

# Project Report

# Australia –India Strategic Research Fund

Round Five 2009-11

## Preparing for climate change under marine systems in India and Australia



### CMFRI 2013



**Project Report**

# **Preparing for climate change in marine systems of Australia and India**



**Central Marine Fisheries Research  
Institute,  
ICAR Post Box No: 1603  
Cochin -682018**



**Project Report**

# **Preparing for climate change in marine systems of Australia and India**

**G.Syda Rao  
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**Central Marine Fisheries Research  
Institute,  
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## Foreword

**G. Syda Rao**

*Director, CMFRI*

Climate change is a major challenge facing governments, industries and communities and requires an inter-disciplinary approach. Marine resources in both southern India and South Eastern Australia provide substantial social and economic benefits which flow into many rural communities. Both regions have been identified as global warming hotspots with the rate of climate warming predicted to be greater than 90% of the global average. Central Marine Fisheries Research Institute, Cochin along with Australian partners, University of Tasmania and Institute of Marine and Antarctic Studies, Commonwealth Scientific and Industrial Research Organisation, University of Adelaide and Tasmanian Aquaculture and Fisheries Institute, were awarded with the AISRF project on conducting two workshops in Australia and India during the fifth round of AISRF. The research project workshop was titled 'Preparing for Climate Change in Marine Systems of Australia and India' for a period of one year with back to back workshops in Australia and India.

The project was meant to develop a strategic research relationship between these countries in preparing collaborative research projects for future funding. The two workshops were held in Hobart, Australia (16 - 20 January 2012) and Cochin, India (6-10 March, 2012). The workshops generated a strategic research plan followed by identified theme areas and ten to fifteen potentially fundable research projects. Based on the prioritized research projects, two to three projects were submitted for external funding. I take this opportunity to thank Dr. Naveen Vasishtha and other research officials from the International Division, Department of Science and Technology, Ministry of Science and Technology, Government of India for funding the project under the Australia India Strategic Research Fund Initiative. I also place on record my sincere appreciation to Dr Stewart Frusher and the Australian team mates for the successful collaboration and research outputs generated during the project period. I also thank the project team members from CMFRI for their meticulous efforts in planning, preparation and implementation of the project. I compliment Dr. Shyam.S.Salim Co-Principal Investigator and Research Co-coordinator of the AISRF project for the excellent co-ordination and follow-ups across the project partners which ensured the smooth conduct of the workshops and the research output. The project led workshops could lead to developing synergy across the different research organizations and strengthening institutional linkages

05.07.13  
Cochin

A handwritten signature in blue ink, appearing to be 'G. Syda Rao'.

( G.Syda Rao)

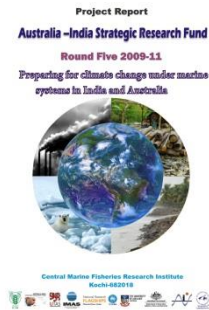
## **Preface**

Climate change challenge facing mankind and governments are looking for practical and time-bound plans for mitigation and adaptation. The management options will be complex, difficult and multi-dimensional undertaking, but a prerequisite for lessening the realized impacts of climate change in warming world. Over 1.1 million people directly dependent on marine fisheries sector of India and approximately 20 per cent of India's population lives in coastal areas. The AISRF funded research project workshop on Preparing for climate in marine systems of Australia and India was funded by the International Division of Department of Science and Technology, Government of India with an outlay of Rs.10 lakhs. The research project workshops included two back to back workshops in Australia and India. The first workshop was held in Hobart, Australia during 16-20 January 2012 and the second workshop in Cochin, India during 6-10 March 2012. The team had Indian and Australian scientists from Central Marine Fisheries Research Institute, Cochin, University of Tasmania and Institute of Marine and Antarctic Studies, Commonwealth Scientific and Industrial Research Organisation, University of Adelaide and Tasmanian Aquaculture and Fisheries Institute .

The workshop developed a Strategic research plan with prioritized research themes and designs. Fifteen research projects were prepared for funding by international agencies in the area of oceanography, biology, social science, economics and governance disciplines as well as inter-disciplinary approaches. The combined expertise of both Australian and Indian marine climate researchers ensured that, the strategic plan will become a "blue print" for adaptation scenarios to minimize the impacts of climate change on industries and associated communities and for maximizing opportunities that will maintain and build the social and economic benefits that can be derived from sustainable use of marine resources. We thank Dr.Stewart Frusher, Australian PI and the research team for their proactive participation during the two workshops. We place on record the appreciation towards Dr.E.V.Radhakrishnan and Dr.E.Vivekanandan, Emeritus Scientists, ICAR for their inputs during the workshops. We also thank all the project team members for their critical inputs in the planning, preparation and development of the strategic research plan. The financial support from Department of Science and Technology, Ministry of Science and Technology, Government of India for funding the project under the Australia India Strategic Research Fund Initiative is gratefully acknowledged. The workshops had developed / strengthened research and development linkages across different national and international institutes. Finally we thank the entire staff of Central Marine Fisheries Research Institute, Cochin for their excellent support during the AISRF workshop.

**G.Syda Rao**  
**Shyam.S.Salim**

05.07.2013  
Cochin



## **Preparing for climate change in marine systems of Australia and India**

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# **Australia-India Strategic Research Fund Project on Preparing for climate change in marine system of Australia and India' held in Australia and India**

## **A. Executive summary**

Climate change is a major challenge facing governments, industries and communities and requires an inter-disciplinary approach to understand impacts and adaptation options across both the biological and human systems. Marine resources in both southern India and south-eastern Australia provide substantial social and economic benefits which flow into many rural communities. Both regions have been identified as global warming hotspots with the rate of climate warming predicted to be greater than 90 per cent of the global average. These areas are already being affected by climate change and are expected to provide case studies for developing adaptation responses across substantially different cultures. This project, based on two workshops, brought together inter-disciplinary researchers from both India and Australia with expertise in physical, biological, social, economic and governance climate change research and developed a strategic research plan for future collaborative research. The workshops identified that the key physical drivers (e.g. temperature, currents) are predicted to affect species abundance and distributions, develop biological, social and economic indices that can be used to monitor impacts on species, industries and rural communities and investigate options for policy and management of marine resources. By developing a strategic and operational plan, the project focused on developing collaborative research opportunities that can assist Governments, Industries and Communities prepare and adapt to changes in their marine resources. Society, economic and governance differences between India and Australia provided an exciting opportunity to determine generic and specific issues and to adapt concepts and methods across broad biological and socio-economic backgrounds

Under the Australia-India Strategic Research Fund (AISRF) project the First workshop for building a Draft Strategic Collaborative Research Plan was organised

in Hobart, Tasmania (Australia) during 16-20 January 2012. The Indian research team consisted of seven scientists from CMFRI with Dr.G.Syda Rao as the Principal Investigator.

An Indian Scientific team of experts on climate change is visiting University of Tasmania to participate in a workshop 'during 16-20 January, 2012. The team comprised the following scientists.

1. Dr. G. Syda Rao, Director, Central Marine Fisheries Research Institute
2. Dr. Shyam S. Salim, Senior Scientist, CMFRI
3. Dr.E.V.Radhakrishnan, Head, CFD, CMFRI
4. Dr.E.Vivekanandan, Principal Scientist, CMFRI
5. Dr.T.V.Sathianandan, Head, FRAD, CMFRI
6. Dr.C.Ramachandran, Senior Scientist, CMFRI
7. Ms. Muktha Menon, Scientist, CMFRI

The Department of Science and Technology (DST) was the collaborator from Indian side which provided the funding support for participation of Indian Scientists in the workshop and conduct of the second workshop to be held at CMFRI, Kochi from 6-10 March 2012. The project proposed to bring together an inter-disciplinary research team from key marine resource institutes in India and Australia to improve our understanding of the impacts of climate change on marine resources and the stakeholders.

The second workshop was held during 6-10 March 2012 in Cochin. Inaugural session of the five day International Workshop on Preparing for Climate Change on Marine Ecosystems in India and Australia commenced on 06<sup>th</sup> March 2012 at 9.30 am at the Central Marine Fisheries Research Institute, Kochi. The registration of the participants was done earlier in the day followed by an invocation which was rendered by the ICAR prayer song. The welcome address was given by Dr.E.Vivekanandan, Principal Scientist and Scientist-in-Charge, Madras Research Centre of Central Marine Fisheries Research Institute.



Mr. Michael Carter, the Consul Commercial and Trade Commissioner of Australia in his introductory remarks expressed that, Indian and Australia should share their best practices for development and growth of the blue economy. He laid stress on the increasing convergence between Australia and India on numerous agendas such as trade, investment and collaboration. He said that the Australian India Strategic Research Fund (AISRF) is set up to support collaborative projects in the priority areas agreed by the two governments. He said that the trade between the two countries is on the rise. Five years back, the trade between the two countries stood at 14 billion dollars and now it has gone up to 21 billion dollars. The trade value is likely to rise in the next three years. Also, India is Australia's fourth largest export destination for goods and services. On the investment front, Indian investment in Australia, mostly is in resource sector and is almost 10 billion dollars. India's need for energy sector will be addressed. The 3 million dollar Grand Challenge Fund over three years is to provide collaborative projects of significant scale and ambition that will deliver practical solutions to some of the key challenges in both countries in the area of health, energy, food, water, security and environment. Research collaboration between Indian and Australian universities is increasing. He touched upon the seven MoU's and research collaboration in Kerala. In his address Michael Carter said that Australia's approach to climate change was based on the reduction of greenhouse gas emissions adapting to climate change and helping to shape a global solution to the issue. Australia is moving to a cleaner economy which is sustainable, competitive and able to withstand the challenges of climate change. The country is committed to reduce its emissions by 60 per cent by 2050, he said.

Dr.E.Vivekanandan gave a brief prologue to the workshop held at Hobart, Australia and also the roles played by both Indian and their Australian counterparts in evolving the five broad areas, of preparing for climate change on Marine Ecosystems in India and Australia such as Food security, Fishing in Carbon economy, Management, Monitoring and modelling complex marine systems and Strategic Communication for Climate Change Preparedness.

The workshop used an objective qualitative modelling approach to determine the vulnerability of key commercial species to climate change. “Collaborative research projects covering oceanography, biology, social sciences, economics and governance disciplines as well as inter disciplinary research. The main aim of these workshops was to increase the strategic alliances between Australian and Indian researchers in the area of climate change impacts and adaptation on marine resources. This will be achieved through the identification of innovative and leading edge in inter-disciplinary research that will be at the forefront of the development of climate change research from metrics and monitoring systems to management systems. Further presentations were conducted on Indian marine science and fisheries contexts. Discipline - focused theme presentations (Physical, Biological, Economical and Social and Governance) were made by both Australian and Indian side followed by discussion on 16 and 17 January 2012. Discussion on cost-effective monitoring systems including the latest development in biomarkers and social and economic metrics were held. The panelists from both sides then discussed the climate change issues and trends and development of generic themes.

The strategic research plan development and mapping exercise and SWOT analysis of current capacity and capabilities were carried. Five theme areas were recognized and a SWOT analysis of the theme areas and key question in each theme area were also prepared. The implementation/operational plan of projects under each theme area was prepared.

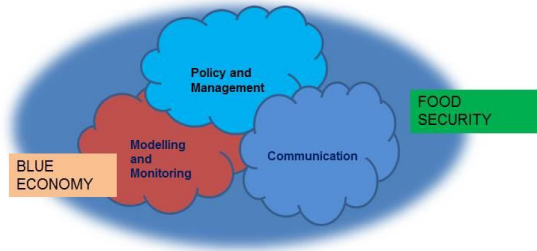
The strategic plan developed by the project will prioritise collaborative research projects for future funding, including AISRF. Projects will cover the oceanography, biology, social science, economics and governance disciplines as well as inter-disciplinary approaches. The plan will include a mix of research projects and PhD projects. In addition to addressing the key needs of both countries in terms of climate change impacts and adaptation on marine resources, the project will increase the strategic alliances between Indian and Australian researchers in the priority area of marine science. By combining the expertise of both Australian and Indian marine

climate researchers, the strategic plan will become a “blue print” for adaptation scenarios to minimise the impacts of climate change on industries and associated communities and for maximising opportunities that will maintain and build the social and economic benefits that can be derived from sustainable use of marine resources

The two workshops held over the year helped Australian and Indian climate researchers to develop an inter-disciplinary strategic plan that will provide a blue-print for research to assist governments and industry prepare for, and maximise the opportunities that will occur as, climate change impacts on marine resources in both countries.

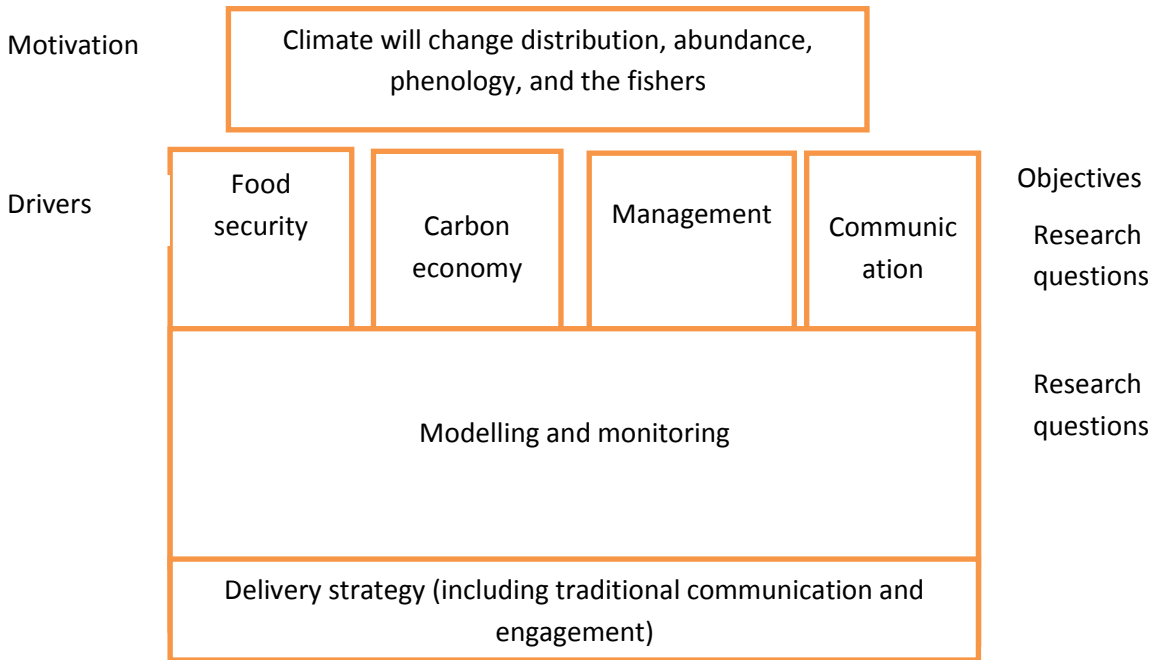
The major outcomes of the project workshops are as follows

**A.) Strategic Research plan**

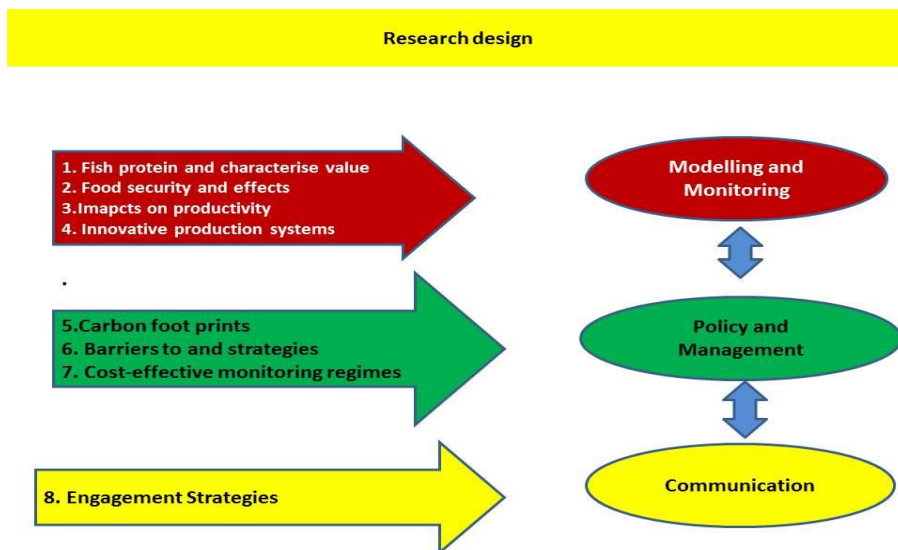


(Theme Areas- Food security and Blue economy Approaches ( Modelling & Monitoring, Policy and Management, Communication).

Schematic representation on the development of the Strategic Research plan



## (B) Development of Research / Theme Areas



## (C) Potentially fundable projects developed

- AUSAID project under Public Sector Linkage Programme - The Activity Concept centres on developing capacity to achieve effective management of marine systems to ensure food security and sustainable livelihoods in the context of a changing climate and increasing coastal pressures (population, pollution etc). This includes documenting/mapping existing policy and management arrangements in India; identifying drivers, values, risk perception, incentives and barriers related to projected climate change and population related impacts on marine resources; and benchmarking existing and alternative options for adapting to and managing climate change in the context of food security, utilising the knowledge and capability of Australian experts. The Australia (IMAS/CSIRO/UAdel)-India (CMFRI) collaboration utilises an inter-disciplinary approach to address these inter-related components. It adopts a social ecological systems framework to incorporate economic, ecological, social and biophysical sciences to explore challenges to fisheries management directed at climate change and food security. Such an approach strengthens existing institutional linkages. The project extends an existing India-Australia collaboration, and fills a need identified by the partner organisation in relation to the impacts of a changing climate. Australia and India share common interests in

sustainable fisheries management and oceans governance. The Activity Concept provides mechanisms to enhance the inter-disciplinary linkages required to better understand the impacts of climate change and increasing world demand for seafood on marine resources and the related communities' dependent upon them. As India progresses its aspirations as a leading Indian Ocean fishing nation via development of offshore fishing capacity, the Activity Concept will provide improved mechanisms for scientific and management exchange and capacity building, with particular support to mid-level career staff at CMFRI to spend time at IMAS and related institutions in Australia. Based on existing linkages, CMFRI has identified this need in their next five year operational plan and the establishment of an MOU between our partner institutions that will ensure this Concept Activity endures. This Activity Concept addresses the India-specific assessment criteria of climate change; food security, including agriculture and fisheries management. The Activity Concept has been developed in close collaboration with colleagues at the Central Marine Fisheries Research Institute. This builds on the developing linkages and collaborative research and data gathering/analysis workshops recently held in Australia and India. The concept builds on an approach embedded in collaborative learning and exchange by key researchers in workshops in both India and Australia. Collaborative partner workshops in India will be coordinated and managed by CMFRI. Collaborative workshops in Australia and training will be conducted, coordinated and managed by IMAS.

- **Belmont - GULLS - Belmont Forum and G8 Research Councils Initiative Research Project-** Under the “Belmont Forum and G8 Research Councils Initiative on Multilateral Research Funding International Opportunities Fund CMFRI submitted a project titled “Global learning for local solutions: Reducing vulnerability of marine-dependent coastal communities” (GULLS) on the Theme section Coastal Vulnerability with Rhodes University, Grahamstown , CSIRO Marine and Atmospheric Research, Hobart , Central Marine Fisheries Research Institute, Cochin ,University of São Paulo, São Paulo ,National Oceanography Centre, Southampton ,University of California Santa Cruz, Santa Cruz , University of Otago, Dunedin ,University of Victoria, Victoria and Eduardo Mondlane University, Maputo Belmont Forum Research Project- on 13<sup>th</sup> March, 2013.The duration of the project is three years with an expected funding of

Rs.165.60 lakhs and is under review . Dr.Kevern Cochrane, Rhodes University, South Africa is the team leader of the project and Dr.G.Syda Rao, Director, CMFRI leads the Indian side.

- **AISRF Research Project** - A research project proposal on ‘Sustainable marine food security and carbon challenges under a changing climate in Australia and India’ was submitted under Australia-India Strategic Research Fund (AISRF) – Round Seven , 2013/15 (Indo-Australia Fund for Scientific and Technological Cooperation). The proposal is seeking research grant on the theme area of marine sciences .The project expected cost is Rs. 67.47 Lakhs with duration of two years. The project was shortlisted and invited for presentation in the Programme Advisory Committee meeting of the Earth Sciences, Department of Science and Engineering Board on 13<sup>th</sup> June 2013 held at New Delhi. Dr.Stewart Frusher , University of Tasmania, Australia is the theme leader of the project and Dr.G.Syda Rao, Director, CMFRI leads the Indian side .The project proposal on ‘Sustainable blue food security and carbon issues under a changing climate: Challenges in Australia and India’ by the Programme Advisory Committee in the area of Earth Science, Environmental and Marine Sciences in its meeting on 13th June 2013 from 10.30am at Vasant Square Mall, Lower Ground Floor, Vasant Kunj, New Delhi.DST meeting held at Vasant Kunj, New Delhi

**(D) Institutional Linkages developed**

- a. Institute for Marine and Antarctic Studies (IMAS)
- b. Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- c. University of Tasmania
- d. University of Adelaide
- e. Tasmanian Aquaculture and Fisheries Institute
- f. Rhodes University, Grahamstown
- g. University of São Paulo, São Paulo
- h. National Oceanography Centre, Southampton

- i. University of California Santa Cruz, Santa Cruz
- j. University of Victoria, Victoria
- k. Eduardo Mondlane University, Maputo
- l. University of Otago, Dunedin



## **B. Climate Change - Settings**

Over the past decades, changes in climate have been commonly observed in many parts of the world. It is apparent that changes in temperature and rainfall and resulting increases in frequency and intensity of flood and drought events have affected ecological and social systems on the earth. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, warming atmosphere of the climate system is now unequivocal (IPCC 2007). Climate change possess significant risks to the livelihoods, culture and health of millions of people. Ecological and climatic disasters—hurricanes, tornadoes, draught, flooding, landslides—are becoming more frequent, resulting in devastation to family and communities, especially the poor living in precarious environments (Ogata and Sen 2003). Related to this, the number of climate-led disaster events and affected populations has been increasing during the last decades.

Climate change is thus likely to have multiple impacts across sectors, and interactions with other socio-economic and environmental drivers. Most studies so far have looked at climate-driven changes in ocean productivity and its impact on fish distribution and production, and have not considered indirect effects such as those discussed above, where the downscaling of global circulation models is more tedious. These are only some examples of the ways in which changing climate may impact fisheries; the relative importance of these different impact pathways is not yet known. The potentially far-reaching effects of ocean acidification, in particular, are almost completely unknown. Rising atmospheric carbon dioxide (CO<sub>2</sub>) concentrations over the past two centuries have led to greater CO<sub>2</sub> uptake by the oceans, altering the seawater chemistry of the world's oceans. While marine ecosystems have experienced warm conditions in the past they have never experienced acidification conditions as high as present. This limited state of knowledge about the impact of increased CO<sub>2</sub> exposures on marine organisms and ecosystems poses new challenges for scientists as well as fisheries managers and their constituencies.

Poor communities are often most exposed to climate change because of where they live or their livelihood activities occur (DFID 2004). Obviously, coastal areas are one of the most vulnerable places due to sea-level rise, increased level of inundation and storm flooding, coastal erosion, seawater intrusion and increased temperature. Communities in the coastal areas tend to be dependent on climate sensitive resources and coastal people do not have the means to adapt fast enough.

Anthropogenic climate change is thus already affecting aquatic ecosystems and the human societies that depend on them. However, most research on climate variability, change and fisheries has in the past focused on documenting trends and fluctuations in fish abundance and distribution, particularly in relation to oceanic regime changes and the major pelagic fish stocks of upwelling zones that are the target of large-scale industrial fisheries. There are a number of studies that investigate the vulnerability and adaptive capacity of the fisheries sector and dependent communities to climate change. Nevertheless, until recently there has been little directed analysis at the local scale of how climate variability and change is affecting the lives and livelihoods of the “tropical majority” of small-scale fisherfolk, who make up more than 90 per cent of the worlds’ fishers and fish traders.

There are compelling security reasons—both economic and nutritional—for investing in research to guide adaptation planning in fisheries. Worldwide, fish products provide at least 20 per cent of the protein intake of 1.5 billion people and support the livelihoods of approximately 520 million people. Fishery products are one of the most highly traded food and feed commodities, with an export value of 86 billion dollars in 2006, contributing significantly to both total gross domestic products (GDP) and agricultural GDP as well as food security. The sector is also an important source of livelihood for women: it is estimated that in countries such as India, they represent on average half of the fisheries workforce (including post-harvesting activities).

Additionally, many fisheries worldwide have declined sharply in recent decades due to over fishing, and many major fishing grounds are concentrated in

zones threatened by pollution, mismanagement of freshwater and habitat, and coastal zone modifications.

In developing countries like India, climate change could represent an additional stress on ecological and socioeconomic systems that are already facing tremendous pressures due to rapid urbanization, industrialization and economic development. With its huge and growing population, a 7500-km long densely populated and low-lying coastline, and an economy that is closely tied to its natural resource base, India is considerably vulnerable to the impacts of climate change.

Fisher folk depend for a major part of their livelihood on natural resources whose distribution and productivity are known to be influenced by climate dynamics. Fish species distribution has also been altered in the sea due to recent increases in sea surface temperatures, and model projections show that climate change may lead to numerous local extinctions in the sub-polar regions, the tropics and semi-enclosed seas.

The vulnerabilities of those who live in coastal areas and need to build their resilience to cope with such climatic fluctuation are among the more important challenges in adapting to increasing climate change (FAO 2007).

1. To use an objective qualitative modelling approach to determine the vulnerability of key commercial species to climate change so that a list of potential indicator species can be established in both countries.
2. To explore the latest developments in biomarkers that can be used to develop a cost-effective suite of metrics that can be used to monitor the selected species and their ecosystem interactions.
3. To determine a suite of social and economic metrics that can be used to describe and quantify the important social and economic issues that are expected to affect fishers and their rural communities as climate change impacts develop. This aim will also review how such metrics can be incorporated in management plans and Government policy.

4. To evolve strategic plan which will become a “blue print” for adaptation scenarios to minimise the impacts of climate change on industries and associated communities and for maximising opportunities that will maintain and build the social and economic benefits that can be derived from sustainable use of marine resources

### **Effects of climate change on fisheries**

Climate change can impact fisheries through multiple pathways. 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 to marine and freshwater ecosystems and their resident fish populations, directly impacting peoples whose livelihoods depend on those ecosystems. Extreme weather events may also disrupt fishing operations and land-based infrastructure while fluctuations of fishery production and other natural resources can have an impact on livelihoods strategies and outcomes of fishing communities.

Indirect impacts arising from adaptive strategies pursued by different sectors may also be significant and compound the effects of direct climate impacts on fish production and dependent livelihoods. These potential interactions make impact predictions difficult to make and more uncertain. For example, changing patterns of precipitation and increasing frequency of extreme flooding events in river basins may prompt adaptive strategies by the agriculture sector that focus upon the construction of more flood control, drainage and irrigation schemes. These structures are likely, however, to further exacerbate the direct adverse impacts of climate change on fisheries.

In coastal zones, potential declines in mangrove forest habitat resulting from sea level rise, changes in sediment and pollutant loading from river and lake basins combined with land reclamation for agriculture or overexploitation could also impact on fisheries by reducing or degrading critical coastal habitats. Mangrove forest loss for instance can

negatively affect the diversity of benthic invertebrates such as tiger prawns or mud crabs, which are exploited or managed for profits. Faced with declining yields, income and food security, fishers may seek alternative livelihoods, placing pressures on other sectors or resources.

Sea level rise induced by increase in temperature causing melting of ice can be most significant climate change impact. According to IPCC, 2001 the estimated envelope of change in global mean temperature falls between 0.20 ° C to 0.70 ° C in 2015 and 0.75° C to 2.50 ° C in 2050 and rise in sea level from 0.04 -0.06 m in 2015 and 0.08 - 0.25 m in 2050. The impact of climate change has an effect on productivity and distribution of fisheries resources which directly influences the fisherfolk who depend solely on marine fisheries for their livelihood. This assumes importance in the light of existing threats to sustainability of fishing stocks induced by overexploitation and under management. The Governmental efforts to manage the fishery resources includes measures like closed seasons, regulating mesh size, fixing quotas, responsible fishing by participatory management efforts etc. Keeping aside the conservation orientation in the managed fishery, the stakeholders are deprived of their livelihoods at a certain point of time and are forced to adjust or adapt to likely losses of income. Climate variability also warrants such type of adjustments for which fishers may have to plan for migration or alternative avocations in long term. The fine-tuning to these natural phenomena adds to the misery of marginalized sections of the fisherfolk

Fisher folk depend for a major part of their livelihood on natural resources whose distribution and productivity are known to be influenced by climate dynamics. There is increasing concern over the consequences of global warming for food security and livelihoods of the world's 36 million fisher folk and 1.5 billion consumers who rely on fish for more than 20 per cent of their dietary animal protein. Climate change combined with human activities poses significant risks to peoples livelihoods especially in developing countries like India where 14.5 million people are depending fisheries for their livelihood. Obviously, coastal areas are one

of the most vulnerable places due to sea-level rise, increased level of inundation and storm flooding, coastal erosion, seawater intrusion and increased temperature. Fishers and fish-farmers are particularly vulnerable to the direct and indirect impacts of predicted climatic changes, including changes in physical environments and ecosystems, fish stocks, infrastructure and fishing operations, and livelihoods. Communities in the coastal areas tend to be dependent on climate sensitive resources and coastal people do not have the means to adapt fast enough. The vulnerabilities of those who live in coastal areas and need to build their resilience to cope with such climatic fluctuation are among the more important challenges in adapting to increasing climate change (FAO 2007). The vulnerability of the coastal livelihoods depends on the sensitivity, exposure, adaptability and capacity coupled with governmental regulations and interventions

Climate Change is projected to affect the natural productivity and economic potential of the region's fisheries. However, the threat of climate change is slowly and determinedly endangering the livelihood of the region because it is projected to substantially change fresh water and marine ecosystems which will affect the natural productivity and economic potential of the region's fisheries sector.

These workshops are aimed at developing a strategic research plan that will provide the appropriate applied science that governments and industry require for developing wise and timely adaptation responses to climate change. Two workshops, separated by approximately 6 months will provide the strategic plan that will identify priority research areas, including PhD projects, for future funding applications.

Although there is mounting evidence to support climate change impacts on marine systems, most studies have generally been spatially and temporally specific and often single species or single issue focused. This is not surprising as the large number of fished species and ecosystem components that occur in marine systems will only make it possible to undertake research on a small subset of species. Thus there is a need to identify species that are most vulnerable to climate change and which will be indicators of ecosystem change. To determine these species it is necessary to

understand the sensitivity of the range of possible species to the physical exposure (e.g. temperature, acidification etc) and their potential for adaptation in the immediate term as rates of change are considered to be occurring at rates greater than evolutionary responses. Additionally, because of the importance of coastal fish stocks to rural communities it is also essential that vulnerability assessments capture the vulnerability of the human system that is dependent on these exploitable populations. Thus an understanding of the social and economic implications of changes in key species vulnerable to climate change will need to be assessed together with policy and management options.

The study will focus on the following areas and interventions will be developed

- Developing an objective qualitative modelling approach to determine the vulnerability of key commercial species to climate change so that a list of potential indicator species can be established in both countries.
- Exploring the latest developments in biomarkers that can be used to develop a cost-effective suite of metrics that can be used to monitor the selected species and their ecosystem interactions.
- Determining a suite of social and economic metrics that can be used to describe and quantify the important social and economic issues that are expected to affect fishers and their rural communities as climate change impacts develop. This aim will also review how such metrics can be incorporated in management plans and Government policy.
- Evaluating ways of integrating the above knowledge into a modelling framework that can be used to predict future changes and test adaptation scenarios.

### **Expected outcome**

The main outcome of these workshops was to increase the strategic alliances between Australian and Indian researchers in the area of climate change impacts and adaptation on marine resources. This will be achieved through the identification of

innovative and leading edge inter-disciplinary research that will be at the forefront of the development of climate change research from metrics and monitoring systems to management systems .

Outputs from the workshop will be the development of strategically focused collaborative research projects, including PhD projects that cover the physical, biological, social, and economic and governance disciplines. Outcomes of these projects is expected to lead to an improved understanding of climate change impacts and adaptation options for communities, industries and governments in both India and Australia. Importantly, fisheries is an important food-producing sector in both countries and the development of future recommendations on adaptive mechanisms are expected to ensure optimum utilization of available resources, reduce economic losses to fishermen, and ensure seafood supply. Benefits to both India and Australia will include the international recognition of both countries as collaborative leaders in the scientific research field of applied climate change impacts and adaptation on marine resources.

Future benefits will arise from the training of PhD students in climate change science using the expertise of both countries. In particular, students will gain a greater appreciation of the diversity of both biological and human systems that can be impacted in the marine domain. This will range from small scale subsistence and artisanal fish and fisheries to larger scale commercial fish and fisheries.



## **C. Project Profile**

### **The Proposed title of the Workshop - “Preparing for climate change on marine systems in Australia and India”**

#### ***(i) Aims and background***

Climate change is one of the largest challenges facing mankind and Governments globally are looking for sensible mitigation and adaptation strategies. Adaptation to the impacts of climate change will be a complex, difficult and multi-dimensional undertaking, but one that is a necessary prerequisite for lessening the realized impacts of climate change in a dangerously warming world. Our oceans are the earth’s main buffer to climate change, absorbing both 95 per cent of heat and 30 per cent of the atmospheric carbon emitted, and thus feel the double effect of warming and ocean acidification. Changes in air and sea temperatures, rainfall, ocean acidification, sea level, and wind patterns are all contributing to modifications in productivity, distribution and phenology of marine species), impacting ecosystem processes and altering food webs. It is essential that we develop sensible adaptation pathways to improve outcomes for our marine ecosystems, fisheries and aquaculture industries.

#### ***(ii) Objectives of the Workshop***

*The first aim of workshop 1 is to use an objective qualitative modelling approach to determine the vulnerability of key commercial species to climate change so that a list of potential indicator species can be established in both countries.*

Understanding the impacts of climate change on the key species identified in aim 1 of workshop 1 will require an understanding of the physiological responses of these species as well as an understanding of their interactions with the environment. While such an understanding will have been used to select the species, our experience is that rigorous existing baseline data for the majority of species is lacking. This first component of aim 1 will be based on expert opinion as research on

most exploited species has focused on fisheries parameters pertinent to the assessment of fish stocks (e.g. observed growth rates, fishing and natural mortality estimates etc) rather than linking these parameters to physical parameters such as temperature. Similarly, social, economic and governance information is also relatively poor as most fisheries programs have focused on biological issues. Management of marine resources has also be largely underpinned by biological sciences to the extent that performance indicators for marine resources have focused on biological systems rather than combined biological and human systems (socio-ecological systems).

*The second aim of workshop 1 will be to explore the latest developments in biomarkers that can be used to develop a cost-effective suite of metrics that can be used to monitor the selected species and their ecosystem interactions.*

Importantly metrics will be standardised so that comparisons across spatial scales from regions within countries to regions between countries can be undertaken. Specific attention will be placed on the need for relatively simple, easily obtainable and cost-effective metrics.

*The third aim of workshop 1 will be to determine a suite of social and economic metrics that can be used to describe and quantify the important social and economic issues that are expected to affect fishers and their rural communities as climate change impacts develop. This aim will also review how such metrics can be incorporated in management plans and Government policy.*

Although the majority of attention about climate change has focused on detrimental impacts there are also likely to be opportunities as physical changes in currents can also improve productivity, increase recruitment processes (e.g. larval transport) and/or biological responses such as new species distributions, increased growth rates and reproductive capacity. Understanding who will be winners and losers and facilitating adaptation options that minimise detrimental impacts and maximise opportunities will require the development of timely adaptation options. Determining such options will require the need for predictive modelling and scenario evaluation including management and policy responses that are robust to a

range of possible futures. Importantly, any scenario testing will require an understanding of the social and economic drivers of fishers and the importance of their activities in rural communities.

*The first aim of the workshop 2 will be to evaluate ways of integrating the above knowledge into a modelling framework that can be used to predict future changes and test adaptation scenarios.*

*The second aim of workshop 2 will be to consolidate the information from workshop 1 and the first part of workshop 2 into a strategic plan and to identify priority research areas for collaborative funding applications.*

### ***(iii) Why India and Tasmania***

Both Southern India and South Eastern Australia are situated in regions that are predicted to warm substantially faster than the global average. As such, the impacts of climate change are expected to be observed and documented in these regions first, making these regions sentinels of climate impacts for other regions in India and Australia as well as other regions globally. In addition to providing early indications of change, these “hotspot” regions will also be the first to validate predictions by comparing future observations against predicted data as well as validating proposed adaptation strategies.

However, to be able to inform Governments, Industries and communities of change and provide predictions and adaptation scenarios it is essential that appropriate and scientifically rigorous information is collected, analysed and modelled.

This application proposes two workshops to bring together scientists from the biological and physical sciences and from the economic, social science and governance disciplines that are at the forefront of climate change research on marine resources in both Australia and India.

#### **(iv) *Significance and Innovation***

Both southern India and South eastern Australia are significant regions globally for understanding the impacts of climate change on marine systems.

In India, initial studies show that among the coastal regions of India, the southern region may be the first to be affected by climate change. The southern region extending from 8°N to 13°N in the Arabian Sea and Bay of Bengal has wide differences in the oceanographic parameters and fisheries. On the Arabian side, the continental shelf is vast with intense upwelling during the southwest monsoon. The region is rich in productivity and small pelagic species. On the Bay of Bengal side, the continental shelf is very narrow with less productivity. However, both the adjacent regions are subjected to intense fishing activity. Fishing is one of the major food producing sectors in the region.

Similarly, in Australia the south eastern region and Tasmania in particular, is the first to be affected by ocean warming as the rate of warming is 3.8 times the global average, and this area is predicted to be the most intense ‘hotspot’ of ocean warming in the southern hemisphere .

This increased warming is driven by increasingly longer and stronger incursions of the East Australian Current (EAC), which is the major boundary current on the east coast of Australia, into waters off eastern Tasmania. This current transports both heat and larvae of northern species southward to Tasmania. Because the EAC is nutrient-poor (e.g. often  $\leq 1$   $\mu\text{M}$  nitrate, particularly in summer) relative to the sub-Antarctic water masses that, until recently, dominated the oceanographic signature on the east coast of Tasmania , EAC-driven ocean warming off eastern Tasmania is confounded with a decrease in nutrient availability. Thus, marine systems in SE Australia are simultaneously subject to marked increases in temperature and reductions in nutrients (and slight increases in salinity), and any possible synergistic effects that may arise. Fishing is a major social and economic activity within the south east region of Australia accounting for 34 per

cent(~\$450M) of Australia's fisheries production, despite amounting to only 16 per cent of the total coastline.

Outputs from the workshop will include the development of projects, including post-graduate student projects that will be innovative in their use of metrics to develop an inter-disciplinary approach across two very different countries. This will include the need for a conceptual framework that can be used to identify similarities and differences in processes across scales that include temperate and tropical ecosystems and regions of substantially different social and economic profiles. This will, to our knowledge, be the first project to attempt to undertake such a comparison and to develop a strategic plan to address climate change impacts on such differing marine resources.

***(v) Approach and methodology***

*Aim 1: To use an objective qualitative modelling approach to determine the vulnerability of key commercial species to climate change so that a list of potential indicator species can be established in both countries.*

Prior to the first workshop each country will determine a list of species and obtain existing information on their tolerance levels and sensitivities to predicted climate change impacts (e.g. temperate ranges that affect distribution, growth rates, reproductive potential, recruitment strategies etc). A template for the assessments, based on a recent study of the southern rock lobster in Australia ([http://www.climatechange.gov.au/publications/coastline/east-coast-rock lobster.aspx](http://www.climatechange.gov.au/publications/coastline/east-coast-rock%20lobster.aspx)) will be developed to ensure consistency.

Each country will also be responsible for drafting a conceptual model of the critical climate change impacts throughout the life cycle, again based on a template for southern rock lobster. During the first workshop these conceptual models will be converted into qualitative models based on loop-analysis. Understanding the relative importance of factors affecting distribution and abundance, e.g. quantity and quality of food, predation, advection by ocean currents, prevailing temperatures (through

impacts on growth etc), is a challenge that lends itself to loop analysis where multiple feedbacks and the cumulative effects of global warming could be assessed. Originally devised as a means of creating testable hypotheses about the behaviour of dynamic systems in population biology, loop analysis has a very general application in sciences concerned with modelling causal feedback and understanding the nature of system behaviour. Qualitative modelling is a formal technique that draws inferences from community structure and is well suited for assessing potential impacts of climate change, allowing research questions to be defined more precisely, assist in testing hypotheses, and identifying the data needed to provide greater certainty.

*Aim 2: To explore the latest developments in biomarkers that can be used to develop a cost-effective suite of metrics that can be used to monitor the selected species and their ecosystem interactions.*

Prior to workshop 1 each country will be responsible for identifying expertise in their own country that is working on marine biomarkers that could be developed into metrics for monitoring climate change. During the workshop, these will be discussed and a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis undertaken to determine which will be effective metrics to pursue in collaborative comparative studies.

*Aim 3: to determine a suite of social and economic metrics that can be used to describe and quantify the important social and economic issues that are expected to affect fishers and their rural communities as climate change impacts develop. This aim will also review how such metrics can be incorporated in management plans and Government policy.*

Similar to aim 2, each country will be responsible for identifying social and economic metrics that will be discussed at the workshop and used in a SWOT analysis to determine the appropriate metrics to pursue in future projects. Each country will also be responsible for providing current information on fisheries

policy and management arrangements to evaluate how the prioritised metric can influence policy and management plans.

The SWOT analyses for Aims 2 and 3 will also focus on the cost-effectiveness and suitability of the proposed metrics to be developed and maintained as part of long-term monitoring programs.

*Aim 4: To evaluate ways of integrating the above knowledge into a modelling framework that can be used to predict future changes and test adaptation scenarios.*

This aim will be part of the second workshop to be held six months after the first workshop. Between workshops, the outputs of the first workshop will be summarised and each country will be responsible for gathering additional information on the metrics identified including discussions with Government managers and industry representatives to ensure that there is support and acceptance for future projects to implement appropriate data collection and analysis systems. Based on the identified metrics in workshop 1, each country will also be responsible for listing their modelling expertise and identifying models that can be used for modelling both the biological and human components. The first part of the second workshop will be to determine an appropriate framework that will be used to model future scenarios of climate change based on predicted changes (e.g. IPCC changes).

The second part of this project will bring together the outcomes of workshop 1 and the first part of workshop 2 to develop a strategic research plan that prioritises research for the development of collaborative projects, including PhD projects, which will be put forward to the AISRF.

## Project Milestone

<u>Milestone Number: 1</u>	
Milestone Name:	Preparation for first workshop
Activity Start Date:	01/07/2010
Activity Finish Date:	14/11/2010
Applicant Contribution Cash:	\$0.00
Applicant Contribution In-Kind:	\$18,024.00
Australian Partner Cash:	\$0.00
Australian Partner In-Kind:	\$2,827.00
Indian Partner Cash (INR):	45,200.00
Milestone Funding Sought:	\$20,797.00

### Activity Description:

Development of lists of relevant species, identification of potential physical changes in environment, drafting of conceptual model of climate change impacts for species, identifying expertise in biomarkers and provide summaries of methodologies for use in workshop 1, preparation of potential social and economic metrics for discussion at workshop 1, review of current management arrangements and policy for governance of marine resources.

### Performance Indicators:

Expected outcomes: Preparation of the information required for workshop 1 will enable the development of qualitative models during workshop 1 and the SWOT analyses on biomarkers, social and economic metrics and Governance options. The PI for this milestone is that both countries have completed all activities prior to the



commencement of workshop 1.

<u>Milestone Number: 2</u>	
Milestone Name:	Workshop 1 to be held in Kochi, India
Activity Start Date:	13/11/2010
Activity Finish Date:	21/11/2010
Applicant Contribution Cash:	\$0.00
Applicant Contribution In-Kind:	\$33,222.00
Australian Partner Cash:	\$0.00
Australian Partner In-Kind:	\$5,653.00
Indian Partner Cash (INR):	85,000.00
Milestone Funding Sought:	\$14,700.00

**Activity Description:**

Development of qualitative models for Indian and Australian species. SWOT analyses to identify potential biomarkers and social and economic metrics.

**Performance Indicators:**

Expected outcomes will include identification of key species and physical parameters to use as indicators of climate change. Identification of cost effective biomarkers and social and economic metrics suitable for use in both India and Australia. Identification of management and policy issues that will be affected by climate impacts on marine resources.

Performance Indicators for this milestone will be lists of species, biomarkers, and physical parameters, social and economic metrics as key indicators of climate change.

<u>Milestone Number: 3</u>	
Milestone Name:	Preparation for second workshop
Activity Start Date:	22/11/2010
Activity Finish Date:	11/03/2011
Applicant Contribution Cash:	\$0.00
Applicant Contribution In-Kind:	\$18,025.00
Australian Partner Cash:	\$0.00
Australian Partner In-Kind:	\$2,827.00
Indian Partner Cash (INR):	0.00
Milestone Funding Sought:	\$0.00

**Activity Description:**

Discussion of species lists, physical parameters, biomarkers and social and economic metrics with Government fisheries managers, fishing industry representatives and/or fishers to obtain feedback on the acceptance and support for monitoring biophysical and human components of the marine resources.

**Performance Indicators:**

The expected outcomes of this milestone will be the acceptance by Government and industry for future research projects (See workshop 2/ Milestone 4). The performance indicators associated with this workshop will be the finalisation of lists of species, physical parameters, biomarkers and social and economic metrics for discussion on modelling frameworks in workshop 2 and for development of the strategic plan and collaborative projects.

<u>Milestone Number: 4</u>	
Milestone Name:	Second Workshop and development of strategic plan
Activity Start Date:	12/03/2011
Activity Finish Date:	30/06/2011
Applicant Contribution Cash:	\$0.00
Applicant Contribution In-Kind:	\$68,935.00
Australian Partner Cash:	\$0.00
Australian Partner In-Kind:	\$11,816.00
Indian Partner Cash (INR):	1,500,000.00
Milestone Funding Sought:	\$26,183.00

### **Activity Description:**

Based on the species identified and the metrics developed in workshop 1 and feedback from both Government fisheries managers and industry participants, a strategic plan will be developed. The plan will include collaborative projects, including PhD projects for submission to the AISRF. The agreed metrics and species will also be used to evaluate ways of integrating this knowledge into a modelling framework that can be used to predict future changes and test adaptation scenarios.

### **Performance Indicators:**

Expected outcomes from this workshop will include a strategic research plan to address climate change impacts and adaptation. The plan will list collaborative projects, including PhD projects for future funding including the AISRF. The performance indicators for this milestone will be the development of the strategic research plan including the development of collaborative research projects that address climate change issues common to Australia and India. This would include comparative studies of different biological and human systems.

## D. Project Budget / AISRF Contributions

Indian Budget (Rupees)

Item of expenditure	Estimated expenditure	Grant being requested from DST
<b>A. For workshops being organised in India</b>		
1.TA for Indian scientists/invited speakers(no of persons may also be indicated)- 5	75,000	25,000
2. Local hospitality for other participants (no. of persons x days and rate for each item may also be indicated) 20 X 5 X 1000	100,000	25,000
3. Organizational expenses including food, pre-conference printing, typing, stationary, transport etc.	300,000	91,000
4. Local hospitality for foreign scientists-accommodation, per diem, local travel/transport in India etc (no. of persons x days and rate for each item may also be indicated) 7X 7X2000	98,000 30,000	49,000 10,000
5. Misc (please specify) -Incidental		
<b>B. For workshops being organized abroad</b>		
( For 7 Indian Scientists for One week at Hobart, Australia)International to & fro airfare including airport taxes	1000,000	700,000
- Related local travel in Australia	250,000	50,000
- Visa fee	50,000	25,000
- Overseas medical insurance	50,000	25,000
<b>Total</b>	<b>19,53,000</b>	<b>10,00,000</b>

## Australian Budget ( AUD)

### PROJECT PLAN AND BUDGET

#### *Project Funding Totals - Australian Contributions*

		<u>Cash (AUD)</u>	<u>In-Kind (AUD)</u>
AISRF Funding Sought from Australian Government:		\$69,911.00	
Your Contribution:		\$0.00	\$152,429.00
Australian Partner Contributions:			
CSIRO:		\$0.00	\$28,556.00
University of Adelaide:		\$0.00	\$23,584.00
Total Australian Contributions:		\$69,911.00	\$204,569.00

#### *Project Funding Totals - Indian Contributions*

		<u>Cash (AUD)</u>	<u>In-Kind (AUD)</u>
AISRF Funding Sought from Indian Government:		\$41,023.00	
Primary Partner Contribution:			
Central Marine Fisheries Research Institute:		\$3,189.00	\$14,650.00
Other Indian Partner Contributions:			
Total Indian Contributions:		\$44,212.00	\$14,650.00

### PROJECT PHASES

#### Phase Number: 1

Phase Name: Preparation for 1st Workshop

Start Date: 01/07/2011

Finish Date: 14/11/2011

#### Research Activities

Development of lists of relevant species, identification of potential physical changes in environment, drafting of conceptual model of climate change impacts for species, identifying expertise in biomarkers and provide summaries of methodologies for use

in workshop 1, preparation of potential social and economic metrics for discussion at workshop 1, review of current management arrangements and policy for governance of marine resources.

**Performance Indicators**

**Expenses**

<b><u>Expense Type</u></b>	<b><u>Amount</u></b>	<b><u>Description</u></b>
Salaries for Australian personnel	\$18,473.00	Research assistant support to develop lists and drafting of conceptual models and identify Australian biomarker expertise and assist in the preparation of workshop materials in consultation with Australian PI.

**Phase Number: 2**

**Phase Name:** Workshop 1 (Australia)

**Start Date:** 14/11/2011

**Finish Date:** 18/11/2011

**Research Activities**

Development of qualitative models for Indian and Australian species. SWOT analyses to identify potential biomarkers and social and economic metrics.

**Performance Indicators**

<b><u>No</u></b>	<b><u>Description</u></b>
1	Expected outcomes will include identification of key species and physical parameters to use as indicators of climate change. Identification of cost effective biomarkers and social and economic metrics suitable for use in both India and Australia. Identification of management and policy issues that will be affected by climate impacts on marine resources. Performance Indicators for this milestone will be lists of species, biomarkers, physical parameters, social and economic metrics as key indicators of climate change.

## Expenses

<u>Expense Type</u>	<u>Amount</u>	<u>Description</u>
International economy class airfare for Indian researchers	\$ AUD23,002.00	Economy return airfares Kochito Hobart for Rao, Radhakrishnan, Vivekanandan, Sathianandan, Ramachandran, Shyam and Muktha (7 x AUD 3286)
Living expenses for researchers	\$AUD14,700.00	Costs for 7 Indian researchers for 7 days @ \$300/day to attend Australian workshop
Project specific workshop & meeting expenses	\$AUD4,000.00	Workshop catering including morning and afternoon teas and lunches.

### Phase Number: 3

**Phase Name:** Preparation for 2nd Workshop

**Start Date:** 21/11/2011

**Finish Date:** 09/03/2012

### Research Activities

Discussion of species lists, physical parameters, biomarkers and social and economic metrics with Government fisheries managers, fishing industry representatives and/or fishers to obtain feedback on the acceptance and support for monitoring biophysical and human components of the marine resources.

### Performance Indicators

<u>No:</u>	<u>Description</u>
1	The expected outcomes of this milestone will be the acceptance by Government and industry for future research projects (see workshop 2/ Milestone 4).The performance indicators associated with this workshop will be the finalisation of lists of species, physical parameters, biomarkers and social and economic metrics for discussion on modelling frameworks in workshop 2 and for development of the strategic plan and collaborative projects.

## Expenses

<u>Expense Type</u>	<u>Amount</u>	<u>Description</u>
Salaries for Australian personnel	\$9,019.00	Collation of Australian government and industry responses in preparation for second workshop. Preparation for second workshop including assistance with accommodation requirements etc for Indian delegates

### Phase Number: 4

**Phase Name:** Second Workshop (India) and Development of strategic plan

**Start Date:** 12/03/2012

**Finish Date:** 16/03/2012

### Research Activities

Based on the species identified and the metrics developed in workshop 1 and feedback from both Government fisheries managers and industry participants, a strategic plan will be developed. The plan will include collaborative projects, including PhD projects for submission to the AISRF. The agreed metrics and species will also be used to evaluate ways of integrating this knowledge into a modelling framework that can be used to predict future changes and test adaptation scenarios.

### Performance Indicators

<u>No:</u>	<u>Description</u>
1	Expected outcomes from this workshop will include a strategic research plan to address climate change impacts and adaptation. The plan will list collaborative projects, including PhD projects for future funding including the AISRF. The performance indicators for this milestone will be the development of the strategic research plan including the development of collaborative research projects that address climate change issues common to Australia



	and India. This would include comparative studies of different biological and human systems.
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### **Expenses**

<b><u>Expense Type</u></b>	<b><u>Amount</u></b>	<b><u>Description</u></b>
International economy class airfare for Australian researchers	\$14,700.00	Economy return airfares Hobart to Kochi for Frusher, Hobday, Pecl, Jennings, Nursey-Bray, Haward and Holbrook (7 x \$2100)
Living expenses for researchers	\$1,225.00	Costs for 7 Australian researchers for 7 days @ \$25/day to attend Indian workshop
Project specific workshop & meeting expenses	\$2,000.00	Workshop catering including morning and afternoon teas and lunches.

### **Criterion D:**

All salaries of the Australian and Indian participants will be provided as in-kind. This relates to two weeks for workshop attendance for all participants and an additional 4 -5 weeks for the chief investigators in each country (Frusher – Australia and Syda Rao – India) and an additional 2 weeks for all other participants. The additional time for the CI's is associated with the development of workshop agendas, documentation of workshop summaries, development of the strategic research plan and delivery of final reports to the respective funding bodies. The additional time for all other participants is associated with the preparation of background information for the workshops in their specific areas of expertise.

Facilities for holding the workshops will be provided as in-kind by the University of Tasmania/CSIRO in Hobart and the Central Marine Fisheries Research Institute in Cochin. Each country will also be responsible for audio-visual equipment and computing facilities including internet connections during the respective workshops.

Office facilities, internet connections, computing facilities and vehicles will be made available to the research associates who will be assisting the CI's in each country to ensure that their responsibilities for workshop preparation and collation of background materials is efficient.

## **E. AISRF Workshops**

### **Proceedings of the Workshop in Australia**

Under the Australia-India Strategic Research Fund (AISRF) project the First workshop on Preparing for Climate Change on the marine systems in India and Australia for building a Draft Strategic Collaborative Research Plan was organized in Hobart, Tasmania (Australia) during 16-20 January 2012. The workshop commenced on 16 January, 2012 at 09.30 hrs with a welcome address and introduction by Dr. Stewart Frusher, Associate Professor, University of Tasmania. He then presented information on Australian marine science. Dr Syda Rao highlighted the initiatives taken by Central Marine Fisheries Research Institute, Cochin on climate change and also presented on the research and development activities and accomplishments on Central Marine Fisheries Research Institute, Cochin. Further presentations were conducted on Indian marine science and fisheries contexts. Discipline - focused theme presentations (Physical, Biological, Economical and Social and Governance) were made by both Australian and Indian side followed by discussion on 16 and 17 January 2012. Discussion on cost-effective monitoring systems including the latest development in biomarkers and social and economic metrics were held. The panelists from both sides then discussed the climate change issues and trends and development of generic themes. The strategic research plan development and mapping exercise and SWOT analysis of current capacity and capabilities were carried out on 18 January 2012. Five theme areas were recognized and a SWOT analysis of the theme areas and key question in each theme area were also prepared on 19 January,

2012. On 20 January 2012 implementation/operational plan of projects under each theme area was prepared.

Dr.Syda Rao, PI Indian team delivered the opening remarks in response to welcome speech by Dr. Marcus Haward. He discussed on the research initiative and accomplishment of CMFRI for the last 60 years. He opined that the workshop should evolve research projects related to climate change and should be under the theme shall taking the advantage of the first mover.

Dr.E.V.Radhakrishnan discussed on the marine science research in India and explained about oceanography and fishery research, primary and secondary production. He also discussed on the rich coastal biodiversity of marine fisheries resource assessment and management biotechnology and environmental health. He enlisted the different organizations involved in the marine science research in India.

Dr.T.V.Sathianandan discussed about the Indian fisheries in the context of production species and craft and gear operational and the management conservation measures availing in the country.

Dr.E.Vivekanandan presented in detail the existing climate change activities in India with reference to the different projects & approaches regarding the climate change initiative in India. The different research areas in operation / completed include Impact on marine fish (distributional shifts & phenological changes), Vulnerability of corals, development of vulnerability Index of coastal districts, carbon footprint of marine fishing boats, and indigenous Technical Knowledge of fishermen

Dr.E.Vivekanandan presented on the physical aspects of climate change including physical profile, monsoon wings the different subsystems, marine systems etc. He highlighted the sea surface temperature along the Indian coast, occurrence distribution cyclone and its simulatesocean current area, sea erosion. Sea level rise and enlisted the elements and metrics and issues and its adaptability related to physical parameters to climate change.

Dr.Muktha Menon presented the available biological data related to climate change related to biological parameters, issued and its adaptability. She opined that major issues rest with limitation in identification of the institutional and legal frame work and the Ministries/Organization involving in the governance for marine fisheries in India.

Dr.Shyam S. Salim delivered the Economic perspectives and possible impacts of climate change on the Indian marine fisheries sector and discussed on the economic indicators, efficiency, trade, investments, primary stakeholders, climate change vis-à-vis economy, key elements with data sets, issues and adaptability

Dr.C.Ramachandran presented the social dimension of the climate change with reference to India and suggested need for a climate change informed fishers

The visit of Indian team was helpful in preparing a draft strategic research plan which will be further discussed and project proposals formulated during the second workshop to be held at Cochin from 6-10 March, 2012.

Consequent to the AISRRF workshop on Preparing for climate change on marine systems in Australia and India” during 12<sup>th</sup> to 20<sup>th</sup> January, 2012 at Hobart, Tasmania a preparatory meeting for the conduct of the second workshop to be held in Cochin during March 2012 was held in Doha, Qatar on 24<sup>th</sup> January 2012.

The following team members attended

1. Dr. G. Syda Rao, Director, CMFRI, Kochi and Principal Investigator
2. Dr. Shyam S. Salim, Senior Scientist, CMFRI, Kochi , Co-Pi and Research Co-ordinator
3. Dr.E.V.Radhakrishnan, Principal Scientist & Head, CFD, CMFRI, Kochi
4. Dr.E.Vivekanandan, Principal Scientist & SIC, Madras RC of CMFRI, Chennai
5. Dr.C. Ramachandran, Senior Scientist, CMFRI, Kochi
6. Dr.T.V.Sathianandan, Senior Scientist, CMFRI, Kochi

7. Smt. Muktha Menon., Scientist, Visakhapatnam RC of CMFRI,  
Visakhapatnam

In connection the proposed workshop to be held at India during 6-10 March 2012 a preparatory meeting was held at Doha on the 24<sup>th</sup> January 2012 with Director, Central Marine Fisheries Research Institute, Cochin. The Director, Central Marine Fisheries Research Institute complimented the efforts of the team in showcasing the research activities and work plan for the workshop held at Australia.

The proceeding of the meetings is indicated below

1. The proposed workshop will aim at developing prioritized research projects with the detailed methodology and work plan. Around 2-3 research project will have to formulated across the five theme areas viz., Food security concerns and marine resource capacity, Fishing in a Carbon economy, Management and governance arrangements, Modelling and monitoring complex marine systems and Communication The workshop will also try to finalize the probable funding agency where the same can be submitted.
2. The workshop will be held during 6<sup>th</sup> to 10<sup>th</sup> March, 2012 and the venue of the workshop will be Head Quarters, Central Marine Fisheries Research Institute, Cochin. The workshop venue will be Room No. 201/ 101 after arranging for appropriate audio visual facilities.
3. The programme will include an inaugural function with scientists, technical and administrative staff of CMFRI. Following the inaugural session there will be 3-4 technical Session and valedictory Session on 10<sup>th</sup> March 2012
4. The involvement of the Australian Embassy officials / DST India personnel to inaugurate the workshop needs to be explored
5. As the project scope has widened on account of developing 2-3 research projects under the different theme area inclusion of the new project personnel is important .It was also discussed on the possible inclusion of oceanographer from NIO / AndhraUniversity.

6. It was felt that involving the Universities would lead to an added advantage of student participation which is one of the prime anticipated outcome of the projects
7. The accommodation for the Australian participants will be arranged at CMFRI Farmer's Rest Room. Sufficient arrangements with regard to infrastructure, internal connectivity will have to be ensured.
8. The detailed work plan of the workshop agenda is to be prepared after consultation with the Australian counter parts
9. Dr, Shyam .S Salim ,Senior Scientist will be the co-ordinator of the workshop
10. The Director reiterated the need for continuing dialogue and interaction across the members of the identified theme groups for developing better clarity in the conceptualization of the project

### **Proceedings of the Workshop in India**

The inaugural session of the five day International Workshop on Preparing for Climate Change on Marine Ecosystems in India and Australia commenced on 06<sup>th</sup> March 2012 at 9.30 am at the Central Marine Fisheries Research Institute, Kochi. The registration of the participants was done earlier in the day followed by an invocation which was rendered by the ICAR prayer song. The welcome address was given by Dr.E.Vivekanandan, Principal Scientist and Scientist-in-Charge, Madras Research Centre of Central Marine Fisheries Research Institute. Dr.E.Vivekanandan gave a brief prologue to the workshop held at Hobart, Australia and also the roles played by both Indian and their Australian counterparts in evolving the five broad areas of preparing for climate change on Marine Ecosystems in India and Australia such as Food security, Fishing in Carbon economy, Management, Monitoring and modelling complex marine systems and Strategic Communication for Climate Change Preparedness.

The workshop proposed to use an objective qualitative modelling approach to determine the vulnerability of key commercial species to climate change.

“Collaborative research projects covering oceanography, biology, social sciences, economics and governance disciplines as well as inter disciplinary research. At the outset he welcomed the Chief guest, Mr. Michael Carter, His Excellency, the Consul Commercial and Trade Commissioner of Australia at Chennai, followed by Dr.Stewart Frusher, Dr.Ingrid Van Putten, Dr.GrettaPecl, Dr.Melissa Nursery Bray,Dr. Sarah Jennings ,Dr Marcus Howard and Dr Neil Holbrook.Dr.E.Vivekanandan also welcomed all the Heads of divisions and Scientists, technical and other staff who attended the inaugural function .In his presidential address, Dr.G.SydaRao the Director, Central Marine fisheries Research Institute, Kochi and Indian programme leader highlighted that Southern India and South Eastern Australia were the hot spots for climate change and the scientific expertise in both the countries can be utilised to their fullest so as to benefit both the countries mutually and to help them in facing the challenges for Climate Change. Besides, he also extended a warm welcome to the Chief Guest and participating Australian team members, who came to participate in the workshop.

Dr.StewartFrusher, Associate Professor, Institute of Marine and Antarctic Studies, University of Tasmania and the Australian Team leader, in his capacity as Guest of Honour, addressed the gathering. The changes in the Marine domains of India and Australia are affecting the circulation patterns, distribution and abundance of marine species in the two countries, he said. Dr.Frusher said that such changes were also impacting the marine industries and associated communities. Enhancing the marine production systems to meet the needs of a growing global population, mitigating the carbon footprints and sequestering carbon are the challenges before the countries. To tackle the issues as broad and important as climate change, one needs to understand both the biological and physical systems. The gradual changes in Ocean Currents, rising sea levels and increased frequency of extreme events such as cyclones and storms and rainfall are also matters of concern. The response of marine ecosystems to these changes is also important. The project according to him, brings together expertise in Oceanography, biology, economics, social science and governance through an inter-disciplinary approach for the development of a strategic

plan for both countries to meet the challenges of a changing climate, he said. This is the second workshop- the first was held in January, 2012 at Hobart, Australia, where five draft themes were identified. Based on the themes, projects will be developed at the workshop. According to Dr.Frusher, Southern India and South EasternAustralia are among the top 10 per cent of the regions that are warming fast globally. These regions are expected to be Earth's early warning laboratories for studying the impact of global warming laboratories for studying the impact of global warming on marine systems- observations will be made. Methodologies and adaptation responses developed, tested and validated, he said.

Mr. Michael Carter, his Excellency, the Consul Commercial and Trade Commissioner of Australia at Chennai inaugurated the workshop by lighting the traditional lamp and this was followed by his inaugural address. In his introductory remarks, he said that Indian and Australia should share their best practices for development and growth of the blue economy. He laid stress on the increasing convergence between Australia and India on numerous agendas such as trade, investment and collaboration. He said that the Australian India Strategic Research Fund (AISRF) is set up to support collaborative projects in the priority areas agreed by the two governments. He said that the trade between the two countries is on the rise. Five years back, the trade between the two countries stood at 14 billion dollars and now it has gone up to 21 billion dollars. The trade value is likely to rise in the next three years. Also, India is Australia's fourth largest fourth largest export destination for goods and services. On the investment front, Indian investment in Australian, mostly is in resource sector and is almost 10 billion dollars. India's need for energy sector will be addressed. The 3 million dollar Grand Challenge Fund over three years is to provide collaborative projects of significant scale and ambition that will deliver practical solutions to some of the key challenges in both countries in the area of health, energy, food water security and environment. Research collaboration between Indian and Australian varsities is increasing. He touched upon the seven MoU's and research collaboration in Kerala. In his address Michael Carter said thatAustralia's approach to climate change was based on the reduction of greenhouse



gas emissions adapting to climate change and helping to shape a global solution to the issue. Australia is moving to a cleaner economy which is sustainable, competitive and able to withstand the challenges of climate change. The country is committed to reduce its emissions by 60 per cent by 2050, he said.

The inaugural session concluded with a formal vote of thanks proposed by Dr.T.V.Sathianandan, Head of Division, Fisheries Resource Assessment Division. (FRAD). The formal end of the inaugural session was marked by the playing of the National Anthem.

The Technical session I commenced with Dr.E.Vivekanandan, Principal Scientist, who presented a brief outline of the work done by both the Indian and Australian team members at Hobart, Australia. He delineated the three steps which gave a broad overview of the work done at Hobart, Australia.

In step I, he said that there was presentation and discussion on broad researchable areas. In step 2 he said that, from the five major areas, five themes were delineated. They were:

1. Food security
2. Fishing in carbon economy
3. Management issues
4. Modelling and Monitoring Systems
5. Strategic Communication for Climate Change Preparedness and Responsible Marine Fisheries Governance

This was followed by a SWOT analysis. At Hobart, the draft research project proposals for each template were developed. The different theme areas were identified and the different themes were explained

Theme 1 was on food security and Marine Resource capacity. The objective of this theme was to assess the current status of the fishery resources and predict the future impacts of the climate change on these resources.

Theme 2 was on fishing in carbon economy. This dealt with adapting the fishery system to a carbon regulated economy.

Theme 3 was on Management and Governance regimes.

Theme 4 was on Modelling and Monitoring.

Theme 5 was on development of Communication Strategies Dr.Marcus spoke about the Grand Challenge funds and how best it could be utilised for the present research projects.

The session began with the presentation by the theme on “Fishing in a carbon economy”. The theme had interdisciplinary interventions such as Assessment of role of incentives in adopting carbon mitigation strategies by stakeholders in fishing communities. Dr.Swathilakshmi was of the opinion that an adoption index could be worked out for evaluating the extent of adoption of carbon mitigation strategies by stakeholders and this could be included under the methodology. Dr.R.Narayana Kumar said that several awareness campaigns could be undertaken to educate the stakeholders on carbon mitigation strategies. Under the theme of food security it was decided to undertake pilot trials/ experimental trials for artificial reefs.

Following this, presentations on the other theme areas such as management and governance, communication and modelling were made.

Dr.Melissa was of the opinion that while documenting the indigenous traditional knowledge under communication theme care should be taken for studying the intellectual property regimes with respect to each country.

Dr.Stewart said that the strategic plan would be a public document. In strategic plan only issues and headings are taken care of and not project per say, but when funding is ready, projects may be included.

The next hour was devoted to the clearing of doubts with respect to the project. To a question by Dr.Narayana Kumar as to whether the project cost would be calculated in Indian or Australian currency, Dr.Stewart said that it could be in Indian currency.

Dr.Muktha wanted to know about the geographical hotspots which would probably form the locale of research. Dr.Stewart said that Southern India and South east Australia would be the geographical hot spots which would form the locale of research for the projects.

Dr.Muktha also wanted to know whether North West India for latitudinal shifts in climate change has to be included. It was decided that this could be based on species specificity and observations made.

As the final phase of the workshop came to an end, Dr.Shyam Salim co-ordinator of the workshop announced the team leaders responsible for carrying out and completing the projects. They were:

1. Food security: Dr.Ingrid Van Putten and Dr.Vinod
2. Carbon Economy: Dr.Narayana Kumar and Dr.Sarah Jennings
3. Management and Policy: Dr.Zachariah
4. Modelling: Dr.T.V.Sathianandan
5. Communication: Dr.P.S.Swathilekshmi

Under project 1, Dr.Sarah said that, Measuring the carbon footprint across the value chain for key fisheries in Australia and India would be undertaken Under this project, the main objectives were as follows:

- Identifying opportunities for carbon mitigation across the value chain in key fisheries in Australia and India.
- Assessment of barriers adaptation and evaluation of economically efficient carbon mitigation/adaptation strategies across the value chain in key fisheries in Australia and India.
- Identifying optimal fisheries carbon adaptation pathways and the role of incentives, regulations and offsets.

Under project 2 the following objectives were identified:

- Identification of threats to carbon sequestration (overfishing, pollution, coastal development etc.) and potential for increasing carbon sequestration in key coastal ecosystems in Australia and India.
- Understanding the interaction between the use of coastal ecosystems for carbon sequestration and other uses such as fisheries and biodiversity.

- Economic evaluation of alternative carbon sequestration systems, including the identification of coastal ecosystem management objectives, the valuation of sequestered blue carbon (with and without blue carbon markets) and the valuation of alternative uses of coastal ecosystems (e.g. changes in biodiversity values and fisheries productivity).
- Incorporation of blue carbon into integrated coastal management systems.
- Understanding the potential role of blue carbon farming in strengthening coastal community livelihoods.

### PROJECT TITLE

An interdisciplinary assessment of fishery systems in the carbon economy: Carbon footprint and sequestration opportunities in India and Australia(OR) AN interdisciplinary assessment of carbon footprint and sequestration in fishing

#### Back ground of the study

Carbon dioxide is a greenhouse gas emitted from anthropogenic and natural sources, which is now modifying the atmosphere and terrestrial and ocean systems. Increasingly, carbon will be regulated and priced under national (e.g. emissions trading schemes) and international agreements (eg .Copenhagen agreements).

One of the main ways in which fishery systems will be impacted is through market and government-driven increases in the price of carbon-based fuels. The high exposure of many fisheries systems to rising carbon prices is a major source of climate-risk, and results in high vulnerability of many fisheries, and their linked supply chains and communities. ‘Carbon-proofing’ fisheries production systems through cost-effective adaptations can reduce this vulnerability and will also mitigate the sectors carbon footprint.

The term ‘Blue Carbon’ describes the natural processes by which atmospheric carbon is captured and stored (sequestered) by marine environments. ‘Carbon sequestration’ means carbon storage that is unlikely to be reintroduced to the

atmosphere for more than some period of time (say 100 years). Coastal wetlands have the potential to sequester carbon in the tissues of plants and sediments, just as trees on land sequester carbon. Carbon sequestration and storage in seagrass, mangrove and wetland ecosystems is considered to be extremely high (rates of up to 5 times those of tropical forests) and turnover is low in undisturbed systems.

Australian and Indian coastal ecosystems also support many valuable inshore fisheries, creating jobs and providing high quality protein, and are a source of rich biodiversity. They also support a wide range of other coastal activities including recreation and aquaculture. Both countries have lost large quantities of coastal ecosystems, which in turn have impacted on coastal biodiversity, ecosystem services, and fisheries productivity and sustainability.

It is suggested that restoration or protection of these coastal habitats presents a win-win-win situation: (1) positive biodiversity outcomes, (2) enhanced fishery production (many species use these habitats as nursery areas), and (3) an important opportunity for ecosystem-based climate mitigation -‘blue carbon’- which also preserves the essential ecosystem services of these habitats. However this suggestion needs to be tested within the context of specific coastal ecosystems in both Australia and India.

In the case of blue carbon, there is also a viable market that could be created for carbon trading (as on land – called the Green Economy), although significant efforts are required to develop this into reality, including science background and policy reform.

#### GENERAL OBJECTIVE

To prepare fishery systems in India and Australia to adapt to a carbon regulated economy through the adoption of mitigating actions to reduce the carbon footprint and to take advantage of blue carbon opportunities.

## Specific objectives

1. To identify efficient carbon mitigation actions across the supply chain for selected commercially important fisheries in India and Australia
2. To develop optimal carbon mitigation strategies for selected commercially important fisheries in India and Australia
3. To identify the potential for efficient carbon sequestrations in the key coastal ecosystems in India and Australia
4. To develop strategies for incorporating blue carbon into integrated coastal management systems and coastal livelihoods

## Tasks and Activities

- Identification of the fisheries systems important to India and Australia and to select those for study
- Characterisation of the supply chains and identification of the main points of carbon impact for selected fishery systems.
- Quantification of the carbon footprint across the supply chain for selected fishery systems.
- Identification of opportunities across the supply chain for carbon mitigation.
- Assessment the carbon mitigation actions and prospects
- Identification of the barriers to adoption of efficient carbon mitigation actions.
- Development of strategies for addressing the barriers – communication , governance
- Economic evaluation of different carbon adaptation strategies
- Assess the role of incentives in adopting carbon mitigation strategies by the stakeholders or (fishing communities)
- Identification and classification of potential carbon sequestration systems
- Identification of threats to carbon sequestration (over fishing, resistance to alternative livelihoods, pollution, coastal development, anthropogenic

activities, climate change, etc.).

- Understanding the interaction between the use of coastal ecosystems for carbon sequestration and other uses.
- Social cost benefit analysis of the alternative carbon sequestration systems
- Identify opportunities for coastal communities to participate in the blue carbon economy
- Identification of barriers in establishing a blue carbon economy ;
- Development of strategies for addressing barriers affecting coastal communities in carrying out blue carbon farming

Project (STUDY) area

India and Australia- selected coastal states of India and Australia

Tentative Work plan

- Identification of the fisheries systems important to India and Australia - Selection criteria and assessment of important fisheries –
  - Share of the fisheries in the overall valuation
  - Level of employment provided by the fishery
  - Export value earned,
  - Craft and gear combination deployed for the fishery (??)
- Characterisation of constituents in the supply chains and identifying main points of carbon impact.-
  - Harvest and post-harvest marketing functionaries
- Quantification of the carbon footprint across the supply chain.-
  - Life cycle assessment of the selected fishery (or species???)
- Identification and evaluation of the opportunities available across the supply chain for carbon mitigation-
  - Comparison with existing standards and analysing the scope for interventions (by

whom??)

- Assessment of the existing carbon mitigation actions and prospects
- Survey of the carbon mitigation actions existing
- Work out their cost-benefit. This can be extended to work out the additional costs incurred in carrying out the carbon mitigation plans and the increased returns due to it (May be a partial budgeting?)
- Identification of the barriers to adoption of efficient carbon mitigation actions.
- By conducting opinion surveys and personal interview with the stakeholders
- Development of strategies for addressing the barriers – communication , governance
- Developing best tool of communication
- Coordinating a governance method similar to the Vana Samrakshna Samithi is (VSS) translated as :Forest Protection Councils
- Conducting periodical refresher or awareness campaigns on the carbon mitigation and its possible impact (???)
- Economic evaluation of different carbon adaptation strategies and the role of incentives
- Working out the economic cost benefit of the adaptation strategies,
- Identification and classification of potential carbon sequestration systems
- Biological component to be addressed by the biologist in the team
- Identification of threats to carbon sequestration (over fishing, resistance to alternative livelihoods, pollution, coastal development, anthropogenic activities, climate change, etc.).
- Through survey with open end questionnaire (more of subjective in nature)
- Understanding the interaction between the use of coastal ecosystems for carbon sequestration and other uses.
- Biological component to be addressed by the biologist in the team



- After listing out the interactions, the same can be valued with the available environmental economics methodology (is this needed???)
- Social cost benefit analysis of the alternative carbon sequestration systems
- Applying standard social cost benefit analysis methodology like (following CBA approach of Partha Dasgupta ???)
- Assess the opportunities and challenges for coastal communities to participate in the blue carbon economy
- Identification of barriers in establishing a blue carbon economy (May be deleted as this is combined with the above method) ;
- Development of strategies for addressing barriers affecting coastal communities in carrying out blue carbon farming
- Again to arrive at through interviews and interactions with stakeholders through series of discussion meetings
- identification of coastal ecosystem management objectives,
- valuation of sequestered blue carbon (under different assumptions about blue carbon markets and prices);
- valuation of alternative uses of coastal ecosystems (e.g. changes in biodiversity values and fisheries productivity);

#### POTENTIAL STAKEHOLDERS

- Fishing industry
- Government
- CSIRO Coastal Carbon Cluster
- CSIRO Coastal Cluster

#### MAIN OUTPUTS (EXPECTED OUTCOMES)

- The project will bring out the intensity of the carbon utilization in the fisheries under various supply chains and ecosystems in India and Australia. The

amount of carbon utilized per kg of production of a fish under different craft gear combinations (and under different ecosystem) will be estimated.

- The various carbon mitigation strategies available for reduction of carbon foot print will be listed and evaluated to find out the optimal carbon reduction action or strategy under each fishery or ecosystem identified.
- The effective sources of carbon sequestration will be identified and measures to promote them by incorporating into **blue carbon farming** will be developed.
- The stakeholders will be sensitized on the impact of carbon footprints and the benefits of carbon sequestration in the long run through effective communication tools and mobilizing effective governance mechanisms (May be split into two sentences??)
- The long term benefit will be mooted the concept of “**blue auditing**” on lines of green auditing for terrestrial ecosystem while measuring the contribution of fisheries to the economy of the country (May be this will become the order of the day some time later??)

The potential stakeholders would be:

- Fishers / Fishing industry
- Government / Policy planners
- CSIRO Coastal Carbon Cluster / Different fishing Sectors
- CSIRO Coastal Cluster

The main outputs expected out of this project would be:

- Lifecycle assessment of fishing activities
- Possible trade offs in each fishing sector

According to Dr.Sarah, in Australia and India, the fuel input would be a major component of the variable cost. According to Dr.Stewart, the industry’s role of blue carbon farming in strengthening coastal livelihoods had to be studied.

Dr.Shyam. was of the opinion that the economics of reducing carbon needed to be worked out. At present there were no norms to curb carbon emission. On calculation of the net benefits, it should ultimately impress upon the policy makers,

Dr.E.Vivekanandan, added that the emission from the carbon sector in India may not be more than 0.06, when compared to the total carbon emissions from all other sectors, put together.

According to Dr.G. SydaRao, Director, CMFRI, the use of solar energy for chilling of water on board the trawlers could be considered.

Dr.R.Narayana Kumar was of the opinion that, the additional cost of installing carbon indicators in vessels needed to be studied.

Dr.Shyam Salim raised the doubts as to whether carbon labels should be brought in in the lines of eco labelling which specify the limits of carbon in fishes which were exported.

Dr.Stewart was of the view that the methodologies which could minimise the carbon use in sea food business need to be developed.

Dr. Pratibha Rohit, was of the opinion that in countries like India where fisheries was a livelihood issue, the question of feasibility in the use and advocacy of such labels was debatable.

Dr.ShyamSalim said that the levels of emission of carbon by producing a fish had to be quantified.

According to E.V. Radhakrishnan, in a multi gear, multi craft tropical fisheries system as was prevalent in India, the extent to which carbon labelling would be practically feasible had to be debated upon.

- Dr.R.Narayana Kumar was of the opinion that, the beneficial impact of carbon labelling would be felt only in the long run.

Following the presentations made by all the team leaders on the 5 major themes, Dr.StewartFrusher, the Australian Team leader summarised the deliberations made in the presented themes.

Sarah explained that food security and carbon economy are 2 major themes underpinned by Modelling, monitoring, management and communication leading to formulation of a communication strategy for strategic plan.

#### Potential funding agency

The Indian team leader and Director of CMFRI, Dr.G.Syda Rao discussed the possibilities and sources of fund for the Australia - India Strategic Research Fund (AISRF). He said that ICAR (Indian Council of Agricultural Research) could be a major funding source. Dr.E.Vivekanandan was of the opinion that the nodal agency for funding was the Ministry of Environment and the AISRF. Apart from the Grand Challenge fund these, three sources could be made use of , he said.

According to Dr.Radhakrishnan, UNEP was a major funding agency. Dr.Vivekanandan was of the opinion that, every year the UNEP comes up with a major theme for funding. In 2012, the theme was conservation of *Dugong dugong* (endangered species).

The other available funding agencies were Asian Development Bank, Global Environment Facility (GEF) and UNDP.

Dr.E.Vivekanandan said that a deadline for deciding the source of funding agency should be made and it was unanimously decided by all the team members that the deadline would be on July 30<sup>th</sup>, 2012. He further suggested the team to make use of websites to explore the various sources of funds.

Dr. Neil wanted to know whether MoU's have been organised. He pointed out that, in the absence of MoU's funding was going to be a challenge.

Dr. Stewart Frusher, said that, once the draft was prepared than, preparations for MoU's could be undertaken.

Dr.E.Vivekanandan wanted to know whether the endorsement was for the entire project or plan. Dr. Steward said that, it was with respect to the plan.

Dr.Swathilekshmi mentioned that ACCCP was yet another funding agency in respect of climate change.

Following this the focus of discussion was shifted on project formulation. Dr.E. Vivekanandan was of the opinion that each of the 5 themes could be made in to a project and all the 5 projects could come under an umbrella of a big project.

Dr.G.Syda Rao pointed out that, we could have 5 projects under an umbrella project. The Indian component of funding was under the five year plan. Following this, Dr.E.Vivekanandan explained about the functioning of the ICAR network project.

It was decided at this point of discussions that the team reorganise itself in to 5 working groups to formulate the first draft of the projects. It was emphasised that while formulating the projects, the objectives would have to be finalised, time frame, work elements and methodologies should be decided by each group. Besides a tentative time frame and budgeting and benefits /out comes to science/community could also be incorporated.

Following this the working groups were organised and the groups started working, discussing, interacting and formulating their respective projects.

On the last day of the workshop each of the groups presented their formulated projects and was discussed in the plenary session

As the curtains to the workshop came to a draw, Dr.Stewart Frusher, the Australian team leader thanked the Indian team comprising of the Director Dr.G.Syda Rao, and his scientists. He also thanked Dr.Shyam Salim the co-ordinator of the workshop for his untiring efforts in making the workshop a success and also for the hospitality bestowed on them.

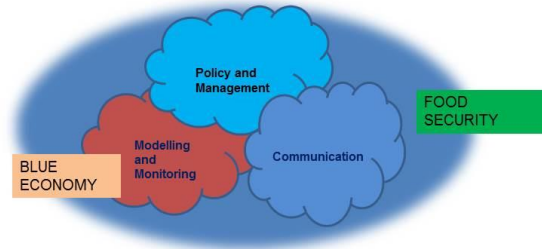
Dr.G.Syda Rao, Director CMFRI and the Indian Team leader said that the workshop was very productive with the sharing of strengths form both the teams mutually and forging ahead for further improvements. He thanked the scientists, the technical and

supporting staff for contributing to making the workshop a grand success and wished that the group should enlarge and strengthen further.

Dr. Shyam Salim the Co-ordinator of the workshop thanked the Director, CMFRI, Dr. G. Syda Rao on the confidence reposed in him as the coordinator of the workshop. He also thanked the team members, technical and supporting and also thanked his Australian counterparts for their excellent scientific inputs, their gesture of co-operation and good will during the entire course of the workshop. Thanks were also accorded to Dr. E. V. Radhakrishnan for his impeccable punctuality and also to Dr. E. Vivekanandan for giving a lead in conducting the workshop. The workshop came to an end at 12.00 hrs.

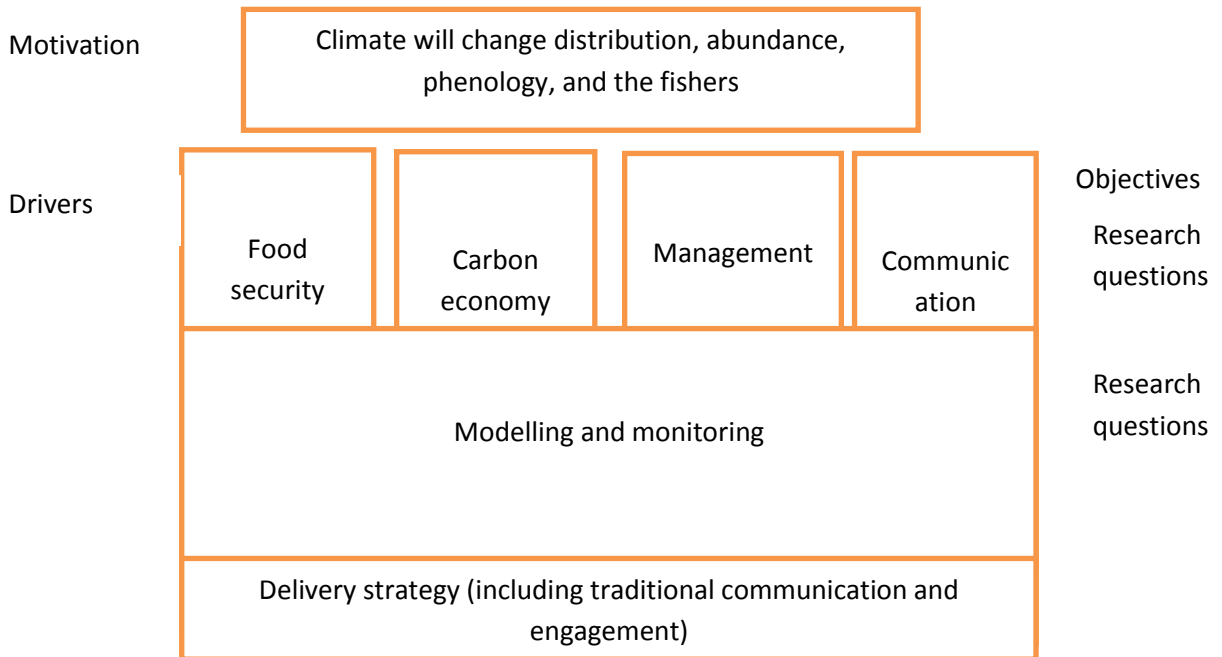
## F. Output

### A.) Strategic Research plan



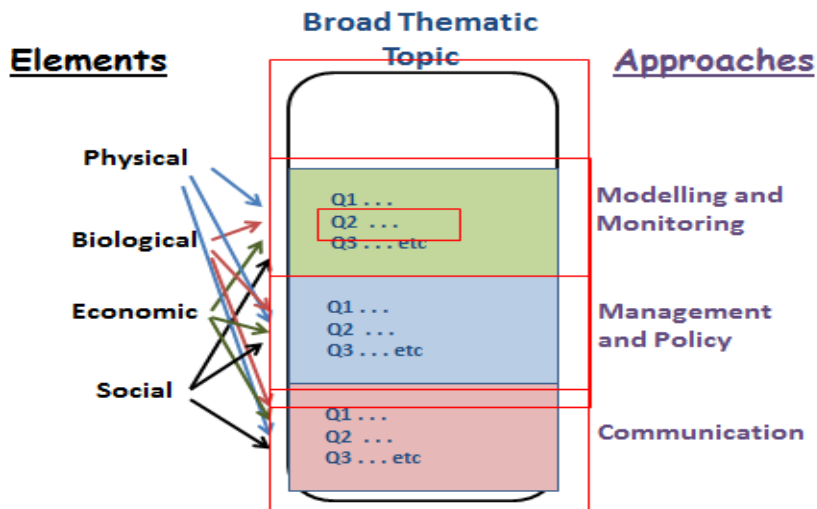
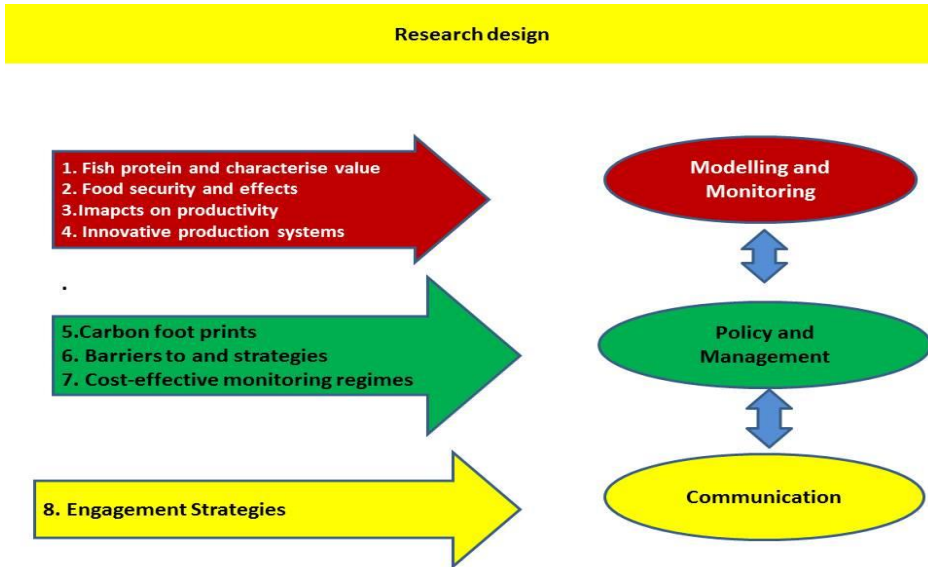
(Theme Areas- Food security and Blue economy  
Approaches ( Modelling & Monitoring, Policy and Management, Communication).

Schematic representation on the development of the Strategic Research plan



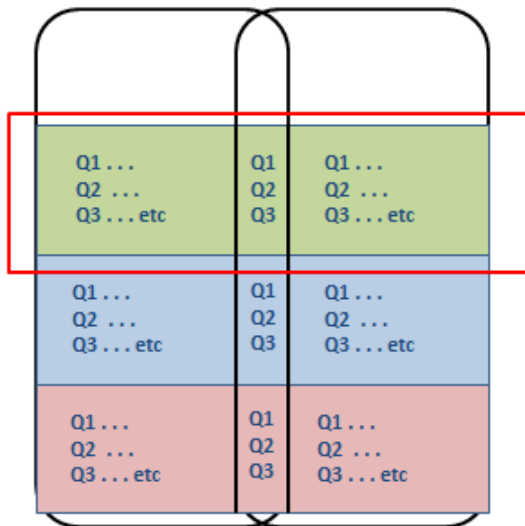
## (B) Development of Research / Theme Areas

### (i) Research design developed





## Broad Thematic Topics



**(ii) Theme areas developed:** The theme areas developed were discussed under a SWOL analysis and the different issues/ concerns / questions were generated

**SCOPE:** Marine ecosystems (including commercial-, recreational-, artisanal-, and subsistence fisheries, aquaculture, and biodiversity conservation).

**Overall research plan objective:** be innovative, cost effective, novel, informed, build on diversity,

Benefit from first mover advantage (marine hotspots) and build on India and Australia researcher capacity

### **1. Theme: Food security concerns and marine resource capacity**

**Objective:** Assessment of impacts and opportunities of climate change for food security

## **Strengths**

- Theme is something that people and governments connect to; generally seafood is part of many people's diets
- Knowledge base/baseline data is present (such as scientific and traditional knowledge)
- Biodiversity may lead to increased resilience
- Alternative stocks may be available in species rich systems
- Efficiency of trade and distribution arrangements
- Food reserves as an alternative to other protein substitutes: fisheries are a buffer
- Capacity to farm seafood (existing and test aquaculture industries)
- Strong resource base
- Increased purchasing power and standards of living which builds adaptive capital

## **Weaknesses**

- Ecological surprises
- Other immediate threats (e.g., pollution)
- Threats less visible in the ocean
- Poor forecast
- Unequal access to resources
- Regional differences in resource dependency and food security
- Regulatory and ethical constraints on technological solutions

## **Opportunities**

- Markets for new fish species (fisheries and aquaculture)
- Improvement in model forecasts
- Technological solutions (e.g., translocation, enhancement, genomics)
- Win-win for conservation, production and exports

- Develop systems/solutions and test/validate these (world leader/supplier of knowledge/technology)

### **Threats**

- Poor forecast affects the market in a negative way
- Population growth and pressure
- Changing environment
- Ecological surprises
- Lack of property rights regimes/leasing rights
- Synergistic threats
- Consumer preference
- Disease (increased susceptibility, prevalence, spillover/spillback)
- Difficulty to secure funding in this area due to competition for limited outlay

### **Research Analysis/ Concerns**

- Impact of climate change on food security in Australia also needs to be looked in to.
- Purchasing power of fishermen has to be assessed.
- Studies on consumption pattern of fish (data base) at present unavailable.
- To address nutrition, livelihood and consumer demand to be addressed.
- Regulatory framework for fisheries has to be looked in to.
- Opportunities arising from climate change to be harnessed eg: Aquaculture.
- In course of time some species to become dominant and how they can be used for value addition.

### **Questions**

1. Modelling and forecasting of physical metrics on fish production expected yields (hind- & forecast)
2. Evaluation of model forecasts on fish production

3. Predict future productivity and extractive potential within an ecosystem framework(ecosystem approach to food security - maintaining healthy, diverse and productivity ecosystems)
4. Impact of the productivity changes in the economy – with respect to cost and revenue for the different stakeholders and economic agents (e.g. understanding consumer demand for marine protein)
5. Alternative production systems and needs analysis which could emerge or be developed consequent to climate change effect (identify, assess evaluate, and document).
6. Pressure exerted on international trade patterns, barriers, agreements by climate drivers and their economic impact on domestic food security.
7. What is/documentation of the link between food security and natural disasters?
8. Identification of extent/scale of loss of livelihood (hence food security) as result of climate change
9. Assessment of the impact of new or exotic species on food security including the potential utilisation of lower trophic level new species

## **2. Theme: Fishing in a Carbon economy**

**Objective:** Adapting fishery systems to a carbon regulated environment and assessing the opportunities for carbon sequestrations in the marine environment (adapting to a biomass economy)

### **Strengths**

- Technological advancements: i.e., in fishing gear/recruitment, low emissions engines etc.
- Diversity of habitats/species
- Theme is something that people and governments connect to; generally seafood is part of many people's diets
- Win-win conservation and extractive objectives

- Efficient fuel to protein conversion (in comparison to other foods)

### **Weakness**

- Cost/investment in carbon friendly technologies high/prohibitive
- Availability/access
- Export of fish has large carbon footprint (Australia)
- Marine sequestration is excluded from policy (global); but may be opportunities for development of the issue on domestic agendas

### **Opportunities**

- Habitat remediation (e.g., mangrove/halophytes (*Salicornia*)/seagrass plantation)
- Trying to understand C capture from a physical perspective
- Creation of incentives
- Bio-sequestration
- Algal production (e.g., bio-diesel, human consumption, pharmaceuticals, nutraceuticals)
- Marine sequestration research development
- Cost-effective fishing businesses (win-win)
- Potentials for other carbon trading
- Use marine sequestration as a driver for greater funding for monitoring (establish capacity and maintenance of carbon stock)
- Marine offsets (e.g., link stock enhancements with sequestration)

### **Threats**

- Unregulated introduction of fishing technologies (technology creep)
- Use of extractive technologies
- Food supply (carbon footprint of transport/storage)

- Increasing search effort (burns more fuel if stock abundance decreases or overland commute to distant fishing areas)
- Increasing fuel price/peak oil
- Changes in subsidies

### **Research Analysis/ Concerns**

- In carbon sequestration systems, whether decision making systems are in place or to be developed?
- The emission of C from fishing sector is negligible. How to impress policy makers?
- Use of solar energy for chilling water on board trawlers can be considered.
- Additional investments for installing C indicators to be worked out.
- Eco-labelling vs livelihood issue?
- Quantification of C emitted. (Whether possible in a tropical multi gear &craft fishery system?)
- Though feasible whether benefits may be realized in the long run only?

### **Questions**

- Identification of incentives for fishers / industry to incorporate carbon mitigation/adaptation techniques/initiatives
- Development of incentives
- Documentation of barriers to adoption of mitigation/adaptation measures
- Literature review of technologies/techniques being used
- Evaluation of efficiency of offset programs

### **3. Theme: Management and governance arrangements**

**Objective:** Developing optimal and responsible marine ecosystem management regimes and governance in a changing climate

## **Strengths**

- Drive to sustain resources in fishing families exist
- Inter-generational/Traditional knowledge
- Real-time management tools such as seasonal forecasting using remote sensing in India (e.g. pelagic fishes); parameters such as rainfall onset, upwelling and SST linked to stock abundance (India: fishers/Australia: managers)
- Both countries have strong history of governance
- Diversity of approaches across the two countries in terms of governance/management
- Willingness of fishing industry/fishers to participate in collection of data
- Growing literature base/tradition of research on the topic
- Strong connections between researchers and managers/accepted by government that need assessments
- Non-governmental organizations maintain close linkages with fishers (India)

## **Weakness**

- Move to adaptive management without ongoing monitoring
- Compliance issues and implementation of management (India)
- Incorporation of climate change as an issue into management (India & Australia)/policy (Australia)
- Perception that climate change is already captured in management models by scientists but tools are lacking to deal with extreme events/case scenarios
- Absence of adaptive/flexibility for institutions to administer policy/management change (e.g., in the case of overfishing there will be a time delay in India prior to a response)
- Established physical-biological/bio-economic relationships for only a few species

- Reliance on remote sensing systems such as Sea WIFS may not always be reliable (e.g., problematic during cloud)

## **Opportunities**

- Development of policies and management strategies to enable alternative fisheries/aquaculture
- Greater adaptive capacity with multi-species and multi-gear fisheries
- Resolution of forecasts species-specific
- Physical information required for spatial management
- How to make seasonal forecast useful for fishermen and other people
- Forecast based models are an opportunity for aquaculture
- Forecast modelling using remote sensing (e.g., chlorophyll-based fisheries forecast and validation) for management support
- Incorporation of climate change as an issue into management and policy
- Occasion to learn from each countries experience: similarities/differences

## **Threats**

- Short term thinking
- Poor model forecast for a particular year
- Management challenges with multi-species and multi-gear fisheries
- Government stability/continuity in policy??
- Policy has inequitable distribution of wealth
- Unregulated, unreported, misreported and illegal activity
- Property rights are an issue that influences management
- Questions of adjustment to changes in management regimes
- Social acceptance/resistance to changes in management
- Management frameworks more suited to incremental versus transformational changes



## **Research Analysis/ Concerns**

- Precautionary approach and ecosystem approach to be added.
- The present governance system should include climate change aspect also.
- Incorporation of time frame for precautionary planning.
- Governance system for maintaining ecological sustenance of target species should be taken care of.

## **Questions/Directions/Projects**

1. Benchmarking ‘good’ marine governance systems (identifying effective attributes and characteristics of management systems)
2. Mapping existing management arrangements and comparative analysis of strengths and weaknesses of management and governance systems between the two countries
3. Identifying economic incentives for optimal compliance of the different regulatory and management practices
4. Evaluating the performance of the different input-output control mechanisms and suggesting appropriate policy mix
5. Economic evaluation of the different adaptation options (planning, process, measures) and the scope of adaptability
6. Long-term projection of location for fishing and aquaculture planning and management arrangements (e.g., prawn farming is now only in specific areas on the Indian coasts and in the future may shift)
7. Forecast modelling using remote sensing (e.g., chlorophyll-based fisheries forecast and validation) for management support
8. Analysis of adoptability of potential climate change mitigation and adaptation mechanisms within management
9. Incorporation of diverse forms of knowledge into management and governance

10. Identify regulatory barriers to the development of alternative fisheries/aquaculture

#### **4. Theme: Modelling and monitoring complex marine systems**

**Objective:** Develop innovative, comprehensive, dynamic, integrated, cost effective monitoring systems and modelling of socio-ecological marine systems

##### **Strengths**

- Good understanding of physical processes
- Project climate change into the future
- Sophisticated and considers the entire earth system
- Good collaboration with monitoring institutions (both countries)
- Technology for reporting increased information at low cost
- Technology

##### **Weakness**

- Not integrated with socio-economics
- Coordination of activity/information
- Mismatch of scales with adaptation needs and across disciplines, strength and quality of data/model outputs vary
- Finite life of monitoring programs/lack of continuous data
- Management of vast quantities of data
- Researchers aren't used to working with other disciplines
- Transparency of assumptions

##### **Opportunities**

- Collaboration/interdisciplinary coordination of sampling efforts/models for understanding complex systems
- Data from remote sensing is very good

- Capturing human behaviour (finding ways to integrate qualitative data into existing model structures)
- Well established/robust existing methodologies in social sciences to collect data
- Model/tool for facilitating interdisciplinary research
- Capacity building opportunity in interdisciplinary research as a training exercise

### **Threats**

- Monitoring programmes get cut
- Communication of complex systems and behaviour challenging
- All models are not equal or interpreted correctly
- Capacity of layperson to make critical evaluations of model outputs may be limited
- Funding agendas can compromise objective modelling

### **Research Analysis/ Concerns**

- Whether case studies on parameters such as cyclone which have direct effect on livelihood of fishermen have to be undertaken.
- Temperature increase has led to cancer incidence in fishermen. (Researchable areas)
- Exercise to determine values of a system and select performance indicators.

### **Questions/Directions/Projects**

1. Incorporating economic and biological parameters in ecosystem models to derive optimal adaptation pathways
2. Identifying optimal system measurement, and implementation programmes to deter climate change effects

3. Evaluating the impact of climate change on production and the ecosystems through different modelling approaches
4. Can we use the development of the research plan as a case study and model for facilitating and understanding the epistemology of interdisciplinary and intercultural research?
5. Understanding boundary currents and upwelling (trends in time/variation in onset/intensity) e.g. using remotesensing information: in a targeted zone where fishing productive could place mooring to understanding the variability in oceanographic features
6. How do we integrate qualitative/quantitative models to help manage uncertainty/complexity/diversity/risk (address compounded error)?
7. How can models and the model outputs be used in decision making?

## **5. Theme Communication**

**Objective:** Design and validate cost effective communication tools and strategies for the exchange of climate change knowledge

### **Strengths**

- Technology: very good communication network through mobile phone, TV, WWW etc
- Climate change understanding/awareness is increasing due to personal experience (e.g., extreme events, phenological shifts)
- Climate change knowledge increasing
- Support for climate change communication in existing networks/facilities
- Extension services are strong (India: e.g., field staff collecting landings data and Fish Watch disseminating prices, Australia: e.g., Ocean Watch)

### **Weaknesses**

- Scientists are not good at marketing/communicating research value/outcomes for end-users

- Extension needs to be a priority at the institutional and funding level (Australia)
- Communication interface between extension and end-users limited
- Engagement needs to be a two-way process
- Media focuses on the negative aspects of climate change
- Interpretation of maps/statistics is not accessible across dates to all people
- Lack of coastal information
- Climate change denial and lack of understanding and differing levels of awareness across sectors
- Terminology may have different meaning across cultures/sectors/disciplines
- Different strategies for communicating climate change
- Literacy
- Complexity of the message and changing way that people perceive information

### **Opportunities**

- How best to deliver or communicate scientific information cross dates to all people
- www based tools for fishermen such as SST, productivity
- Capturing community knowledge
- Incorporate climate information in existing fisheries services
- Developing science communication
- Incorporating climate change research into primary and secondary education
- Categorize diverse mediums of communication/approaches
- Communication facilitates data exchange

### **Threats/Challenges**

- Diversity of approaches

- Layered approaches – incremental changes of thoughts/actions and transformative changes
- Communicating climate change to address cumulative temporal and variable (weather) nature of the problem
- Switch from immediate to long term priorities (changing social norms)
- Reconciling climate change issues versus livelihood issues: environmental commodities are luxury goods
- Community knowledge gets lost if not captured
- Communication format can lead to rejection of information by communities
- Attribution (climate vs. others)
- Communicating opportunities arising from climate change
- Communication to close gap in uptake of change/action

### **Research Analysis/ Concerns**

- Behavioural change in 3 components namely Cognitive, affective and psychomotor domains to be emphasized.
- Education of fishers about climate change, trust building, and development of communication tools ranging from traditional to innovative tools for heterogeneous audience.
- The present extension system to be reoriented, like agricultural sector, involvement of fisheries extension officers at field level to educate fishers. (bottom up/participatory approach)

### **Questions**

1. Identifying current levels of understanding/awareness of climate change issues
2. Climate change communications barriers analysis
3. Communication/information needs analysis
4. Design of and validation/trial of climate change communication tools
5. Documentation of project and inter-disciplinarity

6. Documentation and validation of traditional and historical indigenous (technical) knowledge and using it to develop picture of past climate change
7. Capturing and using current fisher observational information and knowledge and incorporating this knowledge into models.
8. Studies of stakeholders perception on risk of climate change on fisheries and implications for decision making
9. To develop tools/protocols that address communication of climate change impacts and adaptation options
10. Identifying innovative opportunities to gather real time economic data for developing adaptive / mitigation measures
11. Analysing the cost of communication to the different stakeholders for their perceived change in their knowledge and attitude toward climate change
12. Identifying the impact of ICT on the efficiency of fishing operations, markets and price
13. What are the physical factors used for fishing?
14. Development of physical knowledge based communication systems

**(iii) Potentially fundable projects developed and submitted for funding**

- **AUSAID project under Public Sector Linkage Programme** - The Activity Concept centres on developing capacity to achieve effective management of marine systems to ensure food security and sustainable livelihoods in the context of a changing climate and increasing coastal pressures (population, pollution etc). This includes documenting/mapping existing policy and management arrangements in India; identifying drivers, values, risk perception, incentives and barriers related to projected climate change and population related impacts on marine resources; and benchmarking existing and alternative options for adapting to and managing climate change in the context of food security, utilising the knowledge and capability of Australian experts. The Australia (IMAS/CSIRO/UAdel)-India (CMFRI) collaboration utilises an inter-disciplinary approach to address these inter-related components. It adopts a social ecological systems framework to incorporate economic, ecological, social and biophysical sciences to explore challenges to fisheries management directed at climate change and food security. Such an approach strengthens existing

institutional linkages. The project extends an existing India-Australia collaboration, and fills a need identified by the partner organisation in relation to the impacts of a changing climate. Australia and India share common interests in sustainable fisheries management and oceans governance. The Activity Concept provides mechanisms to enhance the inter-disciplinary linkages required to better understand the impacts of climate change and increasing world demand for seafood on marine resources and the related communities' dependent upon them. As India progresses its aspirations as a leading Indian Ocean fishing nation via development of offshore fishing capacity, the Activity Concept will provide improved mechanisms for scientific and management exchange and capacity building, with particular support to mid-level career staff at CMFRI to spend time at IMAS and related institutions in Australia. Based on existing linkages, CMFRI has identified this need in their next five year operational plan and the establishment of an MOU between our partner institutions that will ensure this Concept Activity endures. This Activity Concept addresses the India-specific assessment criteria of climate change; food security, including agriculture and fisheries management. The Activity Concept has been developed in close collaboration with colleagues at the Central Marine Fisheries Research Institute. This builds on the developing linkages and collaborative research and data gathering/analysis workshops recently held in Australia and India. The concept builds on an approach embedded in collaborative learning and exchange by key researchers in workshops in both India and Australia. Collaborative partner workshops in India will be coordinated and managed by CMFRI. Collaborative workshops in Australia and training will be conducted, coordinated and managed by IMAS.

- **Belmont - GULLS - Belmont Forum and G8 Research Councils Initiative Research Project-** Under the “Belmont Forum and G8 Research Councils Initiative on Multilateral Research Funding International Opportunities Fund CMFRI submitted a project titled “Global learning for local solutions: Reducing vulnerability of marine-dependent coastal communities” (GULLS) on the Theme section Coastal Vulnerability with Rhodes University, Grahamstown , CSIRO Marine and Atmospheric Research, Hobart , Central Marine Fisheries Research Institute, Cochin ,University of São Paulo, São Paulo ,National Oceanography Centre, Southampton ,University of California Santa Cruz, Santa Cruz ,



University of Otago, Dunedin ,University of Victoria, Victoria and Eduardo Mondlane University, Maputo Belmont Forum Research Project- on 13<sup>th</sup> March, 2013.The duration of the project is three years with an expected funding of Rs.165.60 lakhs and is under review .Dr.Kevern Cochrane, Rhodes University, South Africa is the theme leader of the project and Dr.G.Syda Rao, Director, CMFRI leads the Indian side and Dr.Shyam.S.Salim as the Co- Principal Investigator.

- **AISRF Research Project** - A research project proposal on ‘Sustainable marine food security and carbon challenges under a changing climate in Australia and India’ was submitted under Australia-India Strategic Research Fund (AISRF) – Round Seven , 2013/15 (Indo-Australia Fund for Scientific and Technological Cooperation). The proposal is seeking research grant on the theme area of marine sciences .The project expected cost is Rs. 67.47 Lakhs with duration of two years. The project was shortlisted and invited for presentation in the Programme Advisory Committee meeting of the Earth Sciences, Department of Science and Engineering Board on 13<sup>th</sup> June 2013 held at New Delhi. Dr.Stewart Frusher , University of Tasmania, Australia is the theme leader of the project and Dr.G.Syda Rao,Director,CMFRI leads the Indian side .Theproject proposal on ‘Sustainable blue food security and carbon issues under a changing climate: Challenges in Australia and India’ by the Programme Advisory Committee in the area of Earth Science, Environmental and Marine Sciences in its meeting on 13<sup>th</sup> June 2013 from 10.30am at Vasant Square Mall, Lower Ground Floor, Vasant Kunj, New Delhi.DST meeting held at Vasant Kunj, New Delhi

**(iv) Institutional Linkages developed**

- a. Institute for Marine and Antarctic Studies (IMAS)
- b. Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- c. University of Tasmania
- d. University of Adelaide
- e. Tasmanian Aquaculture and Fisheries Institute
- f. Rhodes University, Grahamstown
- g. University of São Paulo, São Paulo
- h. National Oceanography Centre, Southampton
- i. University of California Santa Cruz, Santa Cruz
- j. University of Victoria, Victoria
- k. Eduardo Mondlane University, Maputo
- l. University of Otago, Dunedin

## **G. Project Consortium**

### **Project Partners**

#### **Central Marine Fisheries Research Institute ,India**

Organisation Type: Not for profit research organisation;

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#### Contact Officer

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#### AUSTRALIAN PROJECT PARTNERS

Partner Name: CSIRO

Organisation Type: Commonwealth-funded research organisation;

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Address Line 1: CSIRO - Marine and Atmospheric Research

Address Line 2: Castray Esplanade

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Title and Name: Dr Alistair Hobday

Phone Number: 03 62325310

Email Address: alistair.hobday@csiro.au

### **C. Indo – Australia Project Team Members**

<b>Sl.No:</b>	<b>Name</b>	<b>Organization</b>
1.	Associate Professor Stewart Frusher	IMAS - FACC
2.	Dr G. SydaRao ,Director	Central Marine Fisheries Research Institute
3.	Dr Gretta Pecl	IMAS - FACC
4.	Dr.Alistair Hobday	CSIRO - IMAS
5.	Dr Sarah Jennings	UTAS, school of Economics and Finance
6.	Dr Melissa Nursey-Bray	University of Adelaide
7.	Associate Professor Neil Holbrook	IMAS-MAF
8.	Associate Professor Marcus Haward	IMAS-MAF
9.	Dr Ingrid van Putten	CSIRO - IMAS
10.	Dr.Shyam S. Salim	Central Marine Fisheries Research Institute
11.	Dr. E.V. Radhakrishnan	Central Marine Fisheries Research Institute
12.	Dr E. Vivekanandan	Central Marine Fisheries Research Institute
13.	Dr.T.V.Sathianandan	Central Marine Fisheries Research Institute
14.	Dr.C.Ramachandran	Central Marine Fisheries Research Institute
15.	Ms Muktha Menon	Central Marine Fisheries Research Institute

## **Project Partners**

The Indian participants are at the forefront of climate impacts and adaptation research in India as is evidenced by their leading roles in executing the ICAR Network Project Impact, Adaptation and Vulnerability of Indian marine Fisheries to Climate Change; providing a report to the Ministry of Environment & Forests on marine fisheries at the Second National Communication on Climate Change; preparation and presentation of documents on impact and adaptation options for marine fisheries of South Asia and conducting a Winter School on Climate Change and Marine Fisheries. CMFRI has an extensive database on temporal and spatial fish catch and effort along the Indian coast from 1950 onwards, which will form the basis of analysis to understand the impact of climate change. The National Institutes of Oceanography and Ocean Technology have extensive data on climatic and oceanographic parameters. All the participants have experience in working collaboratively in inter-disciplinary research teams and initiatives

The Australian participants are at the forefront of climate impacts and adaptation research in Australia as is evidence by their leading roles in National Climate Change Initiatives including the National Marine Biodiversity and Resources Climate Change Adaptation Network (Holbrook, Frusher, Hobday, Pecl, Jennings and Nursey-Bray), National Coastal Vulnerability Case Study on Marine Resources (Frusher, Pecl, Jennings, Hobday, Nursey-Bray); National program on economic capacity building for Australian Fisheries (Jennings, Frusher) and their lead roles in Climate Change research at their respective research organisations (UTAS and CSIRO). They are also responsible for co-convening workshops on climate change at International symposium including INTECOL (Frusher) and PICES/ICES Climate Change Effects on Fish and Fisheries (Pecl, Hobday, Frusher). They also have experience in working collaboratively in inter-disciplinary research teams and initiatives. Awards include the 2002 Dean's Award for Research Excellence (Frusher) and the 2009 Tasmanian Fulbright Scholarship and UTAS 'Rising Star' award (Pecl).

## **Brief research backgrounds of Project Team members**

### INDIA

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**Dr G. Syda Rao** is Director of the Central Marine Fisheries Research Institute and oversees the research programmes at the Institute on climate change, fisheries data collection and storage, marine biodiversity, biotechnology and breeding of finfish. These are all strategic areas of national interest in the marine sector.

**Dr. Shyam S. Salim** is a Senior Scientist in Socioeconomics and Technology Transfer Division in CMFRI. He is specialized in trade and marketing management in fisheries. He has 10 years' experience and has 20 publications in marine fishery economics. He will provide expertise on the development of economic impact of climate change on coastal fishermen

**Dr. E.V. Radhakrishnan** is a Principal Research Scientist and Head of the Crustacean Research Division of the Central Marine Fisheries Research Institute. He will lead and coordinate the Indian side of the project. He is a crustacean biologist with specialisation in resource assessment and management and aquaculture. He is the Principal Investigator of ICAR-CMFRI project Resource damage assessment in marine fisheries: impact of selective fishing of juveniles, bycatch and discards in trawl fisheries. He is currently leading a World Bank funded project A value chain on oceanic tuna fisheries in Lakshadweep sea. He is also associated with studies on impact of climate change on shrimp fisheries. He has 32 years of experience in marine fisheries and has over 60 publications on Crustacean fisheries and aquaculture in National and International journals. He will provide expertise on marine fisheries of the region, information on vulnerable species to climate change, their biology and physiology.

**Dr E. Vivekanandan** is a Principal Research Scientist and Head of the Demersal Fisheries Division at the Central Marine Fisheries Research Institute. He is a biologist specialised in marine fish stock assessment and resource management. He is currently leading the ICAR network Project "Impact, Adaptation and Vulnerability of Indian marine Fisheries to Climate Change". He has over 30 years of experience in marine fisheries research and has over 70 publications on Indian marine fisheries

in National and International journals. He will provide expertise in climate change related to fish stock distribution and abundance and predictive modelling.

**Dr. T.V.Sathianandan** is a Senior Scientist in Fisheries Resource Assessment Division in CMFRI. He is a Statistician specialized in Multivariate time series modeling in fisheries. He has over 20 years of research experience and has 20 publications. His expertise is in multivariate time series modelling in fisheries, fish stock assessment and simulation modelling.

**Dr.C.Ramachandran** is a Senior Scientist in Socioeconomics and Technology Transfer Division in CMFRI. He is a social scientist with 20 years of experience and has developed communication tools and films on responsible fishing and has wide knowledge on the social structure of coastal fishermen. He will provide expertise on climate change impact on fishermen communities, their livelihood and issues connected with income and employment.

**Ms Muktha Menon** is a Scientist in Visakhapatnam Research Centre of Central Marine Fisheries Research Institute, Visakhapatnam, Andhra Pradesh. She is specialized in identification, collection, biological studies and stock assessment studies on demersal fisheries resources. She is adept in fisheries biology and taxonomy and will provide an expertise on the spatio- temporal modeling of the fisheries resources.

#### AUSTRALIA

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**Associate Professor Stewart Frusher** leads the Climate Change Theme of the Tasmanian Aquaculture and Fisheries Institute (TAFI) at the University of Tasmania. He will lead and co-ordinate the Australian side of the project. He has expertise in leading inter-disciplinary projects include the recently completed Australian Department of Climate Change's National Coastal Vulnerability case study .He has over 20 years' experience in fisheries science and over 50 international publications. He will provide expertise in marine fisheries.

(<http://www.climatechange.gov.au/publications/coastline/east-coast-rock-lobster.aspx>).

**Dr Gretta Pecl** is a Fulbright Scholar, a UTAS ‘Rising Star’ and Research Fellow at TAFI. She was the lead writer on the Australian Department of Climate Change’s National Coastal Vulnerability case study (<http://www.climatechange.gov.au/publications/coastline/east-coast-rock-lobster.aspx>). She leads the REDMAP project that utilises the knowledge of fishers and the community to identify range extensions of marine species as well as the South East Australian Program’s (SEAP) Risk assessment of impacts of climate change for key species in South Eastern Australia. Dr Pecl’s develop qualitative models for her Fulbright scholarship. She will lead and co-ordinate the qualitative modelling component of this project.

**Dr Alistair Hobday** is a Senior Research Scientist at CSIRO Marine and Atmospheric Research. He is Stream Leader of the Marine Climate Impacts and Adaptation of CSIRO’s Climate Adaptation Flagship. Dr Hobday is a biological oceanographer and will provide expertise in the coupling of biological and physical systems and in pelagic fisheries.

**Dr Sarah Jennings** is Head of the School of Economics and Finance at the University of Tasmania. Dr Jennings leads the Australian Government’s project on Building Economic Capability to Improve the Management of Marine Resources in Australia. Dr Jennings will provide expertise on the development of economic metrics for climate change. Dr Jennings is a member of the Markets node of the National Climate Adaptation Network for Marine Biodiversity and Resources.

**Dr Melissa Nursey-Bray** is a marine social researcher with expertise in both climate change and artisanal and subsistence use of marine resources. She will provide expertise in the development of social metrics for climate change. She is co-theme leader of the communities dimension for the National Climate Adaptation Network for Marine Biodiversity and Resources.

**Associate Professor Neil Holbrook** is a physical oceanographer at the University of Tasmania. He leads Australia’s Marine Biodiversity and Resources Network of the National Climate Change Adaptation Research Facility ([www.nccarf.edu.au/marine/](http://www.nccarf.edu.au/marine/)). He is Executive Secretary of the International



Commission on Climate and past Associate Editor of the JOURNAL OF CLIMATE[2006-2008]. He will provide expertise in physical oceanography climate change, variability and risk.

**Associate Professor Marcus Haward** is a political scientist specialising in oceans governance and marine resources management. He is currently Program Leader, Policy Program, Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) at the University of Tasmania, Hobart. He has over 100 publications on Antarctica, fisheries management, and coastal and oceans governance.

### Participants in the workshops

Sl.No	Name of the participant	Organization
1.	Stewart Frusher, Associate Professor	IMAS - FACC
2.	Dr G. SydaRao ,Director	Central Marine Fisheries Research Institute
3.	Dr Gretta Pecl	IMAS - FACC
4.	Dr.Alistair Hobday	CSIRO -IMAS
5.	Dr Sarah Jennings	UTAS, school of Economics and Finance
6.	Dr Melissa Nursey-Bray	University of Adelaide
7.	Neil Holbrook, Associate Professor	IMAS-MAF
8.	Marcus Haward, Associate Professor	IMAS-MAF
9.	Dr Ingrid van Putten	CSIRO - IMAS
10.	Dr.Shyam S. Salim	Central Marine Fisheries Research Institute
.11.	Dr. E.V. Radhakrishnan	Central Marine Fisheries Research Institute
12	Dr E. Vivekanandan	Central Marine Fisheries Research Institute
13.	Dr.T.V.Sathianandan	Central Marine Fisheries Research Institute
14.	Dr.C.Ramachandran	Central Marine Fisheries Research Institute
15.	Ms Muktha Menon	Central Marine Fisheries Research Institute
16.	Dr.R.Narayanakumar	Central Marine Fisheries Research Institute
17.	Dr.Pratibha Purohit	Central Marine Fisheries Research Institute

18.	Dr.Swathilakshmi .P	Central Marine Fisheries Research Institute
19.	Dr.P.U.Zachariah	Central Marine Fisheries Research Institute
20.	Dr.Vinod.K	Central Marine Fisheries Research Institute
21.	Mr. Gyanranjan Dash	Central Marine Fisheries Research Institute
22.	Dr.Mike Coffin	Executive Director IMAS
23.	Dr.Tony Worby	Deputy Chief , Marine Research

## H. Workshop Outline

### First Workshop on Preparing for Climate Change on Marine Ecosystems in India and Australia (16-20January 2012)

**Date : 16.01.2012 Monday**

8.30 am	Pick at Salamanca and Lenna Hotel, Elsa Gärtner Monday
9:00 – 9:20AM	Welcome words, Prof Mike Coffin (10 min) Indian Response, Dr G. Syda Rao (10 min)
9:20 – 10:30AM	Introduction to workshop and over view of objectives, Assoc Prof Stewart Frusher (20 min) Background of Australian marine science context, Assoc Prof Marcus Haward (10 min) Background of Australian fisheries context, Dr Alistair Hobday and Assoc Prof Stewart Frusher (15 min) Background of Indian marine science context, Dr E.V. Radhakrishnan (10 min) Background of Indian fisheries context, Dr T.V. Sathianandan (15 min)
10:30 –	Morning tea and interview of Dr Syda Rao and Assoc Prof

11:00AM	Stewart Frusher
11:00 – 1:00PM	Context: Overview of Strategic Plan - process and format, Assoc Prof Stewart Frusher (30 min) Background presentation of all existing climate change activities and initiatives in each country Australia – Assoc Prof Neil Holbrook and Assoc Prof Stewart Frusher (25 min) India, Dr E. Vivekanandan – (25 min or 45 min) Discussion and synthesis (40 min)
1:00 – 2:00PM	Lunch
2:00 – 3:10PM	Discipline focused theme presentations (key issue in each area, answer to specific questions) Australia: <ul style="list-style-type: none"> <li>▪ Physical, Assoc Prof Neil Holbrook (20 min)</li> <li>▪ Biological, Assoc Prof Stewart Frusher (20 min)</li> <li>▪ Economical, Dr Sarah Jennings (20 min)</li> <li>▪ Social, Dr Melissa Nursey-Bray (20 min)</li> <li>▪ Governance, Assoc Prof Marcus Haward (20 min)</li> </ul>
4:15 – 5:00PM	Welcome reception at <u>Government House</u> by His Excellency the Honourable Peter Underwood AC and Prof Mike Coffin

Date : 17.01.2012 Tuesday Technical Session I

9:00 – 10:50 AM	Theme presentations India: <ul style="list-style-type: none"> <li>▪ Physical, Dr E. Vivekanandan (20min)</li> <li>▪ Biological, Ms Muktha M. (20 min)</li> <li>▪ Economical, Dr Shyam Salim (20 min)</li> <li>▪ Social, Dr C Ramachandran (20 min)</li> <li>▪ Governance, Dr E.V. Radhakrishnan (20 min)</li> </ul>
10:50 – 11:10AM	Morning tea

11:10 – 1:00PM	<p>Panelist: Dr G. Syda Rao, Assoc Prof Stewart Frusher and Dr Sarah Jennings</p> <p>Discussion on cost-effective monitoring systems including the latest development in biomarkers and social and economic metrics (50 min)</p> <p>Panelist: Dr E. Vivekanandan, Assoc Prof Marcus Haward and Dr Melissa Nursey-Bray</p> <p>Discussion on Climate change issues and trends and development of generic themes (e.g. food security, sustainable livelihood, knowledge action systems, communication education and engagement) (1hr)</p>
1:00 – 2:00PM	Lunch
2:00 – 3:00PM	<p>Summary of key species from each country</p> <p>India, Dr E.V. Radhakrishnan (15 min)</p> <p>Australia, Dr Gretta Pecl (15 min)</p> <p>Development of risk assessment and prioritisation, Dr Alistair Hobday and Dr E. Vivekanandan (30 min)</p>
3:00 – 3:30PM	Afternoon tea
3:30 – 4:00PM	Development of vulnerability assessment, Dr Alistair Hobday and Dr E. Vivekanandan (30 min)

Date :18.01.2012 Wednesday Technical Session II

9:00 – 10:30 AM	Strategic Plan Development, Assoc Prof Stewart Frusher (1hr 30 min)
10:30 – 11:00am	Morning tea
11:00 – 1:00PM	Mapping exercise and SWOT analysis of current capacity and capabilities (2h)
1:00 – 2:00PM	Lunch
2:00 – 5:00PM	Pick up at the hotel to field trip to Bonorong Wildlife Sanctuary

Date :19.01.2012 Thursday Technical Session III

9:00 – 10:30 AM	SWOT ANALYSIS OF CURRENT CAPACITY AND CAPABILITIES: PRIORITIZE PROBLEMS AND WEAKNESSES (1HR 30 MIN)
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<u>10:30 – 11:00AM</u>	Morning tea
11:00 – 1:00pm	Adaptation to the Strategic Plan to the outputs of the SWOP analysis (1hr) Building a Draft Strategic Collaborative Research Plan (1hr)
<u>1:00 – 2:00PM</u>	Lunch
<u>2:00 – 4:00PM</u>	Development of implementation/operational plan

Date: 20.01.2012 Friday Technical Session IV

9:00 – 10:30am	Identification of other research providers and skills required (45 min) Identification of potential projects (45 min)
<u>10:30 – 11:00AM</u>	Morning tea
<u>11:00 – 1:00PM</u>	Prioritization of projects (1h) Next Steps (1h)
<u>1:00 – 2:00PM</u>	Lunch
<u>2:00 – 4:00PM</u>	Free afternoon or overflow session Closing session

Date: 21.01.2012 Saturday Technical Session V

10:00 am	Overflow sessions
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Date: 23.01.2012 Monday Technical Session VI

<u>10:00AM</u>	Go to Administration Desk in Victorian Museum and ask for Dianne Bray for a visit
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## Second Workshop on

### Preparing for Climate Change on Marine Ecosystems in India and Australia (6-10 March 2012)

#### Inaugural Session

Date: 06.03.2012 Tuesday

Venue: Room No: 601

CMFRI Cochin

9.30 am	Registration of participants	
10.15 am	Invocation	
10.15-10.20 am	Welcome Address	
10.20 -10.25 am	About the workshop	Dr.G.Syda Rao Director, CMFRI
10.25-10.30 am	Address by Guest of Honour	Dr.E.Vivekanandan Scientist –in Charge Madras Research Centre of CMFRI
10.30-10.35 am	Address by Guest of Honour	Dr Stewart Frusher Program Leader: Estuaries and Coasts , Institute of Marine and Antarctic Studies, University of Tasmania
10.35-10.45 am	Inauguration of the workshop and Chief Guest Address	Dr. Naveen Vashista Principal Scientific Officer International Bilateral Co-operation Department of Science & Technology
10.45-10.50 am	Vote of Thanks	His Excellency, the Consul Commercial and Trade Commissioner of Australia at Chennai Mr. Michael Carter
10.50 am	National Anthem	Dr.T.V.Sathianandan Head –In- Charge FRA Division

10.50 - 11.30 am HIGH TEA

06.03.12 Technical Session I

11.30 am	Summary of Work done	Dr.G.Syda Rao , Indian Team leader Dr.Stewart Frusher,	(10 mts) (10 mts)
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		Australian team leader	
11.50	Second Workshop Plan and expected outcome	Dr. E.Vivekanandan .	(10 mts)
12.00-13.15	Discussion on the Templates prepared for each theme areas	Theme teams ( 5 themes)-2 members from each group	( 75 mts )
13.15-14.00	Lunch		
14.00-15.00	Prioritising research projects under each theme group		(60 mts)
15.00-15.30	Refreshments		
15.30-16.00	Overflow sessions		(30 mts)

07.03.2012(Wednesday) Technical Session II

09.00 -10.15	Prioritising research projects under each theme groups		(75 mts)
10.15-10.45	Refreshments		
10.45 -11.30	Identifying potential donors across India and Australia followed by deliberations	Dr.Stewart Frusher Dr.E.Vivekanandan	15 mts each + 15 mts deliberations
11.30-13.00	Format for Project Submission	Indian & Australian Team	90 min
13.00-14.00	Lunch		
14.00-15.00	Finalising the Research projects under each theme areas	Identified working groups	60 min
15.00-15.30	Refreshments		
15.30-16.00	Overflow sessions		30 min

08.03.2012(Thursday) Technical Session III

08.30	Leaving for Field trip		
9.30(10.30?)	Refreshments		
10.00-13.30	Research project presentation under each theme area (Probably 2-3 projects )	Identified theme leader	30 mts each
13.30-14.30	Lunch		
14.30-16.00	Research project presentation under each theme area (Probably 2-3 projects )	Identified theme leader	30 min each

09.03.2012(Friday) Technical Session IV

09.00 -10.30	Summing up of the final projects	15 mts for each theme
10.30 -11.00	Refreshments	
11.00-13.00	Budgeting the projects	60 min
13.00-14.00	Lunch	
14.00-15.00	Presentation of final prioritised project	60 min
15.00-15.30	Refreshments	
15.30-16.00	Overflow session	30 min

10.03.2012(Saturday) Technical Session V

09.00 -10.30	Discussion on Grand Challenge Fund	90 min
10.30 -11.00	Refreshments	
11.00-13.00	Identified area and team with responsibilities	120 min
13.00-14.00	Lunch	
14.00-15.00	Session – Valedictory	90 min
15.00	<b>Sessions Close</b>	



## I. Workshop Snaps



The Indo-Australian Project Team with the Governor of Tasmania His Excellency Mr.Underwood and his wife



Dr.Collin Baxton,Chairman, TAFI ,Hobart explaining institute activities



Dr.E.V.Radhakrishnan delivering the context of Indian



Dr.G.Syda Rao,Director CMFRI and Indian team leader enlightening the team about research activities and accomplishments of CMFRI



Dr.E.Vivekandan  
delivering on the climate change



Dr.Mike Coffin, Director IMAS,  
delivering the opening remarks



Indo-Australian  
Workshop 002



Indo-Australian  
Workshop 003



Interactive sessions



Interactive sessions (2)



The theme group discussions on climate change



Indo-Australian Research Team at Governors



Indo- Australian project team for the Second workshop in Cochin



Dr.G.Syda Rao,Director CMFRI addressing the team



Dr.Stewart Frusher ,IMAS giiving the opening remarks



Mr Michael Carter ,the council commercial and trade commissioner of Australia , Inaugurating the workshop



Technical Session



Plenary session



Dr, G, Syda Rao handing over the memento to Dr Stewart Frusher



Indo-Australian Project Team in India



Mr. Michael Carter in his inaugural address



Project Review meet



Theme group discussions



Technical Sessions

## J. Check list and project summary

Sl.No		
1	Title of the Project	Preparing for climate change on marine systems in Australia and India
2	Initiating Institute of project	Central Marine Fisheries Research Institute
3	Sponsoring Agency/Ministry	DST
4	Total cost of the project	Rs 10 lakhs
	Nature and Quantum of foreign Collaboration sought	The project is mutually arranged two workshops first in Australia and the second in India with equal participation by the two countries.
(i)	Financial support:	
(ii)	Equipment support	
(iii)	Technical support	
(iv)	Manpower training	
(v)	Miscellaneous	
5	Is there any possibility, however remote of use of data, information of result of the work which may impinge on India's national security? If yes, the nature of such a use may be indicated. (In case the concerned scrutinizing Ministry do not have clear answer, the matter should be referred to the DRDO and MHA for examination).	No. There is no possibility

## II. Origin of the Project and Its Sponsors:

6	If the proposal is foreign-originated what is the background of the foreign agency or organization which is sponsoring the project? Information available, if any on past collaboration by foreign agency with Indian Institution.	This proposal is a collaborative project finalised on mutual understanding
7	Are the foreign agency, organization, scientists concerned, known to have taken up any project of military significance in the past or are known to be associated with any military organization or project?(if the above information is not known or if there is definite information that there is no such association, these should be clearly indicated).	No. The organization is marine research university
8	Is the proposer (Indian) known to the foreign collaborator and his group for some time and has this emerged naturally from the research work done by the two sides?	Yes. The foreign collaborator is known for some time and the proposal has emerged naturally from the research work done by two sides.

## FUNDING OF THE PROJECT

9	Is the foreign source know to have funded research into sensitive and national security areas in its own country or in other countries?	No
10	Are there reasons to believe that the foreign source is a cover name for some other sponsor?	No

## ADMINISTRATION AND CONTROL OF THE PROJECT

11	Give a list of the likely places of visit : within the country planned by the foreign collaborator. Also give a list of the institutions which the collaborator is likely to visit.	No other institution except the host institution (CMFRI) at Cochin
12	Will any sensitive source material be referred to during the course of the research?	



13	Does the collaboration involve :	
a)	Transfer of biological material(s)	No
b)	Use of radioactive materials	No
c)	Use of environmentally or otherwise hazardous material(s)	No
d)	Use of Genetically Modified Organisms	No
e)	Field trials or testing	No
f)	Ethical issues	No
g)	Issues related to Intellectual Property Rights (IPR)	No
14	If answer to any section of question 13 is yes, are the investigators/ proposers aware of the relevant regulations and have they agreed to abide by them?	Not applicable
15	Will the research be conducted in accordance not only with the country's own ethical and environmental standards, but with international standards as well?	Yes

## Project Summary

1. Project Title: Preparing for climate change on marine systems in Australia and India
2. Total cost of the project (Indian side) (in Rs.) : 10.00 Lakhs
3. Duration of the Project : One year
4. Project Investigators (PIs) and Co-Investigators:
  - a. Indian PIs : Dr.G.Syda Rao, Director ,CMFRI
  - b. Foreign : Dr Stewart Frusher , Associate Professor ,TAFI
5. Other Project participants :
  - 5.2 Indian**
    - (i) Dr E. Vivekanandan, Principal Scientist
    - (ii) Dr. E.V. Radhakrishnan, Principal Scientist
    - (iii) Dr. T.V.Sathianandan ,Senior Scientist
    - (iv) Dr. C.Ramachandran, Senior Scientist
    - (v) Dr. Shyam S. Salim ,Senior Scientist
    - (vi) Ms Muktha Menon , Scientist
  - 5.3 Foreign**
    - (i) Dr Gretta Pecl ,Research Fellow
    - (ii) Dr Alistair Hobday,Senior Research Scientist
    - (iii) Dr Sarah Jennings, Associate Professor
    - (iv) Dr Melissa Nursey-Bray , Associate Professor
    - (v) Neil Holbrook , Associate Professor
    - (vi) Marcus Haward , Associate Professor
6. Implementing Agencies / Institutions:
  - a. Indian : Central Marine Fisheries Research Institute, ,Cochin
  - b. Foreign : Tasmanian Aquaculture and Fisheries Institute (TAFI)
7. Sponsoring Agency / Department / Ministry
  - 7.3 Indian : Department of Science and Technology
  - 7.2 Foreign – AISRF- DIISR-International Science & EIF branch
8. Administrative Ministry in Government of India: Ministry of Science and Technology
9. Has the Project been cleared by Secretary of the Administrative/ Sponsoring Ministry/Department from security/sensitivity angle?-Not applicable:
- 10.If answer to (9) above is 'No', then do the Administrative/ sponsoring Ministry/Department recommend the Project to be considered by High Level Committee of Secretaries? – Not applicable

## Annexure I

Schematic of examples of the main research planning processes underway in Australia that provide direction for research associated with facilitating adaptation to climate change

<u>R&amp;D Strategies</u>	<u>Research Initiatives</u>	<u>Action Plans</u>	<u>Vulnerability Assessments</u>	<u>Response Plans</u>
Marine and Coastal Committee (MACC) Strategic Directions	National Climate Change Adaptation Research Facility - NARPs and networks	National Climate Change and Fisheries Action Plan	National Assessment of the Vulnerability of Australia's Biodiversity	National Approach to Addressing Marine Biodiversity Decline
Ocean Policy Scientific Advisory Group Marine Research Strategy	CSIRO Flagships	National Biodiversity and Climate Change Action Plan	National Coastal Vulnerability Assessment	
Report on 'A National Climate Change Research Strategy for Primary Industries'	Climate Change Research Strategy for Primary Industries	National Agriculture and Climate Change Action Plan	Preliminary assessment of the implications of climate change for aquatic ecosystems in Australia	
Australian Fisheries Management Forum Research priorities	Commonwealth Environment Research Facilities Programme	Climate Change Action Plan for the Great Barrier Reef	Great Barrier Reef Vulnerability Assessment	

## Annexure II

Schematic of research planning process underway in India that provide direction for research associated with facilitating adaptation to climate change

R&D strategies	Research Initiative	Action plans	Vulnerability Assessments	Response Plans
Indian Network on Climate Change Assessment (INCCA)	Establishment of Climate Change Research Centre in Indian Institute of Tropical Meteorology	National Mission on Strategic Knowledge on Climate Change	Assessments in NATCOM reports	Formation of Expert Group on Low carbon economy
Himalayan Glaciers Monitoring Programme,	ICAR Network Project	National and State Action Plans on Climate Change	Coastal vulnerability assessment under ICAR project”	National Policy of Biofuel
Launch of Indian satellite to monitor greenhouse gases	(i) “Impact, Adaptation and Vulnerability of Indian Agriculture to Climate Change”,	Sectoral and Regional Analysis of Climate Change in 2030s		National approach towards Sustainable Fisheries under Ministry of Forests and Environment & Ministry of Agriculture
Assessment of Forest and Tree cover as CO <sub>2</sub> sink	(ii) National Initiative on Climate Resilient Agriculture, (iii) ICAR Platform on Climate Change	National Carbonaceous Aerosol Programme		
Greenhouse Gas Emission Assessment 2007		India’s National Communication to UNFCCC(NATCOM I &II) by the Ministry of Environment & Forest		CMFRI Policy brief on Climate change and Indian marine Fisheries(2010)
Sea Level Rise Analysis Programme of National Institute of Oceanography	Sea weed Carbon sequestration study at CMFRI	Establishment of Department of Climate Change by Govt. of Gujarat		

