Minireview Article

Impact of Climate Change on Arid Region: Case Study of Rajasthan

Abstract

The climate is changing at a very fast rate adding to the increased global concern. During the last few years, the novel Coronavirus held the world by a threat which caused massive economic setbacks and loss of lives. At the same time, the climate crisis continued to contribute to extreme weather events. To mitigate the impact of climate change, whole world came together and made various commitments made in various UN conventions, culminating in the Paris Convention to both implement mitigation and adaptation measures to reduce the emissions. The Sustainable Development Goals agenda was accepted by all members of the United Nations in 2012 at Rio De Janeiro with an aim to promote a healthy and developed future of the planet and its people. It was in 2015 the Sustainable Development Goals (SDG) were adopted with 17 goals; with SDG Goal 13 addressing urgent actions to combat climate change and its impact in all geographical features including arid areas. The paper is an attempt to provide an overview of Arid region, climate vulnerability and to identify the main challenges which climate change presents to the region's future development. The paper further investigates the impact of climate change in an arid region and the adaptation and mitigation approaches to address the concerns of climate change; and concludes with ways to mitigate the impact of climate change in an arid Rajasthan.

Keywords: - Sustainable Development Goals, Arid Rajasthan, Mitigation, Adaptation

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1. Background

Climate change is the greatest global challenge facing us today which through a multitude of impacts poses a risk to our ecology, economy, and society. The IPCC's Special Report on Climate Change and Land, August 2019; says land-based carbon sinks are not limitless. (IPCC Special Report 2019) The report notes that any sequestration gains are "at risk from future loss (or sink reversal) triggered by disturbances such as flood, drought, fire, or future poor management."

Over the past 3.5 billion years, the planet's climate has been altered by volcanic emissions, changes in solar input, continents moving slowly atop shifting tectonic plates, impacts by large meteors, and other factors. Over the past 900,000 years, the atmosphere has experienced prolonged periods of global cooling and global warming. The ongoing anthropogenic climate change is mainly caused by an increase in the amount of greenhouse gases, especially carbon dioxide (CO_2) in the atmosphere (Dhote, De, 2021)

India Meteorological Department, Ministry of Earth Science, Government of India had released a statement on "Climate of India during 2020", published on 4th January 2021. According to this document, the annual mean land surface air temperature averaged over India during 2020 was above normal. The year 2020 was the eighth warmest year on record since nation-wide records commenced in 1901. (Ministry of Earth Sciences, 2021).

To mitigate the impact of climate change, whole world came together and made various commitments made in various UN conventions, culminating in the Paris Convention (12th December 2015) to both implement mitigation and adaptation measures to reduce the emissions. The Sustainable Development Goals agenda was accepted by all members of the United Nations in 2012 at Rio De Janeiro with an aim to promote a healthy and developed future of the planet and its people. (United Nations SDGs, 2015) It was in 2015 the Sustainable Development Goals (SDG) were adopted with 17 goals; with SDG Goal 13 addressing urgent actions to combat climate change and its impact in all geographical features including arid areas. Figure 1 mentioned the major extreme weather events occurred during 2020.

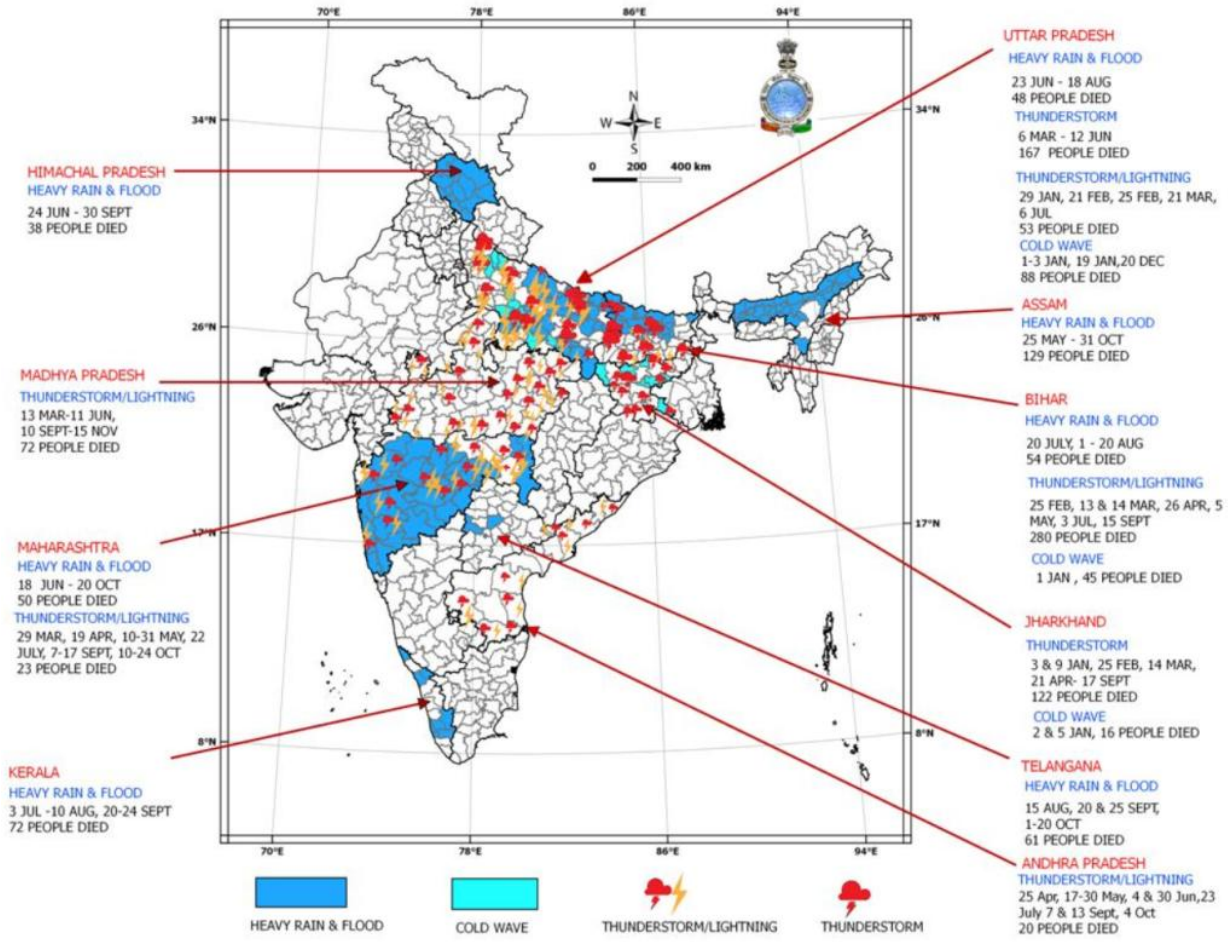


Figure 1: Major extreme weather events occurred during 2020 and associated casualties
Source: - Statement on Climate of India during 2020, India Meteorological Department, Ministry of Earth Science

The Constitution of India clearly demarcated the roles and responsibilities of Centre, State and Local Governments. To mitigate the impact of climate change and to keep a track of it, Climate action portal India was launched by India in 2020. The portal will provide information on the different climate initiatives taken by various line ministries enabling users to access updated status on these initiatives. The eight components of the portal are India's climate profile, national policy framework, India's NDC goals, adaptation actions, mitigation actions, bilateral and multilateral cooperation, international climate negotiations and reports.

2. **Objective of the Study**: -

This study was undertaken to provide an overview of Arid Rajasthan's climate vulnerability and to revisit the past to understand the present-day trends.

3. **Research Questions**: -

To address the above objective, the following questions have been identified for research:

What is climate change in the context of an arid region? What are the adaptation and mitigation approaches addressing the concerns of climate change with respect to Rajasthan?

a) How does climate change affect arid regions? What are the main challenges which climate change presents to the region with respect to current and future development?

b) To what extent do the planning documents address climate change and adaptation and mitigation measures applicable to Arid areas?

c) What are the steps taken by various stakeholders to mitigate the impacts of climate change?

4. **Interrelationship between Climate Change and Arid area**: -

Deserts and semi-deserts are the world's most vast land biomes, covering more than 30% of the planet's surface. They are often predicted to be among the most vulnerable species to global warming.

However, there are still major uncertainties regarding the potential effects of increasing concentrations of either CO_2 or future climate change in arid ecosystems. Interpretation of some paleoclimatic data as the analogues to future climates suggest that global climate change may cause many arid regions to experience higher rainfall and therefore to become more productive ecosystems. Despite the great uncertainties about the responsiveness of arid ecosystems to the ongoing climatic changes, scenarios predicting increases in precipitation in present-day deserts are sometimes interpreted as indicators of a likely increase in productivity of arid zones as a result of the CO_2 increases (Lioubimtseva, 2004).

The fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) clearly indicate that the temperature has increased, and it is anticipated to increase further in the future unless measures are taken. (Solomon et al., 2007) Wet areas are likely to become wetter and dry areas will become drier, increasing water scarcity in these dry areas. Climate change will seriously affect the sustainable development challenges that we face not only in environmental issues but also in other areas. Climate change is going to have a drastic impact on arid ecosystems and its almost 2.5 billion inhabitants. (Dhote, De 2021)

The arid areas (40% of world land surface) are home to over 2 billion people, accounting for 35% of the world's population. Some 55% of arid inhabitants live in rural areas. More than 90% of arid inhabitants are in the developing world and 70% in rural areas. Approximately half of the poorest people in the world live in the dry areas. Most arid ecosystems are already affected by increasing resource demands and unsustainable management practices, and human-induced climate change adds an important new stress. Most arid systems are sensitive to both the magnitude and rate of climate change, and the vulnerability of the people living in these areas is going to increase if their adaptive capacity is not improved (El-Beltagy & Madkour, 2012).

5. **Study area – Arid Rajasthan**: -

Water is scarce in an area dominated by arid and semi-arid lands, and a high percentage of degraded land exists due to Aeolian processes. Rajasthan is facing the problem of climate change peril.

5.1. About Arid Rajasthan: -

The Indian hot arid region occurs between 22 30' and 32 05' N latitudes and from 68 05' to 75 45' E longitudes, covering western part of Rajasthan (19.6 Mha, 69%), north-western Gujarat (6.22 Mha, 21%) and south-western part of Haryana and Punjab (2.75 Mha, 10%). The majority of the hot arid zone comes under northern-western part of Rajasthan covering 12 districts. Rainfall distribution in the region is highly uneven over space and time (Saxena, Goyal, Singh, Roy, 2014). This region covers an area of 208,746 sq. kms with a population of 27,115,542 persons as per census 2011. The study area makes up about

60.99 percent area and 39.51 percent population of the state. It consists of districts such as Hanumangarh, Sriganganagar, Bikaner, Jaisalmer, Barmer, Jalore, Pali, Jodhpur, Nagaur, Churu, Sikar and Jhunjhunu. Figure 2 explains the location and relief of Arid Rajasthan.

Indian researchers have discovered a set of rare wood boring trace fossils in Barmer region which reveal that this area was under tropical forest and even had vast river network 55 million years ago. The rare almond-shaped 'trace fossils' of *Asthenopodichnium lignorum* and J-shaped fossils of *Asthenopodichnium lithuanicum* have been discovered for the first time in India in the Barmers and stone formations (Mishra. R, Down to Earth, 2018).

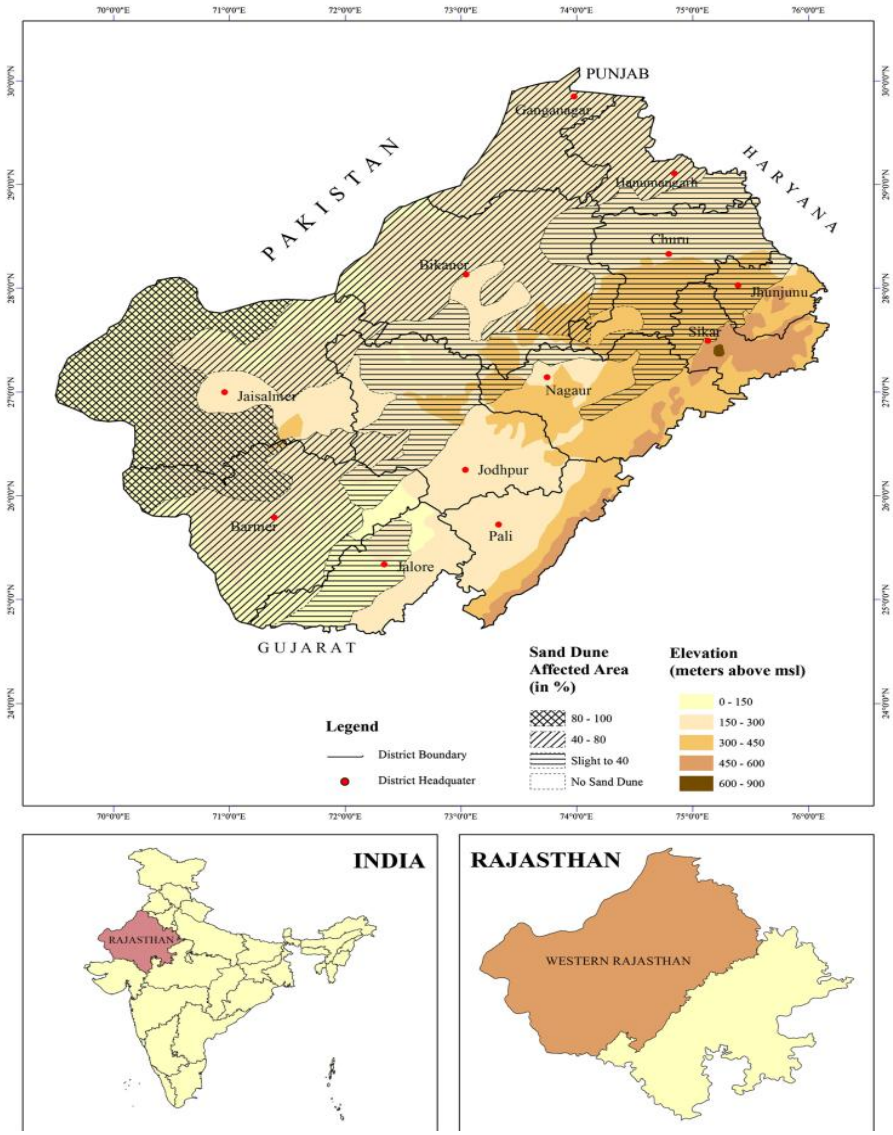
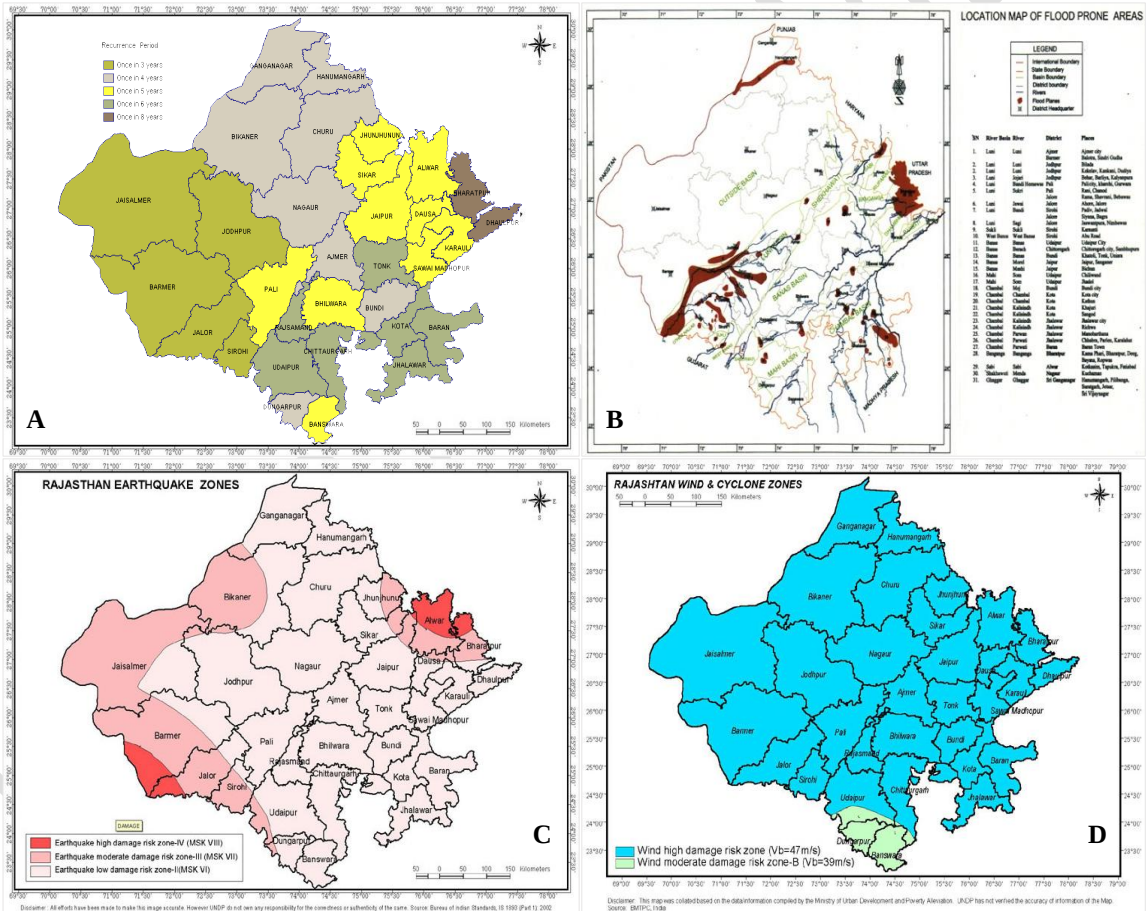


Figure 2: Location, Relief, and sand dunes affected area of the study region

Source - Climate variability and water resource scarcity in drylands of Rajasthan, India (Published on 13th March 2015)

5.2. Impacts of Climate Change on Arid Rajasthan: -

Rajasthan is likely to suffer further water shortage due to overall reduction in rainfall. In addition, the State has the maximum vulnerability and lowest adaptive capacity to climate change challenges. Even though 20% rise in all-India summer monsoon rainfall is projected, in Rajasthan overall rainfall is projected to decrease, and evapotranspiration to increase, due to global warming. (Singh, 2010). Figure 3 explains the climatic conditions of arid Rajasthan i.e., Western Rajasthan, which is prone to all types of disasters i.e., floods, Drought, Earthquake, Wind zones.

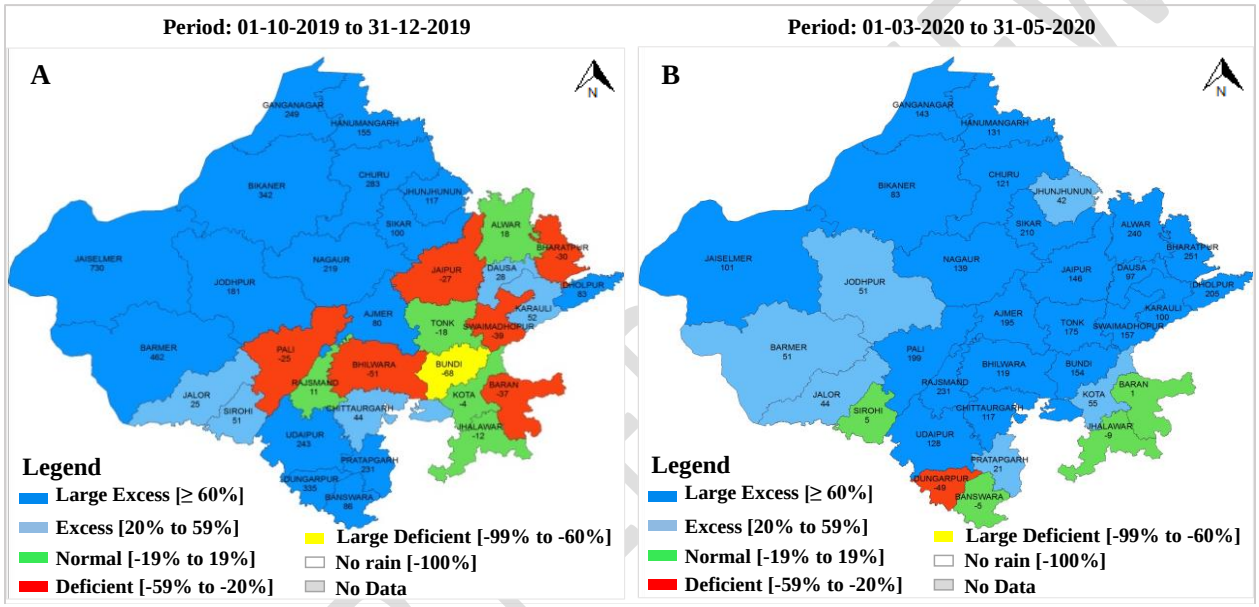


Legend: - A. Drought Frequency, B. Flood Prone Area, C. Earthquake, D. Wind Zones

Fig 3 : Disasters in Rajasthan

Source: - Disaster Management, Relief & Civil Defense Department Government of Rajasthan . Accessed from http://www.dmrelief.rajasthan.gov.in/index.php/citizen-charter/maps-of-rajasthan/multi-hazard-zones

Nowadays, Rajasthan has the maximum probability of even floods in India. During post monsoon 2019 season, Rajasthan had 42.2 mm or 136% above normal rains. Western or Arid Rajasthan had 45.7 mm or 294% above normal rainfall, East Rajasthan had 37.8 mm, 47% above normal rain . During pre-monsoon 2020 season, Rajasthan had 44.9 mm rain, 114% above normal rains. West Rajasthan had 44.7 mm, 99% above normal rains. East Rajasthan had 45.2 mm or 138% above normal rains. (SANDRP, 2020). Figure 4 explains the district rainfall departure map of Rajasthan.



Legend: A. Post Monsoon 2019; B. Pre-Monsoon 2020

Fig 4: District rainfall departure map of Rajasthan

Source: - SANDRP - South Asia Network on Dams, Rivers and People

The climate over Western Rajasthan is still showing definite signs of change, with decrease in rainfall and increase in temperature and aridity. The arid climate belt has shifted eastward, intensifying the process of land degradation, and causing desertification. The water resources are scarce, adding to vulnerability of region towards climate change. But in last few decades there has been tremendous development of various water sources by government in the region and due to these efforts, the north-western part of region has attained good agriculture production and yield. The development of canal irrigation in some parts has intensified the process of land degradation which need to be managed at

priority basis to mitigate the impact of climate change and its impacts (R. B. Singh & Kumar, 2015).

6. Steps taken by government of Rajasthan to mitigate the impacts of Climate Change:

Formulation of a Climate Change Agenda for Rajasthan (CCAR) in 2010 was an important beginning towards addressing climate risks in the state. Being the largest state in the country with unique vulnerabilities in terms of exposure to climatic extremes and varying capabilities for responding to the likely risks, and opportunities that can be tapped (such as harnessing solar energy), this was an important initiative by the state government. Rajasthan released a **State Environment Policy (SEP)** in 2010 identifying the key environmental challenges that the state must address to ensure continued sustainable development and economic growth that is equitable. Within the State Environment Mission, some sectors have been identified as being critical in terms of the climate change impacts on them. These include human health, agriculture and animal husbandry, enhanced energy efficiency including solar energy, and strategic knowledge for climate change (Swami, 2019).

Under the **Rajasthan Environment Mission**, the CCAR listed a set of state priorities for adaptation and mitigation policy and action during the period of 2010-2014. State-specific missions for Rajasthan were developed highlighting research gaps and needs along with relevant policy measures, considering the state's vulnerabilities and capacities. The CCAR identified a list of strategies under the following seven state level Task Forces constituted under the concerned Principal Secretary/Secretary of the Department i.e., Water Resources, Agriculture and Animal Husbandry, Forestry and Biodiversity, Human Health, Enhanced Energy Efficiency and Solar Energy Urban Governance and Sustainable Habitats Strategic Knowledge for Climate Change (Swami, 2019).

6.1. Rajasthan State Action Plan on Climate Change: -

The Rajasthan Action Plan on Climate Change (RAPCC) builds on the key areas as identified under the CCAR by prioritizing urgent areas of action in a phased and time-bound manner and is in coherence with the Rajasthan State Environment Policy and Environment Mission. The Rajasthan State Government established a '**Climate Change and Clean Development Mechanism (CDM) Cell'** in the Rajasthan State Pollution Control Board (RSPCB) to act as a nodal agency for coordinating issues related to climate change in the State. The Cell was constituted in April 2010 and was involved in the drafting of the CCAR. The State of Rajasthan has constituted a team to review the implementation of the Environment Mission. (Singh V, Pandey D, Gupta A, Rabindranath N, 2010)

The vision of RAPCC is to achieve sustainable development by reducing vulnerability to climate change impacts and enhancing resilience of ecological, economic, and social systems in Rajasthan. Figure 5 explains the Rajasthan State Action Plan on Climate change approach chart.

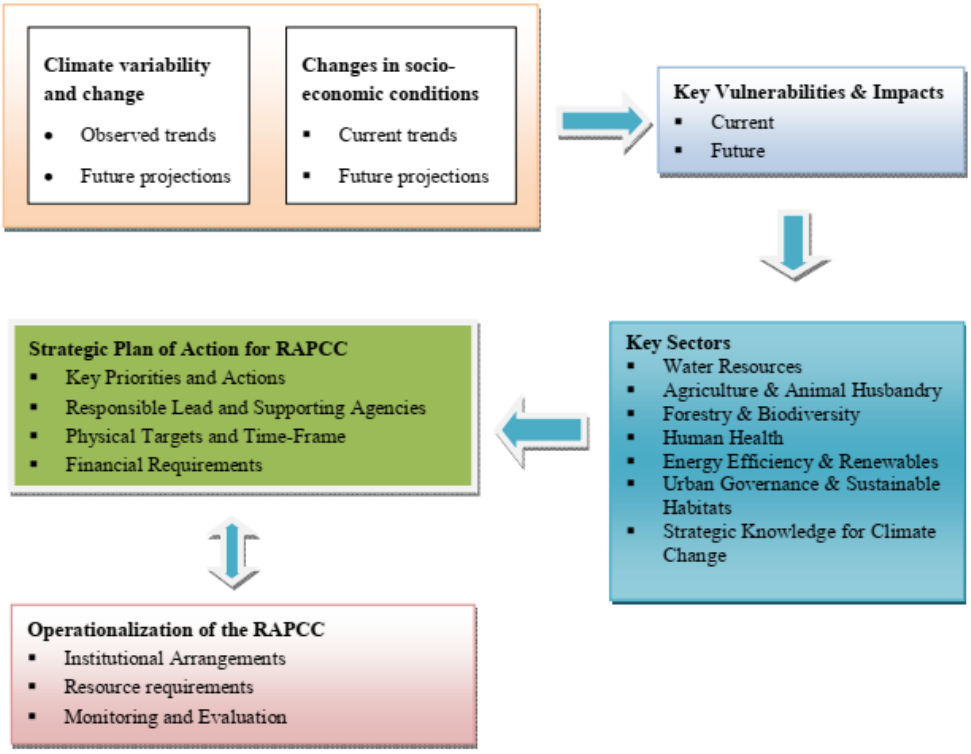


Figure 5: Rajasthan State Action Plan on Climate Change: Approach

Source: Rajasthan State Action Plan on Climate Change, Government of Rajasthan

The RAPCC identifies action points/strategies in the context of climate change. Key sectors identified under RAPCC are – Water resources, Agriculture and Animal Husbandry, Forestry and Biodiversity, Human Health, Energy Efficiency and Renewables, Urban Governance and Sustainable Habitats and Strategic Knowledge for Climate change. Table 1 explains the strategies to be adopted to mitigate the impact of Climate Change in Rajasthan.

Table 1: Strategies to be adopted to mitigate the impact of Climate Change

Key Sectors	Strategies
Water Resources	Integrated Water Resources Management; managing the Supply side and demand side relation; creating Integrated Impact Assessment using regional climate models etc.
Human Health	Strengthening health services by regular research and monitoring; creating public awareness and developing outreach programs specially to combat the rising cases of diseases, etc.
Renewable energy and Enhanced Energy Efficiency	By setting up energy consumption benchmarks for energy-intensive industry sectors and exploring the solar energy potential in the state.
Sustainable Agriculture	Agriculture practices can be strengthened by improvements in agro-extension services related to seed. development, on-ground demonstrations of new techniques, promotion of better irrigation infrastructure and improvement in reclamation of saline or alkaline soils etc.
Forestry and biodiversity	Effectively engaging forest communities in forest protection and conservation schemes; assessing adaptation potential of the various forest species in the changing climate scenario; and exploring the carbon mitigation potential of forest conservation etc.
Strategies for State Mission on Strategic Knowledge on Climate Change	Facilitate studies related to climate change vulnerability and impact assessments for better preparedness in Rajasthan. There is need to assess likely future growth scenarios in the State using an optimization energy environment modelling framework. Mainstreaming climate concerns into ongoing developmental initiatives can offer opportunities for adaptation and mitigation in the State etc.
Developing Sustainable Habitats	By capturing methane emissions from landfills; strict enforcement of Energy Conservation Building Codes and Green Certification guidelines for the building and construction sector; Green Fuel-Efficient urban transport system by using Compressed Natural Gas etc.

Source: compiled by author, adapted by Rajasthan State Action Plan on Climate Change, Government of Rajasthan

6.2. Mukhyamantri Jal Swavlamban Abhiyan :-

Normally in Rajasthan, duration of rainfall is large which has adverse effect on crop production. Due to decline in crop production of farmer and conversion of arable land to wasteland, there is scarcity of fuel, fodder, milk resulting for their weak socio-economic condition. Scarcity of water is the main reason for this situation. (Central Ground Water Board, 2017)As State has 75 percent rural population which depends on agriculture and livestock for their livelihood, hence in light of these conditions of state, Mukhya Mantri Jal Swawlamban Abhiyan was introduced to utilize the Four Waters- Rainfall, runoff, Ground Water & *in-situ* Soil Moisture keeping watershed or Cluster/ index catchment as a unit for Western Rajasthan where there is scanty rainfall & no defined drainage lines and it's the best example of climate change peril.

The Objectives of "Mukhya Mantri Jal Swawalamban Abhiyan" are: -(Mukhya Mantri Jal Swawalamban Abhiyan, Government of Rajasthan)

- To ensure effective implementation of water conservation and water harvesting related activities in rural areas through convergence of schemes of various departments keeping in view the existing guidelines.
- Implementation of works through people's participation by motivating villagers & beneficiaries.
- Harvesting of available runoff (rainwater, ground water, under-ground water & in situ soil moisture) in rural area by treatment of catchment, proper utilization of available water harvesting structures, renovation of the non-functional water harvesting structures & creation of new water harvesting structures.
- Development of Forest, land, water & fauna keeping watershed/cluster/index as a unit for natural resource management.
- Permanent Solution of drinking water by making the Village self-sufficient in terms of water.
- To increase the Irrigated area through water harvesting & conservation.

The project has reached phase V. The Creation of water storage structures, revival of old structures, watershed development, water conservation and water harvesting-related activities are carried out through convergence of schemes of various departments and works are implemented through people's participation in this Programme.

7. Planning literature related to Climate Change: -

In this section, the discussion will be on planning literature related to climate change. The focus will be to what extent planning literature addresses climate concern.

7.1. Master Plan provision related to Climate Change: -

In this subsection, various master plans of Western Rajasthan towns and cities are compared to investigate the master plan provision related to Climate change. The following table 2 mentioned the provisions related to climate change in Master Plans of Rajasthan.

Table 2: Provisions related to Climate change in Master Plans of Arid Rajasthan

City/ Town of Western Rajasthan	National Water Mission	Green India mission	National Solar Mission	National Mission for Enhanced Energy Efficiency	National Mission on Strategic Knowledge for Climate Change	National Mission on Sustainable Habitat	National Mission for Sustainable Agriculture	National Mission for Sustaining Himalayan Ecosystem
Jaisalmer (2011-2031)	Rainwater harvesting	Afforestation Programme, Focus on green highway	Not available	Construction of wind energy power station	Generate awareness among the people	Conservation of water	Krishi Seva Kendra	Not applicable
Jodhpur (2013 – 2031)- Draft	Rainwater harvesting, conservation of water bodies, water treatment planning	Afforestation Programme, Focus on green highway , Hill conservation zone	Solar panels in roads for solar light	Construction of wind energy power station	Disaster Management	Affordable housing policy, Rajiv Gandhi Awas Yojana, slum free city, Health care city	Krishi Upaj Mandi Samiti	Not applicable
Hanumangarh (2017-2035) - Draft	Rainwater harvesting, Rejuvenation of water bodies, river front development	Conservation of trees, Green Highway, Highway development control belt	Not available	Thermal Power plant	Environmental conservation Programme, Community participation	Sewage Treatment Plant	Krishi seva Kendra, Milk dairy farm	Not applicable
Sri Ganganagar (2001 – 2023)	Construction of Jet distributary canal	Public parks, Afforestation Programme	Not available	Thermal Power plant and Bhakra Nangal project	Not available	Not available	Grain distribution center, Indian oil distribution center	Not applicable
Bikaner (2001-2023)	Construction of Filter Plant	Parks in every sectors, Afforestation Programme	Not available	Thermal Power plant	Environmental conservation Programme	Community Participation	Dairy farming	Not applicable

Source: - Compiled by author from various Master Plans of Rajasthan (Master Plan, Rajasthan Government)

The key findings from master plan exercises are that it does not address climate change directly, but some provisions are mentioned in the mentioned in the Master Plans as discussed in the table 2. Another finding is that Master Plans after 2008, tried to address almost all the components of National Action Plan on Climate change. But Master Plans before 2008, tried to address basic National Action Plan on Climate change components such as water conservation, afforestation Programme etc. For example, Jodhpur master plan mentioned about Solar panel, health city, etc. Hanumangarh Master Plan mentioned about Environmental conservation Programme, Sewage treatment plant, Thermal power plants etc. Jaisalmer Master Plan mentioned about indigenous knowledge, generate awareness among the people, green highway and Sri Ganganagar and Bikaner master plans mentioned about afforestation Programme, Community participation etc.

7.2. Gaps mentioned on Rajasthan State Action Plan on Climate Change: - (RAPCC, 2014)

- Rajasthan State Action on Climate Change not implemented till now.
- None of the policies of the Department of Urban Development and Local Self Government address adaptation measures in terms of climate change directly.
- Policy guidelines only provide for conservation actions in terms of guidelines for conserving and encourage an increase in the green footprint by mandating plantation.
- There is a need to either align/amend the existing policies to address these impacts and/or simultaneously formulate separate policies to focus on critical sectors like urban water supply, transport, storm water drainage, etc.
- There is an inadequate knowledge on the impacts of climate change in different sectors of the state.
- Further there is a lack of clear understanding of important processes like desertification, which requires the monitoring of various parameters such as changes in water quality and quantity, biomass, biodiversity, soil salinity, etc.
- No specific studies have been conducted to monitor this process in the state.

7.3. Climate Change Mitigation and Adaptation for arid areas not mentioned in Urban and Regional development plan formulation and implementation guidelines (URDPFI) Volume 1: - (URDPFI Guidelines: Ministry of Urban Development)

- There is a Separate Chapter on Sustainability guidelines in (URDPFI) volume 1.
- Case study of Climate Proofing Guwahati, Assam: City Resilience Strategy and Mainstreaming Plan.
- Not specific guidelines about climate proofing in arid areas mentioned.
- Desert ecosystem sensitive planning is crucial at regional planning stage including mapping of land degradation, drought monitoring and indicating components for the State and District Disaster Management Plan for drought preparedness and warning system groups.
- At Development Plan and local area planning level the key actions suggested in NEP, 2006 as given below to be considered:

a) Intensive water and moisture conservation through practices based on traditional and science-based knowledge and relying on traditional infrastructure.
b) Enhancing and expanding green cover based on local species.
c) Reviewing the agronomic practices in these areas, and promoting agricultural practices and varieties, which are well adapted to the desert eco-system.

7.4 Rural Area Development Plan Formulation and Implementation (RADPFI) Guidelines, 2016 not directly address Climate Change: - (RADPFI Guidelines, 2016)

- There is a separate chapter on Environmental sustainability and disaster management.
- Mentioned about Climate Change Mitigation and Adaptation in RADPFI, here also mentioned focus should be on water security, use of heat repealing materials in construction and minimizing concrete surfaces.
- The expression “climate proofing” is meant as a process that aims to identify risks that an investment project or development plan or simply people and their assets may face as a result of climate change, and to reduce those risks to levels considered to be acceptable has been defined.
- Community Based Disaster Management (CBDM) also mentioned in that guidelines.

8. Stakeholders: -

Climate Change has impacted almost all sectors of development making almost everyone a stakeholder. Stakeholders play an important role in taking forward environmental concerns. The five 'P's of sustainability – Planet, People, Participation, Peace and Prosperity indicate the important role of people in taking forward the actions. Governmental bodies, Civil Society, Companies and private sector and finally the individuals with their collective efforts and action give shape to the various policies and strategies and finally translate them into actions.

8.1 Governmental bodies - With legally binding power and the strength to enforce decisions, have contributed towards taking forward Climate Action. Rajasthan Climate Change Agenda has been prepared to take forward the provisions of the NAPCC and to prepare detail action plan for adaptation and mitigation at the State level. Priority has been given to those activities in Rajasthan that meet a combined set of seven climate-proofing criteria, which can be verified through measurable indicators for ecological, economic and social sustainability: (i) Reduction and/or sequestration of greenhouse gases, (ii) biodiversity conservation and ecosystem functioning, (iii) enhancing the yield of livelihoods goods and services to local people, (iv) reduction in poverty and vulnerability, and improving the resilience and adaptive capacity, (v) local empowerment and capacity development, (vi) synergy with objectives of international instrument and conventions, and (vii) coherence with local strategies for sustainable development.

8.2 Civil society - constitutes non-governmental organizations, private citizens, informal groups, who organize debates, collect feedback from ground, inform government by making their voices heard and by swaying the public opinion in their favor. Through a multitude of actions and channels, these stakeholders have many times reoriented governments' priorities, funds and agendas. From international NGOs such as World-Wide Fund for Nature, India, ICRIER (Indian Council for Research on International Economic

Relations) which works at the National Level, SEWA Mandir, Tarun Bharat Sangh their works cover almost all parts of Rajasthan to local level NGOs there are many organizations working towards addressing the climate change concerns, through inputs into policies, practical and inclusive implementable models. (Surana, 2016)

8.3 Companies and the private sector - Companies and the private sector have been the vehicles of creating economic value in society. Supply chains that influence people to choose one set of goods over other, originate from these stakeholders, and the largest companies have the potential to transform entire industries in one decision. Consequently, they are also the ones to bear a larger part of the responsibility of climate change and pollution. Coca Cola through its Corporate Social Responsibility efforts has contributed in water management in the Desert Areas of Rajasthan.

8.4 Individuals – Individuals hold the responsibility as consumers of goods and services and as actors whose actions have impact on Climate Change. Everyone is also a voter, a professional, a colleague, a member of all these previous bodies and arenas. In the end, all social structures – from family to company to government – are made up of individuals, where made by individuals, and only exist because enough individuals believe in climate change as an issue and the need to act upon it whether as a member of an NGO, part of a Private Company or Government Department. (Surana, 2016)

9. Architectural Heritage in Rajasthan: -

Rajasthan (India) is famous worldwide for its architectural heritage and highly evolved urbanism, created in harsh climatic and territorial conditions. Most of the urban settlements that developed here, (from the 12th to the 19th century) are undisputedly regarded as ecologically sensitive and climatically responsive examples of urban planning and design. The population here is traditionally accustomed to water scarcity, deep, and difficult to draw, ground resources and a highly erratic and sparse rainfall regime. (Gupta, 2011)

The towns here owed their sustainability largely due to the strength of a culture that ensured that the people and governance systems gave due importance and priority towards the development, maintenance, and management of water structures created

alongside, and in harmony with the towns themselves. The respect for water was ingrained in the individual and collective psyche of the local population. (Gupta, 2011) Water harvesting, collection, storage, conservation, and its frugal and careful use began at the individual or household level and social as also religious norms and traditions exercised strict control on its judicious use as a common resource at the larger settlement level-be it urban or rural. Urban settlements here developed fairly complex and sophisticated systems to deal with issues of scarce water. This traditional wisdom is he resource which an individual or group of individuals possess which needs to be taken forward to address climate concerns today.

10. Conclusion: -

Based on the above documents, it appears that Rajasthan has the maximum vulnerability and lowest adaptive capacity to climate change challenges. The state is likely to suffer further water shortage due to overall reducing trend in rainfall. The climate over Western Rajasthan is showing definite signs of change, with decrease in rainfall and increase in temperature and aridity. The arid climate belt has shifted eastward, intensifying the process of land degradation, and causing desertification. The Government of Rajasthan has been taking various steps to mitigate the impacts of Climate Change such as Formulation of a Climate Change Agenda for Rajasthan, Rajasthan State Action Plan on Climate Change etc. Even, there are various Planning documents such as Master Plans provisions, URDPFI guidelines and RADPFI guidelines etc., that directly or indirectly address the climate concerns. However, there are gaps in the Planning documents which may result into inadequate implementation of the provisions. It is important to involve various stakeholders such as Government bodies, Civil societies, Companies, Private sectors, and Individuals, to evolve location specific methodologies to address the impacts of climate change which can help in taking forward the adaptation and mitigation actions in Arid Rajasthan.

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