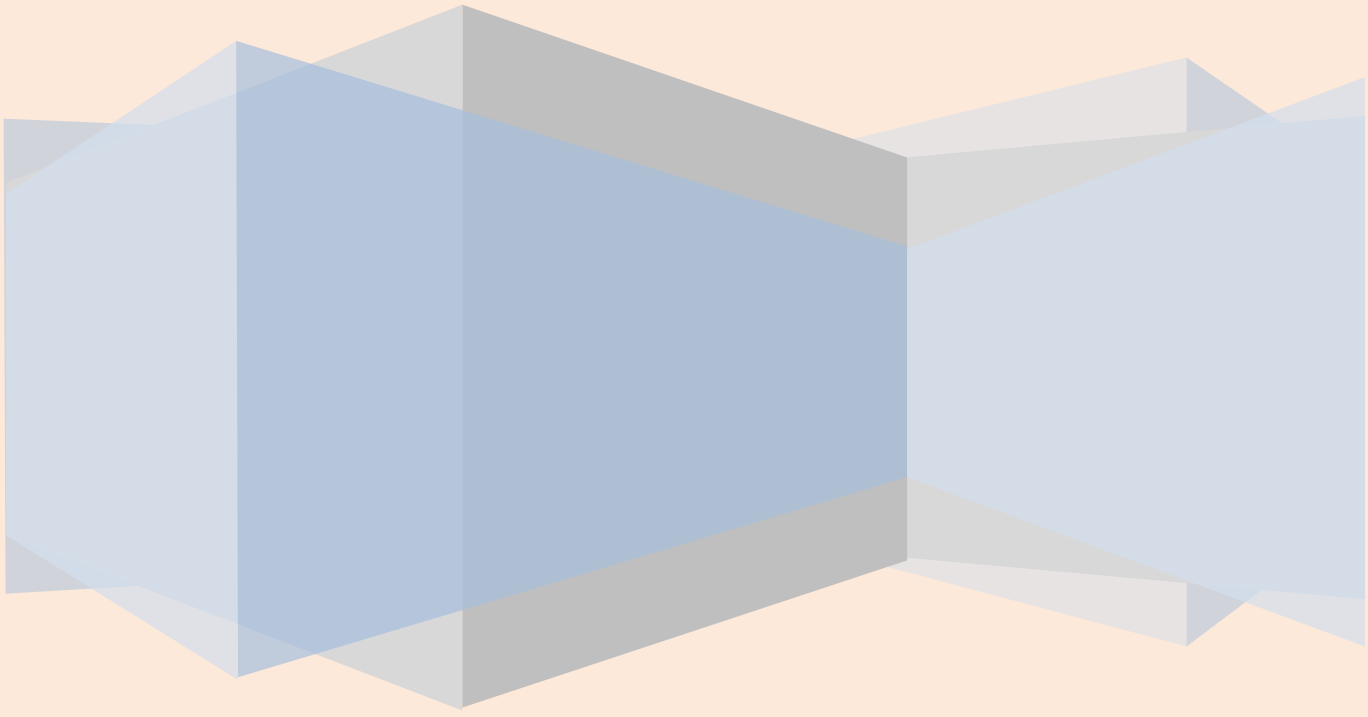
Mid-Term Progress Report

Water Joint Programming Initiative 2018 Joint Call

Closing the water cycle gap - Sustainable management of water resources

This Template should be used by the Project Coordinator for the reporting of the project.

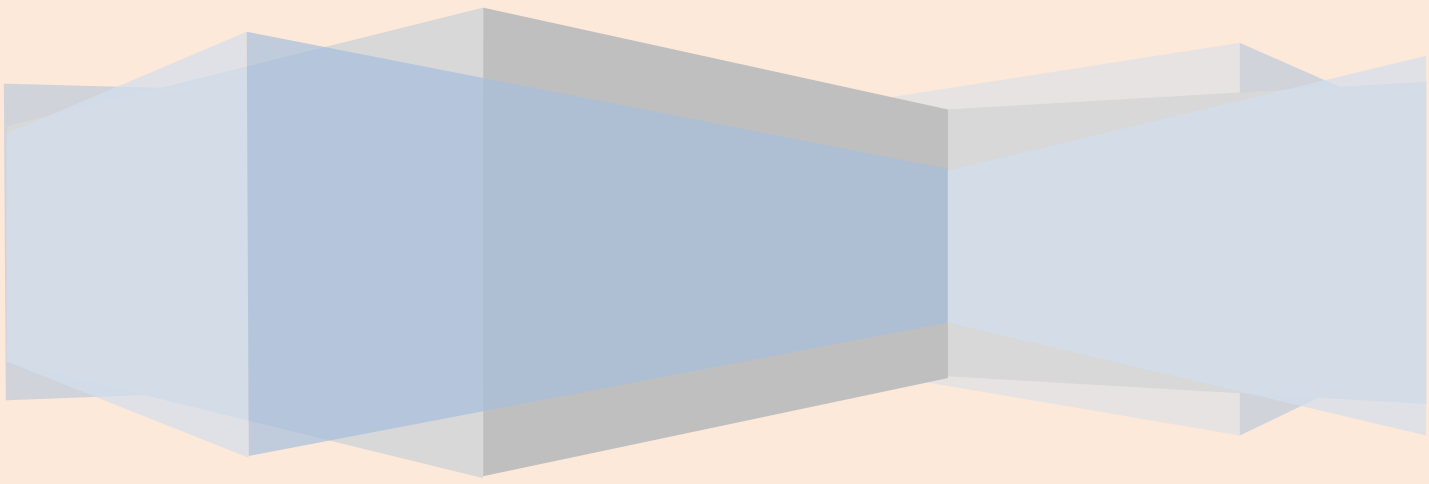
This template does not substitute national regulations



2018 Joint Call
Mid-Term Progress Report
Closing the water cycle gap - Sustainable management of water resources

Closing the Water Cycle Gap with Harmonised Actions for Sustainable Management of Water Resources (WaterHarmony)

The WaterWorks2018 Follow-Up Secretariat will ensure distribution to the concerned national funding agencies. The project coordinator is responsible for sending a copy of the report to its partners.



PROJECT TITLE AND ACRONYM

Author of this report (Coordinator): Harsha Ratnaweera
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Date of submission: 01.11.2020
Project Website: https://www.waterharmony.net/wjpi/
Project code: WaterWorks2018-WaterHarmony

Duration of project: 36 months
Start date: **01.05.2019**
End date: **30.04.2022**
(extension until 31.12.2022 requested)

Period covered by this report:
01.05.2019-31.10.2020

1. Publishable Summary

Maximum 1 page

The content of this section is intended for communication by the Water JPI on the project, mainly through its website. The style should be adapted to communicate to a wide audience (**non-technical** English) and the quality of the data must enable direct publication.
The authors authorise the publication of information about this project by the Water JPI.

The publishable summary should provide the following information:

- *The project context and objectives;*
- *The main results achieved so far;*
- *The expected final results and their potential impact and use (including the socio-economic impact and the wider societal implications of the project so far); and*
- *The address of the project's public website, if applicable.*

Water is a scarce resource. Unsustainable use together with rapidly increasing population amplifies the negative impacts on natural, environmental, geographical and social conditions, which are already under increased pressures from Climate Change. Emerging micropollutants (MPs) and their discharges, even at trace concentrations, contribute to accumulation in the aquatic environment with potentially detrimental consequences to both aquatic ecosystems and human health.

Numerous national and transnational initiatives have led to a better understanding of needs and opportunities in the water sector. Nevertheless, the potential for synergies are underutilised due to insufficient communication between them. The ambition of the Water Harmony project is to improve the communication and collaboration among research teams from 11 counties: Norway, Sweden, Spain, Poland, Romania, Netherlands, Israel, USA, Australia, Singapore and China. The project will also enhance the dialogue with researchers, end-users, policymakers, and the public to develop and jointly demonstrate best practices that are potentially valuable for Europe and beyond. They will also contribute to the SDG 6 "Ensure access to water and sanitation for all", maximising synergies and rationalising resources and efforts.

Thus, **the objective** of the Water Harmony project is **to close the water cycle gap by harmonising good global practices of sound and smart water management concepts that address emerging challenges and mobilise stakeholders**. The project will be demonstrating two strategies that close the water cycle gap via 4 innovative management demo projects and 7 cutting-edge technological showcases, with several cross-cutting actions.

The project aims to demonstrate sound and adaptive **approaches to modern water management** concepts that use BigData and technological advancements addressing challenges concerning global environmental and societal changes; validate **innovative technologies** that enable safer, secure and economically more feasible use and reuse of water, alongside addressing challenges with emerging pollutants; i**ncrease public engagement** to sustainably manage the water challenges that connect sciences and society by using modern, harmonised and shared approaches; and f**acilitate policy decisions** favouring actions that rapidly close the demand-supply gap in the water sector by providing

scientific backgrounds, visualisation tools and social mobilisation of policymakers.

Partners have initiated their work at local levels and shared the progress and challenges among the consortium partners. Partners have initiated and partially completed work on their tasks. With regards to the four management tasks, the Polish partner has come furthest by qualitatively and quantitively monitoring the water in the Łyna catchment, while in the other 3 sites, monitoring equipment is partially or fully installed and ready to start surveillance. Several virtual sensors for water quality were verified. The Dutch partner who will be working with data management of the four management cases have identified the suitable data tools and started to plan the integration of data. Among the technological concepts, the Spanish partner has identified the suitable nanofibers for targeted pollutants, while the Australian partner has documented the positive effect of adsorption as a pre-treatment for improving nanofiltration for removal of various targeted pollutants. The Polish partners have obtained promising results on the removal of dyes by electrocoagulation combined with surface electrooxidation. They have also developed a method for an automated system for optimising coagulation processes. The Chinese partner has successfully demonstrated the production of ultrapure water from domestic wastewater at the Beijing Olympics site. Other partners are in various stages of testing their concepts. Broader stakeholder involvement was planned through innovation camps in Israel, which had to be postponed due to travel restrictions. The management cases studies have plans to further strengthen the dialogues with stakeholders after achieving more concrete results.

The project information is presented in the webpage www.waterharmony.net/wjpi.

2. Work Performed and the Results achieved during the reporting period

Maximum 10 pages.

Please attach any deliverables produced and information on milestones achieved during the reporting period of this report.

a. Scientific and technological progress

Please describe the work performed and the results obtained during the period concerned, and the conformity of the work progress within the initial schedule.
Take into account the following aspects:

- *Has progress been made towards progressing the project objectives according to the original description and milestones? If not, please, explain the deviation.*
- *Detailed update on methodology & results*
- *How has the progress of the project promoted multi-disciplinary work?*

The Polish partner confirms that all scientific and technological tasks were performed according to the schedule. The scope of works performed by UWM included both hydrochemical monitoring of the Łyna catchment area (in-situ), biosorption of dyes and pharmaceuticals from model water solution and

wastewater and also laboratory work on technological solutions related to automatic water analysis systems.

In accordance with the strategy of holistic water circulation management adopted in the Water Harmony project, research was carried out in the catchment area of the Łyna river, which is one of the four demonstration sites in the international Water Harmony project.

Qualitative and quantitative monitoring of the water cycle in the Łyna catchment area was performed. In the first stage, a field reconnaissance of the surface water network was made and the location of the 16 monitoring stations was established. The locations of sampling sites (surface and groundwater) were determined with the use of GPS-RTK receivers, and then the location of the sites was plotted on a numerical model of the Łyna catchment area. Anthropogenic and semi-natural factors disturbing the hydrological cycle in terms of the effect on the physical and chemical properties of water have been identified. Among them were: (i) rural systems as areal sources of pollution and water use; (ii) cumulated effect point sources of pollution from 5 urban areas along the Łyna river watercourse; (iii) climate change-related hydrological extremes (droughts and local flash floods); as well as solutions applied for water quality improvement (e.g. lake restoration, blue-green infrastructure etc.).

In order to identify the quantitative and qualitative status of water resources in the Łyna river basin, from June 2019 onwards, systematic (monthly) field measurements of the physicochemical properties of waters (multi-parameter probe YSI6600R2) were carried out and samples of surface waters (rivers and lakes) and groundwater (piezometers) were taken, which were then analysed in the laboratory of the Department of Water Management, Climatology and Environmental Management (KGWKiKS) UWM in Olsztyn.

Parallel to the hydrochemical research, hydrological observations and measurements were carried out on the river network of the Łyna (water levels and flow rate), using the pre-existing gauge network. Observations of meteorological parameters were also carried out at 5 meteorological stations belonging to UWM. The hydrometeorological database for the need of the model was built. The monitoring will be continued in following years 2021-2022 to obtain material for validation of multi-parametric models in cooperation with other consortium members such as Deltares from the Netherlands.

During the first reporting phase of Water Harmony project, advanced experiments on electrocoagulation were carried out. Efficient purification of azo {Disperse Red 167 and Acid Mixture (Acid Violet 90 and Acid Red 357)}: 50 mg dm-3 of the respective pigment in 0.054 M Na2SO4 supporting solution} dyes-based wastewater was successfully performed through a combination of electrocoagulation and surface electrooxidation processes through the employment of Cu/Al alloy macro-corrosion galvanic couple (much more cost-effective than the direct current-powered system, especially with respect to lack of expensive rectifier infrastructure). Conducted spectrophotometric UV-VIS instrumental analysis implied that both Disperse Red 167, as well as Acid Mixture dyes, underwent significant destruction of their chemical structures, leading to the formation of relatively simple electrodegradation products. Involvement of surface (Al alloy) electrooxidation reactions along with the formation of electrosorbed intermediates was strongly supported by the recorded a.c. Impedance and cyclic voltammetry results. Combined electrodegradation and electrocoagulation processes allowed to obtain final percentage removal at the levels of 32% (for Acid Mixture) and up to 99% for Disperse Red 167 dye.

Further work, along with optimisation of major parameters of the process is necessary in order to assess the suitability of this method for a technical scale and continuous, dye-based and environmentally-friendly wastewater purification system.

The Water Harmony project also involves research and development of automated systems for water analysis. A novel design of an angular detection photometer (ADP) based on detection of infrared

radiation from sources placed at various angles has been developed during the first reporting period by a team of prof. S. Kalinowski. The device allows for real-time monitoring of the coagulation process in in-situ samples. Various parameters affecting the coagulation process were tested, including the pH of the coagulation system, coagulant dose, flocculant type (i.e. anionic, cationic, nonionic). Capabilities of the ADP compared with the standard method of the jar test in optimising the coagulation process of humic acids in a synthetic raw water solution using Al2(SO4)3 have been assessed, as well. In-situ qualitative studies have shown that macromolecular polymers: anionic and nonionic polyacrylamides exhibit strong flocculation abilities with the formation of larger particles, respectively SD = (7.3-10.7) and SD = (9.7-19.7), than the cationic polyacrylamide, SD = (1.4-2.1). It was proved that measurements of particle dispersion, regardless of the angle of incidence of the light beam, are justified in analysing coagulation and can therefore complement analytical procedures used when optimising the coagulation process.

The Norwegian partner has to work with the development of virtual sensors to be used in sewer systems, and promising results were found. A new site to install the sensors were identified due to logistical issues at the first location. In addition to a surveillance system of water quality in the sewers, the task will now also cover the monitoring of stormwater discharge systems, though supplemental analysis of existing online measurements using physical parameters. The Swedish partner has been working with the development of sensors for the sites and are soon ready to deploy at the case study. Scientific paper regarding uncertainties in hydrological modelling was produced.

The Romanian partner is focusing on the water management improvement in a site located in the Danube Delta, on the Sulina Chanel, which is the main arm of the Danube that is discharged into the Black Sea. A stakeholder workshop was held to discuss the importance of water quality monitoring and also to establish a new monitoring system. The need and the benefits were discussed based on valuable historical data and own data base for the last 2 years in 22 monitoring points distributed along the Chanel from Tulcea to Sulina: Stakeholders proposed and agreed to have an automated monitoring system for the surface water quality on a passenger ship (ferry). This can scan (with a sampling frequency of 5 minutes) the water from the Sulina Chanel along with the distance from Tulcea to Sulina and respectively back from Sulina to Tulcea, performing automated measurements. This a quite cost-efficient way of monitoring water quality which is practiced in several marine ferry routes in Europe. Physical water quality sensors, micro analysators from the Polish partner and virtual sensors from the Norwegian partner will be included in the monitoring system. The automated system is expected to provide early warnings related to the potential algal blooms in the river stretch.

The Dutch partner who will be working with integrating and presenting the data from the case studies had identified the suitable data tools and platforms and are in dialogue with the subproject owners on acquiring data. The data will be integrated into the common system as soon as they are available, and anticipated by mid 2021.

Among the technological subprojects, the Spanish partner has selected suitable nanofibers for the different targeted pollutants. PVDF-TiO2 and PAN-Ag.

The Australian partner has investigated the adsorption pre-treatment to enhance the nanofiltration (NF) removal of inorganic ions, dissolved organic carbon (DOC) and organic micropollutants (OMP) from microfiltered (MF) wastewater. MF water from a water reclamation plant located in Sydney, Australia, which treats domestic sewage and stormwater was used as feed water in this study. The feed water contained a large concentration range of inorganics and organics, including 10 MOPs. A preliminary experiment with five NF membranes (NF 90, NF 270, NP 30, NF TS 80, NF Duracid) showed that NF 90, with the highest water contact angle (79%) and one of the lowest molecular weight cut off value (MWCO), had the highest conductivity and DOC rejection. It was therefore selected for use in subsequent experiments. The NF 90 membrane was made from polyamide TFC and supplied by Sterlitech Corporation, WA, USA. The MWCO value of the membrane ranged from 90 to 200 Da.

The NF showed greater rejection for divalent cations (Ca2+, Mg2+) and anions (SO42-) compared to monovalent cations (Na+, K+) and anions (Cl-, NO3-). The degree of total DOC removal was: GAC adsorption + NF (86%) > an ion exchange resin (Purolite) adsorption + NF (81%) > NF operation alone (72%). GAC + NF removed biopolymers and hydrophobic substances almost completely and the highest percentage of LMW neutral substances. In contrast, Purolite + NF almost completely removed humic substances. The degree of membrane fouling order was: LMW neutrals > building blocks > biopolymers > hydrophobics > humics. Adsorption pre-treatment reduced membrane fouling and increased solution flux, the outcome being better with GAC compared to Purolite. Of the 10 MOPs in the MF water, seven were rejected >90% by NF without any pre-treatment. Conversely, Purolite and GAC pre-treatments rejected >90% of all OMPs.

Overall, the study confirmed that adsorption pre-treatment using suitable adsorbents can greatly increase the NF rejection of salts, DOC and OMPs from wastewaters.

The Chinese partner has concluded the first part of the task with producing ultra-pure water from domestic wastewater for the Beijing 2022 site using a dedicated pilot plant and the unit is now continue for additional tests at the Qingdao city wastewater treatment plants. The other partners have started their experiments and are in various stages of implementation. The progress is severely impacted by several partners due to the access restrictions to the sites and laboratories.

b. Collaboration, coordination and mobility

- *Is the collaboration between partners effective? Is the contribution of each partner clearly identifiable? Does the project still meet the transnational nature?*
- *Please, indicate clearly those who performed the work (incl. also in-kind partners).*
- *Are the coordination and organisation of the project efficient?*
- *Please, describe the mobility of the researchers within the Consortium.*
- *Please indicate coordination with other projects funded in the 2018 Joint Call or national and international projects funded by other instruments*

The project started with high enthusiasm for a string collaboration, encouraged by the breadth and the depth of the knowledge and experience partners represent. Several partners met for the first time, and the kick-off workshop in May 2019 was a success, where the ideas for collaboration were exchanged. The team again met in Zaragoza, Spain in December 2019 as a back-to-back event to the EIP Water conference. The team was thereafter planned to meet in Israel in May 2020 to carry out the first innovation camp, but it was first postponed to October 2020 and now delayed until 2021. Although the partners carry out their individual activities at home organisations, there a string interrelationship among the partners, creating an international collaborative atmosphere.

The work envisaged by the partners can not be implemented only with the WaterJPI allocations. Therefore many activities were either supported by supplementary funding from other projects or/and partners own funding. The four partners from Australia, China, Singapore and the USA are making a remarkable contribution to the project by fully finding their activities form other projects or own in-kind funding.
The coordination of the project is partially efficient as the planned physical meetings were not possible to hold in 2020. Several video meeting were held, but is also a challenge due to to the

time zone challenges to include both the US and Australia/China/Singapore with the European partners. Thus most communications involved groups of partners and emails.
The project funding was envisaged only the visits to partners by the members of the other partner teams. Where it is possible, it was planned to involve students and other researchers through additional external funding, but none were carried out so far due to the COVID-19 restrictions. Nevertheless, project partners have already acquired travel and mobility grants to Australia, China, Romania, USA, Poland and Norway and looking forward to use them in 2021.

The inaugural meeting organised by the secretariat in Stockholm in April 2019 was quite useful to establish contacts with other waterworks 2018 projects. Potential projects to collaborate were identified and were planned to initiate further dialogues in 2020 with substantial results. This activity is also delayed.

c. *Impact and knowledge output*

- *Are the main impacts achieved?*
- *Are there any unexpected impacts?*
- *Where do the results of the project impact? (e.g. industry, end users, policy, etc.)*
- *Have the partners identified exploitable results?*
- *Has intellectual property protection been considered?*

The project is only halfway and severely delayed due to the COID-19 restrictions. The partners are, nevertheless, optimistic in achieving the intended impacts, especially if the required extensions will be granted. The extended international network created by the project and the potential synergies due to the complementarity of the partners are expected to generate more positive impacts than anticipated. However, many activities and possibilities are delayed and still less-utilised than the potential due to the prevailing conditions.

Various subprojects envisage various impacts on end-users (utilities and municipalities), industries, academia, policymakers and the general public. Some partners have come a long way to identify exploitable results such as the nanomaterials for commercially valuable membranes, analytical methods and virtual sensors, innovative treatment concepts etc.

The Swedish partner has got their patent application approved, while the Norwegian partner is in discussions with the Technology Transfer Office on IPR.

3. Table of Deliverables

Please indicate whether the planned deliverables are completed, delayed or readjusted. Explain any changes/difficulties encountered and solutions adopted. Please add/delete rows, as necessary in the table below.

	Deliverable	Lead partner	Delivery date	Changes, difficulties

				encountered and new solutions adopted
1.1	Mid-term reports from 4 demo projects produced	NMBU	9/20	Reported but progress delayed
1.2	Best practices guide produced for demos.	UMW	4/21	Anticipated 12/21
1.3	Open network functional	DETARES	2/20	Delayed, anticipated 08/21
2.1	Mid-term reports from 7 showcases produced	NMBU	9/20	Reported, but progress delayes
2.2	Tech forums held in IL, PL, ES, NO	BGU	10/19 7/20 5/21 9/21	Started but delayed
2.3	Technology validation reports	NMBU	2/23	Anticipated 10/23
2.4	Open network functional	DELTARES	2/20	Delayed, anticipated by 5/21
3.1	Implementation framework	DELTARES	10/19	Delayed, anticipated by 2/21
3.2	Report outlining the mapping of state variables	DELTAERS	5/20	Delayed, anticipated by 12/21
3.3	Proof of concept for select demo/case site studies	UMW	2/21	Anticipated 12/21
3.4	Proof of concept for sites -operational capacities	ASCA	7/21	Anticipated 12/21
3.5	A report detailing the outcomes lessons learnt	NMBU	12/21	Anticipated 9/22
4.1	1st Innovation camp in Israel conducted	BGU	12/19	Anticipated 5/21, likely to be delayed further
4.2	2nd Innovation camp in Spain conducted in	ASCA	5/21	Anticipated 10/21, likely to be delayed further
5.1	LinkedIn, ResearchGate, Mendeley operational	NMBU	3/20 3/21 03/22	Operational - delayed
5.2	Policy labs with public	IASI	3/23	Anticipated 10/23
5.3	Policy labs conducted	IASI	10/20	Anticipated 12/21
5.4	Report on best practices on political dialogues	IASI	12/21	Anticipated 07/22
6.1	Development of dissemination & communication plan	NMBU	6/19	Draft ready, finalisation 12/20
6.2	Webpage promoted among stakeholders	IASI	12/19	Anticipated 10/21
6.3	At least 10 scientific publications submitted	UMW	4/23	Anticipated 12/23
6.4	Presentations at UNECE PWH & SDGs meetings	NMBU	3/23	Anticipated 10/23
7.1	Inception report	NMBU	6/19	Completed
7.2	Signed consortium agreement	NMBU	7/19	Completed

7.3	Webpage developed	NMBU	11/19	Completed
7.4	Minutes of meetings x7	NMBU	5/19 12/9 5/20 10/20 5/21 9/21	1+2 completed, 3 cancelled and 4th carried out digitally
7.5	Final report	NMBU	4/23	12/23 anticipated

4. Budget review

Please include a budget breakdown here, i.e. how the funding has been used so far.

	Budget		Use by 10/20	
	Grant	Own funds	Grant	Own funds
NMBU	400 000	0	146 000	0
IVL	300 000	0	109 239	0
Deltares	215 000	0	35 000	0
UMW	135 000	0	15 576	0
ACSA	160 000	240 000	67 858	101 787
BGU	125 000	43 000	33 860	0
UTS	0	30 000		25 000
QUT	0	45 000		25 000
Marcor	40 000	18 000	0	0
MSU	0	10 000		3 000
NUS	0	30 000		12 000
IASI	125 000	0	74 000	0

5. Consortium Meetings

Please list below the Consortium meetings which took place during the reporting period, by filling in the table below. Add/delete rows as necessary in the table below.

N°	Date	Location	Attending partners	Purpose/ main issues/main decisions?
1	15.6.2019	Norway	All except MSU	Inaugural, routines, consortium agreement
2	11.11.2019	Spain	All except MSU, NUS	Progress, detailed planning on innovation camps

3	15.10.20	Video	All except MSU, BGU, NUS	Delays- agreed to request extension

6. Stakeholder/Industry Engagement

Maximum 1 page

- Please indicate how stakeholders/industry were involved in the project during the reporting period:
- *Has the project succeeded to engage with stakeholders/industry? If Yes, how? If No – why?*
- *If applicable, please, describe the provision of data by stakeholders/involvement of industry and dialogue between the project and stakeholders/industry.*
- *Has the cooperation between the Consortium and industry/stakeholder partners influenced the project outcome(s) to date? If Yes, How? If No, why?*
- *Outline the progress made towards achieving the project expected impacts.*
- *Were there unexpected impacts to date?*

- Several meetings with Sandviken Energy including following topics: informing, planning of activities, dissemination of co-operation in WH. Public Outreach:
  - https://www.slideshare.net/SGU_Sverige/johan-strandbergdricksvattenproduktionnarspelreglernaandras
  - https://www.ivl.se/toppmeny/pressrum/nyheter/nyheter---arkiv/2019-07-04-sandviken-forbereder-dricksvattenproduktionen-pa-ett-forandrat-klimat.html
  - https://www.linkedin.com/posts/ivl-swedish-environmental-research-institute_h%C3%A5llbar-f%C3%B6rvaltning-av-vattenresurser-activity-6575299518550601728-SOU8/
  - https://www.ivl.se/toppmeny/pressrum/pressmeddelanden/pressmeddelande---arkiv/2018-09-27-digitalisering-ska-sakra-sandvikens-framtida-dricksvatten.html
- Romanian partner:
  - The International Workshop “INCREASING THE PERFORMANCES OF THE WATER RESOURCES MANAGEMENT ON THE SULINA CHANEL BY ENCHASING THE COMMUNICATION BETWEEN PUBLIC ORGANIZATIONS, ADMINISTRATIVE AUTHORITIES AND CIVIL SOCIETY”, 29 -31 August 2019, Hotel Delta, Tulcea, Romania The presentation of actual situation related to the water quality on the Sulina Chanel and the need to implement an automated water quality monitoring system on the passenger ship https://www.facebook.com/INCDDD/posts/378827226140789?__tn__=-R https://twitter.com/ddni_ddtic/status/1168495210705444866?lang=ar 2.
  - Establishing a collaboration agreement (August 2019) with Danube Delta National Institute for R & D : permanent access on their server for transmitted data and storage as a database (communication between the water monitoring system installed on the ship and the server of institute - tested and working): the July 2020
  - Establishing a collaboration agreement (July 2020) with "Aquaserv" Water Utility Company (historical data about the main water quality indicators of the treated wastewater discharged into the Sulina Chanel and implementation of a warning system in the case of overcoming the Maximum Allowable Concentration of each water quality indicators (nitrate/nitrite and COD), along with the location of the polluted area (through the geographical coordinates detected by the GPS system from the ship) and the moment when the pollution was found) https://www.aquaservtulcea.ro/ https://www.facebook.com/AquaservTulcea/?ref=py_c
  - Establishing a mutual collaboration agreement (formal approved, but it still pending) with Danube Delta Biosphere Reserve Authority http://www.ddbra.ro/en

- Establishing a collaboration support (formal approved, but it still pending) with governmental authority : https://www.vatupdate.com/wp-content/uploads/2020/02/2020-12-02-Governmental-program-EN.pdf
- Norwegian parent had meetings with three municipalities / treatment plants
- Israeli partner had discussions with the Arad municipality and potential participants to the Innovation camp.
- Spanish partner had discussions with several potential participants to the innovation camp

The Water Harmony project brought together many partners for the first time creating a unique network, This gives new possibilities for joint projects.

The biggest unexpected impact is the restrictions imposed due to the COVID-19 Pandemic conditions. Most partners still struggle to star their work in normal conditions, and still it is not possible to predict when it will be normalised.

7. List of Publications produced by the Project - Open Access

- List all presentations, posters, and publications in scientific, peer-reviewed journals derived from this project, separating those in preparation, those in review and those accepted or in press.
- Provide websites and/or electronic copies of the key ones.
- Indicate all the co-authors for each publication.
- Order publications per date (chronologically) and for each year by alphabetical order.

Metadata on all project publications are required to be submitted as part of the final reporting. This will be done via the **Open Data & Open Access platform**, available at: http://opendata.waterjpi.eu/ (also accessible from the bar menu of the Water JPI website).

International	Peer-reviewed journals	1. Jamil, S., Loganathan, P., Listowski A., Kandasamy J., Khourshed C., Vigneswaran S. (2019). Simultaneous removal of natural organic matter and micro-organic pollutants from reverse osmosis concentrate using granular activated carbon. Water Research, 155: 106-114. 2. Ida K. Westerberg, Anna E. Sikorska-Senoner, Daniel Viviroli, Marc Vis & Jan Seibert. 2020. Hydrological model calibration with uncertain discharge data. Hydrological Sciences Journal. 3. Smoczyński L., Pierożyński B., Mikołajczyk T., 2020. The Effect of Temperature on the Biosorption of Dyes from Aqueous Solutions. Processes 8, 636. 4. Libecki B., Kalinowski S., Wardzyńska R., Bęś A., 2020. Using an angular detection photometer (ADP) in analyzing the humic acids

		coagulation proces. Journal of Water Process Engineering 37, 101507. 5. Łuba M., Mikołajczyk T., Bogusław Pierożyński B., Smoczyński, Wojtacha P., Kuczyński M., 2020. Electrochemical Degradation of Industrial Dyes in Wastewater through the Dissolution of Aluminum Sacrificial Anode of Cu/Al Macro-Corrosion Galvanic Cell. Molecules, 25, 4108. 6. Bartosz Libecki, Sławomir Kalinowski, Regina Wardzyńska*, Agnieszka Bęś, Using an angular detection photometer (ADP) in analyzing the humic acids coagulation process, Journal of Water Process Engineering 37 (2020) 101507 7. Nair, A., Hykkerud, A., Ratnaweera, H.: A cost-effective IoT strategy for remote deployment of soft sensors – a case study on implementing a soft sensor in a multistage MBBR plant. Water Sci Technol (2020) 81 (8): 1733–1739. https://doi.org/10.2166/wst.2020.067
	Books or chapters in books	1. 2. 3.
	Communications (presentations, posters)	1. Shahzad Jamil, Paripurnanda Loganathan, Andrzej Listowski, Jaya Kandasamy, Saravanamuthu Vigneswaran (2019) Dissolved organic carbon fractions and micro-organic pollutants removal from reverse osmosis concentrate using granular activated carbon and ion exchange resin, AWWTR2019, WEF-EESS Conference on Advancement in Water and Wastewater Treatment and Reuse, Singapore 29 July to 1 August 2019 2. Implementing conservation practices in the Łyna River catchment (UWM, PL), Glińska-Lewczuk K., 14-17.05. 2019, Oslo, Norway 3. UWM activities on water/wastewater purification technologies (UWM, PL), Pierożyński B., 14-17.05. 2019, Oslo, Norway 4. The Effect of Temperature on the Biosorption of Dyes from Wastewater (UWM, PL), Smoczyński L..12-14.01.2020 Harbin, China, 5. New methods of internal calibration of water quality monitoring systems in cold climate, (UWM, PL), Kalinowski S., Koronkiewicz S., 12-14.01.2020 Harbin, China, 6. Energy- and reagents-saving analytical systems for monitoring of water quality in cold climate, (UWM, PL), Koronkiewicz S.,

		Kalinowski S. 12-14.01.2020 Harbin, China, 7. A poster presentation at an International Conference ICCE2020, in Iasi, Romania (see the last poster): http://www.cercetare.icpm.tuiasi.ro/conferinte/ICCE2020/pdf/ICCE2020-PosterSection3.pdf
National (separate lists for each nationality)	Peer-reviewed journals	1. 2. 3.
	Books or chapters in books	1. 2. 3.
	Communications (presentations, posters)	1. At SGU Grundvattendagarna 2019. Dricksvattenproduktion när spelreglerna ändras. Användning av yt- och grundvattenmodeller I dricksvattenproduktion, Johan Strandberg, IVL. Water Recycling,(Marcor), Marjanowski J., Nalikowski A. 21-22.11.2019, Gniew Castl
Dissemination initiatives	Popular articles	1. 2. 3.
	Popularconferences	1. 2. 3.
	Others	1. 2. 3.

8. Knowledge output transfer

For each of the Knowledge Output arising from the project so far, please complete the following table.

Short Title *Please provide a short and concise title to describe the Knowledge Output*	
Knowledge Output Description *Please only include generated Knowledge Outputs, not those that are expected. Note: Knowledge Outputs can be non-deliverables, milestones or 'grey knowledge'. Also, multiple Knowledge Outputs could exist within one deliverable, and should be separated.*	

Try to give a comprehensive description, making the Knowledge Output fully understandable to a non-expert. *If relevant please provide detail of where the Knowledge Output differs from its equivalent, e.g. What are the key characteristics of the Knowledge Output? What research is it adding to and what is innovative about the Knowledge Output? (Max 500 characters).*	
Knowledge Type	Please choose one option – delete the rest: * exploitable scientific result * scientific publication * report * book/review * RTD protocol/technical manual * guidelines/standards * training activity/learning module * software/modelling tools * product * prototype * services/tools * multimedia * data * other
Link to Knowledge Output *If you can provide a link to the Knowledge Output then please do so, e.g. digital object identifier (DOI), web address, download, research paper.* *If the Knowledge Output is not publicly available currently but will be in the future, please provide details. Also, if it is available but only upon request, please state this.* *If the Knowledge Output is not planned to be publicly available, please state "Not available for public".*	
Sectors & Subsectors *Choose as many options as required from the list. Pick those sectors that you think would benefit from the application of this Knowledge Output.*	• Basin Management • Flood Risk Management • Water Scarcity and Droughts • Drinking Water • Bathing Water • Emissions and Water Reuse • Adaptation to Global Change • Others ○ Other General

	○ Agriculture ○ Governance ○ Consumer Health & Welfare ○ Finance ○ Modelling & Prediction ○ Socio-Economics ○ Stakeholder Involvement
End User *Choose as many options as required* *Per identified End User, please identify possible applications of the Knowledge Output.*	o Education & Training o Environmental Managers & Monitoring o Industry o Policy Makers / Decision Makers o Scientific Community o Civil Society o Other
IPR *Please indicate whether IPR has been applied to this Knowledge Output (applied for a patent, copyright etc), or not.* *Please insert "n/a" if no IPR has been applied.*	IVL
Policy-Relevance If the Knowledge Output is relevant to the WFD or any other related Directives, please list and explain why	
Status *Please identify whether the Knowledge Output is finalised, is still being generated or whose status/future is unknown. Consider:* *• Is your knowledge conclusive enough that it provides sufficient evidence to make an impact on, or be applied by, an End User?* *• Is there a corroborating body of evidence, or are contradictory results, available?* *• Does your knowledge progress beyond the current state-of-the-art / evidence base?* *• Is more research or demonstration needed to validate the results?*	

9. Open Data

In relation to Open Data, the funded projects will be requested to submit metadata on all the resources directly generated by the project, as well as additional information on how these data will

be exploited, if and how data will be made accessible for verification and re-use, and how it will be curated and preserved. Metadata on all project resources are required to be submitted as part of the final reporting. This will be done via the **Open Data & Open Access platform**, available at: http://opendata.waterjpi.eu/ (also accessible from the bar menu of the Water JPI website).

At present data are stored in DropBox. Data will be stored according to the national guidelines.

10. Problems Encountered during Project Implementation

- Please indicate if any problems were encountered during the Project Implementation.
- Did any of the partners find difficulties related to the grant agreement, the availability of funds at national level or other similar issues not specifically related to the technical part of the project?

There were some delays in the signing of the grant agreements with local financing agencies. Some national agencies required the Consortium agreement signed by all partners before granting the national funds, while others required the national funds granted before signing the Consortium agreement. There were severe delays but finally we manged to get the Consortium agreement signed by all parties on ten 21.8.2019.

The project is severely delayed due to COVID 19 pandemic conditions.

Partner	Requested extension	Status
NMBU (NO)	28.02.2023	Request pending WaterJPI secretariat's recommendation
IVL (SE)	28.2.2023	Granted by the National authority
ACSA (ES)	30.6.2022	Granted by the national authority
UMW (PL)	31.12.2020	Granted by the national authority
BGU (IL)	31.12.2022	Applied, decision pending
IASI (RO)	31.12.2022	Request pending WaterJPI secretariat's recommendation
Others	Not decided yet	

11. Suggestions for improvement regarding project implementation?