D5.1 Initial roadmap for the implementation and monitoring of actions at the Case Studies

Leading author:
Lydia Vamvakeridou-Lyroudia (KWR)

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Introductory Table

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Project Title	Reliability and effectiveness of integrated alternative water resources management for regional climate change adaptation
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Deliverable Information Sheet

Version	Date	Author	Document history/approvals
1.0	17-06-2024	Lydia Vamvakeridou-Lyroudia (KWR)	Draft version created (V1)
1.1	24-06-2024	Pia Schumann, Veronika Zhiteneva (KWB)	Initial review
2.0	26-06-2024	Lydia Vamvakeridou-Lyroudia (KWR)	Corrections after the review – Version V2 created
3.0	27-06-2024	Digu Aruchamy (EUT)	Final Quality check and minor formatting changes included

Executive Summary Section

This deliverable (D5.1) is related to Work Package (WP) 5 of the RECREATE project, which focuses on the Case Studies (CS). There are four diverse and complementary CS in RECREATE:

CS#1: North Holland (Netherlands); CS#2: Kalundborg (Denmark); CS#3: Syros Island – South Aegean (Greece); and CS#4: Costa Brava (Spain). Details about them are included in this deliverable.

In terms of actions, WP5 is structured into three Tasks: Task 5.1. Development of a roadmap for the implementation, testing and monitoring of actions in all the CSs [M1-M48]; Task 5.2 Implementation and testing of actions at all the CS, structures in four subtasks running in parallel (one subtask for each CS), [M4-M45]; Task 5.3. Validation of solutions for each CS, evidence-based knowledge, and recommendations at EU level [M37-M48].

This Deliverable (D5.1) is reporting the progress (actions, i.e., activities and plans) related to Task 5.1 and to Task 5.2, which are running in parallel. It is the first version of the actions at the CS. It will be updated at regular intervals (D5.2-M18, D5.3-M36), with the final version to be submitted at the end of the project as D5.4-M48.

The Deliverable D5.1 includes detailed information about each of the CS covering a detailed description, the CS goals, ambitions and barriers regarding Alternative Water Resources (AWR) use, data and modelling needs, possible gaps, etc. These types of information, collected in a template for each CS help also in determining and defining the future steps for the coming months. The document also includes information about the monitoring of the activities through a bi-weekly teleconference, as well as information about the planned actions in the coming months at each CS, as Gantt charts, concluding with the next steps.

Related Deliverables: D5.2, D5.3, D5.4 to be submitted in M18, M36 and M48 respectively.

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List of Abbreviations

ABM	*Agent Based Model*
AC	*Activated Carbon*
AI	*Artificial Intelligence*
AOP	*Advanced Oxidation Processes*
ASR	*Aquifer Storage and Recovery*
ASTR	*Aquifer Transport and Recovery*
AWR	*Alternative Water Resources*
CoP	*Community of Practice*
DoA	*Description of the Action*
DWTP	*Drinking Water Treatment Plant*
EHS	*Environment Health and Safety*
ESR	*Ethics Summary Report*
GA	*Grant Agreement*
HMS	*Hellenic Meteorological Service*
KNMI	*Royal Netherlands Meteorological Institute*
KPI	*Key Performance Indicator*
LCA	*Life Cycle Assessment*
LSRRO	*Low Salt Rejection Reverse Osmosis*
MAR	*Managed Aquifer Recharge*
MCr	*Membrane crystallization*
MD	*Membrane Distillation*
OARO	*Osmotically Assisted Reverse Osmosis*
PE	*Population Equivalents*
QMRA	*Quantitative Microbial Risk Assessment*
QCRA	*Quantitative Chemical Risk Assessment*
UF	*Ultrafiltration*
RO	*Reverse Osmosis*

RWH	*Rainwater Harvesting*
SDM	*System Dynamics Model*
UWOT	*Urban Water Optioneering Tool*
WP	*Work Package*
WWTP	*Wastewater Treatment Plant*

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1. Introduction

This deliverable is related to Work Package (WP)5 of the RECREATE project. WP5 focuses on the Case Studies (CS) of the project. It aims to describe the planning, implementation and monitoring of all the actions and activities at the CS. There are four diverse and complementary CS:

CS#1: North Holland (Netherlands)

CS#2: Kalundborg (Denmark)

CS#3: Syros Island – South Aegean (Greece)

CS#4: Costa Brava (Spain)

The objectives of this WP are:

(i) to develop a roadmap of actions for all the CS;

(ii) to coordinate the activities and actions in all the CS and the interactions with the other WPs;

(iii) to guide and monitor the implementation of the aforementioned actions, i.e., testing and monitoring actions, installation of sensor equipment, data collection, stakeholder engagement, etc.;

(iv) to assess the impact of the AWR solutions (including technical, social, economic and cultural aspects);

(v) to develop and coordinate the validation procedures (by the stakeholders) for the solutions in all the CS;

(vi) to provide evidence-based knowledge, lessons learnt and recommendations at EU level (horizontally from all the CS).

Several activities and actions are implemented at the CS. Some are specific for each CS, and some horizontally across all of them. Moreover, the actions and activities at the CS are interlinked with activities in other WPs. Figure 1 shows the links and interactions of WP5 with the other WPs

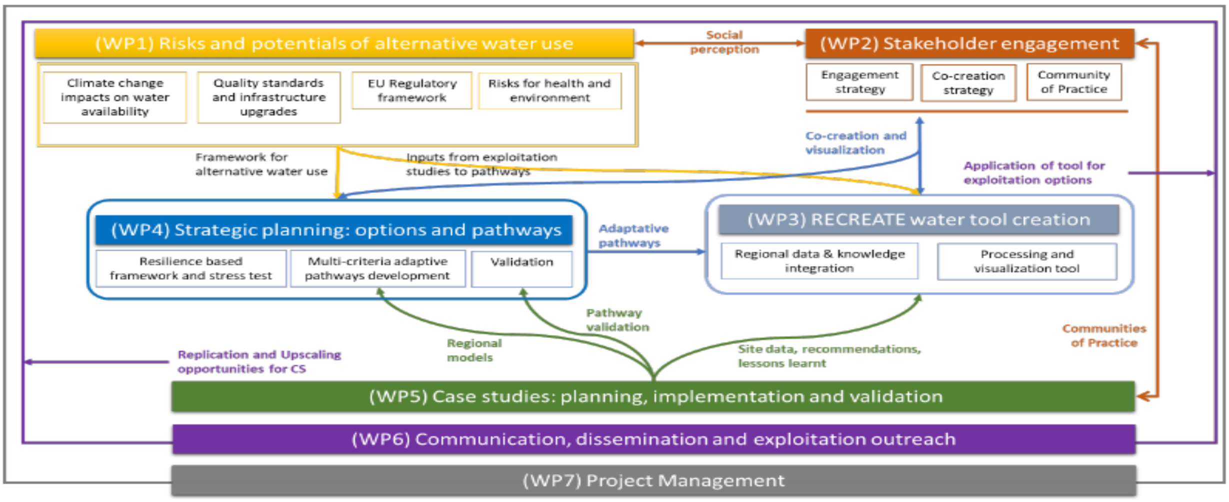


Figure 1: WP5 Interlinkages with the other WPs

In terms of actions, WP5 is structured in three Tasks:

Task 5.1. Development of a roadmap for the implementation, testing and monitoring of actions in all the CSs [M1-M48];

Task 5.2 Implementation and testing of actions at all the CS, structures in four subtasks running in parallel (one subtask for each CS), [M4-M45];

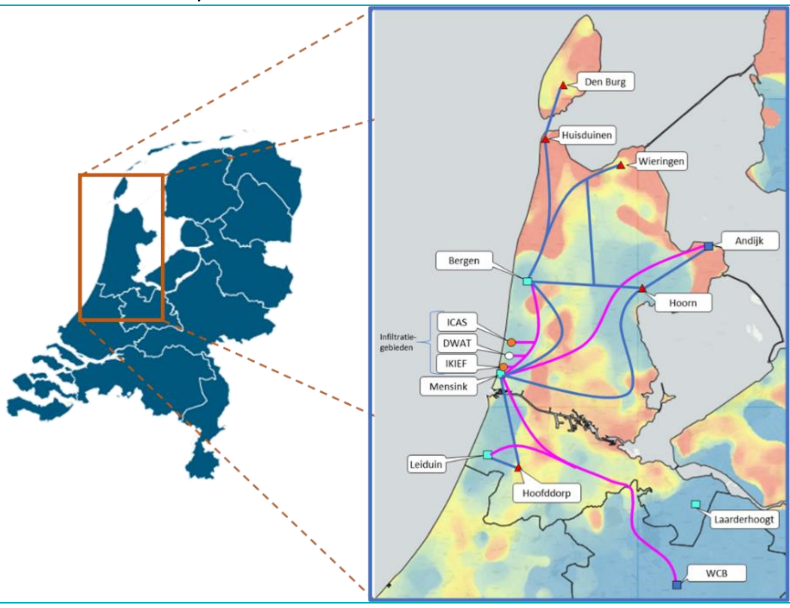
Task 5.3. Validation of solutions for each CS, evidence-based knowledge, and recommendations at EU level [M37-M48]

This Deliverable (D5.1) is reporting actions (activities and plans) related to Task 5.1 and to Task 5.2. It is the first version of the actions at the CS. It will be updated at regular intervals (D5.2-M18, D5.3-M36), with the final version to be submitted at the end of the project D5.4-M48. It is structured as follows: Chapter 2 includes detailed information about each of the CS, in related subsections. Chapter 3 includes the actions performed so far, including monitoring, as well as the planned actions in the coming months at each CS, as Gantt charts. Finally, Chapter 4 includes conclusions and next steps.

2. Case Studies in detail (description, partners, scope, needs, plans, next steps)

The following sections present the details about each Case Study. The information is structured in the same way for all the CS, following a common template. The type of information needed by each CS has been defined with the cooperation of all the WPs of the project. It covers all aspects that are relevant for all the WPs of the project. So far (M6), the information collected is enough for all the WPs to interact with the CS and for the CS to proceed with their actions on site. If more information is needed at a later stage, then an additional template may be distributed to the CS, to be included in the updated versions of this deliverable.

2.1 CS#1: North Holland- The Netherlands

CS#1 North Holland (the Netherlands)	**Leading partner: PWN, other partners: KWR** **Leading person: Iverna Créton (PWN)**
Title	Case study 1: Atlantic region – North Holland (Netherlands)
Biogeographical region	Atlantic
Water system type	Drinking water, industrial, agriculture
Area (km^2)	4,000 km^2 (Province of North Holland, the Netherlands), Focus on management area of water authority HHNK (i.e., water authority north of the Noordzeekanaal).
Map image/photo	
Goals/challenges	Framework already in place to support PWN in strategic thinking and action, developed jointly with regional stakeholders. This joint framework will support PWN in making long-term investment planning (with a focus on 2030 – 2050) to make the water system resilient to the future climate (2050 and beyond), taking into account rising salinity levels in Lake IJssel

	and an increasing water demand due to population increase and a growing economy. The framework will help to navigate in an uncertain future, with multiple AWR options considered.
Project partners involved (institutions and names)	PWN: Iverna Créton, Koen Zuurbier KWR: Mollie Torello, Sija Stofberg, Klaasjan Raat, Lydia Vamvakeridou-Lyroudia
Description	<u>Current situation:</u> About 3 million people live and work in the province of Noord-Holland, the Netherlands. Drinking water is supplied by utilities Waternet (Amsterdam and the surrounding area) and PWN. PWN supplies water to more than 800,000 households, companies and institutions in the province, that together use about 112 million cubic meters of drinking water annually. The current (drinking) water system was developed from the 1950s onwards. Surface water is the main water source. Part of it is directly treated and distributed to the client, but the backbone of the drinking water supply are the dune infiltration (managed aquifer recharge (MAR)) systems that are fed with pretreated surface water. After infiltration and recovery this water is distributed. The long transport pipelines from the raw water intake points to the dunes make the system vulnerable: the failure of a pipeline has major consequences. The water quality at the intake points is also under pressure, because of salinization at the intake point of the surface water during low flows of the river Rhine. <u>Challenges:</u> The demand for water is expected to increase in the coming decades due to population growth and increasing economic activity. At the same time, climate change is putting pressure on the supply of freshwater, especially during long dry periods. The prolonged droughts in 2018, 2019, 2020 and 2022 were clear warnings of what awaits us more often in the near future. In response, PWN wants to transform its current linear water system to a more robust and resilient circular system. Key components in the foreseen water transition in Noord-Holland are the use of alternative water resources, e.g. by incorporatingbrackish groundwater desalination, treated wastewater effluent reuse, and the creation of additional storage capacity, especially through nature based solutions such as Aquifer Storage and Recovery (ASR). The question is how and where to add these different new components to the current (drinking) water system and how to integrate them with the natural existing water systems. <u>Proposed activities:</u> Activities for Case Study #1 North-Holland include: - Mapping experiences, lessons learnt, knowledge gained, uncertainties and obstacles from (ongoing) pilots and studies on

	AWR (brackish water, ASR, water reuse, rainwater harvesting), i.e., technical, water quality and health, governance and legislative, societal and market topics related to CS1 (PWN, KWR). - Developing system dynamics model (SDM) for the North Holland regional water system, as a tool to quickly evaluate multiple scenarios for AWR management and to provide insights on how adaptations and interventions may propagate through the regional water system (KWR, PWN). - Setting up future climate and water demand scenarios for North Holland, based on conventional viewpoints and possible extremes, thereby covering all possible future climate and demand scenarios (KWR, PWN). - Costumize serious game Aqua Ludens (Van Aalderen, 2023, https://library.kwrwater.nl/publication/71251304) for North Holland, with the North Holland system dynamics model as the computing engine. Through serious gaming, develop a mutual understanding among all stakeholders of water system functioning and climatic, operational, and strategic challenges (KWR, PWN). - Construction of several possible adaptation strategies, jointly with all stakeholders, using AWR options as new building blocks and possible new connections in the water system (PWN, KWR). - Evaluation of the stress test outcomes, synthesizing insights and lessons learnt into possible adaptation pathways for robust regional water supply in North Holland, denoting which and when to take actions and initiatives for AWR solutions, and by and with whom (PWN, KWR).
Hazards and type(s) of interventions planned/relevant	
Hazards	Hazards of major concerns: • Prolonged droughts regionally . Droughts impact the regional (hydrologic) water system and the quality and availability of water resources. Also, prolonged droughts result in increasing periodic water demands for drinking water and irrigation water. • Prolonged droughts in the wider Rhine basin. Prolonged droughts in the river Rhine basin will result in low river flows and increasing concentrations of anthropogenic substances (less dilution). This will impact the water quality at the water intake (see below). Under climate change, the river Rhine will change from a snow and glacier fed into a rain fed river, also resulting in possible lower flows in summer. • Water pollution. Pollution of water resources, in particular at the surface water intake of PWN at Andijk / Lake IJssel is a major concern. Possible causes of pollution include calamities, like illegal discharge of (industrial) wastewater or a shipwreck close to the water intake, and algae blooms during prolonged warm periods (heat waves). Per- and polyfluoroalkyl substances (PFAS) form a

	risk for water supply, and impact all water resources in North Holland. • <u>Salinization</u>. The surface water intake at Andijk / Lake IJssel is close to the Afsluitdijk, i.e. the dam separating Lake IJssel (freshwater) from the Wadden sea. During low flows of the river Rhine (see above) there is the risk of salinization at the raw water intake, because of sea water entering Lake IJssel via the ship locks that connect lake and sea. • <u>Extreme (intense) rain events</u> and <u>storms</u>. Extreme rain events may hamper the current drinking water infrastructure, for example by pluvial flooding of local pumping stations or microbial contamination of the dune water system. Falling trees may damage the drinking distribution system, as was the case during the 2023 storm. Sewer overflow and runoff from paved areas during extreme rain events can have adverse effects on surface water quality, which is mostly of concern for the regional water authority. Secondary Hazards • <u>Sea level rise</u>. Sea level rise is expected to affect the PWN system only gradually and indirectly. Supplementing sands is a response strategy to widen and strengthen the coastal dunes. This may affect the functioning of PWN's dune infiltration systems. Sea level rise will increase hydraulic pressure of the deeper brackish groundwaters underlying the coastal dunes. Coastal freshwater lenses / groundwater resources may thus decrease.
Compound risks	System dynamics modelling is an extremely helpful tool to quickly evaluate multiple scenarios and to provide insights on how adaptations (like incorporating AWR in the water system) may affect the different components and functioning of the water system (i.e. how adaptation measures propagate through the water system). The scenarios that will be evaluated will (must) include compound risks / combinations of stresses, to provide a realistic insight in risks and challenges. Through serious gaming (Aqua Ludens), stakeholders learn and experience the impact of possible combined stresses.
Types of AWR interventions	Brackish groundwater treatment by desalination, water reclamation and reuse, and rainwater harvesting are interventions that may be evaluated. Also, the creation of additional storage capacity through ASR and a climate buffer near the surface water intake at Andijk will be evaluated. For PWN, in the case study, first and primary focus will be on the creation of additional storage capacity via ASR and brackish groundwater treatment. Water reclamation and reuse and rainwater harvesting are interventions that will be evaluated in conjunction with other (non

	potable) water users (industries, agriculture) and the regional water authority. While focus initially is on the drinking water system north of the Noordzeekanaal (water authority HHNK), we have the ambition to extend the SDM to include also the drinking water system south of the canal. PWN currently is evaluating two AWR options there, namely MAR, inland near Hilversum (WAAG project), and aquifer transport and recovery (ASTR) near the coast in Overveen.
Ethics	There will not be any physical experiments or pilots carried out within the CS#1 North Holland. As such, there are no ethics and/or related health risks associated with the actual work in this CS. Data collected within the project will follow the data management plan developed for RECREATE. Additionally, any use of AI during the pilot will respect and follow the ethical guidelines as addressed in WP 8 of RECREATE.
DATA needs related to modelling and validation/testing	
Physical data/needs	Physical data are needed to develop / setup the SDM and to develop climate and socio-scenario for evaluation (desktop scenario evaluations), but also serious gaming. The following data is foreseen to be needed: - Drinking water system (network, production locations, buffers, dune system) - Primary waterways (surface water) - Industrial abstractions and discharges from/to groundwater and surface water and discharges to the sewage system. - Agricultural abstractions of surface water and groundwater - Wastewater treatment plants (WWTPs) (location, capacity) - Current and expected drinking water demand (daily patterns, distinguished between households and industry) - Meteorological data (precipitation) (KNMI) - Discharges and water quality of river Rhine (Rijkswaterstaat) - Current and predicted salinity levels at Andijk (PWN) - Industrial non potable water demand

Physical data/availability	The following datasets are not available yet, but should be available from / through regional stakeholders: - Industrial abstractions and discharges from/to groundwater, and surface water and rainwater harvesting, and discharges to the sewage system. - Agricultural abstractions of surface water and groundwater - WWTPs (capacity) All other data are available from own or public sources.
Calibration	A SDM will be developed for the North Holland regional water system, as a tool to quickly evaluate multiple scenarios for AWR management and to provide insights on how adaptations and interventions may propagate through the regional water system. First focus will be on the regional drinking water system, later to be expanded stepways to include other aspect of the (wider) regional system (i.e. surface waters, primary waterways, WWTPs). There is sufficient historical data to calibrate the SDM for the drinking water system (data from PWN, data on river Rhine from Rijkswaterstaat, …). Together with the stakeholders (in particular water authority HHNK) we need to evaluate availability of (historical) records for the primary waterways, WWTPs.
Historical/scaling	In April 2024, new climate scenarios and socio-economic response scenarios ("Delta scenarios") were released for the Netherlands. We need to evaluate these scenarios and scale them for use in our case. Also, we anticipate developing compound scenarios that include multiple climate stresses.
Climate variables/data	Rhine River flows / salinity levels in Lake IJssel and precipitation patterns (cluster rains and prolonged droughts) are important variables. Ideally, we would construct scenarios comprising multiple years with weekly or even daily resolutions. Final decisions will be made during development of theSDM.
Downscaling climate scenarios	National climate scenarios are available from the Dutch national meteorological institute KNMI. The latest national scenarios are based on the 6th IPCC assessment report. In April 2024, socio-economic response scenarios ("Delta scenarios") werereleased for the Netherlands. These Delta scenarios are built from the climate scenarios.
Measurements/water quality data	This case study is dedicated to the regional (drinking) water system in North Holland, with primary focus on the PWN drinking water system. No on-site testing or piloting of AWR will be conducted. Monitoring data from

	the PWN system will be available for the project. Salinity is the most important water quality parameter for this case study.
Technical details	Standard monitoring data will be supplied by PWN where relevant (water flow, water quality, focus salinity). Also, models are available to fill in data gaps and/or to generate additional data (existing PWN and Dutch groundwater models; digital twin of Lake IJssel).
Outcomes for decision-makers	The framework developed in this case study (SDM, scenario analyses, stress testing, serious gaming) will support PWN in making long-term investment planning (with a focus on 2030 – 2050) to make the water system future-climate resilient (2050 and beyond), taking into account rising salinity levels in Lake IJssel and an increasing water demand due to population increase and a growing economy. Information needs include answers to: - How do external developments like climate change, water demand, increasing salinity, water pollution events, affect the current drinking water system? - What AWR options are available and how and where can these be used / implemented to make the regional (drinking) water system more resilient? - How do interventions / adaptation measures affect different components of and stakeholders in the regional water system. How do interventions propagate through the system, what are positive or adverse cascading effects? - What are possible adaptation strategies and interventions, who and with whom should take actions and initiatives.
Open data	Open source data will be used during this case study from multipile sources. This data will be used through the SDM and will ultimately assist in informed decision making. KWR and PWN through other EU projects are well versed in the FAIR data management principles and will follow them as much as possible (while still maintaining proper confidentiality).
Additional equipment	No additional equipment is known to be necessary at this time for data collection, model calibration, or testing.
Modelling needs for AWR for the Case Study	
Technical bio-physical mathematical modelling	
Hazards	We plan to model these hazards of major concern: prolonged droughts, both locally and regionally, salinization, and water pollution. Additional scenarios may be set up in consultation with the case study stakeholders, also in relation to their challenges and concerns. These additional scenarios may include, but are not restricted to, extreme rain events and storms (hazard of major concern) and sea level rise (secondary hazards). An important aspect to model is the compound risk of hazards.

Tools	A SDM will be developed for the North Holland regional water system, as a tool to quickly evaluate multiple scenarios for AWR management and to provide insights on how adaptations and interventions may propagate through the regional water system. This model will partly be built from existing models in operation at PWN, namely the IJsselmeer chloride prediction model ('bakjesmodel') and EPANET/distribution model. The SDM will be the computing engine of the Aqua Ludens serious game which will be tailored for the RECREATE North Holland case.
Background	Extensive knowledge on hazard modelling through KWR. Examples include the work carried outbwithin the ARSINOE project (cascading effects from extreme rainfall events), experience in groundwater modelling and salinity modelling, and in working within EU projects on modelling and digital twin production for water quality. In the past three years, within the WiCE research program (https://www.kwrwater.nl/en/samenwerkingen/collectief-onderzoek-water-circulaire-economie/) and Horizon Europe project B-Watersmart, KWR has developed SDMs dedicated for modelling water systems and water resources. In addition, case study stakeholders hold expertise in: - Water authority HHNK: Experience in modelling dike strength and water risks. - Rijkswaterstaat (RWS): Experience in modelling coastal erosion and water quality (IJsselmeer).
Compound hazards and related risks	KWR brings in expertise in building and applying SDM. SDM is an extremely helpful tool to quickly evaluate multiple scenarios, and thus compound risks. In the past years, PWN has been developing strategies to become more resilient in the long-term: this process involves evaluation of compound risks, from climate to socio-economic challenges.
Treatment train	- Drinking water production system: Depending on the production site, these include several treatment trains for surface water, for example: (A) coagulation, sand filtration, UV/H_2O_2, activated carbon, chlorine dosing, (B) coagulation, sedimentation, sand filtration, UV/ H_2O_2, activated carbon, dune filtration and soil passage, aeration, rapid sand filtration, UV disinfection, or (C)

	coagulation, sedimentation, sand filtration, ultrafiltration (UF), reverse osmosis (RO). - ASR of drinking water: Creation of a seasonal or daily buffer. The drinking water stored will come from the current water production system (see above). - ASR of pretreated surface water: Coagulation, sedimentation, sand filtration, UV/ H_2O_2, activated carbon, dune filtration and soil passage, aeration, rapid sand filtration, UVdisinfection. - The climate buffer is a buffer and additional treatment step preceding the current drinking water production. - Brackish groundwater: reverse osmosis For both water reclamation and reuse and rainwater harvesting treatment trains need to be designed if and when appropriate.
History/references	- PWN has extensive design and operational experience for drinking water production and managed aquifer recharge (MAR). - PWN and KWR have extensive experience in design, realization and operation of AS(T)R systems. This includes experience from the drinking water ASR pilot at Hoorn. - KWR has experience in brackish groundwater reverse osmosis from pilot with water utilities Vitens and Brabant Water (2009 – 2012) and Dunea (2022 – present - PWN and stakeholder HHNK have experience in treatment for water reuse from the Wervershoof water reuse pilot.
Environmental modelling	
Aspects	Water levels and water quality are the most important environmental aspects to be evaluated and modeled. Salinity is a challenge for the entire region, for Lake IJssel and waterways / canals in the region, both from an environmental as well as water resources perspective. Specific habitats in the dune areas are groundwater fed and rely on high groundwater tables. While primary focus of the modeling is not on these environmental aspects, they do put important constrains/boundary conditions for implementation of AWR within the regional water system.
Tools	The SDM will need to encompass the modeling of these aspects. To reach this goal, we will build both from our water system understanding (system variables, system relations such as hydrographs), available data, as well as knowledge already encompassed in existing surface and groundwater models. The SDM will have to able to model system responses adequately, but not (always, everywhere) in every detail.

Background	Both PWN and KWR have extensive knowledge in groundwater and surface water modeling, both quantity and quality. Also, both partners have experts (and models) that can evaluate model outcomes, for example on ecological and biodiversity impact. In the past 3 years, water system thinking and water system dynamics modeling (i.e. SDM dedicated to water resources questions) has been developed at KWR.
History/References	Stofberg et al. (2024) provide an overview of SDM models recently developed for different water systems / landscapes and for different water resources questions: - https://library.kwrwater.nl/publication/71685755/interventies-in-het-watersysteem/ Modeling tools for different subsystems, from which knowledge and model formulations and model equations *may* be used in setting up the SDM, include: - Groundwater model from the dune infiltration systems - Groundwater model for drinking water ASR system - IJsselmeer chloride prediction model ('bakjesmodel') - EPANET/water distribution network model
Socio-economic modelling	
Tools	Serious gaming will be an important method to evaluate environmental stresses and AWR strategies in a socio-economic context. The Aqua Ludens serious game, tailored for the North Holland case, will be played with regional stakeholders, and results will be evaluated. Different socio-economic scenarios may be evaluated. In April 2024, socio-economic response scenarios ("Delta scenarios") were released for the Netherlands, building from latest climate scenarios. These Delta scenarios may form the basis from which to build tailored scenarios for the North Holland case, for example for public, industrial and agricultural water demand.
Background	KWR has an experienced governance research team which includes researchers working on socio-economics topics. Researchers of this team will be involved in developing the serious game, and in developing adaptation strategies and pathways. PWN, as a company, is widely experienced in economic evaluations and investment decisions. The serious game developed and applied is not dedicated to socio-economics, but by playing the game socio-economic risks and challenges may become apparent.

History/References	The main previous socio-economic tool used is the serious game Aqua Ludens, mentioned above.
Capacity expertise	
Project partners	Currently, no gaps have been identified which would require the assistance of other partners within RECREATE for the case study.
New researchers	*n/a*
Outsourcing	*n/a*
Other issues about data/modelling	
Other needs /gaps	Access to necessary data within PWN IT infrastructure.
Ambition	
Ambition during the project	The RECREATE project will support PWN in making informed choices for investment decisions (with a focus on 2030 – 2050) to make the water system future-climate resilient (2050 and beyond). The project will provide insights into the effectiveness of, and added system resilience by various solutions, including brackish groundwater desalination, WWTP effluent reuse and the creation of additional storage capacity, especially through natural-based solutions such as ASR. Also, the project will support in PWN in aligning its agenda with its regional stakeholders.
Ambition after the project	PWN has already started evaluating AWR which could be realized in the next 10 – 15 years, including the climate buffer near the surface water intake at Andijk, ASR of drinking water in Hoorn, MAR inland near Hilversum (WAAG project), and ASTR near the coast in Overveen. RECREATE will support PWN in making informed choices for (further) realization of these AWR solutions, and the need for additional solutions on the long term (2050 and further).
Outscaling potential	PWN and KWR are both members of the BTO (the joint research initiative of water utilities across the Netherlands and Belgium). These utilities, both coastal and more inland, face similar challenges as PWN (climate change, demand increase, salinity). Many of them are working on strategic plans to become more resilient (regional scale), and are al looking at AWR. The work, methods and results from RECREATE will be reported and disseminated to the other BTO members. The SDM approach may help to

	make (better) informed decisions, while the Serious Game approach will help to align better with stakeholders, supporting implementation.
Potential barriers	Most important potential barriers foreseen now are governance and legislation. Not only PWN, also other sectors are faced with water resources challenges and increasing demands. How to solve these in society, governance and also legal setting that has become increasingly complex? The Serious Gaming in the case study is dedicated to connecting with regional stakeholders, including the water authority HHNK and the provincial authority, and will help to reach mutual understanding of the water supply challenges that PWN faces. This mutual understanding is the basis for developing adaptation strategies together. Through other routes, apart from RECREATE, potential legal barriers may be addressed or communicated, for example via VEWIN, i.e., the branch organization of the Dutch water utilities.
Stakeholders	
Initial list	- Hoogheemraadschap Hollands Noorderkwartier (HHNK, regional water authority) - Provincie Noord-Holland (provincial authority) - Water utility Waternet (Amsterdam) - Rijkswaterstaat (executive arm of Ministry of Infrastructure and Water) - Local municipalities - Industries within PWN supply area - Nature and environmental organizations - Citizen groups
Next steps and planning	
Planning M1-M6	- Get mutual understanding of current system, current and future challenges for water supply. - Assess the desires of PWN/KWR for model types and functional use. - Assess initial stakeholders required. - Assess data needs and accessibility. - Serious game session for KWR and PWN. RECREATE project members will play the serious game developed by KWR (Aqua Ludens) to demonstrate the use of a serious game and assess the needs for the serious game proposed in RECREATE.
Planning M7-M18	On Gantt chart
Planning after M18	On Gantt chart

Risks	- Lack of stakeholder engagement: Utilize the stakeholders (and their extended network) who are already participating in other EU projects such as WATERVERSE. - Data availability: access to all relevant data required to complete modelling. This will hopefully be mitigated through proper stakeholder management. - Cyber security: Data management and transfer. Follow best practices and data management plan written within RECREATE.
Other	Not at this time

2.2 CS#2: Kalundborg, Denmark

CS#2: Kalundborg, Denmark	**Leading partner: KCR** **Leading person: Preben Thisgaard**
Title	Kalundborg Industrial Symbiosis
Biogeographical region	Continental
Water system type	Coastal, Urban, Industrial
Area (km2)	575 km²
Map image/photo	 
Goals/challenges	**Ambition until the end of the project** Set up an integrated water management strategy for water supply of industries in the Kalundborg Symbiosis via multiple AWR. Provide the

	industries with the quality of water needed for different industrial processes in a long-term, sustainable way. Minimize the overall environmental impact both from water extraction from traditional sources such as groundwater, lakes, and streams etc. and from wastewater emissions. • Engage RECREATE to gain, develop, and access knowledge and methods • Modelling as a tool to reduce uncertainty on price and systems for distribution of "fit-for-purpose" water **Ambition beyond the project** • Expand the Kalundborg Industrial Symbiosis to be a Water Smart Industrial Symbiosis • Reuse water to reduce need for groundwater pumping and reduce effluent discharges to recipients • Use the existing collaborative setup and market drive • Transition from "only groundwater" to "fit-for-purpose" water produced from different sources including surface water and desalinated seawater • Increase security of supply to the end-users • Step-by-step approach for collaboration with the industry: water for cooling towers, water for flushing, steam production, specific industrial purposes, etc.
Project partners involved (institutions and names)	• KCR (Preben Thisgaard, Hasse Milter, Line Rodenkam Melchiorsen) • KWB (Anne Kleyböcker, Pia Schumann, Veronika Zhiteneva)
Description	**Situation** Kalundborg is located in northwest Zealand, Denmark and it is famous for the "Kalundborg Industrial Symbiosis". The Kalundborg Industrial Symbiosis Association exists since 1972 and interlinks 18 private and public companies. The local industrial sector includes petrochemical, light building construction material, food, pharma, biotech, energy and bioenergy as well as waste processing and water companies and industries. Different circular economy approaches for water, energy and materials are already implemented, e.g. the reuse of cooling water for steam production, the reuse of gypsum from exhaust gas cleaning to produce plasterboards, integrated heat management and the transfer between the industries and the district heating network, as well as heat recovery from process water for district heating. Now, a new industrial area is being established in the northeastern parts of Kalundborg. New companies will become part of the Kalundborg Symbiosis, which not only creates opportunities for the local economy, but also challenges in ensuring fit-for-purpose infrastructure and sustainable use and reuse of resources, particularly in terms of water. The use of water in this case will differ from company to company, but overall the aim is to optimise the use and reuse of water, provide fit-for-purpose

	qualities to fit the local water strategy, and create a sustainable water management plan for the region. Currently, the biotech sector uses groundwater and treated surface water (4-5 Mio m³/a) sources and operates a large industrial wastewater treatment plant (2.3 Mio PE). The used water is treated in an industrial WWTP and the effluent is then sent for further treatment to the municipal WWTP operated by KCR. The industrial water comprises up to 70% of the influent at the municipal WWTP, but the WWTPs are operated separately. To meet the predicted demand by 2028 (up to 20 Mio m³/a, a 300-400% increase compared to today) and to make the industrial water supply more climate resilient, the use of multiple different water sources is foreseen, including reclaimed wastewater and desalinated seawater, shallow groundwater, rainwater, as well as existing sources such as lake water and groundwater. **Challenges** • Current Danish national laws and regulations do not allow water reuse • Resistance to EU Water Reuse Regulation 2020/741 (use of treated wastewater for agricultural irrigation) • Authorities and decision makers are not aware of how effective and efficient wastewater treatment and water reclamation can be • Lack of understanding that wastewater is a possible resource and that water reuse decreases the need to discharge wastewater • The cost for building separate distribution systems for water of different qualities • Uncertainty of the price of fit-for-purpose quality and how to finance new distribution systems for fit-for-purpose water • Brine handling **Interest and outline of the proposed activities during the project** • Cost efficient integrated water management strategy • Engage RECREATE to gain, develop, and access knowledge and methods to explore or integrate new water sources in the water portfolio • Modelling as a tool to reduce uncertainty about pricing and systems for distribution of fit-for-purpose water
Hazards and type(s) of interventions planned/relevant	
Hazards	**Hazards of major concern:** • Heat waves, droughts • Intense rainfall and storm events • Extreme wind **Secondary hazards:** • Floods

Compound risks	We are interested in compound risks from multiple hazards such as Extreme wind: This leads to rising sea levels, causing seawater intrustion into the nearby lake. A simultaneously occurring storm would mix lake water with seawater, ultimately changing lake water quality. However, we have no expertise on this and also no budget foreseen for it.
Types of AWR interventions	• Water reuse (water reclamation from municipal WWTP effluent for industrial use) • Seawater desalination (industrial use) • Rainwater harvesting (industrial use) • Bank filtration (only a nice to have scenario, because it is not realistic in Denmark due to legislation)
Ethics	There will not be any physical experiments or pilots carried out within the CS#2 Kalundborg. As such, there are no ethics and/or related health risks associated with the actual work in this CS. Data collected within the project will follow the data management plan developed for the RECREATE project. Additionally, any use of AI during the pilot will respect and follow the ethical guidelines as addressed in WP 8 of RECREATE.
DATA needs related to modelling and validation/testing	
Physical data/needs	**Existing system** 1. Flowrates (lake water, groundwater, wastewater, etc.) and chemical characterisation (including metals, trace organic chemicals with the focus on persistent and mobile chemicals, PFAS, etc.) of all existing flow streams 2. Surface water volume (lake, reservoirs in CS area) 3. Data for quantitative microbial risk assessment (QMRA): pathogens (bacteria, viruses, protozoa) 4. Surface conditions of runoff areas (roofs, streets, etc., soil type) 5. Geological data/characterisation of subsurface and aquifer (to assess conditions for bank filtration) 6. Groundwater wells 6.1 Level of groundwater 6.2 Flowrate/production rate 6.3 Position of wells 6.4 Depth 6.5 Type of wells 6.6 Water quality 6.7 Water use 7. Groundwater levels in aquifers (piezometric measurements) 8. Distribution networks 8.1 Length 8.2 Age 8.3 Water losses 8.4 Population equivalent served

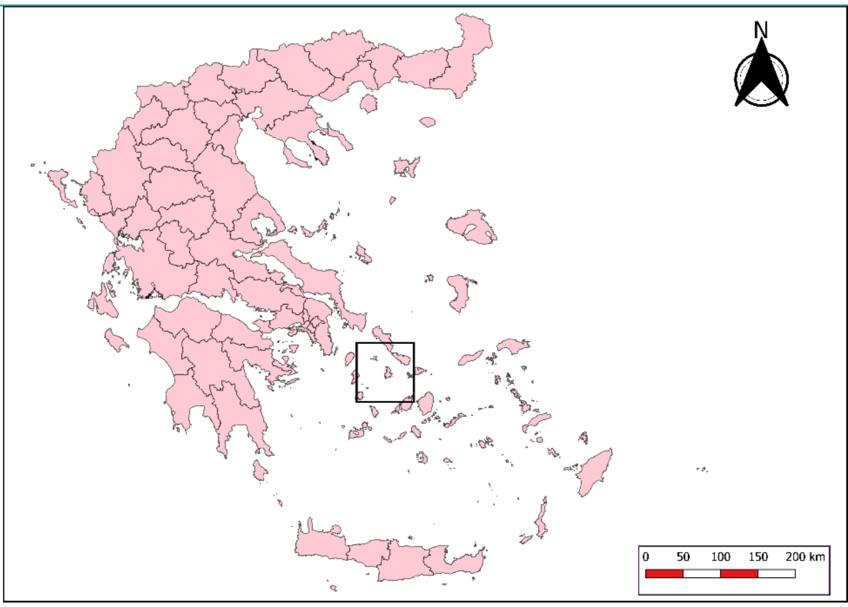
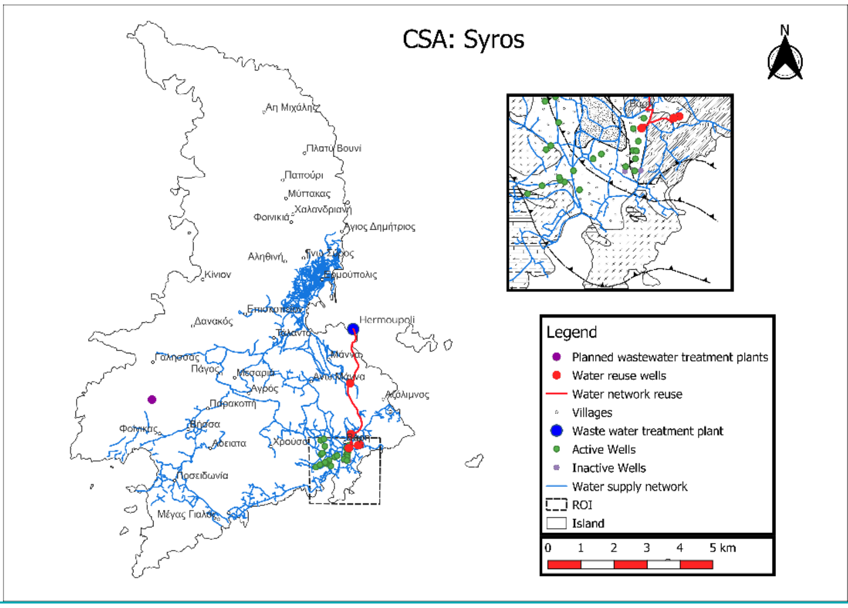
	9. Energy demand of existing WWTP and drinking water treatment plant (DWTP) **Future system:** 10. Estimates for full-scale water reclamation plant: quantity and quality of produced water and brine, demand of energy and chemicals of the system 11. Estimates for seawater desalination: quantity and quality of produced water and brine, demand of energy and chemicals of the system 12. Estimates for rainwater storage and treatment: quantity and quality of produced water (and concentrate/brine?), demand of energy and chemicals of the system 13. Water demand (quantity and quality) of new industries 14. Flowrates and wastewater types of new industries 15. Energy and chemical requirements of future (expanded) WWTPs Estimates for future water availabilities of conventional water resources (groundwater, surface water; e.g. based on regulative restrictions)
Physical data/availability	1. Flowrates of main existing water and wastewater streams 2. Chemical composition of main wastewater streams (COD, TN, TP, sulphur) 3. Energy and chemicals demand of existing WWTPs 4. Weather data: https://open-meteo.com/en/docs/historical-weather-api
Calibration	**Urban Water Optioneering Tool (UWOT) (KWB):** If all data listed in "data needs" will be available, we will have enough information to calibrate our model.**Climate change impact modelling (ICRA):** See "data needs"
Historical/scaling	No, we do not feel that historical event data are sufficient to calibrate our models in view of future events. We do not know if additional scaling or modelling will be required to better understand future extreme event return times and magnitudes.
Climate variables/data	The required spatial and temporal resolution would be the region of Zealand and 2a, 5a, 10a, 50a and 100a from now on.
Downscaling climate scenarios	No, we do not have climate downscaled variables or the possibility of accessing them from any regional or national stakeholder.
Measurements/water quality data	Not planned (no budget foreseen in the project for measurements)
Technical details	If data are available, the party using the data will most likely be required to sign a non-disclosure agreement. The data will be delivered in an excel sheet.
Decision-makers	The decision makers at CS2 need proof that water reuse is safe in terms of reliable supply, its permanent availability, and specifications for use. Additionally, they need proof of its legal compliance and assurance that it won't affect the market acceptance of their products. They need documentation showing that AWR are sustainable (CO_2footprint, water footprint).

Open data	Open data are currently not available.
Additional Equipment	No
Modelling needs for AWR for the Case Study	
Technical bio-physical mathematical modelling	
Hazards	• Heat waves, droughts • Extreme wind • Sea level rise, floods • - Sabotage of infrastructure
Tools	Quantitative chemical risk assessment (QCRA) will include sabotage of infrastructure as a scenario for seawater desalination.
Background	KWB has expertise in conducting QCRA. However, we have no expertise/background regarding hazard modelling within the group of local partners supporting our CS and we also have no budget allocated to this task.
Compound hazards and related risks	**Multi-hazard assessment:** Extreme wind: This leads to rising sea levels, causing seawater intrustion into the nearby lake. A simultaneously occurring storm would mix lake water with seawater, ultimately changing lake water quality. The CS partners have no expertise/background regarding compound risk modelling and evaluation/assessment and they also do not have budget allocated to this task.
Treatment train	**Water reuse:** • Dual media filtration, UF, RO • Brine treatment (to be determined) • **Seawater desalination & rainwater harvesting:**To be determined
History/References	-
Environmental modelling	
Aspects	• Water quantity and quality (UWOT, QCRA, QMRA) • Carbon footprint (Life cycle assessment (LCA))
Tools	QMRA, QCRA, UWOT, LCA
Background	KWB has the expertise for QMRA, QCRA, UWOT and LCA
History/References	• QMRA to assess the microbial health risk for the water reuse scheme in Kalundborg (ULTIMATE, D2.2 (in preparation)) • QCRA to assess the chemical risk of water reuse on the environment by irrigating agricultural fields (ULTIMATE, D2.2 (in preparation)) • LCA for water reuse scheme in Kalundborg (ULTIMATE D2.2; in preparation)
Socio-economic modelling	
Tools	No, we have not thought of or selected specific tools and methodologies to be employed in our CS for modelling socio-economic aspects.

Background	No expertise/background regarding socio-economic modelling within the group of local partners.
History/references	-
Capacity expertise	
Project partners	So far, we have not detected any kind of gap or need that could be covered/assisted by other partners within the RECREATE consortium.
New researchers	We consider the current expertise as suitable and do not intend to hire new researchers/experts.
Outsourcing	No, we have no intension to subcontract or pay for modelling services.
Other issues about data/modelling	
Other needs/gaps	Data referring to the industries or revealing any hint to their activities are usually confidential and might be difficult to collect for the modelling activities. Where data cannot be shared because they are too sensitive, we will have to make reasonable estimates and/or cluster data.
Ambition	
Ambition during the project	**Ambition until the end of the project:** Cost efficient integrated water management strategy for water supply of existing and/or new industries (based on UWOT and LCA results): KER: Use of RECREATE tools, if suitable 1. Stakeholders, decision makers and authorities are convinced to support and allow industrial water reuse in Kalundborg: KER: policy brief 2. Defined limits and thresholds for new industries to discharge their wastewater to the municipal WWTP 3. Concept/feasibility study for rainwater harvesting and bank filtration completed: KER: Replication of similar systems implemented in other CS; lessons learned from them will be considered **Activities by KCR in parallel to RECREATE, but not in DoA:** 4. Design of water reclamation plant completed 5. Implementation of water reclamation plant started Design of seawater desalination started: KER: Low energy desalination schemes will be considered
Ambition after the project	1. Expand the Kalundborg Industrial Symbiosis to be a Water Smart Industrial Symbiosis 2. Reuse water to reduce need for groundwater pumping and reduce effluent discharges 3. Use the existing collaborative setup and market drive 4. Transition from only groundwater to fit-for-purpose water produced from different sources including surface water and seawater desalination

	5. Increase security of supply to the end-users 6. Step-by-step approach for collaboration with the industry: water for cooling towers, water for flushing, steam production, specific industrial purposes, etc.
Outscaling potential	High potential to be transferred to other industrial parks in Denmark and Danish cities in the Baltic Sea region (Copenhagen, Aalborg, Aarhus, Esbjerg)
Potential barriers	**Governance**: Creation of a new entity in the Kalundborg Utility Group as an industrial water supplier might be necessary to provide circular activities in water management and to separate industrial water needs from potable water needs for the public. **Funding**: Currently, water infrastructure is publicly owned: a new entity (maybe owned by the industry?) might acquire private funds and accelerate the implementation of the new infrastructure. **Legislation**: New Danish water law does not allow for the reuse of treated wastewater at all - the Danish Environmental Protection Agency is resistant to adopting EU 2020/741. In case the EU 2020/741 integrates specific requirements for industrial water reuse, it would be a big advantage if Denmark would adopt it. **Social acceptance** is growing as the demand for sustainable and reliable water supply increases: it is crucial for the growing local economy.
Stakeholders	
Initial list	1. KCR and KWB 2. All public and private companies of the Kalundborg Industrial Symbiosis 3. Municipality of Kalundborg 4. Municipality of Holbæk 5. Environmental Protection Agency, Department of Environment 6. Ministry of the Environment 7. Local educational institutions 8. Local politicians/decision makers 9. Danish public (citizens, students, pupils)
Next steps and planning	
Planning M1-M6	**See also timeline CS2:** 1. Preparation of LCA and UWOT modelling 2. Cooperation with H2020 project ULTIMATE to further use the structure and participants of the already established community of practice (CoP) 3. Stakeholder mapping to be completed until M6
Planning M7-M18	**See also timeline CS2**
Planning after M18	**See also timeline CS2**
Risks	Data for modelling are incomplete and/or confidential No permission for water reuse scheme obtained No funding for AWR available
Other	*No*

2.3 CS#3: Syros Island-South Aegean, Greece

CS#3: Syros, South Aegean, Greece	**Leading partner: DEYAS** **Leading person: Dimitrios Vakondios**
Title	Mediterranean Self-Sustained Area - Syros South Aegean (GR)
Biogeographical region	Mediterranean
Water system type	Island, Coastal
Area (km2)	83.6 km²
Map image/photo	 

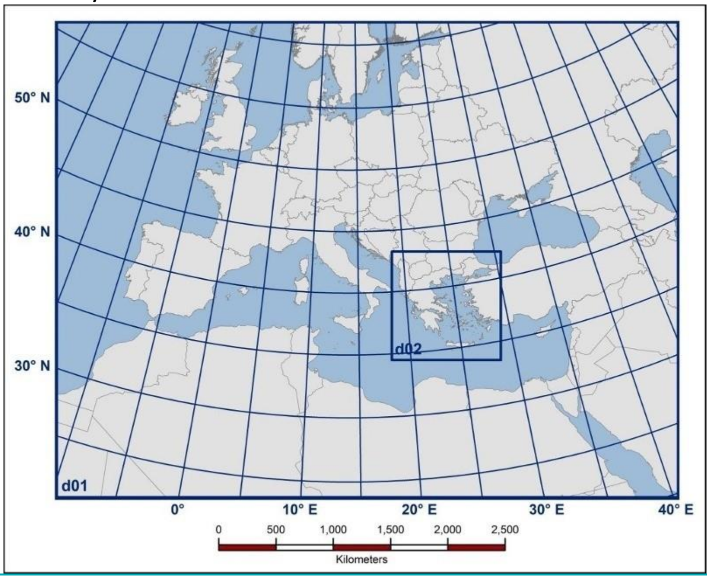
Goals/challenges	• Creation of supply interconnections among the 5 (currently separate) regions to increase system resilience through integrated multi-source interregional water management. • Extension of treated wastewater reuse for irrigation and ASR, instead of using desalinated sea/brackish water for agriculture. • Investigation of applicability and upscaling of long-term traditional rainwater harvesting (RWH) methods under different socio-technical and climatic scenarios. • Investigation of improvements in operational efficiency and energy footprint and sustainability of existing desalination plants.
Project partners involved (institutions and names)	• DEYAS • NCSRD • NTUA
Description	Syros is a Greek island in the Cyclades with a population of 21,507 people. The island's water management is handled by DEYA Syros, which oversees the entire water cycle, from drinking water supply to wastewater treatment and production of reclaimed water. The region is supplied with water from desalination plants with RO, with a total supply of 1.7-2.2 Mm^3/year. The system is divided into five sub-systems based on the desalination plants that feed the water supply network. The island is affected by climate change, with severe droughts and heatwaves expected to increase in the future. The tourism industry, which brings in many people during the summer months, poses additional challenge for water supply, as consumption increases drastically during this period.
Hazards and type(s) of interventions planned/relevant	
Hazards	• Drought • Groundwater degradation (salinization) • Heatwaves • Extreme winds • Storm surge flooding
Compound risks	We are interested in compound risks from multiple hazards such as • Extreme wind → decrease in energy production → decrease in energy availability for desalination plants. • Heatwaves → increase of heat stress on people → increase in water needs → desalinated production is fixed → decrease in water reserves. • Drought → increase in water demand → in association with heatwaves → decrease in water reserves. • Storm surge flooding → commonly associated with extreme winds → decrease in energy production → decrease water production → with the addition to potential infrastructure damages → service disruption.

Types of AWR interventions	AWR to be investigated within the project: • MAR at the village of Vari, with the use of treated wastewater for the local WWTPs. • Integration of RWH to the islands Integrated Water Resources Management
Ethics	• Water (drinking water quality) supply via seawater desalination or surface water treatment for commercial use. • Irrigation water supply via wastewater treatment and reuse/MAR in wells.
DATA needs related to modelling and validation/testing	

Physical data/needs	<u>Water Consumption and Demographic Data</u>
	• Consumption/population data per consumer group (permanent residents, tourism, farmers).
	• Agricultural demand (total irrigation demand, percentage of agricultural demand covered by treated water (wastewater)).
	• Consumer demographic data (number of households, household members, income, age).
	• Consumer awareness campaigns: (when they were conducted)
	• Energy and water bills as time series: (daily or monthly step) and tiered tariffs.
	
	<u>Climatic data</u>
	• Historical time series of temperature and precipitation (daily timestep).
	• Climate data trends: Downscaled IPCC scenarios in the form of time series of the climatic variables for the predetermined simulation horizon (i.e., 2024-2050, 2050-2099).
	
	<u>Technical Data</u>
	• System operation rules (optional)
	• Desalination:
	  ○ Number and processing capacity (average and maximum daily production)
	  ○ Time series of desalinated water production (daily)
	  ○ Efficiency fluctuations due to membrane wear (if applicable)
	• Wells:
	  ○ Number of installed units
	  ○ Maximum pumping capacity
	  ○ Time series of water withdrawal from wells (daily) (water quality measurements if available)
	• Volume and location of reservoirs
	• Main gravity and pressure pipelines:
	  ○ Flow rate
	  ○ Length
	  ○ Material

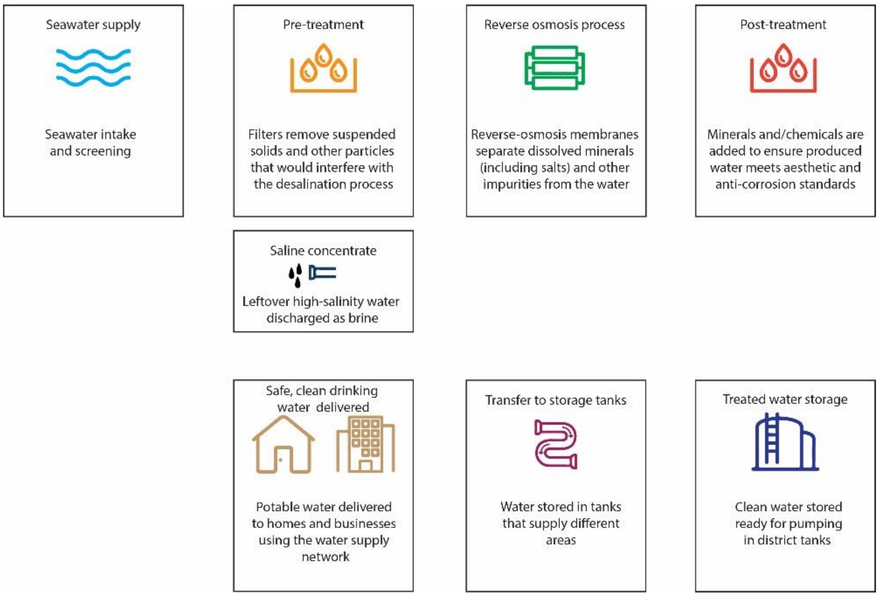
	○ Losses • Drinking Water treatment plants - water treatment units: ○ Location ○ Maximum capacity (daily - design) ○ Storage capacity • WWTPs: ○ Location ○ Treatment capacity (maximum daily - design) ○ Quality of produced water ○ Time series of treated water production • Water distribution network: ○ Length (approximate-cumulative) ○ Losses • Household tanks: ○ Number (approximate) ○ Average volume ○ Type of needs covered (domestic - agricultural) • System structure: ○ Topology of water sources and users (which consumers are supplied with water/irrigation and from which sources)
Physical data/availability	<u>Water consumption and demographic data</u> • Consumption/population data per consumer group (permanent residents, tourism, farmers) • Consumer demographic data (number of households, household members, income, age) • Energy and water bills as time series: (daily or monthly step) and tiered tariffs <u>Climatic data</u> • Historical time series of temperature and precipitation (daily timestep) • Climate data trends: Downscaled IPCC scenarios in the form of time series of the climatic variables for the predetermined simulation horizon (i.e. 2024-2050,2050-2099) <u>Technical data</u> • System operation rules (optional) • Desalination: ○ Number and processing capacity (average and maximum daily production) ○ Time series of desalinated water production (daily) • Wells:

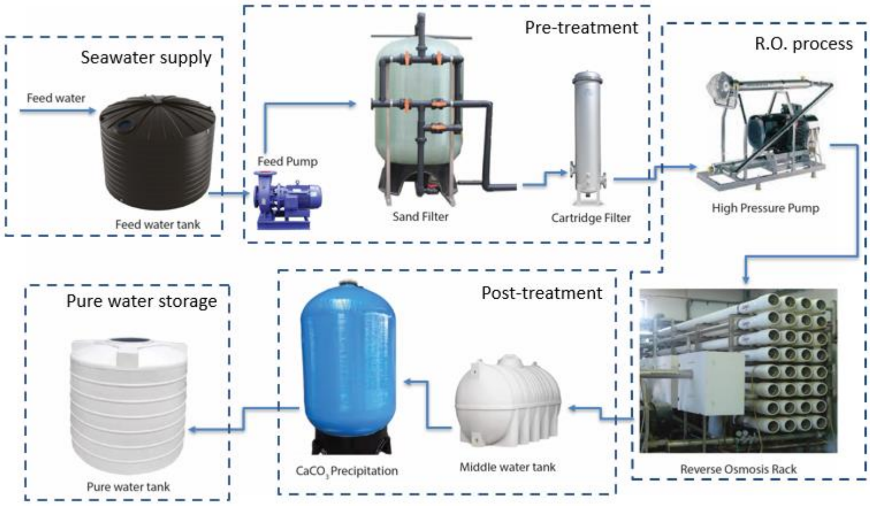
	○ Number of installed units ○ Maximum pumping capacity • Volume and location of reservoirs • Drinking Water treatment plants - water treatment units: ○ Location ○ Maximum capacity (daily - design) ○ Storage capacity • WWTPs: ○ Location ○ Treatment capacity (maximum daily - design) ○ Quality of produced water ○ Time series of treated water production • Water distribution network: ○ Length (approximate-cumulative) ○ Losses
Calibration	The models to be implemented are: • UWOT is used to simulate the physical water system of Syros and provide a general overview of the system's behavior. UWOT is typically calibrated using data from each population data group such as demands, average household occupancy and fluctuation of demands. Other components of UWOT such as water losses through the water network are calibrated using water production and water consumption time series. • Agent Based Models (ABMs) are used to capture the effect of behavioral aspects that affect water demands such as water pricing fluctuations and consumer awareness campaigns. ABMs are calibrated using data from the population, that are next categorized into groups, according to the demographics (i.e., income, pattern of demand, type of consumer) • MODFLOW is used to evaluate the existing and post-MAR implementation groundwater level and solutions effectiveness. The model will be calibrated with field measurements from existing wells.
Historical/scaling	Historical data is crucial for calibrating water system models, establishing a realistic baseline for current behavior. This validated baseline ensures future scenarios reflect the system's response to various climatic stresses. However, climate projections suggest more extreme events outside the historical range, potentially limiting the data's ability to capture their full impact.
Climate variables/data	Available climatic data from Hellenic Meteorological Service (HMS)
Downscaling climate scenarios	High-resolution daily precipitation datasets are required for the investigation of rainwater availability at the sub-basin scale in the study area. For this purpose, time series of gridded precipitation datasets were generated by high-resolution climate simulations with the use of non-hydrostatic Weather Research and Forecasting (WRF/ARW, v3.6.1) model (Skamarock et al. 2008). Model simulations consist of two nested domains

	(see below), following a one-way nesting setup with spatial resolutions of 20 (d01) and 5 km (d02) respectively. The first domain is centred in the Mediterranean basin at 42.5 N and 16.00 E, and the second high-resolution inner domain covers the area of Greece, and of course the CVase Study Area. 
Measurements/water quality data	Water quality sensors will be purchased and installed at the injection wells. Details to be defined by M12.
Technical details	Continuous exchange between engaged teams (DEYAS, NCSRD, NTUA).
Decision-makers	Municipality of Syros-Hermoupolis South Aegean Regional Authority
Open data	Research outcomes will be publicly available (presentations, CoP, publications). Infrastructure and sensitive data will remain confidential.
Additional equipment	No
Modelling needs for AWR for the Case Study	
Technical bio-physical mathematical modelling and Socio-economic modelling	
Hazards	• Climatic hazard analysis (single and multi-hazard risk assessment) – leveraging the framework developed within ICARIA project (D2.1), different scenarios that can be linked with RECREATE objectives will be investigated.
Tools	• QGIS/ArcGIS • UWOT • ABMs • MODFLOW

Background	• DEYAS: Water distribution, production, and wastewater treatment. • NCSRD: Climatic conditions, Extreme weather events, geological mapping, GIS data collection and analysis, risk analysis. • NTUA: UWOT model, ABM, experience with green and grey (central and decentralised) measures for AWR, resilience assessment, risk analysis.
Compound hazards and related risks[1]	Multi-hazard assessment is not relevant for CS#3 within RECREATE.
Treatment train	**Seawater Desalination** The implementation of seawater desalination process that occurs in the island of Syros is defined by the following five main steps: 1. Seawater supply 2. Pre-treatment 3. RO process 4. Post-treatment 5. Pure water storage and delivery Seawater supply is very critical to the desalination units operation. Seawater intake and screening is implemented by the use of centrifugal pumps that obtain all the volume of seawater needed to ensure the proper filling of the feed water tank. During the desalination process, the feed water tank always needs refilling as a certain quantity of seawater is consumed according to how many desalination units are used. In the second step of pre-treatment, a pair of pumps that works alternatively, drives seawater in sand filters. Sand filters work by providing the particulate solids with many opportunities to be captured on the surface of a sand grain. In cooperation with cartridge filters (5 µm and 1 µm), which are installed inline, they remove suspended solids and other particles that would interfere with the desalination process. Thus, pre-treatment filtration prevents the RO high pressure pump from damages. The high pressure pump feeds the RO membranes with seawater approximately in 58 – 62 bars. This rate is acquired not only by the high pressure pump operation but also by the use of the kinetic energy of the brine consumed in the energy recovery system of the unit. RO membranes separate dissolved minerals (including salts) and other impurities from the water. High-salinity water discharged as brine is leftover and clean water is going in a middle tank for membranes backwashing and post-treatment. In post-treatment, minerals and/chemicals are added to ensure produced water meets aesthetic and anti-corrosion standards. $CaCO_3$ precipitation is implemented to produce pure water in accordance with the potable water standards. Pure water is stored in tanks ready for pumping to district areas.

Lastly, treated water is stored in district tanks after pumping. These destination tanks are installed in places with altitude that can serve and supply different district areas. Safe, clean drinking water is delivered to homes and businesses using the water supply gravity network.

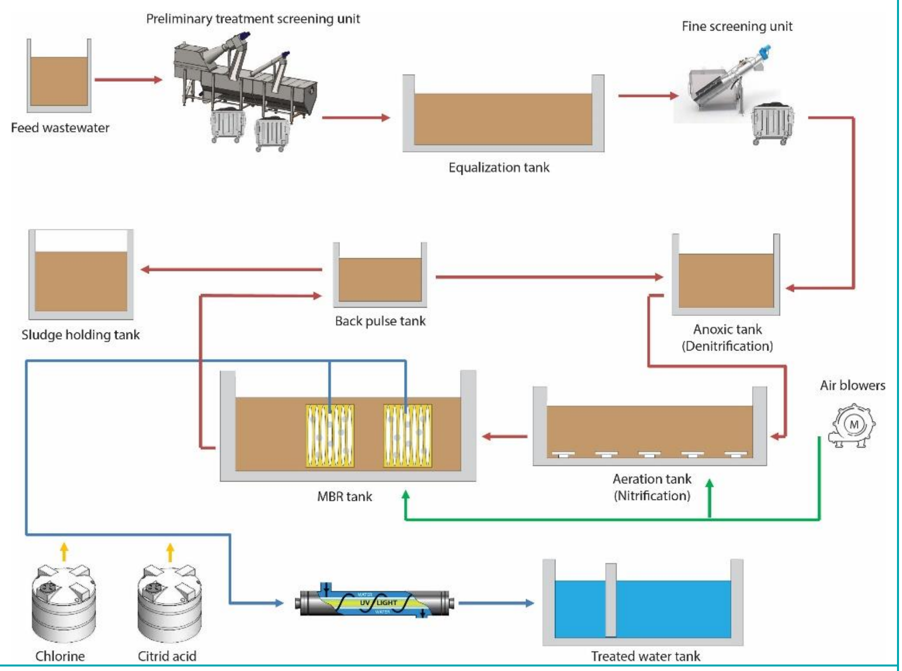




Waste water treatment of MAR

The first treatment steps that influent wastewater undergoes in a typical WWTP are screening and grinding, grit removal, flow measurement, flow control and odor control. These steps together are referred to as preliminary treatment. Raw wastewater contains sticks, rocks, sand, bottles, scraps of metal, rags, and many other similar items. These items can cause collector mechanisms to jam, damage pumps, plug pipes, and collect in tanks such as biological reactors, which, in turn, can damage equipment, reduce the volume available in tanks and lower the overall efficiency of the treatment plant. This can result in the discharge

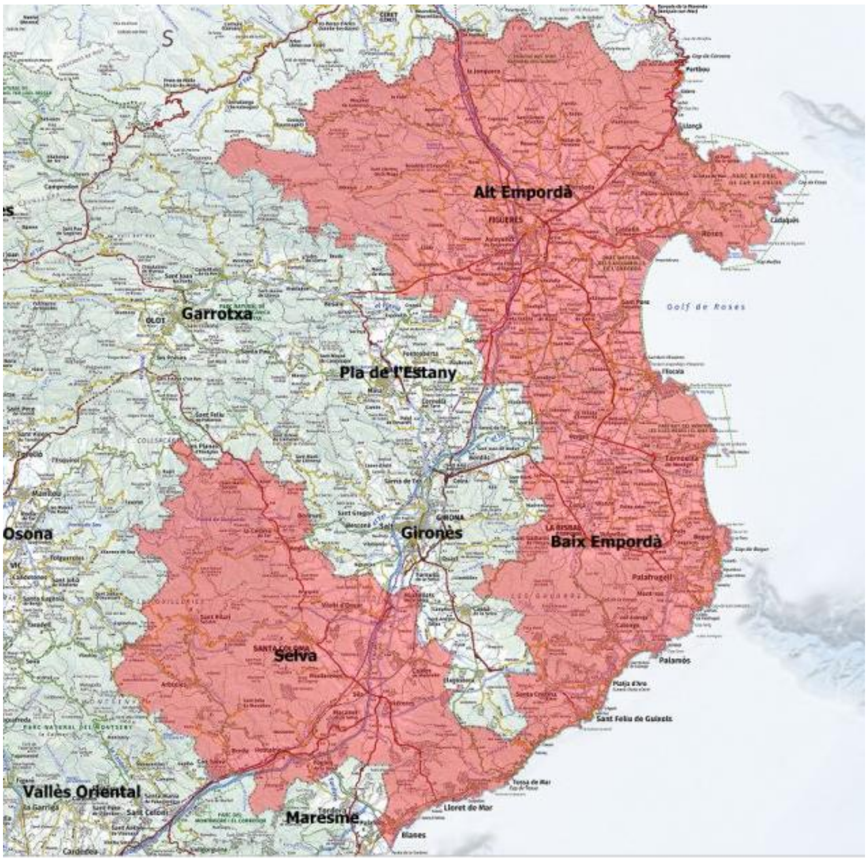
	of pollutants to receiving waters. It is important, therefore, to remove these materials early in the treatment process, during preliminary treatment. The equalization tank is an important part of the treatment process. Equalization provides hydraulic and pollutant load buffering for the downstream processes. Wastewater enters the equalization tank via gravity flow. Waste entering the equalization tank is held temporarily prior to release to the downstream treatment process. An actuated valve placed on the outlet of the equalization tank allows water to flow out of the tank. Typically, the equalization valve is controlled by the liquid level in the downstream process. If the water level in the downstream process is low enough the equalization auto valve will be called to open. If the water level in the downstream process is too high the auto valve will remain closed until the downstream water level is within the appropriate range to open. Fine screening is the second mechanical pre-treatment process allowing finer separation than coarse screens of the solid waste contained in the raw water. Filtration is carried out by a 6 mm to 0.25 mm opening using perforated sheet or wedge wire mesh. Fine Screens are automated thanks to a motorization of the system of collection by a spiral-screw. The wastewater goes through a fine screen for the removal of big objects that might cause damage to the downstream equipment. Then it enters an anoxic zone for the treatment of nitrogenous matter and phosphate following an aerobic zone where microorganisms with the help of the oxygen coming out of the fine bubble diffusers will digest the organic matter in the wastewater and aggregate as they do so, producing sludge. This sludge will enter the immersed membrane bioreactor where the membrane will separate the solids and microorganisms from water. Chlorination and ultaviolet (UV) radiation are used to inactivate potentially infectious organisms. Chlorine is one of the most practical and widely used disinfectants for wastewater. Chlorination is used because it can kill disease-causing bacteria and control nuisance organisms such as iron-reducing bacteria, slime, and sulfate-reducing bacteria. Chlorine destroys target organisms by oxidizing the cellular material of bacteria. Citric acid is used just to reduce alkaline pH levels. An UV disinfection system transfers electromagnetic energy from a mercury arc lamp to an organism's genetic material (DNA and RNA). When UV radiation penetrates the cell wall of an organism, it destroys the cell's ability to reproduce. UV radiation, generated by an electrical discharge through mercury vapor, penetrates the genetic material of microorganisms and retards their ability to reproduce. Treated water is stored in a tank for future pumping to the regional wells with the aim of enriching the aquifer.

	
History/References	**Climatic simulations:** (N. Politi et al. 2018; Nadia Politi et al. 2020; N. Politi et al. 2021; Nadia Politi et al. 2022; Katopodis et al. 2020, 2021) **AWR**: Rainwater harvesting (Zarikos et al. 2023)
Capacity expertise	
Project partners	So far, we have not detected any kind of gap or need that could be covered/assisted by other partners within the RECREATE consortium.
New researchers	We consider the current expertise suitable and do not intend to hire new researchers/experts.
Outsourcing	No subcontracting is foreseen.
Other issues about data/modelling	
Other needs /gaps	Data availability seems not to be a major concern for this project. NTUA/NCSRD will address any data quality issues that arise. Fortunately, the increased volume of data available should allow us to achieve a high degree of data accuracy. For the software tools, NTUA is considering both UWOT and ABMs. Both software options have a proven track record of simulating various scenarios and offer the flexibility to adapt models to specific situations. Hardware-wise, we don't foresee any potential concerns at this time.
Ambition	
Ambition during the project	• Assess AWR (e.g., RWH), their potential of upscaling at the island level. • Increase awareness and acceptance of AWR. • Assess impact of aquifer recharge using treated wastewater. • The AWR to be examined foresee to enhance climate change adaptation/mitigation.

Ambition after the project	• Upscale and transfer the AWR to other neighboring islands (CoP). • Expand MAR to the rest of the island. • Seek funding opportunities within EU to continue and expand RECREATE's applications.
Outscaling potential	High potential of the upscaling and transfer of AWR to other neighboring islands.
Potential barriers	**Governance**: delay in project planning and implementation due to bureaucratic reasons. **Legislation**: gaps in existing legislation on water reuse. **Funding**: limited public funding. **Social acceptance:** is needed for sustainable and reliable water supply to be increased.
Stakeholders	
Initial list	• Municipality of Syros-Hermoupolis • South Aegean Regional Authority • Industrial Chamber of Cyclades • Cyclades Chamber of Commerce • Environmental Quality Observatory • Agricultural sector (farmers) • Association of touristic corporations
Next steps and planning	
Planning M1-M6	• Finalize the installation of MAR supply network (DEYAS with support by NCSRD). • Identification and request for offer of the water quality sensors to be installed (DEYAS). • Data exchange, understand the area under study and co-create vision (DEYAS, NCSRD, NTUA).
Planning M7-M18	• Establish overall modeling approach (NTUA, NCSRD). • Groundwater modelling of the injection area (NCSRD). • Monitoring water quality (details to be defined) of injected water initiated (NCSRD). • Initiating the CoP (DEYAS, NCSRD). • Baseline modelling using UWOT/ABM well advanced (NTUA).
Planning after M18	• Propose and predict effectiveness (based on the existing planning) of the expansion of AWR solution to the rest of the island (DEYAS, NCSRD). • Modelling of co-defined scenarios (e.g., upgrades and AWR, climatic scenarios, etc.) using UWOT, ABMs in progress (NTUA with inputs by DEAYS, NCSRD). • Increase stakeholders' awareness and social acceptance of the solution via the CoP (DEYAS, NCSRD).

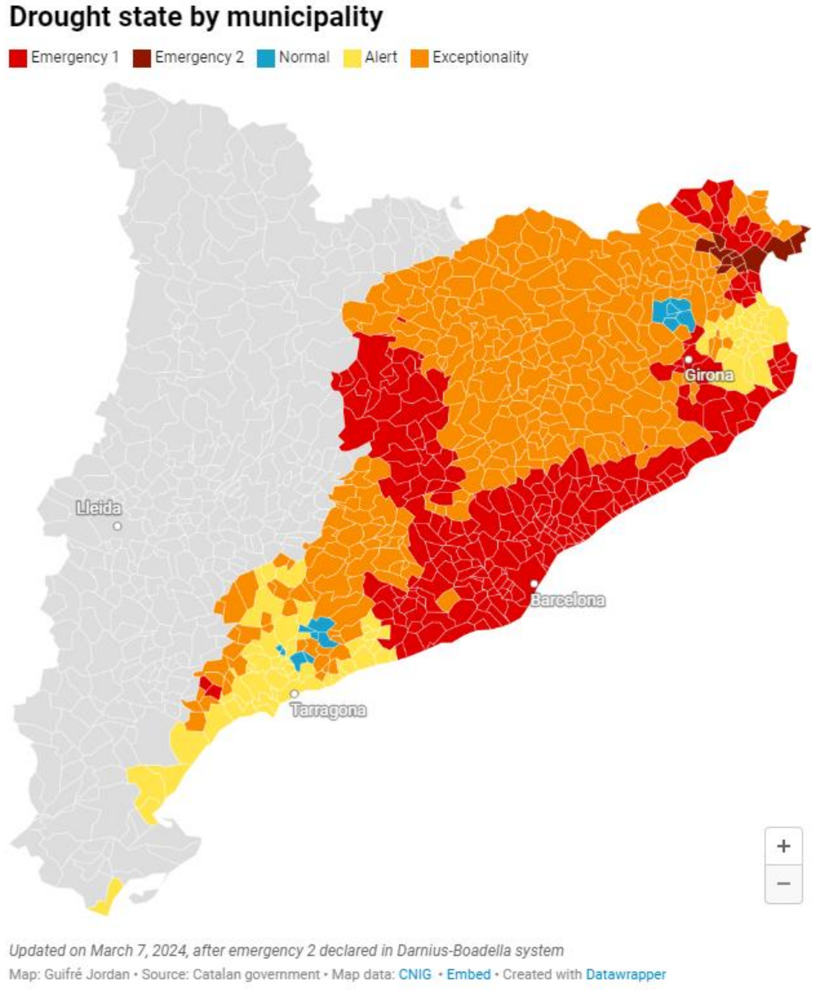
Risks	• Data for modelling are incomplete and/or confidential. • Water quality sensors availability (low). • Stakeholder engagement (low).

2.4 CS#4: Costa Brava, Spain

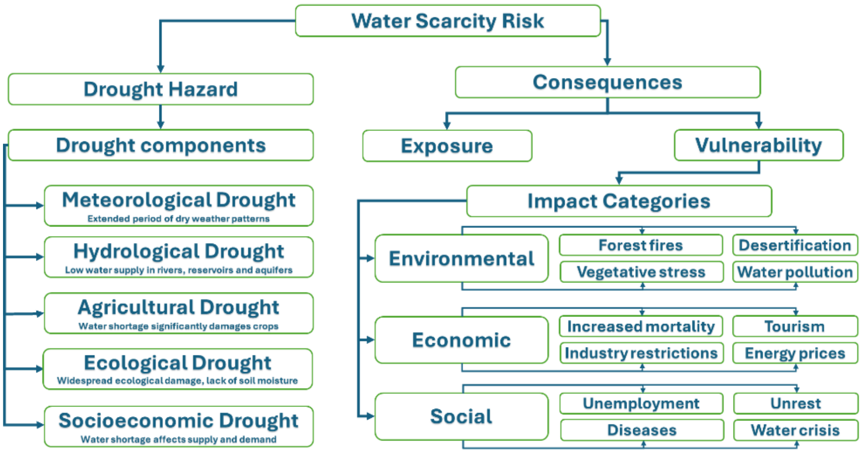
CS#4: Costa Brava (Spain)	**Leading partner: ICRA** **Leading person: Wolfgang Gernjak**
Title	Costa Brava, Catalonia, Spain
Biogeographical region	*West Mediterranean*
Water system type	Coastal, inland, groundwater recharge, indirect potable reuse
Area (km2)	3072 km2
Map image/Photo	 Source: ICGS Catalonia, modified by QGIS.3.33, scala 1:42000
Goals/challenges	• Implement an integrated water management strategy considering multiple water sources. • Support and demonstrate the potential use of reclaimed water for aquifer and well recharge to protect groundwater bodies. • Consolidate the current infrastructure (DWTPs, water reclamation plants (WRPs), desalination plants) to include AWR into the integrated water system and to engage relevant stakeholders at local, regional and national levels to co-create a

	management plan and to promote the social acceptance of reclaimed water.
Project partners involved (institutions and names)	Partners: • ICRA (Institut Català de Recerca de l'Aigua): Nikolaus Klamerth, Wolfgang Gernjak, Lluis Corominas • EUT (Eurecat): Queralt Plana, Queralt Farràs, Mireia Mesas, Manuel Martínez **Stakeholders**: • CACBGi (Consorci D'Aigües Costa Brava Girona) • ACA (Agència Catalana de l'Aigua) • ATL (Aigües Ter-Llobregat) • DDS-GDC (Department de Salud – Generalitat de Catalunya)
Description	Girona – Costa Brava is a coastal region of northeastern (NE) Catalonia, that stretches from the eastern foothills of the Pyrenees (French border) to the mouth of the River Tordera (Barcelona province border). The region is divided into three different counties (comarcas) Alt Empordà (1357 km^2), Baix Empordà (702 km^2) and La Selva (995 km^2) and is part of the internal basins of Catalonia and provides water to 634 municipalities and 6.5 million inhabitants and is managed by Agència Catalana de l'Aigua (ACA). The water management of the Costa Brava region is the responsibility of the Consorci D'Aigües Costa Brava Girona (CACBGi). It ranges from infrastructure to drinking water supply, wastewater treatment and the supply of reclaimed water to cover non-potable demands. The region can be divided into three zones: Costa Brava North, Costa Brava South and Costa Brava Centre. Within these areas, the resident population is about 250.000 inhabitants, and with a seasonal increase in summer that can reach above 1 million people (up to 4.5 million tourists per year), which requires the facilities to be able to provide adequate services in the peak period. The water network of the region supplies up to 27 hm^3/year coming from groundwater, surface water and a desalination plant located in Blanes. The region's 20 WWTPs treat an annual volume of ca. 30 hm^3 (or 1.1 M population equivalents (PE)) with a maximum of 125.000 m^3 daily in summer and very high variations of flow and load during the year. The transition into a circular-based economy in the water cycle management has become one of the main objectives of ACA and CACBGi. Since 1989 one of CACBGi's main activities lies in the supply of treated effluents from 14 facilities for irrigation, urban and environmental uses (6.4 hm^3/year in 2010 and 3.1 hm^3/year in 2012), with a total volume of around 30 hm^3 as of 2015 for the Costa Brava region. The accessible water infrastructure in this project includes 14 WRPs of different sizes and at different places throughout the region, a full-scale desalination RO

	plant at Tordera with a capacity of 20 hm^3/year. A reclamation pilot plant for aquifer recharge will be installed in Roses (funded by ACA) with a capacity of 50.000 m^3/year. This plant will use UF, RO, advanced oxidation processes (AOP) and activated carbon (AC) treatment. ACA and CACBGi aim to triple the amount of reclaimed water in the following 4 years. As can be seen in the change in precipitation in the last 5 years, climate change is putting pressure on the supply of available freshwater. Since 2020, Catalonia is experiencing the worst drought in history, with an accumulated rainfall deficit of around 500 mm and water reserves at an all-time low below 16%. An official drought emergency has been declared in the Ter-Llobregat system, which supplies water to 6 million people. The state of emergency allows the Catalan government to impose tougher water restrictions and allow for the potable reuse of treated wastewater although potable reuse under non-emergency situations is actually forbidden in Spain. The demand for water is expected to increase in the coming decades due to population growth, increased tourism and economic activity (agriculture and industry). The challenges will be: • Current Spanish national and Catalan regional laws do not allow water reuse under normal circumstances. • Resistance to water reuse and misunderstanding of the efficiency of water treatment. • Consolidation of existing infrastructure • Integrate reused water into the water network and transform the linear water system into a circular one. • Engagement of the public to accept the use reused water. Proposed activities: • Modelling as a tool to provide robust decision tools for municipalities and regional government. • Future climate and water demand scenarios. • Stakeholder engagement to disseminate and implement water reuse • Use of a pilot plant for indirect water reuse (aquifer recharge) • Theoretical study for direct potable reuse to support future regulations

<table>
<tr><td></td><td>
</td></tr>
<tr><td colspan="2">Hazards and type(s) of interventions planned/relevant</td></tr>
<tr><td>Hazards</td><td>Hazards of major concern:
• Drought
• Heatwaves
• Overuse of water resources during high season
• Surface water pollution and environmental pollution

Secondary concerns:
• Failing infrastructure
• Coaster aquifer degradation and seawater intrusion</td></tr>
</table>

Compound risks	• Interests lie in the compound risks between drought components, impact categories and water sources for direct/indirect reuse. 
Types of AWR interventions	Technical: • Monitoring current water reclamation plants to determine the risk associated for use • Implementation of virtual sensors for monitoring uncommon or expensive online measurements like trihalomethane (THM) • Monitoring desalination process at bench scale under different configurations. • Simulation of desalination treatment systems for cost-efficiency improvement based on historical data and bench scale tests. • Consolidation of current infrastructures used as AWR. • Test current infrastructures under climate change impacts. • Simulate impact of water infrastructure (well-maintained vs. derelict) Society: • Engage relevant and concerned stakeholders such as CACBGi, ACA, DDS-GDC, ATL, municipalities and local government, medical doctors, journalists, teachers, etc. • Organization of CoP with the engaged stakeholders. Market: • Evaluate best cost-efficiency strategy for desalination. • Use of WWTP effluents as a source for indirect potable reuse like groundwater recharge.
Ethics	• Water reuse of treated municipal wastewater • Limiting access to fresh water in times of severe drought and water crisis

	• Including local decision makers like doctors, teachers and journalists to provide informed opinions to the general public. • Use of treated water for industry, agriculture, urban purposes and potable uses.
DATA needs related to modelling and validation/testing	
Physical data/needs	• Surface water volume (reservoirs, rivers within the study area) • Groundwater levels and flow rates (state of the aquifers) • Water quality (full chemical analysis: COD, BOD, TOC, N, P, TSS, 254 nm absorption, contaminant analysis, pathogens) of treated wastewater effluents. • Data for QMRA: human related fecal pathogens (e.g. CrASS-phage, coliforms) • Aquifer characterization: depth, soil and water quality • Temperature (historical maximum, minimum, average) • Precipitation (historical maximum, minimum, cumulative) • Water demand per sector (agricultural, industrial, touristic seasonal, urban) • Water distribution network (length, age, losses throughout the network, population served) • Energy demand of WWTP, DWTP, and desalination plant • Projection of future water demand, water availability, energy demand, water quality...
Physical data/availability	• Census data • Tourism • Surface Water quantity and quality • Groundwater quantity and quality • Geological data • Abstraction wells • GIS Data (agriculture, urban, infrastructure,...) • Land use, land cover, soil sealing • Water distribution network • Water treatment plants • Meteorological data (rainfall, runoff, temperature) • Energy demand of WWTPs and WRPs

Calibration	• SWAT+ • wOTTER • UWOT/LCA adapted for CS Costa Brava • Data-driven models for virtual sensor implementation Under the assumption that all data needs are supplied and available data is reliable, models can be calibrated.
Historical/scaling	There is not enough groundwater data, both in terms of quality and quantity available to calibrate models sufficiently for future events.
Climate variables/data	• Meteo.cat provides temperature and precipitation data for Catalonia from 1950 onwards as well as sea levels and sea temperatures from 1974 on onwards. Prediction models for available water resources for the year 2050 are also available. • Idescat.cat (Catalonian Statistical Institute) provides data on available potable water, distributed water, losses, residual water and reused water. • EDO - European Drought Observatory – Copernicus (https://drought.emergency.copernicus.eu) as European wide database with low resolution. • Daily observations of the Earth Ecosystem – Copernicus https://www.copernicus.eu/en/access-datahttps://open-meteo.com/en/docs/historical-weather-api
Downscaling climate scenarios	There are regionalized climate projections for Catalonia for the years 2030 and 2050 available from gencat with a spatial resolution of 1 km based on the fitfth assessment (AR5). Https://canviclimatic.gencat.cat/canvi/projeccions/
Measurements/water quality data	Water sensors will be installed, and water data will be monitored online (pH, temperature, electrical conductivity, 254 nm absorbance, oxidation-reduction potential, turbidity). Other water parameters will be measured once a month and analyzed. This data includes TSS, TDS, TOC, COD, BOD, free and residual chlorine, micropollutants, metals, and human fecal indicators (coliforms and CrASSphage).
Technical details	Sensors at the pilot plant in ROSES will include pH, T, EC, ORP, 254 Abs and Turbidity. The data will be collected remotely via datalogger. All other parameters mentioned above will be measured once a month (planned) via 24 h compound sample using autosamplers if available. In

	the case no autosamplers can be installed, WWTP personnel will collect grab samples.
Decision-makers	CACBGi, ACA and other decision-makers will be provided with detailed information about the project in this CS. The specific information needs of the stakeholders and decision-makers will be decided on a regular basis.
Open data	Research data gained in this project will be openly available, but infrastructure and sensitive data from municipalities which is confidential will remain so.
Additional Equipment	Not needed
Modelling needs for AWR for the Case Study	
Technical bio-physical mathematical modelling	
Hazards	• Droughts, heatwaves • Groundwater abstraction • Saltwater intrusion • Wildfire risk and subsequent surface water degradation • Water pollution • Sabotage of infrastructure
Tools	• SWAT+ • WOTTER • UWOT/LCA • QCRA/QMRA • DWSIM • Data-driven models
Background	ICRA: Expertise in water quality modelling and hydrological modelling using SWAT EUT: Expertise on freshwater quality modelling, both surface and groundwater (e.g. with SWAT, data-driven models) and water treatment processes modelling (e.g. with DWSIM, data-driven models), QRMA and QCRA.

Compound hazards and related risks	ICRA: Expertise in Life Cycle Analysis EUT: Impact of extreme events due to climate change on water bodies
Treatment train	Wastewater reuse: • Sand filtration • UF • Monochloramine disinfection • RO • AOP (UV/H2O2) • AC The first treatment step that the wastewater undergoes is the typical treatment in a wastewater treatment plant. The wastewater undergoes screening, grit removal, flow measurement, flow and odor control, filtration. The wastewater then enters the anoxic zone for the treatment of nitrogenous matter and phosphates, followed by the aerobic zone, where microorganisms with the help of aeration digest the organic matter producing sludge. The treated wastewater is then cleared in a clarifier tank. Sand Filtration: After the secondary treatment, the effluent is subjected to sand filtration, which removes fine solids (< 100 microns) from the effluent. The filter in this case is a rapid pressure sand filter with a grain size in the range of 0.6 to 1.2 mm. UF: UF is a membrane filtration process, using hydrostatic pressure to force water through a semi-permeable membrane. Suspended solids and compounds with high molecular weight are retained by UF membranes, while low molecular weight compounds and salts usually pass through the membrane. UF is capable of achieving a 2 log pathogen removal. Monochloramine disinfection: Monochloramine is a water treatment that combines chlorine with ammonia to form monochloramine (NH2Cl). It is less aggressive than chlorine and can therefore be used to treat the membranes to prevent fouling. It has a lower tendency than free chlorine to convert organic matter into halogenated organic matter like chlorocarbons, $CHCl_3$ and CCl_4. Monochloramine tends to react with dimethylamines to form highly toxic n-nitrosodimethylamines (NDMAs). RO: RO is a water purification process that uses a semi-permeable membrane to filter out microorganisms, particles and molecules from drinking water. It can remove dissolved salts, chlorine and chloramines, pesticides and many volatile organic compounds, heavy metals and pharmaceuticals. RO uses applied pressure to overcome the osmotic

	pressure and push water from high concentration of contaminants and salts to low concentration. AOP: AOPs are processes designed to remove organic materials and inactivate microorganisms from the water by oxidation through reactions with hydroxyl radicals. The process is particularly useful for cleaning toxic or non-biodegradable materials in water. The UV/H_2O_2 AOP is an approved disinfection technology, where the applied UV enables a homolytic bond cleavage of the O-O bond of H_2O_2, leading to the formation of 2 OH radicals. AC: The AC filter after the AOP treatment is applied to remove residual H_2O_2 from the water stream, befor the water is released into the environment. Novel seawater desalination treatment scheme: • Membrane distillation (MD): MD is a thermally driven separation process where water vapor passes through a hydrophobic membrane due to a partial vapor pressure difference, typically caused by a temperature gradient. The process utilizes a hydrophobic membrane that allows only the vapor phase to pass, effectively separating pure water from salts. Since it operates at atmospheric pressures, it is more cost-efficient compared to Seawater Reverse Osmosis (SRO) , in which high pressures are needed to force the water through the membrane. • Osmotically Assisted Reverse Osmosis (OARO): OARO is a desalination process that uses a semi-permeable membrane to separate fresh water from saline water, aided by an osmotic agent to reduce the transmembrane pressure required. • Low Salt Rejection Reverse Osmosis (LSRRO): LSRRO is a desalination process that uses RO membranes with lower rejection values, resulting in lower energy needs. OARO and LSRRO allow for the treatment of high-salinity brines with potentially lower energy consumption compared to traditional reverse osmosis systems. • Membrane crystallization (MCr): MCr is a technology that combines MD and salt crystallization in a single reactor, allowing to produce high-quality water from concentrated brines and promoting the formation of crystals to recover the salts from the water.

	The proposed treatment scheme involves the use of MD to treat seawater and a combination of OARO or LSRRO with MCr to treat the produced brine. Experiments at bench-scale will be performed integrating the proposed technologies and the data obtained will be used to develop mathematical models. These models will be applied to simulate the novel desalination treatment scheme compared to the conventional seawater desalination, which uses SWRO, to improve the cost and energy efficiency of the desalination processes.
History/References	ICRA has modelled SWAT for most river basins in Catalonia. We have developed a pan-European simulated wastewater derived contamination in rivers. This model is called wOTTER and is freely available (Klink et al, 2024) EUT has experience on water treatment processes and freshwater processes modelling in several regions in Catalonia (e.g. of public projects IMPETUS, SEA4VALUE), as well as chemical and microbiological risk assessment (e.g. of public projects LIFE SOuRCE, LIFE iBATHWATER), and on virtual sensors for water quality monitoring (e.g. FIWARE4WATER)
Environmental modelling	
Aspects	• Water quality • Water quantity
Tools	• wOTTER • UWOT/LCA • SWAT+ • QMRA/QCRA • Data-driven models
Background	ICRA: Expertise in water quality modelling and hydrological modelling using SWAT . EUT: Expertise on freshwater quality modelling, both surface and groundwater (e.g. with SWAT, data-driven models), and QRMA and QCRA.
History/References	ICRA: none EUT: EUT has experience freshwater processes modelling (e.g. of public projects IMPETUS, SEA4VALUE), as well as chemical and microbiological risk assessment (e.g. of public projects LIFE SOuRCE, LIFE iBATHWATER), and climate change impact on water bodies.

Socio-economic modelling	
Tools	N/A
Background	N/A
History/References	*-N/A*
Capacity Expertise	
Project partners	We did not detect any kind of gap or need that could be covered by other partners within the project consortium.
New researchers	We do not plan to hire new researchers/experts.
Outsourcing	No, we do not plan to subcontract any modelling tasks.
Other issues about data/modelling	
Other needs /gaps	Not for now
Ambition	
Ambition during the project	• Evaluation of novel desalination strategies for low-energy consumption • Consolidation of the current infrastructures used for AWR
Ambition after the project	• Integrate fit-for-purpose water produced from AWR in the current water management tools • Develop water management strategies that ensure supply to the entire population even in situations of extreme drought
Outscaling potential	The solutions and approaches could be transferred to similar Mediterranean regions, which suffer severe water scarcity and droughts.

Stakeholders	
Initial list	*1.* ICRA, EURECAT, KWB *2.* Municipalities of the Costa Brava Region 3. ACA 4. CACBGi 5. Local educational institutions 6. Local medical professionals 7. Local / regional politicians 8. DDS-GDC (Department de Salut – Generalitat de Catalunya) 9. Catalan public
Next steps and planning	
Planning M1-M6	Stakeholder Mapping, selecting model approach, pilot plant planning, , data gathering
Planning M7-M18	Stakeholder engagement, mapping of water supply, reuse options, model development (initial phase), beginning of model use for different scenarios. Pilot plant up and runnning and data gathering for virtual sensor calibration. Evaluation of novel desalination processes, optimization of MD at bench scale, optimization of OARO at bench scale
Planning after M18	Stakeholder engagement, finalizing data gathering from water agencies, water mapping, reuse options and risk assessment complete. Modeling water supply demand scenarios, development of tools for water reuse. Assessment of aquifer recharge from pilot plant water quality data. Integration of MD-OARO, modeling of treatment scheme and comparison with conventional processes
Risks	• Data for modelling is incomplete and/or confidential (low). • Water sensors not available (very low). • Pilot plant construction delayed (low-medium) • Stakeholder engagement (very low) • Missing scientific staff (very low) • Public resistance (low)
Other	*N/A*

3. Activities at the Case Studies

3.1 Monitoring, Guidance and Coordination

The monitoring, guidance and coordination of the activities at the Case Studies is being carried out through Task 5.1. This task is developing a roadmap to foster and guide collaboration and coordination of activities to implement the solutions in each CS. The initial roadmap (reported in this document) focuses on: (a) the stakeholder engagement activities within each CS that will contribute to certain WPs (especially WP2), as the information compiled will be used to further refine the design of the CS; (b) organisation of preparatory actions for the implementation of modelling activities (WP3, WP4), i.e. monitoring mechanisms and equipment installation (as needed), testing etc. The preliminary actions related to the above activities are outlined in section 3.2, as Gantt charts for each CS.

This task will also monitor and report about the specific KPIs for each CS. However, since the project is still at early stages (M6), it is too early for this activity.

This task is also monitoring potential risks and the need for amending actions (e.g. delayed work, unforeseen difficulties, lack of data, emergencies, bureaucratic issues with local authorities etc.) and reports about them to WP7 (Management). So far (M6) there have been no emergency situations, major issues or unforeseen risks in any CS of RECREATE.

Monitoring is being carried out through bi-weekly teleconferences. These teleconferences will take place throughout the project duration, until the end (M48).These teleconferences are being organised by the WP Leader (KWR) and take place every 2 weeks on Thursdays (11.30-12.30 CET). All the CS are required to be present with at least one representative, as well as all the other WPs, with one person (at least).

The agenda (and the Teams link for the teleconferences) are always the same, as follows:

- Each CS updates on their activities (5 min)
- Each WP communicated to the CS any matter related to them (relevant for WP1, WP2, WP3, WP4, WP6 and WP7), if any (3-5 minutes each).
- There is no need for preparing presentations. We'll discuss and keep short minutes online.

These scheduled meetings started on Frebruary 29 2024, a few weeks after the project kick-off meeting, where a discussion about them took place. The minutes are included in the Annex.

Fewer participants were present during the first couple of meetings. However, it gradually became clear to everyone how useful these meetings are. Currently all the project partners attend the meetings with one representative (at least). Usually there are 2-3 people from each partner and all the CS send at least one person to the meetings. The meetings evolved into a miniature GA (general assembly), where announcements about the whole project and informal discussions take place, not just about the CS matters exclusively. Based on previous projects, with similar monitoring practices for the CS, these meetings help also in strengthening the interactions and synergies among the project partners overall, hence contributing also to a successful outcome for RECREATE as a project.

3.2 Performed and Planned activities – Timeline (Gantt charts)

This section presents in Gantt charts the timeline of performed and the planned actions for the CS. The timeline is still preliminary, since the project is at the start (M6). It will be updated and more detailed in the update of this Deliverable (D5.2), due for M18. However, the main activities are outlined. The tables also show the interlinkages among the WPs and the CS.

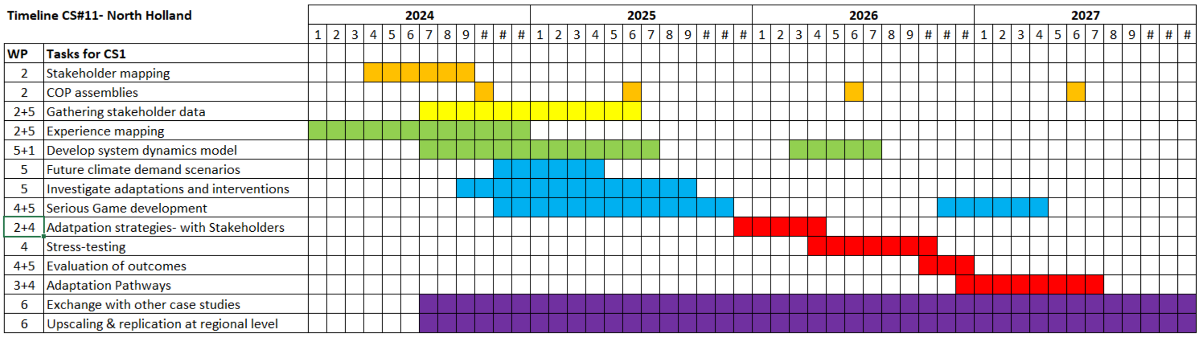
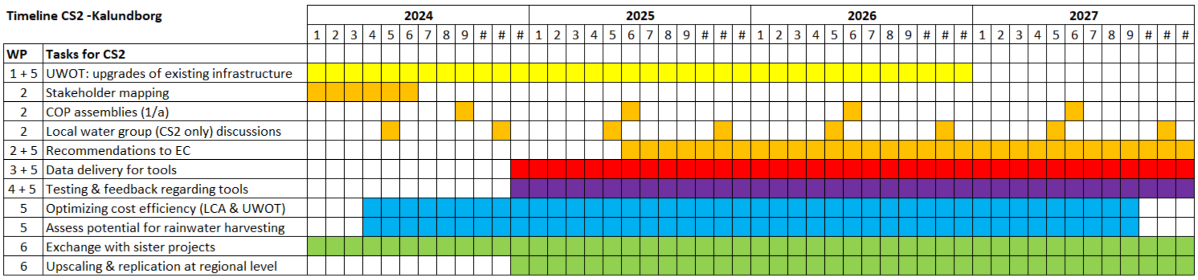


Table 1: Gantt chart of activities for CS#1-North Holland



*Local water group discussions are confidential because of the industrial partners

Table 2: Gantt chart of activities for CS#2-Kalundborg

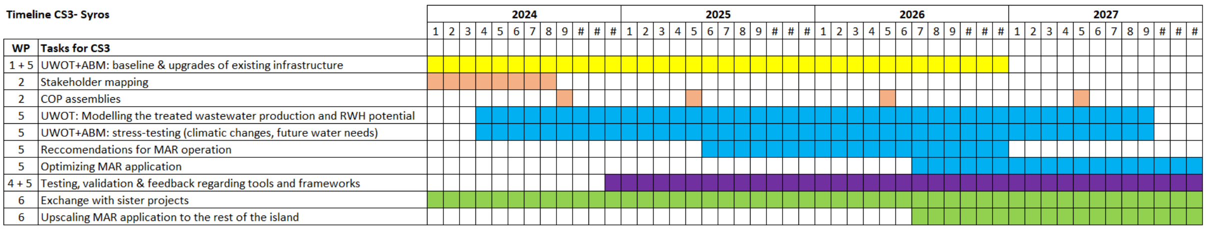


Table 3: Gantt chart of activities for CS#3-Syros Island

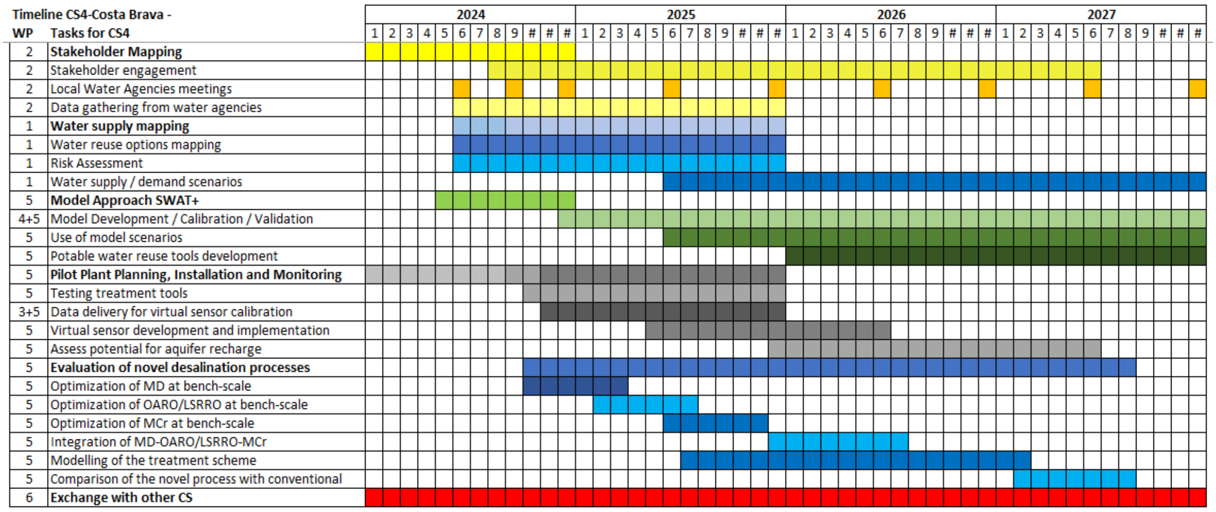


Table 4: Gantt chart of activities for CS#4-Costa Brava

4. Conclusions and next steps

This document presented the details about the CS of the project RECREATE. There are four CS (details presented in Section 2). A number of activities are plnned for the following months at the CS. During the first six months of the project, emphasis was given in achieving a full and detailed description of each CS. Various types of information have been collected and presented in this report, referring to multiple activities planned at the CS, e.g. from stakeholder engagement to modelling capacity and availability of data.

This collection of information, in accordance also with the anticipated requests from the other WPs, helped the CS partners to better understand the details of each CS and (mostly) realise in time, what is needed and what is "missing" (be it in data, capacity or equipment on the ground). It was also helpful in defining a general plan of actions for the duration of the project, which is summarised in section 3.

In the coming months - up to M18, when the next version (D5.2) of this document is due, the CS will start implementing activities on the ground, revolving around three main types of actions: (a) start preparing and performing stakeholder engagement activities, with the guidance of WP2 and in collaboration with them; (b) decide on the climate scenarios to be investigated, in collaboration with WP1 and also on the modelling tools to be used (mostly already decided, as shown in the detailed descriptions); and (c) start collecting data and start modelling their systems.

The monitoring of all activities will continue in a similar way as for D5.1, i.e., via bi-weekly teleconferences.

5. References

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Annex: WP5 Online meetings- Minutes

DATE: 29 February 2024

General announcements:

- Discussion on the detailed information about the CS (template). Any comments: Deadline March 8 (1 week). Then it will be replicated for all the CS.
- Project Management template presented by Digu (WP7)

CS	Attendee	Activities
#1: North Holland	Klaasjan, KWR (on behalf of Iverna, PWN	Interview for BTO (water utilities) newsletter, to be distributed after official RECREATE "press launch"; Iverna (PWN) on holidays next 4 weeks, many activities will start thereafter.
#2: Kalundborg	Preben	Not present
#3: Syros	Ioannis , NCSRD (on behalf of DEYAS)	• In search for offers for the water quality sensors Initial contact with local stakeholders
#4: Costa Brava		Not present
WP1		Not present
WP2		Not present
WP3		Not present
WP4	Dionysis (NTUA)	Not started yet
WP6	Suwi (adelphi) Katherine Peinhardt (ICLEI)	No updates from adelphi. Instructions for info needed about the website for the case studies -Katherine to send email - Deadline March 15
WP7	Digu Aruchamy (EUT)	Risk identification and management strategies to be included for each of the case studies in the questionnaire.

	Queralt Plana (EUT), Queralt Farràs (EUT)	Project Management Template – available in the SharePoint under folder 'COORDINATION'. - All project leads to update their team member info under the 'project team' sheet for the tasks that have already in progress (deadline March 15) - All WP leaders to update any additional WP specific risks presented during the KoM in the sheet 'RISKS' in the excel (deadline March 15)
WP8	Digu Aruchamy (EUT)	Ethics considerations to be included in the Case Study questionnaire

DATE: 14 March 2024

General announcements:

- Next meeting on March 28 to be hosted by Klaasjan starting at 12.00, duration 30 min.
- Template for the Description of the CS- Version 2- All the CS in the same document. RECREATE- WP5-Case Studies-Full Descriptions-V2.docx Deadline **May 1, 2024**
- Reviewers for D5.1: Queralt to think about it and make a suggestion.

CS	Attendee	Activities
#1: North Holland	Klaasjan	Waiting for the main PWN person to get back from abroad.
#2: Kalundborg	Anne (KWB)	Working on the template. The structure used for ULTIMATE for CoP to be used also in RECREATE. Maybe this structure useful for the other CS. Presentation by Anne on April 11 to all the CS and discussion.
#3: Syros	Giannis	To transfer the description to the new template. Working on the completion of the template. Dimitris (DEYAS) working on the water reuse network (field experiment)-checking the network.
#4: Costa Brava	Nikolaus	Working on then template. Meetings with Consortium Costa Brave (CCB). Planning on teh installation of the pilot plant-from an open tender

		by CCB, which will be used here (won by ICRA, EUT, KWB). This pilot plant will feed data for RECREATE. Contacts with admin organisations.
WP1	Anne/ Dia	Modelling work to be reported in WP1 (D1.4), although it will take place under WP5.
WP2		Not present. They need to be present on April 11, for the CoP discussion. Queralt to contact them.
WP3	Eloy	Info about data needs to include technical details on how they will be collected. Eloy to add explanations in the common document.
WP4	Dia	Planning to start discussions about the climate scenarios to be investigated. Take into account previous and other projects (IMPETUS, ARSINOE, NATALIE)
WP6		Not present. Queralt to contact Adelphi
WP7	Queralt	Working on the handbook, including guidelines. DMP in preparation.

DATE: 28 March 2024

General announcements:

- Digu Presented general announcements
  - Project management update- project handbook and quality plan will be submitted today by Digu
  - No specific updates for WP 5

CS	Attendee	Activities
#1: North Holland	Klaasjan	PWN contact Iverna will be returning back from vacation next week.
#2: Kalundborg	Anna	Templates have been filled out for KWB. Waiting to finalize a bit more information.
#3: Syros	Ioannis	Templates have been filled out. Reached out to see what case study data will be available
#4: Costa Brava	Nikolaus	They have started filling out the templates but there is still data missing. They are working to fill out

		the missing information. Next meeting they should have all of the data processes.
WP1	Anna	No news. Everything is going well and they are having meetings with the project partners
WP2	Anika and Elena	They have requested stakeholder engagement lessons learned from other projects. Conrad has over lapping meetings and will only be available every other meeting for WP5. Stakeholder engagement presentations from (COP) Ultimate will need to be moved until the April 25th as many are not available for the April 11th. Titles of presentations will be sent to Klaasjan for an agenda and all presentations need to be 15 min or less. Question to case studies: would the case studies also like to participate in the WP2 meetings for stakeholder engagement? It would give case studies more support before the month 18 report for stakeholder mapping and engagement. If not we should have 15 min each month in this meeting to discuss stakeholder mapping and engagement in the WP5 meetings. May 9 (5 min) and May 23 (15 min) agenda point for WP5 meeting to discuss stakeholder engagement process. On May 11th we need to have a discussion about WP5 deliverable (how to integrate COP into WP5)
WP3	Eloy	Questions on the templates (integrated) 1. Technical aspects of getting data form case studies 2. Policy making questions on data handling. 3. How much interest is there in promoting the open data sharing We can discuss this more in the next meeting to discuss this as a whole group.

WP4	Dia	No new information from last meeting as WP does not start until month 6.
WP6	Conrad	Actively working on website and templates. Task force are made but waiting for confirmation from board. Volunteers will be asked to join task forces once they are confirmed and defined.
WP7	Digu	Additional requirements from WP3- case study partners should make sure they are always using the most up to date template.

DATE: 11 April 2024

General announcements:

- Integration of the COPs into the deliverable. It is important for WP2 to be available for the meetings. All will be available on April 25th.
- Template for the Description of the CS- Version 2- All the CS in the same document. [RECREATE- WP5-Case Studies-Full Descriptions-V2.docx] Deadline **May 1, 2024**
- Digu to send out poll to have the next GA in June

CS	Attendee	Activities
#1: North Holland	Klassjan/Mollie	• Iverna (PWN) is back from holidays • PWN and KWR have a half day meeting on 12/4/2024 to fill out information for first deliverable.

#2: Kalundborg	Preben/Anne	• New water law going to vote for all of Denmark • Water for citizens will only be from ground water sources. • Industrial water- can possibly use desalination • Law will go to parliament for vote in Summer 2024. • This means that for RECREATE Denmark will not be able to participate in the desalination studies, but high interest in learning from other case studies. • COP standards will be similar to that of the ULTIMATE COP currently in practice and well established (average attendance 60-80). • Working with KWB currently to finalize WP5 first deliverable. • Currently Kalunborg is having a higher demand of water than expected. Very difficult times as they are rebuilding main system to double the capacity of the WWTP. • Template for deliverable clarifications- indicate parameters which are important for climate impact modelling- Anne to send clarification email to Nikolaus. • Anne to put case study document onto the SharePoint
#3: Syros	Dimitrios/	• Collection of data underway to send to NTUA on the capacity of water tanks and systems and mapping utilities. Daily communication of current progress. •
#4: Costa Brava	Nikolaus	• Weekly meetings for gathering information. • Gathering stakeholders from the health department • Discussions on types of models will be used. • On tract for deliverable completion.

WP1	Anne	• All case studies need to provide what data is currently available for Surface and Groundwater modelling. Queralt to provide a list of what data needs should be collected. • Discussion if we should have a meeting to discuss all data requirements or if email would be the best communication for this. Maybe more valuable to wait a bit until the 6 month deliverable is completed. • Task 1.5 all the case studies need to perform modelling work to establish base lines for water sources. Different tasks will be created for each case study. All colleagues need to check this out and mark and changes/concerns with the current statis. https://eurecatcloud.sharepoint.com/:x:/r/sites/PR230444_RECREATE/Shared%20Documents/General/03-%20EXECUTION/WP1/WP1_Gantt_20240305.xlsx?d=w73144bffe15b46c8b35c3c8aac667b35&csf=1&web=1&e=LyR8nm
WP2	NA	No WP2 update
WP3	Eloy	• WP3 meeting to happen 12/4/2024- present proposed developmental architecture. Information will be needed form the case studies. • Questions will be developed and requested from case studies. To be discussed in May meeting.
WP4	Archontía	This work package starts in June. First step will be developing the Gannt chart. WP4 kickoff will start in May.
WP6	NA	No update for WP6
WP7 & WP8	Digu/Queralt	• Digu will send out poll to set up next GA in June • Reminder- we need to identify subtasks for task 1.5.

		• Risk assessment for case study- Email issues to Lydia with Klassjan and Mollie in CC.

DATE: 25 April 2024

General announcements:

- Anne to present about stakeholder engagement

CS	Attendee	Activities
#1: North Holland	Iverna	Working on D5.1- Session tomorrow (internal with researchers and 1 stakeholder)
#2: Kalundborg	Preben	Progress. Concerns about data availability from the industry- probably issues, also for a large part of the new area there are not enough data. Issues with the local municipality, which is understaffed. Issues also with the authorities who do not understand the need for AWR.
#3: Syros	Ioannis	Collecting data, meeting with NTUA scheduled, no issues with data (in general) except some data about groundwater.
#4: Costa Brava	Nikolaus	Discussions (internal), meetings with stakeholders about data etc. Working on D5.1.
WP1	Veronika	Exchange about data with the CS-it becomes clear what types of data are needed (T1.1 email sent)- to clarify whether all the CS leaders have got it.
WP2	Anika and Elena	Discussion to follow
WP3	Eloy	Data are important for WP3-special effort needed. Working on the prototype of the RECREATE tool-consultation with stakeholders needed.
WP4	Dia	Preparing a Gantt chart about the WP. WP to start in June (M6)
WP6	Anika	No updates. Working on the templates and the websites.

WP7 & WP8	Queralt F.	Poll for a GA in June to be sent. NTUA to define subtasks for T1.5 (clarification needed)-Discussion with NTUA (Dia) during the meeting. Risk assessment TBD for the CS. Ethics part (in the template of D5.1- TBD where it will be included and how-needs to be filled).

DATE: 9 May 2024

General announcements:

- CS#1, CS#3, CS#4: See whether a similar Gantt as CS#2 can be drawn. (Consult the template). Suggestion (Digu) to add the Deliverables on the Gantt and to get a .xlsx template from CS#2. LVL to create a template on the common folder.
- Ask PWN about possible dates for the f2f meeting in October/November.

CS	Attendee	Activities
#1: North Holland	Not present (holiday)	Template has been completed with info. Suggestion to Klaasjan and Mollie to join WP1 meetings (see below). Dia to send email.
#2: Kalundborg	Not present (holiday)	Template complete.
#3: Syros	Giannis	Meeting last week with NTUA about data. Starting working on parts of the network that was missing and was needed. Description: More details needed about the WWTPs to be complete.
#4: Costa Brava	Nikolaus	Meeting with Costa Brava next week. Working on the planning of the activities. In contact with the stakeholders. Template: some things missing still, but working on them.
WP1		For many WP1 tasks, we still need more exchange with the CS leads / partners. I believe we will wait until D5.1 has been finalized for reaching out for more information, since some data needs are already in the CS templates, but additional information which will require discussion during WP5 meetings include: - Information on water quantity/demand prognoses which perhaps already exist in the local languages (task 1.1) - Information on regional/local legislation relevant for (waste)water infrastructure

		(e.g. stricter national standards compared to the UWWTD or the water reuse regulation) (task 1.2) - Information on data on pathogens and emerging contaminants (task 1.3) → I included this as a question in the D5.1 document for all CS yesterday already Another point: Dia suggested to ask someone from KWR to attend the WP1 meetings, since we do not have a representative from the Noord Holland CS at all in the WP1 meetings currently, which makes discussing questions relating to the Noord Holland CS impossible. She will reach out to the colleagues who are working with her in WP4 to arrange this.
WP2		Not present-holiday
WP3	Eloy	Working on the prototype to be shared within the WP next week, then with the CS about data.
WP4	Dia	No updates (starting in June)
WP6	Digu (update)	Templates (updated) sent yesterday. Final check tomorrow.
WP7 & WP8	Digu &Queralt	Invitation for the next GA sent (June 11) ½ day. Agenda to be sent next week. Meeting with the Ethics board planned with the CS to make sure that the ethics requirements are ok. (Meeting in 2 weeks' time). Queralt: Quality monitoring tool (form) sent to the CS to be filled by the CS leaders (Deadline May 20-21).

DATE: 23 May 2024

General announcements:

- Queralt P. - Struggling to finish the final template of the word version. Table of content issues and date issues. Nicer format is in the works but still a struggle. We could start working on the new template, but there is no point yet as the finalized version is available.
    - Last option would be to create a table manually if it is not available by June for deliverable.
- Deliverable 5.2 - Finalized by June 6, 2024 – Then to review

CS	Attendee	Activities
#1: North Holland	Klaasjan/Mollie	-Completed template for deliverable. Meeting tomorrow to completely finalize with PWN/KWN - Meetings held between PWN/KWR where reviewed system and needs to models - 24/5/2024 Meeting at PWN to play a serious game like will be developed in RECREATE -PWN/KWR has started picking dates and are now waiting for feedback from dates from sister projects (WATERVERSE). Lydia has met with WATERVERSE and they agree not to clash with dates. - Need to complete Ghant chart for case study. Use the template from Kalundborg
#2: Kalundborg	Preben/ Anne	- Using tool developed in ULTIMATE and are now utilizing in RECREATE. - Successfully continuing the research on ULTIMATE between case study and KWB. - Request to share deliverable of the tool to the rest of RECREATE however, that deliverable (2.3) is confidential.
#3: Syros	Dia	- Some missing data still exist but - Finalized contribution to deliverable to 5.1 o Ghant chart contribution not give yet. Lydia will give a template to complete it. Case Study 2: will upload the template they used. - Discussion of types of modelling (both case study 3 and 4 are using the same type of modelling)
#4: Costa Brava	Nikolaus	- Meeting with Queralt - Meetings with modellers to design the focus of the project and the models that are needed - Regularly meeting every 2 weeks for model design - Gathering needed data still

		- Discussion of types of modelling (both case study 3 and 4 are using the same type of modelling)

WP1	Veronika	- Costa Brava is still waiting for LCA and further discussion is needed for generating results. This will show how we can implement this in a resuable way. Queralt and Anne will arrange bi-lateral meetings to discuss this. Additionally, we need to add Christos and a few others within this. Veronika will send an email requesting all those that should be in attendance.
		- Tasks are progressing well so far.
		- Soon (later June) a document on legislation will be completed for each of the case studies.
		    o Case studies will need to add in the missing information that they know. Difficulties around language may have caused confusion
		    o Will be announced in WP5 meeting that case studies will need to complete this.

WP2	- Out on vacation	
WP3	Eloy	- Proposal of the architecture completed- Now in the refining phase. - Still missing information of what need to be address with stakeholders. - Important that input are given as this if for the architecture of the tool. Information needed as soon as possible (preferably before September) - Deliverable for end of the year.
WP4	Dia	- WP starts in June - Doodle will go out soon to arrange kick off meeting.
WP6	Anika	- Confirmation of website – email send out to case studies to provide pictures for the website.

		- Cluster activities- WE is leading the first year of the cluster activities. o Partners need to vote for their choice in the cluster name.
WP7 & WP8	Queralt	- Next online GA- please report Risks detected- NOT in the grant agreement - Cannot quantify the state of the project yet because we are just starting the project - Ethics- working on a checklist for activates and deliverables. o Ethics check list is now being reviewed with the case study - BUT Queralt is meeting to finalize the last after this meeting. o Soon will be sent to all partners. o Consent form needed for the projects still ▪ Mollie will join the ethics meeting to share her experiences with WATERVERSE ethics.

DATE: 6 June 2024

General announcements:

- General Assembly in November- Calendar invites have already been sent out with agenda to be shared in the coming days.
- Word template is now completed! Templates are online at the SharePoint. This has been sent to the deliverable leaders already.
- Website will be online next week. Feedback request from case studies to go out soon.
- Katherine will reach out to case study icons- as edits are needed for most of the case studies.

CS	Attendee	Activities
#1: North Holland	Mollie	No updates- Finishing with the description
#2: Kalundborg	Anne/ Preben	- Regular meetings for data collection and continued strong partnership with tools already developed in Ultimate.

		- Stakeholder system is very strong and they are very excited to continue working in an international projects.
#3: Syros	Ioannis	- Had a meeting with Dimitrius to map all of the data needed for the GIS format. - Master student working on modelling the case study area. So now there is a basic model that they can work on for aquifer recharge.
#4: Costa Brava	Nikolaus	- Pilot plant is going ahead. Meeting after this meeting today. - Stakeholder mapping is going well. - Working to define the boundaries for modelling - Meeting with Queralt for which type of modelling will be better. More expertise in SWOT and not UWOT. - Still collecting data- not an issue currently
WP1	Veronika	- Mollie joined WP1 meetings to represent CS#1 - This will be
WP2	Not Present	
WP3	Eloy	- Waiting for data case studies - Still in the developmental phase for the architecture. - Need a deeper dive into data and how to collect it
WP4	Dia	- Set up kick off date set Friday June 28th. - Finalizing kick off agenda - Overview of WP, challenges, adaptive pathways, serious games. - Waiting for
WP6	Katherine	- D6.1- Communication and dissemination strategy- draft should be finished this week. - D6.2- report of website being created. - More WP6 meetings will be done on June 6th. - Templates Link: https://eurecatcloud.sharepoint.com/sites

		/PR230444_RECREATE/Shared%20Documents/Forms/AllItems.aspx?id=%2Fsites%2FPR230444%5FRECREATE%2FShared%20Documents%2FGeneral%2F05%2D%20COMMUNICATION%20%26%20DISSEMINATION%2FCommunications%20Materials%20and%20Templates&viewid=ad8a352e%2D799b%2D44bc%2Db7f2%2D4d4b2e5deda5
WP7	Queralt	- See general updates - WP 5 presentations should be sent by Monday at Noon.
WP8	Queralt	- Ethics checklists -

DATE: June 20, 2024

1.1 General announcements:

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CS	Attendee	Activities
#1: North Holland	Mollie	- Data preparation and SDM boundaries - Set plan for first running model by September
#2: Kalundborg	Anne	- Data collected internally - KWB still waiting for data to be processed and cleaned
#3: Syros	Dia	- Good data exchange but missing some demographic data - First models for UWOT and base data have been developed - Working on establishing the overall model set up
#4: Costa Brava	Nikolaus	- Installing pilot plant during this time - Checking data of what can be implemented into the model currently
WP1	Veronika	- No major updates since GA. Wants to discuss definiton of scenarios and time frame for task 1.1. THIS NEEDS to be agreed upon by all case studies. - Meeting will be held by task 1.1 leaders for complete this in the next 6 weeks (before August). - All case studies need to be involved in this meeting. - Take over one of the WP5 meetings.
WP2	Anika/Elena	- 2.1 no major updates from GA meeting
WP3	Eloy	- Added the information needed in for the DMP - No update from the case studies yet just currently waiting for the data
WP4	Dia	- Kickoff next Friday, 28th June! - Presentation and lessons learned as part of the agenda. - Interative discussion for the case studies.

WP6	Anika	- Currently working on deliverables for website and for news posts- Final stage
WP7 & WP8	Eloy	- No change since GA

In case of any questions, please contact:

Digu Aruchamy
Project Coordinator

Contact: digu.aruchamy@eurecat.org

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