HYDROUSA

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Water in the context of circular economy

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Brief Description	This document provides layman's leaflets specifically targeted at potential adopters of nature-based solutions for water and nutrient recovery in cities, rural settlements, agriculture, coastal areas and industries, respectively. It also describes how the content of the leaflets was developed. The leaflets can be used for dissemination material directed at people not yet necessarily acquainted with the range of applications of NBS in their fields of work.
Keywords	Nature-based solutions, water and nutrient reuse, circular economy, cities, settlements, agriculture, coastal areas, industries

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EXECUTIVE SUMMARY

Excessive abstraction of freshwater is a major contributing factor to water stress, further exacerbated by increasing demand and climate change. Agricultural irrigation and domestic freshwater demand, including tourism, are the strongest human contributors to water scarcity. Today, more than 11% of the European population and 17% of European territory face the effects of water scarcity (European Commission 2020). Further, Europe imports 29% of nitrogen, 58% of phosphorus and 75% of potassium fertilizers consumed for agricultural purposes (Fertilizers Europe 2019). Europe's agri-food system is therefore strongly import-dependent. All of these aspects raise the need to transition towards a circular water and nutrient economy.

Compared to other water and nutrient recovery technologies, nature-based solutions (NBS) are a more sustainable and cost-efficient option to close water and nutrient cycles. Significant innovation has taken place over the last decades, making NBS more efficient, reducing their spatial footprints, and specifically adapting them to different operational contexts. NBS, specifically constructed wetlands, have been widely applied to treat and in some cases reuse wastewater in rural areas in Europe for decades, in particular where connection to the sewage grid is not possible. However, many wetland technologies are applicable also to urban environments, including building integrated solutions, such as green wall treatment technologies, and various industrial wastewater flows. Constructed wetlands can partly remove organic micropollutants and can even perform better in some cases than conventional biological wastewater treatment plants and thus be applied for tertiary treatment of municipal wastewater, making it safer for reuse (Kaur et al. 2020; Gattringer et al. 2016). Regenerative agriculture NBS can also help to reduce water and nutrient losses.

NBS can simultaneously tackle water, nutrient, microclimate and biodiversity challenges, and are therefore transdisciplinary by nature. Still, some target groups may not be aware of the range of opportunities of nature-based wastewater treatment solutions for their own scope of work. Thus, in order to realize the full potential of NBS, stakeholders must form new wider partnerships.

The present deliverable includes five leaflets addressing five diverse operational contexts and respective target groups: cities, rural settlements, agriculture, coastal areas and industries. They include a brief description of specific major challenges faced by the target groups as well as NBS suitable to tackle these challenges and suitable for the specific requirements of these contexts. They also provide an overview of their role and position within the system of circular water and nutrient loops. Finally, geographical maps indicate the locations of reference projects, where innovative NBS are being demonstrated.

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ABBREVIATIONS

C	**carbon**
CO_2	**carbon dioxide**
EU	**European Union**
IUCN	**International Union for Conservation of Nature**
K	**potassium**
NBS	**nature-based solutions**
P	**phosphorus**

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1. METHODOLOGY & GUIDE TO CONTENT

Five layman's leaflets and an introductory illustration were developed to specifically target five diverse contexts in which NBS can be applied to recover and reuse water and nutrients, namely agriculture, cities, rural settlements, industries and coastal zones. The five contexts, and corresponding target groups, were selected based on the specific needs and installation settings which differ among these groups. For example, the implementation conditions, types of wastewaters and reuses differ strongly between agriculture and industrial facilities. Between cities and rural settlements there are also different needs which require diverse planning and design considerations, resulting in different scales of resource loops and technologies selected to close these loops. Similarly, coastal areas face additional challenges, but also bear opportunities for NBS to recover and reuse water and nutrients.

The overview of challenges and technical solutions presented in the leaflets was developed based on the evidence matrix (see D8.5 report). This matrix includes a total of 107 cases demonstrating water reuse, spanning a wide range of reclaimed water sources (non-conventional water sources), water recovery technologies and treatment trains. The aim was to identify cases demonstrated in Europe, and if the course of the search yielded cases demonstrated outside of Europe but transferable to Europe, these were also taken up in the matrix (7 non-European cases, all located in the Southern Mediterranean). Demonstration cases include Horizon 2020 CIRC, WATER and WASTE and other EU-funded projects (total 96 cases), but also nationally funded projects (5 cases) and private sector projects (6 cases). From this extensive collection of latest demonstrated innovation (minimum TRL 6), the cases employing NBS were extracted and used as the basis for the content of the leaflets.

The leaflets include:

- a briefing on the main challenges that these contexts face and which could be mitigated by applying NBS to close water and nutrient cycles,
- an overview of suitable NBS options and their position within the system of circular water and nutrient flows accompanied by an illustration, and
- a geographical map indicating the locations of reference projects.

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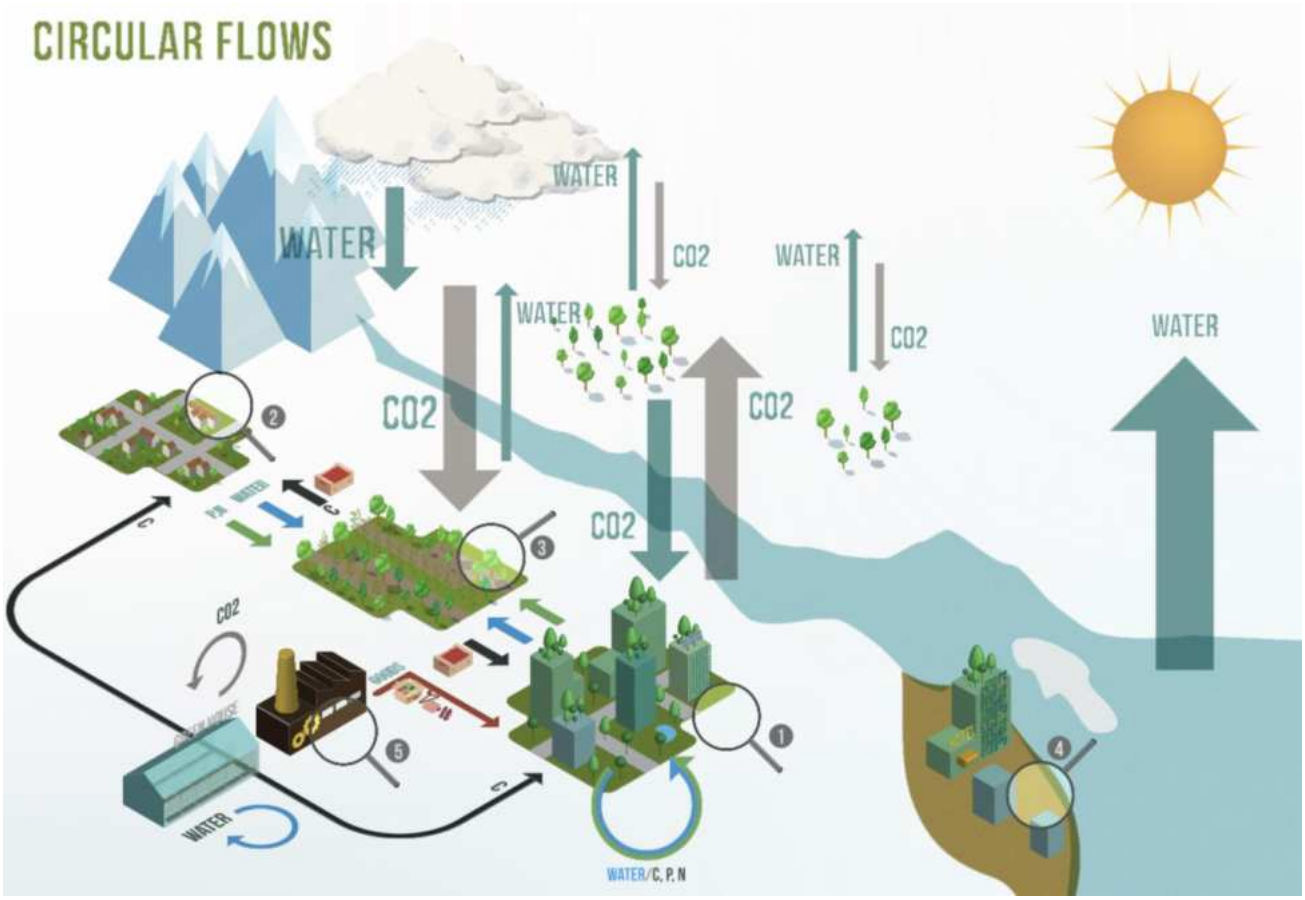
2. LAYMAN'S LEAFLETS



1. **Cities (see 2.1)**
2. **Rural settlements (see 2.2)**
3. **Agriculture (see 2.3)**
4. **Coastal zones (see 2.4)**
5. **Industries (see 2.5)**

2.1. Cities

Demonstration of water loops with regenerative business models for the mediterranean region

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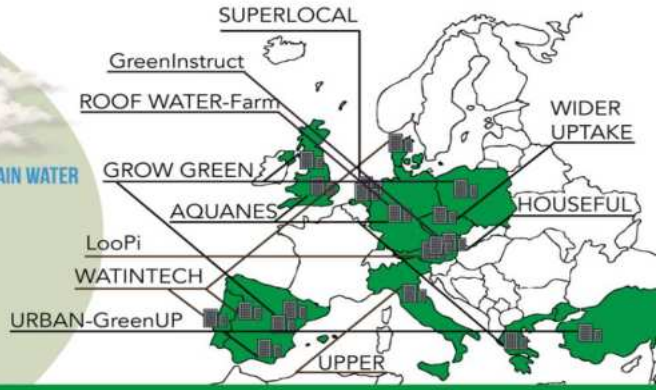
Water Reuse Demonstrations using nature-based solutions in Europe for:

CITIES

nature based solutions:
...are actions to protect, sustainably manage and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits. (IUCN 2016 - definiton)

existing solutions:



challenges:
As centers of resources consumption, cities play a major role in the transition to a circular economy for water and food. Cities also struggle with urban heat islands and biodiversity loss. They must prepare for longer dry periods and more frequent, heavier rains that overload the sewer system.

solutions:
Green urban infrastructures can make cities more climate-resilient and biodiverse. Specifically, constructed wetlands, integrated into built environments such as green walls and façades, drainage systems or green roofs, can treat stormwater runoff, combined sewer overflow and wastewater. Recent innovations have strongly reduced the space needed for wetlands e.g. with new aerated or electric conductive systems and innovative structural set-ups, as well as combination with anaerobic digestion and composting. Building-integrated treatment green walls could also be installed in unutilized infrastructures. The effluent can be reused on site to cultivate vegetables and herbs in field plots on rooftops or hydroponic green walls.

2.2. Rural settlements

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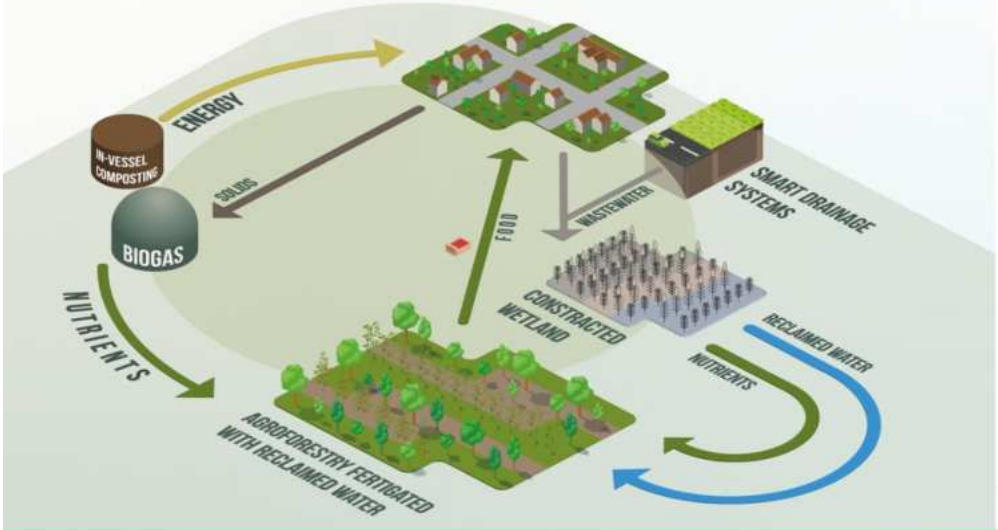
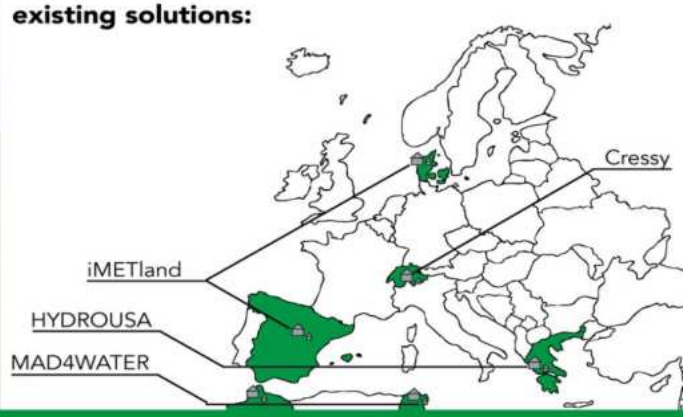
Water Reuse Demonstrations using nature-based solutions in Europe for: RURAL SETTLEMENTS AND MUNICIPALITIES



nature based solutions:
...are actions to protect, sustainably manage and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits. (IUCN 2016 - definiton)

existing solutions:



challenges:
In our linear food system water and nutrients travel through the food value chain to consumers, are discharged to wastewater and are lost for potential reuse. Freshwater with drinking water quality is used even for applications with lower-grade water quality requirements, although wastewater is a highly reliable and largely untapped source of secondary service water and nutrients. Our current conventional treatment of municipal wastewateris energy-intensive and contributes to carbon emissions.

solutions:
Constructed wetlands can reliably treat municipal, agricultural and industrial wastewater for safe reuse in agricultural irrigation and other uses. These zero-energy or low-energy solutions can be installed close to the point of wastewater generation and close to the point of reuse in agricultural fields or other service water uses in towns or industries. These options cut cost and energy consumption and make freshwater and nutrients available, thus mitigating the impacts of droughts.

2.3. Agriculture

Demonstration of water loops with regenerative business models for the mediterranean region

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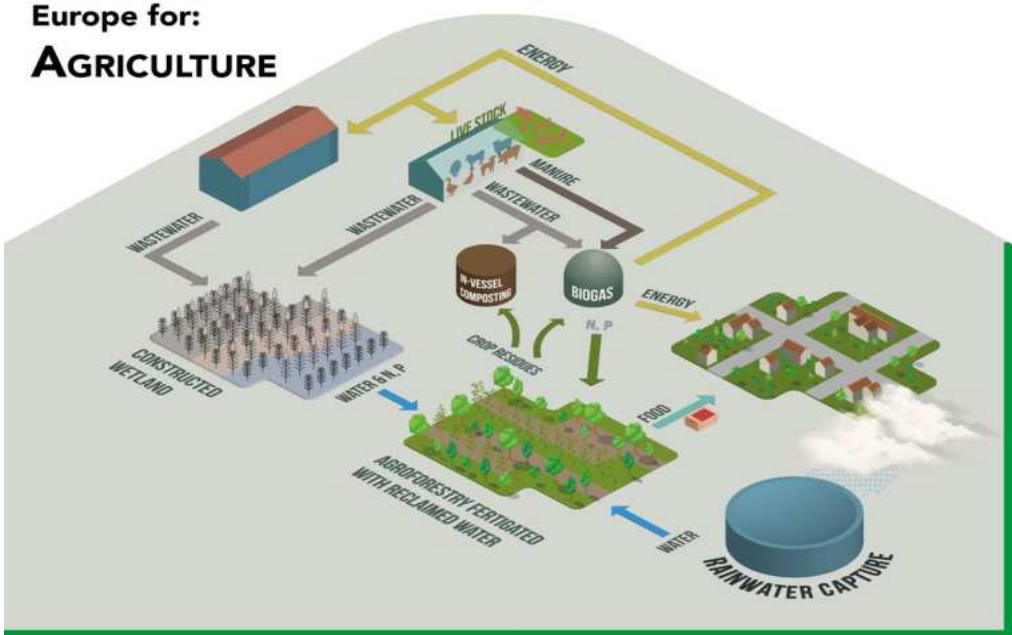
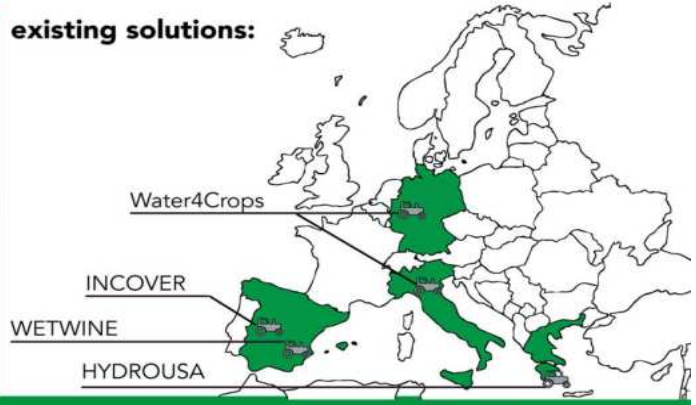
Water Reuse Demonstrations using nature-based solutions in Europe for:

AGRICULTURE



nature based solutions:
...are actions to protect, sustainably manage and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits. (IUCN 2016 - definiton)

existing solutions:



challenges:
A large and growing number of farmers in Europe struggle with water scarcity, which is increasing due to climate change. High contamination of surface water and groundwater with nutrients are a growing challenge and often originate in agricultural parctices.

solutions:
Constructed wetlands are a highly cost-effective option to treat agro-industrial wastewater from livestock and aquaculture, as well as household wastewater. The treated effluent can be directly reused for irrigation of fields. Organic solid waste can be treated in biogas plants and innovative composters and the containing nutrients can be used as cheap and sustainable fertilizer. Nature-based farming techniques such as agroforestry can enhance field water efficiency and agroforestry systems can also be irrigated with NBS-treated wastewater.

2.4. Coastal zones

Demonstration of water loops with regenerative business models for the mediterranean region

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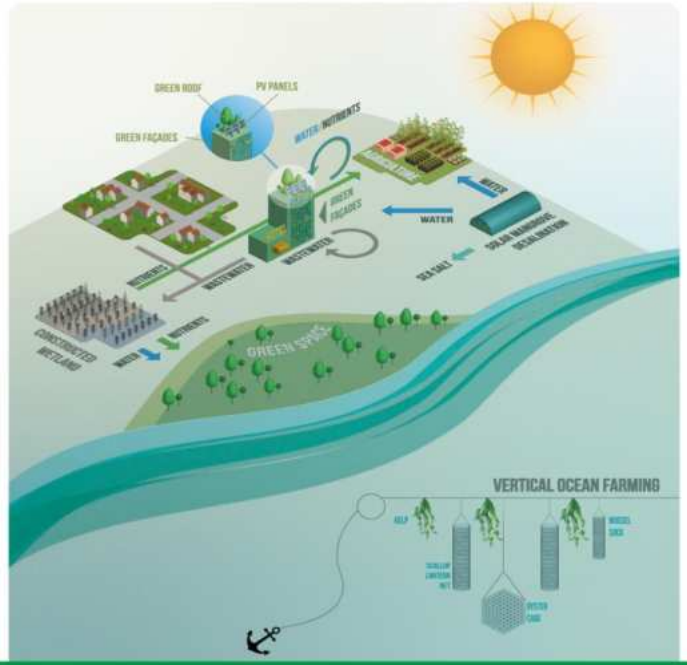
Water Reuse Demonstrations using nature-based solutions in Europe for:

COASTAL ZONES



nature based solutions:

...are actions to protect, sustainably manage and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits. (IUCN 2016 - definiton)

existing solutions:

challenges:

Coastal areas often struggle with water scarcity, droughts and storms. All of these challenges are increasing due to climate change. Coastal tourism poses additional pressure on scarce water resources, especially during the hot and dry summer months.

solutions:

Nature-based wastewater treatment technologies, such as constructed wetlands, green façade panels or other building-integrated vegetated treatment solutions can recover valuable water and nutrients for irrigation of green spaces, edible gardens or for cleaning. This way, the high wastewater volumes generated in hotels can be used to create more lush and attractive green spaces and regenerate surrounding nature. Innovative ocean farming can use nutrients in sea water to cultivate shellfish and kelp.

2.5. Industries

Demonstration of water loops with regenerative business models for the mediterranean region

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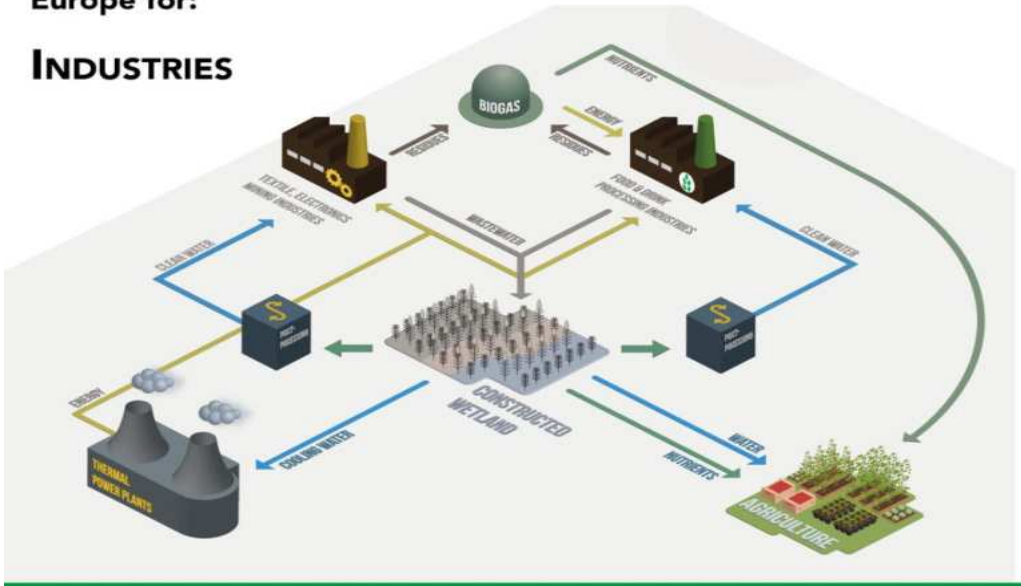
Water Reuse Demonstrations using nature-based solutions in Europe for:

INDUSTRIES



nature based solutions:

...are actions to protect, sustainably manage and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits. (IUCN 2016 - definiton)

existing solutions:

challenges:

Industries often produce highly contaminated and highly variable, complex wastewater. Conventional biological treatment solutions are not suitable to treat many of these cases. Mechanical treatment is usually highly energy-intensive and expensive.

solutions:

Constructed wetlands have been used to effectively treat a wide range of industrial wastewater, such as landfill leachate, food and drink processing wastewater including processing of cheese, meat, vegetables and soft drinks, wineries and breweries and olive mills, as well as mine tailings, residual dye wastewater, airport run-off contaminated with de-icer, as well as wastewater from wood and leather processing, pharmaceuticals and cosmetics industries. Industrial effluents that have been treated by constructed wetlands have also been reused, e.g. recycled carwash water.

3. CONCLUSIONS

Some of the strongest human contributors to water scarcity are agricultural irrigation and domestic freshwater demand, including tourism. Today, more than 11% of the European population and 17% of European territory face the effects of water scarcity (European Commission 2020). Further, Europe imports 29% of nitrogen, 58% of phosphorus and 75% of potassium fertilizers consumed for agricultural purposes (Fertilizers Europe 2019). Europe's agri-food system is therefore strongly import-dependent. All of these aspects raise the need to transition towards a circular water and nutrient economy. The newly adopted EU regulation on minimum requirements for water reuse for agricultural irrigation (European Commission Regulation No 741/2020) states that treatment and recovery of lower quality water and nutrients from wastewater should be executed with minimal energy consumption to offset costs and environmental impact. Compared to other water and nutrient recovery technologies, nature-based solutions (NBS) are a more sustainable and cost-efficient option to close water and nutrient cycles. Nature-based solutions (NBS) are near zero-energy solutions and offer a manifold of co-benefits via green infrastructures, biodiverse habitats, stormwater retention, or heat island abatement in cities. A specific array of NBS has been applied to water recovery in municipal, agricultural and industrial wastewater treatment facilities all over the world.

Significant innovation has taken place over the last decades, making NBS more efficient, reducing their spatial footprints, and specifically adapting them to different operational contexts. NBS, specifically constructed wetlands, have been widely applied to treat and in some cases reuse wastewater in rural areas in Europe for decades, in particular where connection to the sewage grid is not possible. Many wetland technologies are applicable also to urban environments, including building integrated solutions, such as green wall treatment technologies, and various industrial wastewater flows. Despite all the benefits and co-benefits offered by NBS applied to wastewater treatment, policymakers and relevant stakeholders are oftentimes not aware of the range of possibilities offered by NBS. NBS can simultaneously tackle water, nutrient, microclimate and biodiversity challenges, and are thus transdisciplinary by nature. In order to realize the full potential of NBS, stakeholders must form new partnerships, but the relevant target groups may, for example, not be aware of opportunities of nature-based wastewater treatment solutions for their own scope of work. The present work aims at providing evidence-based knowledge to facilitate a broader transition to a circular economy in the EU. Information on barriers, best practices and demo cases of application of NBS to wastewater treatment have been collected from other H2020-CIRC, -WATER and -WASTE projects, the relevant running Innovation Deals, European and national initiatives on circular economy, and major reports in these areas (e.g. Ellen MacArthur Foundation, EC, European Environment Agency, EUROSTAT, Cradle to Cradle@ movements, Circle Economy from the Netherlands). Major findings have been collated in an evidence matrix and shared with all partners. From this extensive collection of latest demonstrated innovation (minimum TRL 6), the cases employing NBS were extracted and used as the basis for the content of the leaflets. The present deliverable includes five leaflets addressing five diverse operational contexts and respective target groups: cities, rural settlements, agriculture, coastal areas and industries. They include a brief description of specific major challenges faced by the target groups as well as NBS suitable to tackle these challenges and suitable for the specific requirements of these contexts. They also provide an overview of their role and position within the system of circular water and nutrient loops. Finally, geographical maps indicate the locations of reference projects, where innovative NBS are being demonstrated.

The leaflets provide a basis for education material that will be used for possible application in schools.

The overview of challenges and technical solutions presented in the leaflets was developed based on the evidence matrix (see D8.5 report).

4. REFERENCES

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