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Assessment and Provision of Environmental Flows in Mediterranean Watercourses

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Concepts, Methods and Emerging Practice

May 2004

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CENTRE FOR Mediterranean COOPERATION

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There is pressure from water use interests of all persuasions to safeguard the combined ecological, social and hydrological functions and services, which natural resource systems provide - and bring these perspectives into water resource planning and management at all levels, from local to basin-level planning

Introduction

Significant progress has been made linking environment concerns to the emerging water resource management challenges in the Mediterranean over the past decade.

Policy initiatives such as the European Water Framework Directive (2000) and new national legislation promoting integrated water resource management in many non-EU countries of the Mediterranean region provide a clear indication of the major transformations now underway in how water is monitored, assessed and managed.

In a marked departure from the past, the environment is increasingly seen as central to achieving sustainable management and longterm protection of water resources, instead of a marginal issue.

Awareness is growing, for instance, of the valuable role that freshwater ecosystems and wetlands play in the hydrological cycle of river basins, in addition to their critical role in providing habitat for many plant and animal species. Measures to conserve and enhance the ecological quality of rivers are increasing part of strategies to safeguard the future quality and quantity of fresh water resources, particularly in basins under stress.

While the outlook may be promising, many barriers to change need to be overcome before the combined ecological and hydrological functions that wetlands and natural resource systems provide are fully realized. Here, environment flows has emerged as a key concept to link water resource and environment management concerns, and around which a new generation of tools and methods are being developed.

What is an environmental flow?

An environmental flow is the provision of water within rivers and associated ground water systems in sufficient quality, quantity, timing and duration to maintain freshwater ecosystems and wetlands and their benefits, where the

Box 1: **Terms used to describe water flows related to ecological maintenance of watercourses**

- **Ecological flow:** a flow specified to maintain some feature of a river ecosystem, most often to limit the abstraction or diversion of water during the dry season.
- **Reserve flow:** a term for the quantity of water reserved to ensure the long-term sustainability of aquatic ecosystem functions and services.
- **Compensation flow:** a term used to denote the volume of water released downstream of a dam.
- **Flushing flow:** a higher than average temporary flow released to clear silt and debris from a river system for key ecological processes to occur.
- **Instream flow requirement (IFR):** an earlier, less-comprehensive term for environmental flows in river streams, often focused on fish survival. The term is now used to imply holistic frameworks for setting flow regimes.
- **Maintenance IFR:** a flow regime required to maintain river ecosystem functions to allow plants and animals to reproduce in most years.
- **Drought IFR:** a drastically reduced flow regime provided in drought years sufficient to maintain species without necessarily supporting reproduction.

river is subject to competing uses and flow regulation.

It is the water allocated to achieve a chosen environmental condition, following a process of environmental, social and economic assessment, where an acceptable balance between a desired ecosystem condition and other social and economic needs for water have been established.

Box 1 illustrates various terms that have been used to define flows for ecological maintenance of watercourses. Narrower approaches have emphasized a minimum flow - often a single fixed value. It is now recognized that the full water regime must be considered when assessing what is needed to sustain freshwater ecosystems and the services they provide (e.g. low flows, seasonal and exceptional flood flows, and river pulses such as daily peaking releases from hydropower dams).

Comprehensive approaches also take into account surface and groundwater flow interactions, and the interactive impacts of flow regulation on habitat and river morphology change, water quality, and nutrient and sediment cycles.

Socio-economic, recreation and cultural heritage values are also important elements in modern approaches to the assessment and provision of environmental flows – that aim to optimise benefit for all water use interests and equitably spread risks.

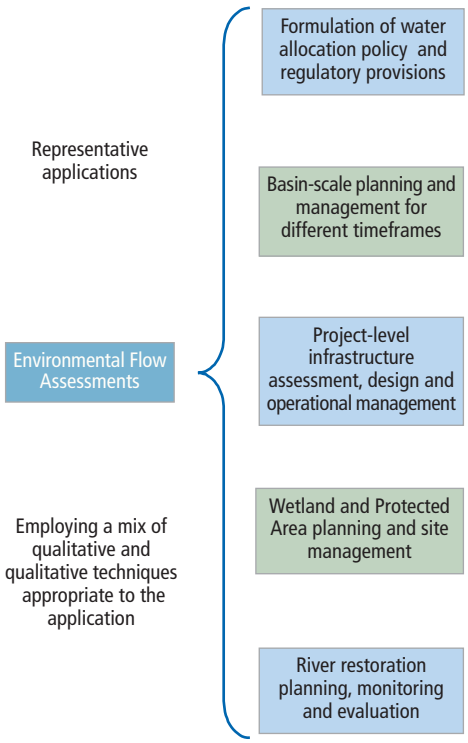
Where do environmental flow assessments fit in integrated water resource management?

Scientific understanding and insights gained through the assessment of environmental flow requirements, made within a broader framework of river basin planning, enable clearer and more informed consideration of measures, for example:

- To protect and optimise hydraulic functions that ecosystems and wetlands provide to improve water availability or quality;
- To minimize or mitigate the impacts of new water resource developments and flow regulation policies;
- To restore degraded wetlands and ecosystems impacted by past developments, and
- To establish benefit and risk sharing policies and calculate costs of compensating people.

Figure 1 illustrates how flow assessments feed into water resource planning at different levels, and for different purposes and timeframes.

Figure 1
Environment flows assessments in integrated water resource management



Environmental flow assessments offer a systematic way to balance economic, social and environment values in water allocation and management – where the quantification of environment needs has long been recognized as the missing part of the equation

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Fisheries protection prompted Italy's first the legislation on environmental flows in 1978. Similarly in France, the 1984 Fisheries Act was the first legislation

In basin planning, environmental flow assessments are needed to set long-term river flow objectives and define an environmentally sensitive water allocation policy. At the project-level, assessments support project evaluation and environmental impact assessment. They also contribute to adaptive management, such as setting policies to manage downstream releases from dams.

Conservation actors have long advocated the use of environmental flow assessments as a primary tool to connect wetland site management with basin-level planning. This recognizes that aquatic ecosystems and wetlands cannot be managed in isolation from other upstream activities.

Experience shows that participatory exercises that bring multi-disciplinary teams and different water use interests together in an environmental flow assessment, create conditions for more informed discussion of overall river management objectives. This is vital where complex tradeoffs in water allocation are involved. Properly conducted, these exercises help to break down communications barriers and reduce conflict.

It is important to introduce environmental flows assessments at the early stages of the planning cycle. If left until later, the problems can be more severe and solutions carry higher environmental, economic and social costs.

What policy and regulatory provisions are relevant?

International Conventions and many Pan-Mediterranean agreements on sustainable development provide a basis for the development national policies and regulations on environmental flows. Box 2 notes three examples.

Box 2: International and regional commitments embodying environment flows

- **On Integrated Water Resource Management**
  The Med-21 Declaration (Turin-1994) and subsequent Declarations on Local Water Management (most recent Turin 1999), provide for the specification of ecological flows in surface water bodies in Mediterranean countries.

- **On Wetlands Conservation and Management**
  The Venice Declaration on Mediterranean Wetlands (1996), based on Ramsar (1971), provides that policies to ensure the quality and quantity of water to maintain natural functions and values of wetlands are to be adopted in Mediterranean countries.

- **On Fresh Water Ecosystems**
  The Convention on Biological Diversity (1992) provides that flows to maintain freshwater ecosystems are to be determined and measures to provide them assessed.

These agreements embody consensus to work toward the context-specific assessment and provision of environmental flows as a means to promote the sustainable management of water resources and to conserve the Mediterranean regions' rich biodiversity and heritage values.

European Water Framework Directive (WFD, 2000)

The WFD is the most far-reaching piece of pan-European legislation that brings environment and water management issues together (see Box 3). Two key concepts the WFD introduces to the legislative agenda of EU-Mediterranean counties are 'ecological status' of water bodies and "water management" at the river basin level.

Box 3:

Overall aims of the WFD 2000 (Article 4)

- To prevent further deterioration and protect and enhance the status of aquatic ecosystems and associated wetlands;
- To promote sustainable water use based on the long term protection of available water resources;
- To enhance protection and improvement of the aquatic environment;
- To ensure the progressive reduction of pollution of groundwater and prevent its further pollution; and,
- To contribute to mitigating the effects of floods and droughts.

The WFD obligates these countries to modify their national legislation to achieve "good status" in water bodies (by 2015). "Good ecological status" (GES), a major component of "good status", must include an assessment of biological communities, habitat and hydrological characteristics of water bodies, in combination with the traditional assessment of chemical quality.

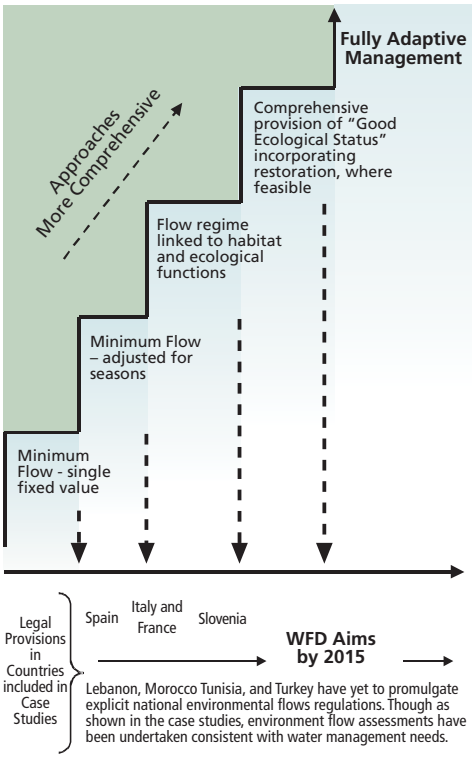
Critics nevertheless argue that a large gap remains between aspiration and practice, particularly between what is required by the WFD and what many countries currently undertake.

National policy and regulatory frameworks

In fact, only a few countries in the Mediterranean have introduced explicit national legislation requiring environmental flow assessments and provisions, as yet. Though environmental flows are implicit in the environment legislation and national water policies in most countries.

Northern Mediterranean countries have been moving through stages in regulation, often starting with a requirement for a minimum flow and progressing to more holistic notions of ecological quality. This is illustrated in Figure 2.

Figure 2. Evolution of environmental flow regulations in selected Mediterranean countries



Appropriate regulations are either made at the national or basin level, depending on the situation. Table 1 shows the evolving national framework laws in Italy. The national regulations call for each River Basin Agency to set specific rules for environmental flows suitable to their basin context.

Perception versus reality – what barriers need to be overcome?

Despite progress and changing attitudes, many perceptual barriers remain to

Slovenia requires the determination of environmental flows (EF) to license water abstractions from running waters, under the Environmental Protection Act and the new Water Act (2002)

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Table 1:
Evolution in criteria to define flow requirements in Italy

1978 "A minimum residual flow in order to assure fish life".	1999 "The quantitative protection of water resources contributes to the achievement of water quality targets sustainable water exploitation".
1994 "The flow necessary to life in rivers so that ecosystem equilibrium will not be damaged".	2002 "The flow that must be maintained downstream of water diversions to maintain vital conditions of ecosystem functionality and quality".
1995 The flow that must be maintained downstream from water diversions in order to maintain vital, although near critical, instantaneous conditions of ecosystem functionality and quality".	

*See the Vomano river case study in the Resource Kit

The perceived conflict between economic needs and the conservation of wildlife and habitats is an artificial one, which is detrimental to reaching consensus on practical and sensible strategies to manage natural resources in the common interest

widespread adoption of environmental flows in the Mediterranean.

Perception 1: Environmental flows are mostly for "water rich" countries in the Mediterranean

A common misconception is that environmental flows are mostly for countries with high rainfall and base flow rivers - typically basins on northern Mediterranean shores, and they have less relevance elsewhere in the Mediterranean where a combination of low rainfall and unregulated water demand has led to chronic water scarcity.

The reality is environmental flows are important in all basins in the region. They help restore and enhance hydraulic functions that wetlands and water-dependent natural resources play in the water cycle (e.g. water retention, storage, purification, and buffers against drought and flood) – while maintaining healthy ecosystems and related services. Moreover, many of the poorest basins, in water terms, have the most to gain.

On top of aggressive water demand management (WDM) and mobilization of non-conventional supply options, environmental flows provide an additional tool to mitigate in water quality degradation and chronic freshwater shortages in basins that are already deficit in water, and avoid similar crises in other river basins coming under increasing pressure.

Moreover, the decline in water-dependent ecosystems not only threatens environment and heritage values, but it directly affects other economic sectors that rely on such ecosystems. One example is the tourist sector, a fast growing job creation sector in many countries, where services provided by ecosystems are important.

Perception 2: Providing environmental flows means returning rivers to their natural state.

RAMSAR recognises that returning most rivers and wetlands to their natural states would be impossible due to long-established patterns of human use and impacts.

In reality, an environmental flow allocation cannot be seen only in terms of a flow regime that returns a river or other wetland ecosystem to a completely

natural state. Rather it is the flow that conserves the functions and attributes of ecosystems and wetlands that are desired by river communities and users, which in turn secure the sustained availability of the goods and services.

Perception 3: Average flows are sufficient to determine water allocations

A third common misconception is that average flows are sufficient to determine environmental flows, and by extension, to set flow regulation and water abstraction policies for different uses.

The reality is average river discharge may be one of the least essential elements of natural flow. Variability in flow quantity, quality, timing, and duration are more important to healthy rivers.

This is particularly so in Mediterranean basins where seasonal flooding may be followed by long periods of sparse rain, or multi-year drought episodes. In these circumstances ecosystems and indigenous riparian vegetation are generally adapted to drought cycles, dry riverbeds and intermittent river flows. But they critically need certain amounts of water to reset critical biological processes when the rains return. Allocations based on minimum or average flow conditions are not useful in such circumstances.

In severe drought situations, it may be necessary to allocate most of the available water to essential human needs and still protect the environment provided that provision is made for the ecosystems to receive water and recover once rains return. An environmental flow assessment will establish what is best in a particular basin.

Ultimately the degree of 'good health' to which a river and associated groundwater system will be sustained is a societal judgement that will vary from country-to-country and basin-to-basin.

CONCEPTS AND METHODS

Early methodological work on environmental flows in the late 1970's and 1980's was mainly applied to base flow rivers in temperate climates. Fisheries interests were among the first to promote these assessments to protect salmonoid species (trout) under threat in northern European and North American rivers.

Today's concepts for environmental flows assessment have a much broader scope. They reflect collaborative efforts of researchers in physical, natural and social science disciplines working on different aspects of ecology, hydrobiology and sustainable water management.

In the last decade the methods have been extended to rivers systems in semi-arid regions, more relevant to the Mediterranean situation. In Europe there has been a considerable infusion of financial and technical resources to develop methods and tools related to determining the ecological status of freshwater bodies, to underpin the Water Framework Directive.

What are the essential components of environmental flows?

Flow regimes of rivers may be divided into base flows, small floods that occur every year, and occasional large floods that spread over the floodplains.

- **Base flows**

The base flow influences the overall character of the river and wetlands ecosystem. In the Mediterranean context, base flows define whether the river is perennial or intermittent. Base flows create an assortment of conditions for

Agriculture and tourism each account for close to 14% of the Mediterranean region's GDP – where as agriculture represents 70% of consumptive water use, on average. Maintaining and restoring ecosystem services are factors in the tourist economy

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ecosystems processes in different seasons.

The low flow regime in conjunction with water quality is a critical factor in maintaining physical habitat and assuring the longer-term sustainability of the entire freshwater ecosystem. Low flows also impact on the intrusion of seawater in the river mouth and the alteration of estuary ecosystems in coastal zones.

- **Flood flows**

Floods recharge riparian groundwater systems and scour the riverbed and estuaries to maintain their stability and structure. Floods are essential to synchronize a range of ecological processes in the river system as varied as spawning and upstream migration of fish to the germination of seedlings on riverbanks. They trigger bursts of growth in many floodplain plant and animal species.

Small floods flush out poor-quality water, move debris and clean the riverbed and create different kinds of habitat. Large floods are responsible for changes in river morphology and sediment transport and deposit silt, nutrients, eggs, and seeds on floodplains. In some basins they support flood recession agriculture and a range of flood–related livelihoods.

An environmental flow assessment will seek to quantify and determine which elements of the natural flow regime are critical to achieve the desired ecological objectives and services to protect or restore. For example, it might be discovered that the flood stage or peak, rather than duration, is critical to push salt loads or silt out of the river mouth. In other parts of the same river, it may be important to inundate floodplains for a certain minimum period to stimulate fish breeding.

Wetlands will need flows that correspond to their hydroperiod (i.e. the patterns of water depth, and the duration, frequency, and seasonality of flooding) in order to sustain themselves and the hydraulic services they provide. In turn, the wetland's hydroperiod, among other factors, determines its vegetation composition, habitat for aquatic organisms, and production characteristics that are valued.

Similarly, the pattern of water flow in the river directly influences the structure and function of freshwater ecosystems, as noted in Box 4.

What are the main approaches?

The two main approaches for establishing environment flow requirements are objectives and scenario-based approaches. Objectives or scenarios may be derived for a particular river reach, sub-catchment, the estuary, or a wetland area - within the

The WFD defines "good ecological status" qualitatively, with reference to populations and communities of fish, macro-invertebrates, macrophytes, phytobenthos and phytoplankton. Also channel form and water depth impacting on biological elements

Box 4:

Flow regimes and aquatic ecosystems

Alteration of the river flow regime has many cascading ecological effects. First, the amount of water determines the amount and character of liveable habitat for aquatic organisms. More water generally means more contact with the shoreline or floodplain, which increases nutrient supply and types of food available to aquatic organisms. Second, the rate at which water moves through a system influences the ecosystem processes that occur and the kinds of organisms that can live in them. Third, the timing of hydrologic inputs is critical for creating and maintaining seasonal habitats and for supplying sediment and nutrients. Organisms are adapted to specific timing of high and low water levels, and extreme flow levels may be needed to maintain certain species within the community.

broader framework of water management objectives for the basin.

Objective-based approaches

Here, the aim is to set environmental performance indicators based on pre-established objectives, then identify a flow regime to meet those objectives.

The WFD sets the qualitative objective of achieving "good ecological status" (GES) in water bodies. While general criteria are specified, the objectives must be translated to specific performance indicators. It is also necessary to identify threshold flows, above, or below which, a change in status is evident.

Negotiated scenarios

An alternative approach is to compare the effects of a plausible range of water allocation and flow scenarios on ecosystems and the different water use interests represented in the basin. This leads to a negotiated approach to set the preferred environment flow regime, where the basin or government authorities are the final arbitrators.

What methods are used to quantify environmental flows?

Methods that support these approaches may be divided into two groups, namely: quantification methods and broader frameworks.

A. Quantification methods

Quantitative methods tend to be prescriptive and straightforward. Four main families of methods, in order of increasing complexity and data intensiveness are:

- Index Methods / Look up Tables
- Rating Methods / Desk Top Analysis
- Functional Methods /Expert Panels
- Physical Habitat Models

These methods are discussed in detailed in the accompanying booklet "Flow" and in material in the Resource Kit CD.

B. Broader frameworks

More in-depth procedures may incorporate one or more of the quantification methods noted above into a wider assessment framework. These frameworks tend to be interactive and look at a range of flow regimes each linked to different river flow objectives.

The IFIM framework is the oldest and most commonly used framework internationally, while the DRIFT framework is one of the newest.

- Instream Flow Incremental Methodology (IFIM)

The IFIM framework typically has five stages: problem identification; catchment characterization; modelling; formulation and assessing flow scenarios; and input to negotiations. It is scenario-based. It is often favoured for negotiations, but it is less suitable in setting flow regimes for pre-determined ecological objectives.

- Downstream Response to Imposed Flow Transformation (DRIFT)

The DRIFT framework developed in South Africa addresses all aspects of the river ecosystem. It employs four modules to construct scenarios and their ecological, social and economic implications (see Figure 3). An innovative feature is the strong socio-economic module, which in the developing country context, can be used to describe the predicted impacts of each scenario on subsistence users of the resources of a river.

The environmental flow assessment was a key element in government-led efforts to strike a balance between irrigation and municipal water use interests and freshwater inflows to retain the ecological character of the lake Ichkeul and wetland complex

Ichkeul Case Study, Tunisia

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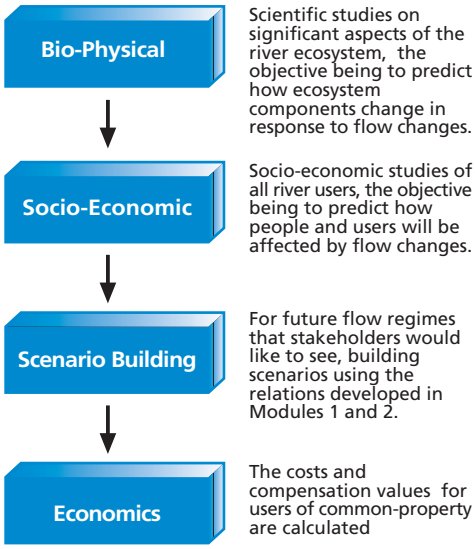
The Ebro Delta Environmental Plan (PIPDE), proposes "the definition of a hydrologic regime (including floods events) which allows the development of the ecological functions and associated values of the river, the delta and the adjacent marine ecosystem".

Ebro case study, Spain

Figure 3
Four modules in the DRIFT Framework



How are the methods and framework selected?

There is no single best approach, method or framework to assess environmental flow requirements. The choice would be determined mainly by the data and resources available and the issue to be addressed.

Where many river basins are to be assessed, a rapid method such as an index or rating method may be most appropiate. Where there is a single impacted site or stretch of river, physical habitat modelling may be best flow assessments associated with the appraisal of large dam projects or water transfer schemes, which are likely to call for considerable negotiation and tradeoffs between environment and development issues, typically require a more comprehensive approach than do flow assessments for coarse-scale planning studies.

What measures are available to provide Environmental Flows?

How environmental flows are best provided depends on the specific basin. In combination with an environmentally sensitive water allocation policy, measures may be categorized as:

(a) **Active flow management:** where actions are taken with flow regulation infrastructure, such as opening a bottom flow outlet on a dam or a sluice gate to implement an agreed flow regime, or
(b) **Restrictive flow management:** where abstractions or diversions from the river itself, or from groundwater within an aquifer supplying the river are regulated to achieve a desired environmental flow.

Some measures could be implemented rapidly, such as improving releases from dams. Other measures need more time to take effect, such as those to promote long-term structural changes in water demand or land use management in the catchment. These reduce pressure for water abstraction and leave more flexibility to allocate water to sustain ecological systems. In situations where water is already heavily over-allocated to consumptive uses, providing the water needs of aquatic ecosystems may mean reducing water use in one or more sectors, at certain times, on permanently. Hard choices are needed to balance between meeting immediate needs with unsustainable practices and advancing the long-term protection of water availability and quality.

Downstream releases from dams are good starting point

The 4,000 large dams on Mediterranean rivers are a good starting point for environmental flow improvement. While the opportunities depend on the type of dam and its function, existing reservoir

operating policies should be reviewed for ways to introduce environmentally sensitive criteria.

Managed floods are another new approach. Here environmental objectives can be incorporated in policies for managing floods, along with traditional economic and technical tradeoffs. Other technical measures may be considered to improve the water quality of downstream releases from deep reservoirs (e.g. to address temperature and dissolved oxygen levels).

Integrating other resource and environmental management actions

Ideally, actions in an environmental flow programme would be supported by a comprehensive package of basin-wide regulations and management interventions.

Such measures tipically involve land-use management in the catchment to control erosion and sedimentation, management of agriculture and industrial pollution impacting on surface and ground water quality, municipal wastewater treatment and salinity management. Other steps may involve the legal protection of wetlands, protected area management and programmes for restoration of habitats.

Adaptive management: monitoring, periodic review and adjustment

The determination of the water requirements of health freshwater ecosystems and wetlands should be based on the best available information and knowledge. But even so, it is seldom possible to predict exactly how complex ecosystems will respond to changes in flow regimes or water quality. Hence it is necessary to monitor the response of the system over time, followed by regular evaluation, and adjustment where needed. Monitoring and review forms an essential part of environmental flow setting and management.

Method type	Sub-type	Advantages	Disadvantages
Index Methods and Look-up tables	Hydrological Ecological	Rapid to use once calculated	Not site-specific. Hydrological indices not valid ecologically. Ecological indices need data to be calculated
Rating Methods / Desktop Analysis	Hydrological Hydraulic Ecological	Site specific Limited new data collection	Long time series required. No explicit use of ecological data Ecological data time consuming to collect
Habitat modelling	Physical and Ecological	Replicable, predictive	Expensive to collect hydraulic and ecological data
Functional Methods/ Expert consensus		Flexible, robust, and inclusive	Results may vary between expert teams. Consensus may not be achieved.
Broader Frameworks		More comprehensive and conducive to exploring options	Require a full programme of studies and sufficient resources

The drought and alteration of the hydrology of Sultan Marshes had several effects on local people with direct relationship with the wetland ecosystem. More than 80% cut reed for their personal needs (e.g. for feeding animals, covering roofs of houses and barns). Reed cutting is also the second most important income source after agriculture

Sultan Marshes Case Study, Turkey

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Table 2 indicates the range of valued natural features of river systems and wetlands that may be protected or enhanced by an improved environmental flow regime, aspects of which may be incorporated in monitoring.

Table 2: Valued natural features of river systems protected or enhanced by environment flows

Feature(s)	Value(s)
Aquifers and groundwater	Groundwater systems as direct sources of water –year round, during the dry season, or as reservoirs for buffers against drought periods
Wetlands functions and services	Prevention, loss or degradation of ecological, social and hydraulic functions of wetlands (e.g. as a genetic reservoir in addition to hydraulic and water quality functions that include groundwater recharge, flood buffers, shoreline stabilization, erosion control, and sediment and nutrient retention)
Floodplains	Support role in fisheries; flood-recession agriculture, particularly in semi-arid zones
Estuaries	Habitat and nursery areas for marine fish and shell fish; support for complex functions and interconnection of coastal lagoons
Recreational, aesthetics, tourism and cultural features	Clean water and rapids for river rafting; features valued by anglers, birdwatchers, and photographers and eco-tourists
Fish and aquatic animals	Biodiversity conservation; Fish as a valuable source of protein for people, aquatic animals and waterfowl; aquatic life that forms the base of the food chain (e.g. pelagic, benthic, and littoral food webs)
Waterfowl	Biodiversity conservation that supports about 2 billion migratory birds of 150 species, which use Mediterranean water courses as a stopover, or seasonal sites
Riparian vegetation	Stabilization of river banks and shorelines reducing erosion and improving water quality
Other ecosystem services and functions	The capacity of aquatic ecosystems to regulate essential ecological processes, for instance to purify water, limit eutrophication, or control disease vectors

Environmental Flow Provision Example(s)
• Floods to recharge the aquifers along the river reach and floodplains
• flows to respond to the hydroperiod of wetlands • flows to maintain suitable water quality • flows to maintain ground water levels for wetlands systems fed by groundwater
• floods to inundate the floodplain at the appropriate time of the year
• flows to maintain the required salt-freshwater balance and ocean connection to estuaries. • flows to prevent saltwater intrusion upstream in the river and in associated coastal aquifers
• flows to flush sediments and algae, and that maintain water quality • flows to maximize natural aesthetic features, including many flows mentioned above
• flows to maintain the physical habitat; • flows to maintain suitable water quality; • flows to allow passage for migratory fish; • small floods to trigger life-cycle cues such as fish spawning or egg-laying
• flows to maintain riparian vegetation, floodplains and wetland habitat for water fowl • flows to combat salinization of lakes and maintain required salt-freshwater balance in coastal lagoons and river mouths
• flows to maintain soil-moisture in river banks; • high flows to deposit nutrients on the banks and floodplains to distribute seeds. • Post-drought flood flows to reset growth
• flows to maintain biodiversity and ecosystem functioning

Adapted from: "Wetland Conservation," edited by P.J. Dugan and published by the IUCN, 1990; and "Water Resources and Environment - Environmental Flows: Concepts and Methods – Technical Note C1", edited by Richard Davis and Rafik Hirji, The World Bank, 2003

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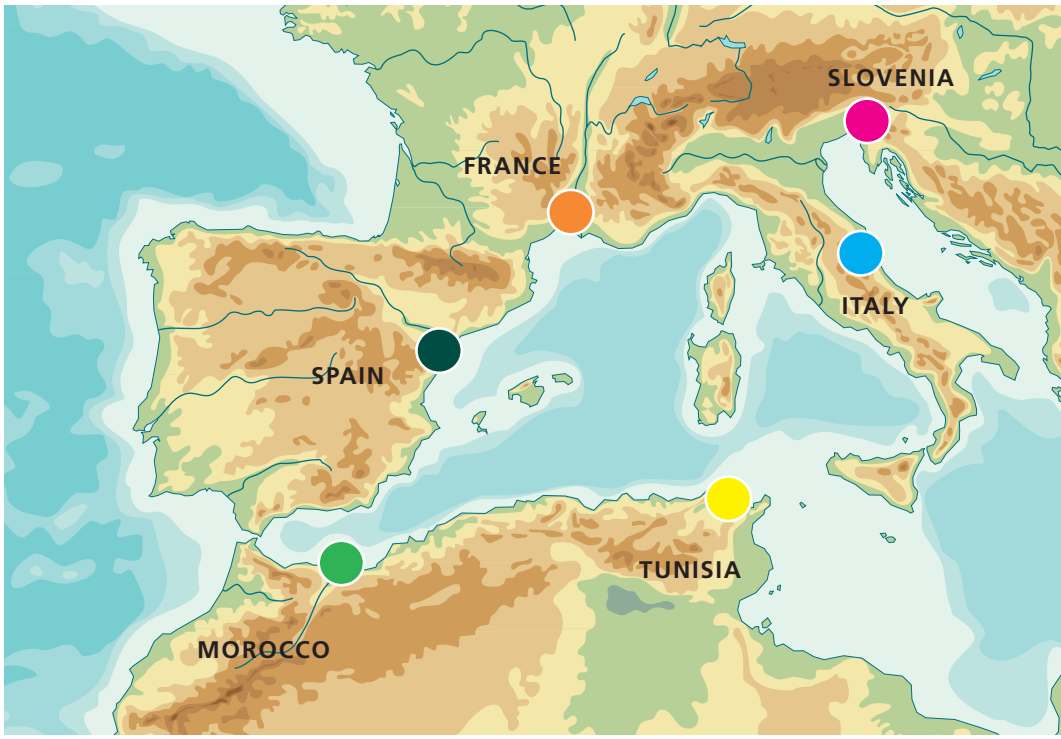
Case studies: emerging experience



The Resource Kit includes eight case studies to profile emerging Mediterranean experience with environmental flow assessment (EFA) and measures to provide them. Some assessments described are ongoing. Thus as a group, they illustrate how EFAs have already, or can in future, inform water management decisions in different situations. Additional case studies in the Resource Kit provide a cross-section of international experience.

Spain- Environmental Flow Assessment on the Ebro River
This case reviews the context and application of EFA methods on the Ebro river system in north-eastern Spain. It describes how EFAs have been used to set boundary conditions for water allocation tradeoffs considering abstractions, transfers, reservoir operating policies and catchment management generally.

Author: *César Alcácer,* Independent Consultant, Spain

Morocco – Some essential elements in the assessment of environmental flows for the Moulouya River
This case describes research-oriented EFAs to improve the understanding of measures to tackle interrelated issues of reservoir sedimentation, water quality deterioration and ecological maintenance in a river basin management context.

Author: *Maria Snoussi*, Université Mohamed V, Morocco

Slovenia –Evolving methods for environmental flow assessment and recent applications on the Rižana River

This case describes evolving national legislation and methods to establish environment flow requirements for Slovenian rivers. It describes recent methods to identify environmental flows requirements for the Rižana river that flows into the Škocjanski Zatok, the largest brachial wetland in Slovenia.

Author: *Nataša Smolar-Žvanut,* Limnos, Water Ecology Group, Slovenia

Italy - Environmental Flows and Integrated Water Resource Management: the Vomano River Case Study

This case describes how EFAs were applied in Vomano river system in central Italy to bring environmental objectives more explicitly into multi-criteria methods used to establish flow regulation policies and basin-level management plans.

Case Study Author: *Stefano Maran,* Environment Business Unit, CESI, Italy

Lebanon - Aammiq Wetland Case Study

This case shows how an EFA was used to identify measures to balance irrigation abstraction with protection of an ecologically significant marsh system fed by underground springs.

Author: *Richard Storey,* A Rocha, Lebanon

France - The Rhone River: Hydromorphological and Ecological Rehabilitation of a Heavily Modified Hydro system

This case shows how EFAs were applied in the Decennial Rhone River Hydraulics and Ecological Rehabilitation Plan (2000) in France. The aim was to restore ecosystem functions in several bypass sections of the "vieux" Rhone river.

Author: *Yves Souchon*, CEMAGREF, Freshwater Biology Research Unit, Quantitative Hydroecology Laboratory, France

Turkey: Sultan Sazliği: Biodiversity And Natural Resources Management Pilot GEF-2 Project

This case describes the EFA for the Sultan Marshes (Sultan Sazlığı), a large wetland complex in Turkey. It discusses how the drying out of Sultan Marshes in 2001-2002 prompted measures to address the immediate problem and discussion on longer-term measures for flow restoration.

Authors: *Uygar Özesmi,* Erciyes University and İbrahim Gürer, Gazi University, Turkey

Tunisia: Wetland conservation in a dry country: Ichkeul, Tunisia

This case shows how EFA methods were incorporated in the rehabilitation of Lake Ichkeul and the associated marsh system that form part of Parc National de l'Ichkeul in Tunisia, a World Heritage site.

Author: *Mike Smart,* Independent Consultant from the UK and formerly Chairman of the MedWet1 Steering Committee

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Just as the aims of the environmental flows assessment were designed to fit within the limitations of personnel, lack of baseline data and unpredictable water management, so the methods employed were chosen to be rapid, low technology and flexible.

Aammiq Wetland Case Study, Lebanon

What is needed to build awareness and capacity for environmental flows?

Developing and implementing a successful program for environmental flows is dependent on commitment and action from many different sectors of the community – governments, water users, and non-government groups including representatives of river users and environmental interest groups.

Professionals in the water, environment and scientific communities in the Mediterranean have considerable expertise and experience, which provides the building blocks for environmental flow assessment. However, there is a general lack of awareness of the new generation of methods and tools to apply environment flow assessments in different situations. Thus, while the ingredients already exist, the main challenge is to bring all the essential elements together in an integrated way.

In particular, more joint activities and stronger links between the water managers, conservation actors, water utilities, planners, scientific bodies and water researches are needed: - both to develop tools and to pilot applications. Some tools are required for highly specialized applications. Simple, user-friendly tools are also needed to empower and support multi-stakeholder bodies that operate at basin and local levels.

A further challenge is to improve the dissemination of quantitative information on the hydraulic functions that wetlands and freshwater ecosystems provide. This is not only important to raise awareness, but also to show how gains can be factored into planning, water allocation and river flow regulation decisions.

The broader opportunity rests with systematically bringing environment flows concepts and methods into the new approaches for integrated catchment management that are developing today.

Where is more information available on environmental flow procedures?

The Resource Kit that accompanies this brochure contains material that we feel will be useful to readers. The information compiled is aimed at actors involved in environmental flows including policy-makers, water managers, practitioners, dam operators and river basin agency managers, as well as non-government and civil society stakeholders in the environment and water management fields.

These materials can also be accessed on the Mediterranean Centre's website and through the links it provides to other key website sources.

The IUCN stands ready to share its experience with Members and partners to support interested parties in developing capacity to apply environment flow assessments in the Mediterranean.

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