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CLIMATE CHANGE AWARENESS, PREPAREDNESS, ADAPTATION AND MITIGATION STRATEGIES: FISHERFOLKS PERCEPTION IN COASTAL KERALA

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Abstract: Coastal environments cover 8 per cent of the world's surface, house 70 per cent of the human population, provide 90 per cent of the global fish catch, and deliver 40 per cent of the estimated economic value derived from ecosystem goods and services. In addition to increasing population pressure and demand for marine protein, climate change is modifying coastal environments and increasing the vulnerability of marine-dependent communities around the world. Climate change is modifying the distribution, productivity of marine and freshwater species thereby impacts the sustainability of fisheries and aquaculture, eventually on the livelihoods of the communities that depend on fisheries. The effect of sea level rise means that coastal fishing communities are vulnerable and are in the front line of the deleterious effects of climate change. Changing seawater temperature and current flows will likely bring increases, decreases and shifts in the distribution of marine fish stocks, with some areas benefiting while others lose. These changes may have impacts on the nature and value of commercial fisheries. Many artisanal fishers are extremely poor with social and political marginalization with limited access to healthcare, education and other public services. With little capacity to adapt, the small-scale and migrant fishers are highly vulnerable to losses of natural capital consequent to climate impacts. The impacts of climate change going to affect economy as well the social standards of fisher folk with implications for food security and sustainablelivelihoods . Thus the climate change effects impact the environment, fishery, social, economic and development drivers..Consequently, it is important to understand factors that contribute to vulnerability of coastal biological and human systems in order to develop sustainable adaptation pathways; and develop effective mechanisms and expertise to translate findings into management guidelines and policy advice addressing natural, social and economic implications. Globally each government are looking for pragmatic time-bound strategies and plans for mitigation and adaptation. The climate changes impacts are global but adaptation and mitigation plans are location specific. The observed climate change is a long term phenomenon process hence; the fishers need not be aware of the effects of climate change. They are affected with the immediate effects of cyclones, extreme weather events monsoonal fluctuations, loss in fishing day's etc. leading to their reduced income and livelihood. The primary stakeholders involved in the climate change mitigation plans aren't equipped with climate change impacts and causal factors. The lack of awareness and knowledge leads to non-participation of the primary stakeholders including fishermen in the climate change mitigation processes. Considering climate change causes to be localized leading to global impacts it is prime important that the primary stakeholders are involved in the climate change adaptation and mitigation plans .The level of awareness, response to the different domains of climate change are to be incorporated in the different strategies to equip the fishers in dealing with the disaster preparedness and management. The proactive participation of the primary stakeholders- fishers is a prerequisite in the development of the disaster management, adaptation and mitigation plans. The fishers are believed to be unaware if not unwilling to participate in the climate change mitigation and adaptation due to their low level of awareness in the climate change dialogues and process. The perception of the fishers will be important in the development of the mitigation

plan. Their felt needs coupled with varied perception will be useful in developing and ensuring their proactive participation in the climate change mitigation plans. Variables that identify the demographic diversity of a community can help policy planners understand the characteristics of the community they are working with and plan relevant adaptation strategies. The perception of the primary stakeholders- fishers plays a major role in proactive participation in disaster management, adaptation and mitigation plans. It is under this context that the present study was conducted to assess the climate change Awareness, Preparedness, Adaptation and Mitigation (APAM) strategies of the costal fisher households in Alappuzha district of Kerala. Alappuzha district was selected based on the vulnerability assessment of five different parameters *viz*, demography, occupation, infrastructure, climate components and fishery across the costal districts of Kerala. The different coastal villages were selected based on the different socio-economic parameters, number of families below poverty line, adult- child ratio, average family size, gender ratio, literacy rate, dependency on fishing activities, craft and gear inventories, participation in cooperatives and ancillary activities. The objectives of the present study is to assess the socio economic profile and assess the awareness level of the fisher households in the context of climate change, to deduce the causal factors of climate change as perceived by the fishermen households and consequent vulnerability assessment impact of the fisher households , and to develop a to develop a participatory awareness, preparedness , adaptation and mitigation (APAM) framework for climate change based on the outcome of the study which will enable the fishers to play a major role in proactive participation in disaster management plans and which has utilityin future climate change adaptation and mitigation research and development measures The study was conducted in Chethy , Thumboly and Arthungal fishing villages of Alappuzha district and 971 fisher households were selected . The study revealed that the perception of fishers on the causal factors of climate change indicated that temperature followed by sea-level rise and cyclones. The level of awareness towards the climate change indicated that 75.07 per cent of the fishers knew about climate change but only 67.35 per cent of the fishers were aware. The major sources of climate change knowledge were through media, information exchange between family members, friends and village administration guidelines. The indigenous technical knowledge related to climate change was available across the fisher households but weren't tapped enough for the adaptation process. There exists various alternative avocations but adequate knowledge and skill upgradation is required. The level of community involvement is minimal and the fishers foresee improved awareness and training programmes for the future. The level of governmental support isn't noteworthy for climate change awareness and adaptation options. The APAM assessment will provide policy inputs for developing adaptation and mitigation plans. The study advocates the need for a bottom up approach in developing location specific plans to ensure the livelihood of the fishers and the sustainable development of the fisheries sector in the climate change regime.

Key words: Climate change, Vulnerability, Awareness, Preparedness, Stakeholders, Adaptation, Mitigation , Management, Perception, APAM, Livelihoods,Community

INTRODUCTION

Climate change is the biggest global challenge facing mankind today; governments around the world are looking for practical and time-bound plans to cope with the changing environment. The consequence of climate change is experienced by both inland and coastal regions, but coasts being the transition zone between the lithosphere and hydrosphere are prone to more changes than the other zones. Not only are coastal regions geographically important, but they are vital domains in terms of economy and biology. Sixty percent of the world's 39 metropolises with a population of over 5 million are located within 100 km of the coast, including 12 of the world's 16 cities with populations greater than 10 million (IPCC 2001).

In developing countries, such as in India where approximately 20 per cent of its population live in coastal areas (TERI ,2008), fishing is the major source of livelihood. It is unfortunate but evident that climate change is modifying the distribution and productivity of marine and freshwater species and is impacting the sustainability of fisheries and aquaculture, eventually having a profound effect on the livelihoods of the communities that depend on fisheries. The effect of sea level change means that coastal fishing communities are vulnerable and are in the front line of the detrimental effects of the changing climate. Change in physical ocean parameters, such as seawater temperature and current flows will likely bring

increases, decreases and shifts in the distribution of marine fish stocks, with some areas benefiting while others are at lose. The Intergovernmental Panel on Climate Change predicts that as sea temperatures change, fish numbers will change and fish will move to different areas, some species will go extinct in particular areas, predators and prey will move to different areas, disrupting food chains, wetlands and other low lying habitats where fish reproduce will be covered by rising sea levels and erratic weather may stop fishers going to sea. (Adger *et al.*, 2003).

These changes may have impacts on the nature and value of commercial fisheries. The fact that many artisanal fishers are extremely poor and are often socially and politically marginalized with limited access to healthcare, education and other public services doesn't help in the changing environments. With little capacity to adapt, the small-scale and migrant fishers are highly vulnerable to losses of natural capital consequent to climate impacts. Thus leading to a situation where fisher folk are more susceptible to climate change, thereby having a negative impact on the economy as well the social standards. The extent to which a community is impacted negatively by the changes can be deduced from analyzing the vulnerability of the region, thus vulnerability has emerged as a central concept for understanding the impacts of climate change and natural hazards and for developing adequate risk management strategies. Coastal vulnerability describes the susceptibility of the natural system and of coastal societies (persons, groups or communities) towards coastal hazards. Assessing coastal vulnerability is an important prerequisite to determine where there are areas of high risk, why they are at risk and what to do to reduce the risk (Brooks, 2005).

Vulnerability is a condition wherein the internal ability or lack thereof to cope, recover and adapt to climate stress (Kasperson *et al.*, 2003). Studies on climate change impacts and vulnerability of social and ecological systems perhaps have begun with the seminal work of Timmerman (1981) who provided intellectual underpinning for linking the concepts of vulnerability, resilience, and climate change. IPCC 2001 concludes that the vulnerability is the extent to which climate change may damage or harm a system; it depends not only on a system's sensitivity, but also its ability to adapt to new climatic conditions. Of the major impacts of climate change projected in marine fisheries, sea-level rise and consequent changes in habitat, frequency of extreme events, variability in the catch and revenue are the most important (Vivekanandan, 2007, 2011). Kumar (2003) constructed a coastal vulnerability index by hypothesizing vulnerability as a function of impact on the district and the resistance and resilience of the district in responding to the impact it experiences. Vijayakumaran (2008) approximated direct scores were made for 39 factors under seven dimensions based on the information obtained from the villages. The scores were subjected to further analysis for constructing the relative vulnerability profiles of different villages adopting a slightly modifying the model used by Patnaik and Narayanan (2005). Szlafsztein and Sterr (2007) formulated an index combining a number of separate variables that reflect natural and socio-economic characteristics that contribute to coastal vulnerability due to natural hazards. In the context of the present paper vulnerability is defined as the fishers inherent inability or lack to cope with, recover from and adapt to climate stress.

The observed climate change is a chronic long term phenomenon hence, the fishers fail to be aware of the effects of climate change. They are affected with the immediate effects of cyclones, extreme weather events monsoonal fluctuations, loss in fishing days etc. leading to their reduced income and livelihood. The primary stakeholders, namely the community members, who are majorly fishermen by profession aren't equipped with climate change knowledge on impacts and causal factors of change. The lack of awareness and knowledge leads to non-participation of the primary stakeholders including fishermen in the climate change mitigation processes. Considering climate change causes to be localized leading to global impacts it is of prime importance that the primary stakeholders are involved in the climate change adaptation and mitigation plans .Their level of awareness, response to the different domains of climate change are to be incorporated in the different strategies to equip the fishers in dealing with the disaster preparedness and management.

The fishers are believed to be not able to relate climate change in its rightful context nor are they able to visualize the integrated and chain events and understand its synergistic nature; thereby the willingness to participate and contribute is negligible in the climate change mitigation and adaptation strategies. The perception of the fishers is of utmost importance in the development of a localized climate change action plan, which would fulfil their felt needs. The varied perception will be useful in developing and ensuring their proactive participation in the climate change mitigation plans. Variables that identify the demographic diversity of a community can help managers understand the characteristics of the community they are working with and plan relevant adaptation strategies. The objectives of the study are to develop a methodological framework for assessing the coastal vulnerability of fisher households through developing extensive interlinking and tier based models ,to analyze fishers' perception on climate change effects in comparison with real time data, to develop a bottom up approach in climate change mitigation and adaptations involving stakeholders' participation.

MATERIALS AND METHODS

Kerala is one of the major coastal districts of the country with a coastline of 590 km distributed across 222 fishing villages and 187 landing centers. The marine fish production has been over 6.6 lakh tonnes with the people involved the primary and secondary sector amounting to around 2.1 lakhs. Kerala houses a fishermen population of around 6,10,165 with a density of population 2740 people per fishing village which is much higher than the country average (1099) (Source: Marine fisheries census 2010). There are nine coastal districts in Kerala *viz*, Thiruvananthapuram, Kollam, Alappuzha, Ernakulum, Thrissur, Malappuram, Kozhikode, Kannur and Kasaragod.

The vulnerability of the coastal households was based on the following flow diagram given below. The assessment was based on the following steps.

Based on the above flow chart (Fig.1) the selection of the district was based up on computation of an index which was developed by Patnaik and Narayan (2005). The factors considered were demography, occupation (both

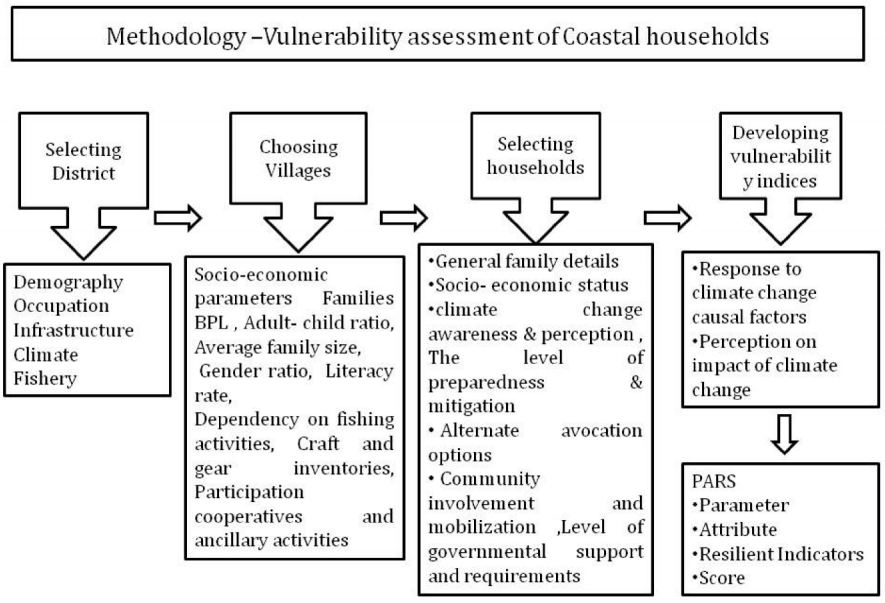

Fig. 1. Methodology – Vulnerability assessment of coastal households

major and minor), the infrastructure present in that district, climate parameters and the status and plight of marine fisheries in that particular district. The next stage after deciding the district, is to narrow down the study to potential villages. The villages were chosen based on socio economic parameters, families' economic status, adult- child ratio (which determines the dependency), average family size (nuclear/joint), the male female ration, literacy rate. Livelihood details such as dependency on fishing activities, craft and gears employed was also taken into account. The willingness to cooperate and participate in ancillary activities was also a key issue.

With the selection of the villages done, the study further narrowed down to identifying households for the research. This was based on socio economic status, climate change awareness, and perception, level of preparedness, existing mitigation plans, alternate avocation options, mobilization capacity and level of government support required and available.

The vulnerability indices were constructed using PARS methodology, a conceptual framework was developed for assessing the climate change vulnerability of coastal livelihoods. PARS-Parameter, Attribute, Resilient indicator and Score, the methodology provides prioritization and ranking of different impacts as perceived by the fishers. The framework allows adequate distribution between fishing. The fishers were asked to rank between 1 – 5 indicating the severity of the vulnerability 5 indicates very high, 4- high, 3- medium, 2- low and 1- negligible/marginal. So each and every parameters were again would lead to different attributes and the attributes will lead to different statements or resilient indicators which will be based up on different scores. The rank based quotient technique was used to analyse the scores and the ranks were given in a way the most affected attribute will get the highest ranking. PARS methodology was analysed using Rank Based Quotient (RBQ) formula (Sabarathnam, 1988) which is given below.

VI=Vulnerability index =

$$VI = \left[\sum_{i=1}^{n} (AI_i)^{\alpha}\right]^{1/\alpha} \Big/ n$$

(AI) is the average index for each source of vulnerability, n is the number of source of vulnerability and α =n.

The values were measured for each statement and the analysis was done 125 statements which are related to the climate change in the schedule.

$$RankBasedQuotient = \sum_{i=1} (\mathrm{Fi})(\mathrm{n} + 1 - \mathrm{i}) X \frac{100}{Nn}$$

This methodology is very much useful to find out which parameter or which attribute of the parameter is the most vulnerable factor of the area in terms of climate change on a first hand analysis itself. This kind of bottom up approach would help the climatologists and policy makers to implement climate adaptation plans for the district, state and finally to the country.

RESULTS AND DISCUSSION

The study was conducted for a period of 6 months from May to November 2012 in Alappuzha district of Kerala and 971 fishing households spread across three fishing villages.The results are discussed under the following heads.

Socio-economic profile

The socio economic profile collected include ages of the fishers, educational standards of the fishers , experience in fishing(years) and distance of houses from coastline (m).

The study on the age distribution of respondents revealed that the majority of them (520) belonged to the mid age group of 36 to 55 years. This was followed by older age group, i.e.; people belonging to over 55 years of age (360) and finally the young age group. The younger group being in minority can probably be attributed to change from traditional fishing to other means of livelihood.

The educational status of the respondents was computed, the results suggested that the literacy rate was very high (97.17 per cent), this proves that the majority of the population are exposed

Table 1. Socio- economic profile of the fisher households

Age (years)		Education		Experience (years)		Distance of household from the Sea (m)	
Age	Respondents	Literacy	Respondents	Experience	Respondents	Distance	Respondents
Less than 35	91 (9.40)	Illiterate	27 (2.83)	Less than 10	46 (4.70)	Less than 100	458 (47.20)
36-55	520 (53.50)	Literates	944 (97.17)	10-20	168 (17.30)	101-500	476 (49.10)
More than 55	360 (37.10)			More than 20	757 (78.00)	More than 500	37 (3.80)

Figures in parenthesis indicate percentage to total

to at least minimum level of education (primary schooling). This further establishes the fact that there is a scope to induce climate change knowledge into this society.

The experience in fishing (in terms of years) was collected from the study site. The data was classified into three sub divisions, experience less than 10 years, experience between 10 to 20 years and fishing experience greater than 20 years. The results showed that the majority of the respondents (757) fell under the highly experienced group (> 20 years), followed by the mid-level experience and finally by experience less than 10 years (46). This clearly indicates that the respondents rely to a greater extent on fishing for their living.

The distance of houses from the coastline was studied; the results suggested that 476 houses were within 0.5 km from the coastline, while 458 houses were within 0.1 km from the coastline. A meager number of 37 houses were farther than 0.5 km from the coastline. The numbers clearly states that the fishers are willing to stay very close to the coast in spite of the threats it possesses.

Fishers perception on the causal factors of climate change

An analysis was carried out to assess the fishers' response to what could possibly be the causal factors for climate change. The perception of the fishers towards the casual factors of climate change indicated that temperature, sea level rise, ocean currents, landslides, orbital changes, cyclones ,industrialization, farming systems, habitat destruction ,urbanizations, transportation, pollution and wind were considered as the causative agents of climate change. The RBQ analysis was done and the scores obtained for each factors is represented in Fig. 2.

The fishers responded that temperature (90.9) followed by pollution(64.2) and sea level rise (63.1) were the significant causal factors for climate change. The analysis of the real time data for the last 45 years, collected for the study area also had indicated that the temperature has risen by 0.05%, the increased pollutions due to emissions and discharge, a change in sea level was witnessed (-0.242%), and the wind speed showed an increase with a zonal value of 0.539, meridonial value of 5.951 and scalar value of 1.389 over the period.

Vulnerability assessment of the fisher households

Based on the Patnaik and Narayan model coastal district vulnerability index was derived for different coastal districts of Kerala. The selection of the District was based on assessment of coastal district vulnerability index estimated for different coastal districts (Table 2) of Kerala.

Alappuzha comprises three taluks of Karthikapalli, Ambalapuzha and Cherthala extending from Azheekal in south to Aroor in north direction. The district harbours 30 coastal fishing villages. The selection of different villages of Alappuzha district was carried out based on the indices derived using the different social and economic parameters like, number of fishermen

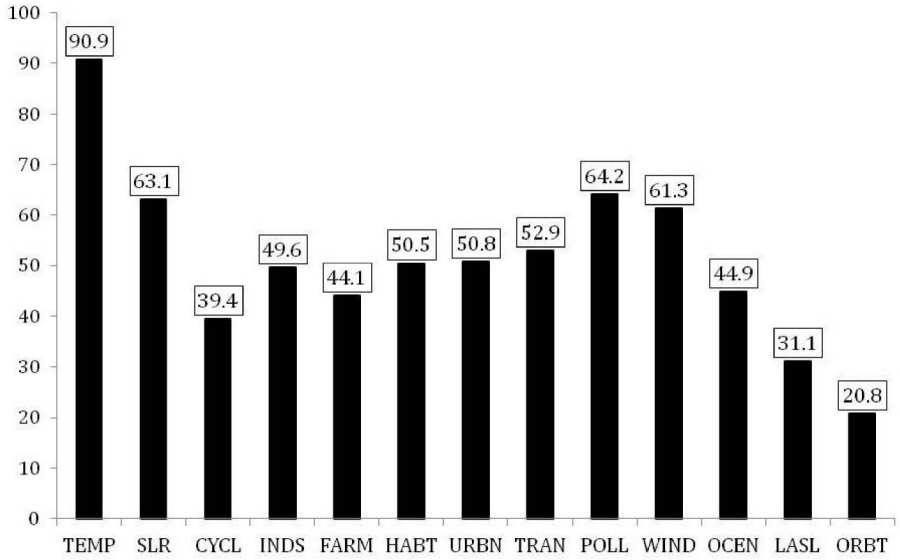

Fig. 2. Fishers response to climate change causal factors

families with due weightage given to traditional fishermen families, BPL families, Adult- Child Ratio, Average family size, sex ratio, literacy rate, full time fisher men, part time fishermen, craft and gear used and number, cooperatives and ancillary activities based. The vulnerability index calculated for each coastal district.Based on the indices three villages were identified *viz*, Arthungal and Chethy, which exhibited vulnerability indices very high and also Thumboly South was selected considering the emerging possibilities of alternate avocations and 971 fisher households were selected for the study.

PARS methodology was applied in an effort to understand the indicator factors of coastal vulnerability in the selected fishing villages of Alappuzha district and scale up the impacts, adaptations and mitigation plans of coastal livelihoods to the district level. The application of PARS methodology in this study helped to assess impact of climate change on the five different parameters considered. The study in the selected fisher households in all the three villages indicated that climate change has mostly impacted fishery based on fishers' perception on different attributes followed by Economic

Table 2. Vulnerability assessment of coastal districts in Kerala

District	Demography	Infrastructure	Occupation	Climate	Fishery	VI
Trivandrum	0.620	0.410	0.740	0.510	0.720	0.18
Kollam	0.270	0.480	0.190	0.720	0.260	0.15
Alappuzha	0.780	0.450	0.940	0.480	0.410	0.20
Ernakulam	0.190	0.190	0.210	0.630	0.180	0.13
Thrissur	0.110	0.450	0.040	0.560	0.140	0.12
Malappuram	0.630	0.290	0.440	0.460	0.320	0.14
Kozhikode	0.730	0.760	0.660	0.490	0.400	0.18
Kannur	0.040	0.370	0.010	0.550	0.150	0.11
Kasaragod	0.080	0.190	0.110	0.510	0.060	0.10

Table 3. Vulnerability indices for fishing villages in Alappuzha district

Taluk -I		Taluk -II				Taluk -III	
Karthikappally (69.94)		Ambalappuzha (64.31)				Cherthala (75.91)	
Arattupuzha	71.67	Ambalappuzha	68.45	Punnapra North	84.06	Arthungal	86.19
Kallikadu	70.33	Chettikad	65.96	Punthala	58.82	Azheekal	87.78
Pallana	60.33	Kanjiramchira	51.92	Purakkad	65.81	Chennaveli	72.12
Pathiyankara	61.14	Kattoor	67.76	Thottappally	57.14	Chethy	72.01
Tharayilkadavu	80.66	Neerkunnam	65.80	Thumboly North	53.17	Ottamassery	70.47
Thrikkunnapuzha	77.34	Pollethai	73.83	Thumboly South	56.44	Pallithode North	67.88
Valiazheekal	68.11	Punnapra south	56.70	Vadakal North	75.67	Pallithode South	71.19
				Vadakkal South	63.22	Thykal	79.67

and environmental factors in Chethy. In Thumboly fishing village, Environmental impacts and Economic impacts followed Fishery impacts, whereas Social impacts and economic attributes impacted Arthungal next to Fishery (Table 4).

The data on the composite villages indicated that data also fishery is the most impacted parameter as a result of climate change followed by economic and environmental impacts. Social impact is the least impacted parameters as perceived by the fishers .

Fishers awareness on climate change

The fishers' awareness, preparedness and mitigation level was assessed. The results were obtained based on their perception on climate change and the existing socio economic conditions of their environment. The study pointed out that 75.1 % of the total respondent population had heard about climate change, while an inadequate percent of 24.7 were aware about climate change. The difficulty in differentiating between just hearing and being aware of the issue was evident among the respondents. This clearly demarcates that climate change wasn't perceived in its right context.

The respondent households were surveyed on the key sources of information on climate change. It was found that the major source of information was the media, contributing to a

Table 4. Climate Parameter Assessment across the coastal villages

Parameters	Chethy	Rank	Thumboly	Rank	Arthungal	Rank	Composite data	Rank
Environmental	52.27	III	61.43	II	47.33	V	53.68	III
Fishery	57.38	I|	63.06	I	60.12	I	60.19	I
Social	50.11	V	45.62	V	55.56	II	50.43	V
Economic	53.53	II	58.37	III	51.27	III	54.39	II
Development Drivers	50.45	IV	54.91	IV	49.80	IV	51.72	IV

44% , the fishers received information through audio- visual media as well as print media. Friends and relatives were also considered to be sources of information (41 %) as climate issues have been locally discussed among the fisher community. State government organizations contributed to 21.5% as information sources. Around 37% of climate change awareness among fisher folk was attributed to the existing indigenous technology knowledge, which is based on the wind, colour and nature of the sea. The fact that a large number of respondents have had a sea faring experience of more than a decade, and have been in the same profession of fishing for several generations aids in them understanding the changing environment in better light.

The option of having alternate avocations was minimal, only 12% of the respondents were aware about the alternate jobs such as marketing of fish, agriculture, livestock, dairy and coir industry. Majority of the respondents being traditional fishermen for generations are not willing to look into other options, this may be due to the attitude towards fishing and the lack of knowledge on allied fields. The study indicates that there is scope for community involvement and mobilization among the respondent fishermen in terms of coordinating activities in response to natural hazards and events, such as in the case of Indian ocean tsunami of 2004 and several other cyclonic events. The fishers (72 per cent) found that the level of governmental support in providing knowledge, imparting training, construction of seawall and providing alternative avocations was inadequate

Development of Participatory Attitude, Preparedness, Adaptation and Mitigation (APAM)

Based on the vulnerability assessments of the selected households in the coastal district of Alappuzha in Kerala, it was found that the level of awareness was quite low, but there does exists an avenue for significant institutional mechanisms which could facilitate in bringing about an environment which will be amenable to climate change education for the future. Based on the study conducted, it was necessary to develop a methodological framework which would provide a panacea to the issue of low level awareness on climate change among the fishers in developing countries such as India. Thus an APAM framework was developed, which would act in four different levels, namely inculcating and improving the awareness, increasing the preparedness, providing adaptation options and developing mitigation strategies, thereby the APAM frameworks functions with four key elements of Awareness, Preparedness, Adaptation and Mitigation.(Fig.3)

The APAM framework functions on the principle that local solution developed and practiced can act as a precursor in addressing global challenges. The framework demands a participatory approach with the different elements and approaches , outlined in leading to suggestive outcomes, The APAM framework involves three significant climate change agents viz., government ,society and individuals. . The government as the apex agency could provide macro level policy guidelines, appropriate budgetary allocations and timely logistic support for the effective execution of the plan . Village is the largest institutional system in the country represented by the people, which can bring paradigm changes within a society.Villages with the support of local governmental bodies (Gramasabha) as well as non-governmental organizations can see to that the framework is dutifully carried out. The onus of the Climate change rests with the micro climate agents, namely the individuals, who are the torch bearers of the society whose individual rational decision making would determine carbon footprints at household level , eventually leading to establishment a green community and economy with future incentives and tradeoffs..

The approaches of the APAM framework overlap, with gestation period. All the approaches leads to aninclusive change within the knowledge skill and attitude of the different climate change agents. This includes developing a positive attitude towards climate change as an opportunity ensuring sustainablelivelihoods analysis as in the case of the present study where redeployment of fisher who live at very close proximity to the sea and who are reluctant to relocate in spite of the sea posing a threat to their lives and property as their

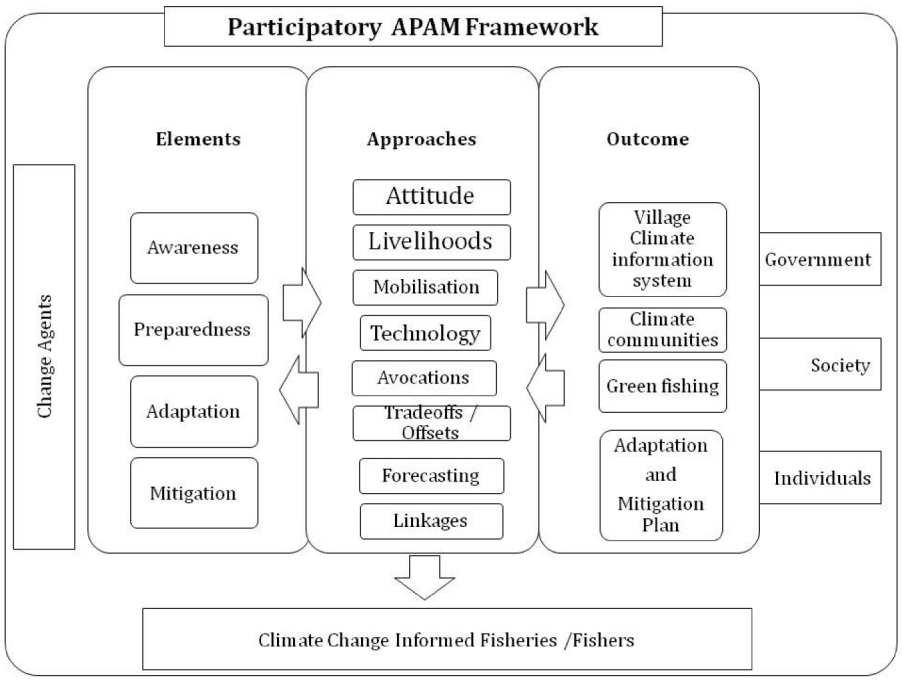

Fig. 3. Participatory APAM framework

living solely depends on fishing. The other significant approaches include mobilizing the community through micro level organizations such as NGOs and SHGs. Harnessing indigenous knowledge leading to green technologies which may not provide detrimental effect on the environment are to be identified and developed . Alternate avocations which are available within the village or in close proximity are to be identified for the benefit of the fisher households in enhancing their skills and knowledge.

Tradeoffs and off sets are innovative approaches towards climate change for a society, beneficial mechanisms such as CDM (clean development mechanism), and carbon credits are all effective means of luring the society for their proactive participation to go green. One of the most important tool in the APAM framework is the forecasting, as forecasting helps deciding for the future scenarios. Forecasting can be achieved through various methods such as risk analysis, statistical predictions, GIS and other decision support systems. Climate change is a complex issue and requires the intervention of departments pertaining to technology, sciences and social science. Therefore linkages in APAM framework requireliaising across various departments as well as ministries and other non-governmental agencies.

The approaches lead to development of village climate information system, which helps in climate data base management in addition to developing climate news and intelligence. The APAM framework helps in evolving climate communities, who are self-reliant and acts as key informants, innovators and progressive leadersin the climate adaptation and mitigation process. The outcome also visualizes green fishing and blue carbon economy where developing energy efficient craft and gear , value additions , better management practices ,by catch reduction etc,. APAM also ensures that the community develops its won adaptation and mitigation plans which are location specific and implemented on a consensus building approach.

CONCLUSIONS

The study indicated that socioeconomic profile including age, education and experience of the respondent households were congenial in their proactive participation in the climate change

adaptation and mitigationstrategies and plans. However it was alarming to find that 96.30 per cent of the respondent households lived within 500 m from the coastline .Huge efforts are required in persuading them to relocate towards safer areas consequent to sealevel changes and inundation.

The study indicated that fishers' response to climate changes was in consonance with real time changes in the environment, with regard to temperature rise, rate of pollution, the change in wind pattern as well other ocean parameters. Unfortunately the fisher folk could not attribute these changes to climate change, thus revealing a lack of climate change awareness amongst them. It was also deduced that the long term effects of climate change weren't felt much among the fisher household. The fishers could only realize immediate issues such as loss in fishing days and erratic monsoon resultant which in turn leads to economic losses.

The level of awareness is low (24.7 per cent) which indicate that the fishers couldn't correlate environmental changes consequent to climate change to their livelihood however the possibility of exploring institutional mechanism with the concerted efforts and intervention of state government bodies, line departments, non-governmental organizations is high, therefore providing pathways for high rate of awareness among the fishing community. This could be achieved through a bottom up approach involving primary stakeholders ie; the fisher folk and their governing bodies, along with the community as this will adequately position them to be better informed and aware about climate change.

There is need to improve on the awareness of the fishers knowledge to climate change by involving them in the disaster preparedness and planning process. Thus s a bottom up approach involving the primary stakeholders along with the community will adequately position them to climate change adaptation and mitigation by augmenting their traditional knowledge. The alternative avocations available across the different fishing villages need to be strengthened in order to negate the different risks and uncertainties of climate change and in ensuring a climate change informed fishers in the future. The APAM model framework, developedprovides a development plan to comprehensively integrate the elementsof the Awareness, preparedness, adaptation and mitigation strategies in transforming individuals and societies to climate change informed fishers or climate leaders.

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