Technical Assistance Report

Project Number: 46460
Capacity Development Technical Assistance (CDTA)
April 2014

India: Climate-Resilient Coastal Protection and Management Project

(Financed by the Global Environment Facility)

Asian Development Bank

CURRENCY EQUIVALENTS

(as of 1 March 2014)

Re1.00	=	$0.016183
$1.00	=	Rs61.795

ABBREVIATIONS

ADB	–	Asian Development Bank
CWC	–	Central Water Commission
CWPRS	–	Central Water and Power Research Station
GEF	–	Global Environment Facility
GIS	–	geographic information system
km	–	kilometer
MOEF	–	Ministry of Environment and Forests
MOWR	–	Ministry of Water Resources
SCPMIP	–	Sustainable Coastal Protection and Management Investment Program
TA	–	technical assistance

TECHNICAL ASSISTANCE CLASSIFICATION

Type	–	Capacity development technical assistance (CDTA)
Targeting classification	–	General intervention
Sector (subsector)	–	Agriculture, natural resources and rural development (water-based natural resources management)
Strategic Agendas	–	**Environmentally sustainable growth** (disaster risk management) **Inclusive economic growth** (access to economic opportunities, including jobs, made more inclusive)
Drivers of Change	–	**Governance and capacity development** (institutional systems and political economy, civil society participation) **Partnerships** Type of Partner (civil society organization, international finance institution) Nature of Partnership (official cofinancing)
Climate change on project	–	High
Adaptation	–	$2,000,000

NOTE

In this report, "$" refers to US dollars.

Vice-President	W. Zhang, Operations 1
Director General	J. Miranda, South Asia Department (SARD)
Director	T. Matsuo, Environment, Natural Resources and Agriculture Division, SARD
Team leader	A. Cauchois, Senior Water Resources Specialist, SARD
Team member	H. Varma, Senior Project Officer (Natural Resources and Agriculture), SARD

CONTENTS

I. INTRODUCTION

1. The proposed technical assistance (TA) was requested by the Government of India to complement India's Sustainable Coastal Protection and Management Investment Program (SCPMIP).[1] The SCPMIP is designed to deal with immediate coastal protection needs and coastal instabilities through planning, design, and investment in environmentally and socially appropriate protection and management in the states of Karnataka and Maharashtra. The TA is designed to incorporate and mainstream measures for coastal climate change adaptation in the program.

2. A Global Environment Facility (GEF) project identification form was prepared in late 2010. It was endorsed by the two state governments of Karnataka and Maharashtra, Ministry of Water Resources (MOWR), and Ministry of Environment and Forests (MOEF), and approved by GEF in November 2011. Preparation for the TA from April to September 2012 included wide-ranging consultations with the central government, the state executing agencies for the SCPMIP, district government and community organizations, and key coastal research organizations. The TA formulation incorporates the insights gained during the discussions. A TA fact-finding mission was fielded on 13–28 June 2013, during which the government confirmed the proposed TA design and monitoring framework, cost, implementation arrangement, and terms of reference for consultants. The design and monitoring framework is in Appendix 1.[2] The GEF financing proposal was approved by both states, MOWR, and MOEF in July 2013 and GEF letter of commitment was received on 12 March 2014.

II. ISSUES

3. India has a coastline of 7,525 kilometers (km) of which 5,425 km encompass the nine mainland coastal states and 2,100 km the union territories and islands. There has been limited external assistance for coastal protection and management, which resulted in a lack of exposure to new ideas and practices. The most frequently applied methods for coastal protection have been hard structures such as seawalls or groins. The on-going SCPMIP and World Bank financed Integrated Coastal Zone Management Project (ICZMP) are both trying to address this gap through complementary initiatives fostering the adoption of more socially and environmentally friendly coastal erosion protection and management measures in India. The SCPMIP is supporting the states of Maharashtra and Karnataka in (i) developing integrated participatory shoreline management plans for long term sustainable management and development of the shoreline and, (ii) pilot testing the transition to softer coastal protection measure aimed at restoring lost beaches, rather than merely preventing land erosion. The later includes the construction of semi-submerged off shore artificial reefs and the provision of beach nourishment in critically eroded beaches. The ICZMP assist the Government of India in developing coastal zone management national guidelines, mapping of India coastal hazard line and costal sediment cells. It also supports integrated planning and pilots soft coastal protection investments in the states of Gujarat, Odisha.

4. The ongoing erosion of beaches in India is a major challenge that threatens communities and livelihoods in a variety of areas, including artisanal fishing, tourism, and other activities related to beaches and natural resources. Coastal erosion is responsible for the loss of land, houses, infrastructure, and business opportunities, and poses a high risk to human well-being,

[1] ADB. 2010. *Multitranche Financing Facility to India for Sustainable Coastal Protection and Management Investment Program*. Manila.

[2] The TA first appeared in the business opportunities section of ADB's website on 21 June 2013.

economic development, and ecological integrity. It undermines the livelihoods of coastal communities, particularly poor households, and ultimately the coastal economies. Every year, about 400 hectares of coastal land is lost and, 75,000 hectares of crop areas, 34,000 residential houses and industrial establishments are affected by coastal erosion and flooding. The impact could be much more extensive in the coming years as the coastline is increasingly subject to a wide range of economic developments and changes in land use, many of which create conflicts and pressures on the already disturbed natural coastal environments. While it is the poor rural coastal communities that are the most vulnerable to the impacts of erosion and inadequate coastal management, many of India's rapidly growing urban areas are also vulnerable to coastal erosion. Mumbai, for example, incurs a cost of $2.5 million per km to protect some of its prime waterfront property.

5. The government needs to encourage low-cost protection solutions, including natural protection such as beach dunes and mangrove management. Natural protection is being developed internationally, and India already counts successful initiatives that the SCPMIP and the proposed TA can build on.

6. The threats of climate change on the coast result from (i) a rise in sea levels caused by thermal expansion of sea water, melting glaciers and ice caps, and over-exploitation of groundwater; (ii) changes in wave characteristics such as size and direction due to changes in wind patterns and increases in depth, changing the impact of wave on the coast; (iii) changes in frequency and intensities of storms and storm surges; (iv) vertical land movements from isostatic adjustments (changes in the earth's crust) and localized land settlement affecting the net changes in sea level; and (v) changes in freshwater flow regimes, flood flows, and salinity, which have effects on the estuaries and coastal rivers.

7. All the Indian coastal states and territories are affected by coastal erosion. The rise in sea levels and the likely increase in frequency and intensity of storms will aggravate the erosion, with serious economic and environmental consequences for coastal states. Beaches cover 43% of the coast, and coastal wetlands (mud flats) cover 36%, and both play an extremely valuable role in protecting the coastline. Disturbances to the beaches and coastal wetlands from anthropogenic and climate change impacts can be very significant. Current estimates predict that shoreline recession can be in the range of 50 to 200 times the rise in relative sea level, estimated to be around 0.3 meter by mid-century. Mangroves are reasonably tolerant to changes in sea levels and salinities, but are vulnerable to sediment removal, which can preclude natural renewal and conventional planting methods. Rising sea levels combined with storm surges can significantly increase coastal and estuarine flood risk. Coastal infrastructure is currently designed based on historic sea levels and wave regimes, with an estimated design life of 50–100 years. Infrastructure projects will become increasingly vulnerable to damage unless appropriate measures of climate resilience are incorporated.

8. Without climate change studies that focus on coastal areas, construction of coastal protection infrastructure and planning of shoreline management proceed largely according to current standards, which do not explicitly consider climate-change-related risks and vulnerabilities. In the absence of clear and officially endorsed design guidelines, planners and designers have neither the knowledge base nor the mandate to design for potential impact scenarios under climate change. Government decision makers require adequate evidence of the risks to support the provision of additional finance for climate resilience.

III. THE PROPOSED TECHNICAL ASSISTANCE

A. Impact and Outcome

9. The impact of the TA will be strengthened resilience of the Indian coast to the impacts of climate change. The outcome will be that climate change impacts are factored into coastal protection and management interventions in India. The TA will support mainstreaming of climate change resilience into coastal protection and shoreline management through carefully targeted measures, including (i) specialist support to the SCPMIP to incorporate climate change resilience in projects 2 and 3 investments; (ii) preparation of officially endorsed climate change adaptation guidelines to be officially communicated to all maritime states and union territories; and (iii) successful implementation of pilot community protection subprojects.[3]

B. Methodology and Key Activities

10. The TA will be implemented over 3 years and will support mainstreaming of climate change in costal planning and management at the national level and in the two focal states of Karnataka and Maharashtra, where the SCPMIP project is operational. The four key outputs and activities are summarized below:

(i) **Climate change adaptation guidelines for protection and management of the Indian coast are officially endorsed.** This includes (i) analysis and interpretation of climate change trends and projections for the whole Indian coast, building on ongoing work of key Indian research institutes as well as international climate research; (ii) incorporating climate change parameters into information systems being developed by the central agencies; and (iii) preparing planning and design criteria and guidelines for coastal climate change adaptation.

(ii) **Shoreline management is climate-resilient in two focal states**. This involves provision of expertise to support the SCPMIP in incorporating climate change information and adaptation measures into planning and design of subprojects, shoreline management plans, and coastal information systems. Outputs of the climate change analyses and guidelines will be applied to planning and design studies in the two focal states, and in socioeconomic studies of different adaptation strategies. Special focus will be given to planning and design of community-led natural protection measures and support for community livelihoods.

(iii) **Coastal investments in two focal states incorporate climate resilience.** Through more scientific and rigorous analysis under the TA, the investments under project 2 and 3 of the SCPMIP in Karnataka and Maharashtra will incorporate appropriate approaches to climate resilience, including both soft and hard measures. Soft infrastructure interventions will focus on the use of innovative, less invasive technologies such as climate-resilient beach nourishment, dune management, coastal mangrove, and vegetation restoration and protection. Hard infrastructure intervention will consist of higher-investment and engineering-type solutions designed to perform under climate change conditions. In addition, the TA will directly finance the implementation of up to six small pilot projects that will test and demonstrate community-based, climate-resilient natural protection focusing on beach and dune management.

[3] Project 1 implementation is expected to be completed late 2015. It was initially delayed due to lack of readiness, necessity to modify the detail designs and delayed approvals and implementation capacity of the executing agencies. Project 2 and Project 3 of the SCPMIP will be submitted for ADB approval in 2015 and 2016, respectively.

(iv) **Institutions have strengthened capacity and raised awareness of coastal climate change and adaptation measures.** The TA will support (i) training in climate adaptation guidelines, supplementing the SCPMIP training programs in the two focal states; (ii) training for a cadre of about 25 state and national trainers in the application of climate change guidelines, including coastal climate change information systems; (iii) training courses for senior officials and stakeholders from other maritime states and union territories; and (iv) dissemination of information, awareness raising of decision makers and other stakeholders, and strengthening of the knowledge networks concerned with climate change adaptation in coastal areas.

11. The key assumptions are that (i) the maritime states accept the climate change adaptation guidelines and absorb the additional costs to incorporate climate resilience; (ii) central and state ministries are committed to revising regulation so as to integrate climate change into design and investments; and (iii) recipients of training are, and remain, active players in coastal protection and management activities.

12. Some associated risks are: (i) climate change impacts exceed model projections; (ii) state governments and communities do not adopt adaptation measures because impacts of climate change are uncertain and difficult to measure, and periods of moderate climate conditions exist; and (iii) community-based natural protection measures may not demonstrate sufficient benefit and may provide levels of protection below stakeholder expectations, resulting in poor stakeholder response and government reluctance to support upscaling.

C. Cost and Financing

13. The TA is estimated to cost $2,050,000, of which $ 2,000,000 will be financed on a grant basis by GEF, and administered by ADB. The government will provide counterpart support in the form of (i) office space at the Central Water and Power Research Station (CWPRS) and Central Water Commission (CWC); (ii) office space in SCPMIP offices in Mangalore and Mumbai; and (iii) counterpart staff to support coordination and liaison for pilot community projects in the two focal states, and processes to officially endorse the climate change adaptation guidelines. The cost estimates and financing plan is in Appendix 2.

D. Implementation Arrangements

14. The executing agency for the TA will be MOWR; the nominated focal person will be the CWC's chief engineer, flood management, supported by the director of coastal erosion. The executing agency will supervise and coordinate overall project execution. MOWR will create a national technical committee for the duration of the TA to review and endorse the TA outputs for climate change adaptation. The composition of the committee will include chairperson-member of river management of CWC; chief engineer, flood management of CWC; director, CWPRS; nominees from MOWR, MOEF, Ministry of Earth Sciences, and Bureau of Indian Standards; project directors, SCPMIP Maharashtra and Karnataka; project director of the World Bank-funded Integrated Coastal Zone Management Project; and other technical specialists from national institutes and academia as required. Planning and design guidelines will be reviewed and ratified by the existing coastal protection development advisory committee. MOEF is the GEF focal point in India and will provide support and coordination in ensuring compliance of the project with GEF guidelines. It will also be associated with the review and approval of planning and design guidelines, including TA monitoring and evaluation.

15. The TA will be implemented through three agencies:

(i) Nationally, the CWPRS is to provide specialist technical support and guidance in the analysis and interpretation of climate change data, and in the implementation of training components in coordination with CWC (responsible for outputs 1 and 4).
(ii) At the state level, it is the Public Works Ports and Inland Water Transport Department in Karnataka, and the Maharashtra Maritime Board. TA management and coordination will be carried out through existing program management units of the SCPMIP (responsible for outputs 2 and 3) which are within the two state agencies.

16. The TA will be implemented over 36 months, from June 2014 to June 2017. An interdisciplinary team of international consultants consisting of research scientists and coastal specialists will be recruited. The consultants will work at national, state, district, and community levels. An input of 22 person-months of international consultants and 44 person-months of national consultants is proposed. Consultants will be engaged by ADB through a firm in accordance with ADB's Guidelines on the Use of Consultants. The quality and cost-based selection procedure with a technical–financial weighting of 90:10 on a full technical proposal will be used. The consultancy contract package will include provisional sums to cover the costs of (i) subcontracting three national focal research institutes for climate change analysis; (ii) subcontracting local nongovernment organizations and contractors for the implementation of pilot community projects; (iii) preparing training courses, workshops, and awareness materials; and (iv) engaging an advisory panel of experts. Payments to the consulting firm, including provisional sums, will be made by ADB in accordance with its *Technical Assistance Disbursement Handbook*. The outline terms of reference for consultants are in Appendix 3.

17. The three national focal research institutes to be subcontracted through the consulting firm will undertake climate change studies that require access to data and specialist analysis that are only available to the institutes directly or in cooperation with other institutes. The studies will primarily source and analyze existing data and research and will not require significant new research; and each assignment will be relatively small, requiring less than $100,000 per institute. The unique expertise and access to data of the focal institutes are not available from other sources; hence single-source selection will be applied.[4]

18. The advisory panel of experts will review and endorse the climate change analysis and guidelines for adaptation. To provide interaction of a wide geographical spread of expertise and incorporation of different coastal conditions, each of the 12 maritime states and union territories will be requested to nominate one institute or coastal specialist in addition to the four national experts to be appointed to the panel. The panel will be chaired by one elected member. Consulting inputs to the advisory panel will be 8 person-months in total. The panel members will be recruited through institutes or as individual experts. The consulting firm will be responsible for the contractual arrangements and remuneration of the panel members.

IV. THE PRESIDENT'S RECOMMENDATION

19. The President recommends that the Board approve ADB administering technical assistance not exceeding the equivalent of $2,000,000 to the Government of India to be financed on a grant basis by the Global Environment Facility for the Climate-Resilient Coastal Protection and Management Project.

[4] The proposed institutes and main areas of support are the (i) National Institute of Oceanography—historic trends in sea levels, projections for sea level rise, changes in vertical land levels, changes in wave characteristics from climate change; (ii) Indian Institute of Tropical Meteorology—downscaled wind, rainfall, and temperature projections, including analysis of uncertainty; and (iii) Centre for Atmospheric Sciences, Indian Institute of Technology Delhi—analysis of historic and projected storm surges.

DESIGN AND MONITORING FRAMEWORK

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
Impact Strengthened resilience of the Indian coast to impacts of climate change	By 2024: 30% of new and rehabilitated major coastal infrastructure in India incorporate climate resilience according to the guidelines supported by the Special Climate Change Fund (baseline 2013 = 0)[a]	Detailed project reports submitted for approval by state governments to CWC and CWPRS	**Assumption** Maritime states accept financing of additional costs for climate change adaptation **Risk** Climate change impacts exceed model projections
Outcome Climate change impacts are factored into coastal protection and management interventions in India	By 2019: Project clearances by state and central authorities require climate resilience to be factored into the design of coastal infrastructure 50% of new and rehabilitated coastal protection and infrastructure projects in the two focal states incorporate climate resilience (baseline 2013 = 0) 20% of the 520 kilometers of vulnerable shorelines in the two focal states incorporate low-cost natural protection measures (baseline 2013 = 0%)	Advisory notice from the Ministry of Water Resources to maritime states and union territories to apply the adaptation guidelines and to ensure that climate resilience is incorporated in coastal planning and design Detailed project reports submitted for approval by state governments to CWC and CWPRS Questionnaires and surveys to communities	**Risks** Poor stakeholder response to community-based natural protection measures, and government reluctance to support upscaling
Outputs 1. Climate change adaptation guidelines for the protection and management of the Indian coast are officially endorsed	By 2016: Planning and design guidelines prepared and endorsed by a panel of experts and national technical committees	Analysis of reviews by the TA panel of experts and National Institute of Oceanography Minutes of national technical committee meetings	

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
2. Shoreline management is climate-resilient in two focal states	By 2015: Shoreline management plans incorporating climate change impacts are approved by the two focal states By 2015: Coastal information systems in the two focal states incorporate climate change parameters	For all indicators: SCPMIP progress report and minutes of the program steering committee meetings	
3. Coastal investments in two focal states incorporate climate resilience	By 2015: Investments under projects 2 and 3 of the SCPMIP incorporate climate change resilience By 2016: Up to six TA-funded community protection pilot subprojects in the two focal states are implemented, with 50% of activities involving women	For all indicators: SCPMIP progress reports and minutes of the program steering committee meetings	
4. Institutions have strengthened capacity and raised awareness of coastal climate change and adaptation measures	By 2015: All training programs by the SCPMIP in the two focal states incorporate climate change adaptation By 2016: Awareness materials based on the climate adaptation guidelines are prepared and distributed By 2016: A total of 25 experienced trainers from state and national institutions are able to train civil servants on the use of guidelines for climate change adaptation	Training reports and post-training questionnaires produced by the TA consultants SCPMIP progress report Post-training evaluation reports produced by the TA consultants	**Assumption** Recipients of training are and remain active players in coastal protection and management activities **Risk** Follow-on training is not conducted due to limited commitment or financial constraints

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
Activities with Milestones			**Inputs**
1. Climate change adaptation guidelines for the protection and management of the Indian coast are prepared and officially endorsed 1.1 Engage TA consultants (Q2 2014) 1.2 Engage three focal research institutes by TA consultants (Q3 2014) 1.3 Collect, analyze, and interpret climate change trends and projections data (Q2–Q4 2014) 1.4 Recruit panel of expert for review of guidelines (Q2 2015) 1.5 Organize regional and national workshops for presentation and validation of the proposed guidelines (Q3 2015) 1.6 Submit guidelines for final endorsement by the panel of experts and national technical committee (draft in Q4 2015, final endorsed Q1 2016) 1.7 Prepare recommendations to incorporate climate change parameters into national coastal information systems (Q2 2016) **2. Shoreline management is climate resilient in two focal states** 2.1 Review shoreline management planning guidelines in the two focal states and incorporate climate change parameters (Q4 2014) 2.2 Revise the two focal states' shoreline management plans and incorporate climate change resilience (Q1 2015) 2.3 Validate revised plans through district and state workshops (Q1 2015) **3. Coastal investment in two focal states incorporate climate resilience** 3.1 Revise design of project 2 and 3 investments in the two focal states to incorporate climate change (project 2 in Q3 2014, project 3 in Q2 2015) 3.2 Identify and design six TA community protection pilot projects in the two focal states with 50% of activities involving women (Q2 2015) 3.3 Contract nongovernment organizations and community organizations for implementation of community protection pilots (Q3 2015) 3.4 Assess pilot results and prepare evaluation reports for knowledge sharing (Q3–Q4 2016) **4. Institutions have strengthened capacity and enhanced raised awareness of coastal climate change and adaptation measures** 4.1 Prepare training programs for the two focal states that incorporate climate change adaptation (Q1 2015) 4.2 Undertake training for 25 experienced trainers from various states and national institutions on the approved guidelines for climate change adaptation (Q1 2015 and Q2 2016) 4.3 Organize two senior-level training courses for selected central and maritime state officials and stakeholders (Q2 2015 and Q3 2016) 4.4 Prepare and distribute awareness materials based on the climate adaptation guidelines (Q2–Q4 2016)			ADB: $2,000,000 (Global Environment Facility) Note: The government will provide counterpart support in the form of counterpart staff, office space, and support to source data and help link up with research institutes, and other in-kind contributions.

CWC = Central Water Commission, CWPRS = Central Water and Power Research Station, Q = quarter, SCPMIP = Sustainable Coastal Protection and Management Investment Program, TA = technical assistance.

[a] Major projects are projects with cost exceeding Rs150 million. Efforts are made to build information systems that can compile the information for measurement of resilience through reduced damages of the climate change impacts in future.

Source: Asian Development Bank.

COST ESTIMATES AND FINANCING PLAN
($)

Item	Amount
Global Environment Facility[a]	
1. Consultants[b]	
a. Remuneration and per diem	
i. International consultants (22 person-months)	550,000
ii. National consultants (44 person-months)	260,000
iii. Advisory panel of national experts[c] (8 person-months)	56,000
b. International and local travel	70,000
c. Reports and communications	15,000
2. Equipment[d]	5,000
3. Workshops, training, seminars, and conferences	
a. Training of trainers, training for central government, maritime states, and union territories or islands	52,000
b. Implementation of pilot community protection projects including community awareness, participation, and coordination[e]	400,000
c. Production of awareness materials	10,000
d. Workshops and consultations	20,000
4. Surveys	
a. Studies by focal research institutes[f]	180,000
b. Data, surveys, studies, and GIS[g]	20,000
c. Project monitoring[h]	10,000
5. Miscellaneous administration and support costs[i]	246,818
6. Contingencies	105,182
Total	**2,000,000**

GIS = geographic information system.

Note: The technical assistance (TA) is estimated to cost $2,050,000, of which contributions from the Global Environment Facility are presented in the table above. The government will provide counterpart support in the form of counterpart staff, office space, and support to source data and help link up with research institutes, and other in-kind contributions. The value of government contribution is estimated to account 2.4% of the total TA cost.

[a] Administered by the Asian Development Bank (ADB).

[b] Experts to be engaged through an international consulting firm.

[c] The advisory panel of experts will be nominated by the Ministry of Water Resources and maritime states, and approved by ADB to provide peer review climate analyses and adaptation guidelines. It is proposed to engage one expert or institute from each maritime state and union or island territory, and four national experts. The consulting firm will be responsible for remuneration of the panel members.

[d] Computers, projector, printer, and scanner to be procured will be given to the Central Water and Power Research Station of the Ministry of Water Resources at the end of the TA.

[e] Grants will be for up to six community pilot projects, with activities including awareness, training, demarcation of dunes, planting, sand fencing, access paths, beach scraping, river mouth training, and small sand-filled geotextile bags. Grants will include the engagement of local community coordinators or supervisors and cover about six locations in the two focal states, with about 3 kilometers of natural protection per project. Pilot projects will be managed and paid through the consulting firm and subcontracted to nongovernment organizations and local contractors in accordance with ADB's Procurement Guidelines, and Guidelines on the Use of Consultants by ADB, with prior approval of ADB.

[f] Focal research institutes will be subcontracted by the consulting firm to undertake analyses of climate change impacts and to support the preparation of guidelines.

[g] Other studies and preparation of GIS to be commissioned as required.

[h] Data collection and processing (surveys, data operators, etc.).

[i] Office support staff, stationeries, inclusive of the Global Environment Facility administration cost of 10% or $181,818.

Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

A. International Consultants

1. **Team leader and coastal engineer** (6 person-months, intermittent). The tasks include:
   - (i) Plan and coordinate all the inputs and outputs from the consultants.
   - (ii) Prepare, in coordination with various consultants, briefing papers that outline latest international research findings and proposed work plans for the three national focal research institutes; review outputs from the institutes.
   - (iii) Assess needs, implications, and estimated costs to incorporate climate change resilience for typical coastal protection works and coastal infrastructure.
   - (iv) Coordinate preparation of climate change adaptation criteria and guidelines based on outputs from consultants and focal research institutes.
   - (v) Support the incorporation of climate change parameters into the information systems and focal and support coordination; merge coastal climate information with other state or central systems.
   - (vi) Support technical committee briefings, processes in endorsing the guidelines, and establishment of a coastal adaptation policy.

2. **Meteorologist and climate change specialist** (2 person–months, intermittent)**.** The tasks include:
   - (i) Carry out a comprehensive review of international and Indian climate prediction research with specific reference to the projected changes on the Indian coast.
   - (ii) Work closely with the Indian climate research institute or agency in preparing downscaled climate projections.
   - (iii) Advise the various experts on the probabilities and uncertainties of climate change, and the development of approaches to incorporate them into the climate change guidelines.
   - (iv) Support preparation of adaptation guidelines, training modules, and awareness materials.

3. **Coastal oceanographer and climate change specialist** (3 person**-**months, intermittent). The tasks include:
   - (i) Analyze and interpret latest research on historic and projected sea level changes and other coastal climate change effects, both globally and with special reference to the Indian coast.
   - (ii) Analyze research on current and projected storm surges both globally and for India.
   - (iii) Compile best estimates of projected changes in sea level for India, including local variations and effects of changes in land levels and, where possible, support the assignments of probabilities of different events.
   - (iv) Support the preparation of coastal adaptation guidelines.
   - (v) Support preparation of training modules and awareness materials.

4. **Coastal engineering design specialist** (4 person-months, intermittent)**.** The tasks include:
   - (i) Review the various climate change impacts and assess the likely implications on coastal protection and coastal infrastructure.
   - (ii) Review current standards and norms for coastal engineering and present adjustments to meet the needs of climate resilience.

(iii) Work with the climate change economist to support the cost–benefit analysis of various adaptation strategies.
(iv) Work with other consultants to develop design guidelines for beach and mangrove management under climate change.
(v) Prepare guidelines for designers to accommodate climate resilience into coastal infrastructure design, including hard and soft technologies for coastal protection.
(vi) Support the Sustainable Coastal Protection and Investment Management Program (SCPMIP) designers to incorporate climate resilience for the tranche 2 designs, and to prepare recommendations for climate resilience for the subprojects identified for tranche 3 under the shoreline planning activities.
(vii) Prepare, in consultation with the Central Water and Power Research Station (CWPRS) and other coastal design organizations, recommendations for long-term strengthening of coastal engineering design to meet climate impacts, including hard and soft solutions.
(viii) Support preparation of adaptation guidelines, training modules, and awareness materials.

5. **Climate change economist** (2.5 person-months, intermittent)**.** The tasks include:
(i) Prepare an analysis of financial risks if climate change resilience is not incorporated into coastal protection and other infrastructure. The analysis should be based on case studies for typical coastal protection and management situations.
(ii) Prepare a cost–benefit analysis and sensitivity analysis of various approaches and scenarios for coastal protection, including economic assessments of the approaches to incorporate climate resilience into coastal infrastructure. The analysis will be based on selected projects under the shoreline planning of SCPMIP.

6. **Coastal morphologist and beach management specialist** (2.5 person-months, intermittent). The tasks include:
(i) Review outputs of shoreline management plans in the two focal states and other parts of the Indian coast with special reference to morphological impacts of climate change on the equilibrium of beaches and coastal wetlands (mud flats).
(ii) Undertake a more detailed analysis of at least five case studies, to assess the current issues of instability and the potential future impacts of climate change.
(iii) Present proposals and outline designs and specifications to support stabilization of beaches and coastal wetlands under scenarios of climate change.
(iv) Prepare strategies and outline approaches for TA-funded pilot projects.
(v) Support selection of locations for the six TA-funded pilot subprojects.
(vi) Support preparation of adaptation guidelines, training modules, and awareness materials.

7. **Institutional and training specialist** (2 person-months, intermittent). The tasks include:
(i) Review the institutional base for coastal protection and management and climate change adaptation.
(ii) Identify institutional and capacity constraints in coastal climate change adaptation.
(iii) Develop strategies to support training and awareness.
(iv) Prepare the approach and details for an integrated program of training and awareness under the technical assistance (TA), including adaptation guidelines, training of trainers, modules for training courses, and design of the awareness campaign.

B. National Consultants

8. **Deputy team leader and coastal engineer** (16 person-months, intermittent). The tasks include:

(i) Support the international team leader in all tasks; and support coordination, liaison with government and stakeholders, and maintenance of project direction and programming in the absence of the team leader.
(ii) Coordinate and liaise on the SCPMIPs, including incorporation of climate resilience into shoreline planning and Project 2 and 3 investments designs.
(iii) Prepare contracts and manage the subcontracts, including for the three national focal research institutes, pilot projects, training, and monitoring and evaluation.
(iv) Assess design implications and estimated costs to incorporate climate change resilience for typical coastal protection works.
(v) Support the preparation of climate change adaptation criteria and guidelines based on outputs from consultants and focal research institutes.
(vi) Support the incorporation of climate change parameters into the information systems.
(vii) Support the panel of experts' inputs and ensure smooth liaison between the experts and other technical specialists; synthesize and summarize these findings.
(viii) Supervise coordination with other consultants, the TA-funded community pilot projects, and the training and awareness programs.
(ix) Ensure that all project expenditures are properly documented according to government and Asian Development Bank requirements.
(x) Support the consolidation and editing of project outputs.

9. **Coastal management specialist** (5 person-months, intermittent). The tasks include:

(i) Review the SCPMIP shoreline planning in the two focal states and prepare specific recommendations for incorporation of climate change resilience into the shoreline plans.
(ii) Interpret and assess the potential impacts of the projected climate changes on the coast in coordination with other consultants.
(iii) Review ongoing coastal climate change studies such as the State Action Plans for Climate Change, and the Integrated Coastal Zone Management Project of the Ministry of Environment and Forests, and extract key findings that can be used to support TA outputs.
(iv) Develop climate change scenarios and possible climate change adaptation measures that can be taken forward for detailed analysis.
(v) Work with the engineers and climate economist to develop the cost–benefit analysis of different adaptation strategies.
(vi) Support preparation of adaptation guidelines, training modules, and awareness materials.

10. **Coastal morphologist and beach management specialist** (5 person-months, intermittent). The tasks include:

(i) Review outputs of shoreline management plans in the two focal states and other parts of the Indian coast, with special reference to morphological impacts of climate change on the equilibrium of beaches and coastal wetlands (mud flats).
(ii) Undertake more detailed analyses of not less than five case studies to assess the current issues of instability and the potential future impacts of climate change.

(iii) Present proposals and outline designs and specifications to support stabilization of beaches and coastal wetlands under scenarios of climate change.
(iv) Prepare strategies, approaches, and selection of possible locations for the community pilot projects.
(v) Work with the community specialist in the selection, design, and implementation of the community pilot projects.
(vi) Prepare awareness and training materials to support greater understanding of vulnerabilities of beaches and of the potential to reduce degradation and erosion through beach management.
(vii) Support preparation of adaptation guidelines, training modules, and awareness materials with special reference to beach management.

11. **Institutional and training specialist** (5 person-months, intermittent). The expert will support the international institutional and training specialist in undertaking the following tasks**:**
(i) Review the institutional base for coastal protection and management, and climate change adaptation.
(ii) Identify institutional and capacity constraints in coastal climate change adaptation.
(iii) Develop strategies to support training and awareness.
(iv) Prepare the approach to and details for an integrated program of training and awareness raising under the TA, including adaptation guidelines, training of trainers, modules for training courses, and design of the awareness campaign.

12. **Community specialist** (5 person-months, intermittent). The tasks include:
(i) Support identification, selection, and design of the community pilot projects.
(ii) Lead the community engagement and awareness programs for community projects.
(iii) Work with the communities to determine suitable models for community cooperation with special reference to cofinancing and agreements to ensure long-term sustainable funding after the end of the TA.
(iv) Work in communities to develop the terms of reference and contractual arrangements for the community pilot projects.
(v) Develop appropriate mechanisms to guide and supervise the community projects.
(vi) Support the supervision of the community projects and provide follow-on support to ensure long-term sustainability.
(vii) Support preparation of adaptation guidelines, training modules, and awareness materials with special reference to strategies and mechanisms for community-based coastal protection programs.

13. **Coastal ecologist** (4 person-months, intermittent). The tasks include:
(i) Assess potential ecological effects of climate change on the coast with special reference to impacts of climate change on mangroves, beaches, and coral reefs, and the resulting effects on coastal erosion and instabilities.
(ii) Review ongoing mangrove research and propose strategies to increase the sustainability of mangroves under changing climatic conditions.
(iii) Work with the data management specialist to source geographic information system (GIS) mapping for mangroves and coral reefs for the Indian coast.
(iv) Advise on suitable types of dune vegetation to be incorporated into the pilot projects.
(v) Support the development of adaptation guidelines in relation to ecological coastal protection.

14. **Data management geographic information system specialist** (4 person-months, intermittent). The tasks include:

(i) Work with the TA consultants and research institutes to prepare the design of a coastal climate change information system.
(ii) Work with the SCPMIP consultants to incorporate climate change parameters into the coastal data management system.
(iii) Liaise with the Central Water Commission, Ministry of Environment and Forests, and other organizations that have established or proposed data management systems; review the various systems and prepare strategies to merge climate change parameters.
(iv) Design the framework and metadata for coastal climate change information.
(v) Work with a GIS technician (to be recruited) to prepare the GIS coastal climate change information system, including modules for training.
(vi) Support preparation of adaptation guidelines, training modules, and awareness materials with special reference to coastal information systems.