



**3rd MEDITERRANEAN WATER FORUM**  
 Mediterranean regional process for the 8th World Water Forum  
 January 23rd, 2018. Marriott Hotel, Cairo, EGYPT



GOBIERNO DE ESPAÑA  
 MINISTERIO DE AGRICULTURA Y PESCA, ALIMENTACIÓN Y MEDIO AMBIENTE

CONFEDERACIÓN HIDROGRÁFICA DEL SEGURO

# “Water Ecosystem Services, and restoration techniques”

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Segura River Basin Authority, on behalf of:



**3rd MEDITERRANEAN WATER FORUM**  
 Mediterranean regional process for the  
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Union pour la Méditerranée  
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DEL SEGURA

# WATER IS LIFE!

...and humans are both a PART of ecosystems and a TENANT on them.

So, WHY SHOULD ECOSYSTEMS BE A TOP PRIORITY IN WATER MANAGEMENT ALL OVER THE WORLD?



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A satellite-style map of the Mediterranean region, showing the Mediterranean Sea, the Iberian Peninsula, the Balkans, and parts of North Africa and the Middle East. The text is overlaid on the map in large, bold, red letters.

**1. WATER ECOSYSTEM SERVICES**  
**2. RESTORATION TECHNIQUES**  
**3. CONCLUSIONS**



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# **1. WATER ECOSYSTEM SERVICES**

## 2. RESTORATION TECHNIQUES

## 3. CONCLUSIONS

# 1. WATER ECOSYSTEM SERVICES

What is an **Ecosystem Service**?

*“Benefits that humans derive from ecosystem functions”\**

Features of Ecosystem Services:

- They are **free!**
- **Dynamic**, easy to maintain
- Different time and spatial **scales**
- **Resilient**, yet **vulnerable** to impacts
- Part of **complex** ecosystem processes.



\* The handbook for management and restoration of aquatic ecosystem in river and lake basins, INBO, 2015.

# 1. WATER ECOSYSTEM SERVICES

## Types of Ecosystem Services:

Several alternative, similar classifications:

- The Economics of Ecosystems and Biodiversity (**TEEB**)
- Common International Classification of Ecosystem Services (**CICES**)
- Millennium Assessment



European Environment Agency



Evaluación de los ecosistemas  
del milenio de España - EME -

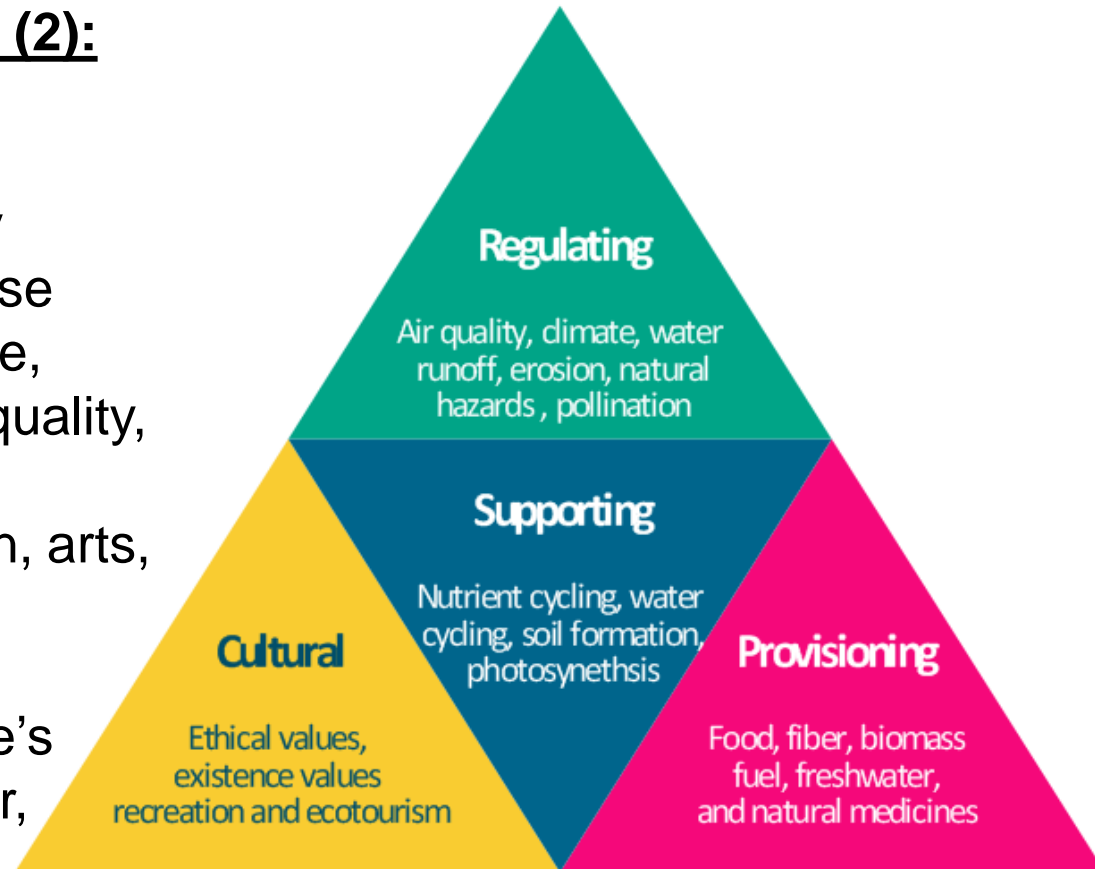


# 1. WATER ECOSYSTEM SERVICES

## Types of Ecosystem Services (2):

General categories:

- **Provisioning** services: they generate products we can use
- **Regulatory** services: climate, floods and droughts, water quality, erosion...
- **Cultural** services: recreation, arts, science&education, cultural heritage...
- **Supporting** services: nature's cycles (energy, matter, water, nutrients...)



# 1. WATER ECOSYSTEM SERVICES

Ecosystem services provided by wetlands:

1. Shore protection
2. Soil retention
3. Flood protection
4. Water supply
5. Water quality
6. Carbon sequestration
7. Produces: fisheries, game, foraging
8. Tourism, recreation, research
9. Cultural , spiritual, heritage values





# 1. WATER ECOSYSTEM SERVICES

## Types of Ecosystem Services (3). CICES:

Provisioning (Abiotic)	Water	Surface water used for nutrition, materials or energy	Surface water for drinking	4.2.1.1	By amount, type, source	Surface water for drinking	1.1.2.1
Provisioning (Abiotic)	Water	Surface water used for nutrition, materials or energy	Surface water used as a material (non-drinking purposes)	4.2.1.2	By amount & source	Surface water for non-drinking purposes	1.2.2.1
Provisioning (Abiotic)	Water	Surface water used for nutrition, materials or energy	Surface water used as an energy source	4.2.1.3	By amount, type, source	Not recognised in V4.3	N/A
Provisioning (Abiotic)	Water	Surface water used for nutrition, materials or energy	Coastal and marine water used as an energy source	4.2.1.4	By amount, type, source	Not recognised in V4.3	N/A
Provisioning (Abiotic)	Water	Ground water used for nutrition, materials or energy	Ground (and subsurface) water for drinking	4.2.2.1	By amount, type, source	Ground water for drinking	1.1.2.2
Provisioning (Abiotic)	Water	Ground water used for nutrition, materials or energy	Ground water (and subsurface) used as a material (non-drinking purposes)	4.2.2.2	By amount & source	Ground water as source of energy	1.2.2.2
Provisioning (Abiotic)	Water	Ground water for used for nutrition, materials or energy	Ground water (and subsurface) used as an energy source	4.2.2.3	By amount & source	Ground water for non-drinking purposes	N/A
Provisioning (Abiotic)	Water	Other aqueous ecosystem outputs	Other	4.2.X.X	Use nested codes to allocate other provisioning services from r. living systems to non-r. living systems (see CICES and CICES)	Not recognised in V4.3	N/A
Regulation (Biotic)	Regulation of physical, chemical, biological conditions	Regulation of physical, chemical, biological conditions	Regulation of the chemical condition of freshwaters by living processes	2.2.5.1	By type of living system	Chemical condition of freshwaters	3.3.1.1
Maintenance (Biotic)	Regulation of biological conditions	Regulation of physical, chemical, biological conditions	Regulation of the chemical condition of salt waters by living processes	2.2.5.2	By type of living system	Chemical condition of salt waters	3.3.1.2
Cultural (Biotic)	Direct, in-situ and outdoor interactions with living systems that depend on presence in the environmental setting	Physical and experiential interactions with natural environment	Characteristics of living systems that that enable activities promoting health, recuperation or enjoyment through active or immersive interactions	3.1.1.1	By type of living system or environmental setting	Experiential use of plants, animals and land-/seascapes in different environmental settings	3.1.1.1
Cultural (Biotic)	Direct, in-situ and outdoor interactions with living systems that depend on presence in the environmental setting	Physical and experiential interactions with natural environment	Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions	3.1.1.2	By type of living system or environmental setting	Physical use of land-/seascapes in different environmental settings	3.1.1.2
Cultural (Biotic)	Direct, in-situ and outdoor interactions with living systems that depend on presence in the environmental setting	Intellectual and representative interactions with natural environment	Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge	3.1.2.1	By type of living system or environmental setting	Scientific	3.1.2.1

*All of this services can be appraised and we can put a price tag on them. Their value is much higher than the cost of maintaining — restoring — enhancing them.*

**Bottom line: IF WE TAKE CARE OF ECOSYSTEMS WE GET BACK A LOT MORE THAN WHAT WE INVESTED!!!!**

# 1.WATER ECOSYSTEM SERVICES

## 2.RESTORATION TECHNIQUES



Picture: Can Cabanyes  
artificial wetland.  
Congost River, SPAIN

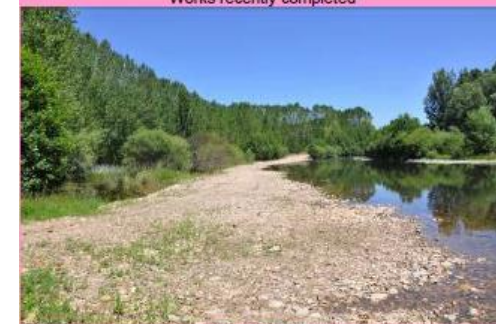
# 2. RESTORATION TECHNIQUES

## Basic concepts & misconceptions

- **Restoration**: to restore the ecosystem to its natural status and functioning (!)

## Other:

- Rehabilitation
- Remediation
- Enhancement
- Mitigation
- Amelioration
- Decontamination
- (...)



# 2. RESTORATION TECHNIQUES

Basic premise:

**IF POSSIBLE, REMOVE THE SOURCE(S) OF ALTERATION(S),**

such as:

- **Biological** changes: **INVASIVE ALIEN SPECIES**
- **Hydromorphological** changes: structure and dynamism
- **Hydrological** changes: abstraction, water regime
- **Pollution**: nutrients, metals, POCs, temperature changes, noise...

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**PROGRAMA DE MANTENIMIENTO Y CONSERVACIÓN DE CAUCES DE LA CUENCA DEL DUERO**

Subprograma 4: Recuperación y mejora de la conexión lateral de nuestros ríos

**RESTAURACIÓN DEL RÍO CASTRÓN EN FERRERAS DE ABAJO, ZAMORA**

El río Castrón en Ferreras de Abajo se canaliza en el año 1980. El río abandona su cauce original y circula por un canal en tierra desconectado de su llanura de inundación natural. Una parte del cauce abandonado se llena de maleza y vertidos sólidos de carácter antropogénico pero conserva en cierta medida su forma. Otra parte del cauce original se tapa por completo al ser nivelado el terreno en las tareas de acondicionamiento para la plantación de una chopera de producción. Nos encontramos por lo tanto con dos tramos diferenciados a la hora de seleccionar los trabajos para la restauración. En el tramo inicial, donde se puede ver o intuir el trazado original, se retiran los vertidos, se elimina la vegetación que invade el cauce y con tratamientos selvícolas se refuerza la presencia de las especies de ribera allí donde todavía se conservan. Este es el tramo que se describe como "cauce recuperado". En el segundo tramo, el cauce ha desaparecido, no hay vegetación de ribera y únicamente se observan algunas zonas húmedas ocasionales por el vertido de fosas sépticas que rebosan al ser insuficientes para la población de Ferreras de Abajo. Este segundo tramo es el que se describe como "cauce restaurado" y ha sido excavado según el trazado que el río tenía en el año 1956. Los términos "restauración" y "recuperación" aquí utilizados sólo pretenden diferenciar las actuaciones necesarias para llevar el río a su estado original desde dos tramos inicialmente distintos. En su conjunto se trata de una obra de "Restauración fluvial".



**CAUCE ORIGINAL**  
 Longitud: 3.050 m  
 Pendiente: 0,33 %  
 8.0 m, 1.5 m

**CAUCE CANALIZADO**  
 Longitud: 1.650 m  
 Pendiente: 0,54 %  
 MOTA, 2.7 m, 8.0 m, 2.5 m, 6.0 m, 5.0 m

Año 1980. Año 2008.

CANALIZACIÓN (1980)

Trazado del río Castrón sobre la fotografía aérea de 1956.



Año 2006.



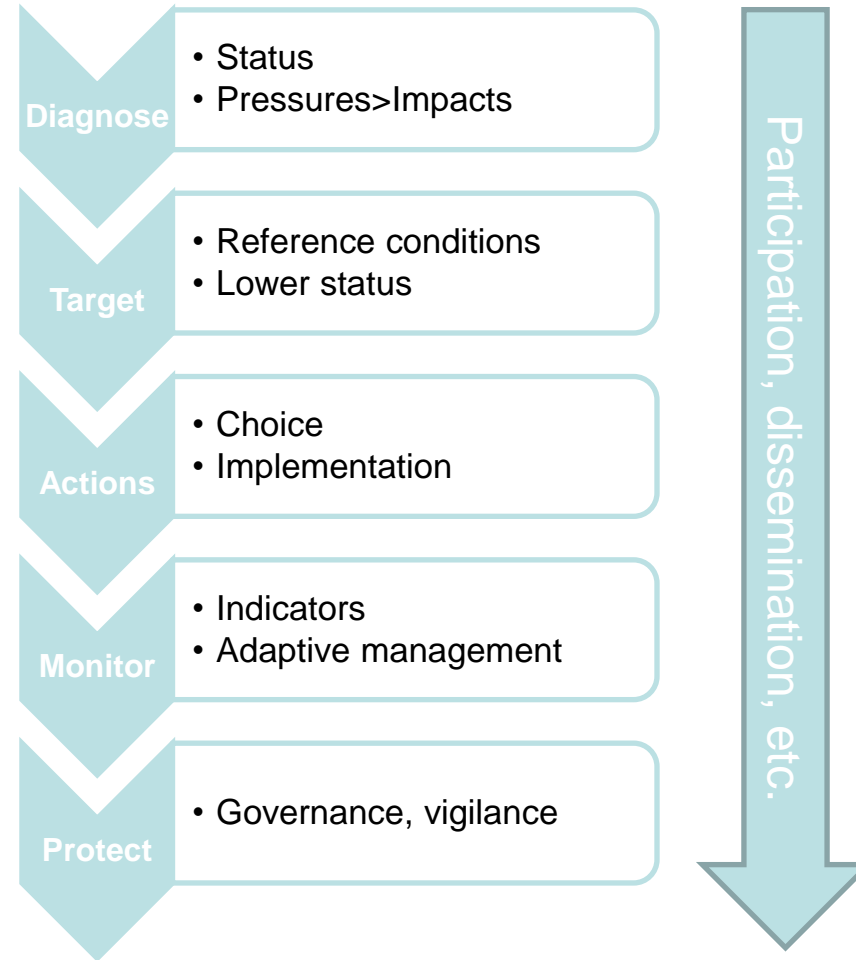
— Trazado original  
 — Cauce recuperado  
 — Cauce restaurado  
 — Canal anulado en esta actuación

# 2. RESTORATION TECHNIQUES

Basic stages:

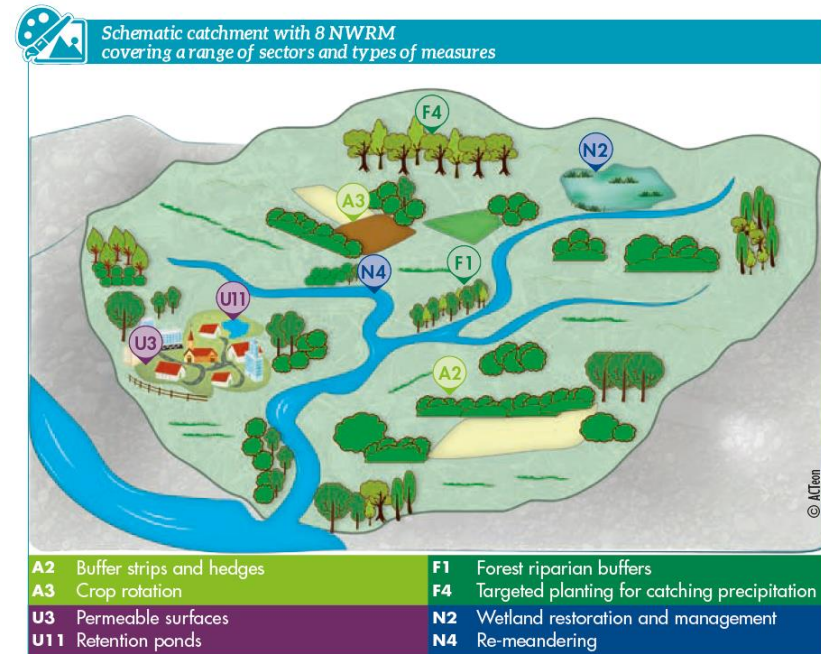
- **Diagnose** the status of your system
- Establish the **target** for your project:
  - Restoration: reference status
  - Enhancement: lower status
- Choose **actions** to be carried out accordingly. Implement
- Monitor via adequate **indicators**, to assess success
- **Protect**, in order to preserve new status

**All throughout:** dissemination, participation, networking, monitoring and adaptive management.



# 2. RESTORATION TECHNIQUES

- Examples (some are multi-purpose):
  - Dam removal. Water flow regime naturalization. Environmental flows. Artificial flash floods. Sediment flushing. Fish passages. Friendly infrastructures...
  - Remeandering, reconnecting riverbeds
  - Water quality: WWTP, bioremoval, artificial wetlands, Green filters, buffer strips, riparian forest plantations...
  
- Cross-cutting labels:
  - Green infrastructure
  - NWRM



Source: P.Strosser, G.Delacámara, A.Hanus, H.Williams and N.Jaritt. 2015. A guide to support the selection, design and implementation of Natural Water Retention Measures in Europe - Capturing the multiple benefits of nature-based solutions. Final version, April 2015.

# 2. RESTORATION TECHNIQUES

- Weir removal.

San Marcos Weir, Bernesga River,  
León, SPAIN



## 2. RESTORATION TECHNIQUES



- Dam removal.  
Demolition of the Umbrías dam (Aravalle river, Duero Basin, Ávila-Spain)



# 2. RESTORATION TECHNIQUES

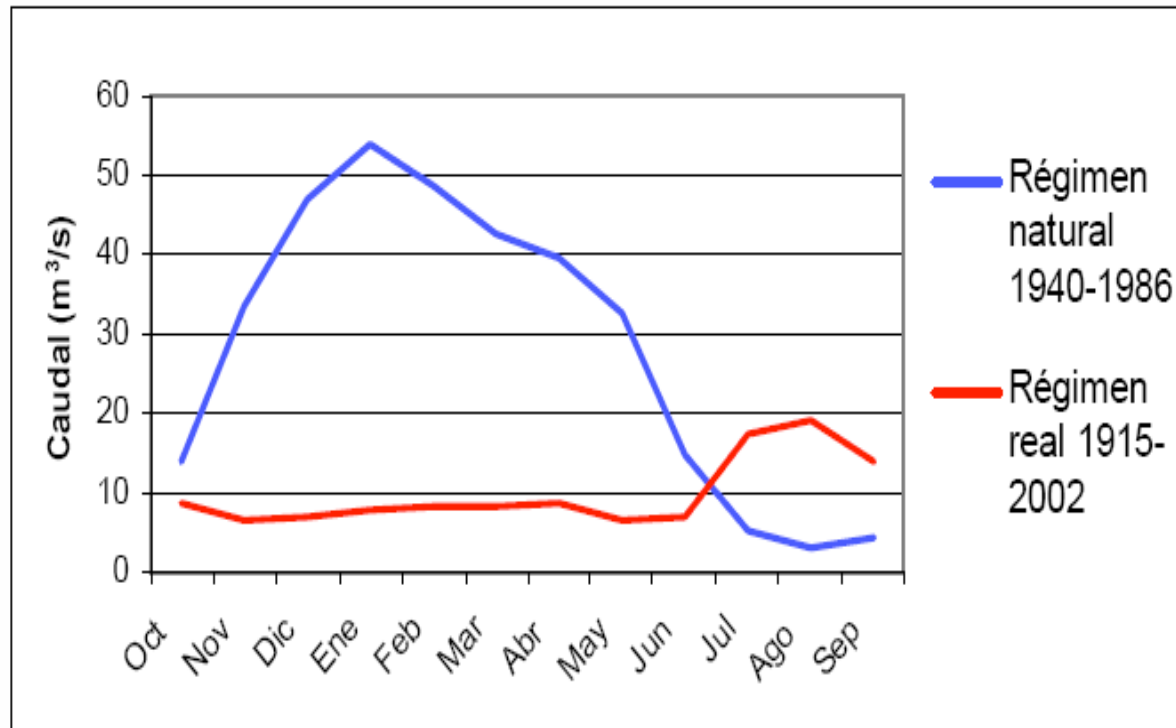
Fish passages, Several examples

Pictures: LIFE+12/ENV/ES/1140 "SEGURA RIVERLINK"  
 Project co-funded with the aid of EU's LIFE+ financial instrument



## 2. RESTORATION TECHNIQUES

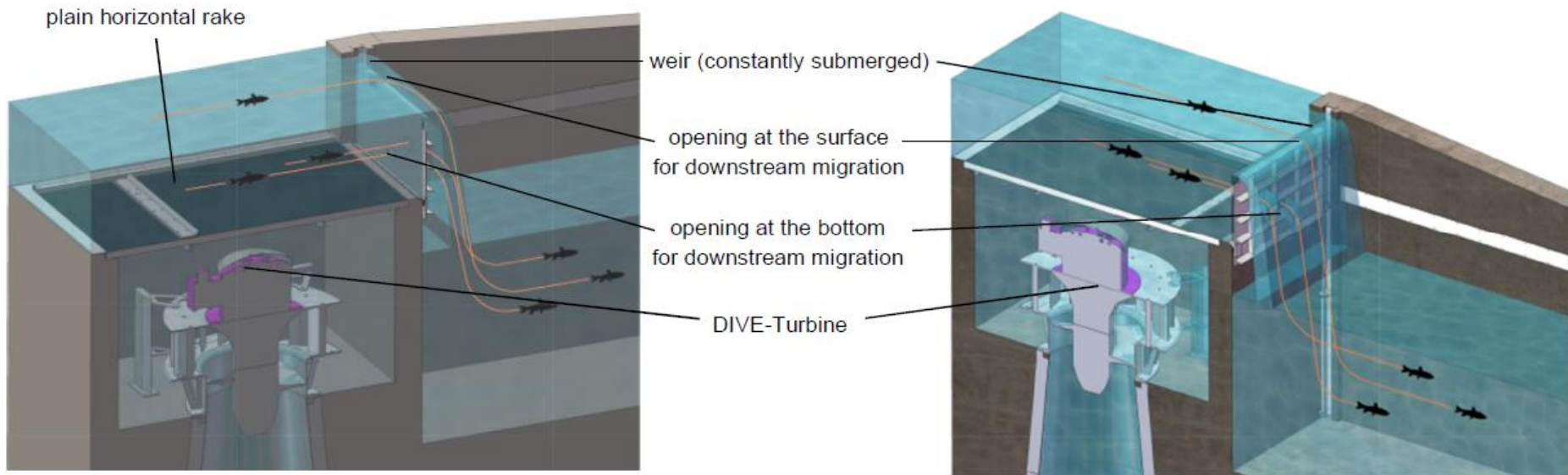
- Environmental Waterflow regime. Ebro River, comparison between natural and artificial yearly water flows.
- Environmental regime to encompass: Maximum flow; Minimum flow; Rate of variation; artificial flash floods or “generative flows”



# 2. RESTORATION TECHNIQUES

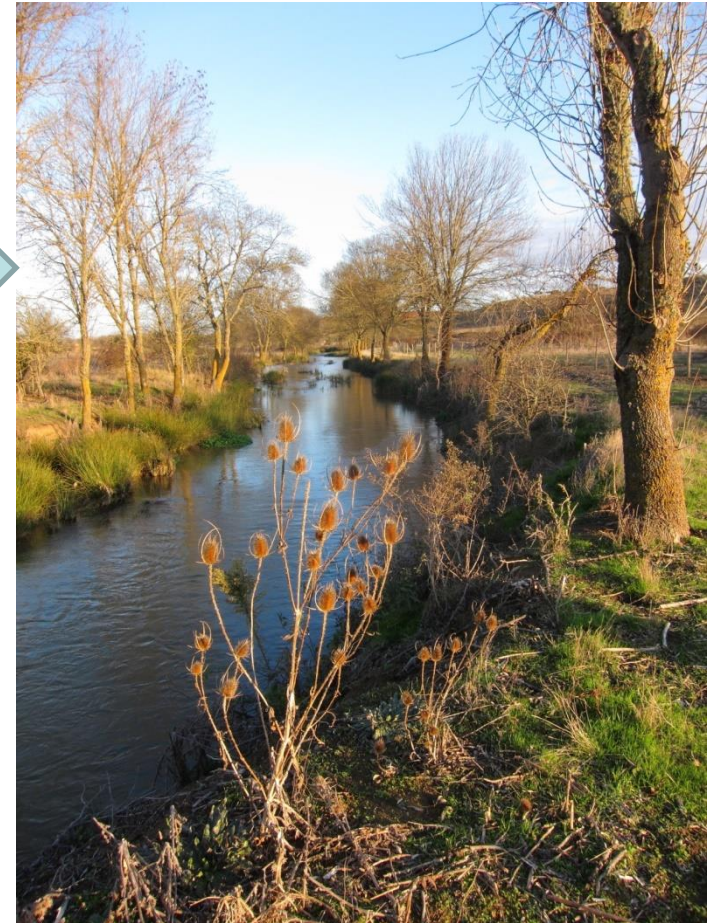
- Fish-friendly hydropower turbines.

Source: DIVE Turbinen GmbH & Co. KG



## 2. RESTORATION TECHNIQUES

- Remeandering/reconnecting riverbeds



Abandoned riverbed restoration.  
Riosequillo, Belver de los Montes,  
Zamora, SPAIN

# 2. RESTORATION TECHNIQUES

- Wastewater Treatment Plants.



# 2. RESTORATION TECHNIQUES

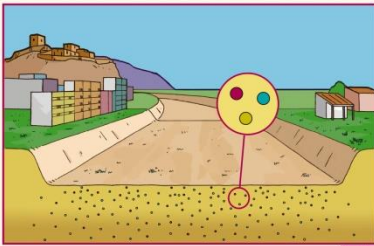
## - Bio removal.

### SITUACIÓN ACTUAL

#### CURRENT SITUATION

La ribera del río Guadalentín tras su paso por la ciudad de Lorca (Región de Murcia) está contaminada por metales pesados procedentes de industrias, granjas y agricultura.

*The riverbed of the Guadalentín River after its flow along the urban nucleus of Lorca (Murcia) is contaminated with heavy metals, this is mainly as a result of direct waste spills coming from industries, farms and agriculture.*



● Cr ● Zn ● Cu

### OBJETIVOS

#### OBJECTIVES

El principal objetivo del proyecto es evaluar, demostrar y difundir una alternativa sostenible para la recuperación ambiental y paisajística de un tramo contaminado de 1.500 m del Río Guadalentín tras su paso por el núcleo urbano de la ciudad de Lorca (Murcia).

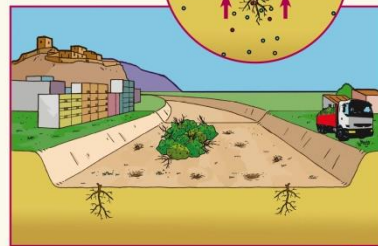
*Our main goal is to assess, demonstrate and disseminate a sustainable alternative for the environmental and landscape recovery of a 1.500 m polluted stretch of the Guadalentín River after its flow along the urban nucleus of Lorca (Murcia).*

### FITOEXTRACCIÓN

#### PHYTOEXTRACTION

La restauración ambiental del lecho fluvial se conseguirá mediante el uso de la técnica denominada fitoextracción. Este mecanismo contribuye a transferir los metales desde el suelo a la vegetación, que será eliminada periódicamente.

*The environmental restoration of the riverbed will be achieved by the use of the phytoextraction technique. This strategy contributes to the transfer of metals from soil to vegetation, which will be periodically removed.*



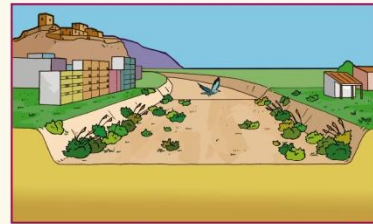
### RESIDUO CERO

#### ZERO WASTE

Las plantas cortadas y arrancadas que han acumulado cromo, cobre y zinc del sedimento del cauce del río, serán transportadas a una cementera para producir energía mediante su combustión.

Las cenizas generadas se incorporarán en la producción de cemento, ya que este requiere de ciertas cantidades de metales pesados para su fabricación. De este modo se consigue el objetivo Residuo Cero.

*The uprooted and cut plants which have accumulated chromium, copper and zinc from the sediment of the riverbed will be transported to a cement factory to produce energy by their combustion. The generated ashes will be incorporated in the cement production, since this product requires some quantities of heavy metals for its production. So Zero Waste objective is achieved.*



Picture: LIFE11 ENV/ES/000506

“RIVERPHY”

**Project co-funded with the aid of EU’s LIFE+ financial instrument**



## 2. RESTORATION TECHNIQUES

- Artificial wetlands: the “Tancat de la Pipa”, adjacent to “Albufera de Valencia”



# 2. RESTORATION TECHNIQUES

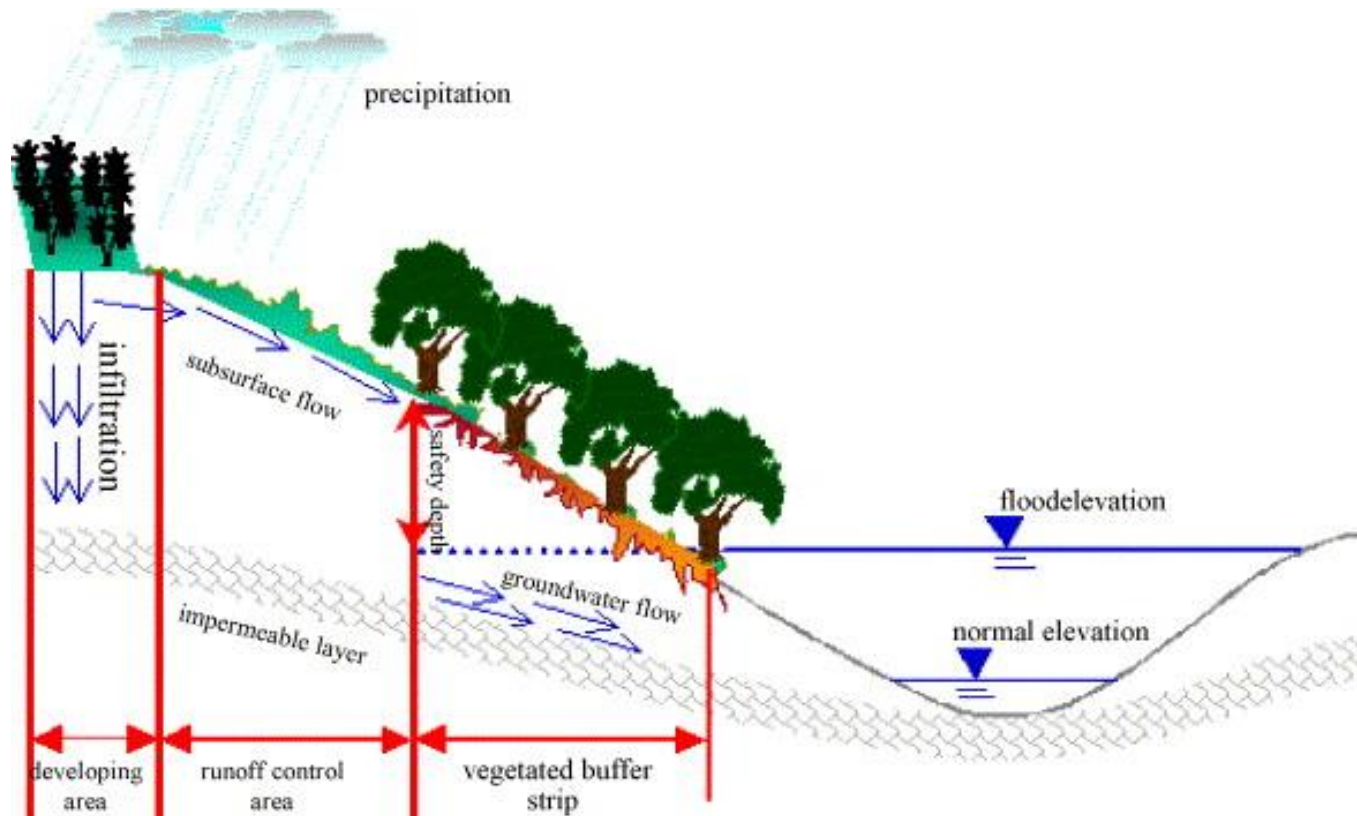
- Green Filters.





# 2. RESTORATION TECHNIQUES

- Buffer strips.



Picture: [www.sciencedirect.com](http://www.sciencedirect.com)

# 2. RESTORATION TECHNIQUES

- Riparian forest plantation.



Picture: LIFE+13/BIO/ES/1407 “RIPISILVANATURA”  
*Project co-funded with the aid of EU’s  
LIFE+ financial instrument*

**RIPISILVA**



# 2. RESTORATION TECHNIQUES

- Green infrastructure.

*The GI approach refers to the natural or semi-natural systems that provide services for water resources management with equivalent or similar benefits to conventional (built) “grey” water infrastructure.*

Source:  
 UNEP. “Green Infrastructure Guide for Water Management: Ecosystem-based management approaches for water-related infrastructure projects”

Table 1 Green Infrastructure solutions for water resources management

Water management issue (Primary service to be provided)	Green Infrastructure solution	Location				Corresponding Grey Infrastructure solution (at the primary service level)
		Watershed	Floodplain	Urban	Coastal	
Water supply regulation (incl. drought mitigation)	Re/afforestation and forest conservation					Dams and groundwater pumping Water distribution systems
	Reconnecting rivers to floodplains					
	Wetlands restoration/conservation					
	Constructing wetlands					
	Water harvesting*					
	Green spaces (bioretention and infiltration)					
	Permeable pavements*					
Water purification	Re/afforestation and forest conservation					Water treatment plant
	Riparian buffers					
	Reconnecting rivers to floodplains					
	Wetlands restoration/conservation					
	Constructing wetlands					
	Green spaces (bioretention and infiltration)					
Erosion control	Re/afforestation and forest conservation					Reinforcement of slopes
	Riparian buffers					
	Reconnecting rivers to floodplains					
	Re/afforestation and forest conservation					
	Riparian buffers					
	Permeable pavements*					
Biological control	Re/afforestation and forest conservation					Water treatment plant
	Riparian buffers					
	Reconnecting rivers to floodplains					
	Wetlands restoration/conservation					
Water temperature control	Constructing wetlands					Dams
	Re/afforestation and forest conservation					
	Riparian buffers					
	Reconnecting rivers to floodplains					
	Wetlands restoration/conservation					
Moderation of extreme events (floods)	Constructing wetlands					Dams and levees
	Green spaces (shading of water ways)					
	Re/afforestation and forest conservation					
	Riparian buffers					
	Reconnecting rivers to floodplains					
	Wetlands restoration/conservation					Urban stormwater infrastructure
	Constructing wetlands					
	Establishing flood bypasses					
	Green roofs					
	Green spaces (bioretention and infiltration)					
Coastal flood (storm) control	Water harvesting*					Sea walls
	Permeable pavements*					
	Protecting/restoring mangroves, coastal marshes and dunes					
	Protecting/restoring reefs (coral/oyster)					

# 2. RESTORATION TECHNIQUES

## - NWRM

*“Natural Water Retention Measures or NWRM are measures with the primary function of enhancing and/or restoring the retention capacity of natural and manmade soil and aquatic ecosystems.*

*As a result, they deliver a range of services and multiple benefits to people while contributing to the achievement of the objectives of different environmental strategies and policies.”*

Box 12: Set of Natural Water Retention Measures							
Agriculture area		Urban area		Aquatic environment		Forest area	
A1	Meadows and Pastures	U1	Green roofs	N1	Basins and ponds	E1	Forest riparian buffers
A2	Buffer strips and hedges	U2	Rainwater harvesting	N2	Wetland restoration and management	E2	Maintenance of forest cover in headwater areas
A3	Crop rotation	U3	Rainwater harvesting	N3	Floodplain restoration and management	E3	Afforestation of reservoir catchments
A4	Strip cropping along contours	U4	Swales	N4	Re-meandering	E4	Targeted planting for "catching" precipitation
A5	Intercropping	U5	Channels and rills	N5	Stream bed re-naturalization	E5	Land use conversion
A6	No till agriculture	U6	Filter strips	N6	Restoration and reconnection of seasonal streams	E6	Continuous cover forestry
A7	Low till agriculture	U7	Soakaways	N7	Reconnection of oxbow lakes and similar features	E7	"Water sensitive" driving
A8	Green cover	U8	Infiltration trenches	N8	Riverbed material renaturalization	E8	Appropriate design of roads and stream crossings
A9	Early sowing	U9	Rain gardens	N9	Removal of dams and other longitudinal barriers	E9	Sediment capture ponds
A10	Early sowing	U10	Detention basins	N10	Natural bank stabilisation	E10	Coarse woody debris
A11	Controlled traffic farming	U11	Retention ponds	N11	Elimination of riverbank protection	E11	Urban forest parks
A12	Reduced stocking density	U12	Infiltration basins	N12	Lake restoration	E12	Trees in urban areas
A13	Mulching			N13	Restoration of natural infiltration to groundwater	E13	Peak flow control structures
				N14	Re-naturalisation of polder areas	E14	Overland flow areas

Source: P.Strosser, G.Delacámara, A.Hanus, H.Williams and N.Jaritt. 2015. A guide to support the selection, design and implementation of Natural Water Retention Measures in Europe - Capturing the multiple benefits of nature-based solutions. Final version, April 2015.

# 3. CONCLUSIONS

- Wetlands provide numerous Ecosystem Services.
- Economic value of ecosystem services >> cost of restoration.
- Maintaining ecosystem services << costs of “grey infrastructure”.
- Several restoration techniques available.
- 1<sup>st</sup> step: good diagnosis.
- If possible, remove impacts/pressures.
- **ECOSYSTEMS: KEY IN PROVIDING QUALITY WATER FOR MANKIND**

# RELEVANT MATERIALS AND BIBLIOGRAPHY

- “TEEB for Water & Wetlands”

<http://www.teebweb.org/areas-of-work/biome-studies/teeb-for-water-and-wetlands/>

- IPBES assessments on Ecosystem services

<https://www.ipbes.net/document-library-categories/assessment-reports-and-outputs>

- RAMSAR: “State of the World’s Wetlands and their Services to people: A compilation of recent analyses”

[https://www.ramsar.org/sites/default/files/documents/library/bn7e\\_0.pdf](https://www.ramsar.org/sites/default/files/documents/library/bn7e_0.pdf)

- INBO: “The handbook for management and restoration of aquatic ecosystems in river and lake basins”. March 2015.

<http://www.inbo-news.org/riob/publications-et-documents/article/the-handbook-for-management-and-4201>

- Protocols for improving the success of hydromorphological restoration measures:

[www.Reformrivers.eu](http://www.Reformrivers.eu)

- Catalogue of river restoration case studies:

[www.Restorerivers.eu](http://www.Restorerivers.eu)

- EU Commission work on Natural Water Retention Measures:

[www.Nwrm.eu](http://www.Nwrm.eu)

- UNEP. Green Infrastructure Guide for Water Management

[http://www.unepdhi.org/-/media/microsite\\_unepdhi/publications/documents/unep/web-unep-dhigroup-green-infrastructure-guide-en-20140814.pdf](http://www.unepdhi.org/-/media/microsite_unepdhi/publications/documents/unep/web-unep-dhigroup-green-infrastructure-guide-en-20140814.pdf)



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# THANKS FOR YOUR ATTENTION!



<http://www.cirefluvial.com/>

**Iberian Center for River  
Restoration**

More:

[www.chsegura.es](http://www.chsegura.es)



[Jaime.fraile@chsegura.es](mailto:Jaime.fraile@chsegura.es)



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