# Inter-sectoral assessment of management scenarios based on ecosystem services



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# As the status of many water bodies remains unsatisfactory

- due to pressures from multiple societal sectors
- that are modified by emerging new drivers

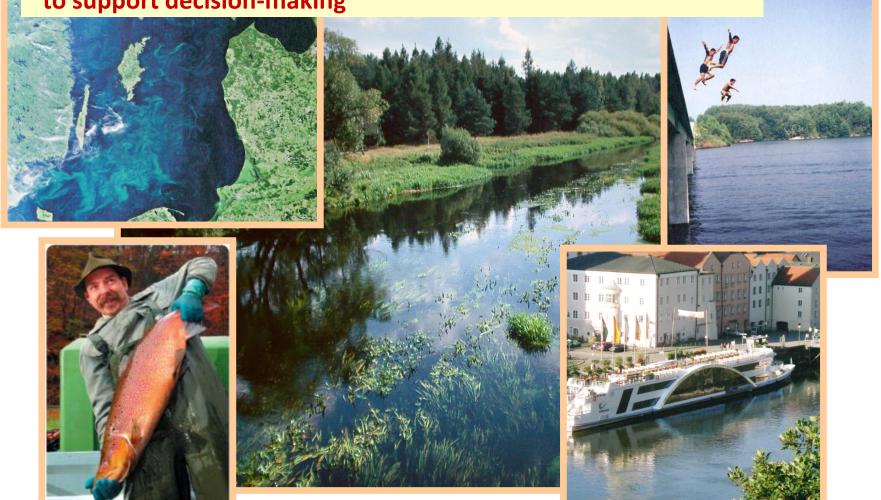




.... integrative scenarios for ecosystem-based-management in aquatic ecosystems

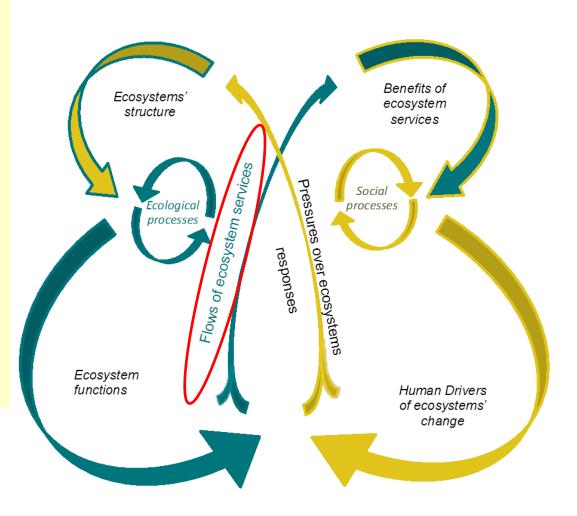
- need and may to be developed based on various available data

- in order to compare, assess and prioritize those scenarios to support decision-making



# **Hypothesis:**

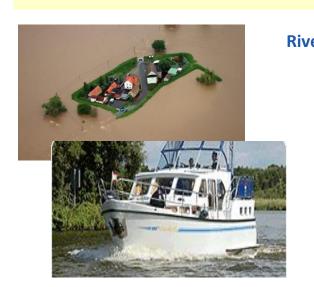
The compliance of complex inter-sectoral scenarios with legal and other societal goals may be best assessed based on the availability of ecosystem services for each scenario, as conceptualized in the **AQUACROSS** assessment framework →



AQUACROSS assessment framework

## **Hypothesis:**

The compliance of complex inter-sectoral scenarios with legal and other societal goals may be best compared based on the availability of ecosystem services for each scenario





# Catalogue of ecosystem services available at water bodies and wetlands

# Classification of Ecosystem Services For the River Ecosystem Service Index



#### www.resi-project.info

Main group	Subgroup	Ecosystem service	Description
Provisioning	Nutrition	Cultivated crops	Agricultural products for consumers
		Plant resources for agricultural use	Plants used to feed farm animals as a basis to produce e.g. milk and meat
		Wild animals and fish	Wild animals and fish (consumptive)
		Surface water for drinking	Collected precipitation, abstracted surface water from rivers, lakes and other open water bodies for drinking
		Ground water for drinking	Freshwater abstracted from groundwater layers or via ground water desalination for drinking
	Resources	Fibers and other materials from plants for direct use or processing	Wood from forest and plantations for direct use or processing
		Water for non-drinking purposes	surface and ground water for non-drinking purposes in industry and agriculture for cooling or irrigation purposes
	Biomass-based energy resources	Plant-based resources	Plant-based resources from agriculture, short rotation coppice, forestry. Biomass as a resource for energy production.
	Retention	Retention of organic C	(Temporary) Retention of organic C by uptake into stationary biomass (e.g.)
	(Self-purification)		assimilation by mussels or biofilm) or by deposition as sediments
			Permanent removal of organic C by respiration
			Microbial degradation of organic pollutants
		Retention of N	(Temporary) Retention of organic N by uptake into stationary biomass (e.,
			assimilation by mussels or macrophytes) or by deposition as sediments
			(Temporary) Retention of inorganic N by uptake into pelagic bioma
			(assimilation by phytoplankton, zooplankton)
			Permanent removal of N by denitrification in river channel or floodpla
			contributing to self-purification
		Retention of P	(Temporary) Retention of P by uptake into stationary biomass (e.
			assimilation by mussels or biofilm) or by deposition as sediments  (Temporary) Retention of P by uptake into pelagic biomass (assimilation by
			phytoplankton, zooplankton)
		Retention of greenhouse gas emission / carbon	Reducing anoxic ways of C degradation (leading to CH4 emissions)
		sequestration	Reducing incomplete anoxic ways of N degradation (leading to N <sub>2</sub> O emission)
			Retention of CO2 by uptake into biomass by biotic assimilation enabling
<b>bo</b>	Global climate regulation		sequestration of C by a) temporary retention by growth of biomass in riv
Ē			channels and banks (e.g. phytoplankton, annual macrophytes) (with parti
nla			trade-off with eutrophication) and b) retention in live or dead biomass
Regulating			floodplain vegetation and soils
_	Extreme discharge		Mitigation of flood discharge and lowering of flood peak by inundation of floodpla
	mediation	Flood risk regulation	areas (retention effect) and high roughness of natural river channels (delay effect,
			which is also broadening the flood wave)
			Mitigation of drought effects on river flow by a) inflow from floodplain aquifers or
		Drought risk regulation	<ul> <li>b) stabilization of river water level by hydraulic roughness of river channel, which is in some river types additionally increased at low flow by dense growth of aquatic</li> </ul>
			macrophytes.
			Possibility for water to be drained from an area into a stream channel following a
	Drainage	Drainage capability	natural slope of the ground
	Sediments		Sediment (incl. suspended) regulation bed load equilibrium and control of channel
		Mass flow / Sediment regulation	incision. Adjustment of local surplus or lack of sediment due to erosion or incision
			or sedimentation (in river channels, floodplains, river mouths, beaches)
		Soil formation in floodplains	Sediment-induced soil formation, favored by sedimentation of suspended particles during floods.
	local climate regulation	Local temperature regulation/Cooling	Cooling effect of water bodies and ground due to evapotranspiration in summer

Catalogue of ecosystem services available at water bodies and in wetlands

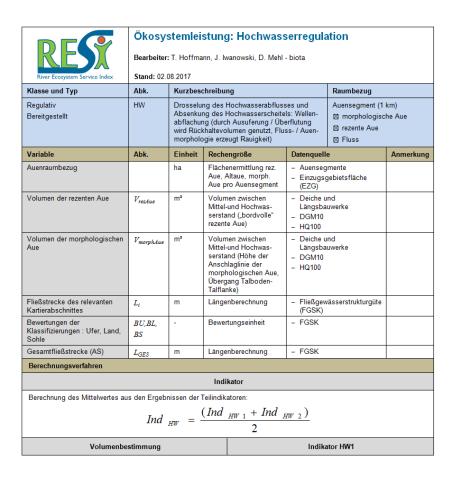
	Cultural	Landscape aesthetics	Aesthetics of landscape as characterized by its diversity, specificity and naturalness		
		Natural and cultural heritage	Entirety of all physical objects (as memorials, species), as well as notional and cultural reflection of physical goods of nature, and informal cultural forms of expression.		
Cultural		Unspecific interactions with riverine ecosystem	Experience of animals, plants and landscapes during activities (e.g. hiking, biking) for recreational purpose		
		Education and Science	Use of river ecosystems for popular or scientific excursions , nature trails, research objects etc. which are relating to river ecosystems		
		Water-related activities	Swimming, un-motorized boating, motorized boating (e.g. cruise tours) and fishing as specific water related activities with recreational purpose		
Sasic unctions	Hydrological cycle and water flow maintenance	Discharge and discharge dynamics	Discharge and discharge dynamics, as determined by the catchment and upstream channel sections		
		Connectivity with aquifers	Hydrological or hydraulic Interaction between river and groundwater		
Basic	Morphology	Physical structure of river channel and floodplain	Physical structure of river channel and floodplain as a result of hydromorphological processes		
Use of abiotic natural capital		Hydropower			
		Navigation			

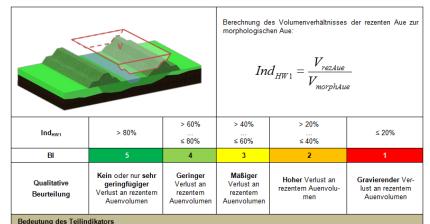


# How to assess ES based on GIS or monitoring data?



# **Example: Factsheet for ES, Flood retention**





#### Boardiang and Forman

#### Interpretation

Der Indikator gibt vereinfachend an, wie stark sich der theoretische Hochwasserrückhalteraum in einem Auenabschnitt im Vergleich zum ursprünglichen Zustand verändert hat und spiegelt damit einen direkten Bezug zur ÖSL Hochwasserregulation wieder.

#### Erweiterungsmöglichkeiten

Im Falle der Verfügbarkeit von berechneten Ausuferungsflächen (z. B. aus Hochwassergefahrenkarten) können diese direkt für eine genauere Bestimmung des Retentionsvolumens der Aue genutzt werden.

#### ■ Datenquellen

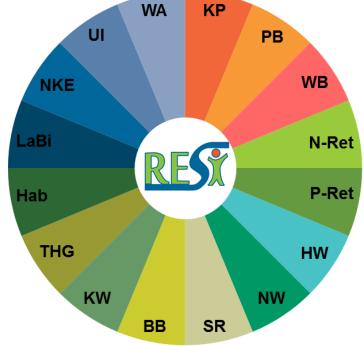
Datensatz	Beschreibung Typ, Katego- rien	Raumbezug	Auflösung / Genauigkeit	Referenz	Aktualität	Kommentar
Digitales Gelän- demodell →DGM10	Raster 10 m	Bundesweit flächen- deckende Kacheln	Lage 10 m Höhe 0,01m/ ± 2 m	© GeoBasis- DE/BKG (2016)	MV 2006 - 2012	
Auensegmente	Polygon, Fluss, rezente Aue, Altaue	Auen	1 : 25.000 (basiert auf Basis DLM)	Institut biota GmbH	2009	Rückgriff auf Deichli- nien, HQ100- Ausuferungslinien (An- schlagslinien) und DGM- Daten (Höhengradienten, Höhenlagen)



# ES assessment visualization: polar chart







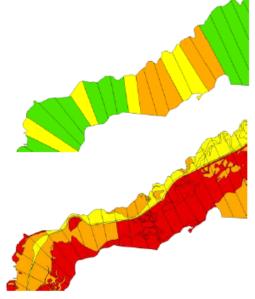
- KP Kulturpflanzen
  PB Pflanzliche Biomasse
  WB Wasserbereitstellung
- N-Ret N-Retention
- P-Ret P-Retention
- HW Hochwasserregulation
- NW Niedrigwasserregulation
- SR Sedimentregulation
- BB Bodenbildung
- KW Kühlwirkung
- THG Treibhausgas Rückhalt
- Hab Habitatbereitstellung
- LaBi Landschaftsbild
- NKE Natur- & Kulturerbe
- UI Unspezifische Interaktion
- WA Wasserbezogene Aktivitäten



# ES assessment visualization: scales and map







Floodplain sections

Compartments: river, active & non-active floodplain

# RESI Scale

5	very high
4	high
3	medium
2	low
1	very low
	NA



# **ES** assessment visualization: combined map and chart

**Ecosystem service** 

Flood risk regulation Drought risk reg.

Cultivated crops

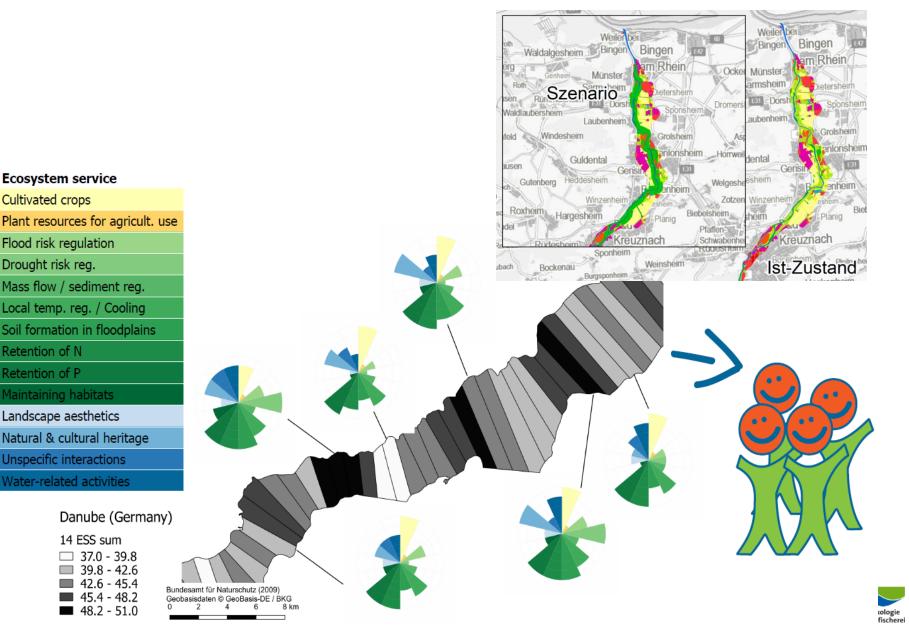
Retention of N Retention of P

Maintaining habitats Landscape aesthetics

Unspecific interactions Water-related activities

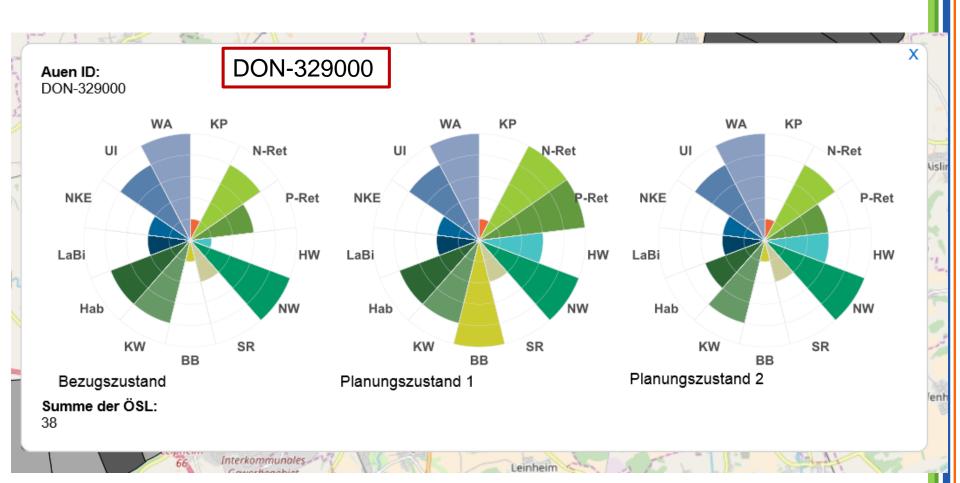
14 ESS sum





# ES assessment visualization: Individual ESS change after management measure

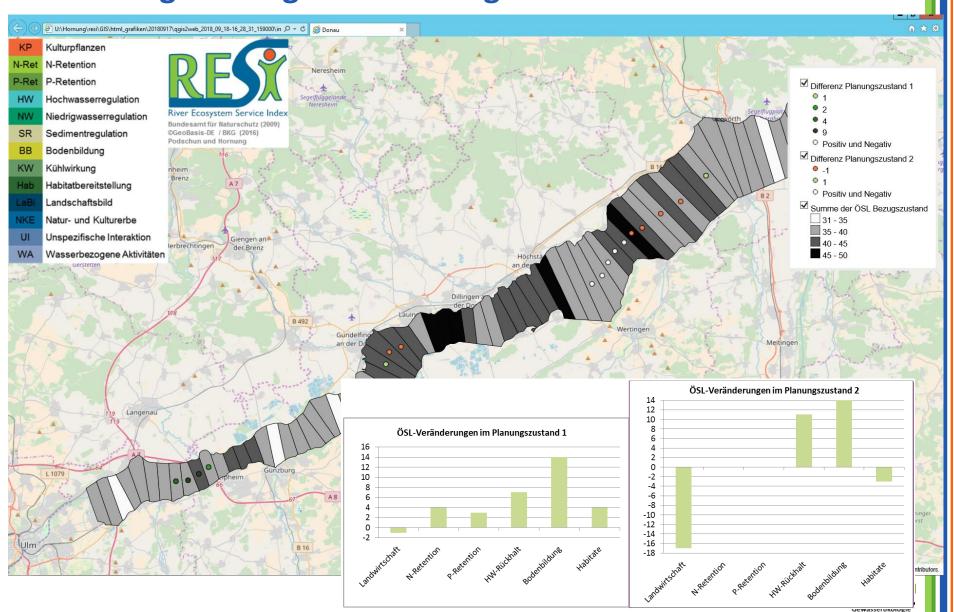






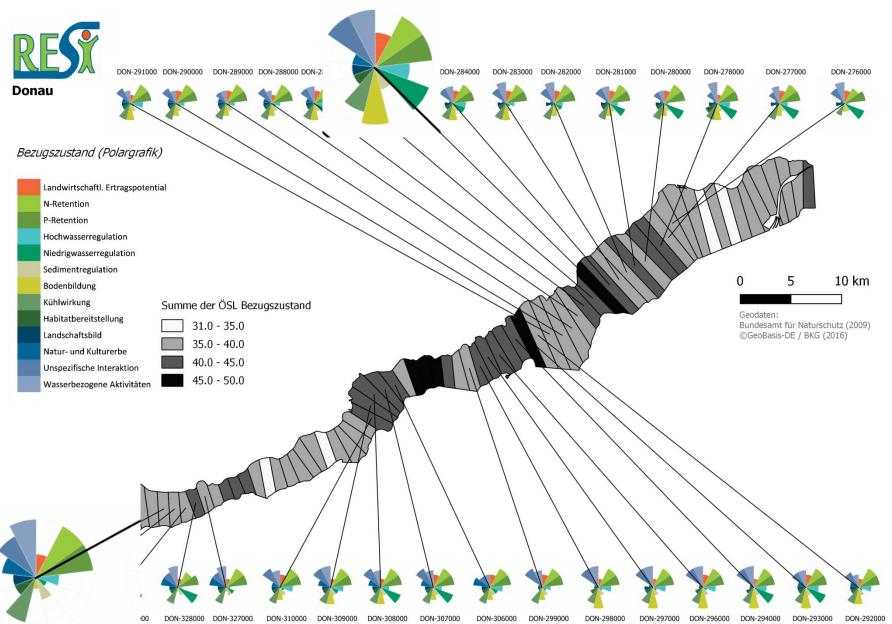
# ES assessment visualization: ESS budget change after management measure





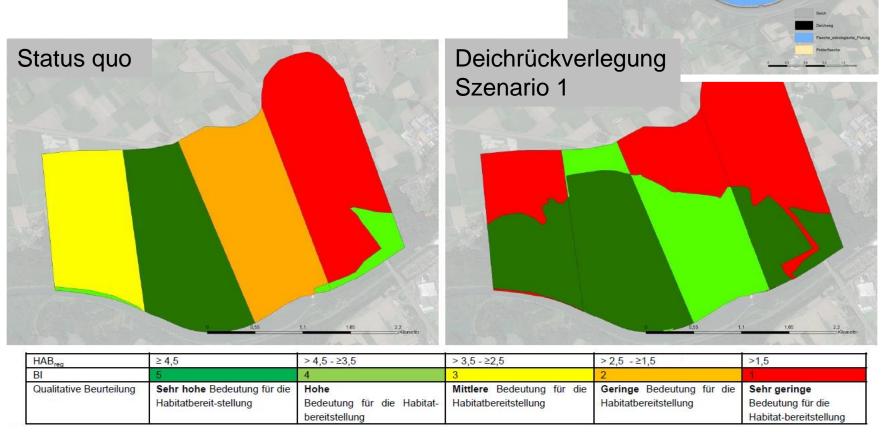
# ES assessment visualization: audience-specific design options





### **ES** assessment visualization:

# Spatially discrete assessment of a planned flood polder on ES



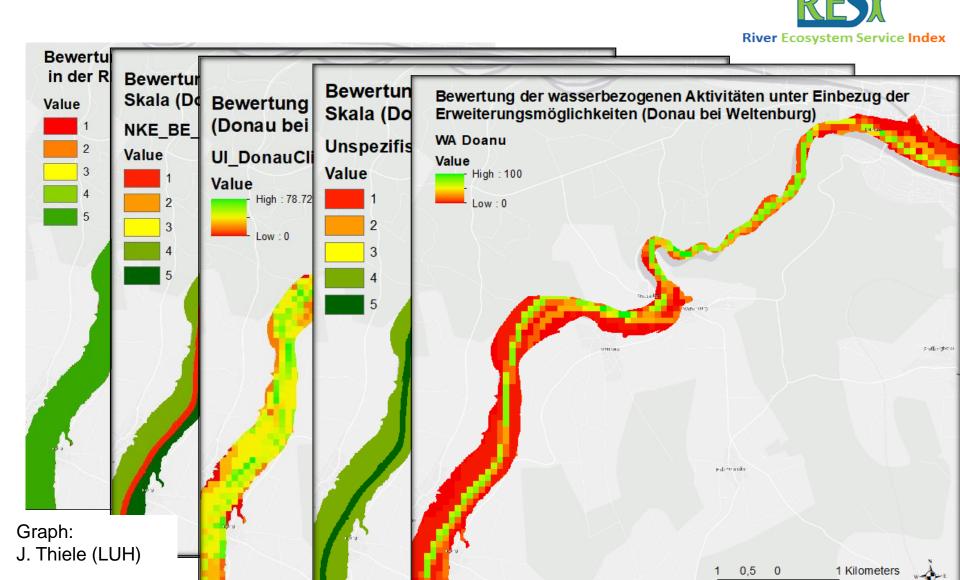
Grafik: M. Gelhaus & B. Stammel (KUEI)

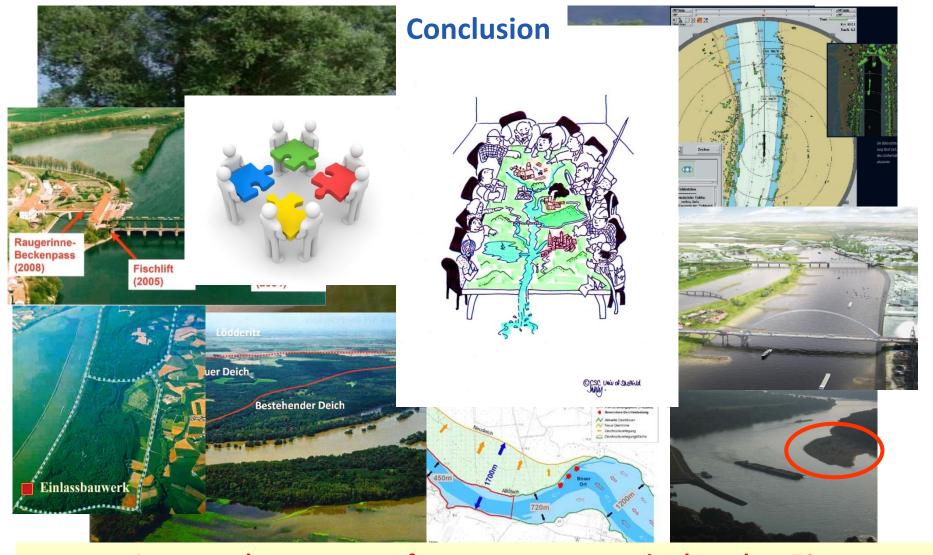
Szenarienbeschreibung Szenario 1, Gesteuerter Rückhalt, Variante

# ES assessment visualization:

Example of cultural ES map of Danube in Bavaria/Germany

Assessment at 100 m \* 100 m raster





Integrated assessment of management scenarios based on ES
by use of existing GIS and monitoring data
may enable communication among stakeholders
and fact-based, inter-sectoral, transparent and sustainable decision making

# For more information:





Experiences show that the performance of restoration measures in rivers and floodplains supporting water resource management and nature conservation may be significantly improved and accelerated if the ecosystem services involved are known that are used by various sectors of society. The RESI project therefore quantifies the offered and the used ecosystem services for five case studies of river sections in Germany. Ecosystem services are visualized by means of the River Ecosystem Service Index (RESI). The RESI represents an innovative and cross-sectoral platform that enables an interdisciplinary economic-ecological assessment of development scenarios. Optimization strategies derived from that will provide important additional decision support for the management of river corridors.



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