Nature Based Solutions for the Black Sea

(Virtual) Stakeholder Workshop

Sameer Safaya
June 2022

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RHDHV Team

- Core Team
  - Sameer Safaya – Sustainability Expert, Hydrologist (Lead)
  - Dr. Gokce Guyer – Wastewater expert
  - Dirkjan Douwma – Environmental specialist

- Support Team
  - Paul Jansen – Wastewater specialist
  - Arend Jan van de Kerk – Civil Engineer
  - Arend de Wilde - Ecologist
  - Petra Dankers – Coastal Morphologist and NBS specialist
  - Bente de Vries - Coastal Morphologist and NBS specialist
  - Kerusha Lutchmiah – Wastewater Engineer & stakeholder manager
  - Micheline Hounjet – STAIN specialist

Mentimeter


Go to www.menti.com and use the code 2548 8621
Instructions
Go to
www.menti.com
Enter the code
2548 8621
Or use QR code
Royal HaskoningDHV
Crimea
Sea of Azov
FEDERATION
Bucharest
Bosporus
2000

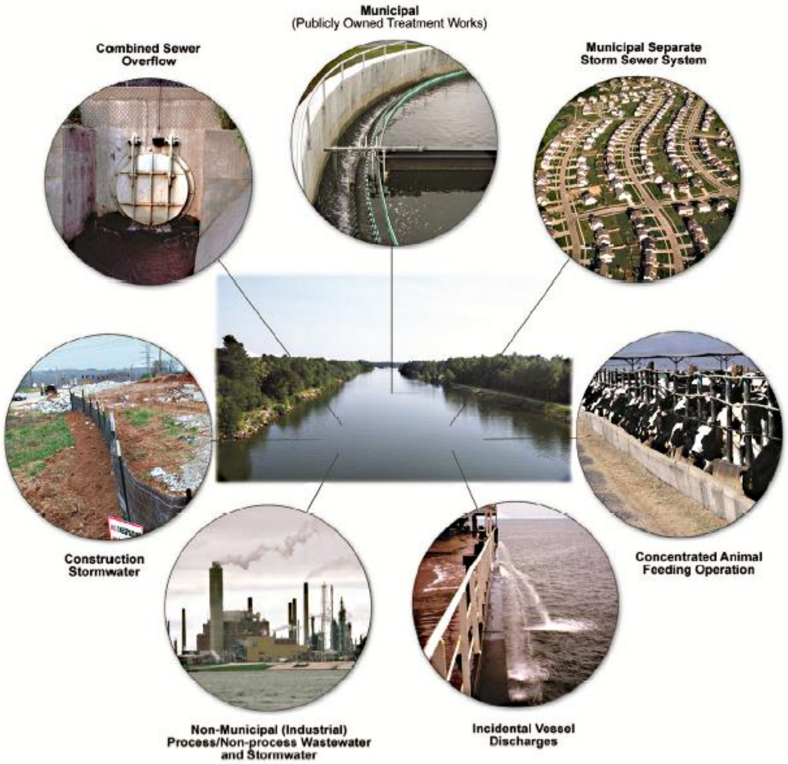
Black Sea Basin

Source:
European Environment Agency, 2001)

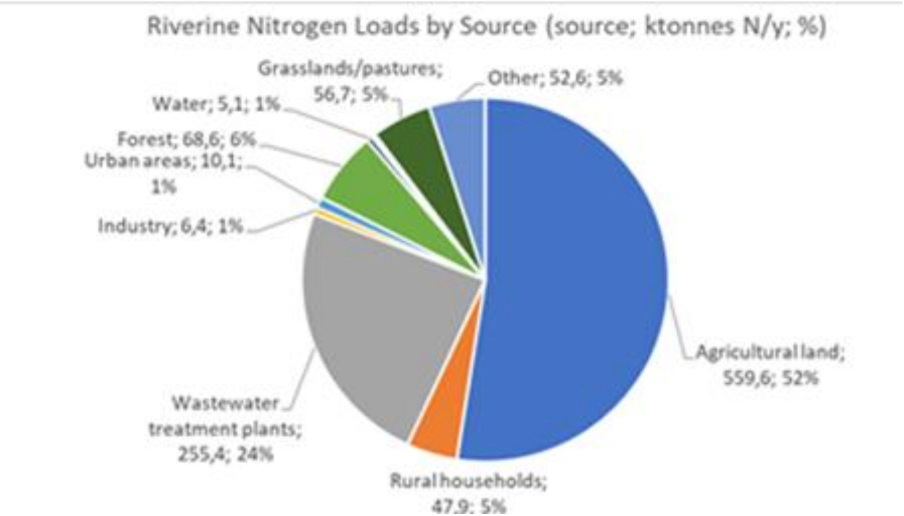
2 main types of pollution

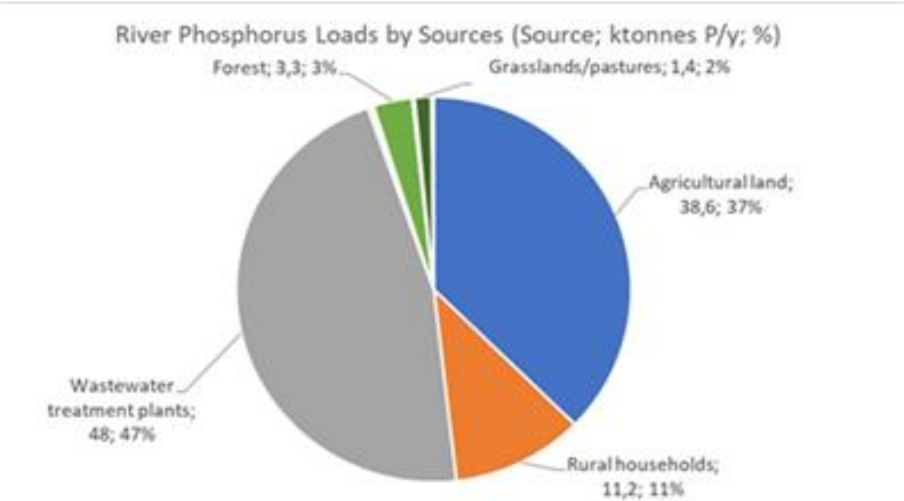
- Point Source
- Diffuse

Exhibit 1-2 Common point source discharges of pollutants to waters of the United States



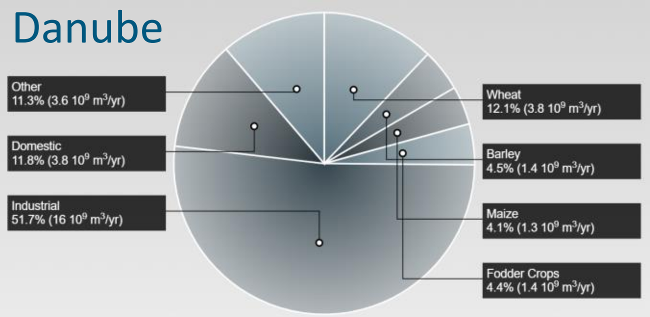
Pollution Diagnostics Report (WB – draft, 2023)



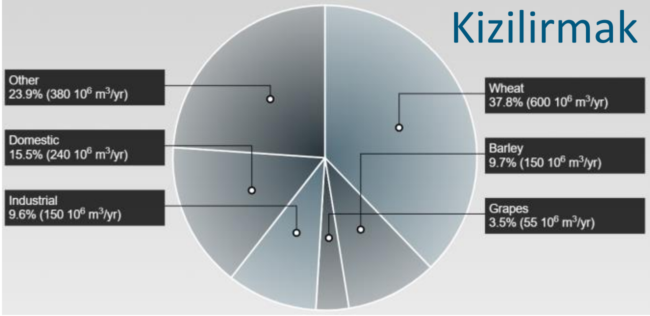


Grey WF – basin level details

Danube



Kizilirmak



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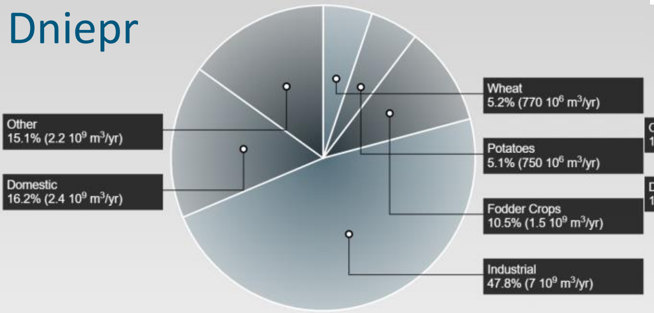
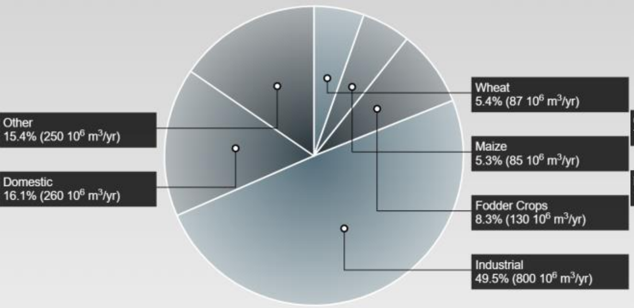
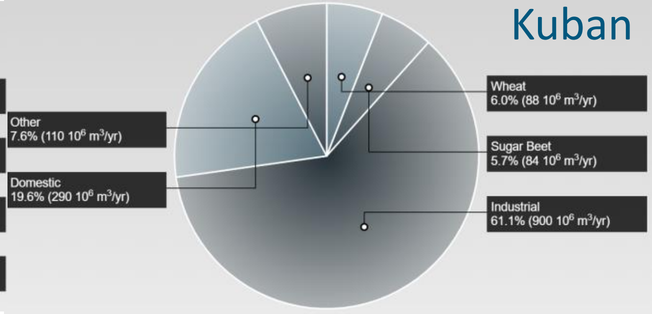


Southern Bug



Kuban



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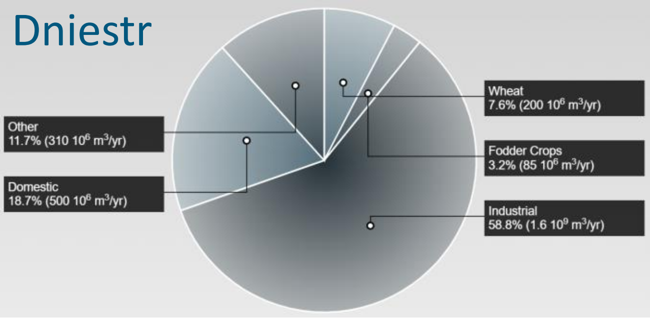
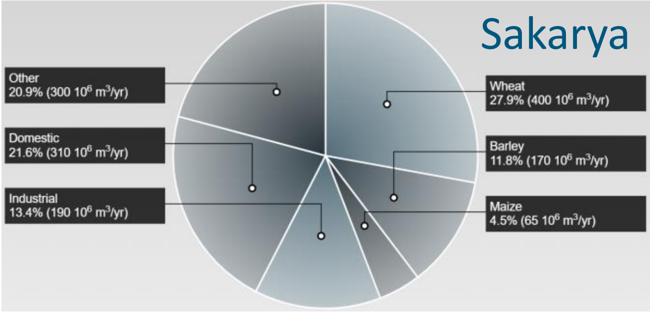


Sakarya



Source: Water Footprint Network

Main source of pollution for each river basin

River basin	N-load (%)	P-load (%)	Country	Main sources of pollution
General	-	-	-	• Main source P-load is generally wastewater treatment plants, then agricultural activities, then untreated household effluents. • Main source N-load is generally agricultural activities. • Mostly well connected to wastewater treatment systems but besides the western Danube, most basins do not have advanced treatment
Danube	54	43	Romania / Bulgaria/ Ukraine	• Main source P-load is wastewater treatment plants. • In Romania and Bulgaria, the connection to wastewater treatment is good, though level of wastewater treatment is mostly biological (secondary)
Don	17	15	Russia/ Ukraine	• Main source P-load is agricultural activity
Dnieper	14	20	Russia/ Belarus/ Ukraine	• Main source P-load is wastewater treatment plants
Dniester	3	5	Moldova/ Ukraine	• Main source P-load is wastewater treatment plants • Moldova has bad connection to wastewater collection system.
Southern Bug	3	3	Ukraine	• Main source P-load is wastewater treatment plants
Kuban	2	3	Russia	• Main source P-load is wastewater treatment plants
Others	7	11	-	• Main source P-load is wastewater treatment plants • Good connection to wastewater collection system, but level of treatment is primary and secondary

Typical Waste Water Treatment in a Plant (WWTP)

- Mechanical stage (primary treatment): screens, grit removal, primary sedimentation
  - large particles & grit removal & partly organic removal, no nutrient removal
- Biological stage (secondary treatment): activated sludge in aeration and settling tanks
  - 80-90% organic removal,
  - Degree of nutrient removal depending on tank sizes / design
  - 30-80% Nitrogen removal (larger tank size = lower loading conditions means more nitrification/denitrification)
  - 20-90% Phosphorus removal. Introduction of Biological P-removal or Chemical P-removal means P-removal % towards 80-90%, otherwise 20-30%
- Additional stage (tertiary treatment): filtration (sandfiltration, membranes), constructed wetlands, desinfection
  - Additional nutrient removal to (very) low values (P-total < 1 mg/l, Ntotal < 5 mg/l)

+

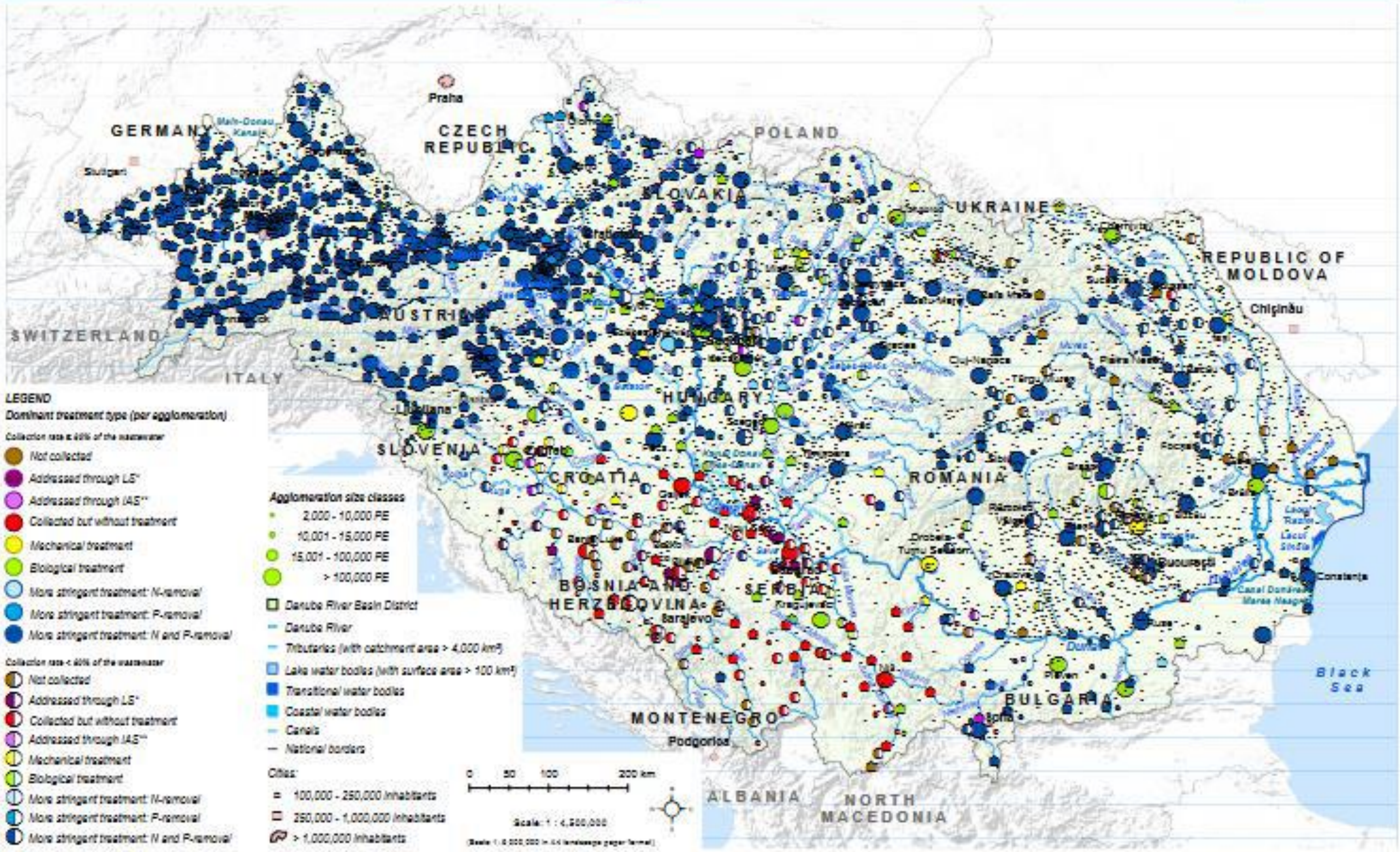
+

Typical values in waste water (sewage) treatment

- EU (National) legislation: N-total < 10 / 15 mg/l; P-total < 1 / 2 mg/l
- National legislation: Variations possible based on size of wwtp, age of wwtp, interpretation of value (average, 95th percentile value, etc.)

mg/L	Influent (untreated)	After primary stage	After secondary (biological stage) incl. Nutrient removal	After tertiary stage
Nitrogen (N)	60	60	10-15	< 5
Phosphorus (P)	10	10	1-2	< 1
Organic (COD)	500	300	50-80	< 50

Urban Wastewater Collection and Treatment – Dominant type: Reference Situation 2018



* LS: Local Systems used for wastewater collection and local treatment (cesspools, septic tanks, small domestic wastewater treatment plants, watertight tanks). LS are applicable only for non-EU Member States.
** IAS: Individual and other Appropriate Systems as defined by the UWWTD (septic tanks with drain fields, small domestic wastewater treatment plants, watertight tanks).

www.icpdr.org

This ICPDR product is based on national information provided by the Contracting Parties to the ICPDR (AT, BA, BG, CZ, DE, HR, HU, MD, ME, RO, RS, SI, SK, UA) and CH. EuroGlobalMap data from EuroGeographics was used for all national borders except for AL, BA, ME where the data from the ESRI World Countries was used. Shuttle Radar Topography Mission (SRTM) from USGS Seamless Data Distribution System was used as elevation data layer; data from the European Commission (Joint Research Center) was used for the outer border of the DRBD of AL, IT, ME and PL.

Vienna, November 2021

Table 5: Generated urban wastewater load and number of centralized collection and treatment systems in the Danube River Basin (reference year: 2018)

Type of collection and treatment system			Generated load (PE)	Number of centralized collection and treatment systems
Collected by sewer	Collected by sewer and treated in UWWTP	Tertiary treatment	54,345,005	2,220
		Secondary treatment	7,264,840	888
		Primary treatment	1,155,336	100
	Collected but not treated		5,492,920	751
Not collected by sewer	Individually collected and treated	IAS	3,487,062	-
		Local systems	2,750,534	-
	Not collected		10,669,765	-
Total			**85,165,464**	**3,959**

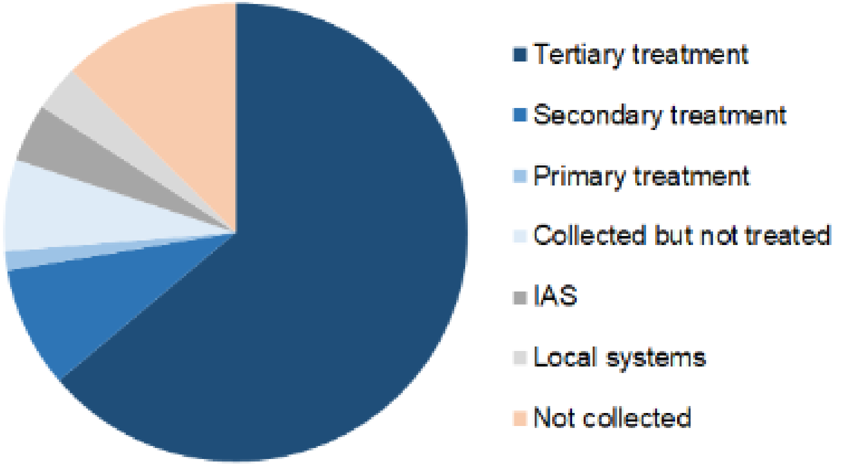


Figure 6: Share of the collection and treatment stages in the total population equivalents (PE) in the Danube River Basin (reference year: 2018)

Rural Population: Adoption of IAS

Table 5: The presence of nature-based solutions (marked green) in the countries of Central and Eastern Europe. Where the data were available also the number of systems is given.

	Bulgaria	Croatia	Estonia	Hungary	Latvia	Moldova	Montenegro	Poland	Romania	Slovakia	Slovenia	Ukraine	Total
Soil infiltration				12								300	>312
Willow systems											1		>1
Waste stabilization ponds				3							2		>5
Aerated ponds											10		>10
Treatment wetlands		8				7	5	8,000		150	180	80	>10.430
Sludge treatment reed beds		8			10		4	1					>23
Vermifilter						1							1
Ecosan technology						70							70

Wastewater collection, treatment and reuse in rural areas of CEE, GWP CEE Report, 2021

Why nature-based solutions?

- Holistic solution (green infrastructure) to address (sustainability) societal challenges with a friendlier ecological footprint
- Dynamic & resilient; evolves with the environment and society over time.
- Intrinsic motivation; Improving the environment and restoring natural habitats improves well-being and societal resilience
- Meets direct needs of traditional (engineered) solutions and offers various co-benefits
- Integrates better with cultural heritage and landscape
- Tends to be cheaper in the long-term
- Links to SDGs and contributes to circular economy
- Scalable

VS

- Traditional engineering of landscapes (grey infrastructure) while more predictable and tested, tend not to blend well with social or environmental goals or norms
- While short-term thinking may deliver immediate results, they tend to have significant externalities (indirect costs to society and environment)
- Static, subject to degradation, tend to be fixed structures that cannot be easily moved (unlike sediment for example)
- Generally requires significant amounts of concrete and other hard materials with significant sustainability impacts (eg. high ecological footprint)
- Maintenance costs may be high in the long-run and tend to have limited co-benefits for the local communities other than their original (singular) functional requirements.
- Not scalable – often disrupts nature

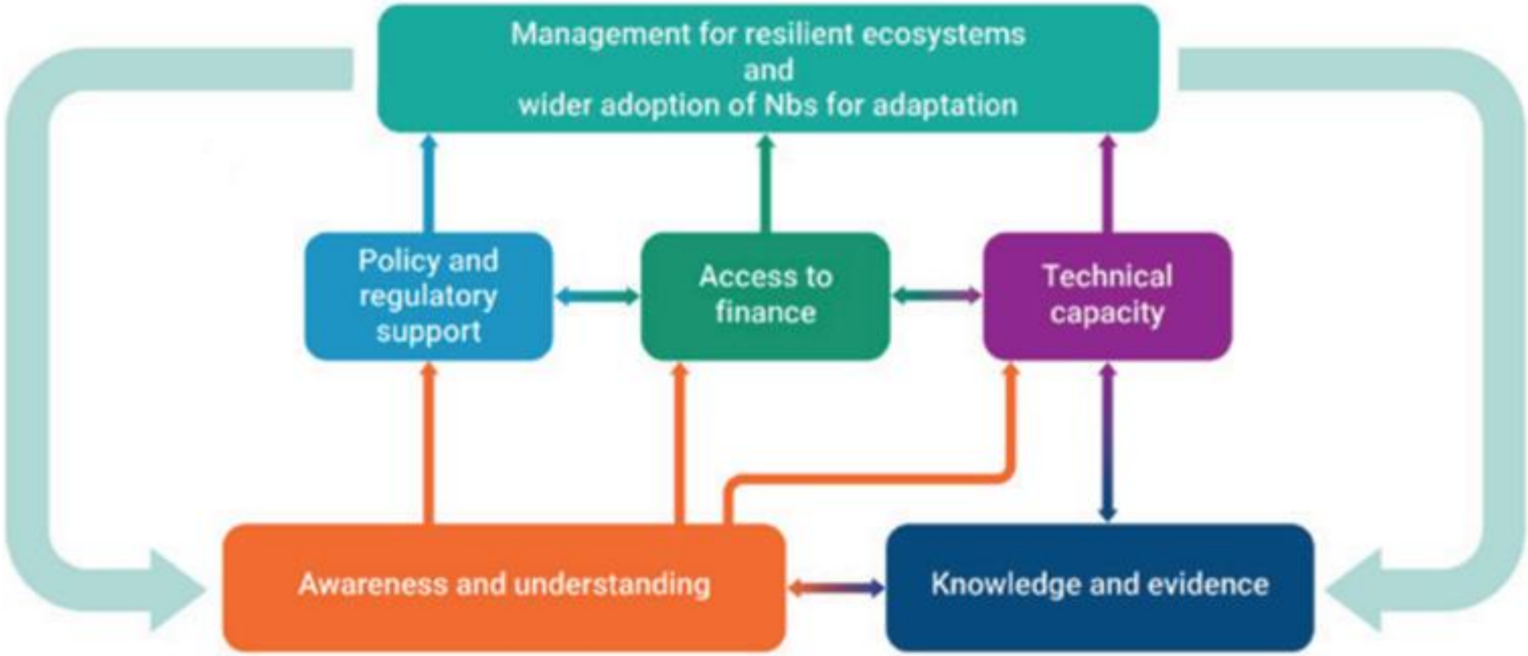
Nature-based Approach → Solutions

- …uses the power of natural processes in innovative ways to tackle socio-ecological challenges such as water quality, climate change and flood risk
- …are suitable for different environments including coasts, estuaries, cities, harbours, rivers and lakes
- …system understanding and in-depth knowledge of the physical system and the socio-economic system and governance context is essential
- …a multidisciplinary team can work in close collaboration with stakeholders on a design which benefits society, biodiversity and economy

External Context & Drivers

- Ethical imperative – society demands
- Business imperative – investor demands (business case)
- Environmental imperative – biodiversity impact
- UN SDGs (needs-based and values-based)
- Building with Nature Principles (Ecoshape)
- ISO 26000 – Social Responsibility
- Circular Economy
- COP26, Drawdown
- EU Water Framework Directive
- Black Sea Commission

Methodological Framework

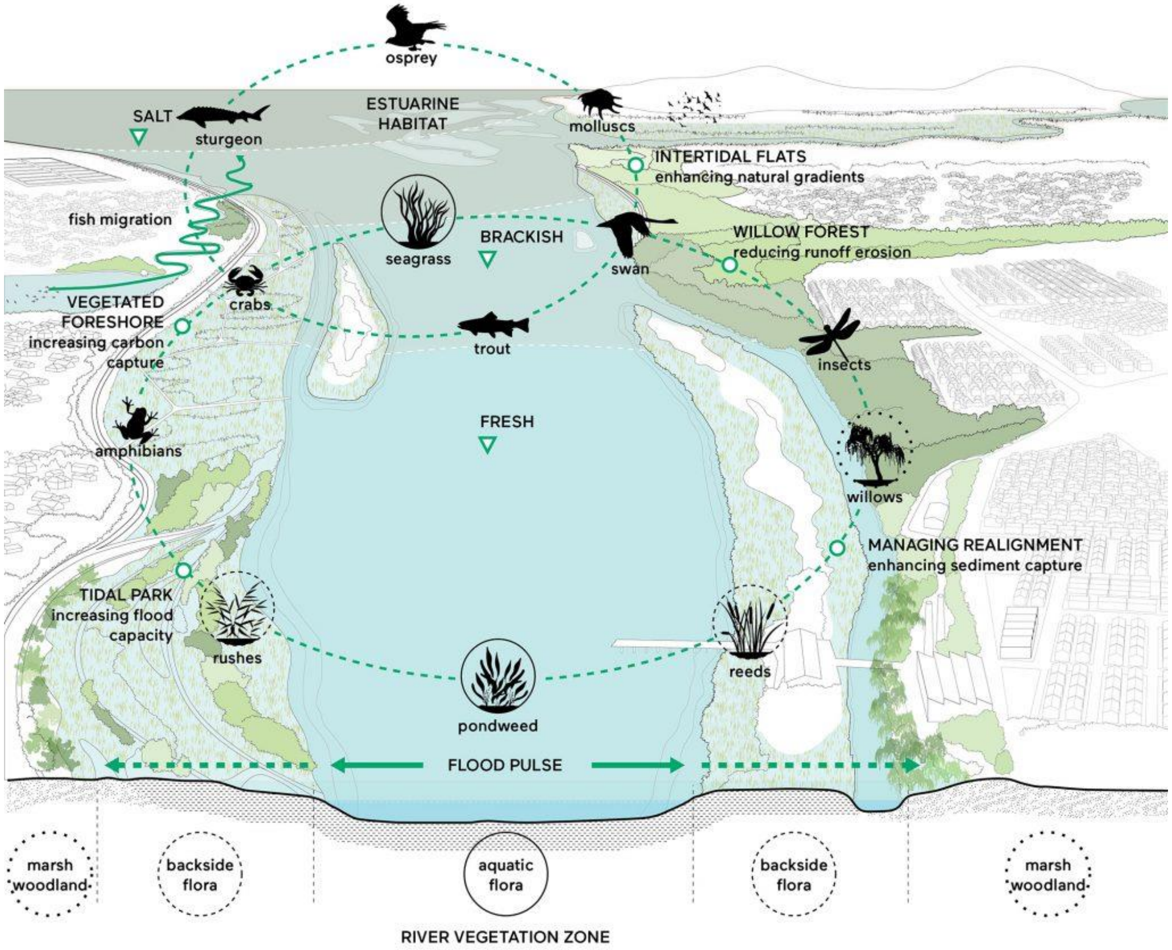


Building blocks to support improved management for ecosystem resilience and wider adoption of NBS for adaptation (from 'The role of the Natural Environment in Adaptation'- Background paper for the Global Commissions on Adaptation)

Nature-based approach: Rivers & Estuaries

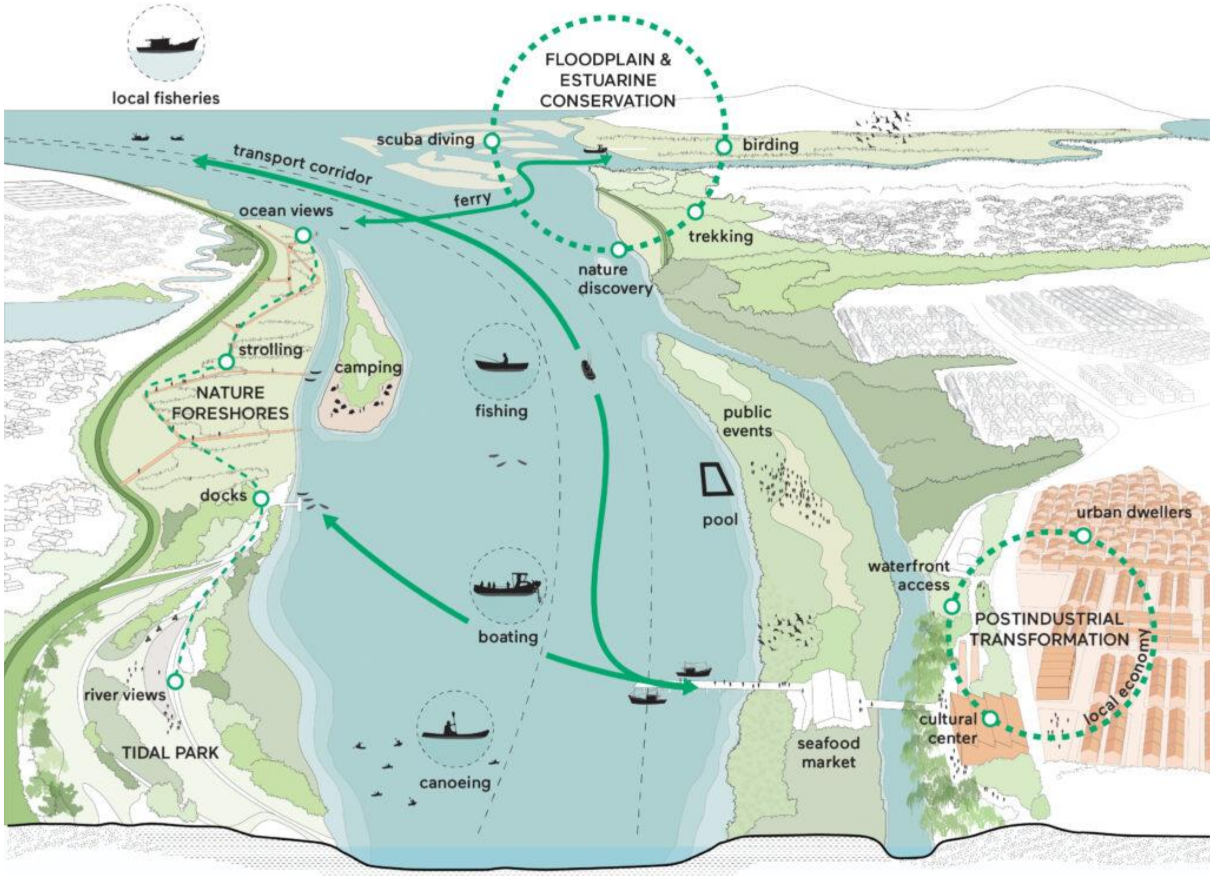
Nature-based approach: Rivers & Estuaries

Ecological Benefits



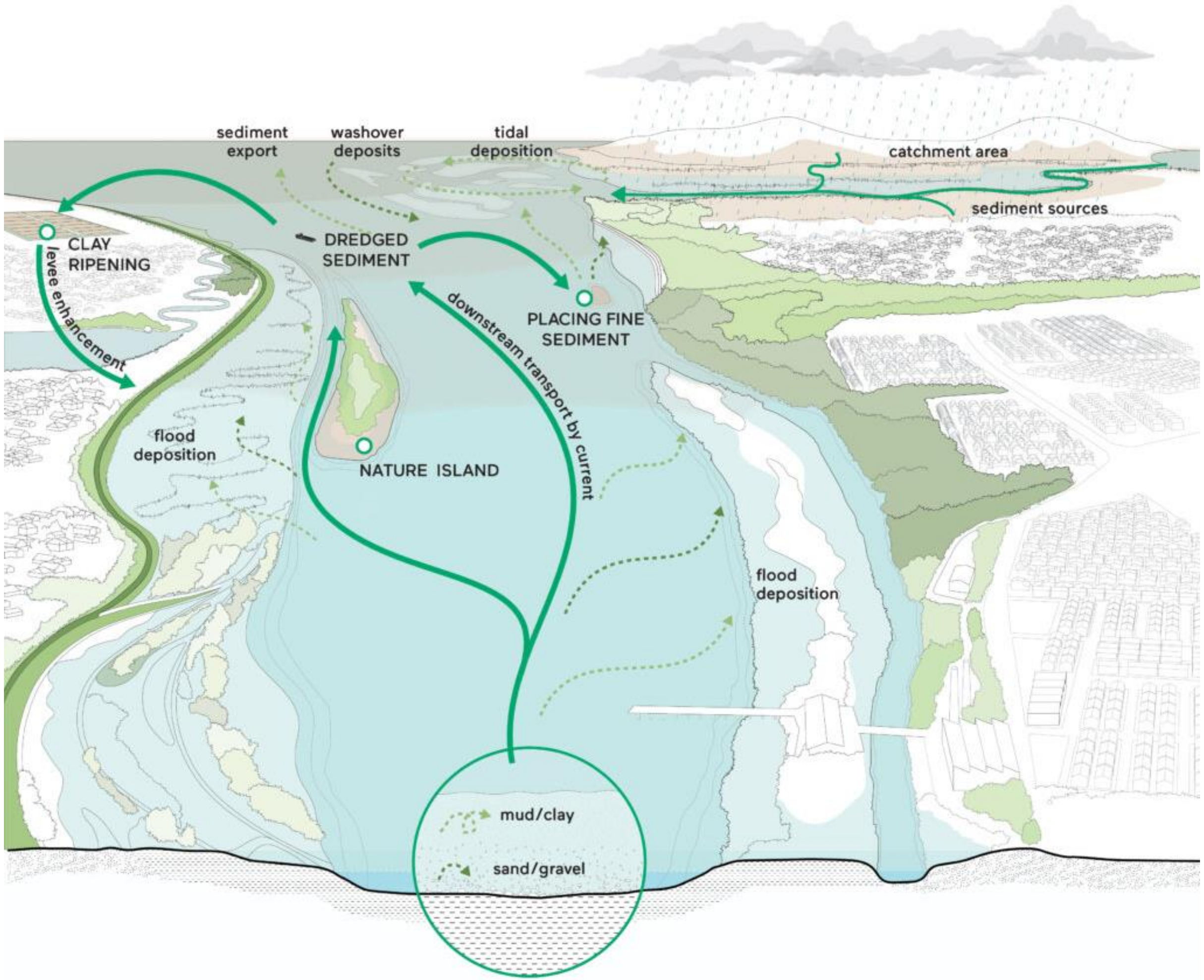
Nature-based approach: Rivers & Estuaries

Socio-economic Activities



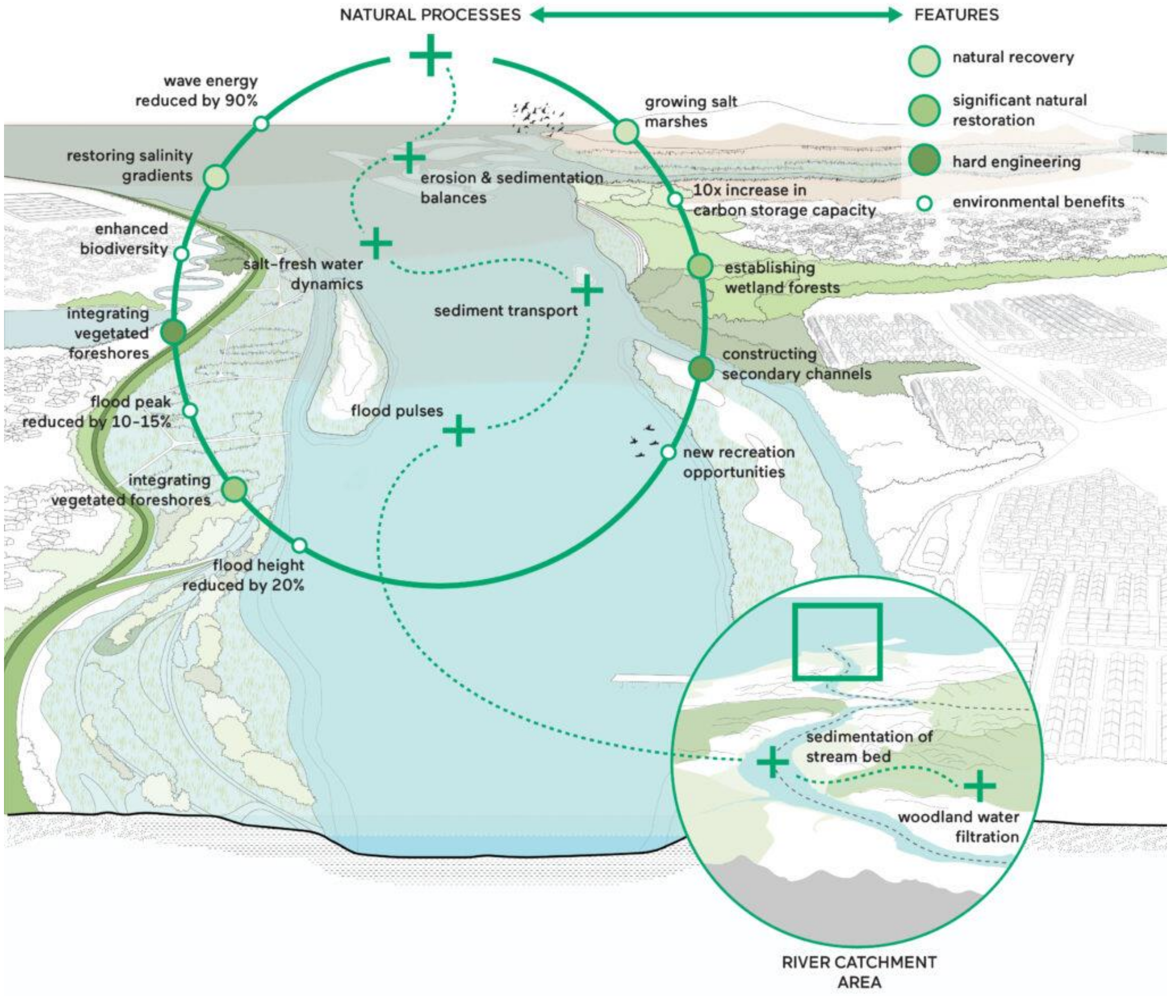
Nature-based approach: Rivers & Estuaries

Physical Processes



Nature-based approach: Rivers & Estuaries

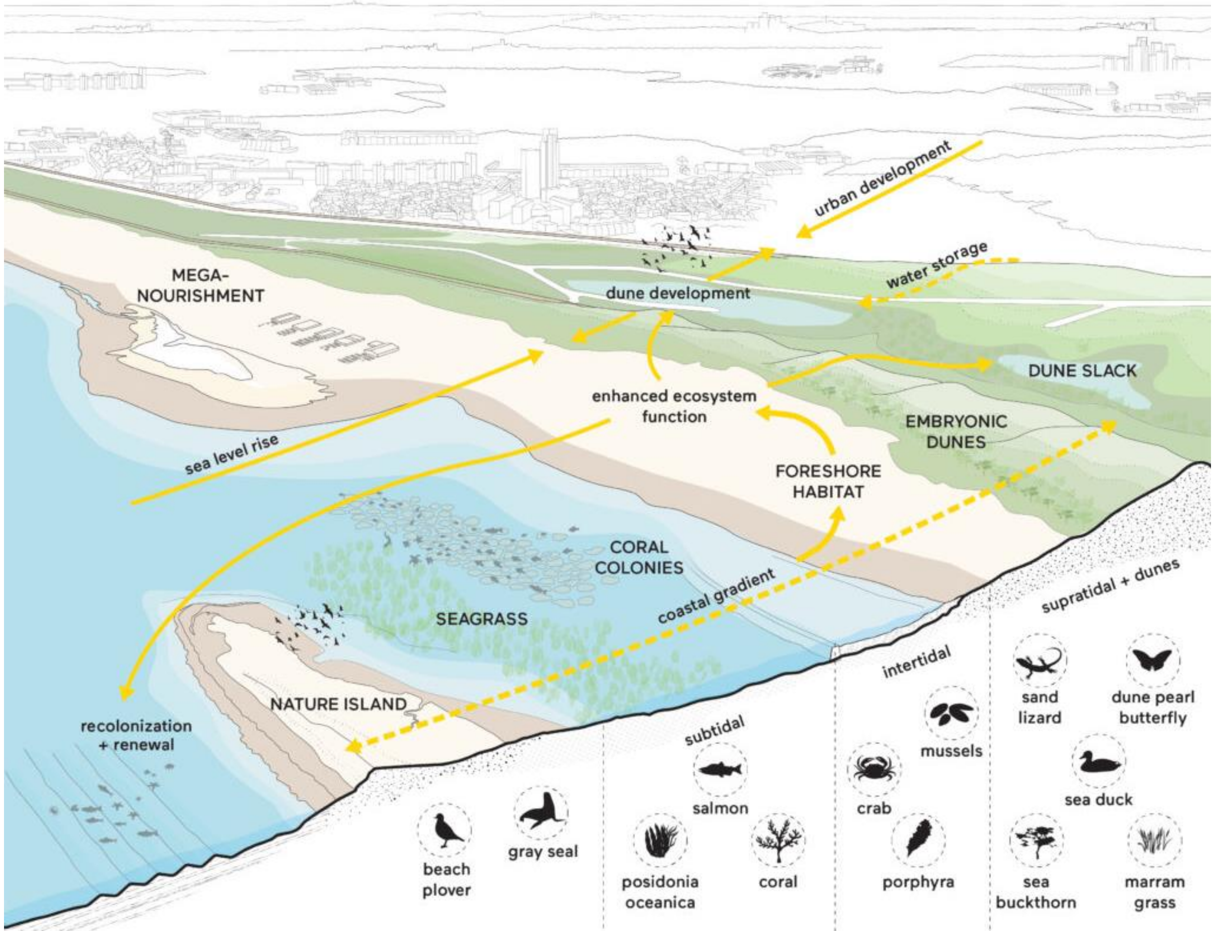
Integrated Approach



Nature-based approach: Sandy Coasts

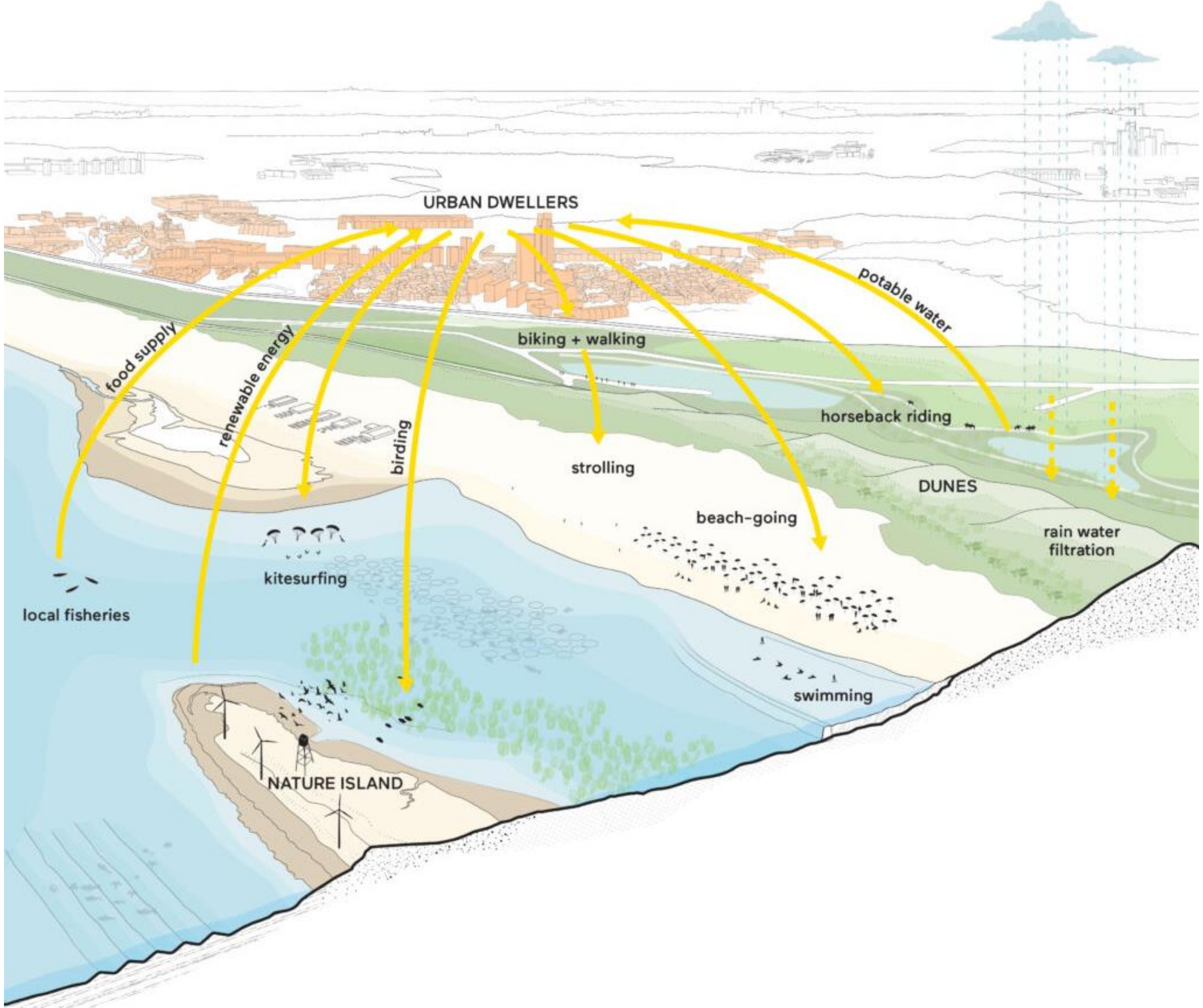
Nature-based approach: Sandy Coasts

Ecological Benefits



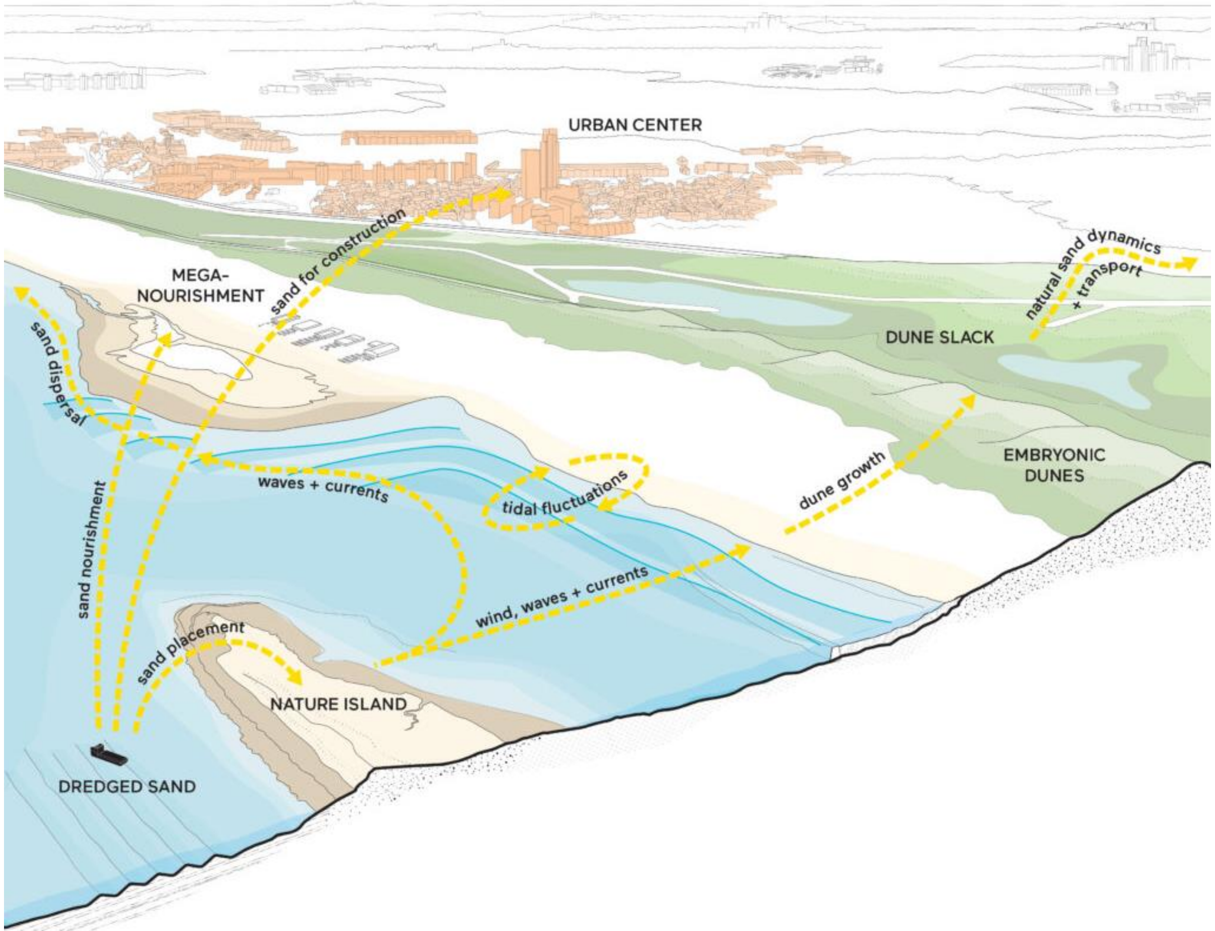
Nature-based approach: Sandy Coasts

Socio-economic Activities



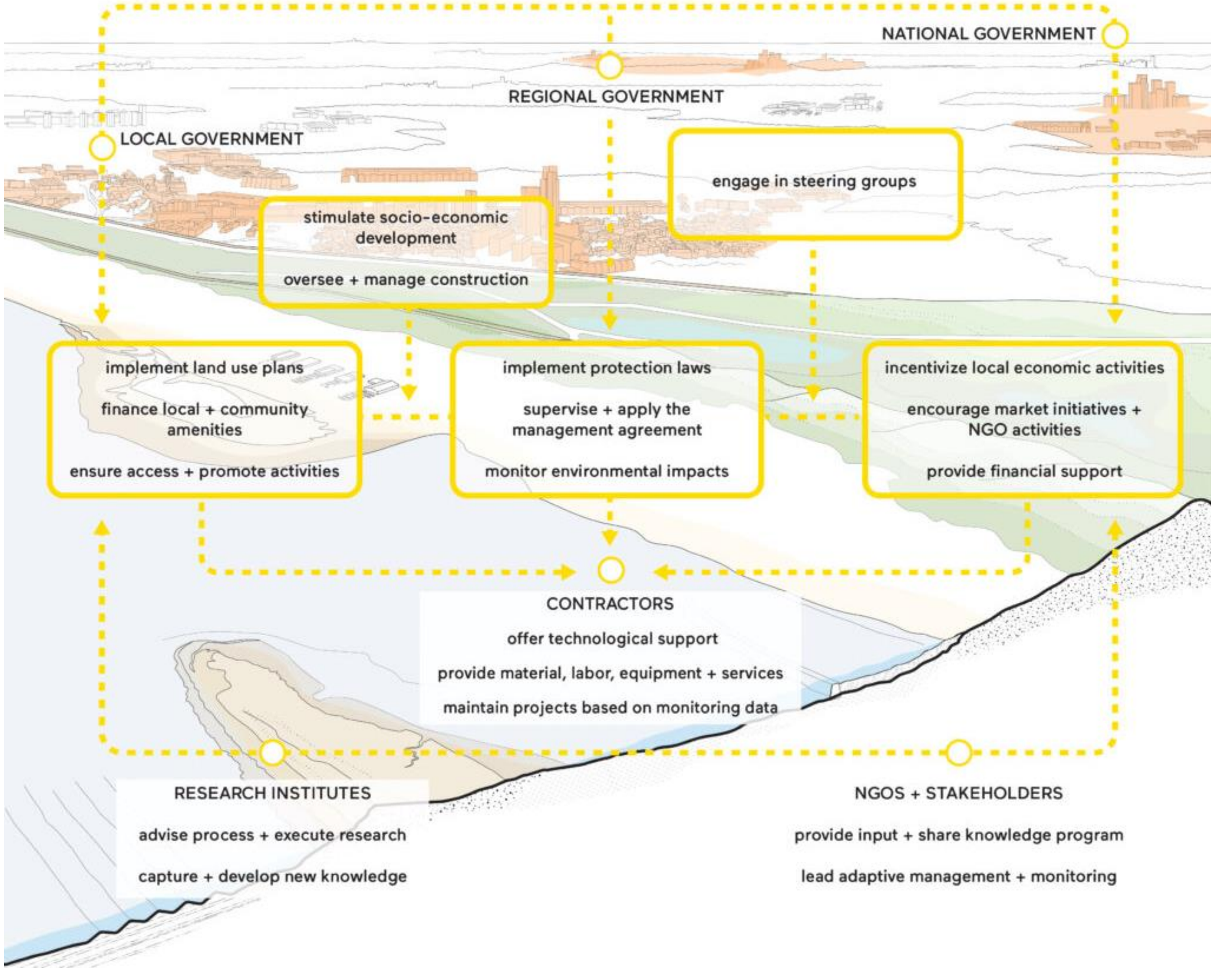
Nature-based approach: Sandy Coasts

Physical Processes



Nature-based approach: Sandy Coasts

Integrated Approach



WWTP and NbS

- Constructed wetlands (all types) can be considered as NbS solution.
- Classic WWTP (primary + secondary stage, ***including*** nutrient removal) and constructed wetlands results in high levels of nutrient removal ie. low concentrations
- Classic WWTP (primary + secondary stage without nutrient removal and constructed wetland results in reasonable levels of nutrient removal
- Developments in WWTP design: for instance, aerobic granular sludge (Nereda) instead of activated sludge improves the nutrient removal capacity of a WWTP further and with a smaller footprint (area required)
  - Eg. Dinxperlo, The Netherlands - constructed wetland combined with a Nereda® WasteWater Treatment Plant

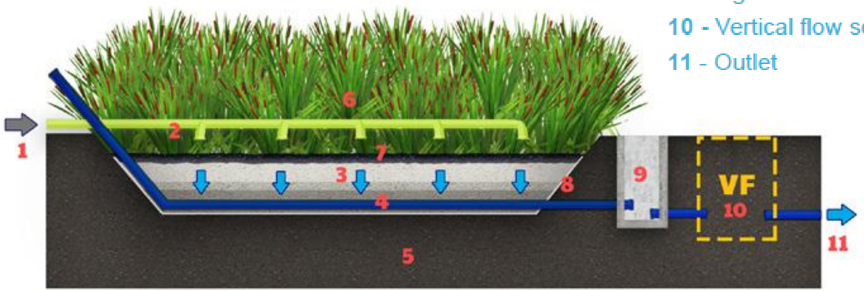
WWTP and NbS

Table 1. Common advantages and frequent challenges of using NBS for wastewater treatment

COMMON ADVANTAGES	FREQUENT CHALLENGES
Very reliable process	Multi-stage and hybrid schemes can be required to fulfil stringent limits on nutrient removal
Good quality effluent	High area demand compared with conventional technological solutions
Used in a variety of different climates and site locations	Proper operation and maintenance also of the primary treatment step (regular removal of settled sludge)
Ease of construction: local materials and plants can be used	Lack of standard guidelines on design and sizing for recently developed types of NBS
Reduced operational, labour, chemical and energy requirements compared with conventional treatment	Require accurate design according to local conditions
Wastewater treatment systems (simple and low-cost operation and maintenance)	Accumulation of phosphorus and metals in soil or other compartments of NBS
Can be applied for decentralised treatment	
Sustainable and environmentally friendly	
Multi-purpose functionality	
Can reduce impacts of water scarcity	
Diverse microbial communities	

FRENCH VERTICAL-FLOW TREATMENT WETLANDS

1 - Inlet
2 - Feeding system
3 - Porous media
4 - Drainage system
5 - Original soil
6 - Plants
7 - Sludge layer
8 - Waterproof liner
9 - Regulation manhole
10 - Vertical flow second stage
11 - Outlet



NBS for wastewater treatment: basic systems

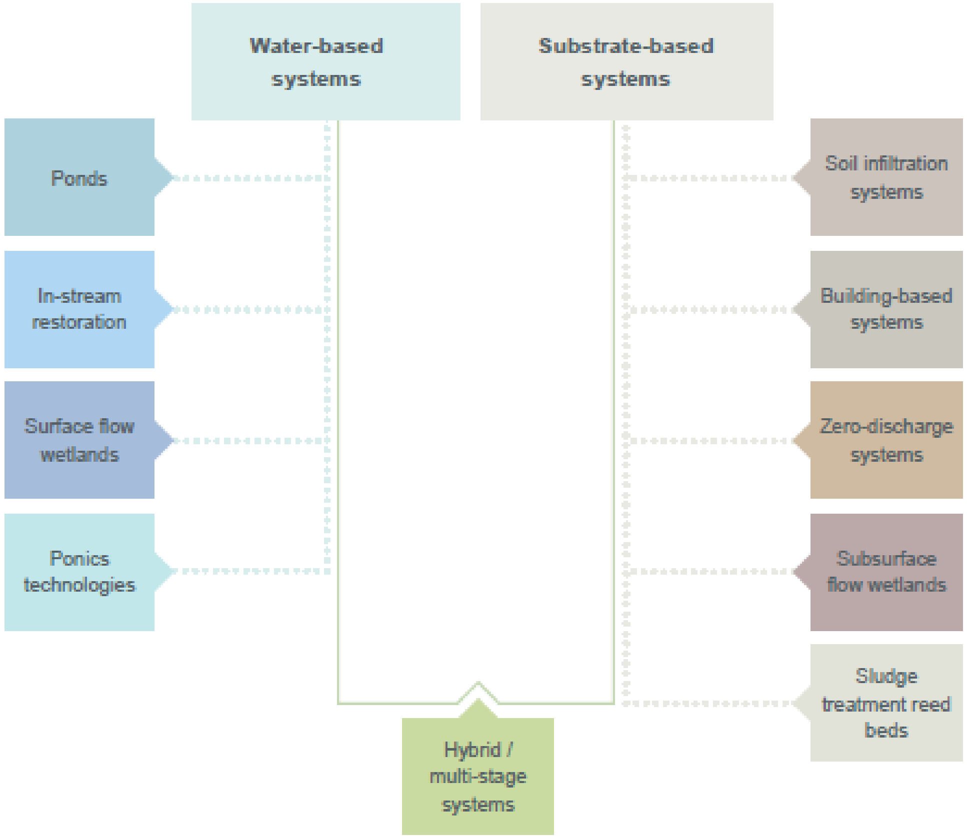


Figure 2. Classification of basic NBS groups for wastewater treatment

Water-based systems

Ponds	In-stream restoration	Surface flow wetlands	Ponics technologies
Anaerobic • Classical • High-rate		Natural	Hydroponics
Intensified • Surface aerated		Floating	Aquaponics
Aerobic • Facultative • Maturation		Free water surface	

Figure 3. Classification of water-based NBS for wastewater treatment

Substrate-based systems

Soil infiltration systems	Building-based systems	Zero-discharge systems	Subsurface flow wetlands	Sludge treatment reed beds
Slow-rate	Rooftop TW	Willow systems	Vertical-flow TW • Vertical-flow (VF) • French VFTW • CSO-TW	
Rapid-rate	Living walls		Horizontal-flow TW	
			Intensified TW • Aerated • Reciprocating • Reactive media in TW	

Figure 4. Classification of substrate-based NBS for wastewater treatment

Selection Criteria

E.g. to select the most appropriate NBS measures from Cross et al. (2021) multiple criteria can be considered

Criteria	Subcriteria	Categories
Can the NBS be applied?		
Suitability for certain land units	Urban areas	Yes / No
	Agriculture (upstream/mountainous)	Yes / No
	Agriculture (downstream/lowland)	Yes / No
	Main river	Yes / No
	Small stream	Yes / No
	Lake	Yes / No
	Sea	Yes / No
How good is this NBS?		
Suitability for a type of influent wastewater	-	• Suitable for raw and grey water • Suitable for primary and secondary treated water • Suitable for river diluted water
Effectiveness for treating different kinds of pollution	Treatment of N	• <30% • >30%
	Treatment of P	• <30% • >30%
	Treatment of suspended solids	• <30% • >30%
	Treatment of ammonia-nitrogen	• <50% • >50%
	Treatment of fecal coliforms	Yes / No
Co-benefits	Contribution to biodiversity	Yes / No
	Contribution to spatial quality (incl. recreation, aesthetic value, reducing heat stress)	Yes / No
	Flood/storm mitigation	Yes / No
	Carbon sequestration	Yes / No

Wetlands Examples

Constructed wetlands, use excessive sediments

Large scale, filtering and buffering (Wwt.org.uk)

Small scale floating filtering (Ecoshape.org)

Large scale, leisure (Ramsar.org) Colombo, Sri Lanka

Moldova

TYPE OF NATURE-BASED SOLUTION (NBS)
French vertical-flow treatment wetlands (French VFTWs)

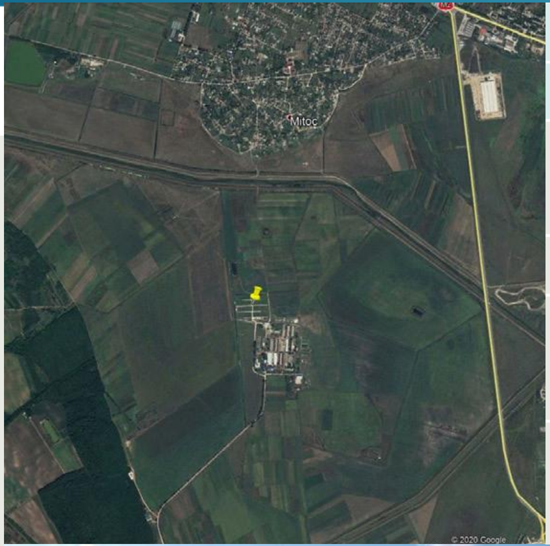
LOCATION
Orhei, Moldova

TREATMENT TYPE
Primary and secondary treatment using French reed beds (FRBs) and VFTWs

COST
€3.4 million (2013)

DATES OF OPERATION
2013 to the present

AREA/SCALE
5 hectares (gross)



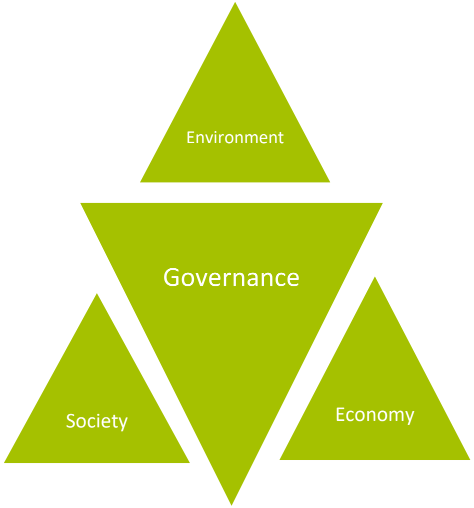
SOURCE TYPE	Domestic, small industries (e.g. fruit juice factory)
DESIGN	
Inflow rate (L/s)	Current: mean 1,000 m^3/d; peak 1,900 m^3/d (monitored data 2013-2015) Future: 2,100-2,700 m^3/d (design value)
Population equivalent (p.e.)	up to 20,000 p.e. (design value)
Area (m^2)	First stage French Reed Bed (FRB): 17,956 m^2 Second stage vertical flow: 16,992 m^2 Total: 34,948 m^2
Population equivalent area (m^2/p.e.)	First stage French Reed Bed (FRB): 0.90 m^2/p.e. (design valu Second stage vertical flow: 0.85 m^2 (design value) Total: 1.75 m^2/p.e. (design value)

Enablers of Building with Nature

Black Sea

Points of Entry

- Plans should be discussed with government officials at an early stage
  - Ministry of agriculture, forestry, environment, waterworks, municipalities
  - Good to build relations with officials, strong cultural element
- Alignment with govt programs at local and regional level necessary, can also avail of co-funding mechanisms
- NGOs (IUCN, TNC, WI, WWF etc.) IFIs (WB, ADB etc.), Academia and other institutions such as Black Sea Commission have existing connections and legacy
- Working with international collaborators brings prestige and a higher level of importance - increases likelihood of success / funding
- Local actors working at IAS level



Measures for Blueing the Black Sea

1. Regarding inflows to the sea - Wetlands: restoring connections between rivers and wetlands
2. In the sea itself - Biodiversity restoration: (prevent overfishing) algae cultivation
3. Possible sediment management (is erosion an issue?) to maintain functioning of ecosystem services to act as a filter
4. Solid waste and plastic capture through constructed wetlands (feels again a bit more like another wetlands measure, but different angle.
5. Policy (and Enforcement)