Republic of Yemen

Environment Protection Authority

National Adaptation Programme of Action

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List of Acronyms

CBD	Convention on Biological Diversity
CATF	Consultative Assessment Task Force
ECATF	Evaluation Criteria Assessment Task Force
EIA	Environmental Impact Assessment
EPA	Environment Protection Authority
GEF	Global Environment Facility
GCM	General Circulation Model
GDP	Gross Domestic Product
INC	Initial National Communication
LEG	Least Developed Countries Expert Group
LDC	Least Developed Country
MCA	Multi-Criteria Analysis
MAI	Ministry of Agriculture and Irrigation
MHP	Ministry of Health and Population
MWE	Ministry of Water and Environment
NAPA	National Adaptation Programme of Action
NPCU	National Project Coordination Unit
MSBRA	Marine Science and Biological Research Authority
NEAP	National Environmental Action Plan
NBSAP	National Biodiversity Strategy & Action Plan
NGO	Non-Government Organizations
PPCU	Province Project Coordination Unit
PRSP	Poverty Reduction Strategy Paper
PPTF	Project Portfolio Task Force
SATF	Synergy Assessment Task Force
SC	Steering Committee
SG	Stakeholder Group
SLR	Sea Level Rise
TC	Technical Committee
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme

WMO World Meteorological Organization

1. Introduction and Setting

Yemen is an arid Middle Eastern country, occupying an area of 527,970 square kilometres at the southern end of the Arabian Peninsula. It is bordered to the north by Saudi Arabia, to the East by Oman, and to the South and West by a 2,200 km coastline along the Gulf of Aden, Arabian Sea and the Red Sea (see Figure 1-1 below).

Figure 1-1 Map of Yemen

As a Least Developed Country (LDC), Yemen is highly vulnerable to climate change-related impacts such as drought, extreme flooding, pests, sudden disease outbreaks, changes of rainfall patterns, increased storm frequency/severity and sea level rise. These are serious concerns as Yemen's economy largely depends on its rural natural resources. Moreover, more than 75% of the population is rural-based engaged in farming and pastoralism and hence highly reliant on favorable climatic conditions for their livelihoods.

Yemen's Initial National Communication (INC) to the UNFCCC in 2001 reported findings concerning the vulnerability of the social and biophysical environment from climate variability and climate change. The major impacts of climate change in Yemen, as reported in the INC, represented the starting point for the NAPA effort. They can be summarized as follows:

- Increased water scarcity and reduced water quality – leading to increased hardship on rural livelihoods;
- Increased drought frequency, increased temperatures, and changes in precipitation patterns – leading to degradation of agricultural lands, soils and terraces;
- Deterioration of habitats and biodiversity – leading to expansion of desertification;
- Reduced agricultural productivity – leading to increased food insecurity and reduced income generating activities;
- Increased sea levels – leading to deterioration of wetlands, coastal mangrove migration, erosion, infrastructure damage, and seawater groundwater intrusion;
- Increased climatic variability – leading to the possibility of spread and growth of vector borne and water borne diseases; and
- Impacts on coastal zones – leading to a loss of tourism

activity due to sea level rise including loss of beaches, and 2

Population Characteristics

Yemen is burdened with low human and economic development, serious environmental challenges, and a high degree of vulnerability to current climatic variability.

With an annual growth rate of 3.5 percent – one of the highest in the world – Yemen's population is growing extremely quickly. As of 2004, Yemenis numbered approximately 21 million, an increase of nearly 4 million over the course of just six years. During the same time, poverty increased nearly threefold, particularly in rural areas, where three quarters of Yemenis live.

Geographic characteristics

Yemen is characterized by five major land systems, as follows (EPC, 1995):

- Hot and humid coastal plain,
- Temperate Highlands,
- High Plateaus (Hadramawt and Mahra Uplands),
- Desert interior, and
- Islands

Some of Yemen's ecological zones are confined to small areas (e.g., islands), with human communities, flora and fauna highly adapted to subsist within them. Other zones are much larger (e.g., Temperate Highlands) and support the majority of the country's agricultural production. In both cases, climate change poses a major threat.

Climatic characteristics

Rainfall varies widely across the country, from less than 50 mm along the coast, rising with the topography to between 500 and 800 mm in the Western Highlands, and dropping again to below 50 mm in the desert interior (see Figure at right). Precipitation occurs primarily in spring and summer, and is determined by two main mechanisms: the Red Sea Convergence and the Inter Tropical Convergence Zone.

Temperature depends primarily on elevation, and in the coastal areas, is determined by distance from the sea. Mean annual temperatures range from less than 12ºC in the Temperate Highlands (with occasional freezing) to 30 ºC in the coastal plains temperatures have increased. The result is occurrence of frequent prolonged hotter droughts during the last three decades interrupted by occurrence of occasional flooding. Drought climate were obvious during the seventies and eighties with low rainfall and record maximum temperatures.

Development context and challenges

Yemen continues to make development strides, yet profound poverty and other challenges persist. Factors such as adult literacy (at 46% of the general population; significantly higher for women), GDP per capita (at US$893/year), and total fertility rate (at 7.6%, second only to Niger) combine to place Yemen near the bottom of the Human Development Index (at 144th). A

third of the country does not have access to improved water sources and 46% of all children under five years of age are underweight (UNDP,2002).

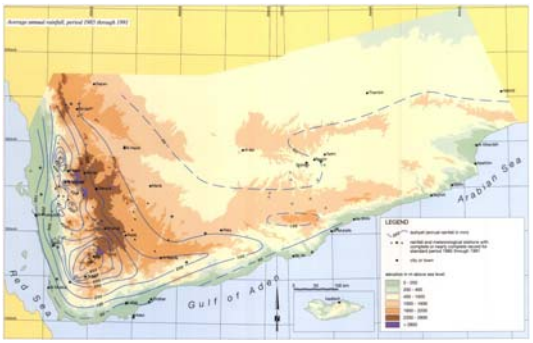

Figure 1-2 Distribution of annual rainfall

Already scarce water resources are becoming increasingly precious, as per capita availability is falling steadily with growing population. In 1955, Yemen's per capita water availability was 1,098 cubic meters; in 1990 it had fallen to 460, and is projected to drop to 150 by 2025 under business-as-usual scenarios of increased demand – to say nothing of future climate impacts. Whereas surface water is largely seasonal and unreliable, groundwater is being simultaneously polluted and extracted in excess of recharge.

Arable land constitutes only 3 percent of Yemen's land area; roughly two thirds of this is currently used for crops or livestock. Agriculture contributes 20% of Yemen's GDP, and supports 53% of employment, with traditional subsistence agriculture dominating production. Addressing poverty through improved agricultural production is among Yemen's development objectives, yet production is consistently quite low, due in part to the vulnerability of rain-fed agriculture to rainfall variability and prolonged drought.

Sustainable use of the marine and coastal environment is a potentially important driver of development. Coral reefs, sea-grass and mangroves provide coastal zones with important biodiversity and fishery potential. Yet, Yemen's coastal ecosystems are already experiencing degradation from manmade as well as climatic causes.

Layered on top of the prevailing conditions of poverty, environmental and climatic factors create a number of pressing challenges for Yemen. Desertification, brought on by human land-use pressures and recurrent drought, has consumed significant land area and continues to threaten arable land. Depletion of forests along the western and southwestern escarpment threatens species, communities, and reduces other services forests provide. These examples represent the type of current environmental concerns that could be exacerbated under climate change conditions.

In response to these challenges, Yemen has sought support from the international community to promote sustainable development. The country has engaged in international environmental processes, developed national policies and plans, started strategic research programs, implemented monitoring mechanisms, facilitated ground-level development work, and sought to strengthen human and institutional capacity.

Key Opportunities for Adaptation

Many opportunities exist for more effective integration of climate change adaptation within development activities whether or not effects of climate change are realized. As a point of departure, progress on adaptation to climate change will require:

- Improving governance, including an active civil society and open, transparent, and accountable policy and decision making processes, which can have a critical bearing on the way in which policies and institutions respond to the impact of climatic factors on the poor;
- Promoting steps towards the mainstreaming of climate change issues into all national, sub-national, and sectoral planning processes, such as Poverty Reduction Strategies (PRS) or national strategies for sustainable development;
- Providing a specific government agency (e.g., Ministry of Planning and International Cooperation) with a broad mandate to pursue mainstreaming adaptation to climate change across all sectors:
- Combining approaches at the government and institutional level with bottom-up approaches rooted in regional, national, and local knowledge;
- Empowering rural communities so that they can participate in assessments and feed in their knowledge to provide useful climate-poverty information; they also need access to climate information;
- Conducting vulnerability assessments that are design to fully address the different dimensions and causes of poverty;
- Providing access to good quality information about the impacts of climate change such as early warning systems and information distribution systems which can help to anticipate and prevent disasters; and
- Integrating climate change impacts into economic planning for the national budget. The rate and pattern of economic growth is a critical element of poverty eradication, and climatic factors can have a powerful bearing on both. Integration will prevent climate change diverting limited resources into disaster relief and recovery activities and away from long-term development priorities.

2. Framework for Adaptation Programme

Vulnerability of communities and economic sectors to climate-related impacts is associated with weather fluctuations in the near term (i.e., climate variability), as well as fluctuations in weather patterns over the long term (i.e., climate change). Yemen's major environmental problems are water scarcity, soil erosion, and desertification each of which is prone to exacerbation under climate change, which are discussed in the sections below.

In addition, there are other climate-related phenomena such as dust storms, thunderstorms, and heat waves whose occurrences, though less frequent, still pose serious threat to local livelihoods. Future climate change is expected to see these hazards intensify.

Future Climate Change

According to the country's First National Communications to the UNFCCC, Yemen's climate is projected to change significantly over the next 50 years (see Table at left). Temperature across the country is expected to rise between 1.4 and 2.8 degrees Celsius by 2050.

Table 2-1: Projected climatic changes in Yemen for 2050 based OSU, ECHAM3TR and UKHI GCMs (GOY, 2001)

	Minimum	Maximum
Temperature (°C)	1.4	2.8
Precipitation (% change)	-24	35
Cloud cover (% change)	-6	18

Precipitation and cloud cover patterns are more uncertain – depending on the GCM, rainfall is projected to decrease by about 24% or increase by about 35%. Follow-up regional climatic modeling indicates that rainfall is expected to decrease across the northern regions, leading to increased pressures on the country's delicate agriculture and water resources sectors.

In recent decades, Yemen rainfall patterns have shown increasing extremes. On the one hand, rainfall has decreased considerably leading led to major agricultural losses, losses of animals and water shortages.

On the other hand, flooding was clearly observed in 1996 and during the period 2005-2008. Under warmer climate these features are likely to be further aggravated. Regional downscaling efforts were undertaken to further explore local climatic regimes (see Annex 3 for a summary).

In addition to the likelihood that rainfall may decrease over much of Yemen, the timing of rainfall, the intensity of individual storms, the delay between falls and the frequency of inter-annual variability may all change. Rainfall changes will be accompanied by changes in the intensity of wind and frequency of high temperatures and changed cloudiness. When projected annual changes in rainfall are combined with changes in potential evaporation, a new

pattern of regime for Yemen is likely to exist by 2050.

Goals of Yemen's NAPA Process

The primary goal of the Yemen NAPA process is to identify priority measures to adapt to climate change and climate variability, and translate them into project based activities that can address Yemen's urgent needs for adapting to the adverse impacts of climate change. Key elements of the process included the following:

- Adequate stakeholder representation in all phases of the process, including the NAPA document itself;
- Synergy and consistency of adaptation measures with national and sectoral policies and plans.
- Capacity building and raise awareness for adapting to climate change impacts; and
- Country-driven criteria by which to evaluate and prioritize potential adaptation measures;

Barriers to NAPA Implementation

There is a range of barriers that could threaten the ultimate implementation of priority adaptation activities identified by the NAPA process. To better understand these risks, a barrier analysis was undertaken, Numerous potential barriers of various types (i.e., technical, economic, financial and institutional in nature) and various levels (i.e., national policymaking, project implementation, multilateral environmental agreement level) – have been identified and will need to be explicitly addressed in future planning efforts. The highest severity barriers for Yemen are briefly summarized below.

- Weak institutional structures and environmental legislations (weak inter-related, lack of executive bills, poor implementation of laws and bills, weak law enforcement);
- Lack of explicit policies to facilitate the implementation of Yemen NAPA recommendations;
- Lack of appropriate data (in terms of lack of adequate monitoring and collection, difficulties experienced in accessing databases, lack of technical capacity to analyze and manipulate data for V&A and lack of quality assurance);
- Uncertainties in regional, local climate change scenarios, and socio-economic scenarios;
- Low awareness for policy- and decision makers regarding climate change;
- Inadequate institutional, technical and financial capacity to develop, modify, or interpret existing models and methodologies, lack of financial sources to implement the adaptation measures;
- Scarce research work on the practical application of policy measures for adapting to climate change (scientific community has not had an active role in addressing V&A); and
- Entrenched poverty conditions worsen local conditions and

constrain efforts to build resilience.

3. Identification of Key Adaptation Needs

Identification of key adaptation needs is an important step in the NAPA preparation process as indicated in the annotated NAPA guidelines. Prior to the identification of adaptation needs, an understanding of vulnerability is needed in order to answer the question 'adapt to what?'.

Vulnerability Assessment of Key Sectors to Climate Change

Yemen's INC Yemen identified three main sectors that are vulnerable to climate change, water resources, agriculture, and coastal zones. The Yemen NAPA effort focused on these critical ectors as they pose potentially severe implications to the citizens at large, and are considered to be in need of immediate and urgent adaptation. In close consultation with stakeholder several additional sectors were identified – biodiversity, health, tourism - for which further delay in adaptation would significantly increase their vulnerability, and/or lead to much higher adaptation costs in the future. A brief summary of the vulnerabilities of each of the vulnerable sectors considered in the NAPA process is provided in Table 3-1.

Table 3-1. Summary of the main vulnerable sectors

Sector	Major Vulnerabilities
Water	Water availability and quality difficult situations due to changing patterns of rainfall, impact directly on the livelihoods of the communities. Groundwater sources are at risk from sea level rise induced sea water intrusion.
Agriculture & Food Security	Drought, temperature variability, and changes in precipitation regime can lead to disastrous consequences for agriculture and food security. Climate changes may imply degradation of agricultural lands, soils and terraces, desertification, which negatively affects agricultural incomes for local communities specifically and leading to national food insecurity as food production levels change.
Biological Diversity	Frequency in drought, temperature fluctuation, and changes in precipitation patterns due to climate change will lead to the deterioration of and changes in the habitats of endangered and endemic species. The intense wave activity of storms already damage near shore coral reefs in the Red Sea and Gulf of Aden, as sea levels rise and storms become more frequent Yemen may see an increase in intense wave activity.
Coastal areas Communities	Flooding of low-lying areas and coastal erosion threaten local communities and their livelihoods. Communities may experience damage to household assets and property, constraints on services such as water supply and quality, and damage to agriculture.
Coastal environment/ infrastructure	Deterioration of wetlands, mangrove forests along the shoreline as well as in islands in the Red Sea. As a result of sea level rise, Yemen can expect damage of infrastructural assets in coastal cities as well as to cultural heritage assets.
Health	Changes in climate will create more suitable conditions for the occurrence and spread of vector borne and water borne diseases such as malaria.
Tourism	Impacts include loss of beaches, degradation of coastal ecosystems, saline water intrusion, damage to infrastructure, and coral reef loss and bleaching.

Adaptation Needs

Yemen has experienced increasingly frequent floods from extreme rainfall events causing terraces deterioration, erosion of fertile soil from the banks of wadis (see Figure on next page). Frequent droughts and flooding events have also affected the sources of income of most of the population. Moreover, many households are facing destruction of their crops by pests and

Figure 3-1: Flooding-induced erosion in wadis

diseases, sand storms and desertification, all of which threaten their food production and security. Overall, adaptation needs in Yemen are driven by the following:

- Loss of soil due to erosion caused by strong and short period heavy rains (runoff);
- Water scarcity, lack of water supply and accessibility to healthy water sources, particularly in highland areas where groundwater is primary supply;
- Health hazards such as the outbreak of vector-borne diseases like malaria in Alqabita villages of the Taiz Governorate;
- Migration of ecological zones leading to non-viability of traditional crop types in areas where agricultural and pastoral activities are major income sources;

Figure 3-2: Coastal erosion, Alfazaa Mosque

- Loss of cultural heritage, historical places and land values in coastal areas (see Figure below) as they are eroded away and threatened by sea level rise.

Adaptation Vision

The NAPA process led to the development of a broad vision for adaptation in each of the identified key vulnerable sectors (i.e., water, agriculture, coastal zones). This vision is briefly summarized below.

- *Water resources:* Conservation and sustainable use of water resources, protection from over-exploitation and quality deterioration through optimal allocation of water resources and use of improved quality control techniques, taking climate variability and change into consideration;
- *Agriculture:* Protection of Yemen's Agricultural Diversity from Degradation, Maintaining

Agricultural Resources and Developing Sustainable Agricultural Programs, Taking Climate Variability and Change into Consideration; and

- *Coastal Zones:* Conservation and sustainable use of marine and fishery resources through the development and strict implementation of policy, legislative and management tools that ensure harvest level of biological resources are maintained within the biological limits, taking climate variability and change into consideration.

It is essential that the broad vision outlined above be pursued in coordination with other national environmental strategies adaptation in order to exploit synergies as they arise. The NAPA process confirmed that climate change issues are indeed closely linked to ongoing national efforts related to the Biodiversity Conventions as well as the Desertification Convention.

For example, drought early warning systems, contingency plans, food security systems, alternative livelihood projects or sustainable irrigation programs could be effective adaptation options in arid and semi-arid areas. At the same time, each of these could serve as a component of a National Action Plan to combat desertification and also to promote biodiversity.

Key Adaptation Activities

Effective adaptation in the priority sectors, when taken proactively and in coordination with national planning processes, will help to minimize future damages to physical infrastructure, natural resources, and household assets. Key activities identified during the NAPA process are summarized in the Table below.

Table 3-2: Priority adaptation activities

Sectors	Adaptation activity
Water	Rainwater harvesting through various techniques including traditional methods.
	Water conservation through reuse of treated waste water and grey water from mosques, and irrigation saving techniques.
Agriculture	Rehabilitation and maintenance of mountainous terraces.
	Promotion of research on drought resistant and heat- and salinity-tolerant crops.
	Develop and implement sustainable land management strategies to combat desertification and land degradation
Coastal Zones	Planting and re-planting of mangroves and palms for adaptation to sea level rise.
	Sustainable management of fisheries resources.
	Develop and implement Integrated Coastal Zone Management Programmes.
Cross Sectoral	Develop and implement an awareness raising programme on adaptation to the potential impacts of climate change on vulnerable

sectors.

Incorporate Climate Change and adaptation into school education.

Develop and implement programs to improve Yemen's preparedness to cope with extreme weather events.

Establishment and Maintaining of Climate Change Database.

4. Criteria for Selecting Priority Projects

The prioritization of adaptation projects involved two major steps in the Yemen NAPA process. First, a number of evaluation criteria were locally determined through the stakeholder consultation process. Then, through a scoring, weighting, and ranking process – part of a multicriteria analysis - a discrete set of prioritized adaptation projects were developed for each of the ecological zones, and for each of the priority sectors. The overall process is illustrated in Figure 4-1.

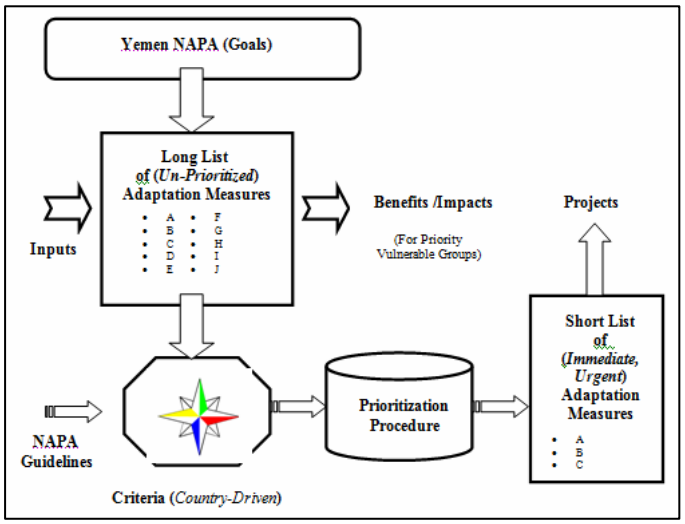

Figure 4-1. Evaluation process for prioritizing options

Proposed Adaptation Activities

During the assessment and consultation process – with both stakeholders and national experts - of the programme, a long list of 95 potential adaptation measures was identified. The complete list of these measures are listed in Annex 2.

Development of Evaluation Criteria

In order to evaluate and rank the total number of proposed adaptation measures, it was necessary to establish evaluation criteria to account for differing perspectives and concerns among stakeholders. This made possible reducing a long list of potential options into a short, prioritized list.

The NAPA process in Yemen emphasized the development of local evaluation criteria that were driven by concerns of stakeholders in each of the five ecological zones. This provided a basis for determining appropriate trade-offs between potential adaptation initiatives relative to the unique concerns and expressed vulnerabilities of the communities.

A review of potential evaluation criteria focused on the NAPA Annotated Guidelines as well as for the recently completed National Environmental Action Plan. After consulting with stakeholders a final set of evaluation criteria by which to evaluate each proposed adaptation measure was chosen, as follows:

- Contribution to Sustainable Development;
- Livelihood security of Local Communities;
  - Poverty reduction to enhance adaptive capacity;
  - Synergy with other multilateral environmental agreements; and
  - Cost-effectiveness

Process for Assigning Scores

For each potential adaptation option, evaluation criteria were assigned scores depending on the

input of stakeholders. Where necessary, uncertainty in stakeholder consensus was reflected by use of low and or high criteria score.

Assigning scores was a participatory process based on a series of workshops held first among local stakeholder groups and later among a national stakeholder group. A consensus approach was used in the local stakeholders to prioritize options, followed by a more rigorous application of multi-criteria assessment at the provincial and national level.

After standardizing the scores and weighting them according to a set of locally-driven weights assigned to each criterion, the initial set of 95 options was narrowed down to a total of 22 options. It is important to note that these are the highest priority projects relative to the complete set of 95 options. However, they are unranked relative to each other. This unprioritized set of potential adaptation projects appears below.

Table 4-1. Summary List of Key, unprioritized adaptation options

1	Rainwater harvesting through various techniques including traditional methods.
2	Develop and implement disaster preparedness and recovery programs, including forecasting, early warning systems and rapid response strategies to cope with extreme weather events.
3	Encourage and expand desalination for drinking water using renewable energy sources, especially on Yemeni islands and coastal areas, where water is unavailable or vulnerable to seawater intrusion.
4	Develop and implement awareness raising programme on adaptation to the potential impacts of climate change on vulnerable sectors.
5	Promote modern and more efficient irrigation technologies to increase use efficiency
6	Improve crop management programs by changing sowing date, crop density, tillage practices, fertilizer levels, growing season for crop, and enhancing crop specific characteristics (harvest index, photosynthetic efficiency). Make use of accumulated experience by farmers, by collecting and documenting local knowledge as a means to mitigate the impacts of drought.
7	Design and implement watershed management and terrace-rehabilitation programs
8	Restore and preserve mountain forests to reduce soil erosion and peak-flows from intense precipitation events
9	Disseminate flow and flood guidance for stations at main wadis
10	Support alternatives sources for fuel-wood to control woodcutting and preserve plant cover e.g. promote liquefied petroleum gas (LPG) for cooking and solar energy applications for drying, heating, and lighting.
11	Conduct studies and research on the following urgent topics: • Development of agriculture manuals for the different zones of Yemen that include sowing dates • New sowing dates • Utilization of flow-water in the wadis • Climate and other agriculture-related databases • Introduce and expand drought tolerate, and heat- and salinity-resistant crops
12	To compensate water shortage, increase reuse of treated waste water from mosques for irrigation
13	Establish a 'National Research Center' to undertake research on climate change and adaptation issues
14	Develop and implement Integrated Coastal Zone Management programmes

15	Expand green-belts for coastal areas in main land and islands by planting and re-planting mangroves and palms; establish and maintain nurseries that provide cultivars and other materials
16	Develop and implement sustainable land management strategies to combat desertification and land degradation
17	Establish a database for all climate change related issues including adaptation activities.
18	Design and implement training and education programmes for use of efficient, environment friendly fishing techniques and equipment
19	Increase soft protection (e.g., beach nourishment and wetland construction and restoration), and building stone walls to protect from storm surges
20	Construct coastal defense and walls for coastal areas vulnerable to erosion
21	Improve and activate marine fishing regulatory laws, and engage relevant stakeholders and local communities in monitoring the implementation of valid fishing laws
22	Incorporate climate change and adaptation issues into school curriculum

5. List of Priority Adaptation Activities

The identification of the highest national priority projects presented in the previous section was an opportunity to think strategically and more broadly about adaptation activities and how they could be integrated into national planning processes, and how a subset could be prioritized for planning purposes. After subjecting Table 4-1 to the five evaluation criteria, a final ranked set of 12 high priority adaptation activities were developed, as identified in Table 5-1. This list represents the most compelling adaptation options for Yemen, in order of priority. Project profiles for the adaptation options below can be found in Annex 1.

Table 5-1. Summary ranked set of priority adaptation options

1	Develop and implement Integrated Coastal Zone Management programmes
2	Water conservation through reuse of treated waste water and grey water from mosques, and irrigation saving techniques.
3	Develop and implement an awareness raising programme on adaptation to the potential impacts of climate change.
4	Establish and maintain database for climate change and adaptation
5	Planting and re-planting of mangroves and palms for adaptation to projected sea level rise
6	Develop and implement programs to improve Yemen's preparedness to cope with extreme weather events
7	Rainwater harvesting through various techniques including traditional methods..
8	Rehabilitation and maintenance of mountainous terraces.
9	Promotion of research on drought resistant and heat- and salinity- tolerant crops.
10	Design and implement sustainable land management strategies to combat desertification and land degradation
11	Sustainable management of fisheries resources.
12	Incorporation of climate change and adaptation to school education

6. NAPA Preparation Process

The objective of the NAPA process was to build awareness about climate risks, solicit feedback on urgent and immediate needs, and synthesize a wide range of information. In seeking to meet this objective, there were many consultations, workshops, meetings, and roundtables. A brief overview of the process is provided below.

Organization

The NAPA process involved the setup of four primary entities (see Figure below) that constituted the Yemeni NAPA Team, each with each with a unique composition and mandate as follows:

- *National Project Coordination Unit (NPCU):* coordination of all NAPA activities with its secretariat in the EPA; The NPCU, in coordination with the SC, was responsible to establish the Multidisciplinary Integrated Assessment Team;
- *Province Project Coordination Unit (PPCU):* assistance to NPCU in coordination of sub-national stakeholder consultative process outside Sana'a, with its secretariat within regional EPA bureaus. Five PPCUs were established for the eastern, coastal, and northern, desert and islands regions;
- *Steering Committee (SC):* provision of strategic oversight and policy guidance to the NAPA Team; and
- *Multidisciplinary Integrated Assessment Team (MAT):* for undertaking well-defined assessments and analyses on a commissioned basis as the technical support unit of the project. The MAT is the technical support unit of the project.

Activities and Outputs

The NAPA process consists of the following major types of activities:

- *Scoping Activities:* available and pertinent information related to vulnerability and adaptation options were collected, reviewed and synthesized;
- *Consultation Activities:* perspectives on pressing vulnerabilities and promising adaptation options, gathered from those most exposed to climate impacts, were conveyed.
- *Prioritization Activities:* country-driven criteria have been

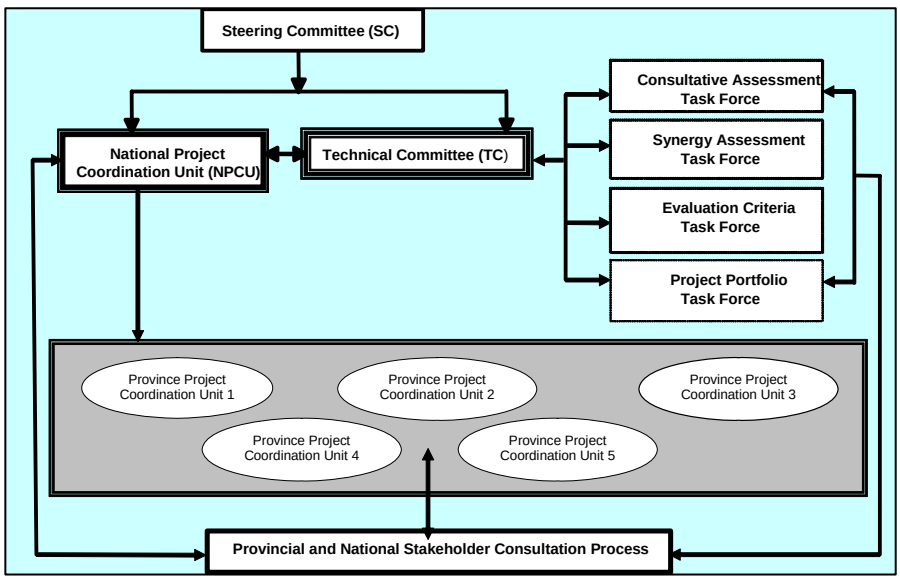

Figure 6-1. Organizational chart for the Yemen NAPA process

applied to prioritize adaptation action.

As part of these activities, the following major types of tasks were pursued:

- *Establishing* a NAPA team to coordinate activities and conduct multidisciplinary assessments;
- *Integrating* a broad range of Yemeni stakeholder perspectives in the NAPA document;
- *Identifying* a comprehensive set of potential climate change adaptation activities based on a review of existing action plans developed to comply with multilateral environmental agreements and other sustainable development initiatives;
- *Developing* country-driven criteria by which to evaluate and prioritize potential climate adaptation activities;
- *Summarizing* a set of consensus-driven set of high priority adaptation activities into a finalized NAPA document and adaptation activity portfolio; and
- *Disseminating* the results of the NAPA process to the Yemeni public

Participatory and Consultative Activities

Yemen NAPA development process was based on participatory planning as recommended by the LEG's 'Annotated Guidelines'. A series of consultations conducted with key stakeholders on local, provincial and national levels were central to the process based on those consultation methodologies that were recommended by NAPA team.

Yemen's NAPA consultative process had several stages in the form of a series of consultation activities, mainly participatory workshops. The objectives of these consultations were to:

- "Groundtruth" the vulnerability synthesis report and multidisciplinary assessment report;
- Refine key vulnerable geographic areas, sectors, and communities;
- Clarify adaptation criteria and priorities;
- Identify, prioritize, and select adaptation activities, and
- Build awareness.

Workshop Programme

The main objective of the workshops was to involve all relevant stakeholder groups at national and local level in NAPA development process, as per the stakeholder analysis conducted earlier to identify all parties that have direct and indirect interests in the development of the NAPA project and its potential impacts. The national and local media, including newspapers, radio and television, also played a key role by reporting regularly on Yemen NAPA consultation workshops.

7. List of References

Abdullatif, Tawfik, 'Climate Change Impacts on Water Resources, Adaptation Measures and Synergy Assessment', July 2005

Al-Aqil, Mansour, 'Climate Change Impacts on Agricultural Crops and Adaptation Options in Yemen', July, 2005

Al-Herrani, Gamal, 'Climate Change Impact and Adaptation on the Marine/Coastal Sector in Yemen', August, 2005

Alsubbary, A., Abu Baker, M., Darwish, A., Abdul Rahim, M. Al-Dhabbi, S. and Al-Safani, M. 2000.Assessment of Potential Impact of Climate Change on Coastal Zone Areas of Yemen. For Initial National Communication, Under United Nation Framework Convention of Climate Change

Annotated guidelines for the preparation of national adaptation programs of action, Least Developed Countries Expert Group, July 2002, http://unfccc.int/adaptation/

Fuad, Ali, 'Environmental Management Practices in Yemen, Overview of activities to be developed', Natural Resources Management Team, UNDP Yemen, 2004

Handbook on methods for climate change impact assessment and adaptation strategies, Jan. F. Fenstra, Ian Burton, Joel B. Smith and Richard J. Tol., version 2, October 1998.

Initial National Communication on climate change, Yemen, 2001

Ministry of Planning and Development (MPD) 1996. Statistical Yearbook, 1995. General Statistical Organization. Sana'a, April 1996.

National Environment Action Plan, NEAP, 1996, Environment Protection Council,

National Water Sector Strategy and Investment Program, 2005-2009 (NWSSIP), Ministry of Water and Environment.

'Poverty and Climate Change - Reducing the Vulnerability of the Poor through Adaptation', www.undp.org/energy/docs/

Putting Climate Change Adaptation in the Development Mainstream, OECD Policy Brief, March, 2006, www.oecd.org/env/cc/bridge

Spanger-Siegfried, Erika and Dougherty, Bill, 2004. *User's Manual: NAPAssess: A Decision*
Support Tool for Use in Yemen NAPA Process, Stockholm Environment Institute, Boston

Center.

User's Guidebook for the Adaptation Policy Framework, February 2004, www.undp.org/cc/whatsnew.htm

Yemen, Millennium Development Goals Report 2003, Ministry of Planning & International Cooperation, 2003.

Annex 1: Project Descriptions of High Priority Projects

This Annex presents a total of twelve projects that have emerged from the NAPA consultative process. They represent the highest priority interventions as determined through a structured multi-criteria assessment process that involved a broad range of stakeholders (see Section 6 for a discussion of the NAPA stakeholder consultation process). Each project is briefly described regarding its rationale, objectives, activities, expected outcomes, implementation arrangements and budget.

PROJECT PROFILE -1

Project Title: Develop and Implement Integrated Coastal Zone Management (ICZM).

Locality: Four locations in the Red Sea and Arabian Sea

Project Sector Field: Marine and coastal areas.

Implementing Agency: EPA and MSBRA

Project cost: The project is estimated to cost US$ 3.2 million.

Sources of Finance: Donor or Funding Agencies.

RATIONALE

The shoreline of the Republic of Yemen extends for more than 2500 km along the Red Sea and Arabian Sea, which includes a large portion of the fertile lowlands and diverse habitats in coastal areas which have great significance in the life cycles of many marine animals. Effective management of coastal resources requires an understanding of the functions of marine and coastal systems, their inter-relationships, and their vulnerability to climate changes. Occurrence and frequency of storm surges is projected to increase as a consequence of climate change in the coastal areas of Yemen.

Coastal zone management is important to guide human development activities in the coastal zone, but is in particular vital to minimize or eliminate pressures imposed on the coastal ecosystems as a result of activities, such as urban development including ports, industrial activities, fisheries, tourism, and construction of buildings and access roads.

ICZM should be based on information gathering, mapping and assessment of potential critical habitats, reflecting the consequences of environmental degradation as a result of human and development activities as well as the impacts of climate change.

OVERALL GOAL:

This project aims to develop and implement comprehensive Integrated Coastal Zone Management Plans for four areas in the coastal line of Yemen in order to strengthen the resistance of the coastal zones to variability and climate change as well as strengthen community livelihood and conserve national marine resources.

OBJECTIVES:

- Identify and design of the Integrated Coastal Zone Management Plans.

- Develop and Implement four management plans in the Red Sea and Arabian Sea.

MAIN ACTIVITIES:

- Carryout a baseline bathymetric and topographic survey of coastlines of interest.
- Conduct training and awareness raising activities.
- Data gathering and analysis (including gap assessment and priority listing) and integration into GIS systems if applicable.
- Revise national regulatory framework for integration of the protection needs of the coastal zones in terms of adaptation to climate variability and climate change
- Installation and rehabilitation of coastal protection systems.
- Develop and implement Coastal Zone Monitoring Program.
- Strengthen capacity building, awareness raising and information exchange.
- Prepare and carryout regular follow-up surveys.

INPUTS

- Trained personnel and coastal engineers.
- Legal and regulatory framework, enforced policies and guidelines.
- Capacity development plans for coastal zone management.
- Data and information.
- Research and training needs.
- Public awareness.
- Community Involvement
- Satellite images
- Adequate fund to undertake activities.

MAIN OUTPUTS:

- Integrated and comprehensive database and related GIS established and functional.
- Comprehensive plans for coastal areas design complete, supportive information, maps and justification for each site developed and adopted by the government.
- Proposals, including budget estimates for all priority areas prepared and implemented.
- Institutional, technical and human resource capacities.
- The following data and measurements are regularly captured and analyzed:

- Topographic data.
- Bathymetric data.
- Nearshore wave measurements.
- Sea water level data.
- Tidal & wave-driven current measurements.
- Meteorological data.

- A baseline bathymetric and topographic survey of coastline.
- Follow-up surveys are performed regularly.
- Access to recorded data through graphs and images for use by coastal engineering consultants and other interested parties are enabled.

IMPLEMENTATION AND INSTITUTIONAL ARRANGEMENTS:

Implementation is the responsibility of Environment Protection Authority, in coordination with Ministry of Planning and International Cooperation, Ministry of Fish Wealth, Marine Science and Biological Research Authority, Maritime Affairs Authority, NGOs, local stakeholders and communities, donors and funding agencies.

RISKS AND BARRIERS:

The main barriers include the following:

- Inadequate resources.
- Lack of legislative framework.
- Weak of technical and institutional capabilities.
- Weak coordination among relevant agencies.
- Insufficient environmental monitoring and assessment capacities.
- Lack of environmental awareness and information base.
- Poor knowledge of relationship between climate change and ICZM.

MONITORING AND EVALUATION: M& E will be done via normal methods of:

1. Progress reports.
2. Technical and financial reports
3. Beneficiary interviews.
4. Socio-economic impact survey.

TIMEFRAME: 4 years

FINANCIAL RESOURCES: The project is estimated to cost US$ 3.2 million.

Activities	**Amount (US$)**
Investment, equipment, conservation and field protection activities.	1,200,000
Data collection and surveys.	200,000
Institutional, technical and human resources capacity building.	400,000
Development of ICZM plans.	600,000
Research, awareness and training needs.	400,000
Project management.	400,000
TOTAL COST	**3,200,000**

PROJECT PROFILE-2

Project Title: Water conservation through reuse of treated waste water and grey water from mosques, and irrigation saving techniques.

Locality: A-Irrigation technology (Dhamar, Lahj and Marib)

B- Reuse of treated waste water (Aden, Hodiedah and Mukalla)

C- Reuse of Grey water from mosques (Taiz, Sana'a and Hajja)

Project Sector Field: Water and agriculture.

Implementing Agency: MWE, EPA and MAI

Project cost: The project is estimated to cost US$ 3.2 million.

Sources of Finance: Donor or Funding Agencies.

RATIONALE

Groundwater levels in Yemen are currently declining in most of the critical aquifers partly due to heavy extraction for irrigation purposes and partly due to inefficient water use practices and technologies. Under warmer climate water depletion would be triggered as a result of higher evaporation rate and fluctuating drought periods. Promotion of modern technologies and practices in improve water use efficiency for agriculture and forestry programs is crucial to protect water resources from depletion and to compensate water losses associated with extreme events of climate change. Reuse of grey-water from mosques effluents for irrigating boulevard trees of streets, the reuse of treated sewage for agro-forestry plantation programs, and the introductions of drip technologies for irrigating water-demanding crops are potential options to improve water use efficiency and to reduced pressure on scarce water resources of Yemen.

OVERALL GOAL:

- To conserve ground water resources used for agriculture through water saving technologies, techniques and practices.
- To eliminate climate change impact on ground water resources

OBJECTIVES:

- To promote water-saving irrigation methods such as drip technique for irrigating crops in pilot areas.
- To reduce the pressure on groundwater resources through the reuse of grey-water of mosques for irrigation of landscapes and boulevard trees of streets.
- To promote reuse of treated wastewater for increasing wetlands areas in pilot costal cities.

ACTIVITIES:

- Conduct research and assessment on current irrigation practices of Yemen.
- Assess existing international technologies on irrigation efficiency and assess the feasibility to transferee the best of which to enhance irrigation efficiency in agriculture.
- Develop criteria and guidelines on the proper, selection, design and use of suitable irrigation techniques for agriculture.
- Develop criteria and guidelines on the proper, selection, design and use of treated wastewater and techniques for agro-forestry programs.
- Develop criteria and guidelines on the proper, selection, design and use of wastewater from effluent of mosques for plantation of cities landscapes and boulevard trees of streets.
- Conduct training programs for farmers in the application of techniques to improve water use efficiency
- Apply the new technology (drip techniques) into different climatic zones (Dhamar, Lahj and Mariib)
- Conduct research and assessment on uses of recycled wastewater for various purposes
- Assess the feasibility study for reusing treated wastewater for increasing wetland areas in three coastal areas (Aden Hodidah and Mukala).
- Provide equipment and build infrastructure and network needed for supplying the selected coastal wetlands with treated wastewater
- Conduct feasibility study for the reuse of grey-water from mosques for irrigating landscapes in three critically water scarce cities (Taiz, Sana'a and Haja).
- Provide the equipment and infrastructure for the reuse of grey-water of mosques for irrigating landscapes of the target cities.
- Assessment of raising public awareness on water wastage and conservation practices and securing public acceptance for land and water resource protection measures to adapt to climate change.
- Monitoring, evaluating and reporting performance progress towards goals.

INPUTS:

The main inputs are:

- Institutional and technical capacity development.
- Equipment and materials
- Research and training needs
- Technology transfer and adoption
- Public awareness
- Farmer's participation

- Financial resources

OUTPUT:

New efficient use of surface and ground water maintained in several pilot areas.

- Training programs for stakeholders in the application of techniques to improve water use efficiency conducted.
- Public awareness on the reuse of wastewater for agriculture agro-forestry programs enhanced.
- Guidelines on the reuse of treated wastewater for irrigation purposes formulated and accessible to end users.
- Guidelines on the use irrigation techniques for agricultures formulated and accessible to farmers.

INSTITUTIONAL ARRANGEMENTS: There are three components under this project:

1- Drip irrigation technology component will be implemented by the Ministry of Agriculture and Irrigation.

2- Reuse of treated waste water, and reuse of grey water from mosques will be implemented by the Environment Protection Authority and Ministry of Water and Environment.

Implementation of all components will be in close coordination with local organizations, farmers, and NGOs.

RISKS AND BARRIERS:

The main barriers include the following:

- Lack of action plan and poor monitoring activities.
- Lack of technical personnel.
- Technological and financial limitations.
- Absence of coordination.
- Low institutional capacities.
- Inadequate financial resources
- Acceptance of farmers for the new technologies and reuse of treated waste water.

MONITORING AND EVALUATION: MWE and EPA will do M& E via normal methods of:

1. Progress reports
2. Technical and financial reports

3. Beneficiary interviews
4. Socio-economic impact survey

TIME FRAMEWORK: 3 years

FINANCIAL RESOURCES: The project is estimated to cost US$ 3.2 million.

BUDGET BREAKDOWN

Activities	**Cost USD**
Research and feasibility study to transferee the drip technology for enhancing irrigation efficiency in agriculture.	100,000
Provision and introduction of drip techniques into three climatic zones	700,000
Feasibility study for reusing treated wastewater for wetlands.	80,000
Equipment, infrastructure and network for supplying treated wastewater to coastal wetlands	600,000
Feasibility study for the reuse grey-water of mosques for irrigating purposes.	60,000
Equipment and infrastructure for the reuse grey-water of mosques for irrigating landscapes of the target cities.	900,000
Awareness and training programs for the application of techniques to improve water use efficiency	300,000
Develop criteria and guidelines	60,000
Management and operation coast	400,000
Total	**3,200,000**

PROJECT PROFILE-3

Project Title: Awareness Raising on Adaptation to Climate Changes.

Project Type: Public Awareness

Implementing Agency: EPA in coordination with MWE, CAMA, research institutions, universities, local communities, NGOs and all relevant institutions.

Project cost: The project is estimated to cost US$ 650,000

Sources of Finance: Donor and funding Agencies

RATIONALE

It is generally agreed in Yemen that awareness over climates issues among different groups of society is by far insufficient to mobilize community and government efforts towards climate change induced issues. In particular, government agencies, NGO's and local communities efforts up till now are non-existing or under resourced to respond to climate change issues especially in the highly vulnerable areas, agriculture, water and costal zone.

As long as this situation remains so, climate change concerns will remain out of the government and society interest while planning development plan and policies for both national and local levels. Furthermore, local community impacts will remain unabated causing more stress on the three sectors vulnerable to climate change impacts.

Specific need in this regards is to launch a nation-wide awareness campaign on climate change issues to address causes, impacts, responses an adaptation needs for the most vulnerable areas (agriculture, water and costal zone).

The campaign will be targeted to government policy makers, non-governmental organizations, media men, and local communities. The aim of the campaigns is to increase understanding of and knowledge of climate change issues among target groups utilizing number of awareness tools, including awareness campaigns, TV, radio mass and press programs, community workshops, fact sheets and brochures production, electronic information and other communication materials etc..

OVERALL GOAL:

Promote community-based participatory planning and management of climate change issues at local levels through enhanced public awareness.

OBJECTIVES:

1. *Promote public awareness on various aspects of climate change issues including adaptation through awareness campaigns, TV, radio mass and*

press campaigns, community oriented workshops, fact sheets, posters and brochures production, electronic information and other communication materials.

2. *Expansion of awareness of youth organizations to cover climate change issues*
3. *Improve professional skills of teachers and university lecturers in producing and disseminating awareness materials on climate change issues.*

MAIN OUTPUTS:

- *Greater public role in planning, executing and monitoring of climate change issues at community levels.*
- *Awareness on climate change impacts and adaptation of the target sectors enhanced among policy makers, NGOs, youth clubs, and local communities*
- *Increased awareness of local governments on the interrelationship of climate change issues with other activities.*
- *Climate change unit within EPA adequately strengthened and supported with necessary information and technology equipment plus adequate skilled staff to produce and disseminate awareness materials on climate change issue on sustainable basis.*
- *Targeted campaigns on key climate change issues completed*
- *Awareness and training workshops held for target groups in the most vulnerable areas.*
- *Audio-visual materials (e.g. posters, TV spots, radio programmes, documentaries, newspaper articles) produced and disseminated to target groups for the vulnerable areas*

MAIN ACTIVITIES:

- Design and launch public information and mass media campaigns
- Provide training for policy makers, NGOs & local communities in the vulnerable sectors (specific target groups may include agricultural and coastal communities, framers, fishermen, members of local councils and parliament, high level government employees in the three vulnerable sectors , environmental experts, media workers, artists, school children, and politicians etc...
- Provide training for media men and environmental staff on various climate change issues
- Program development for written media
- Production of educational/awareness materials, extension materials, learning modules and programs for the target areas
- Mobilize key stakeholder e.g. community leaders, religious and political leaders, NGOs and local community to support integration of climate change issues into national and local environmental strategies and plans.
- Production and broadcasting of (audio-)visual awareness material by local and central TVs and Radios
- Integrate climate change issues in the activities of school clubs

INPUTS

- National consultants and media experts
- Awareness workshops.
- Capacity building of local staff.
- Information & technology equipment & visual- audio equipment.
- Mass Media.
- Public awareness materials.
- Community partnership.

INSTITUTIONAL ARRANGEMENTS:

Implementation is the responsibility of Environment Protection Authority in coordination with MWE, CAMA, NGOs, local stakeholders and communities, , Donors/Funding Agencies.

RISKS AND BARRIERS:

- Inadequate financial resources.
- Weak technical and institutional capabilities
- Weak coordination among relevant agencies.
- Absence of environmental monitoring and assessment capacities.
- Low participation of local communities and target groups

MONITORING AND EVALUATION: M& E will be done via normal methods of:

- Progress reports
- Technical and financial reports
- Beneficiary interviews
- Socio-economic impact survey.

TIMEFRAME: *2 years*

FINANCIAL RESOURCES: The project is estimated to cost US$ 650,000

Activities	**Amount– US$**
Training workshops for policy makers, NGOs Stockholders in the vulnerable sectors	50,000
Programs development for written media	50,000
Production of educational/awareness materials, extension materials, learning modules and programs for the target areas	100,000
Provide training for media men and environmental staff on various climate change issues	50,000

Stockholders and community workshops to integrate climate change issues into national and local environmental strategies and plans.	100,000
Production and broadcasting of (audio-)visual awareness material by local and central TVs and Radios	100,000
Conduct climate change related activities at school clubs	50,000
Management and coordination	150,000
Total	**650,000**

PROJECT PROFILE - 4

Title: Establishment and Maintaining of Climate Change Database

Locality: Sana'a

Project sector field: Crosscutting

Implementing agency: Environment Protection Authority in coordination with CAMA and all relevant institutions

Project cost: The project is estimated to cost US$ 350,000

Sources of Finance: Donor or Funding Agencies.

RATIONALE:

The implications of climate change and its adverse impacts on people and their means of life and livelihood require tremendous efforts and actions to be undertaken at local, national, regional and international level. The availability and accessibility of climate change related information is the essential element to know, to deal with the consequences of climate impacts, and to conduct adaptation activities. In Yemen, there are a lot of information and reports relevant to climate change, but they are scattered in different places and not accessible in most of the cases. This situation makes it quite difficult and challenging to inform people and make them aware on how to deal and adopt the appropriate responses to climate change.

Establishment of climate change data base is essential to facilitate information sharing and accessibility to national data, and to create links to the regional and international sources of information.

Objectives:

1. To establish an accessible database for climate change.
2. To strengthen the country capacity to aggregate, analyze, and disseminate climate change information.
3. To improve capacity in producing and interpreting climate modeling and scenarios.

Activities:

- Procurement of materials, hardware and software including GIS system
- Training on data collection, analysis and dissemination
- Collection of relevant data and information
- Establishment of the database
- Create links to national, regional and international data sources
- Documentation of climate extreme events, review and update data
- Developing and preparing reports on climate change related activities

Inputs:

- Data and information
- Equipment
- Training and capacity building
- Financial resources

Outputs

- Accessible data source
- Availability of data in different forms including tables, maps, charts etc.
- Increased knowledge and awareness on climate change and adaptation
- Capacities on research and information sharing strengthened
- Periodical reports on the status of climate change and related activities are prepared.

Risks And Barriers: The main barriers include the following:

- Inadequate resources
- Lack of technical knowledge on data analysis and dissemination
- Lack of resources to maintain the database
- Weak coordination between parties concerned.

TIME FRAMEWORK: 2 years

FINANCIAL RESOURCES: The project is estimated to cost US$ 350,000

BUDGET BREAKDOWN

Activities	**Cost US$**
Data collection and analysis	80,000
Hardware and software	100,000
Training and capacity building	30,000
Developing and production of materials including maps, charts and reports.	40,000
Reviewing, maintaining and updating of information	20,000
Project management and operation	80,000
TOTAL COST	**350,000**

PROJECT PROFILE - 5

Project Title: Planting and re-planting of mangroves and palms for adaptation to sea level rise.

Locality: Three pilot areas (Red Sea and Arabian Sea including islands)

Project Sector Field: Marine and coastal areas

Implementing Agency: EPA, MAI and MFW

Project cost: The project is estimated to cost US$ 2.45 million.

Sources of Finance: Donor or Funding Agencies.

RATIONALE

Climate change vulnerability and adaptation studies in Yemen show that Yemen coastal areas are vulnerable to storm flooding associated with increased shoreline erosion as a result of sea level rise. This potential flooding, increase of shoreline erosion would in turn lead to inundation of coastal wetlands, increased salinity of estuaries and aquifers in addition to destruction of coastal infrastructure. While mangrove forests play an important and essential role for shoreline stabilization, prevention of seawater intrusion and providing protection to the vulnerable coastal areas, they have been degraded due to extraction by local communities as a source of firewood.

To adapt to the potential impacts of climate change on Yemen's costal areas, estuaries, aquifers and agricultural farms, this project is prepared with aim to enhance the adaptive capacity of such ecosystems through number of conservation and adaptation measures including restoration and conservation of mangrove forests, preserving existing sand dunes, establishment of green belts and buffer zones through planting and replanting of mangroves and palms , and rehabilitation of diminished wetlands and degraded sand dunes.

OVERALL GOAL:

Conservation of coastal zone ecosystems, and strengthening of adaptive capacities of vulnerable coastal areas.

OBJECTIVES:

- To protect coastal wetlands, estuaries, aquifers and infrastructure from potential saline water intrusion, coastal flooding and sea level rise associated with climate change.

- Restoration and conservation of mangrove forests and wetlands, preservation of sand dunes, and establishing green belts at critical areas.

MAIN OUTPUTS:

- Data information system strengthened and functional to support the conservation of the sensitive areas under climate change .
- Establishment of nurseries .
- Rehabilitation and restoration of mangrove forests.
- Degraded sand dunes and wetlands preserved and restored.
- Green belts on coastal areas are expanded.

MAIN ACTIVITIES:

- Identify potential local communities and stakeholders for the implementation of project activities.
- Conducts training, capacity building, and awareness activities on nursery, planting and replanting of mangrove.
- Establish nurseries to provide that provide cultivars and other planting materials.
- Establish green belts through planting mangrove, palms, and native coastal species.
- Restore diminished wetlands and create new ones where applicable.
- Encourage and support dune restoration efforts (dune fencing, re-vegetation, sand nourishment, etc.)
- Training and capacity building
- Conduct awareness raising activities.

INPUTS

- Adequate fund to undertake activities.
- Trained personnel and coastal engineers.
- Legal and regulatory framework, enforced policies and guidelines.
- Research, training and capacity development needs.
- Public awareness.
- Community Involvement.

INSTITUTIONAL ARRANGEMENTS: The project will be implemented by the Environment Protection Authority in collaboration with Ministry of Agriculture and Irrigation, Ministry of Fish Wealth, Ministry of Water and Environment, local authorities and NGOs.

RISKS AND BARRIERS: The main barriers include the following:

- Land ownership and tenure issues.
- Inadequate financial resources.

- Weak technical and institutional capabilities.
- Weak coordination among relevant agencies.
- Inadequate participation of local communities.

MONITORING AND EVALUATION: M& E will be done via normal methods of:
- Progress reports
- Technical and financial reports
- Beneficiary interviews
- Socio-economic impact survey.

TIMEFRAME: 5 years

FINANCIAL RESOURCES: The project is estimated to cost US$ 2.45 million.

Activities	**Amount (US$)**
Equipment	200,000
Establishment of nurseries	400,000
Wetlands restoration, planting and rehabilitation of mangrove forests	800,000
Coastal defense for areas subjected to erosion, and sand dune restoration	600,000
Training, capacity building and awareness	200,000
Management	250,000
TOTAL COST	**2,450,000**

PROJECT PROFILE - 6

Project Title: Develop and implement programs to improve Yemen's preparedness to cope with extreme weather events**.**

Implementing Agency: Civil Aviation and Meteorological Authority

Project cost: The project is estimated to cost US$ 5 million.

Sources of Finance: Donor and Funding Agencies.

RATIONALE

Climate-related floods and droughts pose a serious threat to national economies and sustainable development. Over the past decade, Yemen has faced frequent flash floods resulting in wide spread loss of agricultural lands, loss of life and livestock in addition to destruction of country infrastructure and telecommunication facilities. On the other hand the successive droughts of the last decades have negatively impacted groundwater recharge and aggravated desertification causing further loss of agricultural land. Under warmer climate the intensity and frequency of droughts and flash floods is likely to increase, causing more threats to the country population and natural resources.

To minimize impacts of such extreme events on vulnerable sectors and communities, there is a need to develop risks management adaptive capacity for Yemen through establishment of modern weather prediction and warning system to provide vulnerable sectors and communities with the necessary information for the rescue of people life and their properties.

Without the appropriate systems in place, the impacts of climate change on vulnerable sectors and communities would unpredictable and , eventually, the ability the national and community to prevent and mitigate the adverse impacts of this climate features would most difficult. Therefore, the purpose of this project is to put such a system in place with aim to provide the community with precise information needed for the safety and security of their life and properties.

OVERALL GOAL:

To predict and prevent the potential effects of climate variability and extreme weather events (drought and flashflood) on Yemeni people, and to strengthen the nation's adaptive capacity to cope with such events.

OBJECTIVES:

1. To improve climate change monitoring by developing and strengthening adequate automated networks of meteorological observations for recording weather elements needed for impact assessment on water, agriculture, and marine resources.
2. To develop and strengthen satellite-based early warning system and weather radar system for predicting extreme weather events on timely manner.
3. To develop and strengthen the nation's preparedness capacity for safeguarding vulnerable communities through telecommunication system for timely exchange of meteorological and climate information with various data end-user nationally and internationally.
4. To promote awareness of climatic variability and the potential risk of climate change at all levels through enhanced scientific research, curricula development and awareness materials addressing climate change issues.
5. To improve individual capacity in producing and interpreting climate modeling and scenarios and in operation and maintenance of new technology in data collection, processing archiving and retrieval, including maintenance of radar and other metrological equipment

MAIN ACTIVITIES:

- Procurement of the necessary automatic weather stations, hardware and software to upgrade national climate observation systems.
- Installing modern telecommunication system for exchanging meteorological information
- Suggest framework for integrating climate aspects into Yemen educational system at schools and universities
- Studying climate variability and their impact on the long-term.
- Upgrade the facilities of national weather forecasting center to enhance the center capacity in predicting weather, flood and sea level rise etc. this requires to equip the center with appropriate research infrastructure, including early warning supported with Radar system satellite-based data dissemination system, networking system, and provision of climate models to simulate climate change and climate scenarios.
- Upgrade and expand national network of metrological observation to cover needs of all socio-economic areas. This requires automated stations to observe all weather elements.
- Procurement of GIS facilities and produce zoning for drought and flood areas
- Capacity building to empower local staff capacity in use of technology introduced to the National forecasting center
- Production and dissemination of awareness materials addressing climate change issues.

- Procurement of equipment and hardware for improving information sharing with local community, policy makers, media and national and regional telecommunication centers.

INPUTS: Inputs include technical and financial assistance, equipment and institutional support.

MAIN OUTPUTS:

- A modern forecasting and warning weather system introduced and operational .
- A computerized and automated national climate observation network established and functional.
- Climate change impacts and adaptation assessments integrated into national and development plans.
- Policy makers in education system fully aware and ready to integrate Climate change issues into the country educational system
- Policy makers, communities and media men fully aware on need and preparedness for managing risks of climate change issues
- Mapping of drought and flood areas developed and accessible by interested bodies.
- Sharing information among government, business sector and civil society on observed and potential climate change impacts and extreme events.
- New and effective telecommunication system for exchanging meteorological information established and functioning very well

IMPLEMENTATION, INSTITUTIONAL ARRANGEMENTS:

The lead institution in the implementation of this project will be the Civil Aviation and Meteorological Authority in collaboration with Ministry of Water and Environment, Environment Protection Authority, Ministry of Planning and International Cooperation, Ministry of Agriculture and irrigation, Yemen Academic Institutions, local stakeholders and communities, NGOs, and Donors/Funding Agencies.

RISKS AND BARRIERS:

- Long-term maintenance of equipment or technical tools procured through external assistance is difficult and expensive and there might not be a budget allocation for this purpose.
- Limited access to information relating to inputs for use in the early warning systems such as expensive satellite and GIS products.
- High training costs.
- Availability of the required skilled human resources.
- Lack of coordination.
- Resources to undertake the planned activities may not be adequate.

- Poor knowledge of the relationship between climate change and risk management at decision makers.

MONITORING AND EVALUATION:

Monitoring and evaluation will be done by donors and stakeholders based on regular reporting to be prepared by project management. Project manager will be responsible for developing on quarterly basis the following types of reports.

- Periodical reports
- Technical and financial reports

TIME FRAMEWORK: 4 years

The project is estimated to cost US$ 5 million.

BUDGET BREAKDOWN

Activities	**Cost USD**
A modern forecasting and warning weather system, including installation of infra-red weather radar, high-resolution Satellite imagery, Automated climate stations, telemetric rainfall and river gauges and weather radio frequencies for pubic and mariners	4,000,000
Climate research and studies	200.000
Guideline and materials for integrate Climate change issues into the country education	50,000
Awareness materials on climate change issue targeted to various groups	50,000
GIS system and mapping of drought and flood areas	100,000
Telecommunication equipment and networking software	200,000
Capacity building: Train staff to operate and maintain all newly established system, including development of climate models	200,000
Management and operation cost	200,000
Total	**5,000,000**

PROJECT PROFILE - 7

Project Title: Rainwater harvesting through various techniques including traditional methods**.**

Locality: Haggah , Taiz and Almahwit Governorates.

Project Sector Field: Water and Agriculture.

Implementing Agency: MWE/EPA/MAI

Project cost: The project is estimated to cost US$ 2.81 million.

Sources of Finance: Donor or Funding Agencies.

RATIONALE

The location of Yemen in one of the most dry regions reflects the challenges of water scarcity problems the country is facing. Persistence drought as a result of changing climate becomes a common phenomenon in Yemen where the majority of population lives in rural areas and depends primarily on rain fed agriculture.

Due to the frequent increase of such climate extreme events, Yemeni people will severely suffer from scarcity of water for agriculture irrigation as well as for other domestic uses .

Farmers in Yemen have been and continuous trying to find all possible means based on their own traditional knowledge to harvest and store rainwater in order to compensate water shortages during the dry seasons to safeguard crops from failure and loss of animal productivity.

OVERALL GOAL:

The overall goal of this project is to safeguard farmers from water shortages and to get sufficient water to maintain their agricultural production during dry periods

OBJECTIVES:

- To maintain agricultural production during dry periods.
- To improve animal productivity and standard of life of farmers.

ACTIVITIES:

- Assessment of existing traditional knowledge and practices on rainwater harvesting.
- Conduct surveys to collect all required information and data, and visibility study to identify areas suitable for rainwater harvesting .
- Develop criteria for selection of the appropriate pilot areas.
- Select the most applicable rainwater harvesting techniques including the traditional ones.
- Design and implement extension and awareness raising activities.

- Training farmers on construction and maintenance of selected techniques and optimum use of harvested rainwater.
- Construction of rainwater harvesting systems.
- Monitoring activities

INPUTS:

- Technical expertise
- Training and awareness programme
- Farmer's participation and traditional knowledge
- Financial resources

OUTPUT:

- Ensure availability of water for farmers during dry periods.
- Increased awareness on rainwater harvesting among farmers.
- Maintaining agriculture production and improve animal productivity
- Improved life standard of farmers and rural communities.
- Improved food security.

INSTITUTIONAL ARRANGEMENTS: The project will be implemented by the MWE, EPA and MAI in collaboration with farmers, local authorities.

RISKS AND BARRIERS:

- Rainwater harvesting may fail during dry seasons,.
- Low participation and lack of interest of farmers.
- Lack of coordination between relevant institutions and farmers.
- Inadequate financial resources.

MONITORING AND EVALUATION: M& E will be done through:

- Progress, technical and financial reports.
- Beneficiary interviews.
- Socio-economic impact survey.

TIME FRAMEWORK: 3 years

FINANCIAL RESOURCES: The project is estimated to cost US$ 2.81 million.

BUDGET BREAKDOWN

7.1. Activities	**Cost USD**
Assessment of exiting knowledge	50,000
Conduct surveys and visibility study	200,000
Develop selection criteria	20,000
Design and implement extension and awareness programmes	80,000
Technical training	60,000

Construction of rainwater harvesting systems	2,200,000
Project management	200,000
TOTAL COST	**2,810,000**

PROJECT PROFILE - 8

Project Title: Rehabilitation and maintenance of mountainous terraces.

Locality: Almahweet, Taiz, Haja, Ibb and Dhamar

Project Sector Field: Agriculture and Land Resources.

Implementing Agency: MAI

Project cost: The project is estimated to cost US$ 4.78 million.

Sources of Finance: Donor or Funding Agencies.

Rationale

The hillside terraces systems in Yemen represent 450,000 ha in area, constituted a national heritage to environmental sustainability and food security in years past. The terrace systems have developed in response to rainfall patterns and rainfall uncertainties and provide optional soil and water management in dry, mountainous terrain. During the last 30 years, social and economic changes have resulted in changing farming and grazing practices and in rapidly expanding urban areas. Recently, Yemen terraces are being drastically reduced by rapid degradation of the environment as a direct result of desertification and droughts. These phenomena have increased drastically in Yemen and threaten about 90% of the land and can be attributed to the following:

a) Cultivation and poor agricultural practices.

b) Wood cutting for firewood, timber and charcoal.

c) Over grazing.

d) Soil salinity

e) Wind erosion and sand dune encroachment.

f) Construction expansion in cities and villages.

Under warmer climate these features will be aggravated causing more stress on fragile terraces lands. One of the potential climate thereat concluded by Yemen's vulnerability study is triggering water erosion which would result in destruction of woody vegetation, increasing land erosion and thus widespread soil erosion and sand encroachment, deforestation, agricultural and rangeland deterioration, and loss of farmland.

The purpose of this project is therefore to address adverse impact of potential climate change and to maintain land productive through trough integrated watershed management system, and through the introduction fruit trees in terraces, the construction of small dams and water reservoirs for irrigation for

the cultivation of cash crops in terraces located downstream from the water constructions in the highlands.

Overall Goal:

To conserve Yemen's terraces through protection measures dedicated for projected triggered soil erosion and increased floods associated with climate change.

Objectives:

- To reduce soil erosion through rehabilitation of critically degraded terraces land in two pilot areas of Yemen highlands (Haja'a , Al Mahweet, Taiz, Ebb and Dhamar).
- To stabilize terraces through increased rangelands, increase area of wood cover, and introduction of fruit trees and cash crops in replacement of food crops of low returns.
- To rehabilitate terraces and rangeland and improve productivity of native species and range management

Main Outputs:

- Database of soil is updated.
- Immigration from affected areas slowed down because of new job opportunities generated.
- Living standards of local residents improved.
- Terraces will become of economic value due to the high return of farming and cultivation of cash crops.
- Watershed management, soil stabilization and erosion control are improved

Main Activities

- Identification of the physical and chemical characteristics of soil and its classification in pilot areas highlands.
- Identification of the current land uses in the selected areas.
- Assessment of the current cultivation practices of traditional food crops and conduct cost benefit analysis of the prevailing cropping systems.
- Assessment of the availability of traditional and or modern water constructions.
- Survey and inventory land vegetation and rangelands in the pilot areas.
- Increasing wood cover and rangelands areas to stabilize terraces in the targeted areas.

- Introduction of integrated watershed management approach in the management of terraces in the target areas.
- Rehabilitation and maintenance of a number of critically degraded agricultural terraces in the pilot areas.
- Construction of small scale dams and water reservoirs in the highlands and downstream where feasible
- Interpreting satellite images of the study area to produce the different thematic maps (soil, land use, land degradation, vegetation and so on) at scale of 1:100,000.

Inputs

- Qualified persons and expertise
- Training programs
- Equipment, Technology transfer and adoption
- Research activities and training programs
- Institutional and technical capacity development.
- Public awareness
- Communities participation

Risks and barriers: The main barriers include the following:

- Poor monitoring activities.
- Low awareness and technical levels.
- Lack of coordination.
- Lack of necessary resources and institutional capacity.
- Lack of active policies
- Failure to develop and implement plans
- Failure to integrate with related national plans.

Monitoring and evaluation:

Monitoring and evaluation (M & E) will be done in close cooperation with the Ministry of Agriculture and Irrigation (MOAI) e.g. the Forestry Department and the Agricultural Research and Extension Authority (AREA),The local councils in the Governorates and Districts in the targeted areas could also play effective role.

M& E will be done via normal methods of:

- Progress reports
- Technical and financial reports
- Beneficiary interviews.
- Socio-economic impact survey

Timeframe: 5 Years.

Financial resources: The project is estimated to cost US$ 4.78 million.

Project Budget

Activities	Amount (US $)
Revise and update the National Plan for sustainable land management.	500,000
Develop guidelines for integrating climate information and disaster preparedness into land use plans.	30,000
Conduct soil surveys	300,000
Assessment of current cultivation practices and land uses, and survey of vegetation cover	300,000
Introducing wood cover and fruit tress to stabilize terraces.	600,000
Rehabilitation and maintenance of number of critically degraded agricultural terraces	1,200,000
Construction of small scale dams and water reservoirs in the highlands and downstream where feasible	900,000
Monitoring land use and land degradation.	300,000
Research and training programs	250,000
Capacity building and awareness	150,000
Management	250,000
TOTAL COST	**4,780,000**

PROJECT PROFILE - 9

Title: Promotion of research on drought, heat and salinity tolerant varieties

Type of project: Research

Locality: Dhamar, Marib, Ibb and Seyoun

Project sector field: Agriculture and land resources

Implementing agency: Agricultural Research Institutions within the MAI and Universities, in coordination with MWE, EPA, Ministry of Agriculture and Irrigation, NGOs and other research centers

Project cost: The project is estimated to cost US$ 3.15 million.

Sources of Finance: Donor and Funding Agencies.

Rationale

As identified by Yemen vulnerability studies, crop production in four areas of studies (Dhamar, Marib, Ibb and Seyoun) are projected to decrease as a result of several changes in the precipitation patterns, shift of climatic zones, increased floods, droughts, higher temperature and increased salinity. This will lead to decrease of crop production and eventually to food shortages. This situation makes it essential to develop and disseminate new types and varieties of crops to resist and tolerate the potential impacts of climate change including droughts, heat and salinity.

The purpose of this project is to assist farmers to safeguard their crop production through new varieties of crops which have proven their ability to tolerate drought heat and salinity.

Overall Goal

To increase and maintain agriculture productivity under projected climate changes

Objectives

- To increase agricultural productivity so as to improve living standards and sustainable livelihoods of vulnerable rural communities.
- To develop and disseminate new varieties of crops such as wheat, maize, potatoes and sorghum etc, to tolerate saline and drought conditions.

Main Outputs

- New varieties of salt, drought and flood tolerant crops produced and made available to the framers.
- Dissemination of the new varieties to the vulnerable areas .

- Local communities and farmer's involvement and knowledge on climate change issues increased.
- GIS compatible soil, climate and farming database for the definition and characterization of environmental aspects under which crops are produced generated and disseminated.

Main activities

- Mapping out vulnerable areas and identifying drought tolerant crops.
- Assess opportunities to improve crops production techniques and climate change impact on crop production.
- Classify and comprehensively describe the various crops with special emphasis on rain fed agriculture.
- Conduct studies and research targeted for identification of the following immediate topics under warmer climate:
  - ❖ Prepare agriculture manuals and calendars including sowing dates for at least three crops in four pilot areas representative of various future climate zones of Yemen
  - ❖ Identification of drought-resistant crops appropriate for cultivation in the selected four pilot areas.
  - ❖ Identification of the precipitation patterns and new mapping of climatic zones under warmer climate.
- Studies to identify crop management patterns, techniques and practices through changing sowing date, crop density, tillage practices, fertilizer levels, growing seasons of crops, making use of accumulated experience by farmers, collection and documentation of their local knowledge and experience, improving crop specific characteristics (harvest index, photosynthetic efficiency) and assess the new techniques impact
- Test and apply recommended techniques where appropriate
- Identify and introduce types of crops suitable to withstand the temporal and spatial climate shifting.
- Collect additional soil, climate, farming and production data to upgrade and complete existing GIS needed by research institutions.
- Monitoring of technology transfer and adoption of modern techniques to adapt to climate change
- Establishment of nurseries

Inputs

- Laboratory facilities
- Studies, research and extension services.
- Vulnerability assessment.
- Mapping and land survey.
- Technical training.
- Project management.

- Extension services

RISKS AND BARRIERS: The main barriers include the following:

- Lack of resources
- Uncertainty of research results to develop new varieties
- Lack of technical knowledge
- Possibility of weak coordination between parties concerned.
- Potential for further disease and insect pest outbreaks if appropriate control measures are not put in place.

TIME FRAMEWORK: 4 years

FINANCIAL RESOURCES: The project is estimated to cost US$ 3,15 million.

BUDGET BREAKDOWN

Activities	**Cost US$**
Laboratory facilities (hardware and human resources) for the main crop research institutes in the country	1,000,000
Studies, research and extension services	1,500,000
Vulnerability assessment	50,000
Mapping and land survey	100,000
Technical training and awareness	100,000
Project management	300,000
Establishment of nurseries and provision of extension services	200,000
TOTAL COST	**3,150,000**

PROJECT PROFILE - 10

Project Title: Sustainable land management to combat desertification and land degradation

Locality: Mareb and Tihama

Project Sector Field: Agriculture and Land Resources.

Implementing Agency: MAI

Project cost: The project is estimated to cost US$ 2.33 million.

Sources of Finance: Donor and Funding Agencies.

RATIONALE

Desertification of the land is gaining in momentum and water erosion has become a major problem throughout Yemen; it is integrally linked with land use and the gradual collapse of the upland terrace systems. This leads to further land development incursions upstream, which reduce the vegetative cover, and accentuates the consequences both on the terraced agriculture and further downstream. this is probably the most dangerous aspect of this form of erosion because it is not only affects the areas victim of mismanagement but it initiates a wadi flash floods causing destruction of economically and ecologically viable lower terraces and wadi agriculture downstream, affecting production system. Wind erosion is the other form of problem that affects particularly the coastal plains where we are again witnessing aggravated loss of productive land affecting the whole production system of the coastal plains.

The collapse of various production systems results in poverty expansion. Climate change impacts in terms of drought and extreme weather events are serious and often critical in Yemen where agricultural land is limited, holding per family remain small, rainfall and surface water flows are erratic and groundwater is being overexploited and used inefficiently. The desire to deal with the problems comes at a critical point in the future of the country.

OVERALL GOAL:

The overall objective of the project is to demonstrate in pilot areas a successful and transferable for combating desertification in the mountainous areas and lower-lands rangelands through integrated management of natural resources with focus on water and vegetative cover including using low quality water in dryer environments.

OBJECTIVES:

- To enhanced native vegetative cover and biodiversity.
- To reduce floods impact economically and ecologically viable lower terraces and wadi agriculture downstream through integrated watershed

management, and construction of small dams and water reservoirs in the highlands and downstream where feasible

- To integrated macro-and micro-catchments for water harvesting within the existing land use system.
- To introduce an appropriate plant species, salt tolerant and cultural practices suitable for the prevailing environment and water available.

MAIN ACTIVITIES:

- Collect data and establish database for desertification and natural resources at national level.
- Revise and update the National Desertification Strategy and the National Plan to combat Desertification.
- Agro-ecological characterization of the pilot site to enhance transferability and compatibility of technologies between pilot areas and other areas.
- Conducting workshops and meetings including all parties for designing and planning the intervention in each of the pilot sites.
- Awareness and capacity building and institutional strengthening of national institutes and community leaders on degradation processes.
- Compilation of database on existing resources (e.g. climate, and land use, production, degradation, institutions etc...).
- Analysis of current status of land degradation in the pilot areas. Plan, design and construct of maintain water and soil conservation measures at selected locations in the pilot areas.
- Introduce appropriate plant material in association with water, soil and management practices.
- Verification and testing of rehabilitation measures in degraded parts of the pilot project.
- Determining the rangeland carrying capacity, the appropriate range grazing system for the development of intensive rangeland areas and the appropriation of supplementary feeding for each range system.
- Evaluate positive and negative environmental indicators overtime in the pilot area using remote sensing and geographic information system (GIS) techniques supported by field observations.
- Establishing plantation of selected plants species including forage shrubs, wood, and shade and industrial plant species.
- Verify the test of different interplaying measures to help sand fixation and improve soil quality.

INPUTS

- National and comprehensive approach in combating desertification.
- Technology transfer and adoption
- Research activities and training programs
- Institutional and technical capacity development.
- Public awareness

- Community participation

MAIN OUTPUTS:

- Assessment of current status of land degradation in pilot areas including wind and water erosion conducted.
- Demonstrations and successful measures and technologies based on indigenous knowledge and modern science are implemented.
- Guidelines and recommendations for the optimal management of natural resources to reduce land degradation in the target environments are prepared.
- Better awareness and understanding of the public and decision maker of the causes and processes of land degradation and the efforts needed to combat it.
- Improved status of natural vegetation cover.
- Methodologies and technologies to enhance land productivity are introduced.
- Proven water and soil conservation technologies practices under the conditions prevailing in the mountainous areas are implemented.
- Range areas within the pilot area rehabilitated with improved vegetation cover and having degradation reduced.
- Salt tolerant plant species with focus on forage shrubs, wood, trees and industrial crops are selected, planted and monitored in the pilot areas using appropriate irrigation.
- Recommended packages of improved soil and water management those are suitable for the selected sites implemented, evaluated and transferred to similar areas.

INSTITUTIONAL ARRANGEMENTS:

This program will be implemented in senergy with the framework of the Convention to Combat Desertification (CCD). All activities will be implemented in close cooperation with the Ministry of Agriculture and Irrigation (MOI), Agricultural Research and Extension Authority (AREA), MWE, private sector,, local organizations, farmers, NGOs, national policymakers and donors.

RISKS AND BARRIERS: The main barriers include the following:

- Poor monitoring activities.
- Low awareness and technical levels.
- Lack of coordination.
- Inadequate resources and institutional capacity.
- Lack of active policies

- Failure to integrate with related national plans.

MONITORING AND EVALUATION:

M& E will be done via normal methods of:

- Progress reports
- Technical and financial reports
- Beneficiary interviews.
- Socio-economic impact survey

TIMEFRAME: 3 Years

FINANCIAL RESOURCES: The project is estimated to cost US$ 2.33 million.

PROJECT BUDGET

Activities	**Amount (US $)**
Revise and update the National Desertification Strategy and the National Plan to combat Desertification.	50,000
Collect data and establish database for desertification and natural resources.	40,000
Conducting workshops and meetings including all parties for designing and planning the intervention in each of the pilot sites.	40,000
Awareness and capacity building and institutional strengthening	50,000
Analysis of current status of land degradation in the pilot areas	70,000
Design, develop and implement water and soil conservation measures, and introduce appropriate plant material.	400,000
Verification and testing of different interplaying measures to help sand fixation and improve soil quality, and rehabilitation measures in degraded parts	800,000
Monitoring land use and land degradation	150,000

Research and training programs	300,000
Capacity building and awareness	200,000
Management and operation cost	230,000
TOTAL COST	**2,330,000**

PROJECT PROFILE - 11

Project Title: Sustainable management of fisheries resources

Locality: Marine and Coastal areas.

Project Sector Field: Fisheries and Marine Resources.

Executing Agency: Ministry of Fish Wealth/ MSBRA

Project cost: The project is estimated to cost US$ 1.18 million.

Sources of Finance: Donor or Funding Agencies.

RATIONALE

Fisheries are economically important to Yemen, which has quite long coastline with a group of offshore islands (nearly about 185 Islands) and large offshore economic zone.

Fishing is the main source of employment and income generation in the coastal areas and has high potential to contribute to poverty alleviation. Fish has become an increasingly important source of protein nutrition, contributing substantially to local food security.

There are two identified main categories of climate change impacts on fish populations:

1) impact on fish at specific locations, such as changes in productivity or health; and

2) impacts on the spatial distribution of fish populations.

Evidences show that, in some regions, fisheries may already be experiencing the effects of climate change. For example, climate change has been identified as a potential contributor to the fluctuations of cuttlefish, indian mackerel stocks and catch on the Gulf of Aden/Arabian Sea (Khimetsa, 1988).

Recent studies on sharks stock assessment and lobster gives an indicator of populations change, only small sized fish were found, however these assessment was taken in assemblages collected from the landing sites in specific areas. Besides, there is evidence emphasize that the cuttlefish and lobsters captured well outside their known areas may be related to temperature fluctuation trends.

There is a need for fishing management schemes to organize fishing activities and to support the sustainable economic development of fisheries sector to achieve sustainable fish resources management improved local livelihood.

OVERALL GOAL:

To mange and harvest fisheries resources within anticipated carrying capacity of marine resources

OBJECTIVES:

- To improve sustainable management of fisheries resources through strengthened research, planning, regulation, and monitoring.
- To increase income derived from fisheries sector development and production through better fish handling, quality and marketing.
- To ensure the establishment of rules and norms taking into consideration the requirements of fish habitat in the planning process of coastal development.

MAIN OUTPUTS:

- Sustainable exploitation of fishing resources, particularly which are susceptible to climate change.
- Habitats are preserved.
- Fisheries resources management are strengthened.
- Fisheries infrastructure and fish quality are improved.
- Cooperative development and income generation for fishing communities are improved.
- Fishermen carry out their activities in accordance to the criteria of sustainable use.
- Climate change is taken into consideration in fishing sector planning and policies.

MAIN ACTIVITIES:

- Develop Maps for fisheries resources under current climate.
- Develop climate scenario to identify projected change of fisheries yield
- Develop new maps for fisheries resources under future climate.
- Prepare vulnerability and impact studies for fishery resources to determine projected change in fisheries stocks
- Develop plans for fisheries, particularly with a view to prohibiting the fishing of certain species very susceptible to the effects of climate change.
- Prepare regulations to keep marine fishing level within the capacity of fisheries resources.
- Integrate climate change dimensions into coastal planning, programs and projects in the fishing sector.
- Develop and transfer new fishing techniques.
- Create awareness among the various stakeholders on innovative fishing techniques.

- Design and implement training and awareness programs for the use of efficient, environment friendly fishing techniques and equipment.
- Develop and implement assessment and monitoring programme for fishery resources.

INPUTS

- Qualified personnel and expertise.
- Training programs.
- Rule and norms.
- Equipment, Technology transfer and adoption.
- Research activities and training programs.
- Institutional and technical capacity development.
- Public awareness.
- Fishermen participation.

INSTITUTIONAL ARRANGEMENTS:

Implementation is the responsibility of Ministry of Fish Wealth/ Marine Science and Biological Research Authority in collaboration with Ministry of Water and Environment, Environment Protection Authority, Ministry of Planning and Development, , Marine Research Centers, Academic Institutions, General Authority for Tourism, local authorities , NGOs and other Donors/Funding Agencies. .

RISKS AND BARRIERS

- Poor monitoring activities.
- Low awareness and technical levels.
- Lack of coordination.
- inadequate resources and institutional capacity.
- Lack of enforcement of marine fishing regulations.
- Failure to develop and implement plans for fisheries.
- Failure to integrate the aspect of climate change into coastal planning.

MONITORING AND EVALUATION: M& E will be done via normal methods of:

- Progress reports
- Technical and financial reports
- Beneficiary interviews
- Socio-economic impact survey

TIMEFRAME: 5 Years

FINANCIAL RESOURCES: The project is estimated to cost US$ 1.18 million.

BUDGET BREAKDOWN

Activities	**Cost**
Research programs	200,000
Vulnerability and impact studies	150,000
Developing maps for fisheries resources under current and future climate	80,000
Prepare plans and regulations	100,000
Develop and transfer new fishing techniques	100,000
Design and implement training and awareness programs for the use of efficient, environment friendly fishing techniques and equipment.	50,000
Develop and implement assessment and monitoring programme for fishery resources.	300,000
Management and operation	200,000
TOTAL COST	**1,180,000**

PROJECT PROFILE -12

Project Title: Incorporation of Climate Change and adaptation into school education

Locality: Country wide

Project Sector Field: Education and awareness

Implementing Agency: Ministry of Education, EPA, and CAMA in coordination with all relevant institutions

Project cost: The project is estimated to cost US$ 820,000

Sources of Finance: Donor and Funding Agencies.

RATIONALE:

The impacts and consequences of climate change are directly related to the way of life of the population in Yemen. These effects appear immediately as a first step on the life and livelihood of local population particularly women and children who are the most vulnerable to the changing climate, but in the long run these adverse impacts will reach every single people in the country. Therefore, immediate actions in terms of education and awareness are essential and required to create knowledge on climate change and adaptation among all levels of population including decision makers, teachers, farmers, and in particular education of future generations at schools.

Objectives:

The aim of this project is to make future generations aware of climate change and adaptation through education at schools.

Inputs and Activities :

- Meetings and round table discussions for all relevant stakeholders on the level and extent of inclusion of Climate change issues into the school curriculum.
- Identification of subjects into which climate change issues will be incorporated.
- Identification of level of education to be considered (primary and/or secondary level or both).
- Develop the appropriate subjects and courses on climate change impacts and adaptation.
- Incorporate the courses and subjects into school curriculum.

Outputs:

- Climate change subjects incorporated into the school curriculum.
- Awareness and knowledge on climate change increased and enhanced.
- Future generations and school students are aware about climate change impacts and adaptation.

Institutional arrangement:

The project will be implemented by the Ministry of Education in coordination with Environment Protection Authority, Civil Aviation and Meteorological Authority, Ministry of Technical Education and Vocational Training, All relevant institutions, and donor agencies.

Risks and barriers

- Lack of interest to incorporate climate change issues into curriculum.
- Inadequate financial resources.

Evaluation and monitoring

Stakeholder's committee to be formulated to monitor and evaluate project activities.

TIMEFRAME: 2 years

FINANCIAL RESOURCES: The project is estimated to cost US$ 820,000

Activities	**Cost (USD)**
Training courses on climate change for the education workers	50,000
Public awareness campaigns	50,000
Meetings and round table discussions	30,000
Develop the appropriate subjects and courses on climate change impacts and adaptation.	100,000
Incorporate the courses and subjects into school curriculum.	150,000
Printing of new curriculum	200,000
Produce and multiply awareness materials such as folders, posters, leaflets, etc	40,000
Management and operation	200,000
Total	**820,000**

Annex 2: All Identified adaptation projects in key vulnerable sectors

Water Sector	Agriculture Sector	Coastal Areas & Fisheries Sector
1. Develop and enforce water quality standards 2. Implement local community-based monitoring systems for water quality 3. Maximize the use of rainwater through water harvesting techniques in all sectors 4. Develop regulations for water tariffs (prices) 5. Encourage planting of crops with low water requirements (Avoid water-depleting crops such as Qat, banana, ... etc) 6. Introduce and expand drought-, heat- and salinity-resistant varieties 7. Generalize and enforce environmental impact assessment and water pollution control measures for all projects on all sectors 8. Promote efficient use and equity in water allocation, so as to enhance socio-economic development and alleviate poverty 9. Promotion of modern irrigation technologies to increase water use efficiency 10. Implement watershed management, terrace rehabilitation and water harvesting projects 11. Restore floodplains and coastal ecosystems as buffers against extreme events 12. Develop and implement disaster preparedness and recovery programs, including forecasting, early warning and rapid response 13. Restore or preserve mountain forests to reduce soil erosion and peak-flows	1. Apply efficient integrated natural resources management 2. Apply efficient integrated land management 3. Control and prevent land degradation and desertification 4. Apply genetic improvement programs through introduction of drought-, salinity-, heat-, disease- and pest resistant/tolerant varieties/crops, adapting to new crops, collection and documentation of genetic sources and their utilization for plant breeding and improvement programs 5. Improve crop management programs through changing sowing date, crop density, tillage practices, fertilizer levels, growing season for crop, making use of accumulated experience by farmers, collection and documentation of their local knowledge and experience, improving crop specific characteristics (harvest index, photosynthetic efficiency) and mitigation of the effects of drought 6. Apply efficient watershed management 7. Design and implement terrace rehabilitation programs 8. Construct dams where appropriate based on environmental impact assessment and technical and economic feasibility 9. Apply irrigation efficiency improvement programs 10. Apply water use efficiency improvement programs 11. Apply improved irrigation practices such as optimal scheduling high frequency and low-volume water delivery, adequate drainage and salinity control	1. Increase soft protection (e.g., beach nourishment and wetland construction and restoration) 2. Construct coastal defense walls for coastal areas subjected to erosion 3. Rely on technology, such as geographic information systems (GIS), to manage information 4. Raise awareness of the need for coastal adaptation that is appropriate for local conditions targeting decision makers and planners down to local community organizations 5. Develop regulations to phase out development in sensitive coastal areas 6. Ensure that new development does not infringe upon the shoreline 7. Re-plan coastal areas in accordance to environmental studies and specifications for protection of marine environment 8. Protect existing investments by maintaining, extending and upgrading existing dyke systems to prevent damage to coastal infrastructure and human activities 9. Construct marine tongues and wave suppressors to avoid waves-induced hazards 10. Establish integrated coastal management network for all coasts of Yemen 11. Protect coastal eco-tourism and implement market based incentives to promote sustainable tourism 12. Expand green belt for coastal areas through protection and re-planting of mangroves and palms 13. Integrated assessment of coastal zone vulnerability, including the capacity of existing coastal zone management policies to address impacts of climate variability and change
14. Introduce climate change considerations in land use planning and infrastructure design (including planning near to wadis routes, building codes, artificial routes for flowage ... etc.) 15. Encourage and expand water desalination using renewable energy sources, especially on Yemeni islands and coastal areas, where drinking water is	12. Improve seasonal weather forecast quality 13. Apply traditional technologies, such as multiple cropping and terracing 14. Apply integrated rangeland management 15. Preserve and restore wetlands 16. Compensate water losses by using treated waste water and mosques waters for irrigation 17. Promote research on adverse	14. Human processes of adaptation, and capacity of stakeholders and political institutions to respond to changing conditions 15. How stakeholders could benefit from potential opportunities that may be presented by climate change 16. Climate change effects on marine species and migration birds 17. Realistic cost estimates for different adaptation options within the coastal zone, including

not available or subject to seawater intrusion to ensure continuity of life 16. Rely on modern technology, such as geographic information systems (GIS), for water resources management 17. Implement artificial precipitation projects 18. Apply integrated management of water resources, including surface water, groundwater and wastewater 19. Disseminate information on water saving techniques in all economic sectors 20. Adapting minimum environmental flow provisions (surface and groundwater) to the hydro-period of wetlands 21. Encourage partnership with users and local communities in the management of water resources, and in financing, operation and maintenance of irrigation and rural water supply projects 22. Undertake demand-side management measures (end-use technologies, recycling and conservation) 23. Undertake supply-side efficiency improvement measures (leak reduction, optimize existing water regulation infrastructure, operation and maintenance)	climate change effects on agriculture in Yemen and disseminate research results to make use of them 18. Establish 'Yemen Climate Impacts and Adaptation Research Network (YCIARN)' with specialized National Climate Change Research Centers for Priority Vulnerable Sectors. 19. Establish 'National Climate Change Research Center for Agriculture' to undertake and coordinate research on immediate and future research needs 20. Activate the environmental and agricultural extension role in coordination with the different extension departments 21. Prepare agriculture manuals for the different zones of Yemen including sowing dates 22. Utilization of flowing water in the wadies 23. Drought-resistant crops 24. New sowing dates 25. Climate and other agriculture-related databases 26. Activate and enforce existing laws, regulations, etc.	consideration of effect of differing rates of water level change 18. Improved understanding of human activities and policies that affect coastal vulnerability to climate change, and existing adaptation barriers 19. Address research work giving due attentions capacity building needs and awareness enhancement 20. Establish 'Yemen Climate Impacts and Adaptation Research Network (YCIARN)' with specialized National Climate Change Research Centers for Priority Vulnerable Sectors. 21. Establish 'National Climate Change Research Center for Coastal Areas and Marine Resources' to undertake and coordinate research on immediate and future research needs 22. Set up a national emergency plan to face natural disasters including climate change induced ones 23. Strengthen the capacity and potential of individuals, agencies, and communities in the planning, implementation, monitoring and evaluation of Yemen NAPA projects 24. Activate and enforce marine fishing regulating laws and regulations 25. Issue licenses for definite types of marine resources and fishes
24. Build the capacity of central and local level institutions on the integration of environmental and sustainability issues within the district development process 25. Promote research on adverse climate change effects on water resources in Yemen and disseminate research results to make use of them 26. Establish 'Yemen Climate Impacts and Adaptation Research Network (YCIARN)' with specialized National Climate Change Research Centers for Priority Vulnerable Sectors 27. Establish 'National Climate Change Research Center for Water Resources' to undertake and coordinate research on immediate and future research needs 28. Promote awareness of climatic variability and the potential risk of climate change at all levels of the community (public and decision makers), arrange local, regional and national awareness raising campaigns to disseminate information on water resources, their	27. Promote awareness of climatic variability and the potential risk of climate change at all levels of the community (public and decision makers): awareness campaigns to inform farmers on appropriate crops, disseminate environmental-agricultural awareness on all levels including school and university curricula 28. Establish flexible mechanisms for intervention especially for dealing with Qat and other water-depleting crops through providing for new alternative cropping 29. Undertake measures to avoid adverse effects of urban planning on agricultural land 30. Establish laboratories to test agricultural changes of crops and support existing laboratories at agriculture research centres for adaptation 31. Support alternatives for fuel wood to control woodcutting and preserve plant cover through promotion of LPG use for cooking and solar energy applications for drying,	26. Specify fishing seasons for each type 27. Specify fishing areas 28. Reduce current catch on fully and overexploited fisheries to restore health of fisheries 29. Capacity building: training/education for use of efficient, marine environment-friendly fishing techniques and equipment 30. Raise awareness of fishermen, sailors and all those related to marine environment through guidance and information services 31. Raise awareness of islands inhabitants 32. Involve relevant stakeholders and local communities in monitoring the implementation of valid fishing laws 33. Establish marine protected areas 34. Conduct studies and research on the following: 35. Monitoring impact of climate change on marine resources 36. Update the eco-graphical information on gulf of Aden and red sea and their impact on fish and marine resources 37. Climate change impacts on social and economic condition of population as a result of impact on fisheries resources

vulnerability and adaptation measures on all levels including school and university curricula	heating, lighting, ... etc. 32. Disseminate flowage/flood guidance stations at main wadies 33. Establish, expand and manage natural protected areas	38. Establish a climate change database

Annex 3: Climate Downscaling

Generally the assessment of climate change impacts on critically vulnerable socio-economic sectors requires creating climate change scenarios, utilizing output information produced by General Circulation Models (GCMs), in addition to historic climate information for the baseline period recommended by WMO. Yemen climate change scenarios developed under the Initial National Communication were designed using outputs from 14 runs (experiments) of GCMs, namely the Oregon State University (OSU); the United Kingdom meteorological office UKHI and; the MAX Plank institute (Geostrophic Ocean) GCM (ECHAM3TR).

As shown in Figure A3-1, Yemen's climate change scenarios were created using INSTAT software, MAGICC (version 2.3) and SCENGEN (version 2.1a) computer software developed by the University of East Angela.

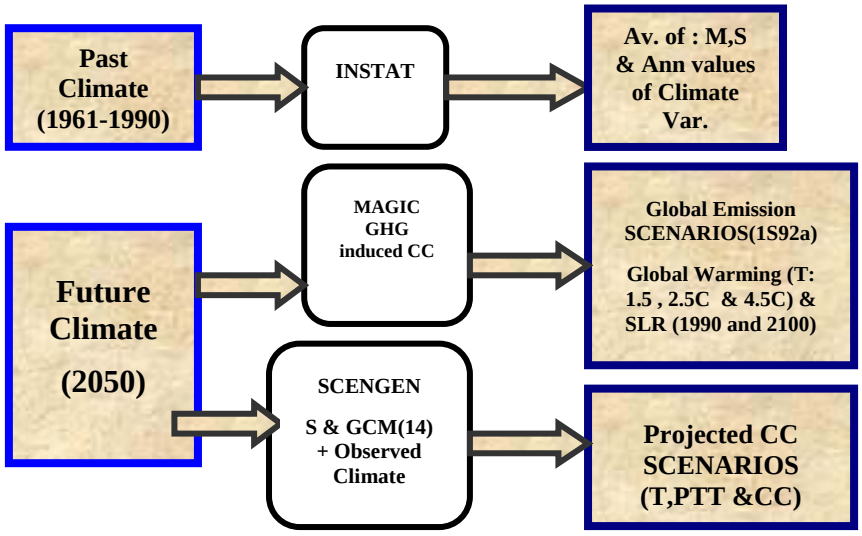

Figure 2. Expected Impacts from Future Climate Change

The INSTAT was used to analyze seasonal and annual precipitation, means surface air temperature, and means cloudiness for WMO recommended baseline period of 1961-1990. INSTAT produced means of monthly, seasonally, and annually values of air surface temperature, rainfall and cloud cover for six GCM grid cells over Yemen selected at a 5^0 latitude/longitude resolution (Figure A3-2).

MAGICC Model was used to define future global GHG emissions levels and to convert these emissions into global warming and subsequent temperature and sea level rise induced by future emissions over the 1990 to 2100 time

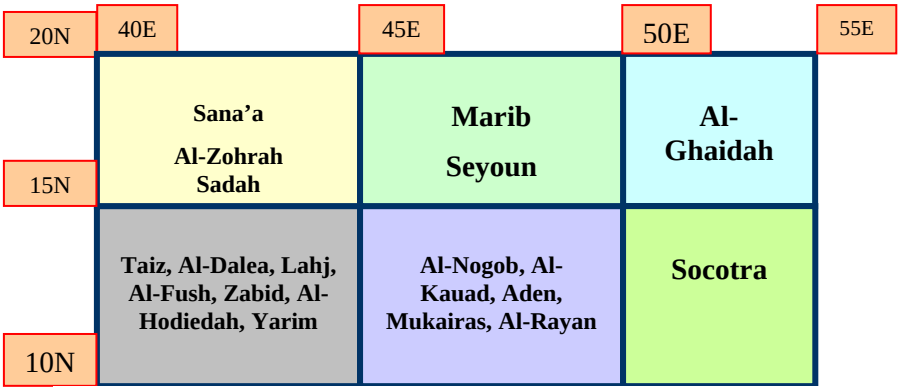

Figure 8. Yemen Grid Cells

horizon.

The comparison of past mean values of air temperature, precipitation, and cloud cover and those values of the time horizon 2050 produced by three climate scenarios shows changes of the three climate variables over Yemen as estimated by the three scenarios.

The table on the follow page shows that Yemen territory would experience seasonal warming average values of air temperature in the range of 1.7°C to 2.3°C in summer and in the range of 1.4°C to 2.5°C in winter. Precipitation data shows inconsistent results where the core and wet scenarios predicted an increase in the range of 4% to 35 % across the four seasons, while the dry scenario shows a decrease in rain across the four seasons in the range of -9% to -25% throughout the year.

Table 6. Projected changes in temperature, precipitation, cloud cover

Variable	Scenario	Season			
		Spring	Summer	Autumn	Winter
Temperature °C)	OSU	1.7	1.8	1.7	1.7
	ECHAM3TR	2.8	2.7	2.3	2.5
	UKHI	1.6	1.7	2.0	1.4
Precipitation (%)	OSU	20.9	7.0	3.9	13.1
	ECHAM3TR	9.7	15.8	18.1	35.4
	UKHI	-12.9	-23.6	-8.8	-10.9
Cloud cover (%)	OSU	-0.2	-0.2	4.5	5.4
	ECHAM3TR	0.5	10.5	18.0	2.6
	UKHI	-4.4	-9.3	-4.5	-6.1

Cloud cover as estimated by UKHI scenario is likely to decrease in the range of –9% to -4.5% across the four seasons, which is consistent with the projected decrease of precipitation. Contrary to UKHI, the ECHAM3TR scenarios projected cloud cover to increase in the range of 1 to 18% for the four seasons. In between to the two scenario, the OSU estimated cloud cover to decrease during spring and summer and to increase during autumn and winter.