

Assessment of the Karnataka State Action Plan on Climate Change with a focus on stakeholder engagement in water and agriculture sectors

Reflections from policy analysis and on-ground surveys highlighting current status and pathways to bridge implementation gaps



A report by Centre for Environment Education with support from Hanns-Seidel-Stiftung India



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Executive Summary

Climate change is the most widespread, rapid, and intensifying phenomena of the 21st century. As per the 2021 IPCC report, India is set to experience extreme heat waves and droughts, and the extreme weather events will become more intense and frequent throughout the world. Such a climate scenario is an emerging threat for an ecologically sensitive, developing and agrarian economy like India and will likely threaten the survival and livelihood of rural communities dependent on agriculture and its allied sectors.

The Government of India proposed a National Action Plan on Climate Change in 2008 to mitigate climate change consequences on a national scale, while also encouraging the states to draft their state action plans to complement the missions whilst prioritizing their local needs. As a result, the Karnataka State Action Plan on Climate Change (KSAPCC) was formulated in 2011 and resubmitted in 2013, in which 31 priority areas were tagged as action points across different vulnerable sectors. The present study focuses on policy implementation in the agriculture and water sector, with an emphasis and progress made on the four identified action points, for each of these sectors.

The primary aim of this research study is to strengthen the efficiency of the KSAPCC, particularly in the Sustainable Agriculture and Integrated Water Resource sectors by reflecting on the implementation challenges, policy and communication gaps with an added emphasis on stakeholder engagement. The key research questions focus on the water and agricultural sector and are aimed at 1) Identifying factors influencing the efficiency of KSAPCC implementation 2) Analyzing outlined policy actions and on-ground challenges faced 3) Improving multi-stakeholder approaches and 4) Recognizing potential policy approaches, education and communication strategies to strengthen further implementation. The study was carried out using a two-pronged approach- policy analysis and qualitative surveys. Interviews with stakeholders from government, civil society and academics at the state level, as well as discussion with farmers in the Uttara Kannada region was conducted.

The KSAPCC is a fundamental policy document focusing on climate change at the state level, however, the next phase of this plan is under development. The policy analysis and synthesis of qualitative surveys reflect progress, and also showcases underlying challenges in terms of awareness generation, stakeholder involvement, coordination mechanisms, budgetary provisions and resource constraints, and above all climate uncertainty. The study concludes with recommendations for effective implementation of the statewide climate plan through strengthening bottom-up approaches in policy development processes, improved fiscal management, building resilience through enhanced scientific approach and strengthened decision making, capacity building requirements at different levels and promoting widespread awareness on climate change as well as its impacts.

Introduction

Human activity is causing the climate emergency to accelerate at an unprecedented rate. The effects of climate change are visible in every region across the world. Extreme weather events such as heat waves, cyclones and heavy rains have become more intense and frequent since the 1950s as a result of anthropogenic activity. Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the Earth's climate system, increasing the likelihood of severe, pervasive and irreversible impacts on people and ecosystems. The Intergovernmental Panel on Climate Change Assessment Report 6 (AR6) states that all climate models indicate a high likelihood for climate extremities such as droughts, tropical cyclones, wildfires and heavy rainfall by the end of the century. This will be further exacerbated by frequent pluvial floods and erratic rainfall patterns in the South Asian region (IPCC 2021: Summary for Policymakers).

As a result of increased scientific understanding, a growing number of impacts and more and more possibilities for cheap action, increased political and economic discussions on climate change were observed at the beginning of the 21st century. Limiting climate change requires substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks (Kumar, 2018). Climate policy requires planning and action for implementation at a global, national and subnational level. The mode of achieving rapid and sustainable climate action is through science-based targets, realistic and participative implementation and monitoring as highlighted by UNEP (UNEP, 2021).

Assessments carried out by the IPCC highlighted that countries mostly affected by climate change would be agrarian dominated, eco-sensitive economies in the global south. This group comprises mainly developing and emerging economies, having lower adaptive capacities, due to inadequacies of infrastructure, low education and income levels. In addition, slower response mechanisms of these nations are compounding their natural vulnerabilities (EMPRI & TERI, 2013). These countries have lower levels of resilience and carry an additional responsibility of meeting the development needs as well as economic progress of its vast population, to reduce the vulnerabilities.

Most governments acknowledge the need for rapid action and are increasingly adopting national programmes for mitigating climate change. Under the Paris Agreement of 2015, all countries are supposed to regularly (every 5 years) develop, submit and implement their so-called Nationally Determined Contributions (NDCs), including amongst others mitigation and resilience-building measures. The recent IPCC AR6 Physical Science report suggests that the Paris goal of limiting global warming to 1.5°C compared to pre-industrial levels is still in reach, if early action is taken globally. Within climate change adaptation, agriculture, followed by water draws maximum global effort, research, action, and funding for meeting challenges towards human survival. The challenges are



enumerated by sector specific studies, highlighted in action plans developed by individual countries (Singh and Schwarz, 2020; Rohilla et al, 2017; CST, 2014).

According to the scenarios of the 2007 IPCC report, a temperature increase of 2.7°C to 4.3°C by the 2080s, precipitation level rise of 6-8% and sea level rise of 88 cm by 2100 are likely in India (IPCC, 2007). Such a scenario would have a perceptible consequence for the livelihood and survival of rural communities largely dependent on agriculture and allied sectors, while also indirectly impacting the urban populations at large. Projected trends in climate change pose a looming threat for an ecologically sensitive, developing and largely agrarian country like India. To counteract such projections and promote economic and inclusive growth, the Government of India introduced the National Action Plan on Climate Change (NAPCC) in 2008. India was one of the world's first countries to propose a comprehensive policy instrument to mitigate climate change and adapt to its impacts in the form of the NAPCC. It sets out the pursuit of development goals that offer growth with long-term 'climate change co-benefits'. Through eight sectoral missions the NAPCC focuses on key sectors impacted by or having an impact on climate change, including agriculture, water, forestry, energy and urban planning. (EMPRI & TERI, 2013).

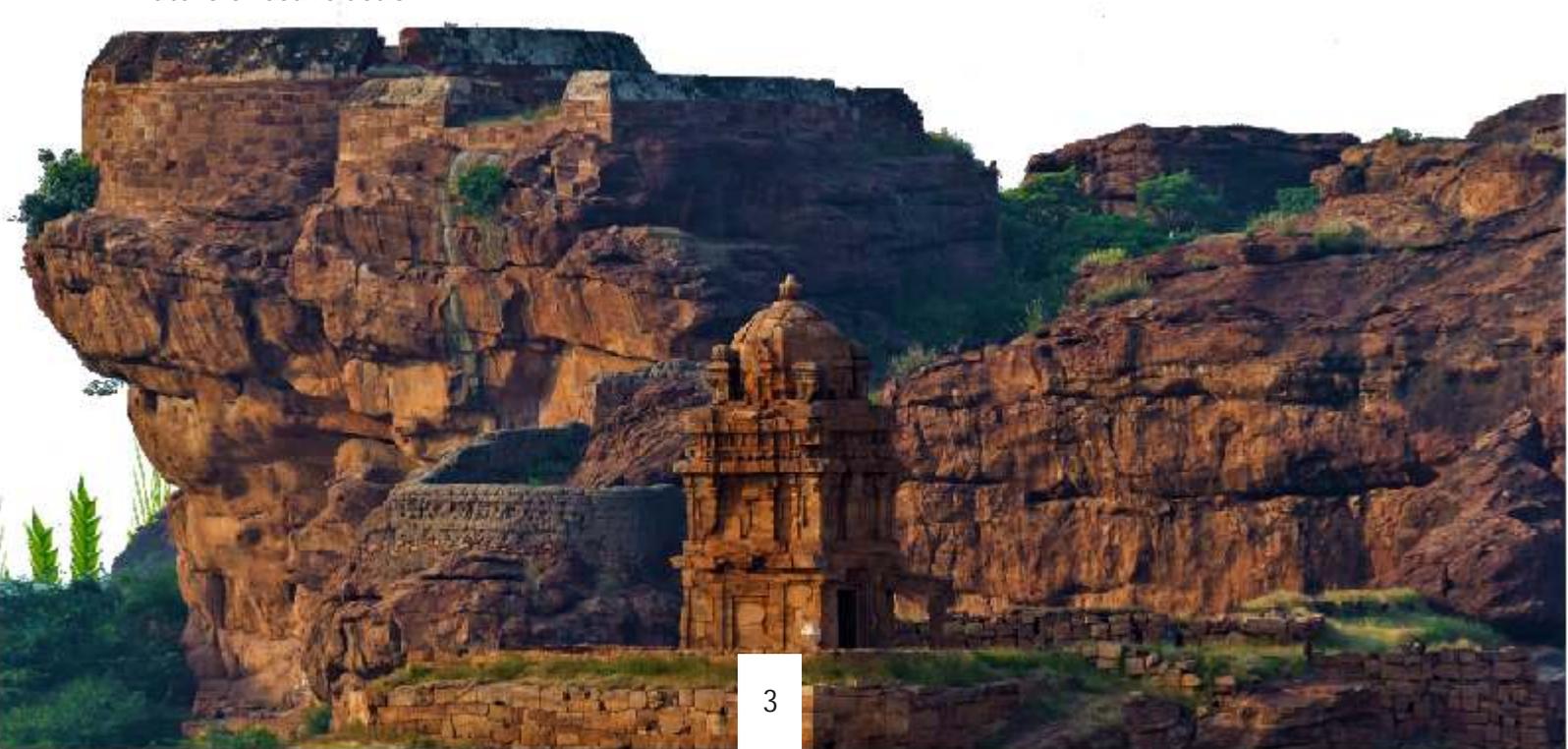
The states are the key implementation agencies of the NAPCC. The State Action Plan on Climate Change (SAPCC) is a framework of action for implementing the missions laid by the NAPCC and aligning them with the specific effects as well as vulnerabilities of climate change in each of the states of India. The plans outline the state's strategies for a range of sectors, including proposed actions and, in some cases, a timeline and budget for each. The rationale for the formation of the SAPCC was to decentralise action beyond the eight missions of the NAPCC, particularly covering subjects like water and agriculture which are actually state subjects. The Centre developed a Common Framework Document, with the assistance of expert agencies, to guide this process, stressing that it be participatory, build capacity, develop a vulnerability assessment, and draw on experts and donors for guidance and support. A number of states embarked on an ambitious plan formulation process. (Dubash and Jogesh, 2014)

The Karnataka State Action Plan on Climate Change

In June 2009, the Government of Karnataka organised a Co-ordination Committee to oversee the adoption of the NAPCC at the State Level. It mandated the preparation of The Karnataka State Action Plan on Climate Change (KSAPCC) to the Environmental Management & Policy Research Institute (EMPRI) and The Energy and Resources Institute (TERI), with the first assessment resubmitted in December 2013. The KSAPCC focuses on those sectors that are important to the local economy and livelihoods, such as agriculture, water, biodiversity, health, transport, energy, industries, urban development and forestry. The KSAPCC was the first policy document to tackle climate change on state level in Karnataka. It laid the ground for crucial mitigation and adaptation action. The revised version of the KSAPCC is under preparation in 2021 and is expected to be released in 2022.

Based on climate research and scenarios cited between 2004 to 2011, the KSAPCC identified scope for immediate actions. The document defined 200 actions of which 31 were tagged as priorities or entry points. It established sector wise target areas with determined action points. The implementation mechanism, determination of interventions and emerging trends in each section are based on missions identified in NAPCC. In order to achieve sector wise targets, the document charts out responsibilities of various departments for implementation of the plan and allocation of funds. The bulk of implementation with regard to individual action points as well as allocation of funds for each target area, and action point for five years beginning from 2012 till 2017, lies with the state government departments.

For the first attempt, the action plan has covered sectors of importance such as agriculture and water. However, the state-level action plan, being first of its kind and developed almost a decade ago, provides an adequate start for addressing climate change and lays a foundation to climate-focused planning. The present study investigates the effectiveness of KSAPCC from a stakeholder engagement perspective, particularly for strengthening the core sector of agriculture and water for future effective action.



The Agricultural and Water Landscape

Karnataka is divided into ten agro-climatic zones and observes three growing seasons. Agriculture contributes 28.6% to the state's Gross State Domestic Product (GSDP). Almost 65% of the geographical area of the state is under cultivation and agriculture accounts for more than 50% of the state's workforce (EMPRI & TERI, 2013). Among these, kharif, the monsoon season lasting from July to October, accounts for 70% of the annual food grain and oilseed production. As per the KSAPCC report, an overall increase in production and yield of major crops such as paddy, maize, and sugarcane has been observed over the last decade. The introduction of these high yielding varieties has progressively reduced the cultivation of traditional varieties of crops such as banana, mango and vegetables in the state, although specific figures for the increase as well as decline have not been quoted in the KSAPCC. The related loss of agricultural biodiversity is a serious concern. Droughts affect agricultural production in the state to a great extent, so do floods, to which especially kharif crops are prone. Agriculture is highly vulnerable to climate change because of its wide exposure to increasing temperature, precipitation change, pests and diseases. Studies suggest that a number of districts may become vulnerable with respect to crops presently grown. Likewise opportunities emerge in terms of improving cultivation conditions for a variety of crops in different areas. However, a net decline of 2.5% in agricultural production has been predicted by a recent study over the next two to five decades with a major reduction in coastal regions. (EMPRI & TERI, 2013)

The KSAPCC document has identified climatic, technical and social challenges in the agriculture sector with respect to the crop yield especially for dryland agricultural practices, theft of irrigation pipes, energy efficiency at farm level, agriculture and horticultural biodiversity. The Government of Karnataka has a broad and efficient policy framework to support agriculture and allied sectors. The Government of India also supports the state government through financial and technical support. Co-existence of policy framework by the state and initiatives led at the national level have provided opportunities for climate risk assessment and increased the resilience of the agrarian sector and its dependents. This is demonstrated in the KSAPCC document through programs and policies such as *Karnataka Agriculture Policy*, *High yielding varieties programme* which covers various integrated programs, *National Food Security Mission*, *Rashtriya Krishi Vikas Yojna*, *Bhoo Chetna*, *National Horticulture Mission*, *Sujala Watershed Programs*, *Schemes on Micro-irrigation*, as well as initiatives promoting organic farming.

In terms of water, the state of Karnataka has seven river basins and receives a total of 236 billion m³ of water every year, 92% of it through rainfall. Around 47% is 'lost' through evapotranspiration and another 46% flows into the Arabian Sea, into Andhra Pradesh and Tamil Nadu. Karnataka meets its requirement from the remainder of about 7.5% paired with groundwater. There are nearly 37,000 tanks and lakes with a water spread area of 6.9 lakh hectare and more than 20,000 irrigation tanks (EMPRI & TERI, 2013). As a study by NABARD-ICRIER (2018) points out, the physical water productivity, which is defined as the ratio of agricultural output to the amount of water consumed (from all available sources of water like rainfall, irrigation, etc), of rice (kg/m³) is lowest in Karnataka among 16 dominant rice growing states in India.

For Integrated Water Resource Management, the *Karnataka State Water Policy, 2002* has established a framework for projects such as *Rainwater Harvesting, Irrigation, Groundwater Protection, Water Resources Management, Sewage Management and Municipal Water Supply*. However, Karnataka is deprived of limited water resources and rapid conservation mechanisms need to be adopted as per KSAPCC, to meet the rising demand of water due to population, urbanisation, rapid industrialisation, and increasing incomes (EMPRI & TERI, 2013) - as well as climate change. Therefore, KSAPCC has laid out emerging intervention areas to assess the quality and quantity of water in the state. Intervention areas include assessments such as:

- Conducting spatial and temporal assessments of water availability for micro-watersheds and analyse trends using models such as Surface Water Assessment Tool (SWAT).
- Setting up dedicated facilities with advanced computing systems to make predictions for water resources.
- Conducting GIS based aquifer studies for assessing recharge possibilities; Conducting assessments on reducing evaporation losses within water storage structures, wastelands, fallow lands, agriculture lands through usage of mulches, canal lining etc.
- Conducting pilot studies to explore augmentation of water resources from flood water.
- Conducting studies on efficient crop water utilisation and pressure irrigation methods.
- Measurement of flows of major irrigation canals for accounting losses and improving efficiency, Regulating the use of bore wells
- Considering a policy on water metering for bulk consumers of groundwater
- Formulating a legal provision in by-laws of local bodies for water conservation (EMPRI & TERI, 2013)

About this Study

This research study aims to strengthen the efficiency of the Karnataka State Action Plan on Climate Change (KSAPCC) with a particular focus on Sustainable Agriculture and Integrated Water Resource Sector, through reflecting the implementation challenges as well as policy and communication gaps - with a special focus on stakeholder involvement. The study also seeks inputs from the state government functionaries and other stakeholders, including representatives from water and agriculture departments, grassroot organizations, knowledge partners and farmer groups, while drawing lessons in the form of recommendations for planning of capacity-building and educational interventions to be carried out by CEE in the next two years. The study also aims to highlight gaps which have acted as a barrier in the effective implementation of the priority action points.

The study report has been developed based on qualitative surveys as well as policy assessment, and provides recommendations for further improvements, as well as implementation of policies by multiple stakeholders such as government officials, policy makers, civil society and farmers. For this, deeper insights were gained on the challenges faced especially by the farmers about the on-ground implementation of the action points pertaining to sustainable agriculture and integrated water resource sectors, as mentioned in the state level climate change policy.

Objectives

The main objective of this study is to understand policy, education and research interventions undertaken in the field of climate change, with an emphasis on Sustainable Agriculture and Integrated Water Resource Management, that could complement or strengthen state level programmes under KSAPCC. It intends to recognize policy and implementation level actions as well as gaps within water resources and agricultural sectors, while also suggesting ways for strengthening linkages and exploring opportunities for possible areas of intervention.

Further, this study aims to investigate opportunities for improving availability and utilisation of water resources for sustainable agriculture in the evolving climate change scenario, that could be effectively implemented under the aegis of KSAPCC.

Lastly, this study would also help identify and establish partnerships with stakeholders for implementing the aforementioned objectives, and help develop Information-Education-Communication strategies for communicating the outcomes as a way forward, as well as developing a two-year plan to address potential policy and education improvements.

Key Research Questions

Based on its objectives, the key research questions for the study are as follows:

- What are the major factors influencing effective implementation of KSAPCC within the water and agricultural sector?
- What are the actions outlined for integrated water resources and sustainable agriculture in the KSAPCC, progress and challenges faced in their implementation?
- What are the ways to improve engagement of multiple stakeholders for better understanding of the focus sectors as well as KSAPCC implementation?
- What policy approaches, education and communication strategies could be designed for better implementation of the state-level plan?

Study Area

Flanked by the Arabian Sea, Karnataka is a coastal state in the south west of India. It is the eighth largest Indian state by size and the ninth by population. While the Western Ghats account for a bulk of the state's forest cover, over 77 per cent of its geographical area is arid or semi-arid, much of this is concentrated in North Karnataka. Karnataka is also the third most urbanised state in the country and water availability is a major concern (Jogesh and Dubash, 2014). The climate of Karnataka State varies from very humid rainy monsoonal climate in the West Coast, the ghats and mainland areas to semiarid warm dry climate on the east. There is a large variation in precipitation with higher amounts in the Western Ghats reducing towards the eastern plains (Irrigation in Karnataka, n.d.)

The study includes surveys of stakeholders from government line departments as well as Farmers group of Uttara Kannada through focus group discussions. The Uttara Kannada region has lately been drought prone, although it generally experiences a good annual rainfall. This was one of the major reasons for selecting this region as a study area. Farmers here have been facing drought every year in the summer season and lack of water storage management is affecting their agricultural practices. The city of Karwar is the administrative headquarters of the district. Karwar, Ankola, Kumta, Honnavar, Bhatkal, Sirsi, Siddapur, Yellapur, Mundgod, Haliyal and Supa are the taluks of the Uttara Kannada District. The main geographical feature of the district is the Western Ghats of Sahyadri range, which runs from the south through the district. Moisture-bearing winds come from the west, the yearly rainfall average is 3,000 mm (120 inch) on the coast, and as high as 5,000 mm (200 inch) on the west-facing slopes of the Sahyadris, which receive as little as 1,000 mm (39 inch) annually. Eighty percent of the district area consists of forest land. The Uttara Kannada district agro-climatic divisions include the Coastal plain (consisting of Karwar, Ankola, Kumta, Honnavar and Bhatkal taluks) and Malenadu (consisting of Sirsi, Siddapur, Yellapur, Haliyal, Joida and Mundgod taluks).

In Uttara Kannada district the study has covered six taluks- Haliyal, Supa, Siddapur, Sirsi, Kumta and Mundgod and eleven villages - Janaga and Yadoga (Haliyal tq); Alur (Supa tq); Dasanagadde and Hulimane (Siddapur tq); Tigani and Kantraji (Sirsi tq); Bhavikodlu and Harumaskeri (Kumta tq); Hunagund and Salagaon (Mundgod tq).

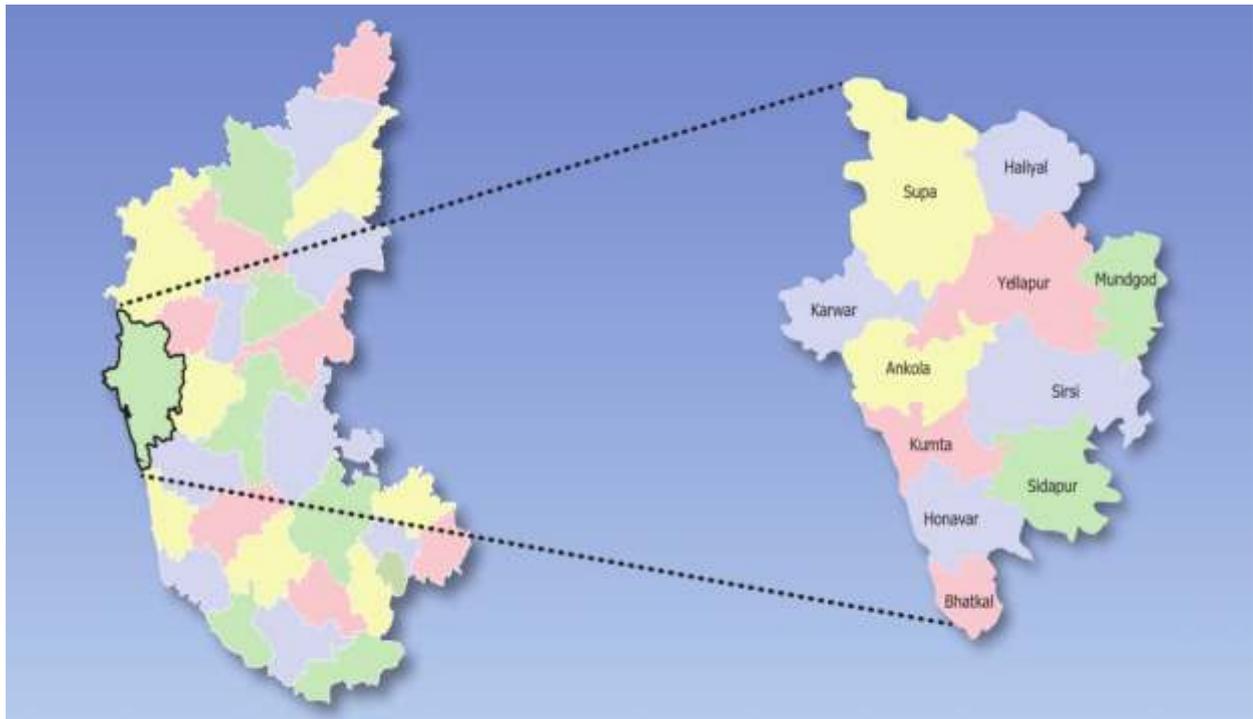


Fig 2. A map showing selected study area Uttara Kannada district, Karnataka State

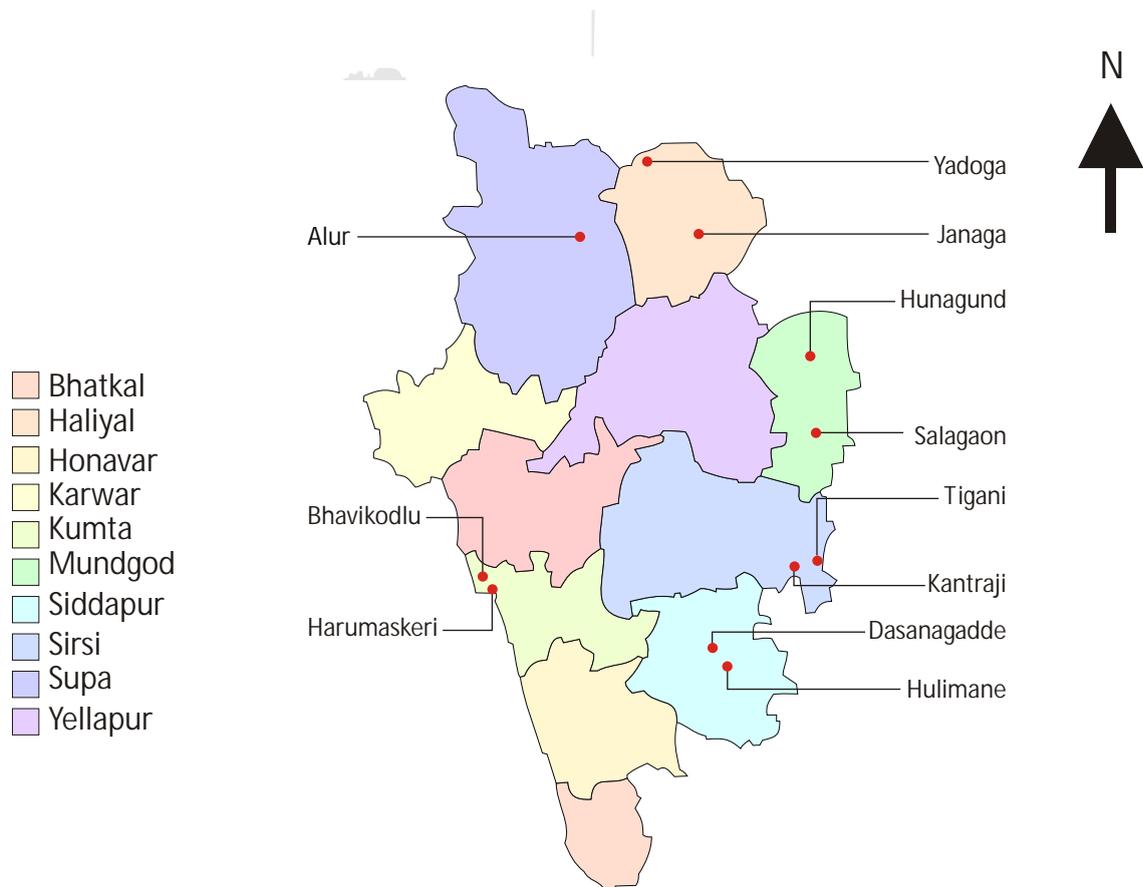


Fig 3. Above map showing the data collection points from the selected eleven villages in six taluks of Uttara Kannada district

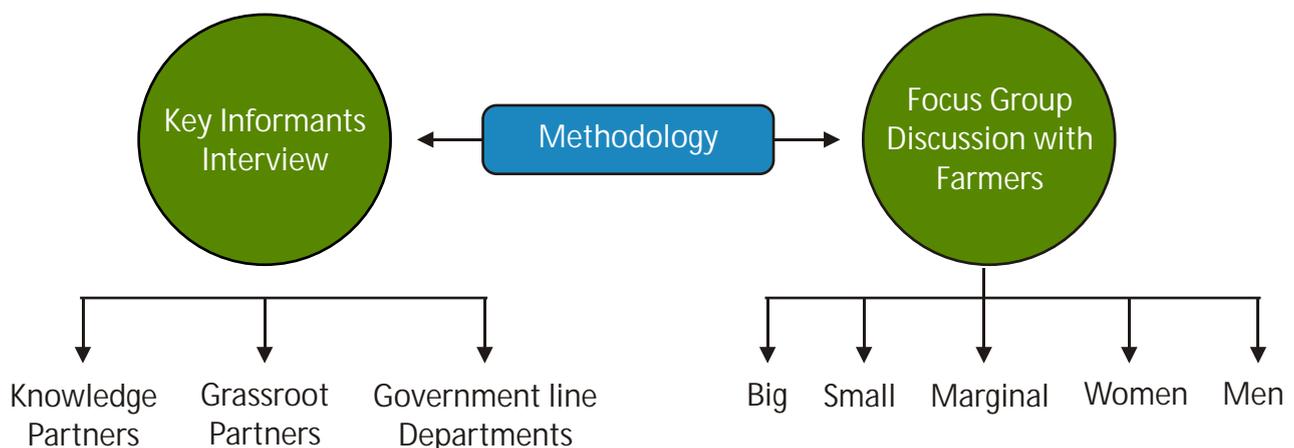
Methodology

The methodology of this study is two-fold: desk study of the public documents, majorly the KSAPCC assessment conducted by EMPRI and TERI (2013), and on-site research with qualitative data collection in semi structured interviews.

The secondary analysis of the KSAPCC document was done through developing linkages between the state-level policy and the key questions of the study. The state level action plan identifies a set of sector-wise priority actions to address climate change impacts in Karnataka. Out of these 31, 8 priority actions were identified as a focus areas of this study, and the inferences from the policy analysis as well as on-ground survey were drawn in line with these action points.

The primary data collection for the research study was undertaken by capturing views of different stakeholders through an open-ended questionnaire, with specific questions for target groups (refer Annexure I). The questionnaire consisted of two phases of questions, the first phase focused on key research questions aimed at understanding the current gaps in policy implementation and future improvements to be considered in the KSAPCC revisions. In the second phase, questions were focused on the respondents from each group to primarily understand their role and the risks and challenges being faced in the policy implementation and execution on the ground level. The surveys were done through online mode as well as in-person discussion with stakeholders.

The interviews were divided in 2 main categories as shown in the figure below.



The survey, which aimed to find the challenges in the State Action Plan on Climate Change and garner prospective policy recommendations for its effective implementation, covered responses from 11 Key Informant Interviews and 10 Focus Group Discussions. All interviews were held during the period of August to October in 2021.

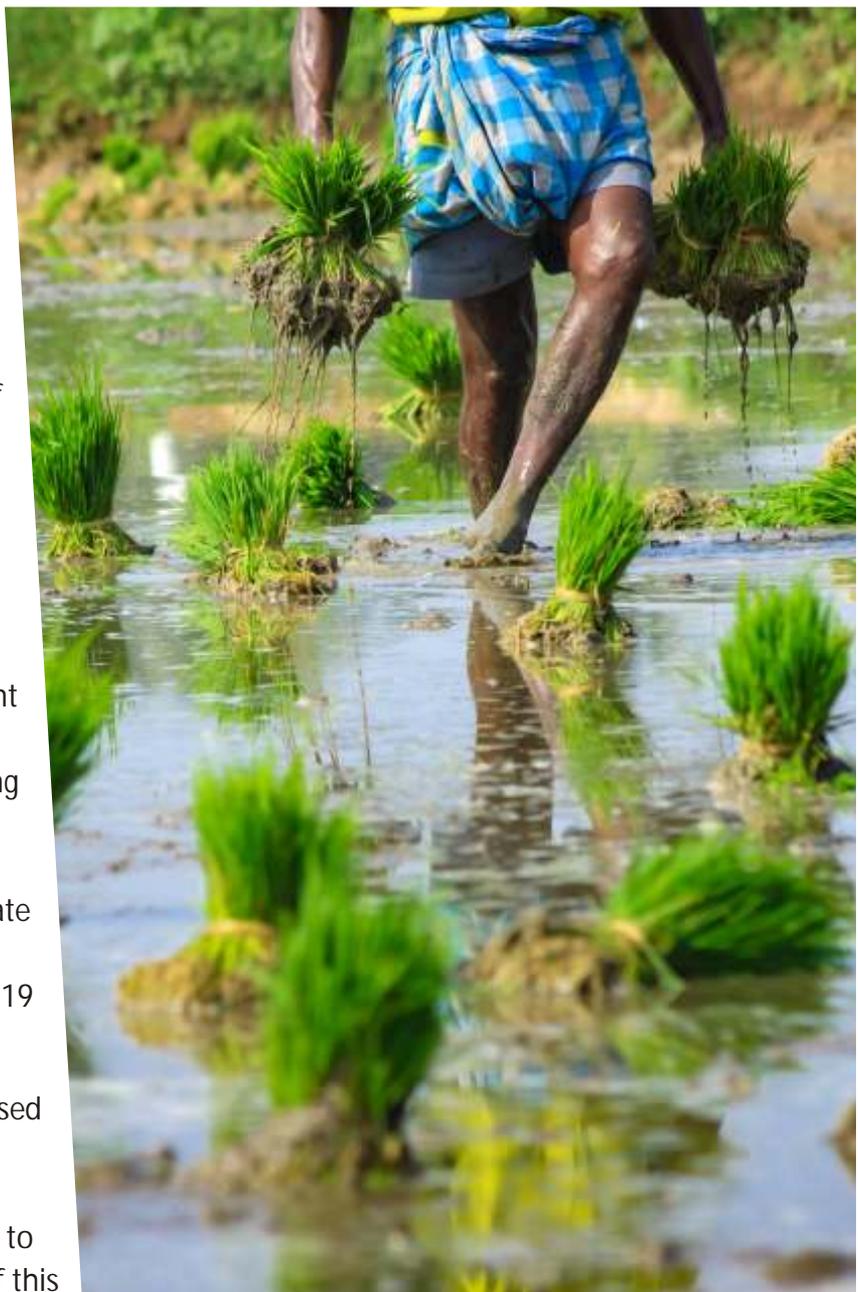
Key Informant Interviews

The key informant interviews focused on representatives involved in agriculture and water-related policy implementation and planning, as well as experts from research institutions, and grass-root NGOs. Interviews were conducted under 3 different categories- Knowledge Partners, Grassroot Partners and Government line department.

Knowledge Partners: This group comprised of research institutions from multi-disciplinary backgrounds, including Indian Institute of Science (IISc), Centre for Policy Research (CPR), Centre for Sustainable Development (CSD), The Energy and Resource Institution (TERI), Ashoka Trust for Research in Ecology and the Environment (ATREE) and Environment Management & Policy Research Institute (EMPRI). The institutions were identified owing to their long-term experience in climate change-related research projects and contributions at a policy level to combat climate change issues nationally. A virtual mode of interview was conducted, owing to the COVID19 situations.

Centre for Environment Education also organised a Knowledge Sharing Forum on November 11, 2021 where experts from different fields of education, water and agriculture were invited to provide their inputs on preliminary findings of this study, mainly collated through the surveys. Their insights and recommendations have been taken into consideration while preparing this study.

Grassroot Partners: An in-person interview was conducted with the Managing Trustee of Manuvikasa Organization, Sirsi, to capture insights on the role and support of grassroot organizations to support rural communities in implementing state-level policies. Manuvikasa has a long-term experience in working on lake rejuvenation and livelihood programmes for farmers in the selected study area of Uttara Kannada district.



Government Line Departments: An electronic mode of interview was conducted with representatives of Water and Agriculture Departments to understand the status of the current policies working on the ground and to identify the challenges in policy implementation and planning from a government's perspective.

Focus Group Discussions: The focus group discussion mode of the survey was conducted with farmer groups in the selected 11 villages of Uttara Kannada district. The discussion was conducted with five different categories of farmers including - Big, Small, Marginal, Men, and Women.



Analysis and Discussions

The Karnataka State Action Plan on Climate Change encompasses a total of 200 actions of which 31 are tagged as priority or entry points on climate change for the state, spread across multiple categories including implementation, data management, research and development as well as policy intervention; and covering a range of sectors. Out of these 31 priority actions, 4 from the agricultural sector and 4 from the water sector fall under the scope of this study (See Table 1). A more detailed analysis of these sector-specific action points and reflections from the qualitative surveys have been provided in the following sections.

Table 1. Priority Action Points for Agriculture and Water Sector

Reference #	Sector	Priority Action Points
2	Agriculture	Establishing a State Level Policy body for devising cropping shifts
3	Agriculture	Promotion of Dry land farming
4	Agriculture	Rendering theft of sprinkler pipes unviable
5	Agriculture	Creation of a market for indigenous agricultural crops
9	Water	Enforcement of Karnataka Groundwater Act
10	Water	Creation of Policy body for restricting groundwater use
11	Water	Introduction of a groundwater cess
14	Water	Revision of pricing policy for irrigation water

Source: EMPRI & TERI, 2013

Agriculture

According to multiple key informant interviews and focus group discussions, the policies working on-ground with respect to agriculture sector are *National Food Security Mission, Rashtriya Krishi Vikas Yojana as well as Bhoo Chetna*, which was completed in 2017, however its major technical core - micronutrient adoption has been continued through soil enrichment programs. Other than these, few policies such as the *Bhoo samruddhi programme*, and *Krishi Bhagya Yojana* are also being implemented according to the surveys conducted for the study.

Priority/Entry Point 2: Establishing state level policy body for shifting cropping patterns

The KSAPCC document mentions increasing crop yield production by promoting shifting cropping patterns in agriculture through *Establishing a State Level Policy body for devising cropping shifts*. It states that as temperature and rainfall change with climate, the agro-climatic features of a particular zone might become favourable for a new crop or may adversely affect the survival of existing crops. Thus, under such a scenario, shifting cropping patterns to diversify crops grown would help in sustaining agricultural activities and support economic resilience of the farming communities, reducing risks. A recommendation paper by Karnataka Jnana Ayoga 2019 also supports this theory and emphasises that diversity of cropping pattern is the key to minimizing both weather as well as market risks. It also affirms that a major shift in cropping pattern from paddy and sugarcane, to millets and pulses, following agro-ecological methods would not only reduce water consumption, but also reduce chemical fertilizer and pesticide consumption while also improving nutritional status, and improve soil quality, thereby creating a triple or quadruple effect on water, environment, incomes and nutrition.

As per the knowledge partners, at present there is no state level body for devising the cropping shift with reference to climate change. The discussion with farmers reveals a shift to millets due to drought conditions prevailing since the last three years. However, it was also found that most of the farmers are unaware of the necessity of changing their cropping patterns in the context of climate change as well as how various government schemes and policies could benefit them. Therefore, it was observed that farmers are quite reluctant to do the same - especially until extremely necessary like in drought conditions. It was also observed that while the majority of farmers were shifting crops from paddy to sugarcane farming to receive a higher production rate and owing to sufficient marketing values, some of the farmers have shifted cultivation patterns from water intensive crops (sugarcane) to less water intensive crops (maize) during the last ten years.

A need for proper prediction systems for suitable cropping patterns also emerged during discussions with policymakers and other stakeholders. Use of artificial intelligence and Drone Camera with GIS technology for weather predictions was suggested, which could be later communicated to farmers to adopt crops that best fit.

Priority/Entry Point 3: Promotion of Dry Land Farming

According to the State Action Plan of Karnataka, dry land farming could become a successful technique to address the issue of water scarcity and fodder unavailability, especially in the northern Karnataka region, which could also offer a reliable source of income to rural communities, largely dependent on agriculture for their income. Thus, promotion of dry land farming in Karnataka has been identified as one of the entry points needing immediate action. Karnataka also has one of the largest areas under dry land agriculture, hence an intervention that enhances productivity is identified in the KSAPCC to provide distinct advantages to the state. For this priority action point, mechanisms such as creation of model farms and villages, establishment of fodder banks as well as development for suitable drought and pest resistant crop varieties, are suggested in the action plan, which also form a part of the National Mission on Sustainable Agriculture. Contrastingly, the surveys portray farmers being unaware of policies or schemes pertaining to this particular action point.



The farmers of Uttara Kannada region reported experiencing drought-like conditions, especially during the years 2016 to 2018, which further enhances the need for implementation of dry land farming techniques since it conserves maximum amount of water through water and soil management practices, which is extremely beneficial for areas receiving uncertain rainfalls. FGDs with farmer groups also reveal that they have been growing dry farming crops like millets, post experiencing the drought conditions.

Priority/Entry Point 4: Rendering theft of sprinkler pipes unviable

As per the State action plan on climate change, Karnataka is promoting the adoption of water efficient technologies such as drip and sprinkler irrigation techniques with a view to enhance water productivity and consequently, the cost of cultivation. The state's Department of Rural Development and Panchayati Raj promotes rainwater harvesting and sprinkler irrigation systems under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), as a drought proofing measure. According to the recommendation on Karnataka State Water Policy as submitted by Karnataka Jnana Ayoga, key technological innovations, along with expansion of drip and sprinkler irrigation, could help reduce water use even in the more water intensive crops such as paddy and sugarcane.

The KSAPCC document states that expansion of micro-irrigation is hampered due to security concerns of distribution pipes. KSAPCC suggests this issue to be tackled through eradication of the market for stolen pipes to be done by redistribution of existing subsidies on micro irrigation and bringing the farmer's net cost of distribution of pipes below the black market cost.

The farmer groups revealed that as their agriculture is mainly rain-fed, their need for sprinkler and drip irrigation increased due to extreme drought-like conditions especially during the years 2016-18. The acute water shortage has led the farmers to implement drip/sprinkler irrigation methods, which they found beneficial in supporting agriculture during the drought period. It was also observed that they are not aware of schemes related to this action point.

Priority/Entry Point 5: Creation of a market for indigenous agricultural crops

One of the action points states creation of a market for indigenous agricultural crops. As per the state action plan, indigenous resilient varieties of crops such as maize, rice, sorghum require interventions to safeguard their conservation. These indigenous varieties need attention not only to conserve gene pool but also to combat climate change impacts.

The introduction of high yielding varieties (HYVs) has progressively reduced the cultivated area for traditional varieties in the state. The KSAPCC document mentions how landraces of many crops have provided the genes needed for pest and disease resistance and/or for the crops to adapt to poor soils, drought and cold temperatures. Hence, the need for creation of a market for indigenous agricultural crops is a necessity to enable farmers to opt for these varieties. Promoting growing of these crops and supporting the entire value chain for their marketing would be necessary.

However, after interviewing farmers, it was observed that farmers were largely unaware of the importance of cultivating climate-resilient indigenous crops as they continue to grow crops which are water intensive, such as sugarcane. It appears that cropping decisions are made based on economic benefits from the yield and not as an informed choice.

Water

The policy analysis reveals that *Karnataka State Water Policy and Mahatma Gandhi National Rural Employment Guarantee Scheme* outlined in the KSAPCC are being implemented on the ground. The latter scheme ensures livelihood and food security by providing unskilled work to people through creation of sustainable assets in the rural areas, and is also being implemented for the farmers of the agricultural sector.



Other than these, according to the conducted surveys, policies and schemes like *Rejuvenation of rivers, Infiltration wells, Kere Sanjeevani, Karnataka Integrated Sustainable Water Resources Management & Investment Program (KISWRMIP), Atal Bhujal Yojana and Suvarna Krishi Honda programme* are implemented. Also, as per interviews with the Government-line departments, for Integrated water resource management, watershed development scheme, rainwater harvesting for recharge of ground water in urban areas, inter-basin water transfer, and ground water regulation schemes in various sectors including domestic, irrigation and industrial, are being implemented.

Priority/Entry Point 9: Enforcement of Karnataka Groundwater Act

According to the KSAPCC document, groundwater, which is one of the important sources of irrigation has been indiscriminately used in the state with the extraction levels exceeding 100 per cent in many regions. The document states that in the agriculture sector, surface irrigation sources and traditionally used tanks have lost the cadence of irrigation and there has been a shift on the development of groundwater based irrigation that has also led a way for intensive multi-season agriculture. Thus, the

groundwater withdrawal is far in excess of recharge leading to declining water levels and increasing pumping costs.

The findings of the current study reveal that the farmers have been using rainwater harvesting pits/tanks as well as constructed *Krishi Honda* (farm pond to harvest rainwater) to mitigate drought

like conditions under the *Suvarna Krishi Honda* Programme. This scheme helps the farmers store the rainwater, preventing it from draining away while recharging and rejuvenating groundwater and provision of water during drought conditions, thus improving farmers' economic conditions by means of encouraging agricultural productivity.

Priority/Entry Point 10: Creation of Policy body for restricting groundwater use

The Karnataka State Action Plan on Climate Change focuses on Groundwater resources that are subjected to over-extraction, especially in 35 overexploited and 3 critical taluks, as quoted in the plan. It states that unplanned and excessive extraction of groundwater may lead to a no-water situation in the near future. To avoid such situations, there should be adequate mechanisms to restrict groundwater use and also to promote groundwater recharge. A study by NABARD-ICRIER (2018) also concludes that “at the present level of water stress existing in the country, there is need to re-calibrate the cropping patterns in line with their physical water productivity (particularly for water guzzler crops like rice and sugarcane), and not remain obsessed with only their land productivity. Else, the country will be moving towards unsustainable agriculture from a water availability point of view, raising risks for the farmers, and promoting extreme inequity in the use of scarce water resources.” Thus, creation of a policy body for restricting groundwater use in Karnataka is essential to address the issue of water scarcity, but its current status is unknown to the policymakers, as per the surveys conducted during the study.

The key informant interviews reveal implementation of regulation schemes regarding ground water extraction for various sectoral uses such as domestic, irrigation and industrial. The knowledge partners also suggested implementation of schemes that could effectively include scientific evidence for better utilisation of groundwater resources like converting dry borewells into groundwater recharging pits for improvement in groundwater table, as well as surface water remediation at contaminated sites to improve groundwater quality.

Priority/Entry Point 11: Introduction of a groundwater cess

The Karnataka Water Policy 2002 mentions that the utilisation of groundwater within the state is not uniform. The interior parts of Karnataka (both in the North and South), utilise more groundwater than the coastal regions. This has led to several wells drying and thus rendered farmers' investments to the extent of Rs. 2000 crores infructuous. According to a status report which is a part of State Specific Action Plan (SSAP) on Climate Change for Water Sector by Public Affairs Centre (2017), there is over-extraction of ground water in 43 Taluks of the State; where in 29 Taluks, over 50% of the available groundwater has already been extracted. As per the KSAPCC document, there is vast potential for collection of rainwater for productive use, groundwater recharge and temporary storage in water bodies in order to reduce the irrigation dependency on groundwater, which was 45% during 2013, remains to be utilised.

This could also be addressed through introduction of groundwater cess, one of the priority action points of the KSAPCC. The groundwater fund created through collection of this cess is planned to finance groundwater recharge schemes proposed by the private and public project proponents. Although groundwater cess was not particularly captured in the surveys, the study revealed that Advanced Centre for Integrated Water Resources Management (ACIWRM), a think tank to government's Water Resources Department (WRD), designed a new approach for groundwater management in partnership with people, Gram Panchayat and Civil Society organizations to prepare a Gram-Panchayat water security plan.

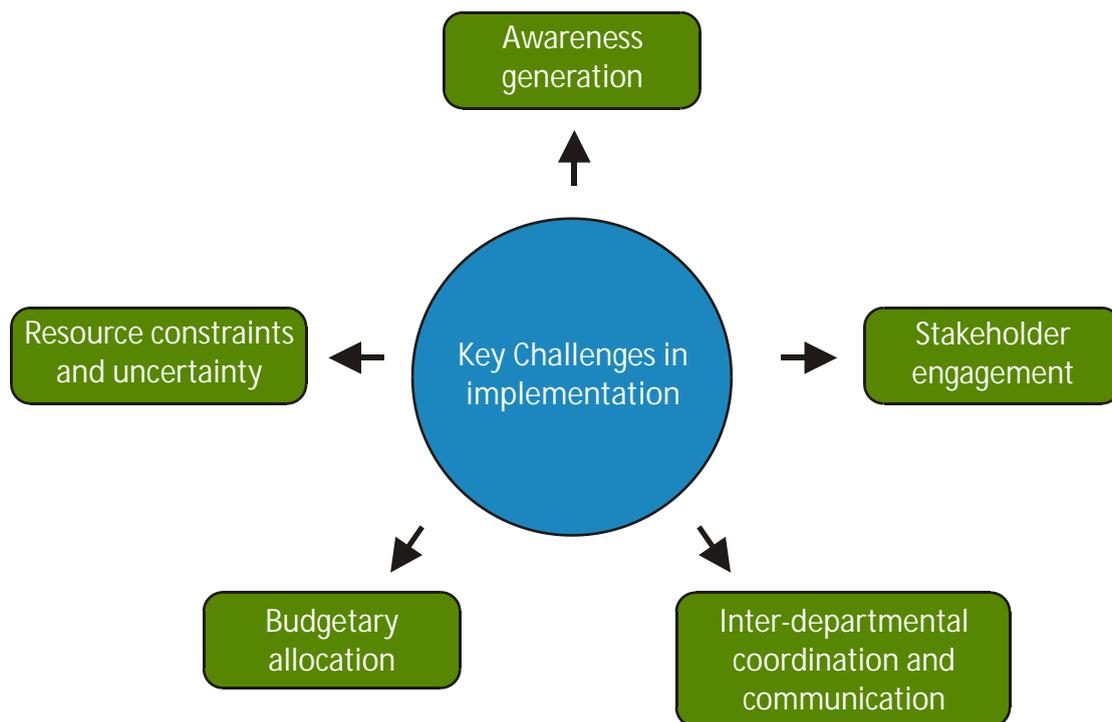


Priority/Entry Point 14: Revision of pricing policy for irrigation water

As recognised by the 2002 Karnataka Water Policy, the rainfall in the state is erratic and not distributed evenly. Thus, the state's irrigation system is highly dependent on surface water from perennial rivers, while groundwater is a fast depleting source of water for irrigation.

One of the priority action points of the plan is the revision of pricing policy for irrigation water. According to the KSAPCC document, low priced irrigation water is a substantial impediment for investment in water infrastructure and sustainable resource utilisation and management, thus there is a need of cost benefit analysis in order to assess the financial burden of irrigation water and to formulate a pricing policy rationalising irrigation in view of efficiency, cost effectiveness and long-term sustainability and the need for adequate finance. The surveyed farmers were unaware of any such pricing policy for irrigation water.

Key Challenges in implementation



1. Awareness amongst farmers:

The interaction with farmers showed that a larger part of the farming community is unaware about climate change and its impacts, especially in terms of the significance of shifting cropping patterns and dry land farming practices, as well as about the necessity of optimum water utilisation for growing crops with maximum production. The knowledge on climate change and its impacts, is critical for the farmers in devising adequate adaptation mechanisms and building resilience.

Apart from the climate-related knowledge, the focus group discussions also highlighted that the farmers, who are the primary beneficiaries of such schemes, have been unable to benefit from most of the state sponsored schemes outlined in the KSAPCC due to limited information about these schemes and their advantages.

Government/panchayat officials should educate farmers in our village about shifting cultivation in every farm land based on the resource availability which will help everyone to grow different crops with coordination at the same time without any competition. Proper information about the schemes/policy from government officials, committee members or from panchayat officers should be made available for maximum benefits.

-Big Farmer Group-1, Uttara Kannada, Mundgod, Salagaon

If the government guides us we can adopt changes in farming methods.

*-Small Farmers Group-2, Uttara
Kannada, Sirsi, Kantraji*

Efforts have been made by NGOs such as Manuvikasa in organizing programmes to increase livelihood and farm yield.

*-Women Farmers Group-2, Uttara
Kannada, Siddapur, Dasanagadde*

Schemes introduced in the action plan are not communicated to farmers properly so programmes & knowledge-sharing related to climate change should be published/ telecasted in newspapers/news to increase capacity building of farmers.

*-Dr. T.V. Ramachandra, Scientist EWRG,
CES, Indian Institute of Science (IISc)*

We have witnessed an increase in temperature over the decades which has led to an increase of disease and pest attacks on crops.

*-Marginal Farmer Group-2, Uttara
Kannada, Siddapur, Hulimane*

2. Stakeholder engagement:

The KSAPCC document highlights a need for engagement of stakeholders from development of the policy to its implementation, along-with subsequent outreach mechanisms. Policy level and on-ground challenges are outlined in the KSAPCC for the agriculture and water resources sector, however most of these issues were not reflected during the surveys, seemingly due to the communication gaps in translation of policies as well as climate-relevant knowledge into actions.

The farmers' group stated that they have been benefiting from the Central Government schemes implemented within the state, however the state schemes have not been benefited by all the farmers. The surveyed farmers believe that the state schemes are mostly meant for farmers of specific caste categories, hence they all have not been able to benefit from them.

Farmers are scared to adopt newer agricultural practices due to fear of less yield and productivity. Government should take the NGO's opinion before planning the action plan and also include their views and recommendations into it.

*-Mr. Ganapati Bhat, Managing Trustee,
Manuvikasa*

Panchayat officers should provide proper guidance to farmers about policies and schemes implemented from both central and state governments.

*-Small Farmers Group-1, Uttara
Kannada, Sirsi, Tigani*

3. Inter-departmental coordination and communication :

Climate change being a cross-cutting issue, needs to be addressed jointly by government line departments. The policy mentions no specific mechanisms for coordination among departments and joint implementation of activities to mitigate climate impacts. Also, the state action plan elements are not designed in tandem with the ongoing or potential activities of the key departments..

Panchayat Raj level programmes and climate change cell should be introduced in every taluka and village to bring awareness amongst individuals about current issues and predictions related to climate change.

-Dr. Shrinivas Badiger, Associate Professor, Ashoka Trust for Research in Ecology and the Environment (ATREE).

4. Budgetary allocation :

The surveys showed that the budget allocated for the policies are not aligned with the time-frame and have mostly expended towards administrative purposes and awareness raising. Additionally, price rates for labour, hybrid seeds and chemical fertilizers have increased drastically which had a huge impact on the farmers' income. The farmers also brought up the issue of the schemes being benefited only by farmers who have their own farm lands, however farmers' with lands under revenue/forest department have not been able to take advantage of those schemes.

We face financial constraints due to an increase in the price of labour charge, seeds and chemical fertilizers. We need a reduction of hybrid seed price in the market through some schemes. Currently, livelihood programmes are organized quarterly in a year by Manuvikasa, followed by entrepreneurship and skills development programmes.

-Women Farmers Group-1, Uttara Kannada, Dandeli, Alur

We have shifted from organic farming to chemical farming to increase crop production and counteract increase in pest attacks resulting in decreased soil fertility in our farm lands. We require knowledge sharing from panchayats and other government agencies to find out schemes applicable to us and avail State Government schemes. We need a reduction in seed rate and increase in crop prices in the market through any policy/scheme/committee from the government.

-Men Farmer Group -1, Uttara Kannada, Haliyal, Janaga

Schemes implemented in future should avoid category wise benefits and make it general so that every farmer will be benefited from the schemes.

-Big Farmer Group-2, Uttara Kannada, Mundgod, Hunagund

5. Resource constraints and uncertainty :

Few farmers are benefiting from the Central Government schemes i.e PM Kisan Samman Nidhi, etc. The farmers stated that they have hardly been able to benefit from the State sponsored schemes. In addition, financial issues have been increasing from the past ten years due to continuous increase in the price of agricultural resources. Weather events and resultant drought conditions had exacerbated their problems.

We need Farmer Producer Organizations (FPOs) for regulating prices of vegetables when they reach the market with guidance and assistance from NGOs or Government.

- Marginal Farmers Group-1, Uttara Kannada, Kumta, Bhavikodlu and Harumaskeri

We have experienced acute water shortages from 2016-2018 which led to zero yield in our farmland. Villagers also require life insurance schemes in case of death due to wildlife attack / tree collapse whilst working in farms.

-Women Farmers Group-2, Uttara Kannada, Siddapur, Dasanagadde

Conclusion

The Karnataka State Action Plan on Climate Change is the first ever plan which establishes a comprehensive roadmap, to tackle the issues of climate change in the state through provision of a scientific framework, while also outlining various challenges and highlighting feasible action points to be implemented by various sectors.

The policy analysis and synthesis of 21 qualitative surveys, focused on water and agriculture, reflect underlying gaps in the implementation of priority action points defined in the state action plan. The KSAPCC (2013) was the first of its kind and understandably shows shortcomings in planning due to limited data available on climate change observations and scenarios for Karnataka and limited capacity in local climate policy making. The challenges mostly occur due to the fact that a few important factors were not fully taken into consideration while designing the state level policy and plays a crucial role in effective policy implementation. As per the study's focus on water and agriculture, this majorly includes participation of public, civil society and other stakeholders during the formulation of policies, lower allocation of funds and awareness level among farmers pertaining to government policies as well as climate change impacts. Other policy gaps have emerged due to reluctance of uncertainty among farmers to adopt new methods and technologies in farming as well as limited coordination and convergence with various departments during preparation of the KSAPCC. Furthermore, the deeper review of the KSAPCC document shows that the departments found it difficult to allocate proper funds for the implementation of certain action points, due to their generic nature. These challenges are expected to be addressed in the second phase of the KSAPCC, which is under revision.

Lack of understanding amongst farmers regarding climate change and changing rainfall patterns, emerged as one of the most significant challenges faced to adapt to climatic changes. For instance, on one hand an action point states creation of a market for indigenous agricultural crops and the study shows that farmers are not easily accepting the new schemes drawn by the government, however on the other hand, expansion to other crops is a necessity according to the changing agro-climatic zones and climate scenarios. Additionally, it is in the farmers' interest that the category wise benefits of state-sponsored schemes are removed in the future and that all schemes are made generally beneficial to every farmer.

The study also identifies the gap of over a decade in the revision and scientific approach of the KSAPCC. Most policies have an implementation period of 2 to 5 years, which makes it necessary for the state government to revise and review the action plan, for necessary updates from time to time.

Recommendations

Strengthen stakeholder engagement and public participation

- Participatory approaches need to be encouraged, through effective stakeholder engagement right from the development stage of the policies and plans, in order to enhance ownership amongst the stakeholders as well as ensure effective on-ground implementation. Provision of hand holding support to the beneficiaries could also prove fruitful.
- Public hearings and/or consultations to take periodic reviews from the beneficiary group, while formulating the plan, could help in subsequent implementation of the policies in the long run.
- Enhancing interaction and collaboration among various stakeholders from policy, practice and research backgrounds at the state level, to inform farmer-driven policies and devise climate solutions.
- Strengthening interlinkages between government line departments at district level, as well as with that of the Gram Panchayats, is extremely essential, especially for increasing the efficacy of the KSAPCC's water and agriculture priorities.

Enhanced scientific approach to build resilience

- Closing the research gaps at both local and state level, to tackle the challenges of climate change in the agriculture and IWRM sectors, is required, in accordance with the recent climate variabilities in Karnataka as well as the latest IPCC report showcasing dangerous impacts of climate change in the South Asia region.
- Promoting exchange of local scientific information and traditional knowledge, to inform the farmers about suitable cropping patterns as per the changing climatic conditions, while taking into account farmers' perceptions and cognition processes. This could be done via seasonal advisories and weather forecasts using mobile-based tools and community radios, and organizing community-level drives.
- Expanding farming to other crops is a necessity due to the changing agro-climatic zones and climate scenarios, this could be well supported by scientific evidence and local research for helping farmers choose the most suitable crops for their area.
- Creating efficient and widespread prediction systems for advising suitable cropping patterns, coupled with water budgeting and water security planning exercises at the local level, could prove helpful in the crop selection process and has the potential to increase the overall yield.

- Designing and implementing schemes for better utilisation of surface and groundwater resources, built over scientific evidence is recommended, along-with a monitoring system for ground water level as well its quality. For example, converting the dry borewells into ground water recharging pits, so that water table levels could be improved and used sustainably.

Strengthened decision making and coordination

- Mainstreaming the action points of the state climate action plan into major initiatives of the departments, has the potential to make an impactful difference, especially in context to the speedy implementation of the KSAPCC.
- Platforms for better coordination between the centre and state government on climate change plans and policies need to be developed, to promote cross-sharing of knowledge and implementation challenges.
- Promotion of bottom-up approaches within the policy formulation process helps to build on the experience and knowledge of local stakeholders and communities, improving transparency, stakeholder participation, successful and cost-effective implementation of policy solutions.
- Climate change schemes with specific sectoral linkages are required to be revisited, through periodic review mechanisms and measurement of the progress made every three years, reflecting on the current climate stresses and building on the past achievements of the action plan.
- Creating coherence between divisions of the government handling closely-linked climate-vulnerable sectors like water and agriculture, for coherent implementation and action on the ground.
- Breaking down the targets mentioned in the state-level action plan into district, block and village level plans could increase the implementation efficacy manifolds.
- Ensuring a decentralised integrated watershed management approach for sustaining rain water and rejuvenating the lakes and ponds in Karnataka.

Capacity building and education

- Developing Gram Panchayats into key information and resource centres, for providing proper guidance and information to farmers about water as well as agriculture-related policies and schemes, being implemented by both central and state governments.
- Fostering interaction with farmers and departments, probably through Water User Cooperative Societies (WUCS) that interact with the departmental agencies on a regular basis.

- Enhancement of knowledge and skills related to comprehending climate change impacts and locally-led adaptation methods need to be offered to the farming community, with supportive measures for better implementation of coping mechanisms like shifting to less water intensive crops and proper utilisation of water resources, especially in water-stressed areas. Choice of crops, growing resilient plant varieties, intercropping, mulching, etc. are other such practices.
- Capacity building of farmers on climate-resilient technologies with complementing energy solutions emerges as one of the needs. Like, micro irrigation and sprinkler irrigation through sensor based monitoring systems, for promotion of better utilisation of water resources.

Improved financial mechanism

- Proper budget allocation and guidelines for reorienting existing funds in the relevant departments, for effective implementation of the sector-specific priority action points and in line with the specific time-frames in the plan, with recommendations from the departments responsible for the scheme implementation.
- Financial support and/or subsidies to farmers in times of high labour prices and increasing costs for hybrid seeds as well as chemical fertilizers, especially considering the uncertainty related to climate.
- To ensure financial security for the farmers, inter cropping needs to be promoted for de-risking farming.

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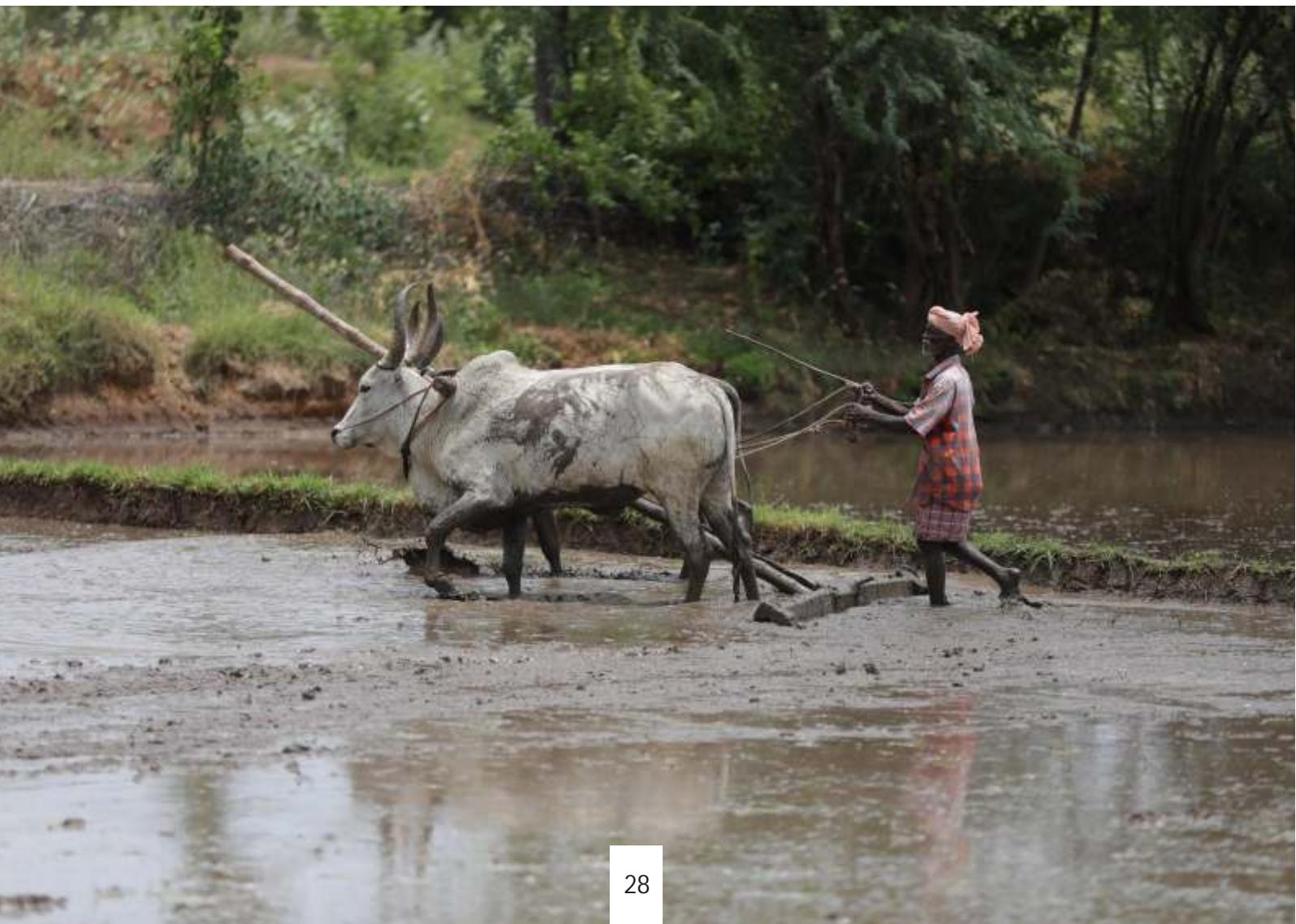
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Annexure

Annexure I: Questionnaire

Key Informant Interviews (Common for all KIIs)

1. What are, in your view, the most important policies in action/implementation of KSAPCC on climate change, water and agriculture? OR What is the implementation level of action of various schemes and policies in the water and agriculture sector?
2. What is the most successful policy/scheme implemented in the sustainable agriculture sector in the last 5 years?
3. Who are the beneficiaries of the successfully implemented policy schemes? Why do you think these schemes have achieved a higher success rate?
4. Have the successfully implemented schemes achieved participation of women in implementation, if yes, how?
5. What do you think are the challenges in implementing remaining policies? (Ask for certain specific example, try to get insights on policy itself and on-ground implementation)
6. What could be the approach/steps/measures/line of communication for achieving a better policy framework and implementation for the Karnataka action plan?
7. The study mentions coastal, north eastern Karnataka, and Western Ghats as most impacted by Climate Change, within these regions, which districts, taluks or blocks, villages would you say, is most impacted (most vulnerable ones) or achieved least implementation success? Any successful initiatives which you could highlight in these areas? Any recommendations for future action?
8. Could you mention or facilitate establishing contact with ground partners and key resource people within agriculture and water government line departments, NGOs working on ground and researchers within Karnataka?

Government line departments-Agriculture

1. Apart from National food security mission, Rasthriya Krishi Vikas Yojana, Bhoochetna, Insurance schemes, which recent schemes should be included in revised version of KSAPCC as per your opinion?

2. Do you think the allied field of horticulture, watershed development, organic farming, fisheries, animal husbandry have been sufficiently represented and implemented? If not, how could this be improved?
3. Livestock amount to 20.2% of Karnataka's GHG emissions. Is there any scheme/policy for this?
4. How has organic farming been integrated for implementing Climate change measures in Karnataka? The report mentions there is no large-scale expansion of the 'State level organic farming mission (2008)' programme. Do you think that holds true on the ground?
5. Are there any dry land farming practices adopted in Karnataka in line with Climate change?
6. What is the departmental integration achieved within the priority area of dryland farming and agroforestry for matters of improved carbon sequestration, tillage techniques, in-situ conservation and inputs from international research?
7. KSAPCC talks about risk management and insurance in agriculture. What are the major risks as per your experience in the sector?
8. Are there any prediction systems in place for cropping patterns that could help cope with the climate change uncertainties?
9. How would you expect stronger stakeholder integration being a benefit for policy making and implementation of KSAPCC in future?

Government line departments-Water

1. The irrigation dependency on groundwater (at present 45%) could be reduced through effective use of rainwater collection which according to the KSAPCC reports have a vast potential but yet remains to be utilised. What could be the reason?
2. What are the potential for improving utilisation of surface and groundwater resources, for sustainable agriculture with climate change linkage within the Action Plan?
3. Some of the key identified areas within water resources are rainwater harvesting, water resource management, ground water demand and pressure from agriculture, etc. Is there any estimated rate of success for the areas? If yes, how much? Could the list of areas be further improved?
4. How has the water resource database helped in achieving implementation goals and target points within the KSAPCC?
5. Could you shed some light on promotion of citizen and state action for sustainable water consumption, conservation and augmentation, basin wide approaches for integrated water resources management. What do you feel has worked and what hasn't worked?

6. How would you expect stronger stakeholder integration being a benefit for policy making and implementation of KSAPCC in future?

Knowledge partners

1. What are the key research recommendations which should be included to strengthen the action plan from Karnataka, India or International research?
2. How would you expect stronger stakeholder integration being a benefit for policy making and implementation of KSAPCC in future?

Grassroot partners

1. Could you please provide a brief profile of your organization, motivation, focus areas and regional presence in Karnataka?
2. What are the challenges you face when interacting with government line departments and farmers for implementing schemes for Karnataka's agriculture and water issues?
3. Do you find participation of women and girls in the conversation around climate change, agriculture, and water while working on ground?
4. How do you achieve successful implementation of various schemes on ground?
5. How would you expect stronger stakeholder integration being a benefit for policy making and implementation of KSAPCC in future?

Focus Group Discussions

1. What crops are you growing? What are the allied agricultural activities in your farms?
2. What climatic and weather conditions have you seen change over the decades?
3. What are the changes in crop production at your farms in the last ten years or so?
4. What is/are the source of water for your fields? How often have you heard about climate change? Do your kids talk about it? What does Climate change mean to you?
5. Do you face acute water shortages? What are the other challenges you face?
6. These are the schemes implemented- Which do you find beneficial?
7. Have there been any efforts to organize farmers for increased livelihood and farm yields? What are the other reasons for such organizations?
8. What changes have you seen which would help fight climate change in the last (say) last few years (1 to 10 years)?
9. Are you aware about KSAPCC and its importance?
10. Would you like to be consulted on the KSAPCC? How? If yes, what would you like to say?

Annexure II: Farmers and Expert Acknowledgement

We would like to thank all the experts who participated in the study and provided their invaluable inputs.

We would like to thank all the farmers of the villages of Uttara Kannada namely Janaga, Yadoga, Alur, Dasanagadde, Tigani, Kantraji, Hulimane, Salagaon, Hunagund, Bhavikodlu and Harumaskeri for their invaluable inputs and participation in the study.

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