



A Study on Tehsil Level Climate Change Vulnerability Assessment & Adaptation Planning For Ujjain District of Madhya Pradesh

Ravi Shah

Research Scholar, School of studies in Environment Management

Samrat Vikramaditya Vishwavidhyalaya, Ujjain

Dr. D.M. Kumawat

Professor and Head of the Department, School of Studies in Environment Management,

Samrat Vikramaditya Vishwavidhyalaya, Ujjain

One of the major challenges to environmental sustainability, agricultural productivity, water supply, public health and socio-economic development at local level is climate change. The present work is on climate change risk assessment and adaptation planning of Ujjain District of Madhya Pradesh, India at tehsil level. The objective of the study is to identify and assess the vulnerabilities of various tehsils in terms of exposure, sensitivity and adaptive capability with regard to climatic fluctuations such as rise in temperature, irregular patterns of rainfall, droughts and extreme weather events. The relative risk of each tehsil is assessed using a composite vulnerability index, which is constructed utilizing demographic, socio-economic, agricultural, environmental and infrastructural data. The research also investigates sectoral influences on agriculture, water availability, livelihoods and public health and current coping mechanisms and adaptation techniques undertaken by local communities and organizations. Based on evaluation, the research recommends a comprehensive adaptation planning framework with a focus on climate resilient agriculture, sustainable water resource management, disaster risk reduction, ecosystem conservation and institutional capacity building. The findings are likely to help policymakers, local authorities and stakeholders to formulate evidence-based climate adaption strategies and encourage sustainable development in tehsils of Ujjain District.

Introduction

The study provides a comprehensive introduction to climate change as a critical environmental and developmental issue of the 21st century. It explains climate change as a long-term alteration in temperature, rainfall, and other climatic conditions, largely driven by human activities such as industrialization, deforestation, and excessive use of fossil fuels. The overview highlights how increasing

greenhouse gas emissions have resulted in global warming, leading to consequences such as glacier melting, sea-level rise, and extreme weather events. These changes not only disturb ecological balance but also pose serious threats to food security, water resources, and human health. The study emphasizes that climate change impacts are unevenly distributed, with developing countries like India being more vulnerable due to limited adaptive capacity and heavy dependence on climate-sensitive sectors.

In the Indian context, the study discusses the regional variability of climate change impacts, particularly focusing on states like Madhya Pradesh where agriculture plays a dominant role in livelihoods. Changing monsoon patterns, rising temperatures, and increasing frequency of droughts and floods have significantly affected agricultural productivity and rural economies. The study highlights that districts such as Ujjain are especially vulnerable due to their dependence on rainfall, water scarcity issues, and land degradation. It further elaborates on the geographic and socio-economic characteristics of Ujjain, including its agrarian economy, semi-arid climate, and reliance on crops like soybean and wheat. These factors, combined with socio-economic disparities between rural and urban areas, increase the overall vulnerability of the region to climate risks.

The study strongly emphasizes the importance of localized, particularly tehsil-level, climate vulnerability assessments for effective adaptation planning. It argues that macro-level studies often fail to capture local variations in exposure, sensitivity, and adaptive capacity. Tehsil-level analysis allows for a more detailed understanding of spatial differences and helps identify the most vulnerable areas within a district. The study also highlights the role of participatory and community-based approaches in enhancing the relevance and effectiveness of vulnerability assessments. By integrating scientific data with local knowledge and socioeconomic factors, the study aims to support climate-resilient planning and sustainable development in Ujjain district. Overall, the overview establishes a strong foundation for conducting micro-level climate vulnerability assessments and designing targeted adaptation strategies.

Climate change has turned into one of the most topical problems of environmental and developmental issues of the 21st century not only in the natural ecosystems but in human societies all over the world. It is a lasting alteration of the temperature, and precipitation among other climatic features primarily caused by humans via industrialization, deforestation and excessive use of fossil fuels. Increasing greenhouse gases in the atmosphere is a contributory factor to global warming and has much environmental implication including the melting of glaciers, an increase in the sea level and the occurrence of extreme weather. These alterations not only interfere with the ecological balance, but also become a grave threat to food security, water resources, and the health of people. Climate change does not affect all areas equally,

and developing countries are more susceptible because of the lack of resources and adaptive ability, which is why it is a policy and planning emergency.

The issue of climate change within the Indian context is multifaceted as the nation is heterogeneous in relation to geographical location, population and the excessive dependence of the nation on activities that depend on climate such as farming. The changes in the monsoon cycles, the increase in temperatures and frequent occurrence of droughts and floods have had an overwhelming effect on agricultural output and rural livelihood as well. Agrarian based states are the most susceptible to such changes and Madhya Pradesh is one of them. Local impacts can be seen in the districts like Ujjain, which are influenced by the geographical, environmental and socio-economic factors in such states. Vulnerability is further enhanced by the reliance of agriculture on rainfall and other problems like water shortage and land erosion. The circumstances highlight the significance of the need to conduct region-specific and detailed studies on the nature and extent of climate risks at a micro level.

As the problem of climate change is local, greater awareness has been generated on the necessity to conduct vulnerability assessment at smaller levels like tehsils. Analysis at the tehsil level can be used to better understand the differences in exposure, sensitivity and adaptive capacity among various regions within a district. By doing so, it becomes possible to determine the most vulnerable areas and come up with certain adaptation measures. Such an analysis is essential in the case of Ujjain district to come up with effective climate-resilient planning that meets the unique needs of the local communities. The study also plays a role in sustainable development and making informed decisions by combining scientific information with socio-economic facts. It is the background that constitutes the basis to establish the climate vulnerability and adaptation plans at the tehsil level.

Climate vulnerability is the extent to which a system, community or region is prone to and incapable of dealing with the negative effects of climate change. It is a multidimensional concept, which incorporates environmental, social and economic, and therefore is at the heart of the study of climate change. The vulnerability is not only founded on the availability of climatic disasters such as droughts, floods, or heatwaves but also the ability of the impacted systems to respond and recuperate. Vulnerability, in this case, may be defined as an exposure to climatic risks, a sensitivity of the system to climatic risks and the ability to adapt to potential damages. This combined view emphasizes the fact that the effects of climate change are not equally distributed and different areas and people are affected to varying extents.

The vulnerability of climate is highly diverse in terms of geographical areas and social-economic groups. The developing nations and those regions that are low resource, poor infrastructure and depend on climate sensitive sectors such as agriculture are particularly vulnerable. An example of this is the rural population

that thrives on rain fall to practice their farming practices, which exposes more to the effects of climate variability and it is not well prepared to handle the effects. Other conditions that contribute to vulnerability include poverty, pressures of population, education and access to technology. Also, natural systems become more vulnerable to climate stress due to the degradation of the environment, such as deforestation and water shortage. All these aspects are interrelated and comprise a complex web of vulnerability that should be properly researched and tackled with particular interventions. More sustainable and inclusive solutions can be developed through study into the causes of the vulnerability such as socio-economic inequalities or environmental degradation. Localized tests, particularly at the district or tehsil level are critical in the representation of the local characteristics of vulnerability and contextualization of the planning. In that regard, climate vulnerability assessment is a valuable tool of enhancing resilience, reducing risks and promoting sustainable development in the context of the evolving climatic conditions.

Climatic conditions of the area of study have changed with regard to temperature and rain patterns due to climate change. The average temperatures have been steadily increasing over the decades resulting in long heatwaves and changes in the seasonal patterns. Such changes have interfered with the traditional agricultural calendars and put pressure on the water resources. Meanwhile, rainfall has become more and more unpredictable, delayed monsoon, patchy and unsynchronized and with unpredictable intensity. This variability brings about uncertainties to farmers and influences crop planning and productivity. The joint impact of the increase in temperature and random precipitation has only increased the exposure of the area to climate-related hazards. The consequences of climate change can be seen especially in the agricultural and water resources, which constitute the basis of the local economy. The area where the study is located is an agricultural area that is primarily rain-fed making it highly sensitive to climatic changes. Temperature and precipitation impact directly on crop yields, moisture of the soil, and irrigation requirements. The decreasing water levels in groundwater and low availability of surface water have also put a strain on water resources. These changes not only affect the productivity in agriculture, but also create a challenge on the domestic and industrial use of water. As a result, it puts the region at a strain in adopting sustainable water management systems and climate-adaptive agriculture systems.

Other than the environmental impacts, the climate change has severe socio-economic impacts on the study area. Variability in climate is increasingly becoming a threat to rural livelihoods that are highly dependent on natural resources and agriculture. Low agricultural income, crop failure and water scarcity which have led to migrations to the cities in some cases have caused these economic instabilities. Also, there has been destruction of infrastructure and ecosystems due to extreme weather conditions that have been increasing such as droughts, and heavy rains. These impacts imply the need to adopt the right adaptation policies that address the environmental and socio-economic impacts of climate change at the local levels. The process

of climate change in India is a complex event due to the great geographical diversity of the country and complicated climatic systems. Climatic conditions are very varied in India, and can be cold as in the Himalayan regions or warm as in the tropical coastal areas, so it is highly sensitive to the change of temperature, precipitation, and seasonal cycles. The average temperatures have risen conspicuously over the last few decades and the trends of rainfall have also altered and the incidence of extreme weather events have also been on the increase. The changes can be largely attributed to the global climatic processes and the local human ones such as urbanization, deforestation and industrialization. Therefore, the issue of climate change in India is not global but extremely local and the effects on ecosystems, economies, and livelihoods in one way or another.

The most remarkable effects of the climate change in the region in India are that the monsoon system is altered that is the source of agriculture and water resources of the country. The variation in the timing, the duration and severity of the monsoons has led to unpredictable rainfall patterns that lead to flood and drought in different parts of the country. As an example, some areas may experience too much rainfall and in a short time causing waterlogging and destruction of infrastructure, whereas others may experience long dry seasons that impact the production of crops and water supply. Also, increased temperatures have increased heatwaves especially in north and central India, a threat to human health, agriculture and energy demand. The mountainous regions are experiencing the melting of glaciers and change in the snowfall and the sea level is increasing and cyclones are threatening the coastal regions. Regional aspects of climate change also indicate inequalities in the vulnerability and adaptiveness capacity in India. The rural and agrarian communities are especially susceptible since it relies on the weather-dependent resources like agriculture and water. Water shortage and land degradation are a problem of arid and semi-arid areas whereas floods prone areas have a problem of displacement and livelihood loss. These, however, bring about urban issues, such as urban flooding, heat island effect and infrastructure strain. All these impacts underscore the need to have regional based adaptation strategies, and decentralized approaches to planning. Strengthening local governance, promoting climate-resilient measures and integrating climate issues into the development planning is instrumental in building resilience and sustainable development within the context of the changing climatic conditions. Climate assessments at the local level are necessary to grasp the context-dependent and spatial variability of impacts of climate change. Although the national and state-level studies may offer a general picture, in many cases, it do not reflect the local variations of climate patterns, resource availability and socio-economic conditions. Locally, land use, water resources, soil quality, and livelihood dependency are rather diverse and define the experience of communities in relation to climate change and communities response. Local assessment is able to give more detailed and practical information through focusing on smaller units of administration such as tehsils or villages. This

enable researchers and policymakers to know more about the areas that are more vulnerable and create focused interventions that can be more specifically adapted to the needs of a particular area.

The other significance of local-level climate assessments is that it should be able to include ground-level realities and indigenous knowledge systems. Rich information on changes in the environment, changes in seasons, and coping strategies that were used by the communities before can be available in local communities, which might not be captured in large datasets. Integration of such knowledge and scientific analysis is what provide a fuller image of climate risks and adaptive capacity. Additionally, vulnerable groups within the communities such as small farmers, women, and marginalized people, which are disproportionately affected by climate change, can be identified using local evaluations. This makes sure that the adaptation strategies are inclusive and that it is also able to deal with social inequalities in order to make more effective and sustainable (Sahoo, et al., 2026). Local-level assessment also plays a key role in improving the decentralized climate resilient planning and governance. It provide a foundation upon which climate can be taken into account in the development plans at the grassroots level so that local institutions can place their actions into perspective based on the specific needs and risks. Such assessments help to allocate resources effectively, improve Disaster preparedness, and adaptation strategies that are context-specific. It also assists in tracking and assessing the interventions to climate, and learning and improvement is a lifelong process. Overall, local-level climate assessment is important to establish resilient communities and sustainable development amidst increasing climate uncertainties.

References

1. Intergovernmental Panel on Climate Change (2023). *Climate Change 2023: Synthesis Report*. Geneva: IPCC.
2. Ministry of Environment, Forest and Climate Change (2014). *India's Initial Adaptation Communication and National Action Plan on Climate Change (NAPCC)*. New Delhi.
3. National Bank for Agriculture and Rural Development (2015). *Climate Change Adaptation in India: Vulnerability Assessment and Resilience Building*. Mumbai: NABARD.
4. Indian Institute of Technology Mandi & Department of Science and Technology (2021). *Climate Vulnerability Assessment for Adaptation Planning in India Using a Common Framework*.
5. Government of Madhya Pradesh (Updated Version). *State Action Plan on Climate Change (SAPCC), Madhya Pradesh*. Bhopal.

6. United Nations Development Programme (2018). *Climate Change Adaptation and Human Development*. New York: UNDP.
7. Food and Agriculture Organization (2017). *Climate-Smart Agriculture Sourcebook*. Rome: FAO.
8. United Nations Environment Programme (2021). *Adaptation Gap Report 2021*. Nairobi: UNEP.
9. World Bank (2022). *Climate Risk Country Profile: India*. Washington, DC.
10. Indian Council of Agricultural Research (2020). *Climate Resilient Agriculture in India: Technologies and Strategies*. New Delhi: ICAR.
11. National Disaster Management Authority (2019). *National Disaster Management Plan*. New Delhi: NDMA.
12. United Nations Framework Convention on Climate Change (2015). *Paris Agreement*. Bonn: UNFCCC.
13. Hahn, M. B., Riederer, A. M., & Foster, S. O. (2009). The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change. *Global Environmental Change*, 19(1), 74–88.
14. Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, 16(3), 268–281.
15. Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*, 84(2), 242–261.