is a critical problem in children living in urban slums. A large proportion of adolescent girls are iron (anaemic) and vitamin deficient. Majority of the dwellers living in urban slums of Visakhapatnam are migrants from neighbouring districts of Vizianagaram and Srikakulam

who have no income security. This low-income group resides in the settlements which are often highly exposed to waterlogging, storm surges and winds. As most of the family income is spent on food, climate change will exacerbate their existing problems of food insecurity by disturbing their livelihood. Increasing temperature and changing precipitation pattern may increase diarrhoeal diseases in their children. Specific to the unhygienic environment of slums, vector-borne diseases and the emergence of new pests will further threaten the food security and reduce the capacity to consume the available food efficiently.

People residing in the peri-urban areas where the principle livelihood is agriculture are facing serious difficulties due to the merging of the fringe villages into the city which led to the loss of their livelihoods and lost access to sufficient nutritious food. Increased water stress in the Gajuwaka and Paravada areas is also leading to decrease in the production of the food in the peri-urban areas of Kurmannapalem which could be worsened due to the increasing climate change impacts.

9.4 Child Protection

The city has a very diverse economic group with the weaker economic groups having a higher impact of climate change and disasters on their livelihoods and safety. Due to the merging of nearby villages into the GVMC, there has been a significant increase in child labour who come to the city core in search of work and better lives. These children generally are employed in the business/industrial activities and are also found picking the waste bottles and plastic bags as rag pickers. Some of them are rescued but due to substance abuse, they generally revert to those activities (Childline) and even engage in illegal activities for the acquisition of intoxicants which is evident by the increase in the juvenile cases being filed in the police stations.

During the monsoons and cyclones, the livelihoods of the low-income groups like fishermen living in the coastal slums and peri-urban farmers living in the fringe villages are disturbed and impacted to such an extent that they prefer to change their livelihoods or migrate to other areas as labourers and daily wagers. This leads to increase in the stress on the natural resources of the region and also mental stress on their children.

Box 5: Child Protection: Vulnerabilities of the city

"I am a fisherman and have been doing fishing for the last 30 years. Over the years, I am being forced to go deep into the sea for the fish. The cyclones are causing severe damage to our fishing crafts like nets and boats. This is leading to severe loss in our livelihoods and is increasing the burden on our women and children, who are forced to work for daily wages. We do not have other livelihood options as we are not aware of any other work."

- Says Thathiah Babu, Peddajalaripeta fishing hamlet, Visakhapatnam

increase in the domestic violence on the women and children to earn income. Due to family traditions, poverty and open access to marine resources, the children of fishermen families get involved in the fishing activities at a very early age which reduces their opportunities for education and livelihood diversification. Children play near the coast, defecate in open and go for fishing at an early age. Due to increasing temperatures, pollution and mechanized fishing, the traditional fishermen are forced to go deep into the sea for a long period (as long as 15 days) which makes them vulnerable in the open sea.

9.5 Water, Sanitation and Hygiene (WASH)

WASH is the major sector that has been neglected until the recent years. It has been gaining importance now due to the increase in the prevalence of water and vector-borne diseases. According to the Smart City Proposal of Visakhapatnam, 40 per cent of the population do not have access to sanitation network and open defecation is a major health hazard.

Due to infrastructural gaps, leakages of the pipes and spillage during transmission, it is a challenge to the city administration to provide safe drinking water to the city dwellers. If water quality decreases, it may lead to the increased incidence of the diarrheal infections among the children present in the schools and slums. The data from the Integrated Disease Surveillance Program (2014) reveals that 22 per cent of the total diagnosed patients in the outpatient departments, suffered from water-borne diseases in Visakhapatnam city.

Box 6: WASH: Vulnerabilities of the city

"We are experiencing increased rainfall in the post monsoon period, leading to waterlogging and occurrence of diseases like diarrhoea, typhoid, skin infections, high fever and vomiting. Children here are more prone to these diseases as they play near the gedda due to lack of another open play area. Sometimes overflow of drains leads to water inflow in our houses damaging our household goods."

-Says Ramanamma, a concerned mother from Mutyamamba Colony, Visakhapatnam

Due to the dumping of raw sewerage through open channel drains which are passing through fishing hamlets and slums, highly unhygienic conditions arise near the coast. This not only degrades the aesthetics but also creates breeding grounds for mosquitoes causing diseases outbreaks when the drain overflows. Children play near these open drains and also defecate in open.

The major 38 malarial hotspots (Biologist, GVMC) which are identified in the city are in the high density populated areas where the incidence and transference of the disease are more because of the lack of proper infrastructure and immense developmental pressure on the existing infrastructure.

Despite the regular doses of treatment being done by the GVMC, the recurrence of the disease is regular and in the recent years, dengue epidemic is prevalent and the cases are being observed well beyond their season of occurrence i.e. during monsoon season (Figure 14). The poor infrastructure facilities to provide safe drinking water, poor facilities to provide water for hand washes, insufficient toilets and inadequate sewerage management are increasing the problem of hygiene among the children. Water-borne diseases are also associated with heavy metal contamination in the settlements near industries and the dumping yard. The climate change effect in the form of increasing temperatures of 2^0C and increased erratic rainfall of are aggravating the situation by causing dehydration, increased occurrence of the disease and reduced immunity of the children due to the lack of proper nutrition.

10. Children Focused City Resilience Strategic Directions for Visakhapatnam

The government is implementing various development plans, policies and schemes in Visakhapatnam city through different institutions. The city requires an in-depth research on various aspects of climate change directly or indirectly affecting the urban systems and the population, specifically the children. Further, there is a need to build the capacity of the local government and institutions through special programmes focusing on “Urban Resilience Building” while addressing the specific vulnerabilities of children. As per the directives of DDMP of Visakhapatnam, there is a need to mainstream climate and disaster resilient components in the National and State Level Flagship Schemes being implemented in the district with utilisation of 10 to 25 per cent of scheme resources for DRR measures.

Three key points to bring about a positive change in the direction of child-centred resilience building in the city are:

- Inter-departmental coordination between various line departments with mainstreaming of the issues concerning UCCR and children specific vulnerabilities in their working agenda.
- A strong political will to identify and implement resilience measures
- Involvement of communities and CSOs (active citizen and behavioural change) in the implementation process

Following are the specific resilience directions developed for Climate Resilient and Child-Friendly Visakhapatnam City:

Table 4: Children Focused City Resilience Strategic Directions for Visakhapatnam

Sector	Children's Vulnerability	Development Deficit	Priority Actions	Policy/Programmes/ Schemes	Institutions
Health	- Vector-borne diseases like Malaria and Dengue - Water-borne diseases like Typhoid, Diarrhoea and Gastroenteritis - Heat Stress causing dehydration, dizziness and vomiting - Air-borne diseases like Allergies, Bronchitis and Nasal Rhinitis - Skin diseases like Allergies and Rashes	- A large number of slum settlements along open drains - Lack of Open/Safe Play Areas for children - Inadequate housing infrastructure in low-income settlements to face the impacts of cyclones, floods & waterlogging and heat waves - Increasing air pollution due to industrial activities, Visakhapatnam Port Trust (VPT) and increasing traffic congestion - Inadequate drinking water supply (quantity and quality) - Groundwater contamination in peri-urban areas due to industrial activities - Breaching of coastline norms and decreasing open green areas within and around the city	**SEWERAGE & WASTE MANAGEMENT** - Developing an integrated underground sewerage system to avoid waterlogging and choking of open drains - Enforcement of cleaner production and waste minimization processes across the industrial zone of the city **HOUSING** - Providing affordable, climate change and disaster resilient houses to urban poor living in unauthorized slums - Promoting low-cost cool roof technologies and terrace gardens to counter urban heat island impacts (for middle and low-income settlements) **HEALTH & ENVIRONMENT** - Maintaining open green areas within and around the city (peri-urban agriculture, urban forests, horticulture) to mitigate air pollution and heat stress - Implementing water quality monitoring mechanisms in schools and related IEC campaigns for awareness building - Increasing anti-malarial and anti-dengue drives in identified disease hotspot areas of the city - Strengthening the remedial measures to curb pollution from VPT - Provision of adequate facilities at Urban Healthcare Centres and Government Hospitals (equipment, medicines, staff and patient counselling) - Increase awareness on available National and State Level Flagship Schemes on Health Insurance and Risk Transfer - Develop and strengthen "Hospital Disaster and Emergency Management Plan and Teams" to respond to the effects of extreme climatic events and disasters **RESEARCH/CAMPAIGNS** - Undertake research studies to investigate links between: climate change and disease pattern & pollution load and disease pattern - Departmental and Community awareness on prevention of diseases emerging from climate change impacts and environmental pollution - Launching a city wide "Climate Protection Campaign" addressing the specific adaptation and mitigation needs of urban systems and population in high risk zones	- Mission *Harita* Andhra Pradesh of GoAP - PMAY-NTR *Nagar* Scheme of GoAP - *Andariki Aarogyam Scheme of GoAP* - State Disaster Management Plan - State Action Plan on Climate Change - Master Plan of VUDA - Visakhapatnam Smart City Project - Green India Mission (National Afforestation Programme) - City Disaster Management Plan - City Development Plan - Heat Wave Action Plan of GoAP - District Disaster Management Plan - PM Housing for All Scheme - National Health Protection Scheme "*Ayushman Bharat*" - *Rashtriya Swasthya Bima Yojana* - National Urban Health Mission - CPHEEO Guidelines on Sewerage Management	- Ministry of Health & Family Welfare, GoI - Department of Health, GoAP - Department of Forestry, GoAP - GVMC - VUDA - VPT - SPCB - CPCB - Private Sector (CSR initiatives) - Andhra Pradesh State Water Board - District Medical Office - Industrial Area Local Authority, GoAP - Housing Department, GoAP - APSDMA - DEOC - CSOs/NGOs/ iNGOs

Sector	Children's Vulnerability	Development Deficit	Priority Actions	Policy/Programmes/ Schemes	Institutions
Education	- Cyclones, waterlogging and heat waves affect access to education and safety of children at school - The burden of diseases affect continuity (seasonal illness) - Early involvement in livelihood activities affecting continuity - Disinterest in education due to lost livelihoods of parents (especially fishermen) - A high number of school dropouts due to distressed migration and lack of identity in new places	- Inadequate number of schools in slum areas especially for higher education - No special schemes for the education of migrant children who lack any identity proof - Inadequate school infrastructure to face extreme weather events - Lack of a Standard Operating Procedure (SOP) for schools when they are to be used as Cyclone Shelters - Inadequate sanitary facilities in schools (number of toilets, water and electricity) resulting in absenteeism and lack of willingness to send children to school - No special programmes to create awareness about the importance of education among parents and children (slum, fishermen, rag pickers, daily labours, street vendors) resulting in their early involvement in parent's livelihood	**SCHOOL SAFETY & MANAGEMENT** - Developing new disaster resilient higher secondary schools in slum areas to increase access to education and discourage discontinuity due to the lack of schools in nearby localities - School Safety Plans and Disaster Evacuation Plans to be formulated and implemented at individual school level with the participation of children. - Conduct regular school mock drills - Preparation of SOP of rehabilitation centres (when schools are supposed to be used as cyclone shelters) - Retrofitting the existing school buildings to bear the increasing climate change impacts and disaster threat - Ensure adequate provision of sanitary facilities at schools - Promoting rooftop solar power generation in school buildings - Formation of School Management Committee to implement and monitor the above actions actively **EDUCATION MANAGEMENT** - Incorporating climate and disaster resilience components in the school curriculum. - Creating awareness among students about climate change and disasters through debates, competitions, songs, dramas, and eco-club formation - Orientation of school teachers on different aspects of climate change and disasters through some Refreshment/Orientation/Training Courses (Vulnerability Assessment and School Disaster Management Plan Preparation) - Awareness programmes/counselling of parents (especially for low-income groups) on the importance of education for their children. - Enhancing the quality of education in GVMC schools to discourage absenteeism (Smart Classes, Infrastructure up-gradation) - Implementation of special school programmes for migrant children	- Visakhapatnam Smart City Project - Visakhapatnam Smart School Initiative - *Sweekaram* programme of GVMC - *Sarva Shiksha Abhiyan* - *Badiki Vastha* – Free Bicycle Scheme for Girl Students, GoAP - *Bangaruthalli,* GoAP - National Program for Education of Girls at Elementary Level - City Disaster Management Plan - District Disaster Management Plan - Member of Parliament Local Area Development Scheme (MPLADS) - State Disaster Management Plan	- GVMC - Department of School Education, GoAP - Department of Health, GoAP - Department of Social Welfare (Women & Child Development) - DEOC - APSDMA - Member of Parliament, Visakhapatnam District - NGOs - Private Sector (Education and Technology) CSOs/NGOs/ iNGOs

Sector	Children's Vulnerability	Development Deficit	Priority Actions	Policy/Programmes/ Schemes	Institutions
WASH	- Water-borne diseases like Typhoid, Diarrhoea Gastroenteritis and viral fever - Skin infections (Dermatitis, Rashes) - The burden of diseases due to open defecation (Diarrhoea, Gastrointestinal Infections, Reduced Immune Capacities)	- Inadequate "Quality" (high turbidity in slums, heavy metal contamination in industrial areas, leachates pollution near dumping yard) and "Quantity" (one hour a day) of water supplied through GVMC pipelines - Inadequate storage infrastructure for supplied water - Choking and overflow of open drains in slum settlements during heavy rains - Inadequate sewerage treatment infrastructure and lack of operation and maintenance of existing infrastructure - Poor infrastructure to hold and store drinking water and construction in the catchment areas of major drinking water sources - Inadequate number of community toilets as per population requirement - Inadequate maintenance of existing community toilets (water, doors, electricity) - Inadequate WASH infrastructure in schools - Lack of proper housing in slum settlements creating an unhygienic environment for children (congested, no toilets, no play areas, unable to bear extreme weather events) - Lack of health and hygiene awareness among parents and children (poor healthcare seeking behaviour, especially for differently abled children)	**DRINKING WATER** - Localized treatment of drinking water at home and at schools - children to be oriented on this at school level - Mandatory rainwater harvesting in schools, larger homes, government buildings, commercial establishments, industrial and public spaces - Up-gradation of drinking water supply infrastructure to support good quality and quantity so that the practices of storing water and using it un-hygienically can be eliminated. - Implementing "NTR *Sujala Pathakam* Scheme" of GoAP as a long-term investment to provide safe drinking water to low-lying slum areas near the open drains **DRAINAGE/SEWERAGE** - Improving the drainage and sewerage system of low-lying areas/ slums - Linking public toilets and household toilets to an integrated underground sewerage system to avoid backflow of water during heavy rainfall - Develop adequate number of STPs and ETPs according to city's requirement and promote using recycled water for low-end use **HEALTH & HYGIENE** - Awareness among children on good hygiene practices through: School curriculum and programmes like "*Janmabhoomi-Maa Vooru*" - More frequent health check-up camps in low-income settlements and special provisions for post-disaster immunization - Sprinkling of bleaching powder and lime on the drains and roads to prevent gastroenteritis - Construction of adequate number of community toilets with the proper discharge of waste - Assessment of infrastructure gaps in public and community toilets- specifically at OD spots - Construction of hazard specific new sanitation infrastructure wherever required based on above assessment - Creation of safe play areas/parks for children	- Swachh Bharat Mission Urban - NTR *Sujala Pathakam* Scheme of GoAP - NTR Urban Housing Scheme of GoAP - *Janmabhoomi-Maa Vooru* - PMAY - Visakhapatnam Smart City Project - Master Plan of VUDA - CPHEEO guidelines on the sewerage system - City Development Plan - District Disaster Management Plan - State Disaster Management Plan - State Action Plan on Climate Change	- GVMC - VUDA - Water Resource Department, GoAP - APSDMA - DEOC - NGOs - Private Sector - CSOs/NGOs/ iNGOs

Sector	Children's Vulnerability	Development Deficit	Priority Actions	Policy/Programmes/ Schemes	Institutions
Nutrition	- Reduced access to nutritionally adequate food due to decreasing purchasing power of parents (Traditional Fishermen) - Protein energy malnutrition (marasmus and kwashiorkor) in urban slums - Increased susceptibility to infectious diseases especially gastro-intestinal infections due to reduced immune capacities - Skin diseases, diarrhoea and dysentery due to unhygienic food intake practices	- Disrupted livelihoods of fishermen due to: i. Coastal ecosystem degradation due to the breaching of coastline norms ii. Increasing marine pollution due to industries and sewerage dumping - No minimum wage security for migrant workers - Destruction of food stocks during disasters due to inadequate storage facilities - Lack of community cold storage facilities in low-income settlements	**POLICY/PROGRAMMES/SCHEMES** - Strengthening the existing nutritional schemes and the programmes run by GoAP in terms of implementation, up-gradation and monitoring of impacts - Integrating the emerging nutritional challenges including issues and implications of climate change and disasters in these schemes (specifically the State Nutrition Mission 2016-26) - Provision of huge cold storage facilities to low-income settlements (slums, fishing hamlets, peri-urban agricultural villages) to store eatables which are easily perishable in summers. - Effective and unbiased functioning & monitoring of the Public Distribution System to achieve good nutritional outcomes with quality ration distribution. **SCHOOLS & ANGANWADIS** - Promotion of nutrition gardens at schools and Anganwadi Centres - Up-gradation of the infrastructure of Anganwadi Centres keeping in mind the increasing heat stress in the city. - Generate awareness on consuming the available food hygienically. Parents need to be educated on these issues, specifically, the mother who plays an important role in child's nutritional status ("Nutrition and Health Days" under ICDS). - Regular Health and nutritional status check-up among the urban slum and fishermen communities to know their nutritional status and emerging deficiencies due to climate change and environmental pollution. - Bringing in new technological interventions to track the data and reports from Anganwadi Centres and ward level data on child and maternal nutritional status. - Conducting technology-oriented training programmes for social workers, Anganwadi staff, ICDS staff and the Department of Women and Child Development with more audio-visual components (State Nutrition Mission). **ECOSYSTEM CONSERVATION** - Conserving the degrading ecological resources in and around the city through community based programmes - Promoting climate and disaster resilient agricultural practices in the peri-urban areas	- "*Maarpu*" Programme of GoAP - State Nutrition Mission 2016-2026 - National Nutrition Mission - Supplementary Nutrition Programme (ICDS) - Mid Day Meal Scheme Master Plan of VUDA - National Food Security Mission - District Disaster Management Plan - State Disaster Management Plan **State Government Schemes:** *1. Anna Amrutha Hastham* *2. Balamrutham* 3. Special Care and Supervised Feeding	- GVMC - VUDA - APSDMA - DEOC - *Anganwadi* Centres - Ministry of Women and Child Development, GoI - Department of Agriculture, GoAP - CSOs/NGOs/ iNGOs

Sector	Children's Vulnerability	Development Deficit	Priority Actions	Policy/Programmes/ Schemes	Institutions
Child Protection	- Induced Child labour (rag-pickers, fishermen, street vendors, small shopkeepers) - Substance abuse (acquisition of intoxicants) - Occupational hazard (fishing, coast, harbour) - Stress among children (Disrupted livelihoods of parents and early involvement in labour)	- Lack of alternate sources of livelihood - Lack of Open/Safe Play Areas - Lack of education and awareness among parents about child safety issues	**POLICY/PROGRAMMES/PLANS** - Livelihood diversification programmes for fishermen and rag picker communities e.g. their engagement in the urban plantation, forest development, horticultural activities and eco-tourism - Develop resource centre to ensure basic education and provide skill-based training - Developing and implementing "Child Protection Policy" at School level i.e. in the school processes and curriculum. (Behavioural change, more teacher-student interaction, enhanced quality of education and fewer drop-outs) - Occupational safety and health (OSH) assessments and improvement actions for fishermen and rag-picker communities - Monitoring of children and youth in the migrating and floating population - Promotion of eco-tourism and water sports tourism by the government which can generate new jobs and extra income for the locales (specifically for local street vendors, shopkeepers and daily wage workers) - Ensure safety from home to school and back –Make a "Child-Friendly Roads and School Transportation Plan" to ensure safety and unhindered access to Schools and Anganwadis **AWARENESS/TRAININGS** - Awareness among parents and children on issues of self-safety and protection during disasters - Psychosocial trauma management trainings for children at school level by trained counsellors **ENFORCEMENT** - Strict enforcement of laws relating to child safety and protection - Preventing child labour through multi-stakeholder approach involving government, NGOs, the private sector, communities, employers and workers (poverty-focused programmes)	- Integrated Child Protection Scheme - National Skill Development Mission - National Plan of Action for Children - National Child Labour Project - District Disaster Management Plan - State Disaster Management Plan	- Ministry of Women and Child Development, GoI - District Child Protection Unit - State Commission for Protection of Child Rights - Labour Department - Police Department - Traffic Police Department - GVMC - VUDA - Forest Department, GoAP - Tourism Department, GoAP - APSDMA - DEOC - Childline - CSOs/NGOs/ iNGOs - Private Sector

11. Best Practices

The city administration – GVMC is proactive in taking new initiatives and adopt best practices, which may improve the 'Quality of Life' of its citizens. Some of the best practices that are being followed to control the ill effects of the climate change in the city are as follows:

Table 5: Best Practices in the City

Sector	Best practices
Energy	• Usage of LED lights to reduce the consumption of conventional electricity. • Promoting solar energy through power generation and utilization.
Sanitation	• Extensive implementation of the "Swachh Vidyalaya" programme to promote good hygiene practices at school level. • Swachh Bharat Mission at the city level.
Health	• Extensive implementation of the "*Harita* Andhra Pradesh" programme for the plantation activities across the city by the government of Andhra Pradesh. • Involvement of the major industries in the city beautification activities like landscape management, reforestation, plantation along the roads, polluted areas as part of their CSR activities as per CPCB norms.
Solid waste management	• Bio-mining from the solid waste dumped at Kapuluppada landfill site on a Zero-cost basis. • Remediation of the existing sites to reclaim the land and reduce the air pollution caused by the burning of the waste. • Public participation in SWM activities.
Education	• Strict enforcement and implementation of free and compulsory education in the fringe areas • Awareness programs in schools.

References

- Andhra Pradesh State Disaster Management Plan, 2017. Andhra Pradesh State Disaster Management Authority, Government of Andhra Pradesh. Available at < http://www.apsdma.ap.gov.in/common_mns/DM_plans/SDMA_pdf/Andhra%20Pradesh%20State%20Disaster%20Management%20Plan-Volume%20I.pdf>
- Andhra Pradesh State Pollution Control Board, http://appcb.ap.nic.in/
- Bhat, et al., 2013. Urbanisation, Poverty, Climate Change – A Synthesis Report, India, Volume 1, TARU Leading Edge Pvt. Ltd.
- Capacity building for urban development, Rapid Baseline Assessment, Visakhapatnam City, Draft Report, Ministry of Urban Development, Government of India, Crisil Infrastructure Advisory, October 2013.
- City Disaster Management Plan, Greater Visakhapatnam Municipal Corporation (GVMC), 2016. Andhra University College of Engineering. Available at < https://gvmc.gov.in/gvmc/images/cdmp2.pdf>
- Detailed project report on municipal solid waste management for Visakhapatnam, Andhra Pradesh Urban Finance & Infrastructure Development Corporation, August 2016.
- District Disaster Management Plan of Visakhapatnam District, Volume II, n.d. District Administration, Visakhapatnam, UNDP India. Available at < http://www.apsdma.ap.gov.in/common_mns/DM_plans/DDMP_pdf/Vishakhapatnam/Visakhapatnam-DDMP-Volume%20II%20Disaster%20Prevention%20and%20Prepardness%20Plan.pdf>
- Ellis, P. and Roberts, M., 2016. Leveraging Urbanization in South Asia: Managing Spatial Transformations for Prosperity and Livability. World Bank Group.
- Greater Visakhapatnam Municipal Corporation, Official Website, www.gvmc.gov.in
- Greater Visakhapatnam Municipality Corporation Visakhapatnam City: Development Strategy and Slum Upgrading Action Plan.
- Handbook of Statistics, Visakhapatnam District, 2013, Chief Planning Officer.
- Heat Wave Action Plan of Andhra Pradesh 2016. Revenue (Disaster Management) Department, Government of Andhra Pradesh. Available at < http://www.imdhyderabad.gov.in/apsite/andhra.pdf>
- National Family Health Survey-4, 2015-16, District Fact Sheet, Visakhapatnam, Andhra Pradesh. Available at < http://rchiips.org/NFHS/FCTS/AP/AP_FactSheet_544_Visakhapatnam.pdf>
- Rajamani, N.S., 2014. An Integrated Study on The Status of Environmental Quality and Vulnerability of Visakhapatnam - A Coastal City on East Coast of India, An unpublished PhD. Thesis, Department of Environmental Science, Andhra University, Visakhapatnam.
- Revised Master Plan for Visakhapatnam Metropolitan Region- 2021. Visakhapatnam Urban Development Authority, April 2007.
- Sarojini, Y et al, 2013. An assessment of drinking water quality supplied by the Greater Visakhapatnam Municipal Corporation, India. *International Journal of Environmental Sciences*, Volume 3, No 5, 2013. ISSN 0976-4402.
- State Action Plan on Climate Change for Andhra Pradesh, 2012. Ministry of Environment, Forest and Climate Change, Government of India. Available at < http://www.moef.nic.in/sites/default/files/sapcc/Andhra-pradesh.pdf>
- Smart City Profile, Visakhapatnam. Available at http://smartcities.gov.in/upload/uploadfiles/files/AndraPradesh_Vishakhapatnam.pdf

- TERI, 2014. Planning climate resilient coastal cities: Learnings from Panaji and Visakhapatnam, India. Available at < http://www.teriin.org/eventdocs/files/Working-Paper-climate-resilient.pdf>
- United Nations, Department of Economic and Social Affairs, Population Division, 2014. World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352). Available at < https://esa.un.org/unpd/wup/Publications/Files/WUP2014-Highlights.pdf>
- United Nations Development Program, Hazard Risk and Vulnerability Analysis (HRVA), City of Visakhapatnam, Andhra Pradesh, Draft Final Report, July 2014.
- Visakhapatnam City Development Plan Strategy and Slum Upgrading Action Plan, n.d. Greater Visakhapatnam Municipal Corporation. Available at < http://documents.worldbank.org/curated/en/195691468042841007/pdf/732240WP0P09510reater0Visakhapatnam.pdf>
- Visakhapatnam urban development authority website www.VUDA.gvt.in

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