



Jorhat : Climate-Ready City

Strategy for Building Resilience to Urban Climate Change



To Seek to Strive and not to Yield



Assam Academic Centre
অসম শৈক্ষিক কেন্দ্ৰ



(ACCCRN) With support from the Gorakhpur Environment Action Group on Sept. 4, 2014 at Assam Agriculture University

9. PCCb (2014): Climate Change 2014: Impacts, Adaptation, and Vulnerability, Summary for Policymakers IPCC WGII AR5, WGII AR5
10. Goswami Dipti "Assessment of surface water quality in Jorhat, Assam, India with respect to inorganic cations and anions" workshop paper presented in Expert Consultation workshop organized under the project of Strategic Planning for Urban Climate Change Resilience of Jorhat, Assam, organized by Aaranyak, Guwahati, SSEAEP, Nagaon, PBET and ACC, Jorhat ; Under ACCCRN with support from the GEAG on Sept, 4, 2014 at Assam Agriculture University.



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Purva Bharati Educational Trust
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Aaranyak

Abbreviations

AAC	Assam Academic Centre
ACCCRN	Asian Cities Climate Change Resilience Network
ASAPCC	Assam State Action Plan on Climate Change
CDMC	City Disaster Management Cell
CMIP5	Coupled Model Inter comparison Project Phase 5
CRS	City Resilience Strategy
DDMA	District Disaster Management Authority
DIC	District Industry Centre
FGD	Focus Group Discussion
GEAG	Gorakhpur Environmental Action Group
GIS	Geographic Information System
IPCC	Intergovernmental Panel on Climate Change
IMD	India Meteorological Department
IWP	India Water Portal
MSW	Municipal Solid Waste
NABARD	National Bank for Agriculture and Rural Development
NEDFI	North Eastern Development Finance Corporation Ltd
NGO	Non Government Organisation
PBET	Purva Bharati Educational Trust
RGVN	RGVN (NE) Microfinance Limited
SHG	Self Help Group
SSEAEP	Society for Socio Economic Awareness and Environment Protection
UCCAC	Urban Climate Change Advisory Committee
UCCR	Urban Climate Change Resilience
WGIIAR5	Working Group II contribution to the IPCC Fifth Assessment Report
WHO	World Health Organisation

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Executive Summary

The fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC), (WGII AR5) released in October, 2013, observes that “Much of key and emerging global climate risks are concentrated in urban areas. Rapid urbanization and growth of large cities in low- and middle-income countries have been accompanied by the rapid growth of highly vulnerable urban communities living in informal settlements many of which are on land at high risk from extreme weather”. Compounded with rapid population growth, unplanned development of cities is gradually worsening the scenario. City's infrastructure are not prepared to carry the pressure of extreme climate events such as uneven but high intensity rainfall often cause water logging in and around city. It has various environmental and health hazards for the community residing in urban areas. The Rockefeller Foundation supported Asian Cities Climate Change Resilience Network (ACCCRN) is an association of experts, civil society organization and urban practitioners involved in building urban resilience through generating knowledge, accessing resources and influencing policies. In India, Gorakhpur Environmental Action Group is one of the partners under ACCCRN, facilitating Urban Climate Change Resilience (UCCR) Intervention through local lead agencies. In Jorhat, the intervention is led by Aaranyak with the support of Purva Bharati Educational Trust, Society for Socioeconomic Awareness, Environment Protection and Assam Academic Centre and Municipal Board of Jorhat. Intervention is carried out on two phases (i) Vulnerability assessment in the context of climate change &

(ii) Identification of resilient options and action plan development.

Section A of the document describes climate change and its impact on urban areas as mentioned above whereas section B has brief introduction about Jorhat city. Jorhat is a rapidly growing city of upper Assam where population growth between 2001-11 was nearly 45% imposing immense pressure on urban landscape and infrastructure. With outgrowth population, city's population is 126736 as per Census 2011.

Section C thoroughly describes the climate change trend of Jorhat city and potential climate changes. It is projected that there will be increase in the frequency and magnitude of warm days (heat index above 40°C) and warm nights (heat index above 30°C). Similarly an increase of 0.9%-1.7% will be observed in annual mean temperature. Annual rainfall is likely to increase by 3%-7% whereas monsoon rainfall may increase by 5%-10%. Section D has description on participatory methodology adopted in the first phase of the study. Scoring method was used to get the issues and ward-wise vulnerability. Section E has thorough description on city vulnerability. Key identified issues can be divided into groups: (i) Water related problem and (ii) Basic amenities related problems. Water logging, drainage and deteriorating open water bodies are key issues under water related problem. 7 wards are prone to water logging, all 19 wards have drainage as key issue where as 12 wards are facing open space deterioration problem. Under amenities related problem, all 19 wards are facing problem

of safe drinking water and solid waste management where as 18 wards are facing traffic and 16 wards have been facing open space problem. Section F is demystifying the identified resilient options and the required process of intervention at departmental level. Review of current project policies, analysing potential threat, identifying areas and activities such as drainage improvement and development, eco-system restoration, water testing and treatment, rejuvenation of water bodies are some of the key suggested interventions. Section G reveals the entire implementation plan in five phases- Break through phase, reinforcing phase, mounting phase, final conditioning phase & review, reframing and follow up stage.

UCCR intervention in Jorhat and other cities is first of its kind in the country providing

development practitioners, government functionaries, local self governments and urban experts an opportunity to generate and share the information for urban climate change resilience building. This CRS document of Jorhat city does not only reveal the detailed snapshots of current and future vulnerability of Jorhat city in context of climate change but it also provides sector wise required actions to counter identified issues and to make the city resilient to climate impacts. Our intervention has clearly identified the required infrastructural as well as soft actions with spatial coverage and timeline for Jorhat city which can be further used by the local government and policy makers in developing inclusive city development plan in context of climate variabilities.

Section : A

Overview : Climate Change and Impact on Cities

Climate change is a major environmental challenge of our time. It has been found that climate change has impacted all types of landscapes, natural environs as well as human societies all over the world in different ways. In case of urban centres, climate change is a very important factor that affects every aspect of the human environment because urban areas have high population density, higher concentration of infrastructure than rural areas and therefore, small-scale impacts get scaled up to large-scale changes and serious consequences.

In developing countries like India, most of the cities are confronting the challenge of resource scarcity, ageing and/ or inadequate infrastructure, and poor quality of critical basic services. The situation is further aggravated by the fact that installing new infrastructure has become nearly impossible due to very high densities and lack of space. Major changes in density and decongestion of core urban areas to improve services are politically unpopular and administratively challenging. Only in rare cases are Urban Local Bodies able to decongest and improve the services in core areas. This problem of development deficit is aggravated further by additional stress from climate change on urban infrastructure and critical basic services (including ecosystem services) consequently producing a large-scale multiplier effect on the rapidly burgeoning urban population. Rapid urbanization compounded with unplanned infrastructural development is topping up the vulnerability to climate change and hazards. Jorhat, one of the largest cities of Assam is a fast

growing city and therefore a strategy needs to be developed to deal with the future climate and hazards vulnerability.

The fifth assessment report of the Intergovernmental Panel on Climate Change(IPCC), (WGII AR5) released in October-2013, observes that “much of the key and emerging global climate risks are concentrated in urban areas. Rapid urbanization and rapid growth of large cities in low- and middle-income countries have been accompanied by the rapid growth of highly vulnerable urban communities living in informal settlements, many of which are on land at high risk from extreme weather”. Climate change will have profound impacts on a broad spectrum of infrastructure systems (water and energy supply, sanitation and drainage, transport and telecommunication), services (including health care and emergency services), the built environment and ecosystem services. These interact with other social, economic and environmental stressors exacerbating and compounding risks to individual and household well-being. Cities and city regions are sufficiently dense and of a spatial scale that they influence their local microclimate. Climate change will interact with these conditions in a variety of ways, some of which will exacerbate the level of climate risk (IPCC, 2013a) so there is significant risk associated with urban area caused by climate change. At the same time, the concentration of human capital, infrastructure, industry and culture in towns and cities, have the potential to make cities a conduit for achieving social and economic good. But it is possible to

pursue the goal of environmentally sustainable development, mitigation of climate change by adopting innovative strategies for reducing greenhouse gas emissions, as well as strengthening people's adaptive capacities through detailed planning of managing urban

development. It is pertinent here to mention that this report has used the definitions provided by the Fifth Assessment Report (AR 5) of the IPCC for key concepts like vulnerability, adaptation and resilience as mentioned below.

Vulnerability : Vulnerability means the propensity or predisposition to be adversely affected and encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Risk : Risk is the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard.

Adaptation : Adaptation is the process of adjustment to actual or expected climate and its effects. Inhuman systems, adaptation seeks to moderate or avoid harm or exploit beneficial Adaptation: Adaptation is the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial.

Resilience : Resilience is the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (IPCC, 2014b).

Urban Climate Change Resilience (UCCR) Initiative under ACCCRN

The Asian Cities Climate Change Resilience Network (ACCCRN) initiative, pioneered by the Rockefeller Foundation, USA in 2008, worked at the intersection of climate change, urban systems and vulnerability to consider both

direct and indirect impacts of climate change in urban areas. ACCCRN worked in 10 cities in 4 Asian countries (India, Indonesia, Thailand and Vietnam) to develop and demonstrate effective processes and practices for addressing urban climate vulnerabilities using multi-stakeholder planning as well as implementing targeted intervention projects. Gorakhpur Environmental Action Group was assigned to lead the

intervention with credible local organisations in the state and city. GEAG started the intervention from Gorakhpur and scaled-up in three cities Jorhat (Assam), Saharsa (Bihar) and Bashirhat (West Bengal). In Jorhat, intervention was implemented in collaboration with four local organisations viz. Aaranyak, Purva Bharati Educational Trust, Society for Socio-economic Awareness and Environment Protection and Assam Academic Centre and Municipal Board of Jorhat to enhance the adaptive capacity of city residents and make city's infrastructure and systems resilient towards climate change impact.

The city of Jorhat is one of the upcoming cities of Assam and hub of commercial activities in upper Assam. Jorhat city has a history of hydrological hazards like heavy rainfall , waterlogging and has potential to be impacted by climate induced multi hazards. This upcoming city has been the destination of migrants from nearby areas and compounded with growing population of the city has put immense pressure on Municipality and departments to review current infrastructures and services and make necessary changes in strategy. Urban planning in such upcoming city should be in such a way that covers the climate change aspect in developmental planning and implementation.

In this perspective, the present endeavour to develop a "Strategic Planning for Urban Climate Change Resilience (UCCR)" for the Jorhat city is a pioneering attempt in Assam to assess urban vulnerability due to environmental degradation and climatic change and formulate a concrete strategy for reducing concerned risk. The development of this City Resilience Strategy (CRS) is based on workshops and engagement activities that leveraged expertise, local knowledge of city, city managers and key community stakeholders. In total, over 100 people have been engaged in the development of the CRS to ensure that it aligns with existing organizational priorities and can be integrated within departmental functions.

Supported by Rockefeller Foundation and led by Mercy Corps, Asian Cities Climate Change Resilience Network (ACCCRN) is a network of practitioners and institutions engaged in building urban climate resilience through knowledge creation, accessing resources and influencing policies. ACCCRN is currently engaged in six counties including India.

Objective

The over-arching objective of the CRS is to build on the city's existing strengths and align current resources to increase the resilience of the Municipality from strategic perspective so that they are able to respond and recover from the impacts of climate change. The sub objectives of the study are as follows:

- To examine the nature of climate variability and climate change based on available information in Jorhat and its neighbourhood
- To study the impact of weather & climatic anomalies on the physical and cultural landscape of the area
- To identify vulnerable area and sectors within the city landscape
- To prepare a strategic Climate Change Adaptation Plan for the area with focus on strengthening UCCR.

This CRS presents the resilience actions of Jorhat city based on the current climatic trends, future shocks and scenario as well as present vulnerability at ward level. This document may help Municipality and urban planners to set their priority areas of developmental work and provide directions for vulnerability reduction activities.

Section : B

The Jorhat City

Jorhat, a historical town situated in upper Assam is the head quarter of Jorhat district of Assam, with 19 Municipal wards. It is located at the intersection of 26.75° N and 94.22° E , with an average elevation of 116 metres from mean sea level. It covers an area of 9.67sq.km with a population of about 71782 (Census 2011). With the outgrowth population data, population of city is 126736. In the context of its importance as urban centre, urban area also sprawls over along with increasing pressure of population. There was a sprawling area of 4.25 sq. km from 1961 to 2001; along with population of 24953 to 67588, household 4102 to 14508 in the same period. The sprawling rate of urban area increased about 30% between 1961-71; 7.81 %

between 1971 -91 and 33.30 % between 1991-01, which vividly indicates that after 1961-71 period, 1991 onwards importance of Jorhat increases and urban activities also increased with sprawling of urban areas (Fig1). As a result of which, for better management of Municipal activities number of wards were increased from 6 in 1961 to 19 in 2011 (Fig 2). It is noteworthy that Jorhat had experienced 44.92% of population growth between the years 2001 to 2011. As a result, the population pressure on urban landscape and infrastructure has increased, e.g. population density of Jorhat was 5041.01 in 1961 which increased up to 10646.30 in 2011.

Fig 2 : Trend of population growth in the Municipal area (based on information of census documents from 1961-2011)

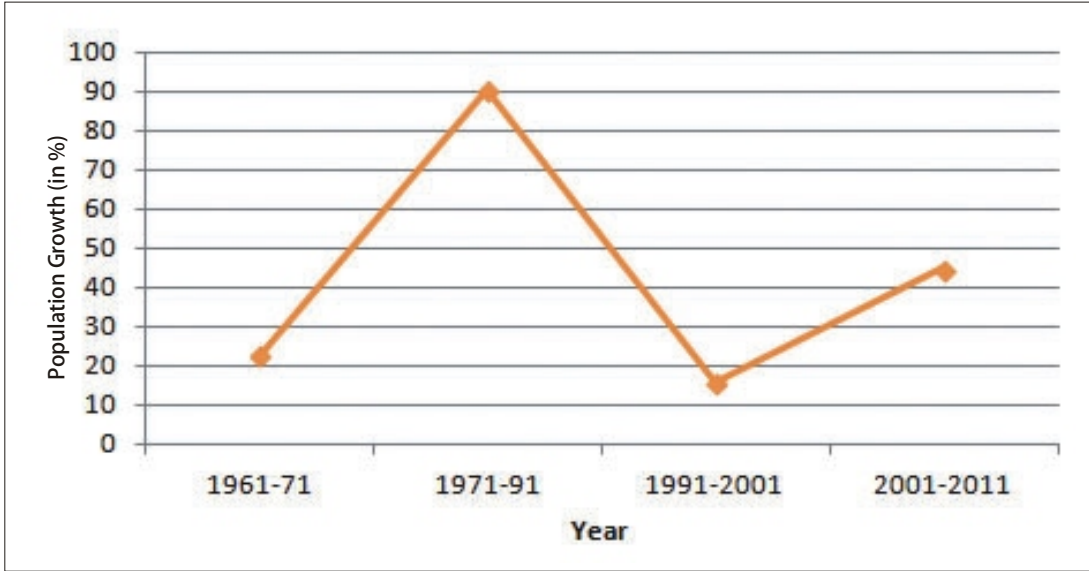
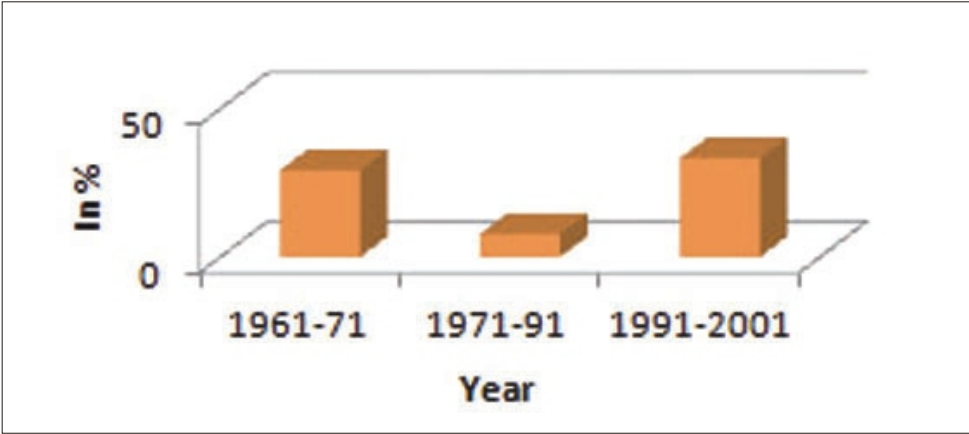


Fig 1 : Trend of sprawling of Municipal area 1961-2001 (based on census data)

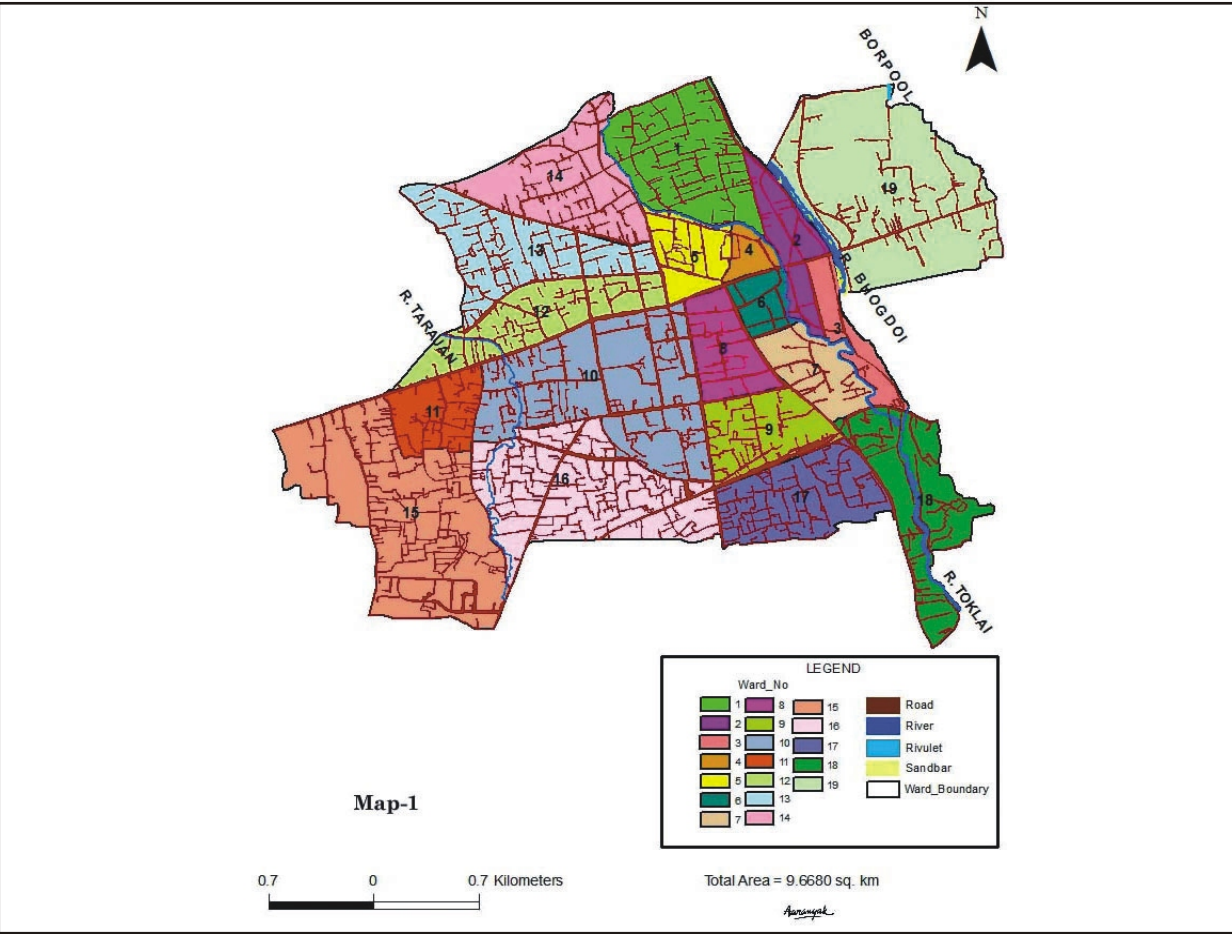


Section : C

Climate Change Scenario in Jorhat

Jorhat experiences a humid subtropical climate characterized by high rainfall and high humidity which is mainly influenced by the south west monsoon (Fig 3). It has a typical monsoon pattern of rainfall distribution with peak during monsoon and scanty in winter. Monsoon contributes around 63% of total annual rainfall and highest rainfall occurs during July. The average minimum temperature is about 10.1°C in January and maximum is about 32.2°C in August with long term average rainfall 2119.5mm. It is noteworthy that except March, May and August all other months exhibited decreasing rainfall trends during recent 3-decades, although trends of monthly rainfall and number of rainy days are not statistically significant.

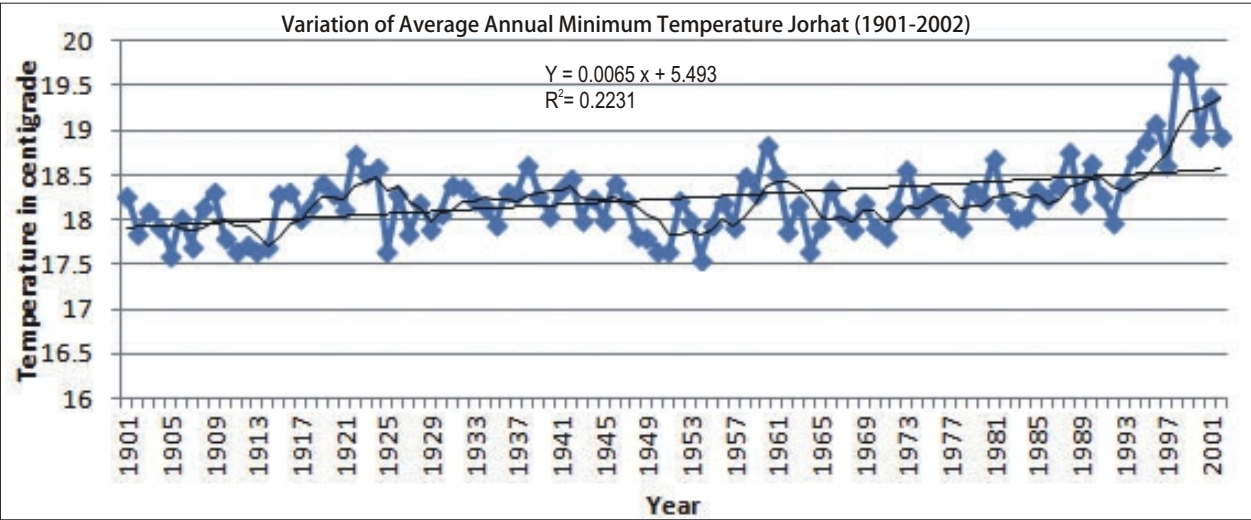
Fig 3 : Map of Jorhat Municipality Area



The Assam State Action Plan on climate change (ASAPCC), 2013 also explicitly mentioned that the minimum temperature of the city is showing an increasing trend. The minimum temperature on an average has risen by 1.40°C over last 90 years (Fig 4). The situation in maximum temperature is also no better. Long term weather data indicated that maximum temperature is also increasing in Jorhat. Not only that, the number of days with maximum temperature more than 35°C has also increased.

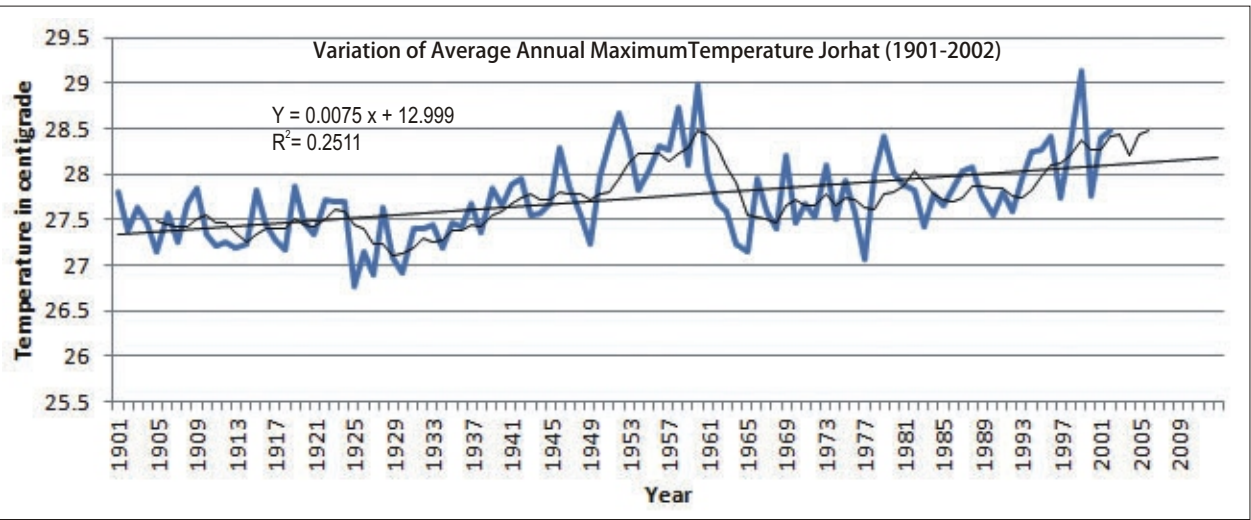
It has now become a bare truth that climate is changing and the impacts of climate change are already being felt in cities across Indo-Gangetic-Brahmaputra plain. Local experiences of climate change impacts show that these can incur high costs to the community as a whole. Early adaptation action to reduce climate risk and building resilience is necessary.

Fig 4 : Graphs showing trend of annaul minimum temperature in Jorhat City from 1901-2002



Source : IMD and IWP

Fig 5 : Graphs showing trend of annaul maximum temperature in Jorhat City from 1901-2002



Source : IMD and IWP

Climate Change Impacts in Jorhat

The ASAPCC indicates that potential climate change will impact the city of Jorhat. It will affect all city administration departments and

service delivery. The CMIP5 downscaled data for Jorhat indicates the following projected change in climate in coming three decades :

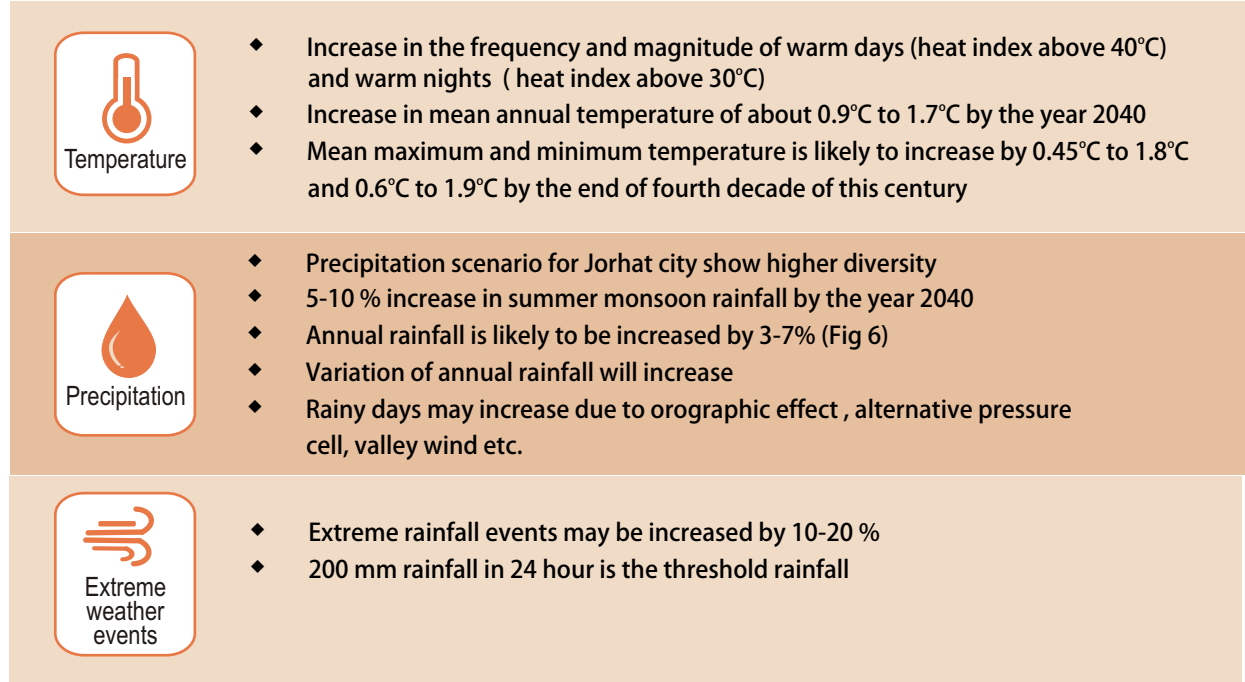
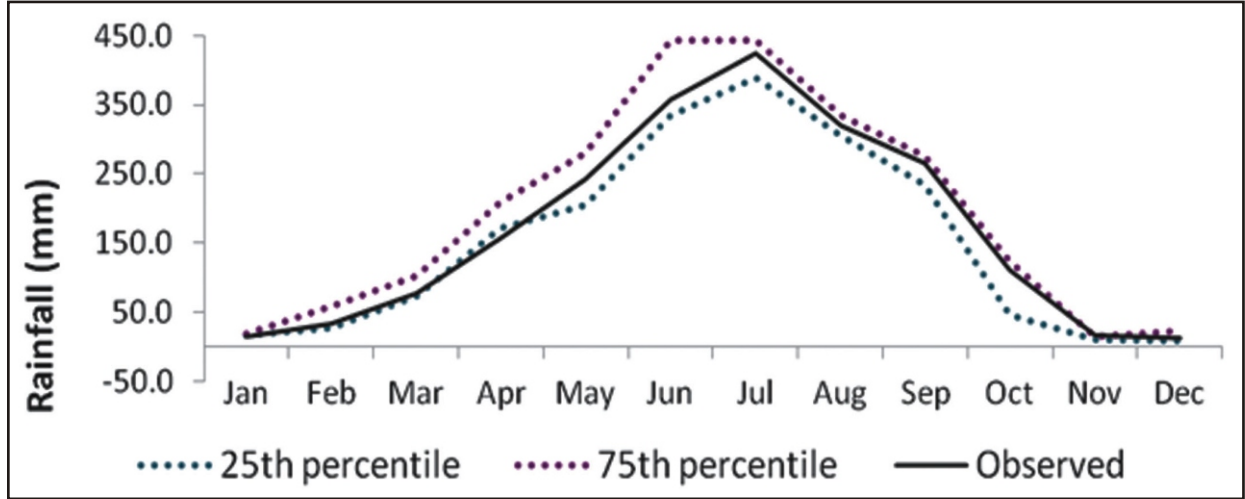


Fig 6 : Jorhat Projected Rainfall 2040



Graphical representation above clearly shows that 5-10% increase will be observed in summer

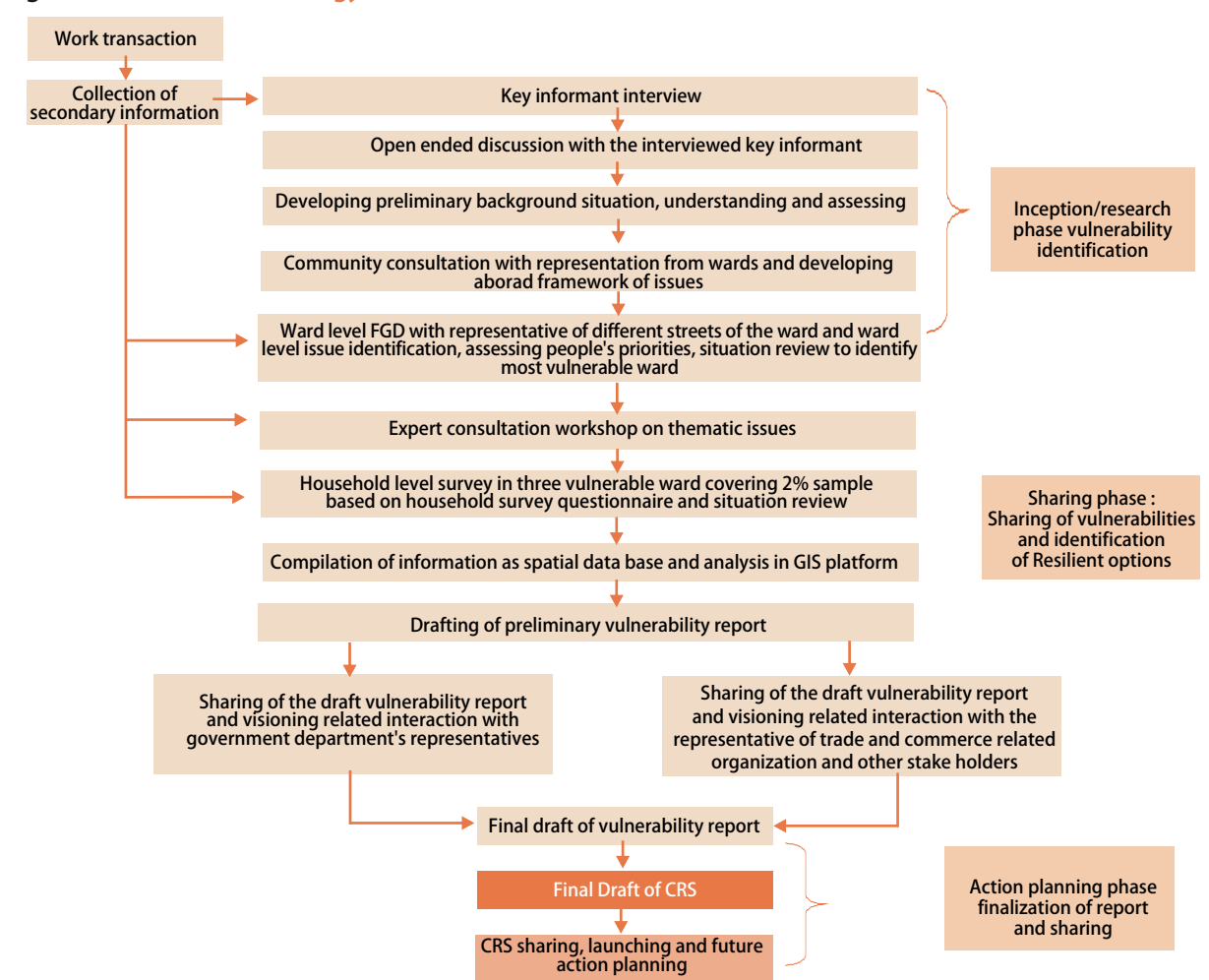
rainfall and 3-7% increase will be observed in annual rainfall by the year 2040.

Section : D Tools and Methodology

The CRS was developed for the Municipal Board and District Administration of Jorhat as a support document for planning and implementation of developmental programmes and schemes. The information presented in the strategy has been the outcome of work of two and a half years. It is intended to be a living document and will continue to be revised and updated as climate change science and adaptation practice evolves. As the first CRS for the Jorhat city many of the proposed actions focus on increasing

understanding of challenges, identifying potential gaps, and integrating climate change into current planning, design, and emergency management practices to build on existing strengths and incorporate resiliency into everyday operations as well as infrastructure investments. The approach to CRS adopted to frame out the strategy are in three phases- Inception/ research phase, Sharing phase and Action planning phase (Fig 7) :

Fig 7 : Tools and Methodology



Section : E

City Vulnerability Assessment

Alike other secondary cities, the city of Jorhat is confronting with water logging, drainage, lack of potable drinking water and sanitation due to poor infrastructural development. The increasing urbanization coupled with climatic variability has added new dimension of vulnerabilities and risks to the people, especially those who are living in low lying areas and slums. The vulnerability assessment of Jorhat reveals that there are two major areas which are responsible for creation of vulnerable situation in the city, viz. (i) water related problems and (ii) problems of amenities and services. Climatic

factors particularly high rainfall in short duration, is responsible for water logging in the town. This water logging situation is linked with degradation of natural water ways, natural water storage, congestion in drains and land use interruption. Encroachment of natural water bodies, disposal of solid waste and sewage to water bodies are the important causes of degradation of natural water bodies.

On the other hand insufficient drainage, congestion of existing drains by solid waste and land use interruption are associated issues that

contribute to water logging. The water logging situation jeopardises normal life in the city by affecting housing and settlement, transportation, communication, sanitation and water supply systems. Therefore, all these are the critical issues which need to be addressed first to develop a resilience mechanism for the Municipal area.



Fig 8 : The Risk Framework

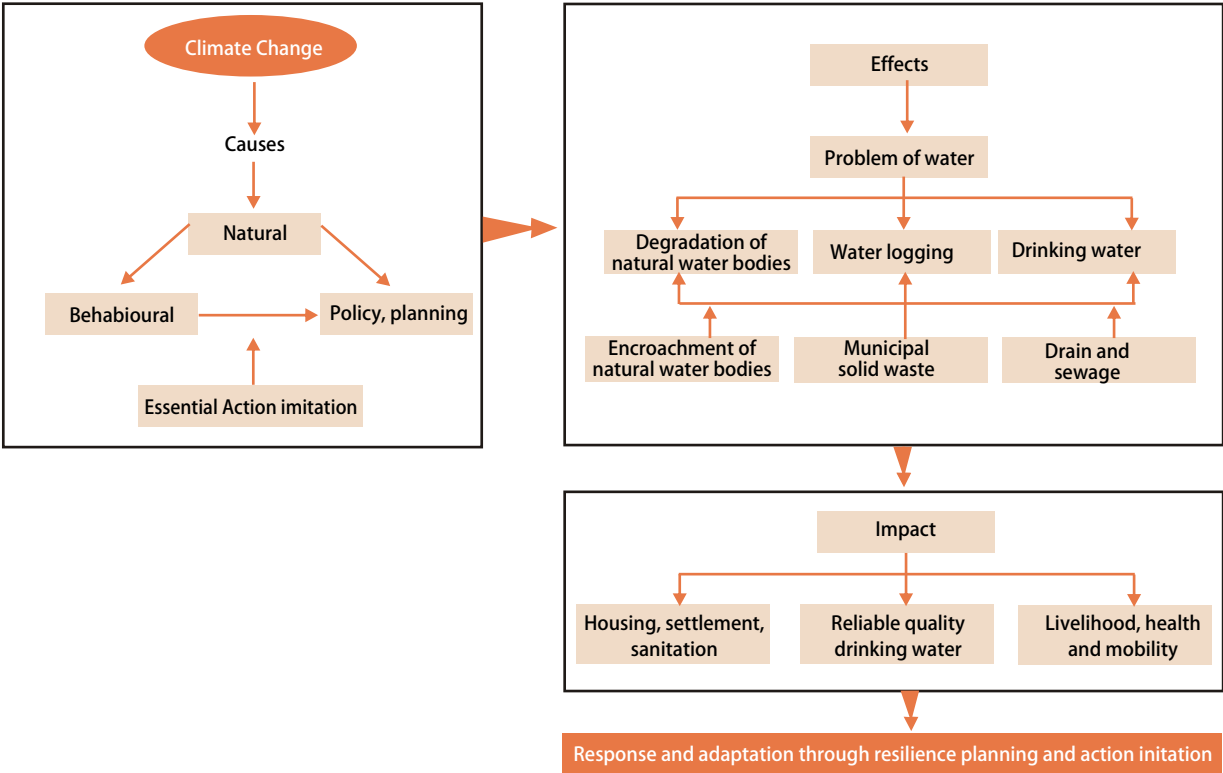
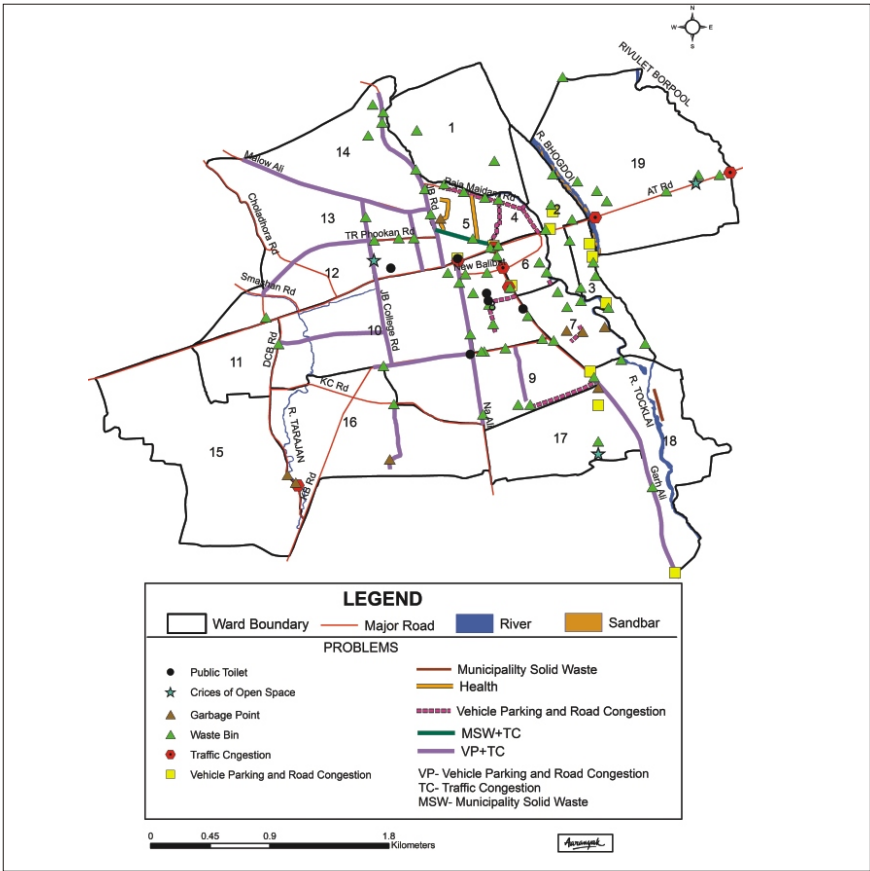


Table 1 : The risk and its spatial pattern of water related problems : (i) Water related problem

Water logging (7 wards)	Drainage problem (19 wards)	Deteriorating natural water bodies (12 wards)
<ul style="list-style-type: none">♦ Out of 19, 7 wards are severely prone- (1,6,8,11,13,16,17) (Fig 9)♦ Mainly it is seasonal mostly in rainy days of monsoon periods, but few pockets have perennial problem;♦ Water logging usually is associated with rain, when excessive water is unable to drain out from the area;♦ Time duration and month of occurrences of water logging varies from space to space within wards, from ward to ward level in the city and even from street to street over the urban area;♦ Water logging on road is common. There are areas where residential pockets including homestead areas and houses are also inundated.	<ul style="list-style-type: none">♦ All 19 wards are severely prone♦ Either absence of drain in the area or exiting drains are not properly functioning;♦ Many of the reason of improper drainage are blockage in the drain, improper gradient, breaks over the drain, encroachment by neighbouring land use, outlet are not connected to major outflow conduit;♦ Lack of cleaning of drain on regular basis	<ul style="list-style-type: none">♦ 12 wards are prone (Ward no 2, 3, 4, 5, 7,9,10, 12, 14, 15, 18, 19)♦ Mainly covers rivers and streams (viz. Toklai, Tarajan, Mohuya Jan, Bhogdoi) and ponds and tanks.♦ Absence of management practices for weeds control, cleaning of water;♦ Disposal of liquid and solid waste;♦ Encroachment on water bodies;♦ Disruption of flow of natural channels due to land use change

Source : Jorhat vulnerability report

Fig 9 : Map showing water related problem points in Jorhat Municipal area through GIS map



Basic amenities related problems : Basic amenities related problems cover drinking water, Municipal Solid Waste (MSW) related

problem, Traffic & Public Toilets related problems. Table below showing the problem with extent, time and causes :

Table 2 : (ii) Basic amenities related problems

Drinking water (19 wards)	MSW (19 wards)	Traffic (18 wards)	Public Toilets (16 wards)
<ul style="list-style-type: none">♦ All wards are affected♦ Irregular supply of tap water (variations are there),♦ Variation of water quality, like in certain periods turbidity level is high, presence of odour♦ Leakage and break in the supply pipeline including homestead areas and houses are also inundated.	<ul style="list-style-type: none">♦ All wards are affected♦ Variation in availability of waste bin in different locations, many un-served areas are there,♦ Irregularity of collection of waste from waste bins, street side, public places,♦ Faulty disposal practices by individual waste generation units , like household, commercial establishment, etc.	<ul style="list-style-type: none">♦ All wards are prone except ward no 16♦ Lack of traffic control and management,♦ Absence of parking space leading to road congestion by road side parked vehicle♦ Absence of control over speed limit	<ul style="list-style-type: none">♦ All wards are prone except ward no 14,15,16♦ Either inadequate in numbers or absent in most important public activity places,♦ Where it is available not maintained properly, provision of separate ladies toilet is not there

Source : Jorhat vulnerability report, 2013



Fig 10 : Map showing availability of amenities and services in Jorhat city

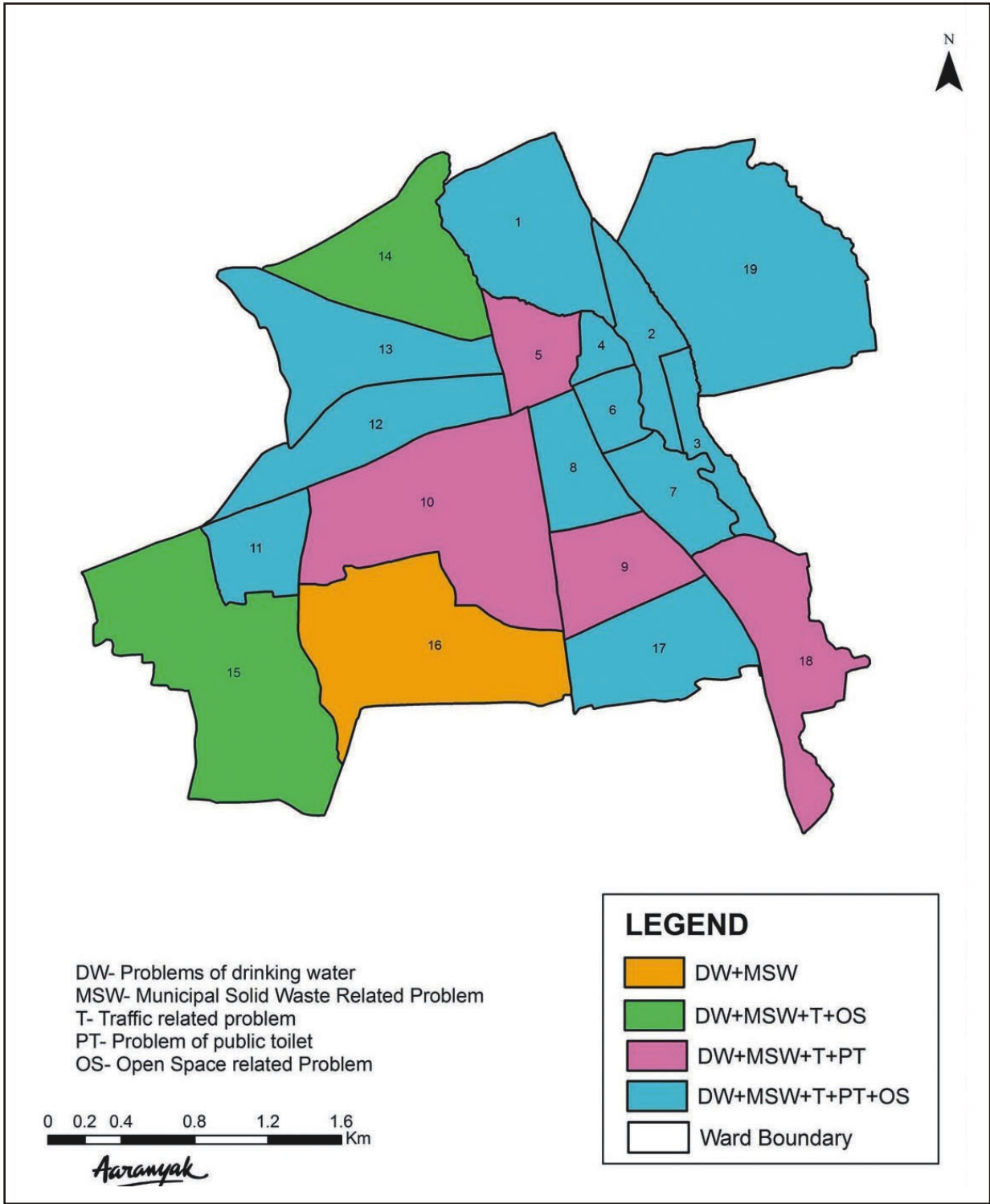
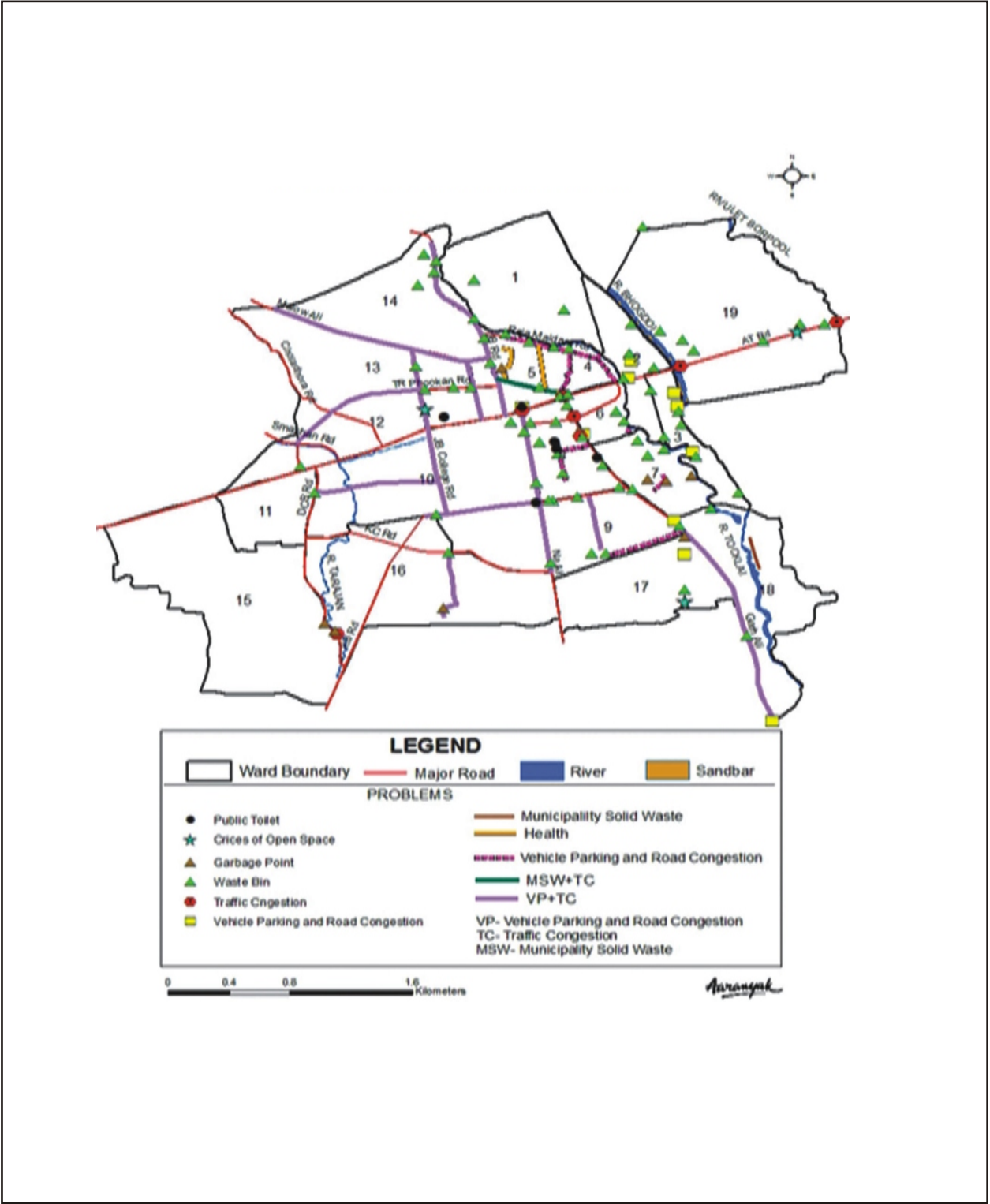





Fig 11 : Map showing the problem points related to amenities and its services



Future Risks and Vulnerabilities

The vulnerability assessment report of Jorhat,2013 clearly manifested that the climate change impacts have the potential to affect the

following sectors and exacerbate the vulnerability of the city.

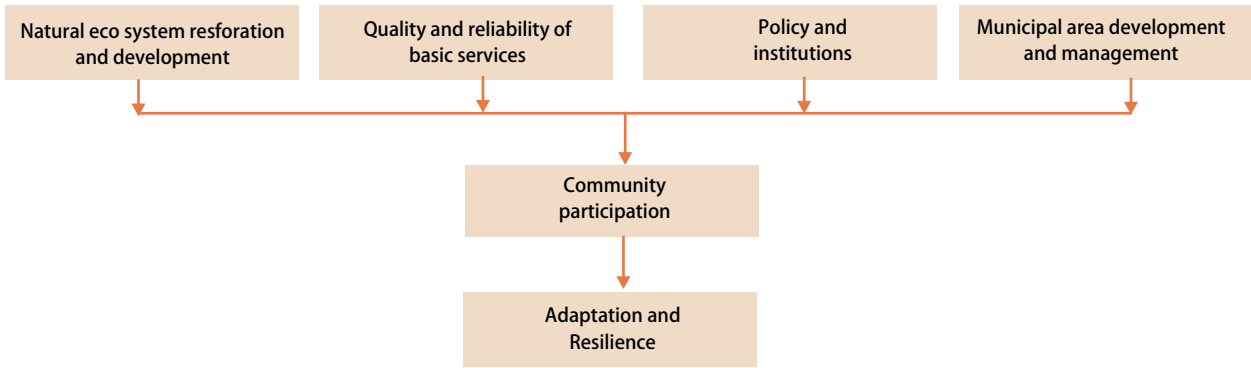
 <p>Environment and natural ecosystem</p>	<ul style="list-style-type: none"> ◆ Greater impact of storm water on rivers and water bodies during heavy rain events (which may increase flooding potential and inundation potential of rivers and water bodies) ◆ Increase in water and vector borne diseases ◆ Decrease in ecosystem services
 <p>Livelihood</p>	<ul style="list-style-type: none"> ◆ Change in the natural environment will affect means of livelihood of rural area, especially will have impact on agricultural livelihood and induce distress migration from rural to urban. ◆ Increased problems with health, housing, and access to medical services (particularly for vulnerable populations) ◆ Increased need of emergency services as more frequent and severe weather events increase the number of disasters
 <p>Economy and infrastructure</p>	<ul style="list-style-type: none"> ◆ Infrastructure damage or disruption in services will impact our local economy

Section : F Resilience Actions

Many of the city's past and current actions are contributing to its ability to adapt to climate change, but existing plans, policies and procedures are not necessarily labelled as "adaptation actions". The focus of the CRS is to align current resources to increase the resilience of the city from a strategic perspective. The resilience actions presented in this strategy provide direction for the city to strengthen policies, develop new programs or practices where gaps exist, work collaboratively

with key partners and other levels of governments, and undertake the steps necessary to integrate climate adaptation as a core function within the Municipality. The resilience framework considers core practices,viz. restoration and development of natural eco-systems, quality & reliability of basic services, policy and institution development and Municipal area development & management through community participation in planning, implementation, monitoring and follow-up (Fig 12).

Fig 12 : Resilient framework



Urban Climate Change Advisory Committee of Jorhat City

An Urban Climate Change Advisory Committee (UCCAC) was constituted in consultation with government agencies of the Jorhat city in 2014. The purpose of forming the committee was to create an interdisciplinary body for ensuring coordination among various agencies involved in planning, execution and management of activities related to the CRS strategy. The participants representing various government

departments in the meeting were all incorporated as members of the committee to begin with. This committee would bring in more members as per requirement from time to time for the purpose. This committee will be developed as the main agency looking after the execution, coordination, monitoring and evaluation of CRS action programmes. However the UCCAC will have to be manned proportionately by members

from government sector, civil society and citizen's groups.

The resilience actions focuses on the core approaches of restoring and developing natural eco-systems, developing basic services and promoting wise practices with appropriate policy framework and institution development. The restoration and development of natural eco-systems, particularly major streams, rivers, pond and water tank can provide storage of surface water, natural conduits to surface water flow and minimize the risk associated with extreme rainfall event and water logging. At the same time restoration, development and promotion of forestry and institutional, home garden at the one hand augments green coverage, nurturing biodiversity and providing alternative sources for nutrition, food and medicine. Moreover, restoration and development of natural eco-systems also strengthens the carbon sink.

Developing the basic services in sectors like MSW management, drainage, sewage treatment, quality drinking water with reliable supply, provision of public toilet and toilet for the economically weaker households, better public transport systems minimizes the risk associated with inadequate basic services in extreme climatic situations and strengthens community health and economic capabilities. Provision of housing for economically weaker families living in waterlogged area along with improvisation in housing design may also reduce the risk of these people.

It has been observed globally that climate change causes increase in incidence of vector and water borne diseases such as malaria, schistosomiasis, chikungunya, diarrhoea etc. Climate stress also effects health directly by causing heat stress, cold stress, respiratory diseases due to air pollution and skin diseases.

Heat stress include heat cramps like muscular pains and spasms, heat exhaustion when body fluids are lost through heavy sweating and heat stroke which may lead to death. Other examples of climatically caused health risk are death or injury during extreme weather situation and mental disorder (Baruah, 2014).

Since Jorhat as a district suffers from inadequate public water supply system and there is no scientific sewerage and drainage network in the city areas, access to and availability of safe drinking water remains a big public health and environmental concern. The general physic-chemical parameters (such as pH, conductivity, total dissolved solid, total hardness etc.) of the Tocklai River are higher in value than permissible limits. Presence of iron everywhere in quantities larger than permissible WHO guidelines is a general water quality concern for the people. In some areas of the city water is found to be contaminated with phenol and oil-grease of industrial origin, and heavy metals like cadmium concentration with concentration higher than WHO guideline value (Goswami, 2014).

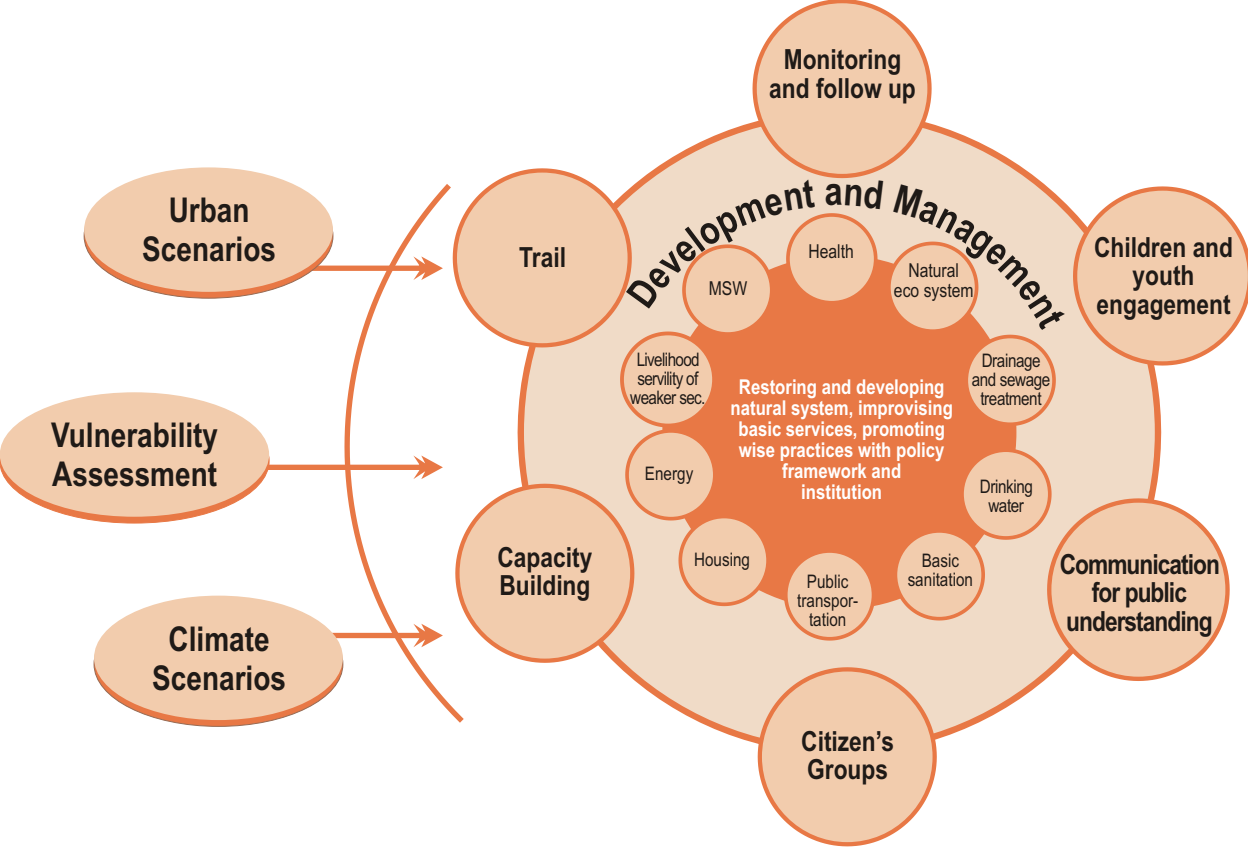
Promotion of energy efficient management practices particularly in public and private institution/organization, especially use of solar energy will reduce carbon foot print and exemplify wise use of energy. In the realm of MSW segregation at source and collection by developing chain of tiny and small value addition unit incorporating practices like vermi-composting, recycling, biogas generation etc. can be considered as good management practices. Adoption of such practices will also generate employment potential. Above all there is a need to strengthen health services.

All these need to be executed through proper strategy and design, for which it is better to start with trial experimentation at micro-scale

than finalize the frame work and design through appropriate monitoring and follow-up. Later on it can be replicated. Moreover, it is essential to involve citizen groups and stakeholders in all phases of planning, implementation and monitoring including in the decision making for follow-up. At the same time there is a need of capacity building of all the stake holders including the individuals in management, governance and policy decisions for efficient participation in the core practices suggested above. Engagement of children and youth through institutions, enhancing understanding

of public through proper communication activities are important pre-requisite for making urban societies for quick rescue, recovery and response mechanism to be in place formation of institutions like city disaster management cell with networks of ward level committees and volunteer is essential. Newly created city disaster management cell has to be linked to existing agencies like the District Disaster Management Authority(DDMA) Keeping all these issues in mind the resilience strategy is illustrated in Fig.13.

Fig 13 : Resilience Strategy



In the above perspectives key issues for strategic plan and action are :

- ◆ Review of current projects and investments of integration of climate component
- ◆ Assess potential threat

- ◆ Restoring and managing natural system
- ◆ Developing basic infrastructure
- ◆ Promoting renewable energy and energy efficiency
- ◆ Provisioning livelihood and social security

- ♦ for the economically weaker section
- ♦ Promoting small scale industry linking with strengthening environmental services and goods
- ♦ Developing and use management and regulation
- ♦ Creating institutional support

While identifying required actions to build up the city's resilience, it was deduced that all level of government and all sections of society have a responsibility to become informed and take

appropriate action within their mandates to prepare for and adapt to the impact of climate change. In this regard, potential actions have been proposed under following strategic directions for implementation of the strategy.

Core Strategic Actions

Following core strategic directions, their sub components, time line and required actions are suggested in context of climate change vulnerability of Jorhat city.

Table 3 : Core Strategic Actions

Risk	Resilient Options	Sub-Components	Time Frame	Key Actions
Lack of understanding about climate change	Review of current projects and investments and integration of climate component	Integration of climate adaptation component into plan, policy, project and investment decision	Short term	<ul style="list-style-type: none"> ♦ Evaluate existing projects that address climate change impacts or considerations to identify opportunities for accelerated implementation. ♦ Create and implement a process to review and assess all new standards, policies, plans, and projects so that climate change adaptation is considered within them
Lack of knowledge about local hazards and disasters	Assess potential threats	Understand the risks specific to climate change impacts	Short term	<ul style="list-style-type: none"> ♦ Conduct a 'Risk mapping' exercise to identify critical areas that would be impacted by extreme weather events and pose risks to infrastructure and populations. ♦ Conduct a detailed evaluation of potential impacts from extreme weather events on Municipal infrastructure. ♦ Identify non-Municipal infrastructure/ facilities that provide critical support to city dwellers and determine their vulnerability to extreme weather events.

Risk	Resilient Options	Sub-Components	Time Frame	Key Actions
Deteriorating ecosystem services like water bodies, soil quality, and decreasing buffering capacity	Restoring and managing natural ecosystem	Restoration and development of natural water bodies, parks and open space through community participation	Short term	♦ Restoration and development of Toklai and Bhogdoi river
			Short term	♦ Restoration and development of public water tanks
			Short term	♦ Restoration and development of private water pond
			Short term	♦ Restoration and development of urban institutional and homestead land gardens and open spaces/ parks
Water logging, availability of drinking water, solid waste management and drainage	Increase resilience of basic services	Scientific management of Municipal Solid Waste	Short term	<ul style="list-style-type: none"> ♦ Implement MSW rule 2000 ♦ Collection and segregation at source along with developing value addition and resource recovery chain through outsource agencies
		Improvisation and development of drains along with sewage treatment systems	Long term	<ul style="list-style-type: none"> ♦ Review of current drainage development plan ♦ Identify faults in current drainage lines and structural gaps ♦ New drainage and improvisation of existing drains through proper slope analysis and technical guidelines
		Improvement of drinking water supply along with adding new facilities	Short term	<ul style="list-style-type: none"> ♦ Decentralized zone based supply systems with quality treatment facilities ♦ Monitoring of quality of water at source and destination ♦ Deploying agency for study on health hazard due to water & sanitation issues and suggest corrective measures ♦ Introducing low cost water filters as well as water treatment/ purification mechanism
		Developing basic sanitation	Short term	♦ Public toilet with gender segregation, provision of toilet to lower income households preceded by awareness drives.
		Developing improved roads, public transportation, traffic management	Short term	♦ Promoting new and fuel/energy efficient public vehicles, improving existing public transportation system (proper repairing and maintenance), improving road condition and traffic management and better parking provisions

Risk	Resilient Options	Sub-Components	Time Frame	Key Actions
	Promoting resilient housing design	Developing low cost housing	Long term	♦ Housing for the lower income groups of water logged areas
		Formulating better and safe housing norms	Short term	♦ Guidelines for housing design for other households for example maintaining specific height of foundation/ plinth level
Energy crisis	Promoting Renewable Energy	Increasing efficiency in energy management practices and renewable energy	Short term	♦ Promoting energy efficient management practices in all institution and organization (both in public and private) ♦ Restoration and development of public water tanks
			Long term	♦ Promoting renewable energy like solar in all public and private premises
Livelihood and social security	Promoting alternative livelihood system with welfare schemes/ programme	Focus on economically weaker sections	Long term	♦ Ensuring basic support systems to urban informal sectors with social security amenities like insurance for life, health and assets,
			Long term	♦ Developing small industrial units by adopting source segregation and collection of MSW followed by resource recovery and recycling through means of vermi-composting and recycling
			Short term	♦ Value addition chain of home garden product like Betel nut leaf based disposal plate & cup, Banana leaf base packaging material, Banana fibber extraction and processing unit, Food processing unit etc.

Risk	Resilient Options	Sub-Components	Time Frame	Key Actions
Urban planning	Land use zoning and regulation	Specific zoning and land use regulation	Short term	♦ Safeguarding eco-sensitive areas and residential areas through zoning and regulation, , imposing restriction on conversion of water bodies to agricultural land or built-up area, implementing river front development.
Capacity Building	Creating institutional support	Form city level disaster management cell	Short term	♦ Disaster management cell mainly for the urban areas with network of ward level committee, and trained volunteers at all level with linkage to the existing District Disaster Management Authority (DDMA)

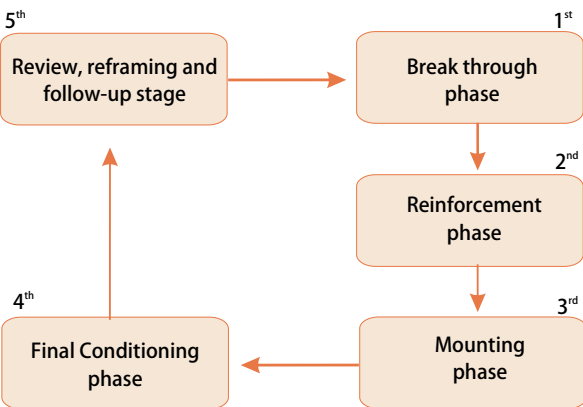
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Implementation

The city resilience strategy also advocates for commitment of the citizens of Jorhat to addressing climate change impacts. It is long-term initiatives that will require participation and engagement across all city Departments as well as collaboration amongst community stakeholders in order to successfully achieve the City's climate adaptation vision. An implementation framework has been developed to provide a detailed roadmap with which to move forward turning the adaptation opportunities into action. These are planned in a cyclical manner with five phases of action initiation.

- ♦ Break through phase,
- ♦ Reinforcement phase,
- ♦ Mounting phase,
- ♦ Final Conditioning phase, and
- ♦ Review, reframing and follow-up stage

Fig 14 : New cycle of implementation and monitoring



The Break through phase is the initial stage of the intervention when entry point activities are started by creating an environment involving community and setting up basic resources. Reinforcement phase is the next stage when some of the activities might need more community involvement, regular monitoring, S&T interventions and more resource input. Successful implementation of activities of this phase is itself a reflection of progress towards developing resilient systems. Actions undertaken in the Mounting Phase need more community participation, sharing and contribution in terms of ideas and implementation (Fig. 14).

The creation of partnership in a win-win situation among public agencies, private entities and people during the reinforcement phase will be the driving force providing momentum to the mounting phase. If the action points of the mounting phase can be executed appropriately it will be a quantum jump to creation of a climate smart system. The action points of Final Conditioning phase are basically related to institutionalization of norms, policy and regulation for maintaining and managing resilient system and climate smart practices. Review, reframing and follow-up is an impact assessment phase to identify success, failure and gap; also to design new plan and execute in a cyclical manner again. Details of the activities under each of the phase are as below :

Table 4 : Delineated Action Points

Component/ aspects	Plot to step forward / plan of action
Phase I	Break through phase
Activitiy (1)	Understanding and caring for water
Approach	♦ Community based campaign and drive for cleaning stream, river and water body as well as conserving, protecting and managing them properly
Objectives	♦ Sensitize community in understanding importance of stream, river and water bodies; ♦ Community based actions for cleanliness and protection, ♦ Identification of required actions in future for maintaining flow, reducing sediment load, appropriate solid waste disposal, pollution control, bank erosion control, development of river front and neighbourhood of water develop bodies; ♦ Developing community based vigilance and management systems
Spatial focus and responsible department/ agency	♦ River Bhogdoi and Toklai, public water tanks and pond (within Municipal area) by Municipal board and elected members with the support of community
Expected out come	♦ Community based vigilance and management systems for natural water bodies
Proposed time line	♦ Short term (Maximum 6 months)
Activitiy (II)	Creating Institutional set-up
Approach	♦ Opening up of strategic action orientation for community participation in planning, implementation, monitoring and follow-up
Objectives	♦ Formation of City Disaster Management Cell(CDMC) as a nodal institution for execution of all activities related to risk reduction and resilience creation ♦ Formation of ward level committees of the CDMC for decentralised execution of work on ground ♦ Formation of expert /advisory group in CDMC with individual members having expertise in various relevant fields from inside or outside City/District, capacity building of members of the CDMC and ward level committees in quick response, rescue, recovery operation in disaster and extreme climatic events including maintenance of basic services to public and health care

Component/ aspects	Plot to step forward / plan of action
Phase 1	Break through phase
Spatial focus & responsible department/agency	♦ Covering all the wards by Municipal board, CBOs, CSOs, media etc.
Expected outcome	♦ Ward and city level disaster response institution
Proposed time line	♦ Short term (Maximum 1 year) followed by refresher training in each year cycle

Component/ aspects	Plot to step forward / plan of action
Phase II	Reinforcement phase
Activity (I)	Restoration and development of river and water bodies
Approach	♦ Community based strategy, planning, implementation, monitoring and management approach
Objectives	<ul style="list-style-type: none"> ♦ Removing encroachment from the banks of river and water bodies with proper provision of rehabilitation of economically weaker section ♦ Developing bank area of water bodies and river front through eco-sensitive measures of growing green cover, gardening, creating water park, water aeration, provision for nature walk, environmental sensitive recreation ♦ Developing vegetative and structural measures for bank protection in rivers and other water bodies
Spatial focus and responsible department/ agency	♦ River Bhogdoi and Toklai, public water tanks and pond (within Municipal area) by Municipal board with the help of other related departments like district administration and local elected representative
Expected out come	♦ Development of river front and bank area of water bodies (bank protection , ecosystem generation, beautification with natural greenery, tourism promotion facility)
Proposed time line	♦ Short term (Maximum 2 years)
Activity (II)	Drainage development, provisioning for surface water storage and sewage treatment
Approach	♦ Community based development and management
Objectives	<ul style="list-style-type: none"> ♦ Improving existing drainage network through proper maintenance of gradation and removing congestion; ♦ Developing new drainage through community based assessment and design ♦ Structure for surface water storage ♦ Sewage treatment plant adopting appropriate treatment method (biological, mechanical and chemical)

Component/ aspects	Plot to step forward / plan of action
Phase II	Reinforcement phase
Spatial focus and responsible department/ agency	♦ All the existing drainage network, area not served by drain, water logged area. Drainage improvement by Municipal board, district administration, funds of local elected representatives
Expected outcome	♦ Total or partial mitigation of the problem of water logging and its impacts
Proposed time line	♦ Short term (Maximum 2 years)
Activity (III)	Municipal Solid Waste Management
Approach	♦ Community based efforts for solid waste collection and segregation at source and resource recovery chain with the involvement of public/ private groups (e.g. SHG, NGO, Co-operative, etc.)
Objectives	<ul style="list-style-type: none"> ♦ Introducing house to house segregated (into bio-degradable and non-degradable components) solid waste collection system; ♦ Developing vermin-composting unit; ♦ Developing bio-gas unit with biodegradable solid waste in market area with provision beak-up of power for lighting in load shading hours; ♦ Developing paper recycling and card board production unit from recycled wastes; ♦ Developing plastic rope production unit utilizing plastic and polythene waste; ♦ Developing systematic scrap material supply business with select entrepreneur groups ♦ To promulgate the concept of “convert waste to resource”
Spatial focus and responsible department/ agency	♦ To be facilitated in all the wards by Municipal board.
Expected outcome	♦ Established MSW management system, resource recovery from solid waste, employment generation, entrepreneurship development.
Proposed time line	♦ Short term (Maximum 2 years)
Activitiy (IV)	Developing quality and reliable drinking water supply system
Approach	♦ Community based monitoring and management collaborating with urban Municipal water supply agencies(both public and private)
Objectives	♦ Developing quality and reliable drinking water supply system with decentralized ward level community based quality monitoring, distribution management and vigilance systems .

Component/ aspects Phase II	Plot to step forward / plan of action Reinforcement phase
Spatial focus and responsible department/ agency	♦ Covering all the wards and to be facilitated by with the help of concerned department
Expected outcome	♦ Drinking water supply to all
Proposed time line	♦ Short term (Maximum 2 years)
Activity (V)	Improvisation and strengthening of existing informal sector
Approach	♦ Linkage with the existing banking, financial and social security institutions and schemes
Objectives	♦ Linking with financial and banking institutes like DIC, NEDFI, NABARD, RGVN, Kanaklata Mahila Cooperative Bank and other nationalized and private banks for livelihood programme, developing and linking with community based micro insurance programme and social security schemes.
Spatial focus and responsible department/ agency	♦ Urban informal sector
Expected outcome	♦ Access to credit and financial assistance to start small scale business, ♦ All families are covered under micro insurance programme and pension
Proposed time line	♦ Short term (Maximum 2 years)

Component/ aspects Phase III	Plot to step forward / plan of action Mounting phase
Activity (I)	Improvisation of housing and sanitation in water logged area
Approach	♦ Participatory planning, implementation, monitoring and follow-up involving stake holders with priority to economically weaker sections
Objectives	♦ Improvisation of housing in the waterlogged area facing the problems of inundation to houses, home campus ♦ Providing toilet to those households where there are no toilets or there are only kaccha toilet ♦ Developing outlet and link with drain or natural conduits to drain out the water from water logged areas

Component/ aspects Phase III	Plot to step forward / plan of action Mounting phase
Spatial focus	♦ All areas having experienced water logging problem and having the potential of water logging in future
Expected outcome	♦ Reduced the risk of detrimental impact of water logging on various aspects of life of urban citizens
Proposed time line	♦ Long term (Maximum 3 years)
Activity (II)	Promoting energy efficient management practices and use of renewable energy
Approach	♦ Participatory planning, execution, monitoring and follow-up involving public and private institutions and organizations
Objectives	♦ Promoting energy efficient management practices in the buildings and premises of public and private institutions and organizations
Spatial focus and responsible department/ agency	♦ All buildings and premises of public and private institutions/ organizations Municipal board and Urban and Town planning department (development authority) with the help of concerned
Expected out come	♦ Optimal use of energy and reduction of carbon foot print
Proposed time line	♦ Long term (Maximum 4 years)
Activity (III)	Developing public transportation system and traffic management
Approach	♦ Participatory planning, execution, monitoring and follow-up involving all the stakeholders.
Objectives	♦ Developing efficient public transportation with low cost energy efficient and environment friendly fuel utilization; ♦ Developing efficient traffic management plan with flow regulation, speed regulation, parking regulation; creating parking space, setting-up time based route circuit with community vigilance, reporting and control; building improved roads and repairing and maintenance of existing roads.
Spatial focus and responsible department/ agency	♦ All the wards and roads- Assam State Transport corporation and Traffic Police
Expected outcome	♦ Hassel free traffic, decrease in number of road accident, increased mobility, energy saving in transportation
Proposed time line	♦ Long term (Maximum 4 years)

Component/ aspects	Plot to step forward / plan of action
Phase III	Mounting phase
Activity (IV)	Developing public toilet system
Approach	♦ Participatory planning, execution, monitoring and follow-up involving all the stakeholders
Objectives	♦ Developing public toilets
Spatial focus and responsible department/ agency	♦ Important public places where movement and gathering of people are there by Urban development department under state govt
Expected out come	♦ Providing basic facilities and promote cleanliness
Proposed time line	♦ Long term (Maximum 3 years)
Activity (V)	Developing rainwater harvesting practices
Approach	♦ Participatory execution, monitoring and follow-up involving all the stakeholders.
Objectives	♦ Promoting and developing rainwater harvesting in public institutions and organizations, private institutions, organization and establishment
Spatial focus and responsible department/ agency	♦ All the public and private sector building and premises ♦ Large and medium scale business establishments like hotel, restaurant, industries, etc. ♦ All the private residential complexes under real estate development
Expected outcome	♦ Optimal use of water
Proposed time line	♦ Long term (Maximum 4 years)

Component/ aspects	Plot to step forward / plan of action
Phase IV	Push-up phase
Activity (I)	Development of urban green cover
Approach	♦ Participatory planning execution, monitoring and follow-up involving all the stakeholders.
Objectives	♦ Developing green cover through gardening and plantation in all public and private premises; Government land ♦ Promotion and improvisation of home garden agro-forestry systems in residential premises ♦ Developing value addition chain of agro-forestry product

Component/ aspects	Plot to step forward / plan of action
Phase IV	Push-up phase
Spatial focus and responsible department/ agency	♦ All the premises where already home garden is there and covering new one on the basis of willingness of owners(need promotion drives) - Municipal board
Expected out come	♦ Developing carbon sink, creating food, nutrition security and self-employment opportunity
Proposed time line	♦ Long term (Maximum 5 years)
Activity (II)	Eco-restoration, preservation and development of pond/ tank and other wetlands under private ownership
Approach	♦ Participatory planning execution, monitoring and follow-up involving all the stakeholders.
Objectives	♦ Promotion and development of pond, water tank and other wetlands under private ownership ensuring better economic returns ♦ Promotion of fisheries ♦ Promotion of useful economic flora, like Makhana, Water lily, Lotus etc.
Spatial focus and responsible department/ agency	♦ Residential and other campuses(private/public) where already pond/water tank/wetlands are there to be facilitated by Municipal board
Expected outcome	♦ Developing surface water storage, promoting ground water recharge, carbon sink protection, providing economic benefit
Proposed time line	♦ Long term (Maximum 5 years)

Component/ aspects	Plot to step forward / plan of action
Phase V	Final conditioning phase
Activity (I)	Developing land use regulation along with zoning
Approach	♦ Participatory strategy development, drafting, planning, execution, monitoring and follow-up involving all the stakeholders
Objectives	♦ Regulate the land use; ♦ Protecting ecological perspectives, land resources and land cover maintenances; ♦ Safeguarding residential area; ♦ Safeguarding eco-sensitive area; ♦ Safeguarding peri-urban area; ♦ Control on conversion of agricultural land to builtup land; ♦ Protecting green cover within the Municipal area; ♦ Protecting water bodies within the Municipal and peri-urban areas.

Component/ aspects Phase V	Plot to step forward / plan of action Final conditioning phase
Spatial focus and responsible department/ agency	♦ All the Municipal wards and peri-urban area- Development authority Town and Country Planning department
Expected out come	♦ Land use management system
Proposed time line	♦ Long term (Maximum 6 years)
Activity (II)	Introduction of discounting/rewards systems
Approach	♦ Community based vigilance and reporting system
Objectives	♦ Developing discounting or reward system to groups, institutions, organizations and individuals promoting innovative/unique eco-friendly practices that contribute to creation of resilience, reducing carbon foot print, caring and nurturing of critical eco-systems through tax rebate/ cash incentives/facility incentives ♦ Imposing fine or tax on all negative environmental externalities caused by institution/organization/establishment /individuals
Spatial focus and responsible department/ agency	♦ In all municipal wards Municipal board to be taken care of with the help of CBOs
Expected out come	♦ Promoting climate smart pratices
Proposed time line	♦ Long term (Maximum 8 years)

Component/ aspects Phase VI	Plot to step forward / plan of action Review, reframing and follow-up stage
Main activity	Review of already implemented actions, identification of success, failure and gaps along with review of the Policy, Law, Act in the new context. The Urban Climate Change Advisory Committee (UCCAC) formed as part of the CRS project in Jorhat city will be the key institution responsible for review, monitoring , coordination and follow-up activities
Approach	♦ Multi stakeholder participatory review and impact assessment
Objectives	♦ Review and impact assessment of the existing policies, laws and already executed initiatives ♦ Identification of success, failure and gap ♦ Reframing, designing and planning of new action plan

Component/ aspects Phase VI	Plot to step forward / plan of action Review, reframing and follow-up stage
Spatial focus and responsible department/ agency	♦ Covering entire Municipal area to be take care of by Municipal board with the help of other departments
Expected out come	♦ Transforming the UCCAC to an agency for review, monitoring, impact assessment and planning ♦ Impact assessment report, new strategies and planning
Proposed time line	♦ Long term (after 2023 so that new cycle can start from 2025)

Conclusion

The successful implementation of CRS will require multi- year and multi stake commitments and coordination amongst Municipal administration, line departments and community. Thus in a nutshell, today, we must confront the new climate reality without desperation but with maximum speed and efficiency. We must use our sense of urgency to seek bold changes and to address the root causes of the climate crisis and we must do so at a meaningful scale, without sacrificing broad democratic engagement. It is also expected that the CRS will add a new and important dimension to urban planning and management in Assam

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