Developing the Capacities of the Arab Countries for Climate Change Adaptation by Applying Integrated Water Resources Management Tools

Training Manual-Environment module

UNDA Project

UNESCWA

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About this manual

The United Nations Development Account project builds on the Regional Initiative for the Assessment of the Impact of Climate Change (CC) on Water `resources and socio –Economic Vulnerability in the Arab Region(RICCAR) findings and propose practical Integrated Water Resource Management (IWRM) tools that Arab Governments can apply to directly respond to the projected impacts of climate change in the region.

The present document is the training manual of the environment module of the project and it is a customization to the Arab region of UNEP and IISD training package on application of ecosystem based management for watershed of 2012 (UNEP-IISD 2011) The Manual includes as well, a set of Power Point presentations including 18 modules to be used during regional and national training sessions.

This Ecosystem Management (EM) training -of-trainers program is designed to bring together, in a facilitated and highly interactive setting, a group of 25-30 catchment managers, advancing their interest and skill in ecosystem approaches to water and to their catchment. Our opening perspective is that the managers and engineers most likely to attend the workshop have acceptable understanding of IWRM and it would bring an engineers' approach to resource management. These materials are designed to support a facilitated, 3-day workshop that will empower managers to understand the tools and concepts needed to build programs, direct staff and allocate resources as they develop and integrate Ecosystem Services (ESs) in IWRM as a concept for adaptation to climate change in the water sector in the Arab region. In addition, participants to the workshop will have a comprehensive exposure on impacts of climate change in the water sector on ecosystems in the Arab region.

The audience for this training includes managers of small to mid-sized catchments. These include decision makers, person with responsibility and authority for managing a land area (perhaps a catchment or a geopolitical jurisdiction within which they have responsibility), and for water-resource management as well as the lands that control the quality and quantity of these water resources. Our intent is to engage the individuals most clearly responsible for decisions about management of the lands and waters of a catchment, whatever their institutional affiliation.

This manual is coupled with an extensive series of PowerPoint slides in support of this capacity building experience. The slides include exercises outlined in the slides refer to managers of "national catchments "while others refer to the "workshop catchment" introduced as an example. Exercises that focus on the managers of national catchments will help participants build tools that participants can use when they return home and continue implementing ecosystem management.

Our ultimate aim is that local institutions are strengthened and local ecosystem management strategies are common; communities develop a strongly proactive approach to managing ecosystems consistent with principles of Integrated Water Resource Management

1-Introduction

Natural ecosystems benefit people in many ways, from regulating local climates to providing clean drinking water. The benefits supplied by natural ecosystems are collectively referred to as ecosystem services. While these services provide the basis for the livelihoods of many societies and play an important role in ensuring food, water and energy security, they are also fundamental tools in climate change adaptation. Essentially, Ecosystem-Based Adaptation (EBA) addresses the crucial links between climate change, biodiversity, ecosystem services and sustainable natural resource management. In this respect, the concept of using ecosystems as a basis to adapt to the impacts of changes in climate has gained momentum in recent years and has now emerged as an important technology in the adaptation to climate change.

Healthy ecosystems and their services provide opportunities for sustainable economic prosperity in conjunction with the provision of defense against the negative effects of climate change. Conversely, degradation of ecosystems results in increased climate change vulnerability for the communities that live in these ecosystems as well as for the ecosystems themselves.

Importantly, decision makers need to be convinced that 'environmental infrastructure' is capable of meeting their adaptation objectives. This will require a systematic consideration of the applicability, limitations and risks of EBA options as compared to traditional, often 'hard' infrastructure alternatives.

The United Nations Environment Programme(UNEP) through its governing Council decisions recognized the adverse impacts of climate change, among other drivers, on ecosystems and on their ability to meet the needs for local food production and national food security and, inter alia, water resources, and acknowledged the dependence of all countries, particularly developing countries, on ecosystems for livelihoods, food production and well-being, including adaptation to the impacts of climate change. UNEP also emphasized the heightened vulnerability of developing countries, particularly the least-developed countries and the small island developing States, to the impacts of climate change and reaffirm that that adaptation and mitigation actions generate multiple co-benefits, and that the resilience of many ecosystems is already being exceeded by an unprecedented combination of climate change, associated disturbances and other drivers. UNEP reaffirmed its support to Ecosystem-based adaption through the United Nations Environment Assembly (UNEA-1, Resolution 1/8)(UNEP 2014)) and considered that Climate Change is one of the greatest challenges of our time, expressing deep concern that all countries, particularly developing countries, are vulnerable to the adverse impacts of climate change and are already experiencing increased impacts, including persistent drought and extreme weather events, sea-level rise, coastal erosion and ocean acidification, further threatening food security. Additionally, in paragraph, 190 of the outcome document of the United Nations Conference on Sustainable Development, entitled “The future we want”, Heads of State and Governments expressed concern that all countries are already experiencing the adverse impacts of climate change, which is threatening efforts to achieve sustainable development, eradicate poverty and achieve food security, and emphasized that adaptation to climate change is an immediate and urgent priority.

Decision X/33 of the 10^{th} Conference of the Parties to the Convention on Biological Diversity (CBD), parties and other Governments were invited, in accordance with national capacities and circumstances, to integrate ecosystem-based approaches for adaptation into relevant strategies, including adaptation strategies and plans, national action plans to combat desertification, national biodiversity strategies and action plans, poverty reduction strategies, disaster risk reduction strategies and sustainable land management strategies on biodiversity and climate change and the role of ecosystem-based adaptation highlighted therein.

The Intergovernmental Panel on Climate Change (IPCC) has identified IWRM as an important climate-adaptation strategy and well-managed water and other natural resources provide high levels of Ecosystem Services (ES). In 2003, the Millennium Ecosystem Assessment (MA) made a strong case for using an ecosystem services approach for effective IWRM. This requires that watershed managers, policymakers, and communities to better understand, communicate, and disseminate the use of Ecosystem Services mechanisms for effective basin management (i.e., IWRM) and the realization of multiple benefits (including climate change adaptation, building resilience in basin riparian communities and conflict resolution).

While the rationale for such synergistic use of IWRM and ES paradigms is conceptually clear, most watershed managers focus on an IWRM framework that looks at traditional water resources such as water quantity, navigation, and hydropower.

In essence, ES valuation and management is a practical way of achieving IWRM goals as well as other tangential socio-economic and environmental benefits. In principle, most managers recognize the need to adopt ecosystem-based approaches to watershed management, acknowledging that watersheds provide important ecological services such as waste assimilation, floodwater storage, erosion control etc. There is also an increasing acceptance of the role of ecosystem management in providing additional social and economic benefits, including local livelihoods and alleviating poverty within catchment.

2-Overview of CC impacts on water sector in the Arab region

The most pertinent studies related to the impacts of Climate Change on the water sector in the Arab region are the following:

2-1 *UNEP assessment of vulnerability of water sector to environment change in West Asia (UNEP 2011)*

In 2009, UNEP launched regional exercise to assess the vulnerability of water sector to environment change based on the methodological guidelines prepared by UNEP and Peking University (UNEP 2009). According to these guidelines, a vulnerability assessment must have a precise understanding of four components of the water resource system, namely: total water resources, water resource development and use, ecological health and conflict management.

The West Asia region can be classified according to water resource availability, population growth, economic activities into two distinct sub-regions, the Mashriq, Yemen (Iraq, Jordan, Lebanon, Occupied Palestinian Territories, Syria and Yemen), and the Gulf Cooperation Council (GCC) countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE). The whole region, however, is suffering from water scarcity that is attributed to large temporal and spatial variations in most of the hydrological parameters, especially the rates of precipitation and evaporation. The most significant parameter causing environmental stress is the rainfall pattern, which influences the generation and dependability of freshwater availability in terms of its amount, frequency and distribution. Climate change will further increase the variability of rainfall adding more uncertainty and complication to the planning and management process of the water sector. Rainfall distribution in the two sub-regions shows that 72 per cent of the region receives on average less than 100 mm mainly in the GCC countries, 18 per cent of its area receives 100-300 mm and only 10 per cent receives more than 300 mm.

Understanding the vulnerability of freshwater resources in West Asia is therefore vital to ensure sustainable water management in the region. Undertaking a vulnerability assessment of fresh water will distinguish gaps in information, and identify the most dominant factors that influence vulnerability in addition to enhancing public awareness. The availability of such an assessment will provide decision makers with options to evaluate and modify existing policies and implement measures to improve water resources management.
The approach used for this vulnerability assessment was based on the methodological guidelines prepared by UNEP and Peking University which is based on the premise that the vulnerability assessment must have a precise understanding of four components of the water resource system, including: total water resources, water resource development and use, ecological health and conflict management

The aim of the Freshwater Vulnerability Assessment is to provide a vulnerability assessment at different scales in order to generate information for decision makers. The methodology relies on the application of the Driver, Pressure, State, Impact, Response (DPSIR) framework. Drivers include population growth and urbanization; water resource availability or deficit; and pollution. Impacts include the change in state of water sector performance and adaptability because of climate change, in addition to other socio-economic activities. Responses are estimated by the adaptive capacity of the ecosystem and humans to potential threats. Vulnerability therefore, Fig (1), is a function of resource stress, water development pressures, ecological health and capacity. Based on these parameters, the vulnerability index (VI) provides an estimated value for a given year ranging from zero (non-vulnerable) to one (most vulnerable) to delineate severity of the stress being experienced by the water sector.

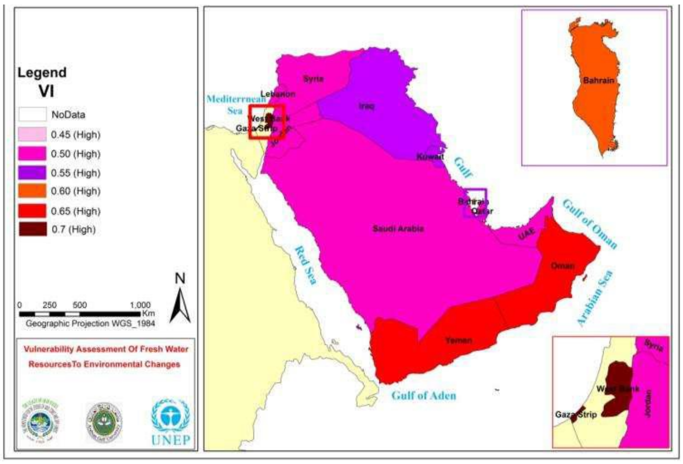


Fig (1) Assessment of the Vulnerability Index according to UNEP methodology

According to the assessment a decrease in rainfall and an increase in temperature are projected to contribute to increased evaporation, decreased surface water, and associated groundwater recharge. The increase in temperatures and the associated sea level rise will result in seawater intrusion into the groundwater aquifers along coastal zones especially in the Arabic Peninsula sub-region as many wadis drain into the long coastal zones. Intake of desalination may be impacted with the potential of additional engineering redesign works and environmental assessment to accommodate the expected increase in seawater temperature and salinity concentration.

Concerning shared water resources, it was predicted that the Tigris and Euphrates River flows could experience a flow reduction of 29-73 per cent as well as variation of quality as most of the winter precipitation may be in the form of rain instead of snow (UNEP 2011).
Weather events experienced during the last five years in the region such as the Gonu floods in Oman in 2007, Yemen and UAE in2008 could be attributed to climate change compounded by marine invasive species from navigational vessels. Cyclone Gonu caused major flooding with significant increases in recharge rates, including nutrients and runoff pollution, to shallow groundwater sources, damage to infrastructure (housing, road, water distribution and wastewater collection system, dams, dikes) and loss of biodiversity. In the Mediterranean, there is consensus that climate change and the increased frequency of extreme weather events will likely cause more flooding and drought; Syria, Jordan and Lebanon will experience extended droughts.

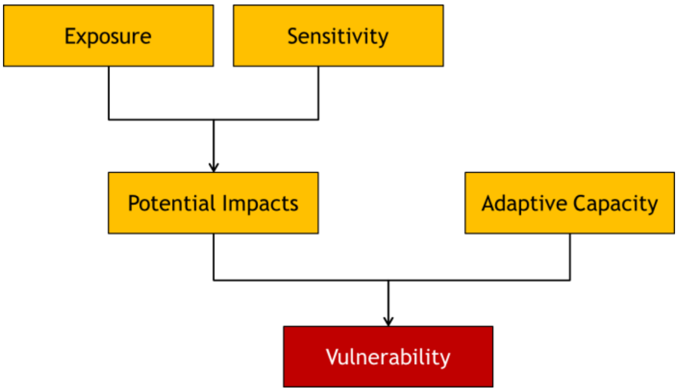
2-2 *The Regional Initiative for the Assessment of the Impact of Climate Change on Water `resources and socio –Economic Vulnerability in the Arab Region (RICCAR)*

RICCAR is a collaborative regional initiative that assesses the impact of climate change on fresh water resources in the Arab region through a consultative and integrated assessment to identify the socio-economic and environmental vulnerability caused by climate change impacts on water resources in the Arab region. The outcomes of the assessment aim to provide a common platform for addressing and responding to climate change impacts on fresh water resources by serving as a basis for dialogue, priority setting and policy formulation on climate change adaptation at the regional and national levels.

An integrated vulnerability assessment methodology was developed through a consultative process with regional stakeholders led by the Arab Center for the Studies of Arid zones and Dry lands (ACSAD), ESCWA, GIZ and the League of Arab States with support provided by GIZ through its Adaptation to Climate Change in the Water sector in the MENA region (ACCWaM) project. The methodology focuses on assessing vulnerability of key sectors to climate change impacts in the Arab region, such as changes in temperature, precipitation and runoff. It can also be adapted to examine droughts or flooding due to shifting rainfall patterns and extreme weather events.

In this framework, the experts have identified thematic sets of indicators to assess the socio-economic impacts of climate change in the water sector, based on the vulnerability concept presented in the Forth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR4). This concept is applied using a set of regional indicators for the Arab region (Table.1). It understands climate change as a function of a system's climate change exposure, sensitivity and adaptive capacity to cope with climate change effects.

The components constituting vulnerability based on the definition of the IPCC



Within the context of the assessment, the components of vulnerability are understood as follows:

- **Exposure** refers to changes in climate parameters that might affect socio-ecological, and biodiversity systems. Such parameters are for example temperature, precipitation and wind speed which climate change alters with regard to their quantity and quality as well as their spatial and temporal distribution.
- **Sensitivity** is understood as the status quo of the physical and natural environmental resources of the affected systems making it particularly susceptible to climate change. For example, such sensitivity factors could be topography, land use land cover, distribution and density of population, built environment, proximity to the coast etc. Exposure and sensitivity form the **potential impact** climate change could have on a system.
- **Adaptive capacity** refers to the societal environmental system that enables a system to cope with adverse impacts of climate change or even to exploit beneficial effects of a changing climate. Such characteristics from the societal environment include e.g. income/GDP, quality and efficiency of governance structures, habitats, technical know-how and application of technologies, but also raising awareness for vulnerable people towards climate change impacts (UNESCWA, RICCAR Training Manual on the Integrated Vulnerability Assessment Methodology -TO BE PUBLISHED)

Combining adaptive capacity and the potential impact will show the **vulnerability** of a system to climate change. Therefore, there is no such thing as a 'general' vulnerability: vulnerability is always related to a specific system and a specific climate change impact, which both clearly need to be defined in order to analyse vulnerability.

Table (1) RICCAR vulnerability assessment indicators

Indicator/Index	Unit	Sector	Potential Impacts
Change in Temperature: Indicates (projected/future) trends and changes in temperature	ºC or %change	Sector Biodiversity and Ecosystems – Vulnerability towards changing water availability Sector Agriculture – Vulnerability towards changing water availability Sector Agriculture – Vulnerability towards changing water availability	Change in area covered by forests Change in area covered by wetlands Change in available water for agriculture/crops Change in available water for livestock
Change in Precipitation: Indicates (projected/future)trends and changes in temperature	Mm or %change	Sector Biodiversity and Ecosystems – Vulnerability towards changing water availability Sector Agriculture – Vulnerability towards changing water availability	Change in area covered by wetlands Change in available water for agriculture/crops
Change in run-off: Indicates (projected/future)trends and changes in runoff	mm/a	Sector Biodiversity and Ecosystems – Vulnerability towards changing water availability Sector Agriculture – Vulnerability towards changing water availability	Change in area covered by wetlands Change in available water for agriculture/crops
Total renewable water available per capita (TARWR): Indicates human pressure on renewable but finite resources.	m3 /inhabitant/ yr.	Sector Water – Vulnerability towards changing water availability Sector Biodiversity and Ecosystems – Vulnerability towards changing water availability Sector Agriculture – Vulnerability towards changing water availability	Water availability Change in area covered by forests Change in area covered by wetlands Change in available water for agriculture/crops Change in available water for livestock
Water consumption per capita: Indicates the intensity of use of actual water resources	m3/inhabitant/yr.	Sector Water – Vulnerability towards changing water availability Sector People – Vulnerability towards changing water availability	Water availability Change in available water for people
Share of water consumption in agriculture	%	Sector Water – Vulnerability towards changing water availability Sector Agriculture – Vulnerability towards changing water availability	Water availability Change in available water for agriculture/crops
Groundwater resources (Hydrogeology)	Area coverage	Sector Water – Vulnerability towards changing water availability Sector People – Vulnerability towards changing water availability	Water availability Change in available water for people

Land Use Land Cover(LULC): Indicates the sensitivity of different LULC-types towards projected Climate Change (Exposure)	LULC classes	Sector Biodiversity and Ecosystems – Vulnerability towards changing water availability	Change in area covered by forests Change in area covered by wetlands
Soil type – Storage capacity: Indicates the natural water storage capacity of the soil	Mm/m	Sector Biodiversity and Ecosystems – Vulnerability towards changing water availability Sector Agriculture – Vulnerability towards changing water availability	Change in area covered by forests Change in area covered by wetlands Change in available water for agriculture/crops Change in employment in agriculture
Degradation of vegetation cover: Indicates the current condition of ecosystems and their ability to cope with additional, climate change induced stress.	Area covered	Sector Biodiversity and Ecosystems – Vulnerability towards changing water availability Sector Agriculture – Vulnerability towards changing water availability Sector Agriculture – Vulnerability towards changing water availability Sector People – Vulnerability towards changing water availability	Change in area covered by forests Change in area covered by wetlands Change in available water for agriculture/crops Change in available water for livestock Change in employment in agriculture

These water and ecosystems indicators will be used, among others, to prepare an integrated vulnerability assessment, according to a defined methodology, that takes a regional perspective on climate change vulnerability in the Arab countries. It thus concentrates on key sectors and climate change impacts relevant throughout the Arab region, providing entry points for a regional dialogue on joint adaptation efforts to cope with the challenges of climate change in the Arab region.

However, the methodology provides the flexibility that allows it to be adapted for application at the national or sub-national level. For example, further climate change impact indicators could be added to the assessment, or be substituted to better reflect the characteristics and interests of single countries or local communities.

3-Projections of the impacts of RICCAR findings on Ecosystems and Biodiversity in Arab Region

In this section, an attempt to develop predictions for the impacts of RICCAR findings on ecosystems and biodiversity in Arab region is elaborated based on best available data and information. It should be emphasized that, there is unsufficient and reliable and comprehensive characterization of ecosystems and biodiversity in the region, and the prediction is done on specific watershed sites in West Asia and North Africa. It aims to provide, to the trainers, some hints to be followed during national sessions. Trainers are requested to follow the same approach to predict impacts in specific sites in their countries.

However, it is worth mentioning here, that since 2010, the Arab Region with support from UNEP-ROWA (Regional Office of West Asia) in Bahrain, joined the global biodiversity discussions and signed the "Biodiversity Compact" alongside 194 countries to comply with the Aichi Biodiversity Targets framework and Strategic Plan for Biodiversity 2011-2020 to curb the loss of biodiversity (which reached 1000 times the rate of loss 50 years ago) and conserve biodiversity components and their sustainable use for human well-being. The countries were empowered to comply with the CBD guidelines by preparing their Fifth National Reports to the CBD and update their National Biodiversity Strategy and Action Plans. The year 2015 witnessed the release of most of the national reports and NBSAPs which assess biodiversity threats, indicators, policies and defines national targets and actions to be undertaken till 2020 (CBD COP 10 Decision X/2 2010), including by mainstreaming biodiversity into national development plans, climate change strategies and SDG's as well as integrating other related MEAs related to biodiversity such as the International Wetlands Convention (Ramsar), The migratory species convention (CMS), the International Trade with Endangered Species of Wild Fauna and Flora Convention (CITES) and the World Heritage Convention. As a result, the most recent data related to biodiversity and ecosystems in the Arab countries was published in the Fifth National Reports. Nevertheless, the reports do not show data of impacts of climate change on ecosystems and biodiversity per-se but some describes potential impacts on ecosystem services such as water resources. The Global biodiversity Outlook Fourth Edition, a United Nations Biodiversity flagship report presented some impacts of biodiversity in 100 years, in a business as usual scenario. The report predicted the overall status of biodiversity in 2020, which showed unfavorable signs
on water-food ecosystem services thus threatening humans and environmental and socio- economic sustainability. The impacts on inland water resources and wetlands was also assessed and demonstrated devastating degradation and loss of wetland biodiversity and ecosystem services (Aichi Target 6,7 and 14) (https://www.cbd.int/nr5)

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3-1 RICCAR Indicators

3-1-1 Change in Temperature

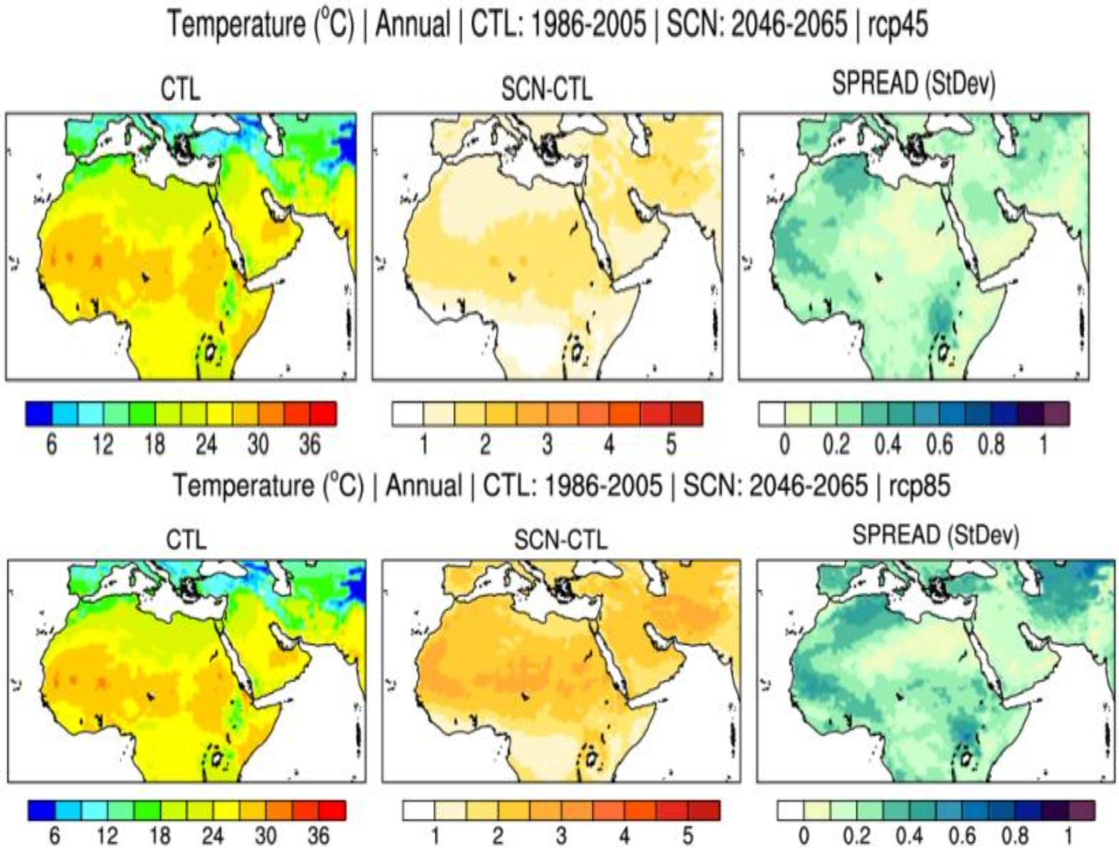


Figure (2) Change in Temperature for the time period 2046-2065 with the baseline 1986-2005 for RCP 4.5 and RCP 8.5. The general change in temperature showed an increase varied between 0.3 and 2.4°C in RCP 4.5 and from 1.1 to 3.4°C with RCP 8.5**.**

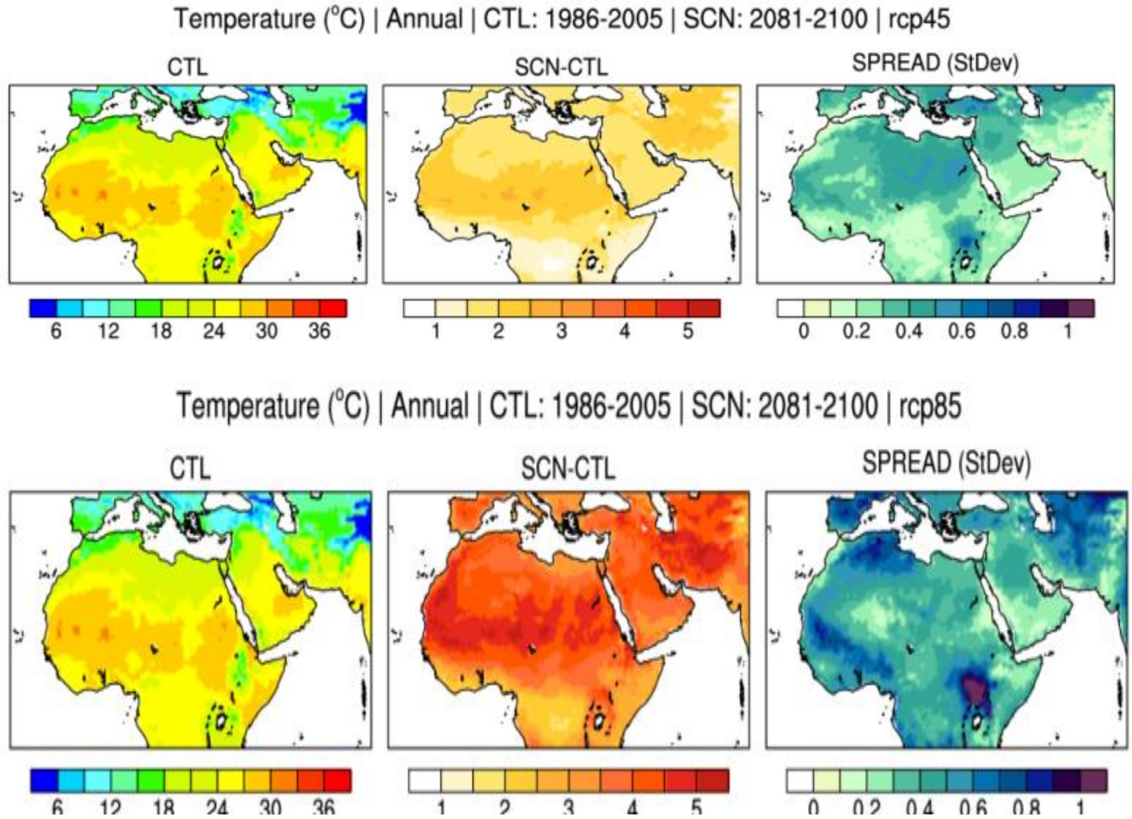


Figure (3) Change in Temperature for the time period 2081-2100 with the baseline 1986-2005 for RCP 4.5 and RCP 8.5. The general change of in Temperature showed an increase between 1 to 3°C in RCP 4.5 and from 2 to 5°C with RCP 8.5.

RCP 8.5 Rising radiative forcing pathway leading to 8.5 W/m² in 2100.
RCP 4.5 Stabilization without overshoot pathway to 4.5 W/m² at stabilization after 2100

3-1-2- Extreme Climate Conditions

SU35: Summer days (Tmax > 35°C)

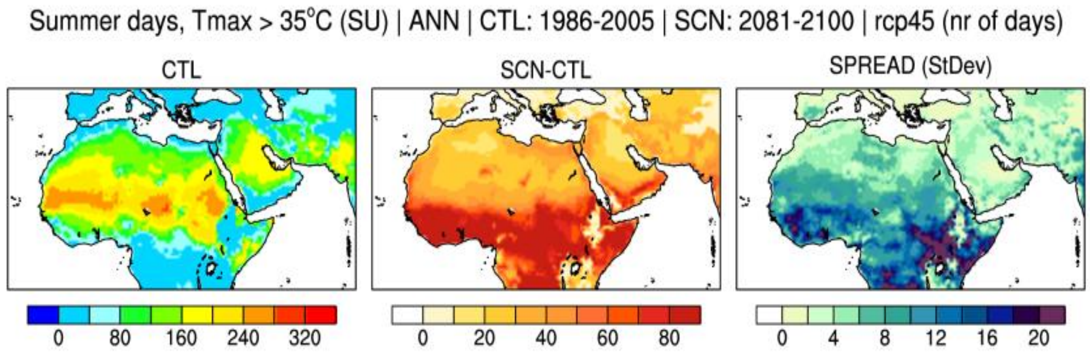


Figure (4) Changes in the Summer days with Tmax > 35°C (i.e. annual number of days when Tmax > 35°C) for the period 2081-2100 for RCP 4.5 and RCP 8.5 compared to the baseline period 1986-2005 for the ensemble of the three projections. The results show significant warming trends in both scenarios reaching up to 80 days in the southern Arabian Peninsula for the RCP 85.

SU40: Summer days (Tmax > 40°C)

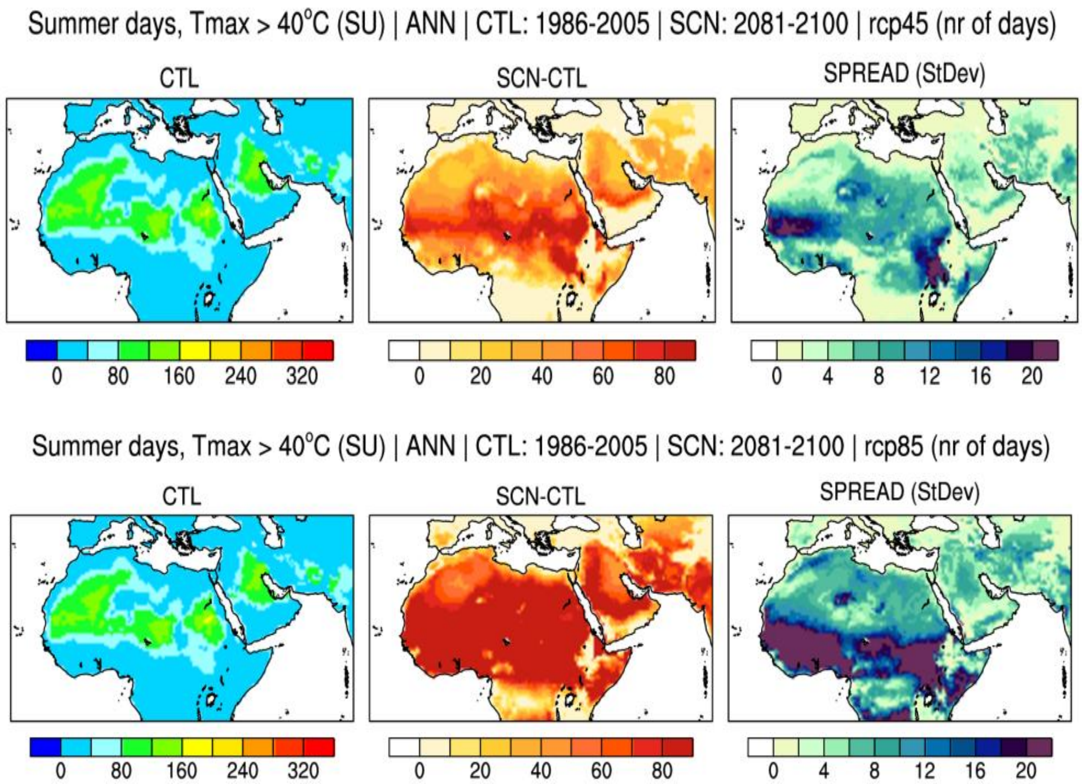


Figure (5) Changes in the Summer days with Tmax > 40°C (i.e. annual number of days when Tmax >40°C) for the period 2081-2100 for RCP 4.5 and RCP 8.5 compared to the baseline period 1986-2005 for the ensemble of the three projections. The results show strong warming in the Sahara and Central Peninsula Areas for RCP8.5, meaning that the increase in the extreme temperature on the coastal areas would be lower than the central parts of the region for both scenarios**.**

3-1-3 Tropical Nights

TR: Tropical nights (annual number of days when Tmin > 20°C)

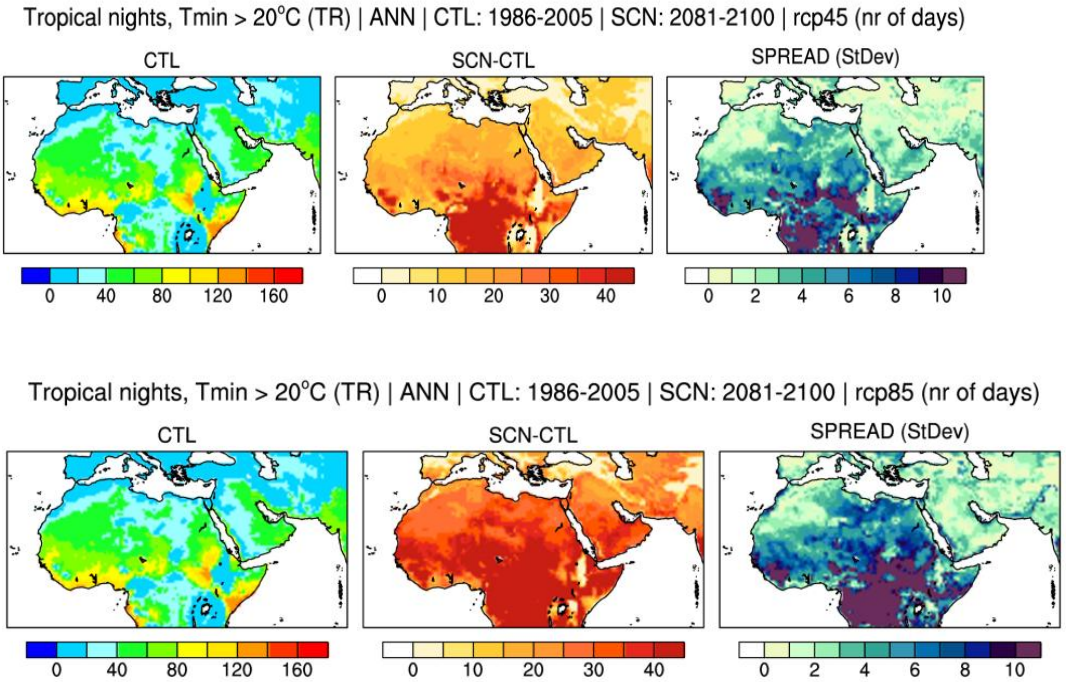


Figure (6) The Tropical nights (annual number of days when Tmin > 20°) for the period 2081-2100 for RCP 4.5 and RCP 8.5 compared to the baseline period 1986-2005 for the ensemble of the three projections. The results show significant warming trends with an increase in tropical nights mainly in Central Africa and Southern Arabian Peninsula regions particularly for RCP 8.5

General predicted Ecosystem and Biodiversity Impacts

-Changes in growth, reproduction, and distribution of lake and stream biodiversity

-Temperature increases could influence the quality of surface water in terms of dissolved oxygen, stratification, mixing ratio, self-purification and biological content and growth especially algal bloom, bacterial content and fungal levels.

-Rapid warming, and higher organic inputs affect marine and lake productivity, while combined impacts of wildfire and insect outbreaks decrease water ecosystems productivity

-Accelerated losses of nutrients from terrestrial ecosystems to receiving (Hershkovitz 2013)

-For lakes higher temperature are likely to lead to higher primary productivity with more intense algal blooms, stronger and longer periods of summer stratification with greater oxygen depletion in the hypolimnion and increased release of phosphorus from sediments (Hershkovitz 2013)

-An increasing number of ecosystems, including areas of high biodiversity, are likely to be further disrupted by a temperature rise of 2°C or more above pre-industrial levels

-Introduction of invasive alien species are another threat to biodiversity and native fauna and flora. Alien species are species, sub-species, or lower tax on occurring outside of their natural range and dispersal potential.

-Under warmer seasons, freshwater phytoplankton and zooplankton blooms are also appearing earlier. Other terrestrial animals and plants are moving uphill as their habitats warm. Since the migration rate of many species is insufficient to keep pace with the speed of climate change, they could be pushed towards extinction in the future (Hershkovitz 2013)

-Roughly, 10 per cent of species will face an increasingly high risk of extinction for every 1°C rise in global mean surface temperature (up to an increase of about 5°C).

-In regions where climatic change may lead to warmer and drier conditions, mountain vegetation could suffer more because of increased evapotranspiration. This is most likely to occur in mountain climates under the influence of continental and Mediterranean regimes. Below 2400 m, the juniper trees are either dead or in very poor condition and regeneration is virtually absent

-Shifts in species ranges are so extensive that by 2100 they may alter biome composition of watershed area. Both winter warming and intensification of the hydrologic cycle cause accelerated losses of nutrients from terrestrial ecosystems to receiving waters. Ecosystem feedbacks, especially those associated with release of carbon dioxide and methane release from wetlands and thawing permafrost soils, magnify the rate of climate change.

Examples of Hot Spots in Arab region

-Those impacts which are most significant for biodiversity include loss of coastal zones due to sea level rise, sea water temperature rise, droughts and desertification, increased water scarcity and ground water salinity (UNEP 2010b). Some projections of climate change impacts suggest reduced rainfall (0-20 percent) coupled with higher temperatures, which would decrease water flows in the Euphrates and Jordan rivers, affecting agriculture in Fertile Crescent lands (Iraq, Syria, Lebanon, Jordan and the Occupied Palestinian Territories).

- The major climate change impacts on wetlands in the region are the decrease of the level of waters and drying of several wetlands which are already under drought stress (e.g. Ammik site in Lebanon, Jabboule site in Syria), the reduction of the fresh waters biodiversity in sites, the elimination of migratory species in the site and the reduction of income of people who are dependent.

-Natural ecosystems especially at risk include the coastal mountain ranges of the Red Sea, the cedar forests of Lebanon and Syria, mangroves in the Regional Organization for the Protection of Marine Environment (ROPME) Sea Area, reed marshes in Iraq, the mountain ranges in Yemen and Oman and all the major river systems (AFED 2009).

-*Juniperusexcelsa*, subsp, *polycarpos* in open woodland in the central range of the Western Hajar Mountains. This species is present from 2100 m to the summit at 3000 m. The juniper woodlands of Oman are unique to the Arabian Peninsula. Juniper would be one of the most threaten species if temperature increased up (El-Keblawy 2014)

-Invasive alien species (IAS) are widely known as a major threat to biological diversity, food and water security and human and animal health. Terrestrial and freshwater ecosystems, estuarine and marine systems are impacted by the spread of IAS and more problems can be expected in the future. In the Arab Region , IUCN has classified 551species of invasive species ranging from plankton to red palm weevil, cacti species, water hyacinth and numerous fish (UNEP 2010b). Among these species, 36 percent are classified as aliens, whereas 51 percent are native and the bio-status of 75 species is yet to be determined. Global warming is expected to exacerbate the introduction and spread of IAS.

-Increased temperatures and the associated sea- level rise will result in seawater intrusion into some coastal areas in the Arab region. This will lead to a number of socio-economic impacts in the Nile Delta region in Egypt, and the inundation of some parts of the Bahraini coast. The archipelago of Bahrain has a limited area of about 745 km2, and with sea-level rise, it is estimated that an area of 36–70 km2, the equivalent of 5–10 per cent of the total area of the Kingdom will be covered with seawater (UNEP 2010)

3-1-4 Dry Spell

CDD: Maximum length of dry spell

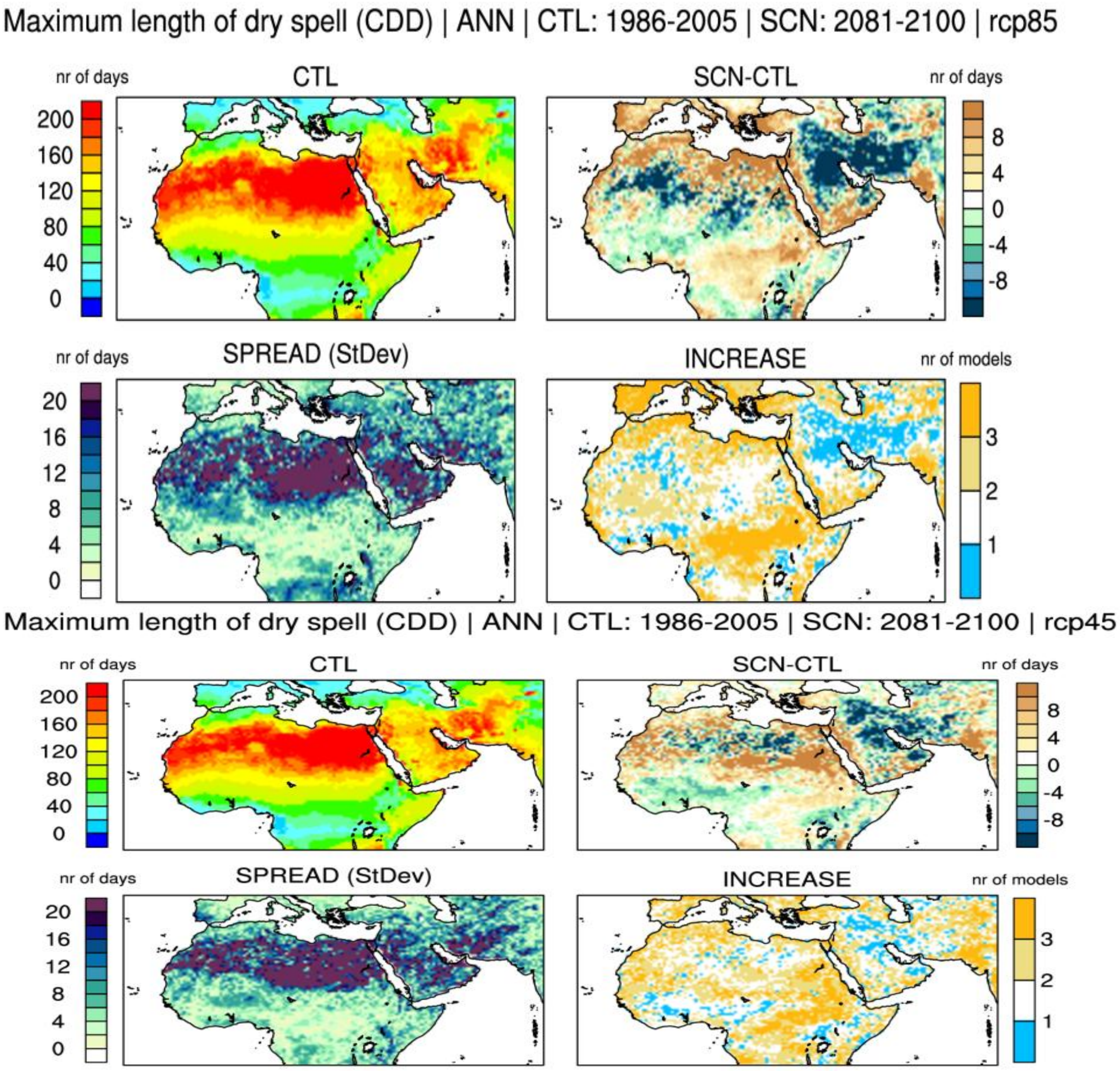


Figure (7) Changes in the maximum length of dry spell of ensembles of three projections for both RCP4.5 and RCP 8.5 for the period 2081 – 2100 compared to the base period 1986-2005. The projections show trends towards drier condition with an increase in number of days specifically Mediterranean and western and northern parts of the Arabian Peninsula by the end of the century. This indicates that the dry season (summer) is extending in length especially in these areas.

General Predicted Ecosystem and Biodiversity Impacts

- Land degradation and desertification will exacerbate habitat loss, including degradation and fragmentation, is the most important cause of biodiversity loss globally. Natural habitats in most parts of the world continue to decline in extent and integrity, although there has been significant progress to reduce this trend in some regions and habitats. Reducing the rate of habitat loss, and eventually halting it, is essential to protect biodiversity and to maintain the ecosystem services vital to human wellbeing.

-Changes in the reproduction of migratory birds that depend on lakes and streams for their breeding cycle

Examples of Hot Spots in Arab region

-Forest area in the West Asian region is less than one per cent of total land cover, the region being a -largely -arid area of sparse vegetation. However, recent analysis based on remote sensed data shows that forest loss in West Asia has increased over the recent decade, with a jump in the deforestation from 2011 to 2012. From 2001-2013, cumulative tree cover loss increased from 0.44 per cent to 5.71 per cent compared to forest cover in 2000. High rates of forest loss were seen in 2012 (2.14 per cent) and 2007 (0.7 per cent), while 2003 and 2004 had the lowest proportion of deforestation (0.1 per cent each). As an attempt to redress some of these losses, countries like the Lebanon have embarked on tree planting programmes (UNEP 2010b)

-Natural ecosystems especially at risk include the coastal mountain ranges of the Red Sea, the cedar forests of Lebanon and Syria, reed marshes in Iraq, the mountain ranges in Yemen and Oman and all the major river systems.

- WadiWurayah National Park in Fujairah covers an area of 200 km2 of the Alhajar Mountain range, which shelters a rich diversity of rare and endangered habitats and speciest. One of the most striking features of the national park is its freshwater wetland area. This freshwater wetland is one of few remaining in the region, which qualified it to be registered on the Ramsar list of internationally important wetlands. The WadiWurayah National Park protects natural and cultural values, and it contributes to the sustainable development of the country. The Park hosts a number of rare and endangered species, such as the Arabian Tahr, Arabitragus jayakari, which is listed as Endangered in the IUCN Red List of Threatened Species. Less than 2,000 of these magnificent wild goats survive and are all found only in the Hajar Mountains in Oman and WadiWurayah in U.A.E. The wetlands also shelter the Garra barreimiae, which is a regionally endemic fish, listed as Vulnerable by IUCN. In addition, 455 species of insects, ten species of spiders, one species of pseudo-scorpion and one species of woodlice have been recorded. Furthermore, the park has a number of archaeological sites that have an intrinsic cultural value, making it a great venue for ecotourism. The establishment of WadiWurayah National Park was part of the Fujairah Emirate 2040 development vision, and the park continues to involve the local community through a wide range of educational activities

- The protected area of wadi Al-Ghaf is located south of the West Bank, Palestinian Authority territories along the Taweel Valley near Al-Khalil city, and covers around 1,000 hectares. Wadi Al-Ghaf protects many species including a species of bat that resides in the Safa Caves and attracts many visitors. The area is also rich in freshwater and local communities rely on it for agriculture. The site hosts a wealth of wildlife including wolf, hyena, deer, porcupine, fox and hedgehog, while the rich vegetation covers and preserves the soil and humidity. There are over 45 kinds of plants and trees in the area, including oak trees, pine trees, maple trees, and sagebrush

3-1-5 Precipitation

Change in Precipitation

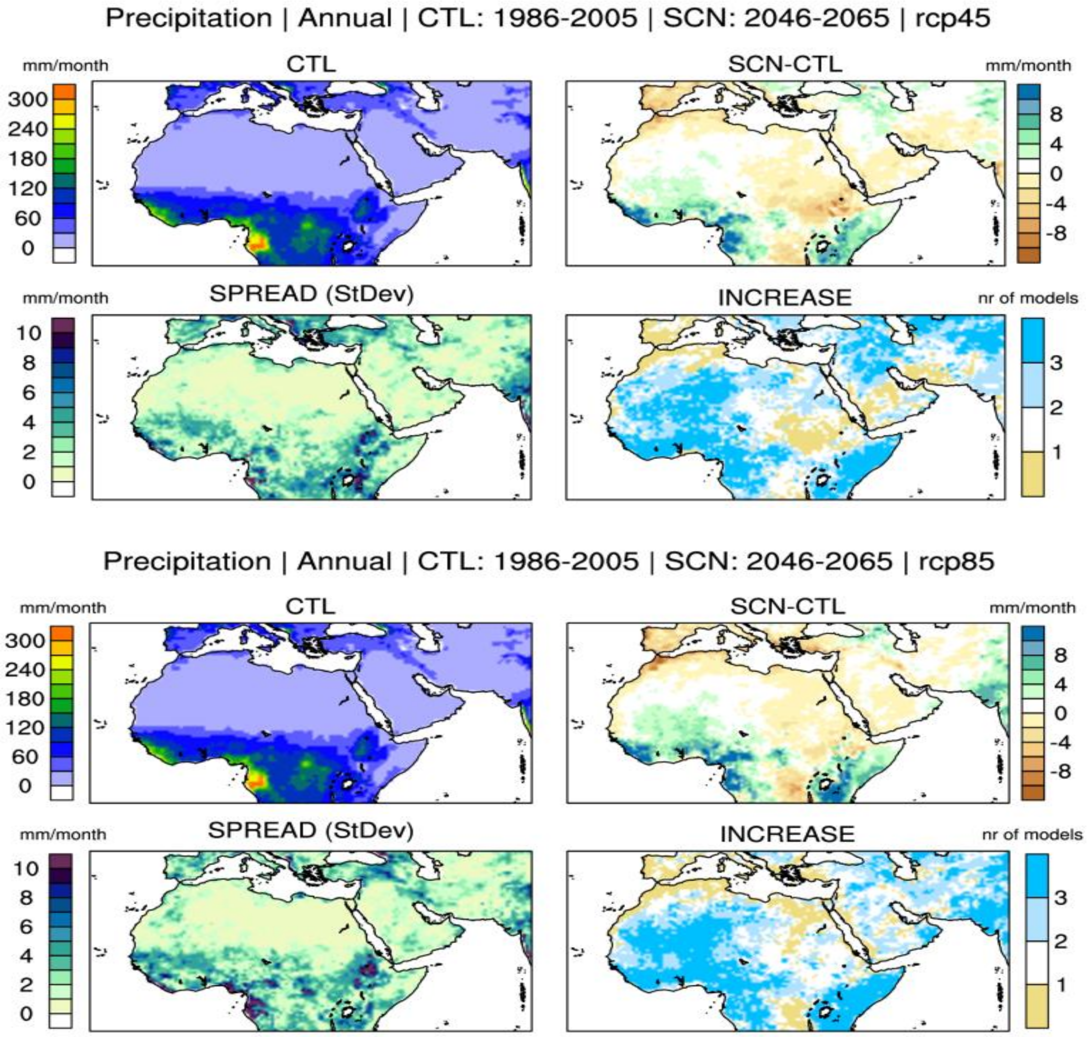
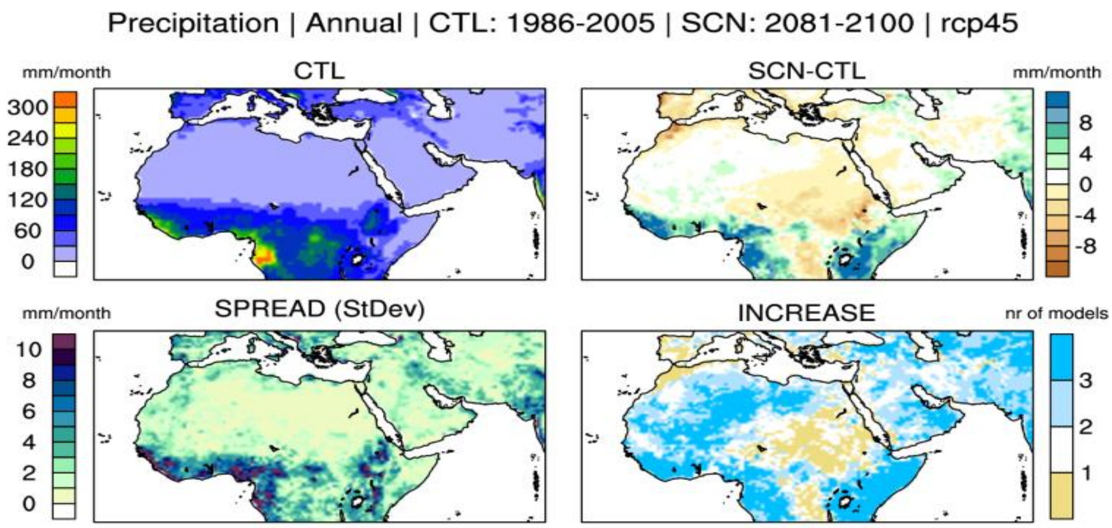


Figure (8) Change in Precipitation for the time period 2046-2065 with the baseline 1986-2005 for RCP 4.5 and RCP 8.5. Decreasing trends are generally shown in most of the Arab region (a reduction of 8 mm in average monthly precipitation at the Atlas Mountains for RCP 8.5 can be seen in the Figure).



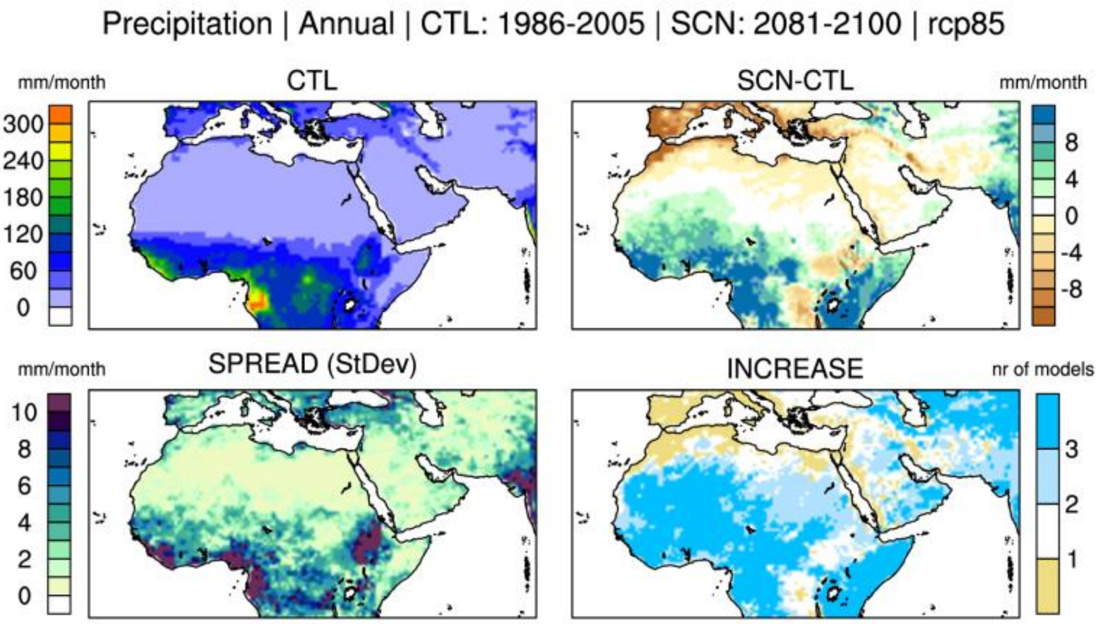


Figure (9) Change in Precipitation for the time period 2081-2100 with the baseline 1986-2005 for RCP 4.5 and RCP 8.5. Mostly there is a reduction of the average monthly precipitation reaching 10 mm in some areas of the region.

R10mm: Heavy precipitation days (ppt ≥ 10 mm)

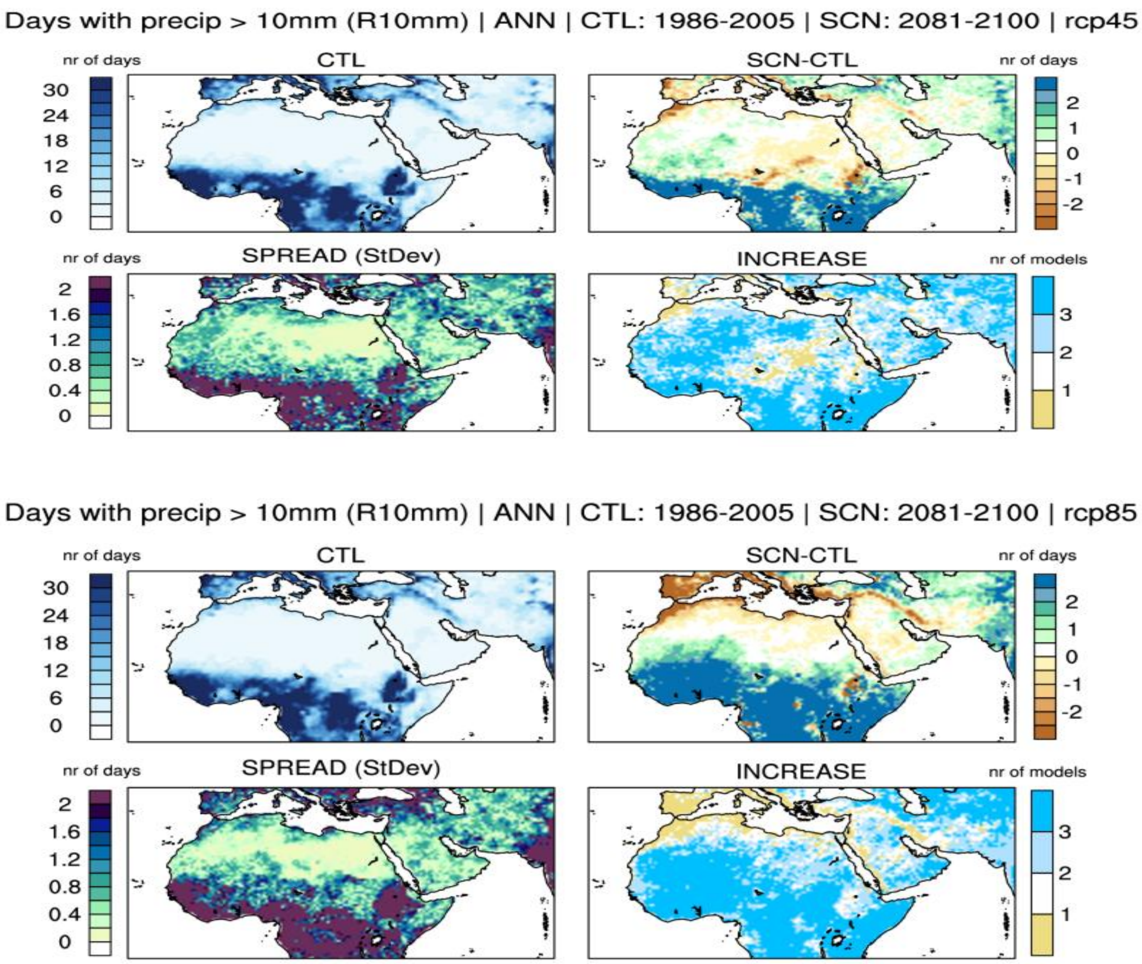


Figure (10) Changes in the “heavy precipitation days” (R10mm, annual number of days when precipitation ≥ 10 mm) for the period 2081-2100 for RCP4.5 and RCP 8.5 compared to the baseline period 1986-2005 for the ensemble of the three projections. Decreasing trends are shown, indicating that there will be an overall reduction in rainy days with intensity greater than 10 mm for the Arab region**.**

R20mm: Heavy precipitation days (ppt ≥ 20 mm)

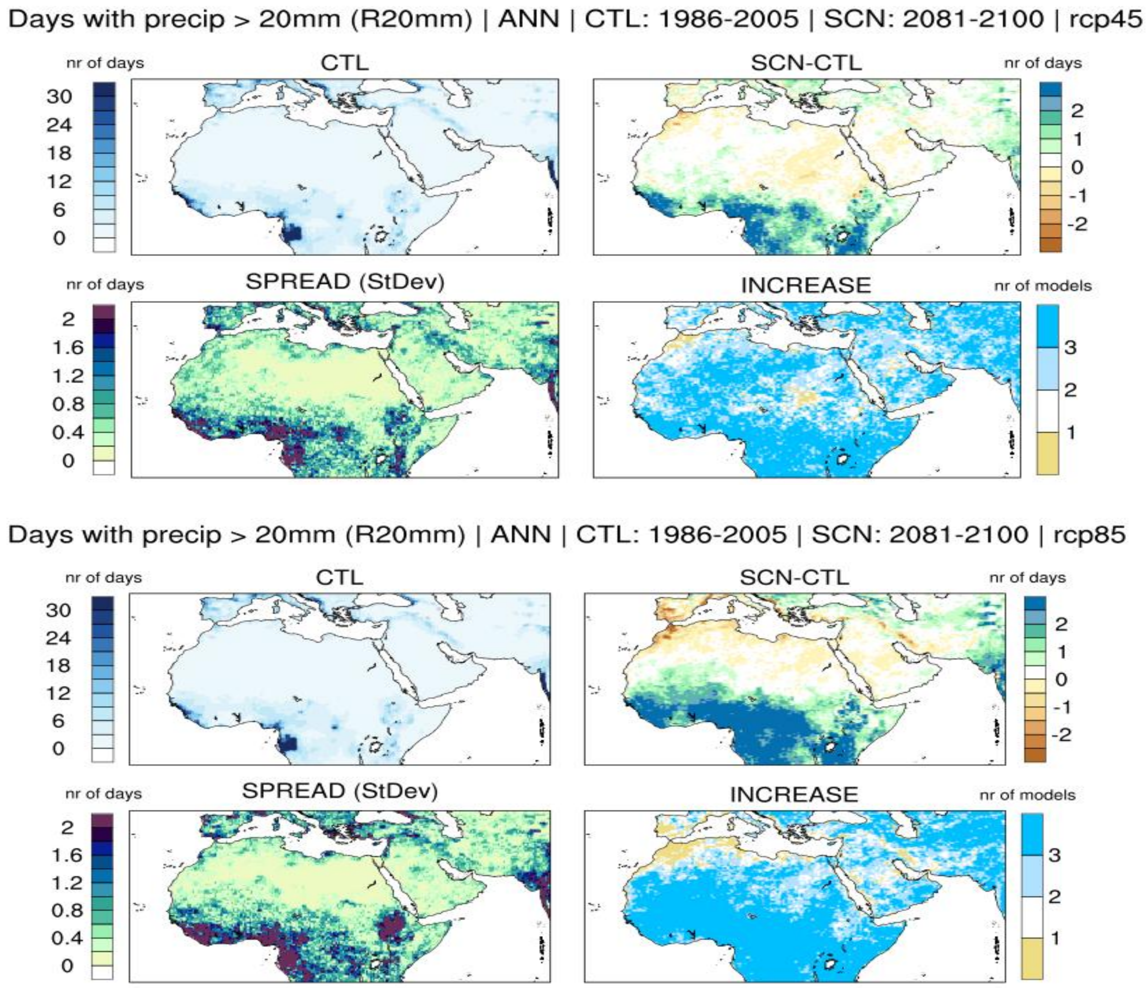


Figure (11) Changes in the "heavy precipitation days" (R20mm, annual number of days when precipitation ≥ 20 mm) for the period 2081-2100 for RCP4.5 and RCP 8.5 compared to the baseline period 1986-2005 for the ensemble of the three projections. The results are similar to the R10mm showing decreasing trends and an overall reduction in rainy days with intensity greater than 20 mm for the Arab region

General predicted Ecosystem and Biodiversity Impacts

-Decreased flow in rivers and streams, causing a loss of ecosystem services.
-Changes in growth, reproduction, and distribution of lake and stream biodiversity
-Changes in community composition and food web structure caused by increased salinity

-Adverse impacts on submerged aquatic plant caused by changes in underwater light regime resulting from an increase in water turbidity caused by more intense precipitation and suspended sediments loads in summer.

-Changes in the reproduction of migratory birds that depend on lakes and streams for their breeding cycle
- At the regional and local scale, drier conditions could induce forest fires, which change biomass stocks, alter the hydrological cycle with knock-on effects for marine systems such as coral reefs, reduce visibility to near zero, impact plant and animal species functioning and detrimentally impact the health and livelihoods of the human population

- The major impacts of human-induced, uncontrolled forest fires on biological diversity and forest ecosystem functioning, and their underlying causes.

-Elimination of migratory species wetland reduction of income of people who are dependent are the major indices of climate change impacts on wetlands in the region

- Apart from the effect on forest vegetation, fire can have a significant impact on forest vertebrates and invertebrates. The direct effect on forest fauna is detrimental.

-Indirect effects of fires are far reaching and longer term and include stress, loss of habitat, territories, shelter and food. Fires can also cause the displacement of territorial birds and mammals.

- The destruction of standing cavity trees as well as dead logs on the ground affects smallest mammal species and cavity-nesting birds

Examples of Hot Spots in Arab region

-Decrease of the level of waters and drying of several which are already under drought stress (e.g. Ammik site in Lebanon, Jabboule site in Syria), reduction of the fresh waters biodiversity in sites, elimination of migratory species in the site, reduction of income of people who are dependent are the major indices of climate change impacts on wetlands in the region.

-In changing precipitation, as for change in temperature, the natural ecosystems especially at risk include the coastal mountain ranges of the Red Sea, the cedar forests of Lebanon and Syria, mangroves in the ROPME Sea Area, reed marshes in Iraq, the mountain ranges in Yemen and Oman and all the major river systems (AFED 2009).

-Reduced rainfall coupled with higher temperatures would decrease water flows in the Euphrates and Jordan rivers by 30 and 80 per cent, respectively, by the end of this century

-For both the Euphrates and the Tigris, it is expected that their discharge would decline at a rate of 30–50 per cent (UNEP 2010).

-Decrease of the level of waters and drying of several that are already under drought stress (e.g. Ammik site in Lebanon, Jabboule site in Syria), reduction of the fresh waters biodiversity in sites.

-2-4 Celsius increase in average air temperature between 2000 and 2100 (RICCAR) might reduce runoff to the Al Wahda Dam (Morocco) by 10 per cent.

-Reduced rainfall coupled with higher temperatures would decrease water flows in the Euphrates and Jordan rivers by 30 and 80 per cent, respectively, by the end of this century - the Fertile Crescent lands (Iraq, Syria, Lebanon, Jordan and the Occupied Palestinian Territories), which depend upon these vital surface waters, will lose fertility due to lack of water and soil erosion (AFED 2009)

-Nine lakes in North Africa (Rhaba, Zerga, Bokka in Morocco, Chitan Ichkeul and Korba in Tunisia and Edkhe, Burullas and Manzela in Egypt) are extremely vulnerable to wind variability due to their value as important bird's habitats. According to EU ChAnge, Stress, Sustainability, and Aquatic ecosystem Resilience In North African(CASSARINA) wetland lakes during the 20th century (Flower, RJ and Patrick, ST 2000) project all nine lakes has undergone substantial ecosystem changes during the last 100 years at an increasing rate over the recent decades. Fresh water availability decreased during the latter part of the 20th century at watersheds.

-General and continuous drought conditions with increase in water deficits in the Mediterranean region. It is expected that such dry conditions and rainfall decrease will put more pressure on available water resources, especially in the major river basins of the region, which will also be influenced by the increase in water demands in the upstream areas of these rivers because of climate change. These phenomena will trigger more competition over water resources, especially in the case of the Tigris and Euphrates (UNEP 2010)

-The number of Ramsar protected sites in the Arab region is 109 with a total area of 12 410 436 ha, 66 per cent of which are in North African countries (Ramsar 2007); the number of World Heritage Sites totals 65 and covers an area of 1 063 259 (8 per cent) in the Arab region. All Ramsar sites in the Arab region will be affected by the impacts of climate change projections. Decrease of the level of waters and drying of several wetlands which are already under drought stress (e.g. Ammik site in Lebanon, Jabboule site in Syria), reduction of the fresh waters biodiversity in sites, elimination of migratory species in the site, reduction of income of people who are dependent are the major indices of climate change impacts on wetlands in the region.

-Mediterranean coastal forests and bushes in Syria, Lebanon, Tunisia, Morocco and Algeria are the most vulnerable to forest fires due to drier conditions. Like other Euro-Mediterranean countries, forest fires have been especially damaging in Lebanon in recent years, representing one of the most important elements that destroy Lebanon's natural resources. Moreover, the absence of a National forest management strategy and the limited human, technical and financial resources contribute to the degradation of Lebanon's forests. The effects of forest destruction have led to fragmentation and loss of the forest ecosystems, which in turn, has had a devastating impact on the livelihoods of local communities. The damages from recent fires were so immense that they reduced the forest cover to 13% in a relatively very short period of time and raised concern at the national and international levels that they could lead to total eradication of forests if radical steps were not taken to solve the problem. To the end of the disastrous forest fires in 2007 which burned more than 2000 ha only in few days. A National Forest Fire Management Strategy launched in 2008 (Ministry of Environment, Lebanon, 2008)

3-1-6 Extreme wind

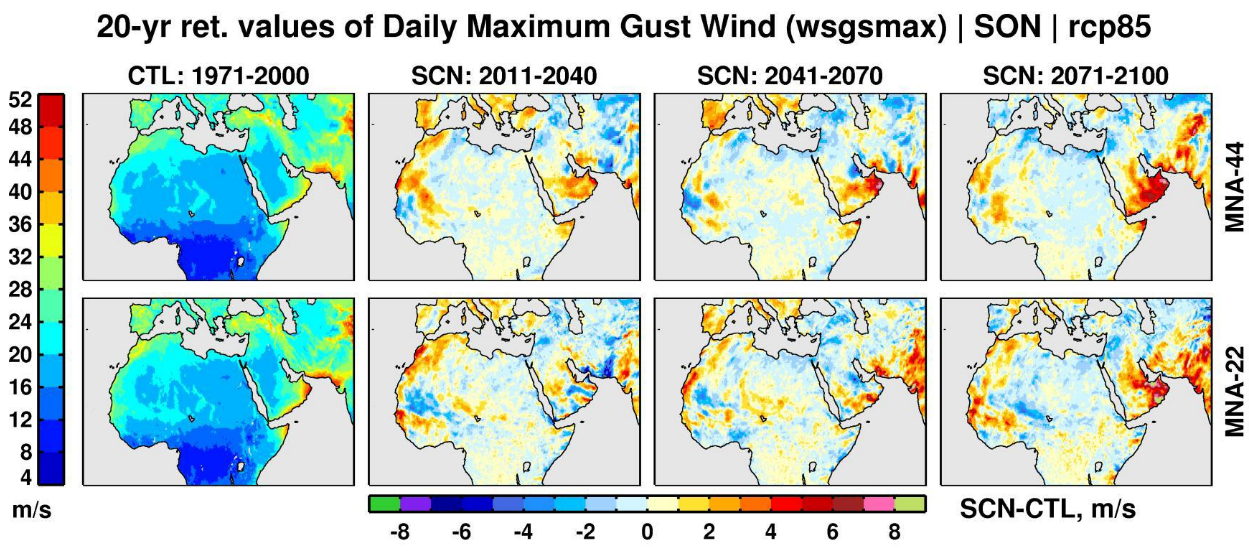


Fig (12) Change in extreme wind pattern for the period 2081-2100 RCP 8.5 compared to the baseline period 1986-2005 for the ensemble of the three projections.

General predicted Ecosystems and Biodiversity Impacts

-Changes in growth, reproduction, and stream biodiversity.
-Increase in water turbidity due to dust sedimentation
-Change in the nutrients load in fresh water systems with high risk of eutrophication due to fertilization of watersheds
-Destruction of selected terrestrial habitats in watershed

-Changes in the reproduction of migratory birds that depend on lakes and streams for their breeding cycle.
- High wind coupled with drier conditions could induce forest fires that have significant adverse impacts on forests fauna and flora with full destruction of forest habitats

Examples of Hot Spots in Arab region

-Merjas Sidi Bou Rhaba and Zerga in Morocco and Garaet El Ichkeul in Tunisia are highly vulnerable because of their value as bird reserves. It supports a high diversity of birds, invertebrates and microphites. Merja Bokka is known locally as a high value site for water birds (Flower, RJ and Patrick, ST 2000).

-The Tihamah plain is home to the majority of southwest Arabian endemic bird species. The mountain juniper woodlands are vital habitat for these birds, such as the Yemen linet (Carduelis yemenensis), Yemen thrush (Turdus menachensis) and Yemen warbler (Parisoma buryi). As the Arabian Peninsula forms a bridge between the African and Eurasian continents, the Asir Mountains and the western highlands of Yemen provide an important resting spot for migrating birds. The high escarpment and cliffs are especially important to migrating raptors in autumn. For example, in excess of 3,000 birds per season pass through Al Hudayah, Gyps fulvus, bearded vulture (Gypaetus barbatus), Yemen linnet (Carduelis yemenensis), Yemen thrush (Turdus menachensis), and African paradise flycatcher (Terpsiphone viridis) are all resident in the high escarpments of the Asir Mountains. Wadi Turabah in Saudi Arabia is the last place in the Arabian Peninsula where the hammerkop (Scopus umbretta) can be found nesting, and the isolated and distinctive endemic race Pica subspicies asirensis is present on Shalla ad-Dhana.

-As for change in precipitation, the nine lakes in North Africa (Rhaba, Zerga, Bokka in Morocco, Chitan Ichkeul and Korba in Tunisia and Edkhe, Burullas and Manzela in Egypt) are extremely vulnerable to wind variability due to their value as important bird s habitats. According to EU CASSARINA project all nine lakes has undergone substantial ecosystem changes during the last 100 years at an increasing rate over the recent decades. Fresh water availability decreased during the latter part of the 20th century at watersheds (Flower, R.J &Al 2000)

-As for change in precipitation, the Mediterranean coastal forests and bushes in Syria, Lebanon, Tunisia, Morocco and Algeria are the most vulnerable to forest fires due to high winds coupled with drier conditions.

4- Ecosystem and IWRM as tools for Climate Change adaptation

The ecosystem approach has emerged as a promising step-wise process to dealing with integration and sustainability of water management (e.g. IWRM). This is because it provides a number of benefits for both people and nature in terms of integrating environment in decision-making, strengthening investment in ecosystems and social inclusion, and catalyzing good governance. Moreover, the ecosystem approach is well adapted to the use of a wider variety of management tools and options. In particular, it deploys alternative non-structural measures to cope with floods and droughts as well as emissions of pollutants into surface and ground waters.

Ecosystem approach: “Focuses on the broader goal of balancing and sustaining ecosystem services, complementing IWRM as a strategy for the integrated management of water, land and living resources in a way that maintains ecosystem health and productivity in balance with sustainable water use…it links ecosystem service delivery and human needs.” (UNEP-IISD 2011)

The Critical Connection

It comes as no surprise that the need for such an approach has increasingly been recognized among water professionals. An ecosystem approach takes into account the role of environmental goods and services, incorporates knowledge about the functioning of the entire catchment ecosystem into planning and management, and focuses on managing water and land resources within catchments and river basins. An ecosystem approach explicitly recognizes the need to maintain watershed ecosystem health. In other words, an ecosystem approach incorporates ecosystem services as a way of expressing value and way to influence behavior to address water security.

The evolution of the IWRM framework to encompass ecosystem services would enable the realization of a broader cluster of benefits from well-managed water and related resources. These would include flood and drought mitigation, biodiversity and wildlife habitat conservation, food production, etc.

4-1 Complementarities between IWRM and EM

What is Integrated Water Resource Management (IWRM)?
IWRM is fundamentally different from traditional water-resource management. Traditional water resource management is concerned with the management of water supply and demand in terms of both quantity and quality. IWRM broadens the biophysical scope of traditional management and explicitly includes the socio-economic context.

IWRM involves integration of two major “systems” and of the elements within each system:
-The natural system, with its critical importance for resource availability and quality; and
-The human system, through which men and women differently determine priorities for resource use, waste production and pollution, and which also sets development priorities.

Natural system integrative elements include:

- Integration of freshwater management and coastal Integration of management of “green water” (water stored in soil or biomass) and “blue water” (water in rivers, lakes and aquifers)
- Integration of surface- and groundwater management
- Integration of quality and quantity in water-resource management
- Integration of upstream and downstream water-related interests
- Integration of management of water stored in the protected areas and use of water in non-protected areas

Human system integrative elements include:

- Mainstreaming water resource issues, and the ways men and women differently approach those issues, into national policies (e.g., economic policy, food policy, environment policy, health policy, energy policy)
- Cross-sectorial integration across all major water use sectors, involving all stakeholders, and Explicitly addressing gender differences

The IWRM framework and ecosystem approach recognize that complementary elements of an effective water resources management system must be developed and strengthened concurrently (Fig.13)

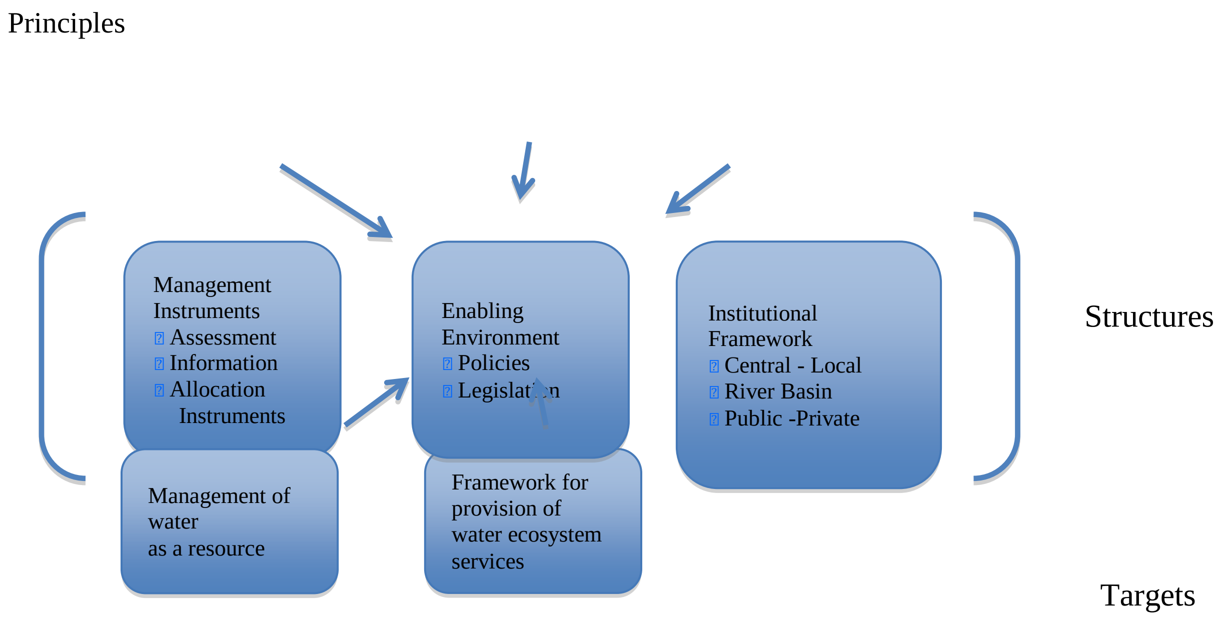


Figure (13) Linkages among principles structure and targets

4-2 Analysis of differences and similarities between IWRM and ecosystem management

Clearly, IWRM and Ecosystem Management have elements in common (Table 2); water is an ecosystem service required from nearly all catchments. Water security controls the lives of millions of people and depends on the characteristics of the ecosystems surrounding the waters. The Critical Connection, an analysis of water security and ecosystem services offers more depth on that relationship and may be an additional useful resource. This analysis of differences and similarities deals with three selected aspects: scope, content and specificity.

Table (2) The complementarity between IWRM and Ecosystem Management. (UNEP-IISD 2011)

IWRM	Ecosystem Management
• Both water quality and water quantity • Provide part of the basis for sustainable livelihoods • Protection and conservation of water resources to sustain functions and characteristics	• Targeted toward human well-being • Supply defined ecosystem services such as provisioning services (e.g., food, fiber), regulating services and cultural services • Watershed services
Typical geographic scope	
• Transboundary • National • River basin • Sub-basin • IWRM typically is applied at an aggregate level	• Ecosystem macro-units (e.g., biomes, eco-regions), meso -units (forests, wetlands, lakes, islands) and micro-units such as farm level • Ecosystems cross river basins or other hydrologic lines • There always is a mosaic of ecosystems in a landscape • Ecosystem management typically is applied at a disaggregated level
Typical thematic content	
• Water cycling • Mineral cycling and biological growth to the degree they have a significant influence	• Water cycling • Mineral cycling • Solar energy flow

on changes in water quality and quantity • Human systems in terms of water use, wastewater production, cross-sectorial water requirements and stakeholder involvement • Natural systems in terms of land and water interaction and upstream-downstream linkages • Interaction between human and natural systems	• Biological growth • Carbon cycling • Land use (e.g., grazing, fire) • Humans as part of the biosphere • Food web • Vegetation layers • Soil coverage • Water bodies • Spatial configuration of species
Typical value statements	
• Economic efficiency • Environmental and ecological sustainability • Social equity and equity in access • Gender plays a strong role	• Values usually are defined on a case by case basis • Human well-being as influenced by ecosystem integrity and ecosystem stability

Global experiences reveal that the successful IWRM implementation is limited in achieving its potential due to inadequate resourcing and fractured governance structures that continue to manage ES as distinct, department or sector-specific objectives (such as agriculture, natural resources, energy, etc.). Actively pursuing an ES agenda would help integrate these sectorial goals through watershed management, while economic instruments, such as Payment for Ecosystem Services, would help provide incentives and resources for such initiatives. Thus, both limitations could be potentially overcome by moving from a more traditional form of IWRM to one that incorporates ecosystem management principles, encourages incentives and markets for managing and providing healthy and sustainable ES, and addressing drivers of ecosystem change more systematically.

4-3 Indicators for Ecosystem Based Adaptation

Indicators facilitate performance assessment. There are a number of guidance manuals that support the selection of indicators to facilitate assessment of Ecosystem Based Adaptation (EBA). When selecting indicators, the following question should be considered:

- How will data availability change during the period of implementing the intervention and beyond?
- What existing metrics are available and what data, collected for other purposes, could be applied in your assessment?
- Can local ecological knowledge inform the selection of indicators?

A FRAMEWORK FOR INDICATOR SELECTION
Ecosystem-based adaptation interventions aim to enhance the delivery of ecosystem services. Monitoring indicators (Table 3) across each element will provide a greater understanding of performance and facilitate adaptive management, with actions focused on the identified areas of concern.

Table (3) Sample of EBA indicators aligned to ecosystem services addressed and different adaptation technologies (UNEP 2011)

Impact area	Adaptation technology	Description	Ecosystem services addressed	Example EBA Indicators
Water Resources:	Rainwater Collection from Ground Surfaces	This practice consists of collecting rainfall from ground surfaces using	-Fresh water -Water cycling -Soil formation and retention	-Number of people with access to clean water -Water quality

		micro-catchments to divert or slow runoff so that it can be stored before it can evaporate.		
	– Small Reservoirs and Micro-catchments	Collecting flows from a river, storm or other natural watercourse (sometimes called floodwater harvesting) which can be stored and used to improve soil moisture for agriculture		-Soil infiltration -Annual per capita water availability -Catchment area
	Catchment Thinning	Catchment thinning involves the planned removal of vegetation (trees) in densely forested areas that are suffering from drought to increase the amount of surface water runoff and increase stream flows. The technique is currently in its infancy	-Food, fiber and fuel -Water cycling	-Stream flow -Number of people with access to clean water -Water quality -Groundwater level -Catchment area -Soil infiltrability
	Bores/Tube wells for Domestic Water Supply During Drought	Increasing access to groundwater through the installation and or improvement of boreholes to ensure a source of potable water during periods of drought	-Fresh water	-Soil salinity -Water quality -Water balance -Number of people with access to clean water -Estimated costs of developing groundwater sources for rural domestic supply
	Desalination	Desalination is the process of removing sodium chloride (salt) from brackish water as well as sea-	-Freshwater	-Number of people with access to clean water -Water quality -Incidence of water borne disease

		water. Desalination can be achieved through either thermal processes (evaporation) or membrane processes		
	Improving the resilience of wells to flooding	This technology consists of construction containment structures (bunds) around wells and bores to prevent contamination from floodwaters. The structures are generally a concrete apron with a clay (bentonite)/grout or concrete seal	-Fresh water -Human disease regulation	-Water quality -Occurrence of well inundation -Number of people with access to clean water
	Rainwater harvesting from rooftops	This basic technology involves the collection of rainwater from rooftop catchments and diversion to a storage reservoir (tank) for later use	-Freshwater	-Number of people with access to clean water -Water quality and quantity -Water storage capacity

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Examples of integrated adaptation management for flood and drought management

As mentioned, in Section 3 of this Manual, RICCAR impacts projections indicated that the Arab region would be subject to extreme events causing floods and long period of drought due to heavy precipitations, therefore flood and drought management are important in the framework of ecosystem based- adaptation in the water sector. World wide several counties adopted extreme events management based on ecosystem based - adaptation. The section related to water management are cited in the following examples:

The **Dutch** strategy includes a section dealing with river improvement. In 2006, the Dutch Cabinet drew up the Spatial Planning Key Decision “Room for the Rivers.” Three objectives are as follows:
-By 2015, the Rhine River branches will safely cope with an outlet capacity of 16,000 m3/s;
-The measures implemented to achieve the above will also improve the quality of the environment of the river basin;
-Rivers will be provided with the extra space needed in the coming decades owing to expected climate change

In **Japan** adaptation strategies in relation to community development: Land-use regulation can enhance the effectiveness of prevention measures. Designation of disaster risk zones based on a legal code can prohibit further development or promote flood proofing in the area. A new concept for urban development, aiming towards more compact built-up of urban areas makes flood protection measures more effective, on the one hand, and more effective in energy consumption, on the other. Regulations, such as city codes and subsidies, should promote implementation of facilities for rainwater storage, infiltration and runoff control in an integrated manner at the (urban) basin scale.

California has established Integrated Flood Management in the California Water Plan, which provides a framework for water managers, legislators and the public to consider options and make decisions regarding California's water future. It recognizes the necessity of paradigm shifts and decided to introduce an Integrated Flood Management (IFM) approach in flood management. Management consists of structural approaches; land-use management; disaster preparedness, response and recovery. It, as well, establish a System Reoperation Task Force comprising state personnel, federal agency representatives and appropriate stakeholders. The Task Force will provide analyses for river basin management. In particular, it will support the update of flood frequency analyses on major rivers and streams.

In **China**, the adaptation strategy includes enhancing water resources management:
-Converting farmland back into lake or river courses, removing polder dikes for flood ways, and dredging river channels and lakes.
-Rehabilitating and protecting rivers from serious ecological problems while strengthening dike construction and key water control projects.
-Enhancing unified management of water resources through basin-wide integration of water resources planning, allocating, saving, protecting, and optimizing water resources.

In **Korea**, the following adaptation strategies in water management:
-Integrated countermeasures for floods among ministries and government agencies,
-Increased efficiency of water resources management, and
-A systematic and accurate structure for early warnings of floods by the central government and local authorities to minimize the damage from disasters.

Drought like many risk management needs a cross-cutting approach and therefore requires a wide range of inputs (e.g. cultural, socio-economic, etc.). Accordingly, drought management capacities must be strengthened, including capacities to develop integrated plans. Evaluation of risk management measures and practices must be undertaken to determine if they are effective. − Those policies should include early warning systems and a set of actions to improve the preparedness within the most vulnerable areas, e.g. improve community socio-economical preparedness (assets, governance and technology), create alternative economic micro and macro opportunities, change land use and crop pattern, introducing new seed varieties more tolerant for drought, increase water irrigation efficiency and income per water cubic meter. The Political issues as well play a great role within the drought risk management and must be committed to create the necessary capacities in order to reduce the risk. That could be seen from the Governments make the drought problems visible to the public eye and the politicians. Governments should invest and promote inter-disciplinary dialogue to improve awareness and to define the issue and communication to address drought risk (ACSAD-ISDR2011)

In 2006, a National Drought Strategy was commissioned by the Ministry of Agriculture and Agrarian Reform (MAAR) in Syria supported by the FAO. The strategy has the intention to put in place mechanisms to determine a drought warning stages, provide measures to minimize the impact and facilitate post-drought recovery. However, this strategy was directed primarily to the agricultural and livestock sectors while the drought also could also cause serious impact on other sectors such as urban water supply energy, industry, tourism, health and ecosystems. Perhaps the most dramatic socio-economic effects of drought are the seemingly irreversible migration of the affected rural population, to urban areas, which Syria has widely witnessed in recent years.
The developed National Drought Strategy could be extended to a national drought strategy encompassing all the water-using sectors (potable water, agriculture, industry, energy and ecosystems) as part of the Water Strategy and the long term development of the Water Sector in the country. This may also include options to mitigate the impact of drought periods by developing options for increasing sub-surface groundwater storage in suitable areas.

These examples indicate the general trend, adopted by watershed managers, planners and decision makers, to consider more and more the application of the elements of ecosystem integrated management as tools for adaptation to climate change to flood management.

5- Ecosystem adaptation measures

Ecosystem -based adaptation measures to climate change in the water sector, are related to the ecosystem structure, its functioning, its state, ecosystem services provided and management tools and monitoring and evaluation.

5-1 The structure and function of ecosystems

What is ecosystem management?
Ecosystem management can, be defined as working with ecosystem functioning to supply defined ecosystem services. The functioning of ecosystems depends on the interactions between core ecosystem processes and the structure of the ecosystem. This section explains what an ecosystem is, what ecosystem services are, and how thinking in terms of ecosystem structure and processes can help management.
In many ways, ecosystem management is a small but significant redirection of management goals and energies. In other ways, ecosystem management is a new perspective or way of thinking about existing management of land and water resources (e.g., farming, forestry, supply of water resources, recreation and tourism, or biodiversity conservation). An ecosystem management perspective helps to achieve these objectives for using land and water resources by including understanding of how the natural environment 'works' or operates as an ecosystem. Understanding the natural world as an ecosystem helps to design management activities that are more likely to produce intended results on a sustainable basis.
Ecosystem management also sees people as not only dependent on ecosystems but also as part of ecosystems. We both depend on ecosystems for services such as food and freshwater and influence them as we harvest products, alter them through farming and other land uses, and emit our wastes into the natural world.
What is an ecosystem?
The concept of an ecosystem comes from the science of ecology, which is the study of the underlying principles and interactions of organisms and their environment. While the science of ecology can be very detailed, this section introduces a few core principles that can be easily understood to help practical management.

What are ecosystem services?
The simplest and most widespread definition of ecosystem services is the benefits people obtain directly and indirectly from ecosystems. A similar definition is that ecosystem services are the benefits provided by ecosystems that contribute to making human life both possible and worth living. Examples of ecosystem services include products (e.g., food, fuel, and water), regulation of floods, prevention of soil erosion, buffering against disease outbreaks, and nonmaterial benefits such as the recreational and spiritual benefits of natural areas.
The Millennium Ecosystem Assessment grouped ecosystem services into four broad categories:

- Provisioning services are products obtained from ecosystems, including food, fiber, fuel, genetic resources, ornamental resources, freshwater, biochemical, natural medicines and pharmaceuticals.
- Regulating services are benefits obtained from the regulation of ecosystem processes including air quality regulation, climate regulation, water regulation, erosion regulation, water purification, waste treatment, disease regulation, pest regulation, pollination and natural hazard regulation.
- Cultural services are non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences, including cultural diversity, spiritual and religious values, knowledge systems, educational values, inspiration, aesthetic values, social relations, sense of place, cultural heritage values, recreation and ecotourism.
- Supporting services are necessary for sustaining the production of all other ecosystem services. Examples are primary production (plant growth) and nutrient cycling for soil formation and water quality regulation. Because ecosystem services are defined in terms of their benefits to people, we should recognize that the value assigned to any ecosystem service is context dependent.

Table (4) Ecosystem Services Provided by or Derived from the Iraqi Marshlands

Service	Sub-category	Definition	Examples
Provisioning services – the goods of products obtained from Marshlands' ecosystems			
Food	Crops	Cultivated plants or agricultural produce which are harvested by people for human or animal consumption	• Paddy rice • Great millet • Dates • Vegetables and fruits
	Livestock	Animals raised for domestic or commercial consumption or use	• Asian water buffalo • Cattle • Sheep • Water-buffalo milk and yogurt
	Capture fisheries	Wild fish captured through trawling and other non-farming methods	• Shrimp • Yellow fin sea bream • Khishni
	Aquaculture	Fish, shellfish, and/or plants that are bred and reared in ponds, enclosures, and other forms of fresh- or salt-water confinement for purposes of harvesting	• Cyprinids • Grass carp • Shellfish
	Wild foods	Edible plant and animal species gathered or captured in the wild	• Wild boar • Waterfowl (coot, teal) • Desert monitor
Freshwater		Inland bodies of water, groundwater, rainwater and surface waters for household, industrial and agricultural uses	• Freshwater for drinking, cleaning, cooling, and transportation (canoeing and boating)
Fiber and fuel	Fiber	Wood and non-wood based fibers for a variety of uses	• Reeds for housing and mats • Date palm wood
	Fuels	Fossil fuel and biomass fuel	• Reeds • Crude oil • Cattle dung
Biochemical		Extracted medicines and other materials from biota	• Potential use of Marsh flora extracts, native herbs for pharmaceuticals and pest control
Genetic materials		Genes and genetic information used for animal breeding, plant improvement and biotechnology	• Resistance and breeding of native plant and animal

			species
Regulating services – the benefits obtained from the Marshland ecosystems’ control of natural processes			
Climate regulation		Source and sink for greenhouse gases; influence local and regional temperature, precipitation, and other climatic processes	• Help moderate the national rainfall patterns and control desertification and dust storms
Water regulation	Hydrological flows	Water storage, timing and magnitude of water flow and recharge of aquifers	• Storage and retention of water flowing from Euphrates-Tigris system upstream and tidal flow downstream • Permeable clay and silt facilitates recharge of the Recent Alluvium aquifer
	Water purification and waste treatment	Retention, recovery and removal of excess nutrients and other pollutants	• Marsh wetlands remove harmful pollutants from water by trapping metals and organic materials • Soil microbes degrade organic waste rendering it less harmful
Erosion regulation		Role vegetative cover plays in soil retention	• Reeds, grasses and estuarine vegetation retain soils and sediments
Natural hazard regulation		Capacity of the Marshland area to reduce the damage caused by natural hazards	• Marsh areas naturally absorb seasonal floods and tidal surges • Moderation of drought at a local scale
Pollination		Animal-assisted pollen transfer between plants, without which many plants cannot reproduce	• Habitat for bees and birds, the key pollinators of economically important crops
Cultural services – the nonmaterial benefits that Iraqis obtain from Marshlands ecosystems			
Ethical values		Spiritual, religious, aesthetic, intrinsic or other values that Iraqis	• Customs, oral traditions, knowledge

		attach to the ecosystems, landscapes or species of the Marshlands	and rituals attached to the use of the land and rivers • Iraqi tangible and intangible cultural heritage • An area of global importance
Recreation and tourism		Recreational activities that people derive from the Marshlands ecosystems	• Canoeing, bird and wild-life watching, recreational fishing, archaeological site visitation, Marsh communities
Aesthetic		The value that Iraqis and the international community place on knowing that the Marshlands exists, even if they never use the area	• Globally significant natural beauty
Educational		Opportunities for formal and informal education and training	• Science, cultural awareness, specialized vocational training, public awareness of national, regional and global importance
Supporting services – the underlying processes that are necessary for the production of all other ecosystems services			
Soil formation		Process by which organic material is decomposed to form soil	• Retaining sediment, recycling and supporting the health of the ecosystem
Nutrient cycling		Storing, recycling, processing and acquisition of nutrients	• Returning phosphorus, sulfur and nitrogen to Iraq's atmosphere, water and soils

Using the concept of ecosystem services in management

When using the concept of ecosystem services in the management of an area, it is easiest to start with identification of the desired provisioning services, also called 'goods' in economic terms, because they are the physical things that can be harvested and consumed or sold. Under conventional land and water resource management approaches, management objectives have often been to maximize production of these physical goods. One way of viewing ecosystem management is to expand the definition of production beyond provisioning ecosystem services to include maintenance of the regulating and supporting services that underpin the provisioning services, and to include as consideration of desired cultural services.

5-2 Ecosystem functioning: Core processes and structure for the supply of services

Ecosystem processes

The functioning of ecosystems, that is, how they ‘work’ or ‘operate’ as an ecological system, can be understood in terms of four core ecosystem processes and how these interact with the structure of the ecosystem and landscape. Management for desired ecosystem services needs to consider both the necessary ecosystem structure and the functioning of ecosystem processes to supply the services.
Thinking of and seeing the natural world in this way is central to an ecosystem approach to management.
The four core ecosystem processes that are part of the functioning of ecosystems at all scales are:

- Water cycling
- Mineral cycling
- Solar energy flow
- Biological growth

When managing land and water resources for particular ecosystem services being able to think in terms of solar energy flow is important for several reasons. All provisioning ecosystem services except freshwater supply are the product of living organisms. The production (biomass) of these organisms depends directly on the amount of solar energy they can obtain.

The four core ecosystem processes are aspects of the same system

While each of the four cores ecosystem processes can be considered individually they are completely interlinked, and so change in the functioning of any one of them automatically means change in the functioning of the others. They are just different aspects of the same system.

Ecosystem structure
For the purposes of ecosystem management, especially in freshwater systems, the most useful types of ecosystem structure that can be considered for management are:

- Structure of the food web
- Physical structure of vegetation layers
- Soil coverage
- Water bodies
- Decomposition of organic matter
- Spatial configuration of species

Climate, topography and soil types are also major determinants of ecosystem structure and processes, but these are obviously less amenable to management actions.

Ecosystem resilience and transformation risk
Another valuable result of thinking of the natural world as an ecological system is that systems can have properties or behavior that only occurs because of the combination of all the components of the system. One such emergent property is the degree of resilience of the system to absorb pressures or stresses on it without significantly altering its structure and functioning.
The resilience of an ecosystem could be measured in terms of the risk of its transformation to an undesirable state. The transformation risk for each ecosystem process could be assessed under current management practices and the practices necessary to deliver the desired ecosystem services.

5-3 A conceptual framework for understanding ecosystem state and impact

Overview of the DPSIR framework
To intervene in ecosystems in the interest of achieving certain management goals and objectives, we must understand the ecosystem’s state and trends, what forces affect them, and the impacts of ecosystem change. Because no two ecosystems are the same, the specifics of an analysis will differ case by case. However, similarities among ecosystem structure, function and dynamics allow us to use general frameworks to guide analysis.

The Driving Force-Pressure-State-Impact-Response (DPSIR) (Fig.14)framework has been developed over thirty years to analyze the dynamic interaction of human society and the environment.
The underlying idea of the DPSIR framework is that the state of the environment or of ecosystems is a combined result of broad natural and anthropogenic forces of change, collectively called Pressures (Pinter & al.2008)

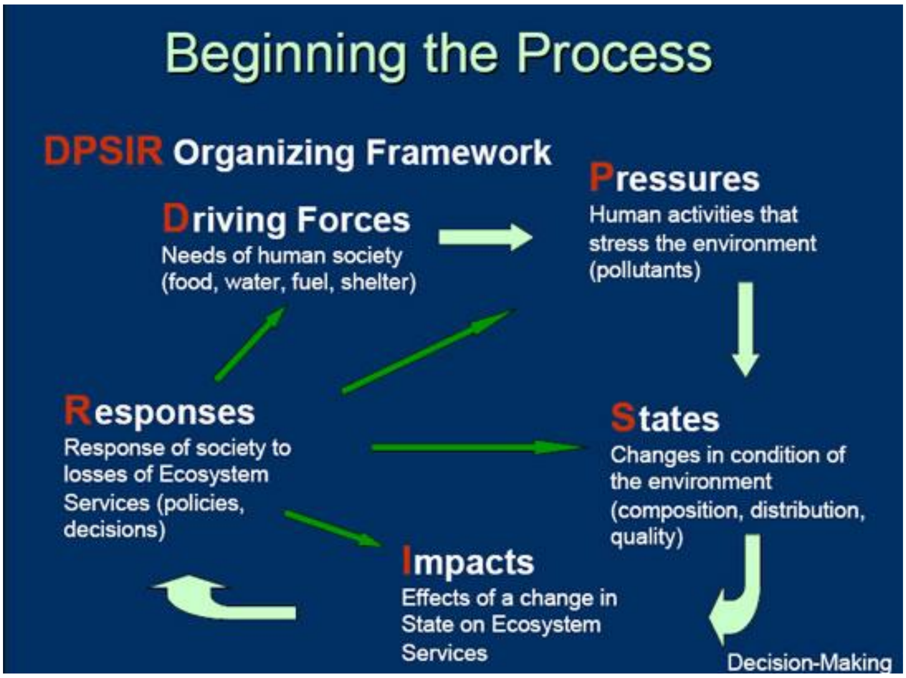

Figure (14) shows a simple representation of the DPSIR components of the framework and their connections.

Of course, these connections are anything but simple. Environmental state and trends are usually the net result of multiple, interacting forces of change. In any given ecosystem, there are also many different subsystems and associated variables (e.g., the hydrological regime, soil, biodiversity) that define overall ecosystem conditions. It is also clear that changes in one ecosystem condition can result in cascading sets of impacts. For example, changes in the hydrologic cycle can have implications for agriculture, hydropower production, public health, municipal infrastructure, and others.
While recognizing simple cause-effect relationships is important, ecosystem management must take into account the full complexity of these relationships as they play out on the landscape over time. A DPSIR analysis focused on a given ecosystem will identify different relationships.

Table (5) Example of DPSIR Indicators

Driving force (economy and social indicators)		Pressure (human activity)	State (current status and environmental change)	Impact (ultimate impact of environmental change)
Social	•Population density •Population growth rate •Education level •Average age of citizens •Number of house	•Urbanization rate •Change of forest area by industrialization •Increase of mining area •Number of production factory •Emission load of waste water •Fertilizer use	•Household water use per day •Water resource supply rate •Achievement rate of environmental flow in river •Irrigation rate •Water resource use per people	•Days under water quality goal •Number of environmental accident •Death rate of below age of 5 years •Population and damage area due to the limited

Economical	•GDP per people •Unemployment rate •Asset value •Number of car per people •Investment of environment part •Development rate	•Impervious area rate •Available seawater resource •Maximum daily rainfall •Totally available water resource •Altitude and watershed slope •SOx, NOx emission rate •Water demand for agriculture •Industrial rate	•Water resource per agricultural land •BOD goal achievement rate •River water quality •Groundwater quality •Floods frequency •Drought rate •Change rate of temperature •Change rate of water quality •Change rate of ecosystem	water supply •Drought damaged property density •Decrease of river water resource •Disease problem caused by water quality
Environmental	•Water bodies •Forest •Agriculture production rate •Number of dams •Protection area			

What is happening to the ecosystem and why?

Successful management requires that we begin by understanding the current state and dynamics of the ecosystem and the conditions that led to the present situation. Answering these questions is the starting point of the DPSIR analysis and should involve addressing the following sub-questions:

-What are the priority issues and concerns in the ecosystem?

-What are the specific states or conditions beyond the priority ecosystem condition identified and how have those states and conditions changed over time?

-What are the key pressures and drivers that contributed to the specific changes identified?

-What are the priority issues and concerns in the ecosystem?

Given the complexity of ecosystems, at any given time, there is a very large number of issues that require the interest of an ecosystem manager. However, without losing a whole-ecosystem perspective, it helps to identify priorities and establish focus that can guide both analysis and management. Because of the large differences among ecosystems depending on their location, size, socio-economic context and other surrounding factors, the mix of priority issues tends to differ from place to place. Priorities may also change over time, because of new ecosystem dynamics, new social priorities or new scientific insights. Therefore, periodic review is essential.

Table (6) Examples of priority environmental issues from the Arab region (UNEP, GEO5)

Freshwater Figures contained in GEO 5 show that water scarcity due to climate change might reduce the available renewable water resources by 15–20 per cent in the next 50 years. This could lead to decreases in the flow of major rivers and groundwater recharge rates, a higher frequency of flash floods and droughts, and a loss of productivity in rain-fed agriculture.	*Soil, Land Use, Land Degradation and Desertification* Land degradation and desertification are one of the main environmental problems facing West Asia, according to GEO 5. Developments such as the intensification of crop and livestock production and pastoral activities, war, overuse of agrochemicals, overstocking of livestock, and a lack of integrated water-land-use planning and management have

	resulted in reduced ecosystem services, including biodiversity loss.
Oceans and Seas The coastal and marine environments in the Arab Region are facing threats due to pressures from the urbanization of coastal zones, tourism, maritime and oil traffic, rapid industrialization and overfishing. This has contributed to the depletion of living resources, coastal zone degradation and marine pollution. Many West Asian countries are involved in land reclamation activities with adverse impacts on coastal and marine ecosystems.	
Priority environmental concerns	
1. Declining Water Quality in Rivers and Coastal Waters 2. Increasing Environmental Risks from Hazardous Materials and Wastes 3. Inadequate or Unsatisfactory Water Supplies 4. Loss of Critical Habitats and Biodiversity 5. Declining Coastal and Marine Resources	6. Increasing Land Degradation 7. Disturbed or Unpredictable Hydrological Regimes 8. Climate Change 9. Air Pollution 10. Noise Pollution

What are the specific states or conditions beyond the priority ecosystem issues identified and how did these states and conditions change over time?

To understand how these ecosystem states, change over space and time, you will need to identify specific indicators. Indicators represent a quantitative description of a specific ecosystem condition and they can serve as instruments to diagnose problems or measure the effects of management action.

Indicator selection is usually a separate sub-process involving, or at least consulting technical experts or literature on how relevant environmental variables can be quantitatively measured. Indicators often rely on data that already existed or can be gathered given existing technical, scientific and capacity constraints. Typically, indicator selection is guided by indicator criteria.

Table (7) Exemplary drivers and pressures, taken from (UNEP, GEO 4)

Drivers • Consumption and production patterns • Demographics • Science and technological innovation • Economic demand, markets and trade • Institutional and socio-political frameworks • Distribution patterns	
Sectors • Agriculture, fisheries and forestry • Transport and housing • Finance and trade • Energy and industry	Human influence • Pollution • Land use • Resource extraction • Modification and movement of organ-

Security and defense • Science and education • Culture	isms

5-4 State of ecosystem services and functioning

Determining management objectives in terms of ecosystem services, processes and structure.
We have defined ecosystem management as working with ecosystem functioning to supply defined ecosystem services. This Module explains the seven steps for setting management objectives with this perspective (Figure 15). An emerging way to encourage good practices and to share costs and benefits among the stakeholders in the catchment involves harnessing the value and specifying the rewards of ecosystem services. Figure (15) illustrates the process of identifying and evaluating ecosystem services in management.

Figure (15) Flow diagram of a pathway for using ecosystem services to identify management objectives

Step 1: What are societal priorities for ecosystem services?
In step 1 determines which ecosystem services are necessary to give the quality of life and income for the users, managers of the land or water area, and 'off-site' or downstream beneficiaries. The identification of ecosystem services is done in relation to each of the four core ecosystem processes. For each process, firstly it is to identify the necessary provisioning and cultural services, and then identify the regulating services that help to maintain them. Ideally, for each service, the desired value and a minimum and maximum acceptable value are determined. It is critical in this step to carefully and explicitly bring in local ecological knowledge, as well as the views of any indigenous and native people who are stakeholders in the catchment.
An important element in this step is to understand local hydrology. Catchments are hydrologically defined. Understanding where and how water is delivered (e.g., as rainfall), how hydrology changes along the axis of the stream channel and with land use, and how different ecosystems services require different water quantities and qualities are critical to sustaining those services. In that regard, it is important to recognize that ecosystem itself is a stakeholder here. Environmental flows are those that maintain the functions of the ecosystem (e.g., fish habitat, water for wildlife). Those minimum base flows must be identified and either quantified or at least estimated to ensure sustainability.

Table (8) Exemplary ecosystem services related to the four cores ecosystem processes (Millennium Ecosystem assessment 2003)

Exemplary ecosystem services related to the water cycling ecosystem process	**Exemplary ecosystem services related to the mineral cycling ecosystem process**
Provisioning ecosystem services	**Provisioning ecosystem services**
Water for crop irrigation: m3 per day for x days	Mineral levels in the soil necessary for food crops, forage for livestock, or tree growth –soil pH, mineral parts per million, % organic matter
Soil water moisture levels for agricultural crop or tree growth: x % humidity for x days	River or lake water turbidity and quality for aquaculture
Water flow from springs or pumped from groundwater for livestock and wildlife drinking at x liters per day for x days	Drinking water quality for x number of people daily, or yearly
River water flow or volume in lake for aquaculture or transport –- x m3 per day	Downstream water quality for other users (e.g., industry, domestic, agriculture, HEP)
Drinking water for x number of people daily, or yearly, at x liters	
Downstream water flow and quality for other users (e.g., industry, domestic, agriculture, HEP)	
Exemplary ecosystem services related to the solar energy flow ecosystem process	**Exemplary ecosystem services related to the biological growth ecosystem process**
Provisioning ecosystem services	**Provisioning ecosystem services**
Levels of photosynthesis by food crops, forage for livestock and wildlife, tree growth– biomass increase, kg/ha	Growth rates and production of food crops forage for livestock and wildlife, trees, medicinal plants, fish, game species. – biomass increase, kg/ha
Levels of sugars and protein in forage for livestock and wildlife: % protein	Availability of prey for wild predators hunted commercially or for recreation
Availability of prey for wild predators valued for hunting, tourism or regulation of prey species	Availability of organisms to ensure the decomposition process
Cultural ecosystem services	**Cultural ecosystem services**
Presence and population size of species and ecological communities valued for spiritual, recreational or educational reasons	Individual and group cultural practices and well-being based on farming, hunting, management and contact with land and water ecosystems and species Presence and population size of species and ecological communities valued for spiritual, recreational or educational purposes
Regulating ecosystem services	**Regulating ecosystem services**
Availability of food for animals that pollinate and disperse the seeds of crops and wild plants	Availability of food and habitat for animals that pollinate and disperse the seeds of crops and wild plants
Availability of food for predators that reduce populations of agricultural	Availability of food and habitats for predators that reduce populations of agricultur-

pests and human disease agents	al pests and human disease agents
Production of plant matter to support soil formation: kg/ha	Production of plant matter and animal wastes to support soil formation: kg/ha.
Global climate regulation through the sequestration of carbon dioxide by vegetation and soils: tons of carbon/ha	Global climate regulation through the Sequestration of carbon dioxide by vegetation and soils: tons of carbon/ha

Step 2: What ecosystem functions are needed to deliver those services?
In step 2 determines the necessary functioning of each of the four ecosystem processes to deliver the desired ecosystem services (there will be considerable overlap in the results because the processes are different aspects of the same system). The necessary functioning of each ecosystem process may be different for different ecosystem services. Catchment-specific consideration will also be required to account for variation in climate, topography and soil types. This means that some prioritization and trade-offs between the desired ecosystem services from an area may be necessary. As a result, there may be a compromise in the level of functioning of the ecosystem processes to satisfy a range of ecosystem services. The identification in step 1 of desired ecosystem services in relation to the ecosystem processes helps to determine the main features of the processes that are required for each land unit or water body being managed.

Step 3: What ecosystem structure is needed to support those functions?
This section introduces ways that ecosystem structure can be described and measured to influence the desired functioning of ecosystem processes. This process should begin by building a description of the food web in terms of the requirements of the decomposers, then the predators, and finally herbivores and plants. Descriptions of the soil structure and vegetation layers should follow.
The descriptions of the functioning of the ecosystem processes in Step 2 will already have produced useful information on the desired ecosystem structure, because the processes are often measured using indicators of physical aspects or structure of the system

Step 4: Map the landscape to identify ecosystem structures
Step 4 considers the spatial distribution or configuration of vegetation and crops, water bodies, livestock, wildlife, recreation and cultural values, etc. as part of the necessary ecosystem structure for the desired services. The overall principle that needs to be kept in mind with this step is to be guided by the likely effects of landscape and waterscape structure on the desired functioning of the ecosystem processes. This will obviously require local knowledge. In addition, the potential for actually changing the spatial configuration of landscape and waterscape structure will depend greatly on local topography and the resources available. This step may well involve a long-term plan and periodic steps.

Step 5: Plan management actions to change landscape structures
Step 5 is the stage of planning actions to move toward the desired structure of the ecosystem and landscape. It is not possible to know fully what actions will be required for the variety of circumstances, desired ecosystem services, and local and scientific knowledge. As stated earlier, in some ways ecosystem management is a new perspective or way of thinking for current of land and water resource managers, such as for farming, forestry, supply of water resources, recreation and tourism, cultural or spiritual values, or biodiversity conservation.

Step 6: Evaluate the risk of bad landscape transformations from a management action. The concept of ecosystem resilience and transformation risk as one way of measuring resilience has been already introduced. Before any planned management actions are implemented, they should be assessed to see if they could increase the risk of transformation of ecosystem functioning to an undesirable state. This first requires identifying possible thresholds for undesirable changes in ecosystem structure and processes. This should be done for each of the ecosystem processes.

Step 7: Design monitoring and evaluation to assess ecosystem service delivery
Section 5-5 describes the adaptive management cycle, an essential part of which is monitoring. When practicing management of ecosystem functioning, it must not be assumed that our understanding of ecosystems and their response to management is sufficient to make fixed plans. The complexity and variability of the natural world mean we must frequently measure our progress toward our goals, and then make needed ad-

justments. In some cases, this may require a complete re-planning if our initial assumptions and plans do not produce the intended results.

Box (1) The Okavango River Basin management plan
(Namibia, Zambia, Zimbabwe, Botswana, Angola)
Ecosystem Services (ES) and Drivers of Change
Freshwater is the major environmental and socio-economic resource in the Okavango River Basin (ORB), directly supporting all human activity, vegetation, and wildlife habitats and their associated productivity. The productivity associated with freshwater use and its related aquatic ecosystems is estimated at approximately 25% of GDP in the basin as a whole, with considerable inter-country variability. Freshwater sources are also the natural resource component most at risk since there is no economic substitute for the basin's watercourses and associated aquifers, which are also the final repository of human waste. The status of the sources and characteristics of the freshwater balance in the basin are critical resources for development and are irreplaceable global environmental assets.
OKAvango COMission (OKACOM) has successfully brought the riparian countries together under the organizing principle of 'Three Nations One River'. The cooperation among states and between nations and civil society to manage transboundary water resources is a significant shift away from the top-down approach to water rights that has been historically prevalent. It is a promising step towards a new model of benefit-sharing across the basin and bodes well for a future of consensual management to solve problems related to shared water resources.
OKACOM's framework analysis under the Transboundary Diagnostic Analysis/Strategic Action Programme(TDA/SAP) views the ORB as a whole and it adopts the IWRM and ES approaches, especially in the application of the Environmental Flows Assessment, which treats the systems in an integrated fashion that cuts across national political boundaries. It also recognizes and addresses the pressures from outside the hydrologically active basin. Through its goal to secure poverty eradication without undermining the integrity of ecological systems, OKACOM acknowledges how changes to ES will affect the economy and livelihoods. Thus, OKACOM consolidates the political basis for transboundary IWRM and continues to provide the unifying structure for cooperation.
Regional demands for water resources need coordination, with an integrated joint management plan and a comprehensive approach to demand management to avoid conflict. OKACOM Ecosystem Approaches in Transboundary IWRM has begun this process, but its role and responsibilities need to be formally expanded to foster the equitable sharing of the basin's waters among riparian nations and to allow them to jointly decide on the types of development they wish to encourage. If the threats to the basin's ES are not addressed through IWRM, however, there will be irreversible changes in the basin's water balance and hydro-chemical and hydrogeomorphological responses. Such changes will affect the productivity and environmental integrity of the basin as a whole.

Understanding current conditions

Information base for managing ecosystems

The development of an information base forms a key element to supporting the establishment of legal, economic or outreach instruments for managing ecosystems. Whereas knowledge lies at the center of any learning process, learning is broader than information. It combines traditional and innovative strategies such as teaching, testing of new ideas or staff exchanges to assist practitioner networks and support professional updating.

A useful toolkit to support learning around this topic is FLOW: The essentials of environmental flows. http://iucn.org/about/work/programmes/water/resources/toolkits/flow/. Methods for evaluating environmental flows are reviewed and contrasted in (Arthingon and Zalucki 1998).

Improved water governance underpins action

Effective water governance capacity is the foundation of efficient management of water resources. Water governance reform processes must work towards building capacity in a cohesive and articulated approach that links national policies, laws and institutions within an enabling environment that allows for their implementation. RULE: Reforming water governance shows how national water reform processes can deliver good water governance by focusing on the principles and practice of reform.

Developing water policies is the first step in the implementation of an ecosystem approach. Policies set goals for water use, protection and conservation. Specific knowledge will however be required on how to prepare national water resources policy as well as to identify policies with relation to water resources. Also part of the same enabling environment, lessons learned and tools for use in the development of water law will be valuable background for improved regulatory capacity whether they address water rights, legislation for water quality or reform of existing legislation.

Lack of transboundary coordination impairs action
A useful toolkit to support learning around this topic is SHARE: Managing waters across boundaries. This document provides an overview of the world's shared water resources and insights for managing these resources. Using case studies from around the world, it describes the benefits to be gained from cooperation and the challenges of constructing legal frameworks, institutions, management processes, financing, and partnership strategies to govern transboundary waters equitably and sustainably.

Financial incentives support implementation of an ecosystem approach
Payments for watershed services are an emerging innovation in water management. PAY: Establishing payments for watershed services offer a hands-on explanation of the issues that need to be addressed when establishing these payment schemes. It explains the services and the values of watershed services. It then highlights the technical, financial, legal and social aspects of establishing payments schemes for maintaining or restoring watershed services critical for downstream water security.

Empowerment enables participation in action
Water practitioners are increasingly called upon to negotiate workable agreements about how to best use, manage and care for water resources. NEGOTIATE: Reaching agreements over water makes the case for constructive engagement and cooperative forms of negotiation in dealing with complex water issues.
At the local level, villagers also have the opportunity to use indigenous knowledge to conduct participatory research for informing decision-making over fish stocks. Other case studies about empowerment and enabled participation can be found at http://iucn.org/about/work/programmes/water/resources/toolkits/negotiate/. One important resource that marginalized people and their allies can use to have a greater positive influence on natural resources policy is IIEED's Power Tools. This toolkit is comprised of 26 "how-to" ideas based on experience from around the world, discussion of power tools in theory and practice, related research on policy tools in action, and a directory of the many other websites that contain policy tool resources.

Building consensus legitimatizes action by actors
NEGOTIATE: Reaching agreements over water is particularly targeted at water practitioners interested in designing, leading or participating in processes enhancing water resources management and resolving water resource conflicts or disputes. In so doing, the toolkit gives an overview of the skills that water professionals will need to build meaningful stakeholder participation in decision-making over water.

5-5 Thinking like a manager: Beginning the cycle of strategic adaptive management

The cycle of strategic and adaptive ecosystem management
Implementing an ecosystem approach in a place-based context necessitates a plan-do-check process that is strategic, analytic, deliberative, and adaptive. Why is such an approach necessary? We simply cannot do everything with limited resources; the inherent complexity demands a synthetic view that is both quantitative and rooted in the multiple perspectives; and the inherent uncertainty and dynamics requires continuous review, learning and adjustment.
The interaction of human, natural and socio-economic systems are more and more being viewed as a complex adaptive system. Successful intervention in such a system therefore, requires a process that embraces unpredictability, continuous learning and adjustment. (Swanson et al. 2009) provides a summary of principles for intervening in complex adaptive systems as compiled from literature across many sectors including natural-resource management, healthcare, information technology, and business management.

Another set of principles for intervening in complex adaptive systems point to the importance of understanding local conditions, strengths and assets and the interactions with the natural, built and social environment. This is the rationale for beginning any ecosystem management effort with assessment. The key to assessment is obtaining an understanding of current conditions and trends both by respecting history – as complex adaptive systems are shaped by their past (Glouberman et al. 2003), (Holling 1978), and through a prospective mind – to help make societies more resilient to external shocks and more flexible in response to rapid change.

These principles are reflected in several steps , as shown in Fig(16), namely:

- Ecosystem assessment – using a conceptual framework of ecosystem goods and services to understand the system – past, present, and future, and to identify advantage points for intervention.
- Shared visioning – Deliberating with stakeholders to identify a shared vision of the ultimate outcome of management interventions.
- Portfolio planning – Deliberating with stakeholders and experts to identify and agree on implementation of a variety of ecosystem initiatives that have potential to achieve the ultimate outcome.
- Portfolio piloting – Implementing a portfolio of ecosystem initiatives and monitoring key performance indicators are at the heart of adaptive management. We refer to this stage as piloting to emphasize that in a complex adaptive system; any ecosystem initiative must always be treated as a hypothesis in need of testing.
- Monitoring and assessment– The spirit of a pilot test is review and learning; this appreciates that in complex adaptive systems, it will be the system that determines what works and what does not. The ecosystem manager must first and foremost be a learner.

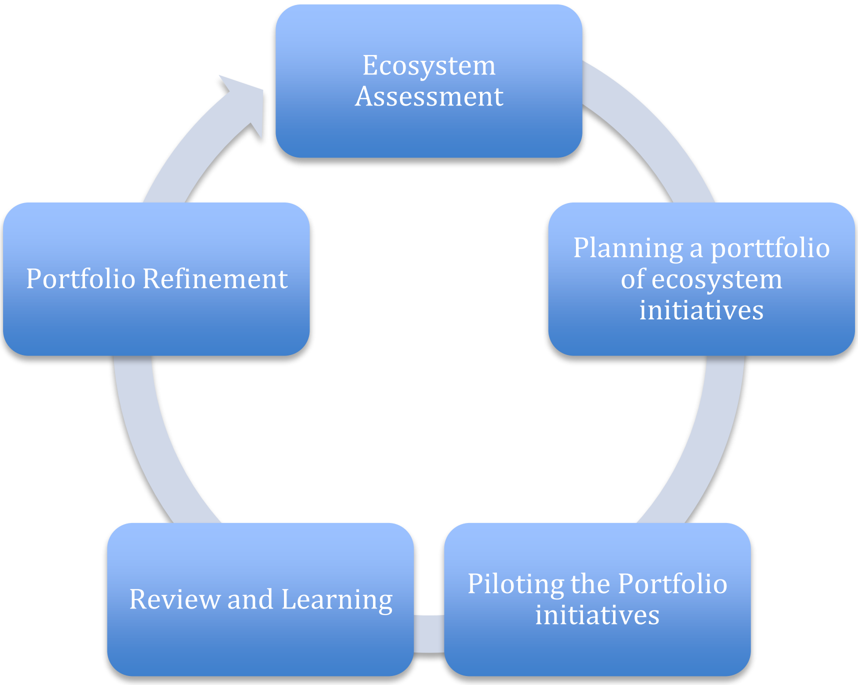

Figure (16) The strategic and adaptive cycle of ecosystem management

Ecosystem assessment (OECD, 2006)
The intent of this first stage of strategic and adaptive ecosystem management is to gain an understanding of the current state and trends of the ecosystem from both a socio-economic and ecologic perspective. A good guiding motto for the ecosystem manager at this stage is: respect the past, understand the present, and explore the future.
Ecosystem assessment requires more than a conceptual model; it also requires a simplified cause and effect systems map to help the ecosystem manager see the integrated story behind particular issues. The Driving - Force-Pressure-State-Impact-Response (DPSIR) framework is one such simplified systems map.
The DPSIR framework addresses three core questions, including:

- What is happening to the environment and why
- What are the consequences for the environment and humanity?

- What is being done and how effective is it?

Box (2) The Iraqi Marshlands of Mesopotamia (al-ahwar), located around the confluence of the Tigris and Euphrates rivers in Southern Iraq, were once home to several hundred thousand inhabitants, the Ma'dan, a people whose unique way of life had been preserved for over 5,000 years. Due to the impacts of climate change and human activities, 90% of the marchland disappeared impacting human life and ecosystems. With a steady water flow, limited interference from human activities, dam construction, pollution and oil industry in addition to a robust management plan, these natural wetlands may continue to provide a sustainable urban environment to its inhabitants, supplying them with enough food, water, fiber and health materials for generations to come. The United Nations Environment Programme, Regional Office for West Asia (UNEP-ROWA) embarked on a project 2014-2016 entitled, “World Heritage Inscription Process as a Tool to enhance the Cultural and Natural Resources Management of the Iraqi Marshlands”, to support the Government of Iraq to nominate the Iraqi Marshlands as a World Heritage Site at the UNESCO World Heritage Convention in Paris. The inscription process which is based on the “Outstanding Universal Values” (OUVs) of the Iraqi Marshlands (biodiversity and cultural values), is used as a vehicle to enhance the natural and cultural resources and strengthen institutional and technical capacity of local communities to manage the marshlands, conserve its biodiversity, sustain its ecosystem services for food, water and fiber, build resilience to climate change and protect its prehistoric relicts. A management planning exercise, integrating the cultural and natural components of the World Heritage file was undertaken in close consultation with marshland stakeholders, relevant local authorities and ministries: environment, tourism and antiquities, water resources, agriculture and oil and gas taking into consideration threats from extreme drought, climate change, mining, water dams and sand and dust storms. A consolidated Management Plan was finalized in June 2015 in collaboration with IUCN-ROWA, Arab Regional Center for World heritage (ARCWH), UNESCO, the Ministry of Environment and Ministry of Tourism and Antiquities. The project also aims to mobilize global and regional support through mainstreaming and promoting international cooperation and build synergy with Multilateral Environmental Agreements (CBD, Ramsar Convention, WHC, UNCCD and others). The consultative process among conflicting stakeholders was challenging but necessary to determine the management objectives and actions as well as roles within an intuitional framework for implementation. The project included Iraq as a State Party to the 1972 World Heritage Convention nominated “The Ahwar of Southern Iraq and Relict Landscape of the Mesopotamian Cities”, a mixed serial property, for inscription on the World Heritage list in January 2014.

Shared visioning

If the ecosystem assessment is comprehensive in nature, that is, not initiated to address a specific issue, an array of pressing ecosystem issues is likely to be identified and in need of attention. How does one proceed given limited financial and human resources? As an ecosystem manager, you will need to prioritize which ones to address first and which will need to be addressed later.

Involving stakeholders in the ecosystem assessment process as early as possible makes the shared visioning process easier to initiate and undertake. The ecosystem assessment is the starting point for articulating a shared vision. The identified future states of the environment provide the framework for the shared vision, as these are the ultimate long-term outcomes.

Ecosystem managers to make progress towards ecosystem maintenance or restoration (Table 7) can use many different types of targets. For example, benchmark targets compare against performance in other jurisdictions. Thresholds on the other hand, are scientifically based and reflect a critical value for an environmental state indicator; a value that once reached can elicit irreversible change in the behavior of the system.

Table (9) Examples of types of targets

Type of Target	Example
Benchmarks	highest percentage of households connected to sewage system in a comparable jurisdiction.
Thresholds	maximum sustainable yield of a fishery.
Principle	the policy should contribute to the increase of environmental literacy.
Standards	water quality standards for a variety of uses.
Policy-specific targets	official development assistance shall be 0.4 percent of national GNP.

Portfolio planning

You have a shared space defined by your agreement on the desired future state of the ecosystem variables. This stage focuses on describing potential pathways to the desired future. This stage is portfolio planning, and it underscores the importance of exploring and implementing a variety of ecosystem initiatives that have the potential to achieve the desired future. Variation is a critical part of adaptive management and successful intervention in complex adaptive systems.

Human activities are central to ecosystem management

Stakeholder analysis

Stakeholders are the people and institutions who have an interest, have something to gain or lose from the ways the catchment is managed. A Stakeholder Analysis is the technique used to identify the key people who have to be won over, to be convinced that your efforts will benefit their definition of successful catchment management. By communicating with stakeholders early and often, you can ensure that they know what you are doing and fully understand the benefits of your project – this means they can support you actively when necessary.

Four steps are needed for this exercise. The first step in Stakeholder Analysis is to identify who your stakeholders are. Here, you can use brainstorming. Think of all the people who are affected by your work, who have influence or power over it, or have an interest in its successful or unsuccessful conclusion. Remember that although stakeholders may be both organizations and people, ultimately you can only communicate with individual people. Make sure that you identify the correct individual stakeholders within a stakeholder organization. You might choose to use an Onion Diagram (Figure 17), asking each stakeholder to tick the position where he/she thinks she/he stands. An important activity is to disaggregate these stakeholders by gender, age and position to enable you to be as inclusive as possible. In this regard, include consideration of influence held by each individual.

Figure (17) The Onion diagram for stakeholder analysis

The next step is to develop a good understanding of the most important stakeholders so that you can consider ways to win their support. You can then record this analysis on a stakeholder map.
You must understand your key stakeholders. You need to know how they are likely to feel about and react to your project. You also need to know how best to engage them in your project and how best to communicate with them. The power/interest grid (Table 8) is a useful tool for such an analysis; identify the location of each principal stakeholder on the grid.

Table (10) Power/Interest Grid for Stakeholder Prioritization

<table>
<tr><td></td><td colspan="3">Interests</td></tr>
<tr><td rowspan="3">Power</td><td></td><td>Low</td><td>High</td></tr>
<tr><td>High</td><td>Keep satisfied</td><td>Manage Closely</td></tr>
<tr><td>Low</td><td>Monitor</td><td>Keep informed</td></tr>
</table>

Example of Fuzzy Cognitive Methodology for stakeholders mapping

A set of quantitative or qualitative variables are given values representing their current state. Then a causal relationship between the variables is identified as well as the direction of the causality and the type of relationship (positive or negative). The strength of the relationship is indicated by a weight. A positive weight indicates an excitatory relationship and a negative weight indicates and inhibitory relationship. This mapping system is used to map the importance, as well as the impact of stakeholders on an environmental component such as water catchment. This tool is also used to provide roles to stakeholders in the EBM plan, at a later stage
In the Fuzzy Cognitive mapping system, the name of the relevant stakeholders is indicated in the circles with a value from 1 to 5. These values designate the importance of the stakeholder to the pearling zones. Red arrows (negative importance) and blue arrows (positive importance) are drawn between the satellite circles and the central one. A positive value (from 1 to 3) indicates positive impacts on the pearling zones, while negative values (from 1 to 3) indicate negative impacts on the pearling zones.

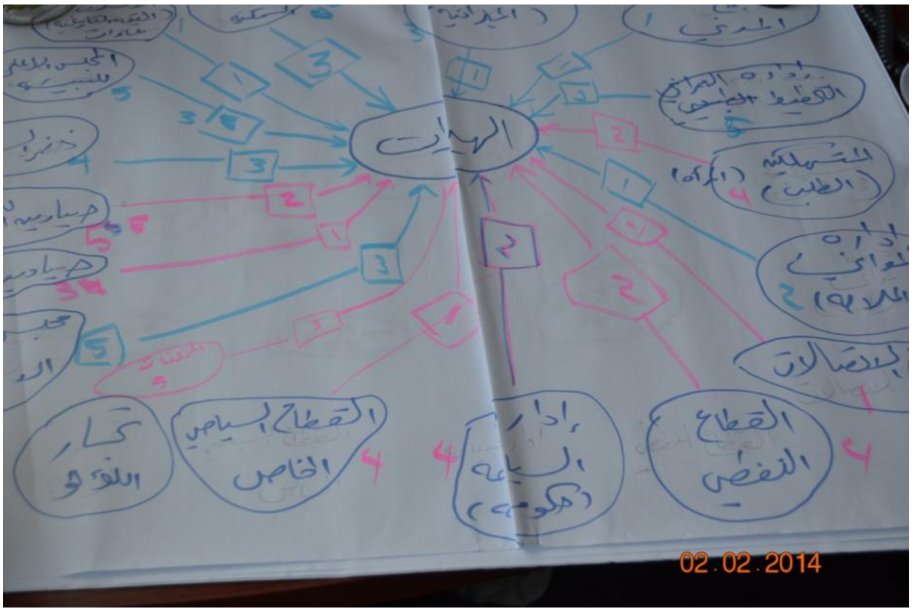

Fig (18) Example of Fuzzy Cognitive Stakeholders mapping

5-6 Valuing ecosystem services

What is Valuation?
To make better decisions regarding use and management of ecosystem services5, their importance to human society must be assessed. The importance or “value” of ecosystems is viewed and expressed differently by different disciplines, cultural conceptions, and philosophical views.’

Definitions of “Value”
The (Millennium Ecosystem Assessment 2003) defined value as “The contribution of an action or object to user-specified goals, objectives, or conditions”. According to the Oxford English Dictionary, the term “value” is used in three main ways:

- Exchange value: The price of a good or service in the market (= market price)
- Utility: The use value of a good or service, which can be very different from the market price (e.g., the market price of water is very low, but its use value very high; the reverse is the case for diamonds or other luxury goods)
- Importance: The appreciation or emotional value we attach to a given good or service (e.g., the emotional or spiritual experience some people have when viewing wildlife or natural scenery or our ethical considerations regarding the existence value of wildlife)

These three definitions of value roughly coincide with the interpretation of the term value by the three main scientific disciplines involved in ecosystem valuation:

- Economics is mainly concerned with measuring the exchange value or price to maintain a system Or its attributes
- Ecology measures the role (importance) of attributes or functions of a system in maintaining ecosystem resilience and health
- Sociology tries to find measures for moral assessments

Why is ecosystem valuation important?
Because of the many services and multiple values of ecosystems, many different stakeholders are involved in ecosystem use (and misuse), often leading to conflicting interests and over-exploitation of some services (e.g., fisheries or waste disposal) at the expense of others (e.g., biodiversity conservation and flood-control). In addition, there are many structural shortcomings in economic accounting and decision-making procedures leading to incomplete cost-benefit analysis of planned interventions in ecosystem systems.

When should valuation be undertaken?
It is particularly important to carry out valuation studies in three situations:

- Assessment of total economic value (TEV) (i.e., determining the total contribution of ecosystems to the local or national economy and human well-being). TEV of ecosystems should be explained and communicated to all stakeholders, creating the boundary conditions for policy making to stimulate conservation and sustainable use of this "natural capital" and prevent degradation or destruction. (Hunter & Gibbs, 2007, p 75).
- Trade-off analysis (i.e., evaluating costs and benefits of alternative development options for a given ecosystem to make informed decisions about possibilities and impossibilities for sustainable, multi-functional use of ecosystem services.
- Impact assessment (e.g., analysis of the effects of proposed wetland drainage or other destructive practices on wetland services. In many cases, there will be good reasons for converting natural eco-systems into another type of land (or water) use. However, in many occasions, loss of ecosystems and services is caused by accidents (e.g., oil spills,) and unintended side effects (externalities) of economic activities.

A framework for ecosystem valuation
Five main steps for valuation are explained below. Additional activities needed for a complete assessment include analysis of pressures, trade-offs and management implications.

- Step 1: Analysis of policy processes and management objectives (why undertake the valuation).
- Step 2: Stakeholder analysis and involvement (who should do the valuation, and for whom?)
- Step 3: Function analysis (identification & quantification of services) (what should be valued?) An inventory of ecosystem ecological processes and components is translated into functions that provide specific ecosystem services.
- Step 4: Valuation of services (how to undertake the valuation?) The benefits of ecosystem services identified in step 3 should be expressed in measurement appropriate units (e.g., ecological, socio-cultural, economic indicators) and monetary units.
- Step 5: Communicating ecosystem values (to whom to provide the assessment results) Valuation of ecosystem services: Total Value and types of value

The Total Ecological Value of an ecosystem is based on ecological, socio-cultural and economic values (Figure 19). Each type has its own criteria and value-units, briefly described below.

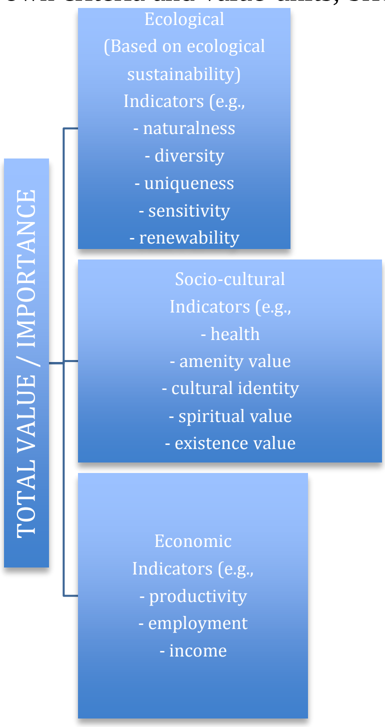

Figure (19) Components of the Total Value of an ecosystem

Socio-cultural value (importance) of ecosystem services
For many people, natural systems are a crucial source of non-material wellbeing through their influence on physical and mental health, historical, national, ethical, religious, and spiritual values. Particular watersheds

may have been the site of an important event in their past, the home or shrine of a deity, the place of a moment of moral transformation, or embodiment of national ideals (see Table 4).

Tradeoffs and goals for ecosystem management
People are part of ecosystems – typically the major driver of impacts. Transition from hunter-gatherer subsistence to agricultural, to urban, to megalopolis has masked the connection between people and ecosystem processes. That transition involves increasing modification and transformation of terrestrial ecosystems and increasingly severe downstream impacts on coastal and marine ecosystems. The ranges and levels of ecosystem service benefits change as the context moves from intact ecosystems to increasingly modified ecosystems, but the level of service depends on use and management. It is typically a gradual process but increasingly major urban, agricultural, industrial, mining and associated water harvest and storage developments are imposing substantial and far-reaching changes. The following site provides educative game for tradeoffs between ecosystem services
http://www.naturalcapitalproject.org/pubs/ES_Games_Verutes_Rosenthal_2014.pdf

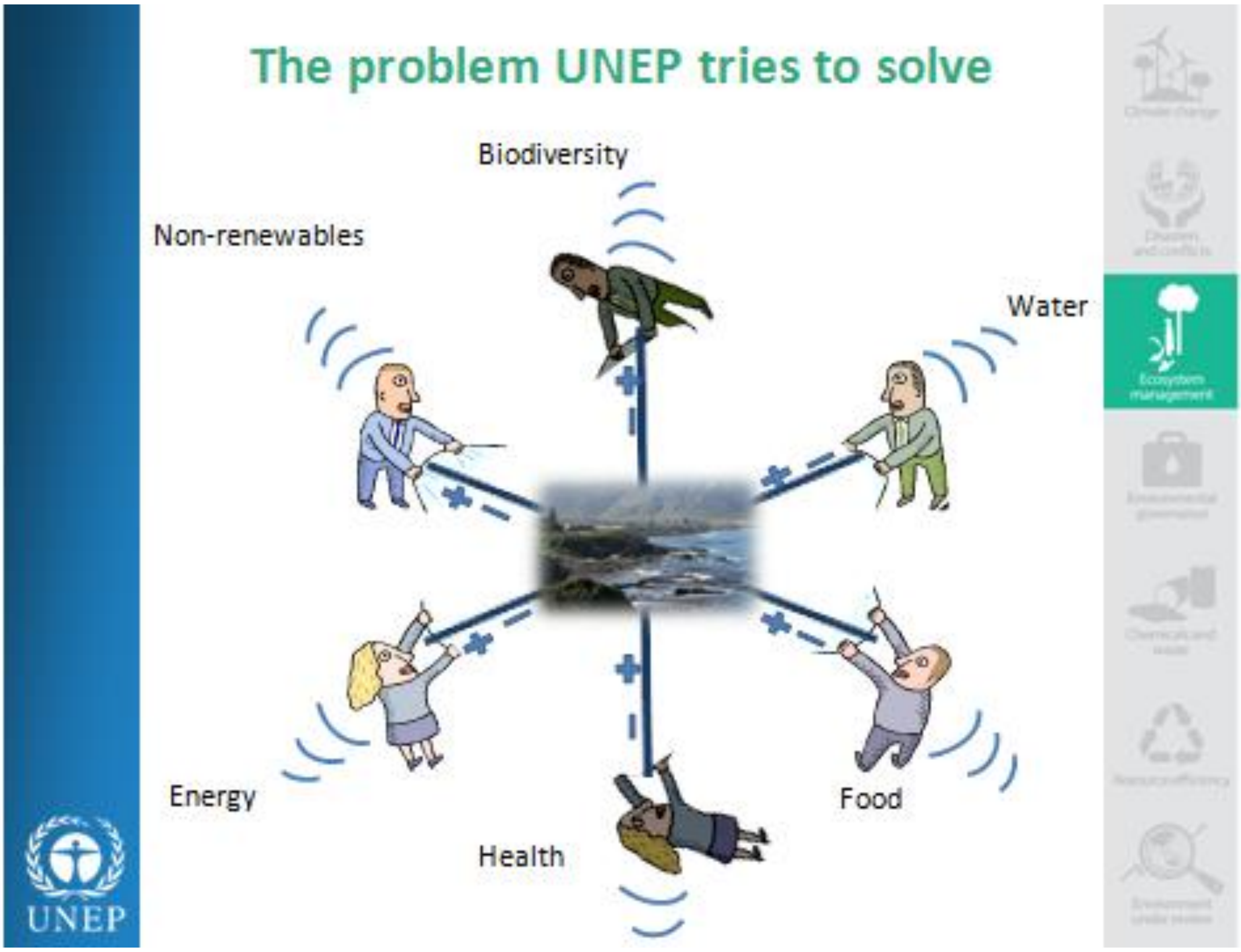

Fig (20) Illustration of concept of tradeoffs between fresh water users

Terrestrial ecosystems
From the point that humans first arrive at an untouched landscape, their decisions become part of local ecosystem dynamics. The initial humans may move on leaving all natural processes relatively intact but at some later point, others may arrive and use the area and its resources in ways that range from undetectable impact to gross alienation and transformation of soils, water flows and pre-existing plant and animal communities. At the lowest levels of impact, the demands for food, water, shelter and resources may be so slight that there is no detectable change in the natural diversity and ecosystem processes of the area. In this situation, human needs and demands are met within the resilience of self-maintenance capacity of the ecosystem.
Water pricing provides one opportunity to use resource allocation to cause changes in the ways in which water is used. There are several ways in which to construct a water-pricing scheme (Easter and Perry2011). Examples include a fixed charge per unit of time, a constant, per-cubic meter rate that, a rate that decreases as

use increases (supporting large volume users like industry), a rate that increases as use increases (advantaging small users such as households), a staggered rate (a particular price per cubic meter for the first volume and a second price for the remaining volume), a constant price for the physical service and an additional cost per unit of water used, and peak-load or seasonally-adjusted pricing.

Example of Watershed Ecosystems Valuation

At global level there are indicatives and average estimates of the value of annual ecosystems services as shown in Table (11).

Table (11) Average Global Value of Annual Ecosystem Services

Ecosystem	Typical cost of restoration	Estimated annual benefits from restoration	Net present value of benefits over 40 years	Internal rate of return	Benefit/cost ratio
	US$/ha	US$/ha	US$/ha	%	Ratio
Marshlands	33,000	14,200	171,300	12%	5.4
Lakes and Rivers	4,000	3,800	69,700	27%	15.5
Coastal	232,700	73,900	935,400	11%	4.4

Another example of valuation of wetlands is based on Ecosystem Benefit Indicators. Indicators include:
-The number of farms that would benefit from an increase in summer water flows as a result of conservation that improves retention of upstream precipitation
-The number and/or value of buildings, farms, and roads in floodplains protected by wetland protection and restoration
-The number of recreators who will benefit from increased open space and species populations.

Other economically relevant, and measurable, indicators include:
-The scarcity, at the scale of the neighborhood, watershed, region, wetlands, open space, habitat, or other ecological features (in general, the scarcer the feature, the more valuable)
-The presence of ecological or social features that complement the resource, such as streams or lakes that add to the experience of forest recreation or trails and docks that provide access to natural resources for recreators.

All of these indicators, and others like them, are relatively easy to measure using existing social and environmental datasets, geo-referenced data in particular (such as census and land-cover data). According to these indicators the values of two wetland ecosystem services are estimated as:
• Wetland A's ecosystem services are worth US $723, 000
• Wetland B's ecosystem services are worth US $537, 000

This estimation analysis could compare the two wetlands in the following way.

WETLAND A:
• Is visible from 712 acres occupied or used by homeowners, businesses, commuters, and recreators
• Protects 23 drinking water wells from saltwater intrusion
• Protects US $5 million in private and public property from flood damage

WETLAND B:
• Is visible from 600 acres occupied or used by homeowners, businesses, commuters, and recreators
• Protects 67 drinking water wells from saltwater intrusion
• Protects US $3 million in private and public property from flood damage

An example from Bahrain is related to the valuation of ecosystems services provided by a World Marine

Heritage site. Based on global estimates and values of similar habitat types and the extent / area of the habitat in the Pearling site, the total combined potential value for the Pearling Site is between US$ 3.4 and 227.1 billion. The different zones of the site are valued differently depending on the habitat type, amount, and services provided. In terms of,

- Ecosystem Services:
    - Tourism, Recreation, and research between US$ 7.5 M and US$ 287 M;
    - Fisheries between US$147.1 M and US$ 5,607.5;
    - Coastal Protection between US$ 3,104.4 M;
    - Biodiversity US$ 109 M; and
    - Water Quality between US$ 48.6 M– US$ 235.7 M.
- Zones:
    - Hayr Shattayyah is valued at between US$ 2,398.9 M to US$ 220,329.9 M;
    - Hayr Bu Am' amah is valued at US$ 456.8 - US$ 482.7 M;
    - Hayr Bul Thamah is valued at US$ 532.3 M -US$ 562.5 M; and
    - Reef Bul Thamah is valued at US$ 28.6 M to US$ 5,768.5 M.

5-7 Monitoring and evaluation

Monitoring is a planned, systematic process of observation that closely follows a course of activities, and compares what is happening with what is expected to happen. Monitoring the implementation of an EM plan makes sure the delivery of ecosystem services and meets societal goals, while working within the scope of allocated resources (i.e., time, financial, human, informational, technical).
Evaluation is a process that assesses achievement against preset criteria.

Foundation of effective monitoring and evaluation
We approach monitoring and evaluation through three steps. First, we will review different purposes of evaluation and then decide on one or more purposes for evaluation of our EM plan. Second, we will identify the primary users of our evaluation, people whose perception will control whether or not our evaluation gets used in guiding the evolution of our EM plan. Third, we will decide whether external or internal evaluators serve best our purpose for a given EM plan.
There are three fundamental types of evaluation; they can render judgment, encourage improvement, or generate new knowledge (Patton 1997). Summative evaluation, accreditation, quality control and audits are examples of judgment-intended evaluations. They follow a deductive method by setting clear criteria and standards against which to judge performance, and often they are quantitative in nature.
Formative evaluation (Fettermann 1996) is improvement oriented. The intent of this type of evaluation is making things better during implementation of a course of behavior.

6- Area for action - Selecting tools for a local application

The intention of the developer of this training manual is to assist local water and land managers to apply EM and to strengthen IWRM as an EBA to climate change in their water catchment. It is a bottom-up approach securing successful and improved watershed management. Government plays a significant role how resources are managed. Some tools are government level and influence a catchment manager, but cannot readily be selected by the manager.

To implement any of the tools in the toolkit of a resource manager, some resource accounting is needed. Especially where only advocacy and extension resources are available, the manager must understand the balance between the demand for ecosystem goods and services and supply from the untransformed and transformed land. The resource manager also has to keep in mind that men and women play different roles in catchment management and have different needs and constraints, which should be addressed.

When the catchment manager considers tools to improve management in the area under his/her jurisdiction, these issues of governance need to be considered. The major tools that could be considered by catchment manager include:

Advocacy and extension programmes are long term interventions, in general, results could take a decade or longer to obtain visible/tangible result. It could start at school and be carried through to adult education and advocacy programmes. In comparison to other tools, it could have a wide impact with limited resources. Very little institutional arrangements and governance is needed for successful implementation. Non-governmental organizations like agricultural unions, cooperatives or other land user associations will enhance and broaden the impact of the programme. Catchment management/agricultural study groups dramatically improve the impact of such programmes. Private sector, through their CSR (Corporate Social Responsibility) programme, may boost the success of the programmes. Advocacy and extension could tackle issues such as water wise food production, rainwater harvesting, crop selection and sustainable consumptive utilization of resources, fire management and water for transportation. Possible outcomes are a general improvement in resource use and measurable changes in land management, but achievable only over the long term. The site http://mediaimpactfunders.org/game-on-new-tools-for-learning-and-advocacy/ provides educative games for learning and advocacy.

Incentives. Both resource and tax incentives have short term impacts; the impact will stay intact as long as the incentive is in place. Outputs are generally measurable and auditable. Normally leads to mainstreaming the programme/intervention into the economy. To be successful, the regional or national government must have access to adequate resources to support the programme; this condition generally is met only in developed countries. Sustainable catchment management sometimes conflicts with economic development goals of a region or country. A strong sub-national, regional or national government and collaboration among land users and natural resource managers are needed for successful implementation. The outcomes are that catchment management can be mainstreamed into the economy, making the implementation more sustainable and with appropriate governance structures in place, the system can be monitored and the probability of success increased

Legislation and Regulation. If well implemented and resourced, this is the most effective way of ensuring sustainable catchment management. Once on the statute books, it is difficult to change it has a long-term effect. There could be legislation that affects negatively on sustainable catchment management, thus undermining the work of natural-resource managers. It takes long and extensive consultation to get legislation and regulations on the statute books. It therefore, makes it difficult for local catchment managers to impact legislation and regulations. Improper law enforcement will hamper their success. The institutional and governance needed for successful implementation are a strong sub-national, regional or national government, adequate catchment management capacity to implement and police natural-resource management activities.

> **Box (3)** Since decentralization in the water sector in Yemen, performance of the urban water sector has improved considerably. In particular, smaller towns that have had external support and coastal towns where there is no pressing water constraint have achieved excellent service standards. By contrast, some large towns in the highlands are encountering problems in providing even limited services, especially where the population has been growing fast, systems are old and high cost, and water resources are in increasingly short supply (World Bank 2009)

Markets for Ecosystem Services. Resource-poor regions can access international funding for catchment management. As long as both suppliers and buyers of services adhere to the agreement, security of the resource is nearly guaranteed, it can be implemented through debt-swap mechanisms. Major challenges include that any payment for watershed services must be greater than potential income from other sources, the transaction costs to access markets for ecosystem services are very high and largely unaffordable to resource poor countries unless they receive international support.

A payments-for-ecosystem-services project has to fit into regional or national legislative framework. If it does not fit, it has little chance of success, Because of high transactions costs; payments for ecosystem services programmes are dependent on a collective approach to natural-resource management. Buyers of ecosystem services are generally not willing to commit to long-term agreements. The market is therefore, aimed at short to medium term agreements. The payments for watershed services are normally aimed at the local water sector. Unless the sector has access to adequate resources, it will not work, which means that it will largely be applicable to more developed regions. Corporate social investment is generally aimed at short-term interventions. The most appropriate party (e.g. local community) does not always receive the financial incentives

Stewardship. Stewardship programmes are generally auditable they are generally not as resource-intensive as payments for ecosystem services**.** Formal stewardship agreements could enhance access to corporate and international funding of natural-resource management**.** Stewardship has very little potential in resource poor regions, unless it goes hand-in-hand with payments for ecosystem services. It will therefore, only work in developed regions**.** If the stewardship programme is linked to a regional or national government, local communities tend not to trust its motives. A strong secretariat is needed to manage the system and an extensive advocacy and extension programme has to be linked to any stewardship programme. Stewardship would ensure that ecosystem services could be secured through biodiversity and forestry stewardship agreements.

Community-based natural-resource management (CBNRM). Generally pro-poor and there are a number of successful CBNRM programmes, especially in Africa that can be used as examples.
Financial implications could become so important that they undermine sustainable watershed management and availability of supported national and sub-national regulation/regulation. Institutional arrangements and governance needed for successful implementation are strong government support, without interfering in the internal affairs of community-based organizations, tribal authorities must buy into the system in communal areas and strong community-based organizations and strong technical support team. CBNRM could ensure better community control over natural-resource management with the objective of restoring and protecting natural resources.

Eco-labeling & marketing. Because international markets are increasingly aware of the need for sustainable catchment management, the market is growing fast. Challenges only applies to sophisticated markets, which generally means it is largely limited to developed countries, a strong secretariat is needed to manage the system and the production standards are generally high for eco- labeling and Compatibility between international standard and national regulation/legislation. Institutional arrangements and governance needed for successful implementation include good marketing infrastructure, a strong secretariat is needed to manage the system and an extensive advocacy and extension programme has to be linked to any eco-labeling programme. Long-term markets for sustainably produced products is considered as the major outcome of this tool.

Micro-credit schemes. It has very localized impact, very much pro-poor and links to nature-based enterprise finance mechanism not always link to natural resources conservation, limited access to formal markets, objectives of the scheme can sometimes be in conflict with sustainable natural-resource management, limited access to micro-finance and Often available only to women are the major challenges in the implementation of this tool. Institutional arrangements and governance needed for successful implementation Strong, community-based organizational structures and strong finance – natural resources conservation linking mechanism. Collective resource management is the major outcome.

Box (4) The most critical ES in the Jordan River Basin (JRB) are related to water supply. Problems of water scarcity and competition for the resource means the needs of ecosystems and their services are often overlooked. Water availability depends on the integrity of the entire hydrological cycle and the water regime. IWRM, however, has not been an active part of the many political arrangements to ease conflict over water among the countries that share the JRB.
In a politically insecure climate, there is a need for an overarching water-management plan, equitable water sharing, and on-going competition for available water among the riparian nations and between economic sectors to avoid potential conflict over shared water resources. Maintaining the functioning of ecosystem services dependent on water has been ignored by the formal efforts to share water in the JRB. The introduction of an ecosystem approach that would foster innovations and identify existing local rights-based approaches to reduce water use in agriculture and through land-use modification could help to enhance ecosystem services for local livelihoods throughout the Jordan Basin. Given the rising demand for water and the potential impacts of climate change, it is increasingly important to create economic incentives to protect and restore water availability and quality in the JRB, in addition to planning on how to share the resource among the riparian countries. The value of ecosystem services needs to be incorporated in water planning and decision making (UNEP-IISD-DHI 2011).

Natural-resource Accounting. Allows the catchment manager to assess the impact of his/her intervention, and ensures that expectations are not unrealistic. There are high levels of expertise needed. Institutional and Governance needed for successful implementation is a strong scientific support for measuring, monitoring and reporting. The major outcome of this tool is a realistic picture of the natural resource potential of an area.

In addition to the above tools, to protect and manage these services, the watershed manager needs the requisite knowledge, skill and the tools to convince stakeholders

The repeated value of water

Water is one of few resources that is repeatedly used and re-used as it passes through a landscape. Water falls as precipitation, interacts with the landscape, and provides benefits to human and nonhuman communities. Those benefits include things like plant growth, drinking water, fish and wildlife habitat.

System function

Application of management principles appropriate in one natural system may not work in another that function in a different way. For example, fire in tropical forest systems causes widespread devastation.

Land tenure

When applying a tool or approach, the resource manager must know the land tenure. Different value systems apply to different types of land tenure.

Water tenure

- Private good in many countries, access to natural flows is linked to ownership of the land.
- Water as a public good. Some of the more progressive water legislation in the world has recognized water as a public good and stipulates that land managers can only register use of a certain amount of water.

Whatever water management approach is being advocated, it is crucial that it fits into the regulatory framework of the region or country. It is useless to try to apply a model taken from a scenario where water is seen as a private good to a country where water is regulated and managed as a public good.

Cultural beliefs and practices

Managers are considering whatever tools or natural-resource management approaches, the process it has to take into account cultural beliefs and practices of local communities.

Bundling tools and markets

No single tool listed in this document will solve all natural-resource management problems in a country or a region. It is therefore, important for natural-resource managers to integrate approaches, using multiple tools to enhance an ecosystem approach to natural-resource management. No natural resource system can optimally serve human society function without regulation.

Impact of perverse incentives/subsidies

Catchment managers must remain aware of the possible impact of perverse incentives or subsidies that could still are on statute books of rules and regulations.

Environmental flows

Natural-resource managers should never forget the importance of environmental flows. Especially in the case of water, over-subscription of the resource leads to collapse of the natural system. The same applies to grazing and others forms of consumptive use such as harvest of roofing and craft materials from wetlands or medicinal plants and timber resources from woodlands.

Table (12) Components of Iraq's well-being derived from the Marshlands*
Security
• A safer environment • Greater resilience to the effects of disasters, such as drought, flood, pests and dust storms • Secure rights and access to ecosystem services
Basic material for good life
• Access to resources for a viable livelihood (including food and building materials) or the income to purchase them
Health
• Sustenance and nutrition • Avoidance of disease • Cleaner and safer drinking water • Cleaner air • Energy for comfortable temperature control
Good social relations
• Realization of aesthetic and recreational values • Ability to express cultural and spiritual values • Opportunity to observe and learn from nature • Development of social capital • Avoidance of tension and conflict over declining resource base
Freedom and choice
• The ability to influence decisions regarding ecosystem services and well-being • Opportunity to be able to achieve what an individual values doing and being
*Based on Linking Ecosystem Services and Human Well-being (Ch.3), Global Assessment Report, Millennium Ecosystem Assessment, 2004.

7-The way forward

Integration of Ecosystem Based Management into IWRM as tools for Ecosystem-Based Adaptation

As mentioned earlier in this training manual, Ecosystem-based Adaptation involves a wide range of ecosystem management activities to increase resilience and reduce the vulnerability of people and the environment to climate change. The adaptation is linked to the security of access to basic human needs, e. g water and food etc., which are services provided by the ecosystems. Therefore, human being, or water ecosystems users, should have the ability to integrate efforts to sustain and restore ecosystem functions and promote human rights under changing climate conditions. This concept is valid to all water ecosystems with special emphasis on regions, e.g. Arab region, which are under high water stress due to scarce water resources, long drought periods, conflicts destroying the terrestrial ecosystems, overexploitation of ground water, pollution, inadequate land use and very low human involvement in decisions making processes.

Experiences showed that EBA can be applied in different landscapes, may be more cost-effective than engineering and technological options and often providing multiple benefits, could be combined with engineering approaches so called “grey-green” infrastructure and finally to help decisions makers to recognize where building resilience is the best adaptation response.

The critical question: **Why and How** watershed managers should integrate EBM to increase the effectiveness of IWRM tools as climate change adaptation in the Arab Region.

The implementation of IWRM in the Arab Countries reveals that after the progress initiating in IWRM planning and establishing an enabling institutional environment for IWRM in many countries, the slow progress made was due to a resistance to a change in mindset, low level of stakeholder’s integration, operational approach, and institutional as well as social change, at all levels. Though the report of (UN-WATER/WWAP/2006/5) is 10 years old, and the situation might be improved in the Arab region on the status of the implementation of IWRM in Egypt, Jordan, Palestine, Yemen, Bahrain, Kuwait, Qatar, Saudi Arabia, UAE, Iraq, Lebanon, Oman, Syria reveals that in 31% of the countries have good progress in the implementation of IWRM, in 38% there is some progress and in 31% of the countries still in early stages of the implementation. The report mentioned the following Key areas for improvement:

- Capacity enhancement
- Civil society involvement
- Adaptive management
- Monitoring and indicator development
- Environmental sustainability

Tacking into consideration these facts, the new development and commitments of Arab countries related to Environmental Multilateral Agreement (MEA’s) in the management of water resources and the ecosystems conservation scientific findings, we believe that there is a strong case to be made for the use of Ecosystem-Based Management to assist watershed managers to improve the management of their catchment bin combining EBM and IWRM tools for an effective preparedness to adapt their watershed and associated human communities to climate change impacts in the Arab region .

Practically, there are twelve principles for the implementation of ecosystem based watershed management. Watershed managers in Arab region could make use of their own experiences to assess the compatibility and complementarity of their IWRM measures with these principles and would consider additional necessary measures for a successful integration of EBM in IWRM towards Ecosystem Based Adaptation.

Principle 1: The objectives of management of land, water and living resources are a matter of societal choice
Rationale:
Different sectors of society view ecosystems in terms of their own economic, cultural and society needs. Indigenous peoples and other local communities living on the land are important stakeholders and their rights and interests should be recognized. Both cultural and biological diversity are central components of the EBM and management should take this into account. Societal choices should be expressed as clearly as possible. Ecosystems should be managed for their intrinsic values and for the tangible or intangible benefits for humans, in a fair and equitable way.

Principle 2
Management should be decentralized to the lowest appropriate level.
Rationale:

Decentralized systems may lead to greater efficiency, effectiveness and equity. Management should involve all stakeholders and balance local interests with the wider public interest. The closer management is to the ecosystem, the greater the responsibility, ownership, accountability, participation, and use of local knowledge.

Principle 3
Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
Rationale:
Management interventions in ecosystems often have unknown or unpredictable effects on other ecosystems; therefore, possible impacts need careful consideration and analysis. This may require new arrangements or ways of organization for institutions involved in decision-making to make, if necessary, appropriate compromises

Principle 4
Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should:
(a) Reduce those market distortions that adversely affect biological diversity;
(b) Align incentives to promote biodiversity conservation and sustainable use;
(c) Internalize costs and benefits in the given ecosystem to the extent feasible.
Rationale:
The greatest threat to biological diversity lies in its replacement by alternative systems of land use. This often arises through market distortions, which undervalue natural systems and populations and provide perverse incentives and subsidies to favour the conversion of land to less diverse systems. Often those who benefit from conservation do not pay the costs associated with conservation and, similarly, those who generate environmental costs (e.g. pollution) escape responsibility. Alignment of incentives allow those who control the resource to benefit and ensures that those who generate environmental costs will pay.

Principle 5
Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.
Rationale:
Ecosystem functioning and resilience depends on a dynamic relationship within species, among species and between species and their abiotic environment, as well as the physical and chemical interactions within the environment. The conservation and, where appropriate, restoration of these interactions and processes is of greater significant for the long-term maintenance of biological diversity than simply protection of species.

Principle 6
Ecosystems must be managed within the limits of their functioning.
Rationale:
In considering the likelihood or ease of attaining the management objectives, attention should be given to the environmental conditions that limit natural productivity, ecosystem structure, functioning and diversity. The limits to ecosystem functioning may be affected to different degrees by temporary, unpredictable or artificially maintained conditions and, accordingly, management should be appropriately cautious.

Principle 7
The EBM should be undertaken at the appropriate spatial and temporal scales.
Rationale:
The approach should be bounded by spatial and temporal scales that are appropriate to the objectives. Boundaries for management will be defined operationally by users, managers, scientists and indigenous and local peoples. Connectivity between areas should be promoted where necessary. The ecosystem approach is based upon the hierarchical nature of biological diversity characterized by the interaction and integration of genes, species and ecosystems.

Principle 8
Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.
Rationale:
Ecosystem processes are characterized by varying temporal scales and lag-effects. This inherently conflicts with the tendency to favor short-term gains and benefits over future ones.

Principle 9
Management must recognize that change is inevitable.
Rationale:
Ecosystem change, including species composition and population abundance. Hence, management should adapt to the changes. Apart from their inherent dynamics of change, ecosystems are beset by a complex of uncertainties and potential “surprises” in the human, biological and environmental realms. Traditional disturbance regimes may be important for ecosystem structure and functioning, and may need to be maintained or restored. The ecosystem approach must utilize adaptive management in order to anticipate and cater for such changes and events and should be cautious in making any decision that may foreclose options, but, at the same time, consider mitigating actions to cope with long-term changes such as climate change.

Principle 10
The EBM should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
Rationale:
Biological diversity is critical both for its intrinsic value and because of the key role it plays in providing the ecosystem and other services upon which we all ultimately depend. There has been a tendency in the past to manage components of biological diversity either as protected or non-protected. There is a need for a shift to more flexible situations, where conservation and use are seen in context and the full range of measures is applied in a continuum from strictly protected to human-made ecosystems.

Principle 11
The EBM should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
Rationale:
Information from all sources is critical to arriving at effective ecosystem management strategies. A much better knowledge of ecosystem functioning and the impact of human use are desirable. All relevant information from any concerned area should be shared with all stakeholders and actors. Assumptions behind proposed management decisions should be made explicit and checked against available knowledge and views of stakeholders.

Principle 12
The EBM should involve all relevant sectors of society and scientific disciplines.
Rationale:
Most problems of biological-diversity management are complex, with interactions, sides-effects and implications, and therefore should involve the necessary expertise and stakeholders at the local, national, regional and international level, as appropriate.

In Table (13) an example exhibiting a methodology that could be used by watershed managers to assess the compatibility and complementarity of IWRM and EBM measures and identify gaps and measures that should be tracked to ensure a better integration between EBM and IWRM tools.

Table (13) Gaps analysis for integration of EBM in IWRM tools for CC adaptation

EBM principle	Rational	IWRM measures already tacked	Gaps in the implementation of IWRM measures	Measures that should be taken to ensure complementarity	Unit Responsible to ensure the complementarity	Monitoring process
Principle 1 Societal Choice	Public participation in the production, review and update of the river basin management plans	introduction of public participation procedures	information is provided to selected stakeholders but no active and comprehensive participation of stakeholders	Institutionalize the active participation of stakeholders in the decision making process. Better comprehensiveness of stakeholders	Catchment Manager office	Report of the catchment manager to stakeholders.
Principle 2 Decentralization						
Principle 3 Adjacent and others ecosystems						
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