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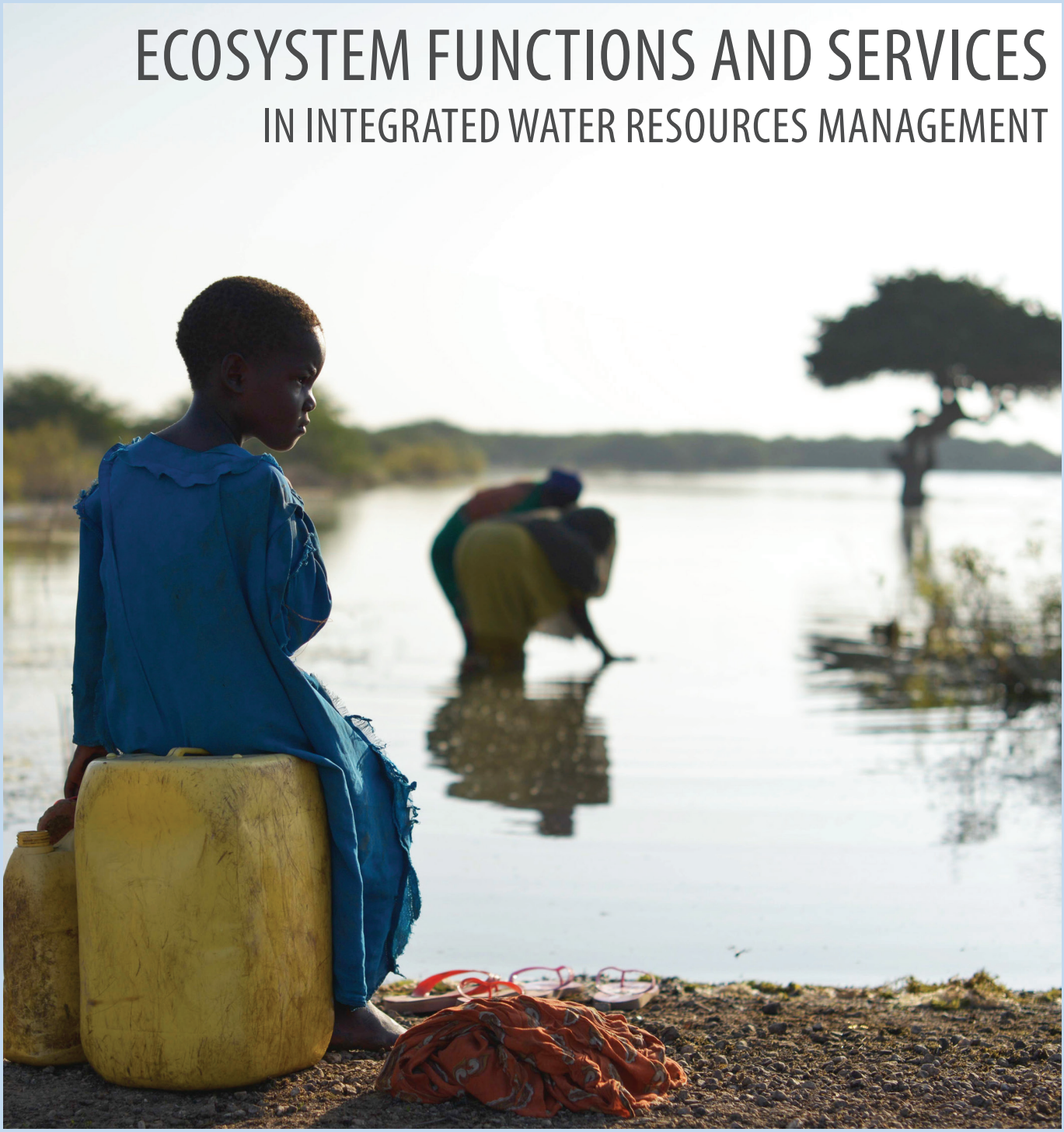
ECOSYSTEM FUNCTIONS AND SERVICES
IN INTEGRATED WATER RESOURCES MANAGEMENT



FACILITATOR'S GUIDE

UNEP

UNESCO-IHE
Institute for Water Education

REDICA
Red Centroamericana de Instituciones de Ingeniería

Cap-Net BD

SIWI

Year of publication: 2016

Cover photo: A young girl sits on a jerry can, near the town of Jowhar, Somalia. December 2013. UN Photo/Tobin Jones

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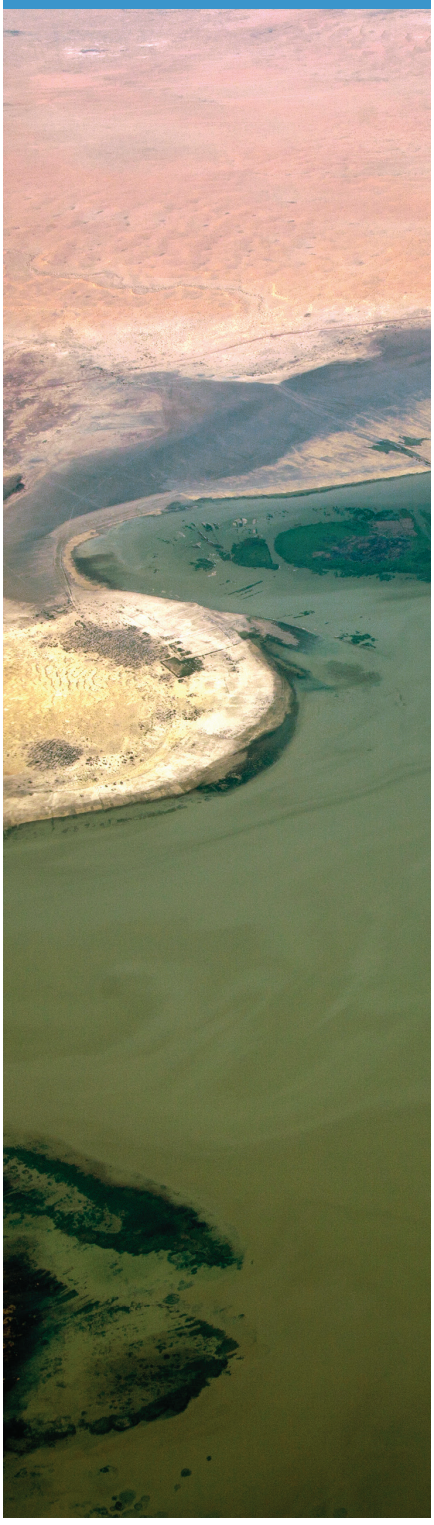
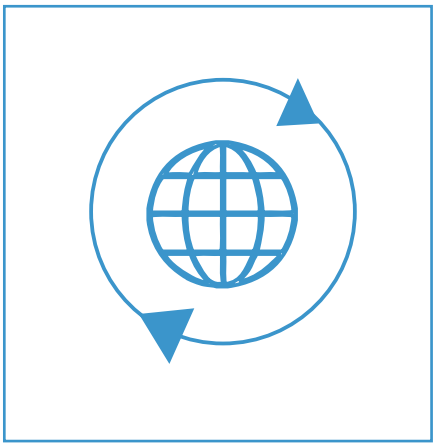


Introduction & Course Objective



MODULE OVERVIEW

The facilitator's guide aims to provide the necessary tools to carry out and facilitate the training course in integrated water resources management (IWRM) and addresses the question of how IWRM can help in environmental management. With a variety of session plans, exercises and case studies, each facilitator has the possibility to tailor the programme accordingly.

The material is structured considering rational processes that start with an understanding of the importance of IWRM, and its strong link with the ecosystem.

- **Module 1** introduces the various functions of water ecosystems, and the different drivers of change. It provides an overall understanding on watershed/ wetland ecosystems, states of wetlands and their basic components, along with an overview of the goods and services brought about by aquatic ecosystems.

- **Module 2** discusses the numerous interactions between ecosystems and other water use sectors ranging from agriculture to the mining industry, energy and transport. A number of case studies are presented to give the participants a deeper understanding of the subject.

- In **Module 3**, the concepts and tools of ecosystem valuation are discussed, with emphasis on their relevance and application to IWRM. Participants will be able to identify how they use ecosystem valuation to address their own management and policy questions and which tools best fit their needs.

- **Module 4** introduces the application of water management tools for ecosystem management. Using case studies and exercises, participants discover the usefulness and challenges of the practical application of some water management tools for ecosystem management.

- **Module 5** aims to provide water managers with an understanding of how governance and administrative structures, as well as laws and institutions can be used to integrate an ecosystem approach into IWRM.

- Finally, **Module 6** ties together all the approaches related to IWRM and the environment, through various concepts and tools, into a concise decision matrix that aids in the identification and critique, within their own contexts, of the possible actions that can be taken during water resources management and planning to ensure that key ecosystems are kept alive and healthy. Legal arrangements that are needed and that are being developed to enable decision makers and local communities to incorporate the ecosystem approach within IWRM at the basin level are also addressed. There are a broad range of examples of mechanisms being employed to strengthen the environmental/ecosystem dimension of domestic laws and regulations.

COURSE OBJECTIVE

This training manual on 'Ecosystem Functions and Services in IWRM' is aimed at building the capacity of water managers particularly. However, it can also be utilized by natural resources managers working with government, NGOs and other entities responsible for developing, training and implementing water resources management projects by introducing the issues and opportunities for integrating an ecosystem approach into IWRM projects.

The knowledge shared through this training will help the participants to develop projects and regulations on water resources management that incorporate ecosystem measures – but will not turn water managers into ecosystem management experts. However, water managers will be able to identify the added value of taking ecosystem approaches into account when dealing with water management and the types of practices that would increase vulnerabilities of the ecosystem.

At the same time, the course aims at enhancing the awareness of IWRM practitioners on the role healthy water resources management can play in ecosystem disaster mitigation and prevention, emphasizing the importance of adopting IWRM for reducing risk.

At the end of the training course participants will be able to:

- identify impacts of water use sectors on ecosystem services and propose measures to mitigate these impacts
- have a clear understanding of freshwater ecosystems, their basic components and current state globally
- understand the different types of valuation, the strengths and weaknesses, and the importance of economic valuation to address management and policy questions
- understand the fundamental role of science in estimating the value of regulating and supporting services ecosystems provide, and that of stakeholders in the valuation process
- understand the limitations of economic valuation and alternative approaches
- have an improved understanding of a range of tools that are useful for considering ecosystem functions and services in water management
- identify opportunities for ecosystem-based management within their own water resources planning (and management) cycle

Sample Course Programme

DAY 1

Time	Topic	Content
0900 – 1030	Introduction	Introduction of programme and participants
1030 – 1130	Introduction to functions of water ecosystems	IWRM principles and concepts are introduced and the way IWRM interacts with the various functions of water ecosystems (ecosystem services and functions; drivers of change will be discussed in this session). Presentation is followed by group discussion.
1130 – 1200	Group discussion	Random groups – report back
1300 – 1400	Exploring goods and services/ functions of aquatic ecosystem	Introduction and discussion
1400 – 1530	Understanding drivers and impacts on water ecosystems	Introduction and discussion
1600 – 1700	Group exercise	Random groups – report back

DAY 2

Time	Topic	Content
0900 – 0930	Recap of previous day	Relevant topics are revisited and clarified. Participants are asked to volunteer to summarize the presentations and discussions in no more than three challenging statements that aim to trigger discussion.
0930 – 1100	Water use sectors	Introduction and discussion Major ecosystem services to water use sectors are discussed.
1100 – 1200	Group exercise	Groups are formed according to the different sectors and the various impacts of water use sectors on ecosystems.
1300 – 1400	Possible impacts of water use sectors on water resources and the environment	Introduction and discussion What are the impacts on water resources at global and regional levels on ecosystems? The expected impacts for various water use sectors are highlighted.
1430 – 1530	Exercise: role play	Same groups as previous session discuss impacts on: • Case 1 – agriculture and aquaculture • Case 2 – industry and mining • Case 3 – energy and transportation • Case 4 – domestic
1600 – 1700	Group exercise	Random groups – report back

DAY 3

Time	Topic	Content
0900 – 0930	Recap of previous day	Relevant topics are revisited and clarified. Participants are asked to volunteer to summarize the presentations and discussions in no more than three challenging statements that aim to trigger discussion.
0930 – 1030	Economic valuation and payment for ecosystem services for IWRM	Introduction and discussion Discussing the different types of valuation and the importance of economic valuation.
1045 – 1200	Group exercise and reporting back in plenary	Groups formed according to the different approaches needed to conduct an economic valuation in ecosystem services: • Group 1: The type of management and policy questions economic valuation can help address • Group 2: The different economic valuation techniques available for each type of ecosystem service, their strengths and weaknesses and which ones are most commonly used to value different types of ecosystem services • Group 3: The fundamental role of science in estimating the value of regulating and supporting services ecosystems provide • Group 4: The limitations of economic valuation and alternative approaches • Group 5: The questions to address before conducting an economic valuation study
1300 – 1800	Field visit	

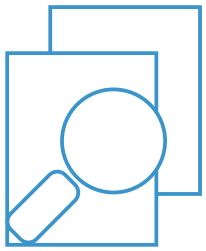
DAY 4

Time	Topic	Content
0900 – 0930	Recap of previous day	
0930 – 1100	Environmental flows	Introduction and discussion The session addresses the main elements of an environmental flow approach to water management, and furthermore its relevance to IWRM, and the challenges and opportunities to put it into practice.
1100 – 1200	Exercise: group work and reporting back	Exploring the various tools per group: Group 1: Look-up tables Group 2: Desk-top analysis Group 3: Functional analysis Group 4: Habitat modelling
1300 – 1430	Payments for Ecosystem Services (PES)	Introduction and discussion 1. The principles of payments for ecosystem services 2. The types of PES 3. The relevance of economic valuation and science to design PES 4. Prerequisite conditions for effective PES mechanism 5. Design issues water managers should consider
1500 – 1700	Exercise: group work and reporting back	The 4 groups propose conditions for environmentally effective PES measures for their respective cases.

DAY 5

Time	Topic	Content
0900 – 0930	Recap of previous day	
0930 – 1030	Legal and institutional arrangements	Introduction and discussion The session addresses the methods used to strengthen enforcement systems and develop incentives for compliance which are important aspects of the implementation process.
1030 – 1200	Group exercise: stakeholder analysis, reporting back and open discussion	1. Make a list of all the stakeholders in environmental IWRM 2. Write the name of each stakeholder on an index card 3. Plot the stakeholders on the matrix according to the criteria: ° Importance for the success of the project ° Influence of the stakeholder 4. Discuss: • Are there any surprises? • Which stakeholders do we have the most/least contact with? • With which stakeholders might we have to make special efforts to ensure engagement?
1300 – 1530	Integrating ecosystems	
1530 – 1630	General discussion	Lessons learned
1630 – 1730	Course evaluation and closure	

Module Outlines



MODULE 1

Title: Introduction to functions of water ecosystems (ecosystem services and functions; drivers of change)

Learning objectives

At the end of this session, participants will:

- Be able to describe the meaning of IWRM and its main principles
- Understand the main reasons for taking an IWRM approach
- Be aware of the importance of water for the environment and vice versa

Needs/requirements for the session

- Presentation equipment
- Laptops or other group exercise reporting tools
- Breakout space

Short summary

The session introduces the main principles and concepts of IWRM and addresses the question of how IWRM can help in environmental management.

Time allocation

- Presentation: 20 minutes
- Discussion: 25 minutes
- Exercise: 60 minutes
- Total: 1 hr 45 minutes

Exercise

Group discussion:
Depending on the size of the group, divide in 3 or 4 groups and discuss the following questions -
Having gone through the basic principles of IWRM, you will probably be able to assess the situation in your own country when it comes to implementation of IWRM and the relation with environmental management. Some of the questions you may want to answer are:

- What is the evidence of commitment to IWRM in your country?
- How adaptable are management practices in your country?
- What are key water use sectors in your country?
- How do they interact with the environment and ecosystems in your country?

MODULE 2.1 (POSSIBLE TO MERGE OR CHOOSE BETWEEN 2.1 AND 2.2)

Title: Interactions between ecosystems and other water use sectors

Learning objectives

At the end of this session, participants will:

- Be able to describe major water use sectors
- Identify impacts of water use sectors on ecosystem services
- Propose measures to mitigate these impacts

Needs/requirements for the session

- Overhead projector
- Laptops/flip charts for reporting group exercises
- Breakout space

Short summary

The PowerPoint sheets provide sufficient information for a lecture of about 1 hr 30 minutes to introduce participants to the major impacts of water use sectors on ecosystem services and possible mitigation measures. Interaction with the participants is required to fill in two tables. Instead of presenting the provided case studies, the participants can also introduce their own cases, e.g. in smaller groups.

Time allocation

- Presentation and discussion: 1 hr 30 minutes
- Cases studies: 1 hr 30 minutes
- Total: 3 hrs

Exercise

Group discussion. Depending on the size of the group, divide in 3 or 4 random groups and discuss the following:

- Have a presentation and discussion: overview of water use sectors and their impacts on ecosystems; fill in two tables with participants (plenary, or in smaller groups)
- Case studies: presentations or group discussions at the facilitator's discretion

End the exercise with brief (5-minute) oral reports to the whole group.

MODULE 2.2

Title: Interactions between ecosystems and other water use sectors

Learning objectives

At the end of this session, participants will:

- Analyse a case study for potential conflicts between various water use sectors
- Provide and defend arguments to protect ecosystems against infrastructure development projects

Needs/requirements for the session

- Setting for a meeting (table, chairs, name tags)
- Handouts with instructions

Short summary

The participants start by reading the case study Ecoland. They first make an overview of potential conflicts between water use sectors (preferably in pairs). This can be discussed briefly in a plenary session. They will then get their roles: stakeholder, guardian angel or observer and time for preparation (15 minutes). During the play the stakeholders sit in a half-circle opposite the observers in such a way that the stakeholders can all see each other. The guardian angels sit behind the stakeholders and write their suggestions on slips of paper and hand these to their respective stakeholders. The Governor opens the meeting and the play starts. During the play the observers are ignored. The facilitator intervenes if the meeting is not progressing or if the discussion becomes 'too intense'. The play runs for about 30 minutes. After this, the observers give their feedback. Then the stakeholder and guardian angel change position and the play starts again, followed by a second round of feedback.

Facilitation

The course facilitator explains the process and keeps track of time. It is important to reserve enough time for the whole session, as sometimes the play itself or the feedback session evolve into very useful discussion and insights about stakeholder participation. The facilitator can also spice up the meeting (if needed) by slipping notes to the stakeholders, stimulating them to take more extreme positions in the debate. The facilitator stops the play when it is going in circles, entering a status quo or if time demands. The facilitator leads the feedback sessions and ends the whole role play with some concluding remarks and lessons learned.

Time allocation

Studying the case study and inventory of conflicts (and presentation): 45 minutes - 1 hr
Role play and discussions: 1 hr - 1 hr 30 minutes
Total: Max. 2 hrs 30 minutes

Exercise

Group discussion. Depending on the size of the group, divide in 3 or 4 random groups and discuss the following:

- Reading and analysis of the case study
- Role play

MODULE 3

Title: Economic valuation and Payments for Ecosystem Services (PES) for IWRM

Learning objectives

At the end of this session, participants will have a clear understanding of:

- The different types of valuation and the importance of economic valuation to address management and policy questions
- The management and policy questions ecosystem valuation can help address
- The economic valuation techniques available for each type of ecosystem services, their strengths and weaknesses and which ones are most commonly used to value different types of ecosystem services
- The fundamental role of science in estimating the value of regulating and supporting services ecosystems provide
- The fundamental role of stakeholders in the valuation process
- The limitations of economic valuation and alternative approaches
- The key questions to address before conducting valuation
- At the end of the course, participants are able to identify how they use ecosystem valuation to address their own management and policy questions and which tools best fit their needs

Needs/requirements for the session

- Overhead projector
- Laptops/flip charts for reporting group exercises
- Markers and cards
- Breakout space
- Handouts

Short summary

The session details how ecosystems provide a range of benefits or services (environmental, social, economic, cultural, religious or recreational) which are essential to human beings and national development. The value of ecosystems and their services (provisioning, regulating, recreational or supporting) is the benefits they provide to humans. Ensuring that ecosystems are treated as part of water infrastructure and that their value is fully reflected in water management decision-making is one of the core principles of the ecosystem approach to resource and environmental management.

Yet these values are seldom appreciated, much less estimated and taken into account in decision-making. Many of these benefits are overlooked because they have no market and no price. They are taken for granted because they are poorly understood by water managers and provided by nature for free. Undervaluing these benefits leads to misguided decision-making, which in turn may jeopardize water security, impede development and increase poverty. Ecosystem valuation, and specifically economic valuation, offers a powerful and practical range of tools to estimate the monetary value of ecosystems and their services and inform decision-making. This module presents the specific valuation tools with their strengths and limitations. It also addresses other highly relevant and practical issues (limitations of economic valuation, governance and communication) that must also be considered for ecosystem valuation to become truly integrated into the IWRM cycle.

Time allocation

- Presentation: 1 hr 30 minutes
- Group exercise 1: 1 hr 30 minutes
- Group exercise 2: 1 hr 30 minutes
- Total: 4 hrs 30 minutes

Exercise

- Group exercise and presentation to plenary.
- Group exercise 1 (1 hr 30 minutes). Discussing general usefulness of economic valuation and entry points in IWRM cycle.

  Participants identify how appropriate ecosystem valuation is in their own IWRM context: i) type of management decision it would help address, ii) most useful valuation tools, and iii) foreseeable challenges to apply economic valuation in practice.
- Group exercise 2 (1 hr 30 minutes. 1 hr exercise, 30 minutes reporting). Working through the range of economic valuation tools using a specific example.

  Participants i) identify a specific management question, ii) how economic valuation could help address it, iii) explore the feasibility of the various methods to estimate the value, and iv) explain how they would use the results in practice.

MODULE 4

Title: Environmental flows

Learning objectives

At the end of this session, participants will:

- Understand the main elements of an environmental flow approach to water management
- Understand the relevance of an environmental flow approach to IWRM as well as the challenges and opportunities in putting the approach into practice
- Understand indicators used to monitor the performance of ecosystem management

Needs/requirements for the session

- Computer and projector
- Breakout space

Short summary

In this session we will discuss the concept of environmental flows as part of a broader notion of taking an ecosystem approach to IWRM:

1. The implications on ecosystems when river flows are increasingly modified through infrastructure development, abstraction for agriculture, urban supply and energy, and maintenance of flows for navigation.
2. Examples of how floods and droughts support an increasing perspective that water resources have been overdeveloped and exploring the adverse effects of this on ecosystems.
3. Understanding the cost benefits associated with a change in flow regime can provide a justification for action and funding.

Time allocation

- Introduction and discussion: 1 hr 30 minutes
- Group work and plenary presentations: 1 hr 30 minutes
- Total: 3 hrs

Exercise

Group work:
Understanding the costs and benefits associated with a change in flow regime can provide a justification for action and funding. Cost-benefit analysis is often a key element to raise awareness and promote political will for environmental flows. A number of key financial and economic questions need to be addressed in order to develop a successful programme of environmental flow.

- What are the benefits and the costs of altering flow regime; who will gain and who will lose?
- How will it be financed? Who will pay and which financing mechanisms will be put in place?
- Which types of incentives and compensation mechanisms can be put in place?

Please try to be very clear with the key issues of the case and the main considerations.

MODULE 5

Title: Legal and institutional arrangements

Learning objectives

At the end of this session, participants will:

- Understand and analyse international and national legal frameworks
- Learn about the types, scope and sources of legal instruments
- Identify different policy and legal mechanisms to implement IWRM from an ecosystem and environmental perspective

Needs/requirements for the session

- Computer and projector
- Breakout space

Short summary

In this session we will discuss the legal arrangements that are needed and that are being developed to enable decision makers and local communities, to incorporate the ecosystem approach within IWRM at the basin level.

1. How national water law has expanded to address environmental protection.
2. Greening of environmental laws can ensure adequate supplies of clean water for the environment, people, communities and nations.
3. Studying a broad array of examples of mechanisms being employed to strengthen the environmental/ecosystemic dimension of domestic laws and regulations.

Time allocation

- Introduction and discussion: 1 hr 30 minutes
- Group work and plenary presentations combined with role play: 1 hr 30 minutes
- Total: 3 hrs

Exercise

Group work:

- 'Copying/pasting' laws v. customized/nationalized drafting of legal instruments.
- How much do policies, laws and regulations cost to implement/comply with and enforce? (Human resources, equipment, skills and knowledge, etc.?)
- Role play on water-related disputes:
- Pulp mills on the River Uruguay (Argentina v. Uruguay)
- Nepal (Suray Prasad v. Godavari Marble Industries and others)
- India (M.C. Mehta v. Kamal Nath on Beas River Case: Imposition of Exemplary Damages)
- South Africa (Harmony Gold Mining v. Regional Director, Department of Water Affairs and Forestry)

Case study:
The Problem

- Identify the problem

- Explain why the problem is important
- Decide the role playing for members of the group to share with the plenary and the dialogues
- Identify the main consideration of the court in solving the case
- Prepare the role play

Please try to be very clear with the key issues of the case and the main consideration of the court in solving the case.

MODULE 6

Title: Integrating ecosystems into mainstream water management

Learning objectives

At the end of this session, participants will:

- Have improved understanding of a range of tools that are useful for considering ecosystem functions and services in water management
- Have identified opportunities for ecosystem-based management within their own water resources planning (and management) cycle
- Experienced through case studies, group work and discussions the usefulness and challenges of practical application of some water management tools for ecosystem management

Needs/requirements for the session

- Overhead projector
- Laptops/flip charts for reporting group exercises
- Markers and cards
- Breakout space
- Handouts

Short summary

This sessions stitches together all the approaches, concepts and tools from the course into a concise decision matrix that helps participants identify and critique within their own contexts the possible actions that can be taken during water resources management and planning to ensure that key ecosystems are kept alive and healthy.

Time allocation

- Presentation: 2 hrs
- Monitoring and evaluation: 30 minutes
- Group exercise: 30 minutes
- Total: 3 hrs

Exercise

Group exercise and presentation to plenary:
Within the range of tools available for ecosystem management; rank them in terms of (i) appropriateness within your own country's water and environmental governance context, and (ii) usefulness to achieve ecosystem management objectives in your country. Record individual scores and aggregate into a group rank. Use Post-it notes to record findings in IWRM planning cycle.

Exercises

MODULE 2: INTERACTIONS BETWEEN ECOSYSTEMS AND OTHER WATER USE SECTORS

Exercise 1: Case study - Ecoland

Introduction

Ecoland is a small, but beautiful country with a tropical climate. The Federal Republic of Ecoland has about 26 million inhabitants. The political situation is very stable, with three main political parties: the Ecoland Democratic Movement Party (EDMP), the Ecoland Labour Party (ELP) and the Liberal Front Party (LFP). The main religion is Roman Catholic (90 percent). Ecoland has two neighbouring countries, in the north and west the republic of Attix, and in the east the small kingdom of Basix. The Ecosea is to the south. The country consists of three Federal States: Tintin in the south, Spirou in the north-east and Thorgal in the north-west. The capital of Ecoland is Hancity (in Tintin at the borders of Lake Behero); it is well known for its commercial and industrial activities.

Ecoland has a wet and dry tropical climate. Most of the country is rather flat, with the exception of the Peyo Mountains on the north-western border with Attix and the Sunset hills on the northern border with Attix (annex 1: map of Ecoland). Several rivers flow through Ecoland. The River Train is the longest, starting its journey in the Peyo Mountains, entering Lake Behero close to Eledelphia and continuing its way through Tintin to the Ecosea.

Hancity has a population of 2.5 million people and an area of 320 km². The population growth is 5.6 percent (2008 census). Hancity's expansion is uncontrolled (slum area), which causes undesirable hygiene conditions because of lack of sanitation. The city has a sewerage system, except for the slum area. There is only primary treatment of the domestic sewage before it is discharged into the River Running and Lake Behero.

The governmental and local policy in recent years has been directed at improving economic conditions by strongly developing industrial production in Hancity. A lot of industrial development took place along the River Running and the shores of Lake Behero (the latter because of the existence of a harbour). The biggest industries should be mentioned: the beer factory and the fish processing industry. Crude petroleum is imported from nearby countries and is refined in a big plant situated in Smaug Town next to Dragon Bay. Part of the end product is used in an oil-fired power plant. The map (annex 1) shows the location of the main activities. By creating favourable conditions in terms of legislation and permits, the development policy has resulted in a significant increase in the number of new industries in Hancity, including a galvanizing industry and a chemical factory.

All the economic activities form a major threat for the environment around and in Hancity, as well as for the public health of the local people. The main forms of pollution in the area are organic pollution, nutrients, pathogenic organisms and toxic materials carried by the rivers. Moreover, the other main cities of Ecoland are adding significant pollution loads to the environment: Limbak at the mouth of the River Kite, Sidonou the state capital of Spirou at the shores of Lake Behero, Eledelphia as state capital of Thorgal, Ribot City (River Train), Smaug Town (Dragon Bay) and Taychezvay in the delta of the Train River. Scientists suggest that if no pollution control measures are taken immediately, pollution in the area will soon exceed a critical level. Moreover, in the local newspapers there are regular reports on dead fish, which have been found in the rivers, Lake Behero and Dragon Bay.

Natural environment

From the steep, rocky and dry Sunset hills, which peak at approximately 800 metres, several small streams originate that come together in the Sunset and Kite rivers. Due to the availability of water, horticulture has developed quickly at the foot of the Sunset hills. In the north-west, the River Train originates from the border mountain areas, first to the east and then southwards into Lake Behero. It continues its way on the other side of the lake towards the Ecosea. Where the river meets the lake, the unique Flamingo wetland is situated. In the north the River Kite originates from the Sunset hills and flows through the Henkerik forest to discharge into Lake Behero. The River Running connects Lake Behero to the Sunset River. Along the coastline east of Kiddle Bay is a mangrove area, the Ewodu mangroves.

The major uses of the various rivers and streams are: drinking

Table 1. Precipitation and temperature in Hancity

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	38	51	121	165	137	69	41	80	87	87	111	93
T. high (°C)	28	27	27	26	25	25	25	26	27	27	27	27
T. low (°C)	18	18	18	18	17	17	17	17	17	17	17	17

water, irrigation, aquaculture, industrial processing, cooling and waste (water) discharge. Lake Behero is centrally situated in Ecoland and covers an area of 31,800 km². It has an average depth of 40 m, and the deepest point is 83 m. The variations in depth, its large surface and the large number of lacustrine wetlands make it an important habitat for migratory birds. The Flamingo swamp is an important bird sanctuary of international importance and became a protected Ramsar site in 2001. Besides the unique Flamingo wetlands, the lake is surrounded by several larger and smaller papyrus-dominated wetlands. The wetlands provide a range of services (building materials, water purification, fish, nursery for lake fish, flood protection, meat, water for irrigation, etc.) and sustain the livelihoods of millions of Ecolanders.

The sea dominates the climate of Ecoland. In table 1 the precipitation and temperature in Hancity can be found. The average annual rainfall amounts to approximately 1000 mm along the coast to around 1100 mm further inland. This is due to the predominant south-westerly winds. The temperature of the seawater varies between 17 and 20°C.

Demographic information

The size of Ecoland is close to 300,000 km², with 26 million people living there. The largest cities are Eledelphia (800,000 inhabitants), Ribot City (900,000) and Hancity with 2.5 million inhabitants. The population growth of Ecoland is 2.8 percent.

Agricultural activities

On the slopes of the Peyo Mountains, coffee is produced, whereas in the lower areas of Thorgal, cattle breeding and horticulture are the main agricultural activities. The farming system is dominated by small-scale vegetable gardening on the alluvial soils along the River Train. Water is pumped with small engine pumps from the river and the lake, and applied with furrow surface irrigation on vegetables for cash income. The crops (tomato, lettuce, cucumber and paprika) are transported and sold all over the country. Pesticides, which are being used, migrate through the soil. The amount of fertilizers used is 100 kg N/ha and 80 kg P2O5/ha.

The reservoir created by the Feijen Dam is used for the production of flowers for the international market, mainly Western Europe. This fast-growing industry demands a large amount of water and has left the River Train dry for two weeks in January of this year. It is expected that in 2015 the river will be dry for between 8 and 10 weeks if the growth of the flower industry continues. The effects on the river, the Flamingo swamp, other lake-fringing wetlands and Eledelphia are potentially disastrous.

Natural environment destruction

Besides the effects of the waste discharges, there are some less obvious activities, which also have an impact on the environment. One of the threats for the lake is that the water table may drop due to the reduced flow of the River Train; the (economic) impacts this has on, for example, the industries in Hancity are yet unknown. It may also lead to migration from the rural areas to the city as the papyrus swamps may no longer be able to provide livelihoods to the rural population living around the lake.

Water supply

The flower farms take water from the Feijen Dam reservoir and the Train River. The horticulture uses water from the Train River and Lake Behero. The Eledelphia Water Supply company has its major water intake in the River Train, just before the river discharges into Lake Behero.

Energy supply

The states of Thorgal and Spirou are mainly depending on hydroelectric power from the Feijen Dam in the Peyo Mountains.

Main cities in Ecoland

The main cities in Ecoland are indicated on the map (annex 1). With the exception of the big industries mentioned in Hancity's description, the economic activities in these smaller cities are to a large extent similar to those in Hancity (garages, chemical laundries, handicrafts, etc.). In addition to that, most of them have one particular economic activity which is dominant, as indicated in table 2.

Investment plans

Table 2. Main cities in Ecoland

Name	Population	Main activities	Discharge into
Limbak	550,000	Forestry, Wood, Vegetables	River Kite, Lake Behero
Sidonou	500,000	Tourism	Lake Behero
Smaug Town	250,000	Energy generation	Dragon Bay
Eledelphia	800,000	Tourism, Fisheries	Lake Behero
Ribot City	900,000	Aquaculture, Maize, Sugar cane	River Train, Lake Behero
Taychezvay	750,000	Fisheries, Aquaculture, Tourism	Kiddle Bay

At present there are two major investment plans developed for the state of Thorgal:

1. Flower Power

A Netherlands company, Flower Power, has plans to intensify its flower-growing activities in the Peyo Mountains. Labour costs in the Netherlands are very high, and the EU environmental regulations have become stricter. Thus Flower Power expects to be able to become more profitable by moving more of its activities to Ecoland. Negotiations with the Government of Thorgal have already started. The company is negotiating for a good price to obtain its water from the Feijen reservoir without restrictions. In turn, the company offers to employ mainly local people and to construct a road between the mountains and Eledelphia (basically to transport their flowers quickly).

2. Flamingo Estate

A developer has made plans to drain part of the Flamingo swamp to develop the area into a resort with a hotel and cottages ('Flamingo Estate'). Along the banks of Lake Behero a private beach for tourists will be created, including a bar/restaurant and facilities for swimming, sailing, windsurfing, etc. It is expected that this resort will attract many foreign visitors, who will make use of the airport in Eledelphia. The developer has therefore also made plans to develop a road between the airport and Eledelphia and make other infrastructural improvements. He will plant oil palms as a substitute for the loss of vegetation.

The Government of Thorgal is quite happy with these plans as they expect a stimulus for the local and national economy (more employment, better infrastructure). They seem to be in a hurry to approve the plans without considering possible negative social and environmental impacts.

Before starting a role play (details will follow later), you are asked to read the case study in detail and to make an overview of potential conflicts that might arise between the various interests. For this activity you can work in pairs. Please realize that not everything is worked out in detail. Therefore it is possible to expand and develop the case to include issues that are not included.

Exercise 2: Ecoland role play - Interactions between ecosystems and other water use sectors

How to play

Each stakeholder is represented by a participant and another participant acts as a guardian angel of the stakeholder. All participants are involved in the role play, as a stakeholder, guardian angel or as an observer. The responsibilities are presented in table 3 below.

Table 3. Roles and responsibilities of the participants

Role: Stakeholder
Responsibility
• Prepares goals and a strategy for the meeting together with guardian angel • Participates actively in the play and places him or herself in the shoes of the stakeholder (only thinks about the greater picture if that is important for him or her as a stakeholder) • Implements the suggestions of the guardian angel • Carries out a self-evaluation during the feedback session reflecting on the goals and strategy
Role: Guardian Angel
Responsibility
• Prepares goals and a strategy for the meeting together with the stakeholder • By giving messages on slips of paper, helps the stakeholder in following the agreed strategy
Role: Observer
Responsibility
• Gives feedback on the play (identifying the stakeholders' goals and strategy, negotiation skills, etc.) • Makes links between the role play and how this relates to reality (what can you learn from this role play) • Respects the players and realizes that they are acting

Annex 1. Map of Ecoland

Based on the information provided and the description of Ecoland, the stakeholder and his or her guardian angel have some time (15 minutes) to prepare for the stakeholder meeting. During this time they agree on goals they want to achieve as an outcome of this meeting and a strategy to achieve these goals. The Governor prepares an agenda for the meeting and prepares him/herself for chairing the session as well as formulating goals and a strategy. During the play the observers try to figure out the goals of the different stakeholders and assess if they have reached these goals. During the preparation time the observers could agree to distribute tasks (focus on a specific stakeholder for example).

Governor of Thorgal

- Tends to value employment over sustainability
- Is not very 'in touch' with the small-scale farmers and fishermen
- Is very upset by rumours that he/she is financially benefiting from the developments
- Over-confident
- Wants to leave the meeting with an agreement in which both projects go ahead

Flamingo Estate

- Feel they have every right to claim the land and access to the shore as they provide employment and contribute to economic growth of the area
- Do not consider appropriate wastewater treatment facilities
- Arrogant
- Try to 'play' the Governor
- Feel competition from Flower Power (less water in the river and pollution with nutrients and pesticides)

Flower Power

- Feel they have every right to use as much water as they need as they provide employment and contribute to economic growth of the area
- Are afraid that Flamingo Estate will interfere with their plans by accusing them of polluting the water (pesticides, nutrients)
- Arrogant
- Try to 'play' the Governor
- Do not want an agreement on water restrictions, unless it doesn't apply to them

Fishermen´s Association

- Know the area very well, lived there for generations
- Need unlimited access to the lake shore
- Worry about water pollution
- Depend on the ecosystem for their income
- Do not want to leave their fishing activities for another job
- Feel overlooked

Small-scale Farmers' Association

- Know the area very well, lived there for generations
- Realize the need for restrictions
- Feel restrictions should mainly (if not only) apply to Flower Power
- Do not like Flower Power and feel that these foreign-owned companies do not care about the river and the lake at all
- Hope to sell more products to Flamingo Estate

Green Ecoland

- Want sustainable management of the lake
- Want to protect the area as a bird sanctuary
- See opportunities to develop ecotourism
- Think the Governor only takes note of short-term issues
- Constructively looking for an agreement

Water Supply Company Eledelphia

- Responsible for the continuous supply of high-quality drinking water
- Concerned about pollution from Flower Power (eutrophication, toxic algal blooms, pesticides)
- Worried about the water level in the River Train
- Want Flamingo Estate to operate proper wastewater treatment
- Are afraid that the Governor has his own interests in the projects

MODULE 4: ENVIRONMENTAL FLOWS

Exercise: Environmental flows and their relevance

Objective

To familiarize the participants with the concepts, tools and processes of environmental flows and their relevance to IWRM.

Activity

1. Work in groups (1hr 30 minutes group work and 30 minutes for reporting).
2. Provide participants with markers and pens. Standard advice is one idea/sentence/bullet per card. Each person completes a card for each question.

Participants evaluate usefulness of tools and concepts by responding to the following questions:
1) Have environmental flows been considered or established in your country?
If they have not:

- How would you make the case for them?
- Which tools developed here would be most useful to you?

2) If they have:

- How was the case made for it?
- Which key challenges have been encountered?

Report back

Participants will read their responses one by one and will post their cards on the wall.

Facilitator

Summarizes results and look for patterns. Highlights issues that deserve further attention (check especially how often participants mention the use of economic analysis to build political will, and the importance of capacity, stakeholders' engagement process (including conflict resolution mechanisms), incentives (economic, social, institutional) and financial resources.

Questions

- Develop criteria to evaluate options for securing the water needed to improve food security and electricity generation within a basin.
- Who would be involved in developing these criteria in your country?
- What options are realistically feasible when a dam has already been proposed?

Building capacity for design and implementation

In many countries, there is no experience, little data and no expertise for environmental flow implementation. A national environmental flow programme may need to be established to develop the most appropriate method, collect relevant data and train personnel. Training the various specialists (hydrologists, engineers, water chemists, biologists, geomorphologists, economists, botanists) to work together in multidisciplinary teams may also be required.

MODULE 5: LEGAL AND INSTITUTIONAL ARRANGEMENTS

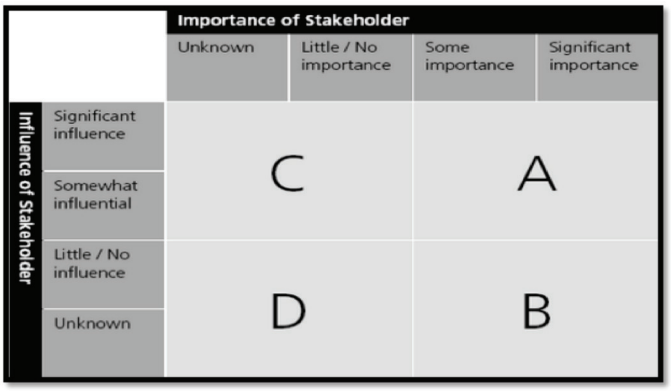
Exercise: Group activity – Stakeholder analysis

Objective

To provide a clearer understanding of stakeholders and, as a result, provide insights as to how best to engage them.

Activity

1. Make a list of all the stakeholders in IWRM
2. Write the name of each stakeholder on an index card
3. Plot the stakeholders on the matrix according to the criteria:
    - Importance for the success of an ecosystem management project
    - Influence of the stakeholder on an ecosystem management project
4. Discuss:
    - Are there any surprises?
    - Which stakeholders do we have the most/least contact with?
    - With which stakeholders might we have to make special efforts to ensure engagement?



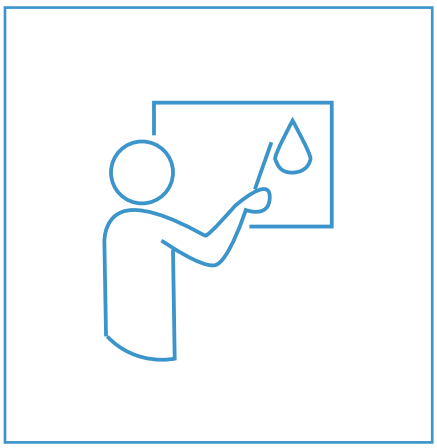
Box A - high degree of influence on the project, of high importance for its success. This implies that the implementing organization will need to construct good working relationships with these stakeholders to ensure an effective coalition of support for the project.

Box B - high importance to the success of the project, but with low influence. They will require special initiatives if their interests are to be protected.

Box C - high influence, who can therefore affect the project outcomes, but whose interests are not necessarily aligned with the overall goals of the project. These stakeholders may be a source of significant risk, and they will need careful monitoring and management.

Box D - low influence on, or importance to the project outcomes, may require limited monitoring or evaluation, but are of low priority.

Planning a Workshop and Developing Training Skills



Content

- What to consider when planning a workshop
- Dynamics and energizers
- Icebreaking
- Planning workshops on ecosystem functions and services in IWRM

This chapter has been designed to support practitioners who will develop training activities on ecosystem functions and services and various approaches as to how IWRM can help.

Introduction

Training activities with adult participants have specific needs that have to be considered when planning the event to ensure training objectives are met. Adult learners favour learning by doing, by sharing experiences, and by the application of new knowledge in real work environments.

The planning process is a tool that you, as the facilitator, can use to enhance the learning process of the participants.

5. Target group - Considering that training has to be adapted for different audiences, you have to be sure that your training materials address different needs and that they meet the requirements of the trainees' profiles. It is also important to identify the material you will use and anticipate all your needs during the planned sessions.
6. External factors - A good preparatory exercise to do is to project possible training scenarios. In this way, you can try to control external factors that may influence the training event, for example, holidays, weather conditions and political events. This exercise also gives you the opportunity to identify particular opportunities that may come up.
7. Internal factors - It is important to be realistic and plan capacity-building according to your strengths and the extra support you are able to raise. The following are some practical tips for planning, conducting and evaluating the training course.

A. Before the training

- Set your training objectives.
- Identify and evaluate the training methods, and choose the most suitable one for your goals.
- Identify your regional/local counterparts.
- Prepare a budget suited to your needs and costs, consider all expenditures and keep an amount for rainy days.
- Solicit financial support.
- Identify the material developed from expert sources and plan review and integration.
- Address administrative and venue issues (restrooms, breakout rooms for working group sessions, layout of the meeting room, access to Internet, air conditioning, connections, evacuation route, etc.).
- Decide how you will measure the objectives.
- Try to establish the situation or knowledge of the participants (e.g. use an application form, ask participants to write an analysis of the situation in their region).
- Identify the improvements you are aiming for.
- Identify assignment responsibilities.
- Prepare energizers and dynamic sessions while planning the content.
- Make a list of materials and equipment you will need.

B. During the training

- Assign 'policing' or organizational roles to volunteer participants.
- Assess and address special needs of participants and trainers.
- Make sure material is circulated on time.
- Add interactive sessions to the technical sessions, so practical application of concepts and principles are part

of the learning process.

- Plan daily recaps to evaluate the activities and understanding of the participants, but be careful that recaps are not just summaries of presentations.
- Consider the breaks you need and the way to bring participants back to the session (play music, ring a bell, turn on/off lights).

C. After the training

- Measure the achievements of the objectives by the indicators identified.
- Review feedback from trainers and participants. Assess what improvements can be made to the programme, materials or facilitation.
- Review the effectiveness of the chosen training method and allocated time.
- Identify any remaining training gaps, and include them in future plans.
- Review your financial results.

If you plan to replicate your training activity, then you have to work on preparing follow-up activities:

1. Meet in groups by regions or countries (depending on the number of participants and the target group you identified for the follow-up).
2. Prepare a proposal to run an activity in your region/country or basin making use of the programme and materials of the training just conducted on IWRM and ecosystem functions and services.
3. You need to identify:
    - Target group
    - Duration of the activity
    - Establish the contents according to the length and the needs and characteristics of the region or country
    - Identify regional or local speakers/experts
    - Make a list of requirements to run your training activity
    - Identify responsible persons
    - Make a timetable
    - Identify funding
    - Prepare a presentation to share in plenary

Some icebreaking/energizing suggestions

Breaking the ice is very important when you are working with adult learners. You are not only responsible for the quality of the material and to guarantee delivery but also for group dynamics. Some icebreakers are presented to help trainers to organize the session, but you can be creative and use your own.

Team-building icebreakers

Activity to meet each other (15 minutes)

Divide the participants into groups of four or five people by giving them names according to the issues of the workshop, like lake, river, rain, spring, etc. You can use colours or other references. You can also give the participants a chocolate or candy with a different label, so they meet with the people who share the same label of candy.

Tell the newly formed groups the rules and their assignment. Prepare a clear and simple guide to make it easy. The assignment can be something easy, such as to find five things they have in common that have nothing to do with work (no body parts and no clothing). This helps the group explore shared interests more broadly.

One person (a volunteer) of the group must take notes and be ready to read their list to the whole group upon completion of the assignment. Then ask each group to share their list with the whole group.

Animal cards (30 minutes)

You can distribute cards with images of animals in pairs, or use opposite cards and ask the participants to meet with the other person who has the matching card. Each one has to introduce the other participant to the plenary revealing something special about the other participant. You can prepare the main question that must be something personal, something that makes him/her special or different. Allow 10 minutes for the pairs to meet and the remaining 20 minutes for introductions to the rest of the group.

The treasure box (30 minutes)

Bring a dark bag or box and ask the participants to give you something that is important to them; avoid pencils or pens and instead suggest glasses (in their case), driver's licence, rings, watches, etc. When you get all the treasures in the bag, draw one and ask the owner to say his or her name and to say something personal that very few people know. The group will decide if the information is personal enough to recover the treasure and if not, the participant has to try again. Don't be easy on the person; keep the item until the group is satisfied.

Roll the ball (20 minutes)

Another way to introduce the participants is to bring a small, colourful ball to toss around and ask the participants to stand up and present themselves one by one as they catch the ball. Make sure that all the participants receive the ball. You can also use the same exercise when the people are tired and ask them to say the name of the person to whom they throw the ball. The one who fails will have a punishment: sing, dance, or something else that the group decides.

The name game (15 minutes)

Ask the participants to sit in a circle. One of them (or a leader) starts the game by saying, "Hi! My name is ..." Then the next person in the circle continues by saying, "Hi! My name is ...

and sitting next to me is ..." This continues around the circle, until the last person introduces him-/herself and also has to introduce the entire circle! This is a great way to learn names.

Other activities to develop during the workshop

The baby picture game

Each person is instructed before the course to bring a baby picture of him or herself. Collect all the pictures and carefully put them on a large paper sheet on the wall, assign a number to each picture and keep them there until the last day. Prepare a big envelope on the side; the participants must identify each of the participants from their baby picture, linking the number to the name, and put this in the envelope during the workshop. On the last day of the training, the person who guessed the most names and pictures right will win a prize.

Sharing chairs

Everyone gets a chair and sits in a circle. The leader reads out a list of items. If any of them apply to a participant, he or she must move the appropriate number of seats clockwise. For example: 1. "Anyone with one brother, move one seat clockwise. If you have two brothers, move two seats." 2. "Anyone with black hair, move one seat clockwise." 3. "Anyone over the age of 21, move three seats anticlockwise." 4. "Everyone wearing brown shoes move one seat." The fun happens when you move, but your neighbour doesn't, and you must sit on his/her lap! Sometimes, you can have three people occupying the same chair! Make sure you have lots of categories so that everyone gets several chances to move.

Dr. Mix-Up

All the participants stand in a circle, holding hands. Select one person to be 'Dr. Mix-Up'. That person leaves the room for a moment. When he/she is gone, everyone else does their best to get tangled up, by climbing over arms, under legs, etc. without letting go of their neighbours' hands. When the circle is suitably tangled, everyone yells "Dr. Mix-Up! Come and fix us!" Dr. Mix-Up then comes in and tries to untangle the circle by directing individuals to go under arms, around bodies, etc.

Shoe factory

Have the group stand in a large circle shoulder to shoulder. Then have everyone remove their shoes and put them in the centre. After the group has formed a pile with their shoes, the leader directs everyone to choose two different shoes other than their own. They should put them on their feet (halfway if they are too small). The group then needs to successfully match the shoes and put them in proper pairs by standing next to the individual wearing the other shoe. This will probably result in a tangled mess and lots of giggles!

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ACRONYMS

ACUMAR	La Autoridad de Cuenca Matanza Riachuelo
AUD	Australian Dollar
BCAS	Bangladesh Centre for Advanced Studies
CAMS	Catchment Abstraction Management Strategies
CBA	Cost-Benefit Analysis
CBD	Convention on Biological Diversity
CIFOR	Centre for International Forestry Research
CGIAR	Consortium of International Agricultural Research Centres
CWCP	Current Water Control Plan
DEFRA	UK Department of Environment, Food and Rural Affairs
DRIFT	Downstream Response to Imposed Flow Transformation
EBM	Ecosystem-Based Management
EF	Environmental Flows
EFA	Environmental Flow Assessment
EFTEC	Economics for the Environment Consultancy
EIA	Environmental Impact Assessment
EKHF	Environmental Know How Fund
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GWP	Global Water Partnership
ICJ	International Court of Justice
IFIM	In-Stream Flow Incremental Methodology
IFPRI	International Food Policy Research Institute
IIED	International Institute of Environment and Development
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
LIFE	Lotic-invertebrate Index for Flow Evaluation
MCDA	Multi-Criteria Decision Analysis
MCP	Modified Conservation Plan
MEA	Millennium Ecosystem Assessment
MFL	Minimum Flows and Levels
NBA	Niger Basin Authority
NBI	Nile Basin Initiative
NGO	National Governmental Organization
NOAA	National Oceanic and Atmosphere Administration
OECD	Organization for Economic Cooperation and Development
PES	Payments for Ecosystem Services
PHABSIM	Physical Habitat Simulation Model
RBO	River Basin Organization
REDICA	Central American Network of Engineering Institutions
SADC	Southern African Development Community
SEA	Strategic Environmental Assessment
SGA	Sub-Global Assessment
SIWI	Stockholm International Water Institute
SWITCH	Sustainable Water Management Improves Tomorrow's Cities' Health
TARWR	Total Annual Renewable Water Resources
TEEB	The Economics of Ecosystems and Biodiversity
TEK	Traditional Ecological Knowledge
TEV	Total Economic Value
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USEPA	United States Environment Protection Agency
WCD	World Commission on Dams
WfW	Working for Water
WWAP	World Water Assessment Programme
WWF-TNC	World Wildlife Fund - The Nature Conservancy

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MODULE 4

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Glossary

Benefits transfer approach: Economic valuation approach in which estimates obtained (by whatever method) in one context are used to estimate values in a different context. (MA 2005)

Bequest value: An example of non-use value. It is the value individuals attach to the fact that the resource will be available for use by future generations.

Biodiversity (a contraction of biological diversity): The variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part. Biodiversity includes diversity within species, between species and between ecosystems. (MA 2005)

Bundled ecosystem services: Ecosystem services which are strongly correlated.

Consumers (ecological definition): Consumers are those organisms that consume primary producers for their food resource. These include grazers such as snails, aquatic invertebrates, shellfish and birds. Consumers are also predators that feed on other animals in an ecosystem. Humans are considered consumers.

Consumers (economic definition): Consumers are economic agents (people) purchasing the goods and services produced in the economy.

Climate change: Any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), which defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." (IPCC 2007c)

Climate variability: Variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forces (external variability).

Consumer surplus: The benefits enjoyed by consumers as a result of being able to purchase a product for a price that is less than the most that they would be willing to pay.

Contingent valuation: Survey technique directly asking individuals about their willingness to pay for a specific benefit. (The individual's preference is 'stated' rather than observed through market behaviour.)

Cost-benefit analysis: A technique designed to determine the feasibility of a project or plan by quantifying its costs and benefits in monetary terms. (MA 2005)

Cultural services: The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experience, including, e.g., knowledge systems, social relations and aesthetic values. (MA 2005)

Desalination: A process that removes any excess salt and other minerals from water or soil (soil desalination). http://en.wikipedia.org/wiki/Desalination - cite_note-1

cycling, water cycling and provisioning of habitat. (MA 2005)

Total Economic Value (TEV): The total gain in well-being from an ecosystem service. It includes use and non-use values.

Trade-offs: Management choices that intentionally or otherwise change the type, magnitude and relative mix of services provided by ecosystems. (MA 2005)

Valuation: The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology, and so on). (MA 2005)

Vulnerability: The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and the variations to which a system is exposed, its sensitivity, and its adaptive capacity.

Wetlands: Transitional, regularly waterlogged areas of poorly drained soils, often found between an aquatic and a terrestrial ecosystem, that are fed from rain, surface water or groundwater. Wetlands are characterized by a prevalence of vegetation adapted for life in saturated soil conditions.

Willingness to accept: The minimum amount that a person is willing to receive to give up the benefits from an ecosystem service.

Willingness to pay: The maximum amount a person is willing to pay to benefit from an ecosystem service they do not have.

Direct use value (of ecosystems): The benefits derived from the services provided by an ecosystem that are used directly by an economic agent. These include consumptive uses (e.g., harvesting goods) and non-consumptive uses (e.g., enjoyment of scenic beauty).

Discounting: A method used to convert future costs or benefits to present values using a discount rate.

Drought: In general terms, drought is a "prolonged absence or marked deficiency of precipitation," a "deficiency that results in water shortage for some activity or for some group," or a "period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious hydrological imbalance" (Heim 2002). Drought has been defined in a number of ways: agricultural drought relates to moisture deficits in the topmost one metre or so of soil (the root zone) that affects crops; meteorological drought is mainly a prolonged deficit of precipitation; and hydrologic drought is related to below-normal streamflow, lake and groundwater levels. A megadrought is a long, drawn-out and pervasive drought, lasting much longer than normal, usually a decade or more.

Economic valuation: The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) in monetary terms.

Ecosystem: Dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit. Humans are an integral part of ecosystems. It is the interactive system formed from all living organisms and their abiotic (physical and chemical) environment within a given area. Ecosystems cover a hierarchy of spatial scales and can comprise the entire globe, continents (biomes) or small, well-circumscribed systems such as a pond.

Ecosystem approach: A strategy for the integrated management of land, water and living resources that provides sustainable delivery of ecosystem services in an equitable way.

Ecosystem function or ecosystem functioning: See ecosystem process.

Ecosystem management: An approach to maintaining or restoring the composition, structure, function and delivery of services of natural and modified ecosystems for the goal of achieving sustainability. It is based on an adaptive, collaboratively developed vision of desired future conditions that integrates ecological, socio-economic and institutional perspectives, applied within a geographic framework, and defined primarily by natural ecological boundaries. (MA 2005)

Ecosystem process: An intrinsic ecosystem characteristic whereby an ecosystem maintains its integrity. Ecosystem processes include physical, chemical, biochemical and biological aspects. For example, decomposition, production, nutrient cycling and fluxes of nutrients and energy (MA 2005) or denutrification (nutrient removal capacity), sediment retention, nitrogen removal, contaminant removal, carbon fixation, water cycle (water storage, evaporation, evapotranspiration). Different ecosystem services will be produced out of the functions or processes depending on the type of ecosystem.

Ecosystem resilience: The level of disturbance that an ecosystem can undergo without crossing a threshold to a situation with different structure or outputs. Resilience depends on ecological dynamics as well as the organizational and institutional capacity to understand, manage and respond to these dynamics. (MA 2005)

Ecosystem services: The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. The concept 'ecosystem goods and services' is synonymous with ecosystem services. (MA 2005)

Ecosystem threshold: The point at which a natural resource exhibits rapid change or sudden collapse (tipping point).

Existence value: The value individuals derive from the knowledge that an ecosystem resource exists, even though they have no current or planned use for it. It is also associated with intrinsic value.

Hydrological cycle: Also referred to as the water cycle, it describes the continuous movement of water above and below the surface of the Earth. Water undergoes changes in its states (liquid, vapour and ice) at various points in the water cycle although the total balance of water on Earth remains constant over time.

Hydrosphere: As defined in physical geography, the zone containing the combined mass of water found on, under and over the surface of a planet, including seas, lakes, aquifers, etc.

Indirect use value: The benefits derived from the goods and services provided by an ecosystem that are used indirectly by

an economic agent. For example, an agent at some distance from an ecosystem may derive benefits from drinking water that has been purified as it passed through the ecosystem. (MA 2005)

Intrinsic value: The worth of a good or service for its own sake.

Net present value: Discounted value of a financial amount.

Market value: The price at which a commodity can be bought or sold, determined by the interaction of buyers and sellers in a market.

Multi-Criteria Analysis (MCA): Analysis of decisions in a context where there are multiple goals (objectives) that cannot be reduced to a single monetary measure.

Opportunity cost: The benefits forgone by undertaking one activity instead of another. (MA 2005)

Option value: The value of preserving the option to use services in the future either by oneself (option value) or by others or heirs (bequest value).

Payments for Ecosystem Services (PES) context:

- **Producer-ecologists definition**: Also referred to as primary producers, they are ecosystem organisms that use photosynthesis to obtain their energy. Producers form the basis of food webs (and are thus important to maintaining biodiversity) and also provide harvestable goods for humans. Producers include algae, wetland plants, forests and crops.
- **Producer-economists definition**: Land users or managers whose land use or land management behaviour affects the ecosystem's ability to provide ecosystem services. They are also referred to as ecosystem providers or suppliers.
- **Consumer-ecologists definition**: Organisms that consume primary producers for their food resource. These include grazers such as snails, aquatic invertebrates, shellfish and birds. Consumers are also predators that feed on other animals in an ecosystem. Humans are considered consumers.
- **Consumer-economists definition**: Individuals that are interested in an ecosystem service, willing to purchase it and able to pay for it. They are also referred to as the demand side of ecosystem services.

Production function: The relationship that may exist between a particular ecosystem service and the production of a market good.

Producers (**ecological** definition): Producers (also referred to as primary producers) are those organisms in ecosystems that use photosynthesis to obtain their energy. Producers form the basis of food webs (and are thus important to maintaining biodiversity) and also provide harvestable goods for humans. Producers include algae, wetland plants, forests and crops.

Producers (**economic** definition): Producers refer to economic agents (people) which use labour, capital and natural resources to produce goods and services.

Provisioning ecosystem services: The products obtained from ecosystems, including, for example, genetic resources, food and fibre, and fresh water. (MA 2005)

Quasi-option value: The value of avoiding irreversible decisions until new information reveals whether certain ecosystem services have values society is not currently aware of. (MA 2005)

Regulating ecosystem services: The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water and some human diseases. (MA 2005)

Revealed preference: A valuation technique using actual individuals' preferences as they can be observed through market behaviour.

Stated preference: A valuation technique using questionnaires to directly elicit individuals' preferences for non-market goods. Preferences are elicited through willingness to pay for an ecosystem service or willingness to accept compensation for the loss of ecosystem service.

Supporting ecosystem services: Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient

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