



Grass root-level planning perspective for the tropical region for addressing implication on climate change for NRM sectors

Sarun S¹, Sheela AM²✉

1.University of Kerala, India

2.Kerala State Pollution Control Board, Kerala, India

✉Corresponding Author:

Kerala State Pollution Control Board,
Kerala,
India;
Email: sheelaamoses@gmail.com

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General Note



Article is recommended to print as color version in recycled paper. *Save Trees, Save Climate.*

ABSTRACT

Climate Change Adaptation is strongly essential to avoid further serious consequences. The priority issues related to climate change are to be identified and the measures to be adopted to combat climate change are to be clearly specified. Agriculture, Fisheries, Forests, and Water Resources are the major affected sectors. It is highly essential to specify the priority issues as well as adaptation

measures to be adopted for the betterment of the society. The urgent need is to provide these adaptation measures at the ground level. Thus the concerned departments as well as Local Self Government can only implement these measures at ground level. The members of the local self-government institution have to recognize this risk and to act accordingly to adapt it to the changes. Understanding local government institution roles and powers for addressing climate change risks is a critical component for motivating climate change action, in Kerala and elsewhere.

1. INTRODUCTION

"Think globally, act locally" was emerged as the battle cry of the 1992 UN Conference on Environment and Development held in Rio de Janeiro, Brazil (Betsill, 2001). This notion leads to the role of local authorities in promoting environmental protection and sustainability. The International Council for Local Environmental Initiatives (ICLEI), which was established in 1990 to serve as the international environment agency for local governments, is to build and support a worldwide movement of local governments to achieve tangible improvements in global environmental conditions through the cumulative impact of local actions (Betsill, 2001). Chapter 28 of Agenda 21 states, "Because so many of the problems and solutions being addressed by Agenda 21 have their roots in local activities, the participation and co-operation of local authorities will be a determining factor in fulfilling its objectives" (Lafferty and Eckerberg, 1997).

Climate Change has been becoming a major threat across the globe. It is predicted that by 2100 the increase in global average surface temperature may be between 1.8° C and 4.0° C. (IPCC, 2007). The response to climate change is envisaged from at the various levels. At the international level, the climate change responsive mechanism includes various cross national platforms like United Nation Framework Convention on Climate Change (UNFCCC) Kyoto Protocol. At the national level, mechanism responsive mechanism covers the National Action Plan on Climate Change and at the state level; the State Action Plan on Climate Change is the prime initiative. It is now widely recognized that better climate change implications could be clearly seen at the local level as well as strategies could be developed optimally from the grassroots level. Thus climate change impacts are manifested locally and vulnerability and adaptive capacities are also realized locally. The anticipated or actual experience of climate change impacts shape adaptation decision making and action. Local actors are the key to achieving real impact on the ground (UNFCCC, 2009). Local planning can make a major contribution to tackle climate change by shaping new and existing developments in specified region and positively build community resilience to problems of climate change.

From a local government perspective, the extent to which issues such as climate change becomes successfully institutionalized in day-to-day operations, planning and decision making can be evaluated using institutional markers (Robert, 2008). Spatial planning has the potential to deliver the right development in the right place in a fair and transparent way, informed by the imperative of sustainable development (Anonymous, 2012). This would give local communities real opportunities to take action on climate change by encouraging community-based development and active participation in plan-making, and by helping them to reap the rewards of green development. Local challenges could be understood at the local more explicitly. Involvement of local authorities and community based organisations in the development of adaptation strategies is crucial (UNFCCC, 2009). Adaptation to climate change is highly local and its effective depends on local and extra local institutions through which incentives for individual and collective action are structured (Agarwal, 2010). The impacts of climate change are experienced locally, and therefore, geographic variability in climate impacts emphasizes the need for 'place-based' approaches to climate vulnerability analysis and adaption (Cutter et al. 2008). The term 'place-based' refers to a spatially distinct group of bio-physical and social conditions, which can, in principle, occur at any scale but tend to focus at local and regional scales where global and local drivers manifest themselves in particular ways (Walker et al. 2002; Turner et al. 2003). The level at which impact is achieved will be very dependent on the existing capacity of those taking action and the level of information available about the expected changes in climate and their effect at the local level (World Resources Institute, 2007). In addition, local governance systems are often the responsible and legitimate entity for managing such impacts. Agrawal (2008) argues that local institutions have three critical roles in climate adaptation, namely 1) structuring responses to local impacts; 2) mediating between individual and collective responses to vulnerability; and 3) governing the delivery of resources to facilitate adaptation. Hence, local organizations are seeking pathways by which they can be empowered to respond to climate change in a manner that yields local benefits.

2. CLIMATE CHANGE VULNERABILITY OF KERALA

In the State of Kerala, the effects of climate change are being experienced through various indicators. The major observed indications are change in rainfall and temperature parameters, increase incidents of climate extremes such floods, drought and heat waves as also the changes in sea level in the coastal areas. The indicators may have wider implication in the State. There was a decline in southwest monsoon and annual rainfall since 1951 onwards at the rate of 5.2 mm/year and 5.6 mm/year, respectively (Rao et al., 2008). The climate of Kerala also shifted from wetness to dry ness with the humid climate during period from 1951 to 2007. Studies of temporal variation in monthly, seasonal and annual rainfall over Kerala for 1871–2005 (Krishnakumar et al., 2009) revealed significant decrease in southwest monsoon rainfall and an increase in post-monsoon season. Decreasing trends, particularly for stations in the hilly terrain, were found in annual extreme rainfall over Kerala (Jain and Kumar, 2012). It showed significant decreasing trend in the monsoon season for three sub-divisions (Rajeevan et al., 2006). Although it is likely that rainfall will increase slightly; the distribution of that rainfall will change, with longer periods of no rainfall and shorter periods of intense rainfall. Ram Mohan et al., 2009 observed that during the period 1951-2005, the number of wet years of Northeast Monsoon increased during the post 1975 period compared to the pre-1976 period. The normal years of northeast monsoon also increased during the post 1976 period. Soman et al. (1998) reported a fall in the annual rainfall in the southern part of Kerala. Regional study of various location also show decreasing trend. The annual rainfall in the Palaghat plain region shows a significant decline trend in the last century (Rajand Azeez, 2010).

Local trends indicate that maximum and minimum temperatures are increasing; suggesting that Kerala is getting warmer (SACON, 2008). It also witnessed increase in temperature since last 30 to 40 years. The annual maximum temperature over Kerala has risen by 0.8 degree C between 1961 and 2003, as per the study undertaken by the Indian Meteorological Department. According to Indian Meteorological Department, during the last 43 years, the mean maximum temperature has risen about 0.8 0° Celsius, the minimum by 0.2 0 Celsius and the average by 0.60 Celsius over Kerala (27.3 - 27.9 0 Celsius) a clear upward trend in surface air temperature. The changes in thermal and moisture regime over the year have resulted in the shifting of climate in Kerala from B4 to B2 class, moving from wetness to dryness within the humid type of climate (Rao et al. 2009). Moreover for the last one decade, sunstrokes events are alarmingly reporting from various parts of the state, which was uncommon in the past

If the sea level rises by one metre, 169 sq. km of the coastal region surrounding Kochi will be inundated. More over SLR will go further the landward causing salinity in the lagoons through inlets. It would also results in shifting of seawater-freshwater interface (salinity intrusion). Lower precipitation and consequent lower infiltration to the coastal aquifers will reduce the volume of drawable freshwater and raise the salinity of the lagoons to adversely affect the aquatic ecosystem.

3. SECTOR WISE CLIMATE CHANGE RESILIENCE STRATEGIES FOR THE LOCAL LEVEL PLANNING

Local governing institutions are capable of planning and implementing activities suitable for the local area to minimize the impact of climate change than the centre-state governments. They have the responsibility, power and authority for it. But before framing programmes at local level it is required to imbibe, national- state perspectives/vision and approaches. Because the activities local governing institutions take-up should be in conformity with it. Moreover the Local governing institutions should be aware of the activities taken up by the center and state governments since their programmes are to supplement them. It should also plan programmes keeping in mind what they can do to overcome or minimize the problems which already occurred as well as anticipated one due to climate change on each NRM sectors. Local government institutions should identify the possibilities for intervention in each sector.

3.1. Agriculture

The agriculture is an important subsector of the primary sector in Kerala. The sector still accounts for more than 80 % of the State Domestic Product generated within the primary sector and 33 % of the State Gross Domestic Product. In the State out of 38, 86,287 ha of total geographical area, 26, 47,461 ha of land, constituting 53.49 % is cultivated one with various crops during the year 2010-11.

Climate Change related consequences cause many effects on the state agriculture. The increased temperature enhances the metabolic activity of the plant, reduces crop duration and reduces crop yield. The decrease in moisture in soil causes drought and which in turn reduces the soil fertility due to increase in the organic matter decomposition. The increase in temperature and precipitation increases the relative humidity of the State which in turn paves way for new pests and diseases. Minor pests turn into

major pest's epidermis in various agricultural region of the State. The excess rainfall received in low field causes scale breach of bund and over flowing of water above the bund. Moreover, deficiency/ failure of northeast monsoon coupled with failure of summer showers led to drying up of surface water during summer which are the major water resources. The meteorological droughts during monsoon and summer are not uncommon across the State during the recent years. The deficiency of rainfall adversely affects most of the perennial crops hence the summer drought adversely affects most of them in Kerala. It will adversely affect crops like black pepper and cardamom as their growth, development and reproductive phase may depend on rainfall distribution.

The rice cultivation in the coastal plain of Kerala which constitutes a special ecological mosaic which mainly depends water for cultivation has been ample and almost exclusively monsoonal. Two crops have been taken from most of the cultivated tracts behind the coastal backwaters. The substantive influence of these ecological conditions on paddy cultivation may be seriously affected by the change in the monsoonal rainfall. With each degree rise in temperature, rice yield would be reducing by 6 %. The crop maturity period may also get reduced, which might affect the paddy productivity drastically.

The urgent measures to be taken for the adaptation for the issues identified in the agricultural sector are given in Table 1.

Table 1 Urgent adaptation measures to be adopted for Agricultural Sector

Issues identified due to change in climate	Solution Proposed for adaptation	Authority
A. CROP FAILURE		
A1. Risk of crop failure due to unexpected rainfall especially the during the summer days	Take steps to use entire cultivable land for cultivation	Agriculture department and Local Self Government Department.
A2. Paddy production loss due to change in rainfall pattern	Encourage production of food crops	
A3. Cash crops such as black pepper and cardamom particularly in the highlands as their growth, development and reproductive hit seriously affected due to change in rainfall and dry spell	Implement facilities for storing cereals, post harvesting storage ware houses etc.	
A4. Productivity of plantation crops is affected due to the dry summer	Encourage enterprises involved in agriculture produce storage, and value added enterprises	
A5. Increase in the incidents of pest attack	Encourage mixed farming	
	Take steps to increase the number of livestock of Indian species and fodder cultivation	
B. SEED DEGRADATION		
B1. Degradation of seed quality	Implement projects for distribute salt resistant seeds to farmers for resisting salt in areas, especially where there is infiltration of salt	Agriculture department and Local Self Government Department.

C. FARM LAND PROBLEM		
C1. Soil erosion and degradation in the farmlands in the highlands caused by heavy rainfall C2. Increase in runoff from enhanced intensity of rainfall leading to erosion and landslides C3. Salt water intrusion and salination of fertile rice land	Prepare micronutrient soil mapping Encourage use of bio fertilizers and bio-pesticides	Agriculture department and Local Self Government Department.
D. FARMERS PROBLEM		
D1. Increasing poverty and debt among the farmers due to crop loss	Encourage agro-forestry projects as they are helpful in carbon sequestration	Agriculture department and Local Self Government Department.

3.2. Fisheries

Fisheries sector plays an important role in the State Domestic Product of Kerala by contributing a substantial amount and it support about 3.3 % of total population in Kerala. It is an important source of livelihood for a large section of people, especially economically backward class of the State. The State is abundantly rich with marine, brackish water and fresh water resources. Climate change can impact fisheries through multiple pathways. The changes in water temperature, precipitation and oceanographic variables such as wind velocity, wave action and sea level rise, can bring about significant ecological and biological changes in marine and freshwater ecosystem and directly impact people whose livelihood depend on those ecosystem. Also, climate change strongly influences the distribution and abundance of fishes.

The effects of increasing temperature on marine and fresh ecosystem are already evident. The increase Sea Surface Temperature due to the climate change results in change in the life history traits of fishes especially the pelagic group of fishes. The resultant increase in temperature leads to faster growth, early maturity thereby decrease in longevity (life span) of fishes. This increase in growth rate is attributed to their increased metabolic rate. Several important species of fish and high-value shrimp too have become rare in the catches, while some traditional species in Vembanad Lake have reportedly disappeared. At the same time, puffer fish has become abundant and are seen as a major cause of destruction of fishing nets. While the overall number of fishing days by small scale boats has decreased, the number has increased (over fewer fishing trips) in case of the larger fishing vessels like trawlers.

Table 2 Urgent adaptation measures to be adopted for Fisheries Sector

Issues identified due to change in climate	Solution Proposed for adaptation	Authority
A. FISH STOCK REDUCTION		
A1. Stock depletion A2. Changes in fish yield in the sea	Prevent all activities in the coastal area that threatens existence of traditional fishermen, environmental protection, and protection of fishery wealth and conservation of coastal area	Fisheries Department and Local Self Government Department

A3. Changes in the boundaries of fish species	Implement activities to increase the area of mangroves and coastal bio-wealth	
A4. Decreased fish pawning		
B. ENTRY OF SILT		
B1. Heavy deposit of silt during heavy flood events	Take steps and make interventions to prevent strictly encroachments of lake, sea coast, sand mining in coastal areas, and unauthorized constructions etc. Prevent seepage of saline water into rivers by afforestation activities in the catchment area of rivers and organizing soil and water conservation activities on the riverbanks so as to increase the water flow.	Fisheries Department and Local Self Government Department
C. FISHERMEN PROBLEM		
C1.Loss of livelihood of fishermen and coastal inhabitants	Organize matsya sabha in each fish villages and act only according to their decisions.	Fisheries Department and Local Self Government Department

3.3. Forest

Forest of Kerala falls in two bio-geographic province of Western Ghats and West Coast and is rich in biodiversity. The recorded forest area in the State is 11,309.48 sq.km which constitutes 29.10 % of State's geographical area. The State has 5 National Parks and 17 Wildlife Sanctuaries constituted in an areas of 3213. 2372 sq. km and this constitutes 6.12% of the State's geographical area. Also the State has two Biosphere Reserves with a combined area of 4738.8 sq.km.

Tropical forest may not be resilient to climate change over the long term, primarily owing to a predicted reduction in rainfall and increased drought (IPCC 2007, Malhi et al. 2009). It is predicted that much of the rain forest will change the State to drier and possibly more open forests, reducing habitats, lowering regional water suppliers and becoming a less productive forest. Sustained increase in temperature of as little as 1 degree C could be sufficient to cause change in the growth and regeneration of capacity of many tress species. Higher elevation (1800 m) of the Western Ghats in Kerala feature stunned Montane forest (Shola) and grasslands that are likely to be highly sensitive to climate change.

Climate change components that affect mangrove in the State include changes in sea level, precipitation, temperature, CO₂ concentration, health of functionally linked neighboring ecosystem, as well as human response to climate change. The recent evidence of animal- human conflict near to the forest areas in the State reveals that there is climate variability inside the forest biome. The frequency and intensity of forest fires in Kerala is a major consideration in assessing the impact of climate change. Increased temperature, lower humidity and reduced precipitation can all increase risk of forest fires. During the year 2010-2011 a total of 489 numbers of incidents relating to forest fire have been reported amounting to a total destruction of 2364.414 ha of forest area.

Table 3 Urgent adaptation measures to be adopted for Forest Sector

Issues identified due to change in climate	Solution Proposed for adaptation	Authority
A. FOREST CHANGE		
A1. Changes in the size of the forest A2. Reduction of forest cover A3. Loss of fragile ecosystem A4. Conservation sites are under risk of extreme events A5. Shifts in species composition	Control changing of forest area into plantation crop area. Create 'kavu' in rural areas and protect existing ones Propagate social forestry and agroforestry programme in rural areas Promote activities to distribute saplings and protect them Create at least one mini forest promoting locally available flora under each local government area jurisdiction Protect the existing mangroves and curb their further destruction	Forest Department and Local Self Government Department
B. FOREST FIRE		
B1. Increase incidents of wild fires	Prevent forest fire and maintain and protect natural streams inside the forest area	Forest Department and Local Self Government Department
C. MAN-ANIMAL CONFLICT		
C1. Increasing the incidence of man animals Conflict		
D. WATER SCARCITY		
D1. Water scarcity becomes severe in the interiors.	Control and prevent quarry mining activities in the forest areas Prevent sand mining from the rivers near forest area.	Forest Department and Local Self Government Department
E. EXOTIC SPECIES		
E1. Competition from exotics species	Measures should be adopted for destroy foreign weeds	Forest Department and Local Self Government Department

F. OTHER MEASURES		
	Prepare a biodiversity register in each local government area and update it periodically	
	Strictly implement the Forest rights Act Biodiversity Act of 2002 and Biodiversity rules of 2004	Forest Department and Local Self Government Department

3.4. Water Resources

Kerala is gifted with nature's bounty of water resources, with 44 rivers of small and medium category interconnecting backwaters and canals, several lakes and ponds of diverse capacities, streams, springs, wells and extensive wetlands and paddy fields. Though Kerala is endowed with plenty of rainfall, the State often experiences scarcity of water in the midst of its abundance. Anthropogenic activities, large scale land use changes and climate change have serious implication on the sustainability of water resources in the State (CWRDM; Padma Mahanti and Sanjeet Kumar, 2017a & 2017b). According to the 4*4 assessment projections of many parts of Kerala, the water resources show a decrease of up to 10% in water yield by 2030 therefore an overall decrease can be expected in the State.

In this circumstance, actions on demand as well as supply management of water, along with adequate conservation measures will be important. Similarly the fertile soil and upper soil that has water retaining capacity erodes and reaches the water sources and thereby reducing their storage capacity. Increased atmospheric temperature causes evaporation and sweating faster from upper surface and plants resulting decline in water source at surface and underground. The consequences would be quick drying of soil and destruction of agriculture crops and biodiversity. Moreover, salinity would sweep to water sources in coastal areas. CWRDM's study in Meenachil, Kuttiyadi, Chaliyar, Valapattanam reveals that during summer saline water pushes up to 25 km from the estuary of rivers in Kerala. Similarly saline water pushes up to 600 m inside from coast. Excessive exploitation of underground water to meet the ever increasing water needs arising from increase in population, urbanization and changing lifestyles increases the rate of seepage of saline water. The increase in sea level as a result of climate change also speeds up the entry of saline water to surface and underground water sources.

Table 4 Urgent adaptation measures to be adopted for Water Resources Sector

Issues identified due to change in climate	Solution Proposed for adaptation	Authority
A. DROUGHT		
A1. Dried up rivers and other water sources recurrent droughts	Control sand mining and rock mining	Department of Water Resources and Local Self Government Department
A2. Drying of natural water bodies	Control laterite mining from the hills/mountains	
	Control of filling paddy lands	
	Rain water harvesting from roof tops	
	Protect and Increase capacity of wells	

B. WATER POLLUTION		
B1. Deterioration and depletion of water resources	Control of water pollution	Department of Water Resources and Local Self Government Department
B2. Salinity ingress and water stress	Conservation of lakes and river banks	
severe stress on availability of drinking water	Removal of silt from water sources	
	Prevent destruction of water channels, canals, ponds, wells etc.	
C. GROUND WATER LEVEL		
C1. Decline in the level of ground water	Steps to increase the efficient use of water	Department of Water Resources and Local Self Government Department
	Encourage paddy and vegetable cultivation	
	Plan and implement small scale social water supply and irrigation projects.	
	Propagation of new irrigation methods of drip irrigation, spingler etc.	

4. WHAT CAN BE DONE BY THE LOCAL GOVERNMENT INSTITUTION OF ADDRESSING CLIMATE CHANGE?

Whatever may be decisions at the International-National-State Level, its fulfillment is based on the efficient implementation at the each local level. Thus it is very important to have interventions of the local government institutions. The constitutional amendments of 73 and 74 as well as Kerala Panchayati Raj and Kerala Municipality Acts have given powers, responsibilities and roles for interventions of these institutions. Local self-governing institutions are the most suitable agents who could address issues and challenges related climate change and handle environmental problems at lower levels most effectively with active participation of people. In tune with the National Biological diversity Act (2002) and Biological diversity roles (2004), State Bio-diversity Board was formed to prepare a document on the rich bio-diversity of the State and to protect it. This Board gave leadership to form Bio-diversity management committees in all the local self-governing institutions and most of the institutions have formed this committee. Moreover, Environmental Protection became fundamental duty with the 42nd Constitutional amendment (1972) and has suggested the responsibilities and powers of Local self-governing institutions and the officials to carry out responsibilities for conservation of water, waste disposal, environmental sanitation, conservation of environment.

The main responsibility and power to control any pollution that creates public nuisance also vested with the local governments. The Kerala Panchayatraj Act stressed roles of Gramapanchayats for the conservation and development of the natural or manmade water ways, springs, water storages, etc in the limits of the panchayats (Section 218). Eight (3,4,5,6,7,8,25,28) out of thirty essential responsibilities laid down under Schedule 1 of Section 30(1) of the Kerala Municipality Act, which are directly related to the protection of our environment. Of the 14 general responsibilities, 6 and 7 are laws related to environmental protection. Most of the sectorial responsibilities also aim environmental protection. Section 315 to 345 and 411 to 441 of the Municipality Act explains the power of municipalities to control and prohibition of any activity harmful for the environment/nature. Sufficient rules are also framed to implement the above mentioned powers and responsibilities.

With regard to climate change following activities to be taken up by the local governing institutions,

1. Evaluate environmental impact while planning and implementing projects.
2. Make environmental clearance compulsory for all activities in environmentally weak areas.
3. Critically examine and avoid construction activities in environmentally vulnerable areas.
4. Ensure that laws on environmental protection are observed and environmental impact assessment can be done while preparing projects on agriculture, water resource development, animal husbandry, fisheries, industry, mining, quarry, mineral mining, processing, afforestation, tourism, transportation, construction of human settlements etc
5. Encourage environment friendly techniques (eg. Green buildings, disaster resistant Houses etc)
6. Cooperate with Eco mark, eco-labeling etc. to promote eco-friendly products and eco-friendly projects.
7. Restrict uncontrolled use and exploitation of natural resources
8. Ensure scientific disposal of all types of waste that will affect the environment negatively.
9. Encourage recycling of waste materials.
10. Encourage reuse possibilities of materials.
11. Prepare an information/data report and document on environment regarding each local governing institution
12. Organize continuous programmes for awareness creation with cooperation of gramasabhas, neighborhood sabhas, and Anganwadi welfare committees etc
13. Ensure system to fruitfully implement all laws and rules formulated to protect environment. .
14. Strengthen various levels of implementing environment policy.

5. CONCLUSION

Climate Change Adaptation is strongly related to the other levels of decision making at the local level. Lessons and experiences with adaptation at the local level must feed into higher levels of decision making to make sure that local strategies remain relevant and appropriate. The priority issues as well as the urgent adaptation strategies to be adopted in the fields of agriculture, fisheries, forests and water resources have been sorted out. This shall be implemented with the concerned departments as well as Local Self Government Department. Local level actors identified shall be experts related climate change at the local level. These include various standing committee members of local bodies institutions from local and district panchayats and also official dealing various issues related to environment that are directly or indirectly linked to climate change. The members of the local self-government institution have to recognize this risk and to act accordingly to adapt it to the changes. Understanding local government institution roles and powers for addressing climate change risks is a critical component for motivating climate change action, in Kerala and elsewhere.

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