The BLUEING THE BLACK SEA PROGRAM (BBSEA)
Nature Based Solutions to Combating Pollution for the Black Sea: Webinar
June 21st 2022
Objective of the BBSEA Program

- Improve knowledge on sources;
- Prevention and mitigation of key marine pollutants in the Black Sea

All done to support the Common Maritime Agenda
Focuses on regional cooperation to reduce pollution as entry point for Blue Economy
BLUEING THE BLACK SEA (BBSEA):
PROGRAM STRUCTURE

Window 1:
INVESTMENT FINANCE

Window 2:
ANALYTICAL WORK

TA & Convening Services

Dialogue, Coordination & Regional Planning

Logos of various organizations involved in the program.
Nature Based Solutions to Combating Pollution for the Black Sea: Webinar
TURNING THE TIDE OF POLLUTION

NBS webinar, 21 June 2022

• BLACK SEA REGIONAL MARINE POLLUTION DIAGNOSTIC
TURNING THE TIDE OF POLLUTION IN THE BLACK SEA

Four main principles are at the core of this project:

• **Filling the knowledge gaps in the region.**

• **Consolidating the foundations for regional cooperation** by supporting regional dialogue on the Black Sea pollution involving the riparian countries and existing regional institutions (i.e. BSC and BSEC)

• **Applying a differentiated approach at national and regional levels.** A customized knowledge by country of key pollution challenges will allow to prioritize pollution categories.

• **Enhancing the social cohesion** through citizen engagement mechanisms and crowd-sourcing participation methods related to pollution and regional cooperation.

• **Pursuing active transmission of knowledge** among stakeholders leading to joint actions to reduce pollution elements.
**APPROACH FOR THE REGIONAL REPORT**

- Building on prior and existing activities
- A desk review of water and marine pollution in the Black sea region
- **Source of information**
  - The data sources used in the National and Regional Reports provided by the participant countries
  - Data sources by Black Sea Commission
  - Regional Reports, Scientific Researches, International Projects (EMEP, EMBLAS-II etc.), SMHI Hypeweb (nutrient loads of the rivers)
- **Stakeholder consultations**
  - BBSEA Consultations in all Black sea countries – 2021
  - Online survey to a large audience of stakeholders
  - Institutional level consultations – July-September 2021,
  - **Ad-hoc consultations with Country Focal points**

<table>
<thead>
<tr>
<th>Country</th>
<th>Academia/Expert</th>
<th>Business</th>
<th>Decision maker</th>
<th>NGO Civil org.</th>
<th>Public org/authorities</th>
<th>Other</th>
<th>Tot</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>International</td>
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<td>1</td>
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</tbody>
</table>
- Regional level marine pollution diagnostic of the Black Sea, including economic, institutional, legal and policy aspects of the water and marine pollution, with a focus on nutrient loads and chemical pollution.

- National level Marine Pollution Background Diagnostic Reports – developed for Georgia, Moldova, Turkey, and Ukraine (funded by ProBlue) and for Bulgaria and Romania (funded by the World Bank) - highlight the principal sources of point and diffuse pollution and the associated pressures and impacts, in particular the role of agriculture, industrial discharges, municipal wastewater discharges and port activities, and the business-as-usual scenarios and legal, institutional and policy gaps in each country.
OBJECTIVES OF THE REGIONAL & NATIONAL REPORTS

- Regional-level legal, policy and institutional analysis:
  - Improve understanding of operation of regional legal and policy framework;
  - Synthesize and communicate findings of six national legal, policy and institutional analyses;
  - Identify commonly occurring gaps and deficiencies in both regional and national regimes;
  - Identify opportunities / interventions for promoting regional collaboration (and increasing environmental, social and economic benefits).

- National-level legal, policy and institutional analysis:
  - Improve understanding of operation of national legal and policy framework;
  - Identify gaps and deficiencies in coverage, implementation and enforcement in national regimes;
  - Inform action for improved operation, implementation and enforcement of national legal and policy framework;
  - Improve regional / Black Sea environmental outcomes.
BAU scenarios are developed through qualitative assessments based on experts' opinions using Delphi technique. BAU scenarios will be elaborated as being based on current trends and considering already decided policy measures.

The attention is focused on nutrient and chemical pollution, and land-based sources. Consequently, the main GES descriptors for which the changes in the state in the BAU are discussed are (D5) Eutrophication and Concentrations of contaminants (D8).
Recommendations

- Recommendations are focused on Agricultural, Industrial, Municipal, and Law/Institutional regulations, and practices.
- Establishing good agricultural practices to prevent excessive fertilizer and uncontrolled pesticide use in the nitrate-sensitive zones
- Adapting European international standards for the treatment of water, strengthening the control over industrial and municipal wastewater treatment systems, and changing the consumer applications to prevent pollutant discharges resourced from domestic practices
- Modernization of existing wastewater treatment plants and the establishment of new facilities equipped with advanced technologies for nutrient removal, especially in densely populated settlements are important needs in the Black Sea basin.
- Construction/rehabilitation of urban sewage systems and financial pollution monitoring systems
- The establishment of marine protected areas and prevention of non-indigenous species' entrance into the Black Sea, along with strengthening the policies and the establishment of smart monitoring/tracking systems to control pollution from vessels in ports is also a current need.
Contents

- Introduction to the RHDHV team
- Mentimeter
- Black Sea summary
  - Types of pollution
  - Typical WWT
- What is the nature-based approach?
  - Riverine
  - Coastal
- NbS and WWT
- Examples
- STAIN workshop
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
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
Black Sea Basin

Source: European Environment Agency, 2001)
2 main types of pollution

- **Point Source**
  - Combined Sewer Overflow
  - Municipal (Publicly Owned Treatment Works)
  - Municipal Separate Storm Sewer System
  - Construction Stormwater
  - Non-Municipal (Industrial) Procession/Process Wastewater and Stormwater
  - Incidental Vessel Discharges

- **Diffuse**
  - Farms, Ranching & Agriculture
  - Sediment, Surface, Point, and Non-Point Sources
  - Neighbors & Roads

Exhibit 1-2: Common point source discharges of pollutants to waters of the United States
Nitrogen Loads of the Rivers (River; ktonnes N/year; %)

- Don: 183.8; 17%
- Southern Bug: 27.9; 3%
- Dnieper: 145.9; 14%
- Yeşilirmak: 16.1; 1%
- Kızılirmak: 16.4; 1%
- Sakarya: 29.7; 3%
- Kuban: 20.7; 2%
- Danube: 571.6; 54%

Riverine Nitrogen Loads by Source (source; ktonnes N/y; %)

- Water: 5.1; 1%
- Grasslands/pastures: 56.7; 5%
- Forest: 68.6; 6%
- Urban areas: 10.1; 1%
- Industry: 6.4; 1%
- Other: 52.6; 5%
- Agricultural land: 559.6; 52%
- Wastewater treatment plants: 255.4; 24%
- Rural households: 47.9; 5%
- Grasslands/pastures: 1.4; 2%

Phosphorus Loads of the Rivers (River; ktonnes P/y; %)

- Don: 15.7; 15%
- Southern Bug: 3.1; 3%
- Dnieper: 20.8; 20%
- Yeşilirmak: 1.4; 1%
- Kızılirmak: 2.7; 3%
- Sakarya: 4.1; 4%
- Kuban: 2.9; 3%
- Danube: 45.1; 43%

River Phosphorus Loads by Sources (Source; ktonnes P/y; %)

- Forest: 3.3; 3%
- Grasslands/pastures: 1.4; 2%
- Agricultural land: 38.6; 37%
- Wastewater treatment plants: 48; 47%
- Rural households: 11.2; 11%
Grey WF – basin level details

Danube
- Wheat: 52.1% (3.8 $10^8$ m$^3$/yr)
- Barley: 4.9% (1.4 $10^8$ m$^3$/yr)
- Maize: 4.1% (1.3 $10^8$ m$^3$/yr)
- Fodder Crops: 4.0% (1.4 $10^8$ m$^3$/yr)
- Domestic: 11.5% (5.8 $10^8$ m$^3$/yr)
- Industrial: 27.7% (16 $10^8$ m$^3$/yr)
- Other: 11.3% (3.6 $10^8$ m$^3$/yr)

Southern Bug

Dniepr
- Wheat: 5.2% (770 $10^7$ m$^3$/yr)
- Potatoes: 5.1% (750 $10^7$ m$^3$/yr)
- Fodder Crops: 10.5% (1.9 $10^8$ m$^3$/yr)
- Domestic: 10.1% (2.2 $10^8$ m$^3$/yr)
- Industrial: 47.8% (7 $10^8$ m$^3$/yr)
- Other: 10.1% (2.1 $10^8$ m$^3$/yr)

Kuban
- Wheat: 5.4% (87 $10^7$ m$^3$/yr)
- Maize: 5.3% (86 $10^7$ m$^3$/yr)
- Fodder Crops: 8.5% (130 $10^7$ m$^3$/yr)
- Domestic: 10.3% (260 $10^7$ m$^3$/yr)
- Industrial: 49.9% (800 $10^7$ m$^3$/yr)
- Other: 7.4% (110 $10^7$ m$^3$/yr)

Kizilirmak
- Wheat: 37.8% (600 $10^7$ m$^3$/yr)
- Barley: 8.7% (150 $10^7$ m$^3$/yr)
- Grapes: 5.6% (95 $10^7$ m$^3$/yr)
- Domestic: 16.3% (240 $10^7$ m$^3$/yr)
- Industrial: 6.1% (100 $10^7$ m$^3$/yr)
- Other: 23.9% (380 $10^7$ m$^3$/yr)

Dniestr
- Wheat: 7.6% (200 $10^7$ m$^3$/yr)
- Fodder Crops: 12.2% (66 $10^7$ m$^3$/yr)
- Domestic: 11.7% (310 $10^7$ m$^3$/yr)
- Industrial: 56.8% (1.6 $10^8$ m$^3$/yr)
- Other: 11.7% (310 $10^7$ m$^3$/yr)

Sakarya
- Wheat: 27.9% (400 $10^7$ m$^3$/yr)
- Barley: 11.8% (170 $10^7$ m$^3$/yr)
- Maize: 4.5% (65 $10^7$ m$^3$/yr)
- Domestic: 18.7% (300 $10^7$ m$^3$/yr)
- Industrial: 11.4% (190 $10^7$ m$^3$/yr)
- Other: 20.9% (300 $10^7$ m$^3$/yr)
## Main source of pollution for each river basin

<table>
<thead>
<tr>
<th>River basin</th>
<th>N-load (%)</th>
<th>P-load (%)</th>
<th>Country</th>
<th>Main sources of pollution</th>
</tr>
</thead>
</table>
| 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. |
| Danube      | 54         | 43         | Romania/ Bulgaria/Ukraine    | • Main source P-load is wastewater treatment plants.  
• In Romania and Bulgaria the connection and level of wastewater treatment is good. |
| 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.                                  |
| Sakarya     | 3          | 4          | Turkey                       | • Main source P-load is wastewater treatment plants  
• In Turkey good connection to wastewater collection system, but level of treatment is low. |
| 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                                        |
| Kızılirmak, | 1          | 3          | Turkey                       | • Main source P-load is wastewater treatment plants  
• In Turkey good connection to wastewater collection system, but level of treatment is low. |
| Yeşilirmak  | 1          | 1          | Turkey                       | • Main source P-load is wastewater treatment plants  
• In Turkey good connection to wastewater collection system, but level of treatment is low. |
| Others      | 2          | 3          | -                            | -                                                                                         |
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.)

<table>
<thead>
<tr>
<th>mg/L</th>
<th>Influent (untreated)</th>
<th>After primary stage</th>
<th>After secondary (biological stage) incl. Nutrient removal</th>
<th>After tertiary stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>60</td>
<td>60</td>
<td>10-15</td>
<td>&lt; 5</td>
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<tr>
<td>Phosphorus (P)</td>
<td>10</td>
<td>10</td>
<td>1-2</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Organic (COD)</td>
<td>500</td>
<td>300</td>
<td>50-80</td>
<td>&lt; 50</td>
</tr>
</tbody>
</table>
### Table 5: Generated urban wastewater load and number of centralized collection and treatment systems in the Danube River Basin (reference year: 2018)

<table>
<thead>
<tr>
<th>Type of collection and treatment system</th>
<th>Generated load (PE)</th>
<th>Number of centralized collection and treatment systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tertiary treatment</td>
<td>54,345,005</td>
<td>2,220</td>
</tr>
<tr>
<td>Secondary treatment</td>
<td>7,264,840</td>
<td>888</td>
</tr>
<tr>
<td>Primary treatment</td>
<td>1,155,336</td>
<td>100</td>
</tr>
<tr>
<td>Collected but not treated</td>
<td>5,492,920</td>
<td>751</td>
</tr>
<tr>
<td>Not collected by sewer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individually collected and treated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IAS</td>
<td>3,487,062</td>
<td>-</td>
</tr>
<tr>
<td>Local systems</td>
<td>2,750,534</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>85,165,464</td>
<td>3,959</td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>Nature-based Solutions</th>
<th>Bulgaria</th>
<th>Croatia</th>
<th>Estonia</th>
<th>Hungary</th>
<th>Latvia</th>
<th>Moldova</th>
<th>Montenegro</th>
<th>Poland</th>
<th>Romania</th>
<th>Slovakia</th>
<th>Slovenia</th>
<th>Ukraine</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil infiltration</td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
<td>&gt;312</td>
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<tr>
<td>Willow systems</td>
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<td></td>
<td></td>
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<td>&gt;1</td>
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<tr>
<td>Waste stabilization ponds</td>
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<td></td>
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<td>Aerated ponds</td>
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<td></td>
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<td>Sludge treatment reed beds</td>
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<td>&gt;23</td>
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<td>Vermifilter</td>
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<tr>
<td>Ecosan technology</td>
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<td></td>
<td></td>
<td>70</td>
</tr>
</tbody>
</table>

Wastewater collection, treatment and reuse in rural areas of CEE, GWP CEE Report, 2021
### Why nature-based solutions?

<table>
<thead>
<tr>
<th>Nature-based Solutions</th>
<th>Traditional Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holistic solution (green infrastructure) to address (sustainability) societal challenges with a friendlier ecological footprint</td>
<td>Traditional engineering of landscapes (grey infrastructure) while more predictable and tested, tend not to blend well with social or environmental goals or norms</td>
</tr>
<tr>
<td>Dynamic &amp; resilient; evolves with the environment and society over time.</td>
<td>While short-term thinking may deliver immediate results, they tend to have significant externalities (indirect costs to society and environment)</td>
</tr>
<tr>
<td>Intrinsic motivation; Improving the environment and restoring natural habitats improves well-being and societal resilience</td>
<td>Static, subject to degradation, tend to be fixed structures that cannot be easily moved (unlike sediment for example)</td>
</tr>
<tr>
<td>Meets direct needs of traditional (engineered) solutions and offers various co-benefits</td>
<td>Generally requires significant amounts of concrete and other hard materials with significant sustainability impacts (eg. high ecological footprint)</td>
</tr>
<tr>
<td>Integrates better with cultural heritage and landscape</td>
<td>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.</td>
</tr>
<tr>
<td>Tends to be cheaper in the long-term</td>
<td>Not scalable – often disrupts nature</td>
</tr>
<tr>
<td>Links to SDGs and contributes to circular economy</td>
<td>Scalable</td>
</tr>
</tbody>
</table>
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
### Common advantages and frequent challenges of using NBS for wastewater treatment

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

**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

**Water-based systems**
- Ponds
- In-stream restoration
- Surface flow wetlands
- Ponics technologies

**Substrate-based systems**
- Soil infiltration systems
- Building-based systems
- Zero-discharge systems
- Subsurface flow wetlands
- Sludge treatment reed beds

**Hybrid / multi-stage systems**

*Figure 2. Classification of basic NBS groups for wastewater treatment*
<table>
<thead>
<tr>
<th>Water-based systems</th>
<th>Substrate-based systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ponds</strong></td>
<td><strong>Soil infiltration systems</strong></td>
</tr>
<tr>
<td>Anaerobic</td>
<td>Slow-rate</td>
</tr>
<tr>
<td>• Classical</td>
<td>Vertical-flow TW</td>
</tr>
<tr>
<td>• High-rate</td>
<td>• Vertical-flow (VF)</td>
</tr>
<tr>
<td><strong>Intensified</strong></td>
<td>Rooftop TW</td>
</tr>
<tr>
<td>• Surface aerated</td>
<td>• French VFTW</td>
</tr>
<tr>
<td><strong>Aerobic</strong></td>
<td>Willow systems</td>
</tr>
<tr>
<td>• Facultative</td>
<td>Horizontal-flow TW</td>
</tr>
<tr>
<td>• Maturation</td>
<td>• Intensified TW</td>
</tr>
<tr>
<td><strong>In-stream</strong></td>
<td></td>
</tr>
<tr>
<td>restoration</td>
<td>• Aerated</td>
</tr>
<tr>
<td><strong>Surface flow</strong></td>
<td></td>
</tr>
<tr>
<td>wetlands</td>
<td>• Reciprocating</td>
</tr>
<tr>
<td><strong>Ponics</strong></td>
<td></td>
</tr>
<tr>
<td>technologies</td>
<td>• Reactive media in TW</td>
</tr>
</tbody>
</table>

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

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

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

- Constructed wetlands, use excessive sediments
- Small scale floating filtering (Ecoshape.org)
- Large scale, filtering and buffering (Wwt.org.uk)
- 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**

<table>
<thead>
<tr>
<th>Source</th>
<th>Value</th>
</tr>
</thead>
</table>
| Inflow rate (L/s) | Current: mean 1,000 m³/d; peak 1,900 m³/d (monitored data 2013-2015)  
Future: 2,100-2,700 m³/d (design value) |
| Population equivalent (p.e.) | up to 20,000 p.e. (design value) |
| Area (m²) | First stage French Reed Bed (FRB): 17,956 m²  
Second stage vertical flow: 16,992 m²  
Total: 34,948 m² |
| Population equivalent area (m²/p.e.) | First stage French Reed Bed (FRB): 0.90 m²/p.e. (design value)  
Second stage vertical flow: 0.85 m² (design value)  
Total: 1.75 m²/p.e. (design value) |
Enablers of Building with Nature

- Technology and system knowledge
- Multi-stakeholder approach
- Management, monitoring and maintenance
- Institutional embedding
- Business Case
- Capacity building
Black Sea

- 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)