



# Climate Change and Adaptive Water Management; Lessons from Best Practices

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**ABSTRACT:** Climate change is one of the pressing challenges of the 21<sup>st</sup> century. Adaptation to climate change can bring sustainable and resilient solutions to many of the socio-economic and environmental repercussions caused by climate change. In the water management scenario, environmentalists have recently propagated and advocated adaptive solutions to climate change-induced water issues to ensure a sustainable future. In the present study, a descriptive analysis is made of multiple dimensions of adaptive water management. Also, one of the NITI Aayog identified Best water management practices in Mandli village of Rajasthan is analysed to understand the significant takeaways from adaptive water management for future replication.

**KEYWORDS:** Adaptation, Climate change, Water.

## I. INTRODUCTION

The climate we live within has a critical role in facilitating the sustainable functioning of human life. Even before the formation of humankind, climate and its non-stationary features were quite influential in adding momentum to the evolution of living and non-living organisms. With the changes in time, Climate change, once wholly attributed to the earth's internal forces, gained a new dimension with anthropogenic influences. The human domination over nature and the resultant changes in climate patterns are much more profound and severe, the consequences of which are difficult to mitigate. From agriculture to the industrial revolution and the ongoing technological boom, the anthropogenic drivers contributing to climate change are infinite in number. The chain of action-reaction turnovers is visible since it involves multiple channels of interlinkages. Whereas on the one end, the human-induced climate change is gaining momentum, the climate change-induced

disasters are simultaneously building up their frequency on the other end. From drought to flood, climate change-induced natural disasters significantly threaten planet earth's sustainability. In the era of human-induced climate change, natural resources face the threat of severe exhaustion and depletion.

Water, the most crucial natural resource for human survival and sustenance, faces severe stress under the changing climatic patterns. Since water is most predominantly used in the various facets of human life, any minor alterations in the water system can immediately affect human life's sustainability. According to the UN, climate change is reflected upon human life primarily through the medium of water. Higher atmospheric temperature accompanied by Global warming has extreme and highly unpredictable effects on water resources availability. The changing temperature level has been causing rainfall variation, melting down of snow, and declining groundwater level, the cumulative effects of which are causing natural disasters such as floods and drought. Climate change is projected to increase the number of water-stressed regions and intensify water shortages in already water-stressed areas. (United Nations, 2020). Since climate change involves high uncertainty, water resource management demands new approaches to meet the changing requirements.

Conventional water resource management has limitations, primarily because it approaches climate from a static perspective. Since climate change has no finite end and continues to proceed infinitely, the time has come to approach water resource management from a different perspective. In the current management practices, the reaction factor is given undue importance in all senses. However, a mere reaction to climate-induced changes in water availability cannot be considered a stable solution upon which we can rely for a more



extended period. Reaction-based water management planning might produce desired results for the short term, but in the long run, with much ambiguity in the climatic conditions, the approach may not work the same way. Rather than reaction, what we should focus on is anticipation. Only a system that fully assumes the non-stationarity of climatic conditions and anticipates future volatility in resource capacity can produce a desired sustainable resource management results.

Anticipation and adaptation are two interlinking concepts. In comparison, adaptation requires anticipation as anticipation results in adaptation. These two elements work together for water management in volatile climatic conditions. In general, what makes natural resource management more complex in climate change is its difficulty in incorporating and anticipating the non-stationarity climatic conditions. Change has become an inevitable characteristic of the environment and the society itself, to which adaptation is required continuously. Therefore, natural resource management must be more dynamic and adaptive so that climate change can be dealt with appropriate planning. Adaptive strategies are proactive, aiming to ensure long-term survival and sustainable social-ecological systems management (Lannerstad & Molden, 2009). Thus adaptive planning and adaptive management of water resources is the new future of water resource management. The classical supply-driven, top-down approaches to water management have proven to fail due to their inability to encompass the people's demand requirements. However, Integrated Water Resource Management (IWRM) is a perfect advancement over the classical version, incorporating multidimensional water management linkages.

## II. OBJECTIVES

Facilitating water management adaptation should be a priority in India since climate change can adversely impact the large population (Satapathy, Porsché, Künkel, Manasfi, & Kalisch, 2009). According to IPCC 2007 report, population growth and climate change will reduce India's per capita water availability to 1000 cubic meters per capita/year by 2025. Most importantly, climate change's effects on water supplies, such as increased severe weather events like droughts and floods and increased rainfall variability, would intensify people's vulnerability. This can potentially harm the development process and sustainability goals in the long run. Thus adaptation-based planning and strategies in water management are

critical for the changing scenario. In this context, the present study examines the various dimensions of adaptive water management and its potential to solve water management issues sustainably. Also, the study analyses one of the best water management practices identified by NITI Aayog to determine the extent to which adaptive water management has been taken into practice and the takeaways from these practices to a general application of adaptive water management. For this purpose, Adaptive water management initiatives in the Mandli village of Rajasthan have been taken as a case study.

## III. ADAPTIVE MANAGEMENT IN WATER GOVERNANCE; SCOPE AND NEED

Adaptive water management is a new age addition to the water management approaches. Rather than an alternative approach to contemporary water management solutions, adaptive water management acts as a complementary theme that adds value to the existing system. It only enhances the efficiency of the integrated approach to water management rather than the question of replacing it. Adaptive Water Management can be considered an important addition to the IWRM approach, reinforcing its significance when dealing with unpredictable and dynamic circumstances e.g., climate change and socio-economic changes (Mysiak, Henrikson, Sullivan, Bromley, & Pahl-Wostl, 2010). By embracing uncertainty in the system, adaptive water management provides added value to the IWRM approach (Mysiak, Henrikson, Sullivan, Bromley, & Pahl-Wostl, 2010). Adaptive water management assumes that in the environmental management scenario, there is an inherent limitation in predicting the key changes that might affect the ecosystem and the possible responses and system behavior. Adaptive Water Management provides greater institutional flexibility by involving stakeholders in an iterative social learning process. Thereby adaptive management facilitates flexibility by adjusting water management strategies to become more resilient under a wide range of volatile future conditions (I.Sundar, 2018). The flexible, learning-oriented, and experimental principles of adaptive water management will improve socio-ecological systems' resilience in response to uncertainty caused by non-linear environmental changes (Fritsch, 2017).



Adaptive water management has three major characteristics that make its more feasible and practical in terms of operational efficacy.

#### 1. Active stakeholder participation

Active participation of the public is crucial for initiating and managing sustainable adaptive water management solutions. Adaptive water management facilitates the participatory process of water management more efficiently. In the social learning process that the approach propagates, collaborative learning and information seeking act as complementary tools for decision-making under uncertainty. The participatory aspect facilitates an environment whereby the public becomes closer to the environmental resource management, directly contributing to the resource management solutions. Thus rather than a beneficiary role, the public also becomes participants, problem solvers, and decision-makers in the system.

However, adaptive water management requires a participatory approach that focuses more on active involvement rather than a mere consultation. The active participation of the public in water governance increases the system's transparency and makes the Government more responsible and accountable for its actions. Moreover, the Government becomes more responsive to the needs of the public as the people are collectively aware of the situation and participate in the solution-making.

#### 2. Polycentric decision making

In the climate governance approaches, polycentric decision-making has a crucial role. Adaptive management requires multiple decision-making centers rather than a rigid centralized decision-making system. Moreover, it also demands a balance between bottom-up and top-down decision ladders and strong stakeholder participation in water management. Also, integration between multiple sectors is essential to evolve sustainable adaptive decisions in water management. Thus adaptive water management enables a solid organizational framework in water governance in the long run. It is a crucial requirement for both social learning and active participation. When decision-making becomes a layered process rather than a single-dimensional activity, it ensures that the management decisions reflect multiple viewpoints and interests. As adaptation is a collaborative process, the decision-making should also be collective rather than a rigid one-sided approach.

#### 3. Environment for social learning

Social learning is defined as 'learning in and by groups to handle shared issues...' (Ridder et al, 2005). As the term implies, it is the collective understanding and learning that matters the most in managing a natural resource of collective use. Social learning in water management ensures that the interests of multiple stakeholders are equally heard, accepted, and ensured in the decision-making process. It is imperative for the collective understanding and sharing of skills and knowledge that is crucial for developing adaptive management solutions. Social learning also involves conflict resolution as the multiple interests and viewpoints are coming into the common discussion platforms. Conflict resolution and collective participation ensure that people recognize their interdependence and collective responsibility in decision-making. One of the crucial advantages of social learning is that it creates an environment for positive behaviour changes among people that is viable for adaptation. It makes implementing adaptive water management tasks more effortless as social learning ensures collective support. The collective responsibility of people involved in decision-making is crucial for the sustainable management of adaptive solutions in the long run. As social learning provides collective responsibility through collaborative actions, adaptive water management solutions will become easy to execute, implement, and sustain in the long run. In other words, social learning also enhances people's capacity to carry out water management tasks.

### **IV. ADAPTIVE WATER MANAGEMENT PRACTICES IN INDIA; MAJOR TAKEAWAYS FROM GOOD PRACTICES**

Climate change adversely affects the sustainable availability of safe drinking water to millions globally. In such an environment, adapting to climate change and adopting sustainable solutions for the long run is a necessity of time. Since climate change is an infinite phenomenon that will affect the environment considerably throughout the future, adaptive solutions can bring sustainable solutions to the climate change-induced problems faced by the people. Water scarcity is a significant challenge caused by the abnormalities in climate, and it is causing considerable socio-economic and environmental consequences on the life of the people.



Rajasthan is one of the drought-prone states of India. The Mandli village in the Barmer district of Rajasthan faced severe water scarcity due to adverse geographical and climatic conditions. Being a desert region, the village faced the most prolonged periods of droughts which devastated their access to safely managed drinking water in adequate quantity. In the absence of a steady and reliable monsoon, people faced severe water scarcity, adversely affecting their daily life. The villagers adopted adaptive solutions that are suitable for their perilous climate conditions. The following sections summarise some of the major takeaways from the programmes implemented by the community;

#### 1. Community managed resource development and restoration

One crucial feature of adaptive management is the active participatory role of communities who are also the beneficiaries of the resource in question. In the Mandli village, the villagers themselves took the role of problem solvers and figured out the best solution for their current problem. Since rainfall is scanty, the villagers chose rainwater harvesting as an alternative way to adapt to the drought. One of the major challenges was that only one pond collected the rainwater, and the capacity was not adequate to meet the water needs of the villagers throughout the year. Therefore, through community discussions and meetings, the villagers decided to enhance the catchment area of the pond so that rainwater harvesting could be done more efficiently and effectively. In this way, the villagers set a perfect example of social learning whereby the shared issues are handled through collective decisions and actions.

#### 2. Community institutions based on democratic principles

The formation of Jal Sabhas (Water Development Group) based on democratic principles and participatory decision-making provided a platform for active discussions on matters related to the management of the water harvesting system. Jal Sabha was a part of a four-tiered decentralized system of water governance. The active discussions and debates in the four tiers, i. e Jal Samithi, Jal Sabha, Jal Parishad, and Jal Sansad, created an environment for enhancing the people's collaborative capacity to co-work on water scarcity issues. Jal sabha enabled productive

discussions and paved the way to conflict resolution on sharing scarce water resources in their locality. Jal sabha ensured women's participation by reserving 20% of the membership for women. It was a crucial decision because women in the village suffered the most hardships due to water scarcity in the region. They had to travel miles to collect water for their household activities, and children also missed school days due to the lack of adequate water for their basic needs. By ensuring the women's participation in Jal sabhas, the discussions became more representative, reflective, and inclusive. The strong network of water user associations enabled a more organized implementation of the projects at the micro-level.

#### 3. Collective Financial Contribution

The financial provision of the water supply is always posing challenges to the Government exchequer. In developing adaptive mechanisms, considerable financial support is required to ensure long-term sustainability. The Mandli model provided new insight into this aspect by showing that voluntary community contribution is a sustainable solution. The Jal Sabha realized the need to have stable financial resources for strengthening the rainwater harvesting capacity of the pond in their village. Through active discussions, the villagers agreed to contribute to the financing of the rainwater harvesting system. The payments from the villagers were pooled into a bank account for financing the expenses related to the programme. To make the people more conscious of the need for water conservation and also to sustainably finance the water harvesting system, the Jal sabha introduced a payment system to water users outside the village. The money collected from the public was utilized for enhancing the capacity and catchment area of the pond. In this way, the project cost was mobilized through community contribution, water payment, and financial support from Jal Bharathi Foundation.

The following part summarises the major impacts of the adaptive programmes followed by the Mandli village.

- Expansion in the capacity of Gawai Talab and Narsingh Nada (Ponds in the region) through community support. (Table No;1 Appendix)



- The enhanced capacity of ponds made a 50% increase in water availability for the village throughout the year.
- Villagers were successful in harvesting the entire monsoon rainfall in the ponds efficiently.
- Almost 13 additional villages got water supply from these ponds even during the worst summer days.
- Reduced people's financial burden as they do not have to purchase water from outsiders.
- Ensured safe access to drinking water throughout the year
- Reduced the hardships faced by women in terms of travelling to collect drinking water for the households.
- Increased the leadership skills of villagers through Jal Sabhas.
- Increased awareness among the villagers about water conservation and conscious use of scarce water.
- A register system was followed to account for each household's water collection. This helped to assess the water use pattern and get a clear picture of water demand requirements in the region.
- Limited dependence on external agencies for water supply during summer days.
- Self-sufficiency in terms of managing scarce resources.
- There is a considerable reduction in the amount of money each villager spends on purchasing water. It is estimated that the expenditure by each household showed a six fold reduction after the adaptive solutions introduced by the village. Before the intervention, each household spent Rs.3550 per annum to buy water. After the intervention, it was drastically reduced to Rs.500 per annum for each household (UNDP,2010).

Table No.1(Appendix) shows some of the major statistics of the water conditions of the Mandli village before and after the adaptive management programme. As the table shows, the villagers successfully enhanced the capacity of both the ponds in the village through community participation and collective action. After the intervention, the ponds, which had only a maximum of 5 months of water availability, increased their capacity to reserve water for up to 8-12 months. Also, Table No.1(Appendix) shows the total cost provisions of the programme

implemented in the village and the corresponding community contribution to the project.

The following section summarises the major takeaways from the Mandli village for future replication of adaptive water management programmes;

- Social cohesion can derive sustainable solutions to climate change-induced resource constraints and related issues at the local level.
- Community investment is a successful financial strategy for the sustainable financing of local water infrastructure.
- Community-managed institutions and infrastructure can act more efficiently when the collective decision-making at the community level is given more priority.
- A bottom-up approach is an efficient strategy to use in resource management at the grass-root level.
- Community institutions for water governance enhance the capacity building of people.
- Macro-level management can develop even from grass root level community organisations.
- Efficient social capital utilization at the grass-root level helps to derive sustainable, equitable, and adaptive solutions.
- Investment in sustainable community water systems can ensure long-term sustainable solutions even without considerable external financial support.

## V. CONCLUSION

Adaptive water management is a perfect example of integrated, participatory, and sustainable resource management. Climate change affects each region differently, and its impact on the population is quite different. Thus each community needs to plan, execute, and implement locally adaptive water management programmes for their water concerns. In a country like India, with vast climatic and geographical differences, adaptation to climate change should be more local rather than following a common macro-level framework. In the long run, such grass root level adaptive solutions can bring more sustainable solutions to climate change-induced resource constraints and thereby enhance the adaptive capacity of the people on a macro level.



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**APPENDIX**

**Table No; 1**

<i>Water Harvesting Structure</i>	<i>Before the implementation of the programme</i>		<i>After the implementation of the programme</i>	
	<i>Capacity (CuM)</i>	<i>Availability</i>	<i>Capacity (CuM)</i>	<i>Availability</i>
Gawai Talab	2869	5 months	5218	12 months
Narsingh Nada	2308	4-5 months	26601	7-8 months
	<i>Total cost</i>		<i>Community contribution</i>	
Gawai Talab	Rs. 501,850/-		Rs.150,555/-	
Narsingh Nada	Rs. 66,732/-		Rs. 20,020/-	

Source : UNDP (2010)