Project[1] Number: **101004186**

Project Acronym: **Water-ForCE**

Project title: Water scenarios For Copernicus Exploitation

Interim Technical Report

Period covered by the report: from 01/01/2022 to 31/12/2022

Periodic report: **Interim**

[1] The term 'project' used in this template equates to an 'action' in certain other Horizon 2020 documentation

1 Explanation of the work carried out by the beneficiaries and Overview of the progress

1.1 Objectives

The **overarching objective of the Water-ForCE project is to develop a Roadmap for future Copernicus water related services.** The Roadmap will define scenarios for delivering water cycle related Copernicus services in the most optimal way in order to support the development and implementation of directives and policies and ensure effective uptake of water-related services by a wide variety of end users from research community to industry.

The Roadmap will summarise technical requirements for future satellite missions to improve their capability to provide high accuracy water related data, develop higher level biogeochemical products, foster closer cooperation between remote sensing, *in situ* and modelling communities in order to build an optimal water component in Copernicus Services that provides necessary information to policy makers, managers, researchers and general public.

During the first reporting period (M1 to M12) the Water-ForCE consortium was dedicated to analyse the current water related Copernicus portfolio and establish a needed network of external experts and stakeholders to build the knowledge and the community which eventually will be the user of the future Copernicus water-related Services. This was needed to get feedback and build an actionable Roadmap.

Even though the Roadmap preparation (WP6) started in the second reporting period according to the work plan given in the Grant Agreement, a skeleton with the general structure with the titles and subtitles of chapters was made ready during the first 12 months to provide guidance on where and how the planned contributions and deliverables fit into the Roadmap and avoiding overlaps. The skeleton went through three iterations with different communities during the first reporting period (Advisory Board, Experts invited to the Workshop: Copernicus water component evolution – policy expert (20-21st October 2021) and Consortium joint input).

During this second reporting period (M13 to M24) most of the technical work has been done with the compilation of technical information from all WPs and the identification of needs and gaps in the water-related Copernicus Services. This was done through desk research and the organisation of meetings, workshops, webinars and public consultations in the form of questionnaires.

The needs and gaps were matched with the current state-of-the-art in the domains of every technical WP (Water Quality, Water Quantity, *In situ* data and Modelling). This work will directly feed the Roadmap and the main recommendations for the potential future scenarios which will be fully developed during the last 12 months of Water-forCE (M25-M36)

The main work and achievements of every WP during this reporting period are explained below.

1.2 Explanation of the work carried out from M13-M24

The Water-ForCE work consists of four overarching WPs and four technical WPs (see Figure 1). The first overarching WP1 - "**Policy, stakeholders and service analysis**", analysed current and coming policies, end users needs, innovation needs, need for supporting water related SDG's, etc. The WP1 provided information and tasks to the technical WPs (WP2-5). The technical WPs are: "**Water quality**

continuum" (WP2), "**Water quantity**" (WP3), "**Aligning *In Situ* and Satellite Earth Observation Activities**" (WP4) and "**Modelling and data assimilation**" (WP5). Each of the technical WPs will produce their recommendations for the Roadmap. This work has been done by mobilising relevant international communities into working groups which developed their recommendations through workshops and other meetings.

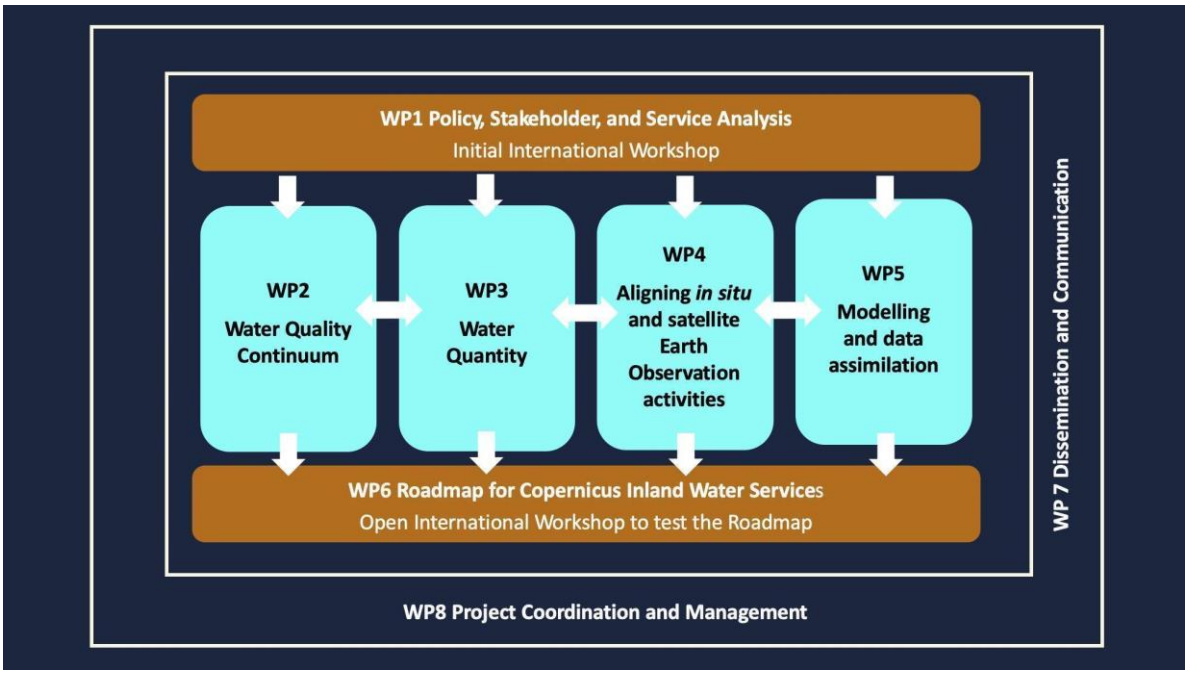

Figure 1. Water-ForCE work concept.

The second overarching WP is WP6 "**Roadmap for Copernicus Inland Water Services**" whose main task is critically summarising the findings of each WP and producing the first draft of the roadmap which will be put in public discussion in an international workshop in spring-summer 2023. Water-ForCE consortium will then analyse all the outcomes of the workshop and will produce the final version of the Roadmap.

The last two overarching WPs are WP7 "**Dissemination and Communicatio**n" and WP8 "**Coordination and Management**". WP7 works in the effective bringing of all relevant parties to the Water-ForCE initiatives and in the promotion of the importance of the Roadmap for policymakers, managers, industry, and research community. Finally, the Coordination and Management WP (WP8) takes care of the smooth progress of the project and of the fulfilment of all the obligations stated in the Grant Agreement (GA).

1.2.1 Work Package 1 – Policy, Stakeholders and Service Analysis

The objective of WP1 is to identify key users within the different public domains and business sectors and evaluate whether Copernicus Services can meet their operational and policy goals. WP1 is an overarching set of activities, where we first bring together all information about the key elements of the Copernicus programme in relation to the inland water cycle: stakeholders, policies and Services.

Based on a thorough analysis of policies and Services, we have started to work with a broad group of stakeholders (with a focus on non-satellite EO communities) to understand their needs and the opportunities for innovation: how do and can Copernicus-based services meet the needs of policy, societal and business needs at European and global (e.g., Sustainable Development Goals; SDGs) level. The result is a comprehensive overview of stakeholders as well as an identification of business sectors and how Copernicus can support these and how sectoral policy can support the evolution of Copernicus to improve service development and stimulate uptake. All work for WP1 was completed in the current reporting period and documented in this report.

There were six deliverables and two milestones in WP1, of which four deliverables and and one milestone were carried out in this reporting period (M13-M24):

D1.1 List of stakeholders (submitted M7. Approved by the EC)

D1.2 Assessment of domain-specific and sectoral policies and legislation (submitted M10. Approved by the EC)

D1.3 Links within and between Copernicus programme (submitted M15)

D1.4 End-user needs (submitted M15)

D1.5 Business opportunities (submitted M15)

D1.6 Satellite EO, SDGs and climate indicators (submitted M15)

MS1 WP1 participants workshop 20 April 2021

MS2 WP1 Input to the Roadmap (19/05/2022)

The main findings and results of the WP1 deliverables and milestones (MS2) achieved during the M13-24 period are described below.

The main partners involved in WP1 were dotSPACE, ICCS and U STIRLING while other contributors and reviewers from WP1 or other WPs have actively participated in increasing the level of the deliverables either providing suggestions or specific information or conducting the internal reviews.

D1.3 Links within and between Copernicus programme

The water sector currently uses 5 core Copernicus services (CLMS, CEMS, CMEMS, C3S, Security) and EEA Copernicus *in situ*. From user needs analysis, there were identified 5 upstream and 4 midstream requirements for future Copernicus missions. There were identified the five future missions relevant to the inland water domain (sensors on Sentinels 8-12).

The analysis identified the following upstream requirements of the water sector based on the information collected from the 'Sensor requirements and capabilities" for each of the new Sentinels:

- Spatial resolution of 1-5 m
- Increased resolution (sub 1 m) in order to identify smaller inland water bodies and provide information on the hydromorphology of rivers
- Spatial resolution 5-20m, pixel resolution to 1 ha minimum mapping unit
- Time resolution yearly and seasonal maps based on daily to weekly information
- Ideal inland and near coastal water quality sensor for general use and covering the needs of most applications (imaging spectrometer with 5-8 nm spectral bands from 340 to 1000 nm,

and a minimum of three SWIR bands, Spatial resolution: 5-10 m ground sampling distance (GSD), Revisit frequency should be high as possible: daily for reservoirs/dams, and weekly for lakes/rivers, monthly for coastal).

Moreover, the following capabilities interpreted as midstream capabilities were identified:

- Integration of radar data and services
- Integration of spectroradiometers in the existing infrastructures
- Wider collection of hyperspectral radiometry
- Hyperspectral data for water quality, algal blooms and shallow water.

A relevant development for the water sector and linked to Copernicus Services is the development of the concept for the Copernicus Thematic Hubs (CTH). The CTH is an initiative to regroup, under one single entry point, information generated by several Copernicus Services for a given high level topic. In order to obtain a rich and operational level of integration it is important to implement for the CTHs the following:

- Collect and maintain in a single catalogue the relevant products and information,
- Harmonise these inputs and provide to users guidance and support with the help of the contributing Copernicus Services.

D1.4 End-user needs

The report was based on 152 interviews carried out online using questionnaires but also using one to one communication. There were identified a number of sector gaps in: water quantity, agriculture, energy, tourism and recreation, and private sector (such as mining and manufacturing). These user needs were compiled and listed using their statistical occurrence (for the complete list of user needs please consult D1.4).

From the large number (28) of emerging user needs that were identified across the application areas below there are listed the first ten (10) in the order of their priority and the number of user requests:

1. Water quality and water levels (quantity) not only on major lakes, but also in smaller reservoirs and rivers and much finer scale (catchment scale). The need for such information has been identified by most of the experts and organisations interviewed for this report (see interviews summary above)
2. Inclusion of microbial, toxin, algal and metal indicators and plastic pollution indicators. Dashboards or early warning systems for algal blooms and cyanobacteria are recurrently identified also in the experts interviews.
3. Watershed modelling, hydrological and hydrodynamic modelling
4. Detection of dissolved organic matter
5. Chlorophyll-a concentration in lakes and inland waters in general.
6. Coupling groundwater level monitoring to land use change
7. Discrimination of permanent and temporary water bodies
8. Risk-related indices to water systems: congestion, fishing jetties, flow speed, overgrowth, subsidence, sedimentation.

9. Monitoring of fast growing water plants and algae. NIOO-KNAW received a request from the Dutch National Water Authority to map the vegetation growth that could hinder vessels movement on inland waterways.
10. Better resolution of the algal community structure and biomass

D1.5 Business opportunities

The report is based on extensive desktop research and seven *in person* extended interviews (>1hr each) with industry players covering the whole value chain. The report was successful in identifying some of the business opportunities and their development thereof (the aim was to engage into an open dialogue with industry and not conduct an exhaustive market research) and assessed how industry and SME policy and instruments support innovation. It also considered technological drivers in the satellite and IT sectors, as well as advances in data collection techniques such as Citizen Science in conjunction with remote sensing.

D1.6 Satellite EO, SDGs and climate indicators

For this specific deliverable it was carried out an extensive literature/online research to identify the EO capabilities for inland waters and links/gaps between EO and SDGs and links with Global Climate Indicators (GCIs). The report provides a summary of existing Copernicus Services based on the service websites and presentations from service representatives given during the Water-ForCE workshop ''Copernicus water component evolution – policy expert'' (20-21 October 2021). Key related projects and international organisations/initiatives were identified which we engaged in order to better understand requirements, needs and opportunities with regards to climate research and SDGs. This information was collected through two main sources:

i. the Water-ForCE workshops and other activities (e.g. webinars) where key international organisations and representatives of global initiatives were invited,

ii. active engagement (memberships, stream works etc.) with international initiatives and relevant projects (e.g. ESA Climate Change Initiative (CCI)).

MS2 WP1 Input to the Roadmap

WP1 has contributed to the Roadmap by providing directly in the live document a series of conclusions derived from the work carried within all work package tasks. The contribution and input has been presented during a **joint meeting (Milestone 2/MS2)** between WP1 and WP6 on May 19th (2022). During the same meeting WP1 has delivered and presented an internal document (**Synthesis Report**) which summarises the WP1 findings besides the input to the Roadmap. This document was developed to serve internally the other project work packages, tasks and deliverables. Moreover, together with the Synthesis report WP1 developed also a **framework** (link) which allows to have a high-level overview of how the requirements identified within all WP1 tasks (user, missions, SDGs) can be met by EO and Copernicus data and services, either alone or with complementary data from drones, *in situ* and citizen science (CS).

The main WP1 suggestions identified within this report (i.e. Synthesis Report) for the development of the Roadmap were:

- Expand the user requirements analysis to more representatives of the private water management sector, and from the mining and industry sectors. Gain a better understanding of the requirements of a water-smart society and the Water-Oriented Living Labs (identified in 24 European countries).
- Use the gap analysis framework to indicate where future Sentinels and Copernicus services should be augmented to meet the technical requirements of all user groups (including water practitioners, EC policies and SDGs) as far as possible.
- Strong consideration of the requirements for *in situ* information coming from the EEA (e.g. for lakes, river level monitoring, inflow data to coastal zones, river level monitoring networks and the use of CS data for calibration/validation (cal-val) of satellite EO water quality products), and from water managers in the public and private sectors.
- Future research and development activities for the development of new services towards the water market, must insist on multi-source information and the use of smart technologies.
- Emphasise the role of EO service providers in the expansion of the market for water information and any digital, thematic hub or platform tailored to the inland water sector.
- Launch an awareness campaign towards private companies in the water sector (non-EO) and those responsible for water monitoring, regarding the capabilities of EO and Copernicus.
- Suggest the creation of a dedicated thematic Water Hub or platform which seamlessly collates data and information from a wide range of sources - EO, *in situ* & citizen science, short-range remote sensing, drones, etc. Such a platform should put more emphasis on multi-source analytics to meet the user demand for situational awareness in water management. To avoid the risk that this concept becomes too EO heavy, perhaps it should not be labelled a 'Copernicus service'
- Completion of the spreadsheets in the Gap Analysis Framework should highlight gaps where EO and Copernicus could further support the information requirements of the water sector.

Deliverable/ Milestone	Title	Lead Beneficiary	Due Date [months]	Status
D1.1	List of stakeholders	U STIRLING	7	Approved by the EC
D1.2	Assessment of domain-specific and sectoral policies and legislation	dotSPACE	10	Approved by the EC
D1.3	Links between mission-service-application	dotSPACE	14	Delivered
D1.4	End-user needs and requirements identification	ICCS	14	Delivered
D1.5	Innovation needs and opportunities	dotSPACE	14	Delivered
D1.6	Contribution towards societal challenges	U STIRLING	14	Delivered
MS1	WP1 participants workshop	U STIRLING	4	Achieved
MS2	Input to the Roadmap	dotSPACE	16	Achieved

Table 1. WP1 deliverables and milestones' status until M24.

WP number\ Beneficiary	UTARTU	ST DOTSPACE	isardSAT	ANTEA	PML	FVB-IGB	GEOECOMAR	ICCS	USTIRLING	IHE DELFT	EMU	NIRDBS	VUB	3edata	CNR	VITO	BOKU	CREAF	SINERGISE	Total PM
WP1	2.00	10.6	2.00	0.90	0.83	2.00	1.29	2.91	4.24	1.45	1.00	1.00	1.00	1.01	1.25	0.91	1.50	1.14	1.00	37.99

Table 2. Draft workload in person months inside of WP1 until M24.

1.2.2 **Work package 2 – Water Quality Continuum**

The objective of WP2 is to analyse the state-of-the-art in water quality remote sensing products compared to the current Copernicus portfolio and to propose, based on the technological advancements and policy-driven requirements identified in WP1, the most effective way to provide different water quality products under the Copernicus services. This includes enlarging the number of higher-level products, providing uncertainty estimates for current and future products, identifying gaps in existing knowledge and technical possibilities as well as training both young remote sensing specialists and end-users how to develop and use future water quality products of the Copernicus services.

There were five deliverables and one milestone until M24:

D2.1 Water Quality Working Group (submitted M5. Approved by the EC)

D2.2 Recommendations on Copernicus products - Water Quality (submitted M7. Approved by the EC)

D2.3 Atmospheric correction (submitted M24)

D2.4 Higher-level biogeochemical products (submitted M24)

D2.5 Technical needs for future Sentinels (submitted M24)

MS3 Workshop of the water quality remote sensing working group (achieved M2)

All the deliverables were submitted on time. The content and the results of the deliverables achieved during the M13-24 period are described below.

The Water-ForCE WP2 team, members of the Water-Force Water Quality Continuum international working group and members of GEO Aquawatch actively discussed in the various Water-ForCE Water Quality Continuum workshops, the ESA Living Planet Symposium 2022 and GEO Aquawatch meetings the state-of-the-art in terms of atmospheric correction and aquatic products, CEOS analysis ready data for (hyperspectral) aquatic reflectance and nomenclature and provided recommendations.

The main Water-ForCE partners involved in WP2 were UTARTU, VITO, IGB, CNR, PML, U STIRLING, WI, BOKU, EMU and 3edata.

D2.3 Atmospheric correction

Deliverable D2.3 Atmospheric Correction (submitted on 20/12/2022) gives an overview of the atmospheric corrections currently used by the Copernicus services for water quality products (inland and coastal waters), the state-of-the-art, needs and recommendations related to atmospheric corrections for water.

After describing the current atmospheric corrections used in the Copernicus water quality related services, collecting Copernicus services, R&D and end-user needs and describing the state–of-the-art in atmospheric correction, recommendations in categories atmospheric correction, *in situ* data for atmospheric correction Cal/Val, atmospheric correction Cal/Val and sensors for atmospheric

correction were collected at the Water-ForCE Water Quality Continuum Atmospheric Correction Workshop on 20/10/2022 with 55 participants. All recommendations (36) provided by the invited speakers were scored by experts in atmospheric correction (validation) in order to prioritise the recommendations. Most high priority recommendations were related to the category *in situ* data for atmospheric correction Cal/Val and to the need to develop atmospheric correction algorithms that include adjacency effect correction.

The top 3 highest priority recommendations are:

● Priority 1: Need for long-term funding programs to support automatic measurement networks

● Priority 2: Need for automated fixed station measurement networks, which are geographically well-distributed and represent different water types to support atmospheric correction validation activities for both coastal and inland waters

● Priority 3: Develop atmospheric correction algorithms that include adjacency effect correction

Deliverable D2.3 (including all 36 recommendations and average scores received) serves as an input for the Water-ForCE Roadmap.

D2.4 Higher-level biogeochemical products

The D2.4 (submitted on 16/12/2022) was supposed to analyse the possibility of delivering some *in situ* higher-level biogeochemical products recommended by D4.5 using remote sensing products as input (according to the original work plan). However, WP1 and D2.2 identified significant gaps in the current Copernicus (inland) water quality portfolio. Therefore, it was decided to broaden the scope of the D2.4 and also include analysis on the state-of -the-art and the possibility of delivering multiple new products within the Copernicus program. The water quality products, that are highly requested by different user groups, but currently missing in the Copernicus portfolio, can be divided into three broad themes:

Carbon fractions in water - dissolved organic carbon (DOC), coloured dissolved organic matter (CDOM), particulate organic carbon (POC), dissolved inorganic carbon (DIC), total organic carbon (TOC), partial pressure of CO_2 (pCO_2), etc.

Shallow water products - bathymetry, benthic habitat type, carbon fixed by benthic habitats, etc.

Floating material products - plastic and other litter, cyanobacterial bloom floating on the water surface, macroalgae (*Sargassum, Ulva*, etc.) mats, pollen, invasive floating plants (e.g. Water Hyacinth), etc.

A workshop was organised in the premises of CNR in Milan on September 20-21 2022 entitled Shallow Water and Floating Matter Remote Sensing workshop to discuss the state-of-the-art of the latter two broad product groups and the potential/readiness of these products within the future Copernicus portfolio. It was stated in the workshop that the launch of Sentinel-2 with its 10 m spatial resolution and high revisit time made it possible to deliver many of the above mentioned products. The plans of Sentinel-2 Next Generation (improved spatial and spectral resolution) will enhance these possibilities even further. On the other hand, there is food for further discussions whether some of the products should be included among the Copernicus core products and delivered freely for all users or whether these products should be delivered on regional or local scale on commercial bases.

D2.5 Technical needs for future Sentinels

The D2.5 was submitted on December 15, 2022. Preliminary Water-ForCE recommendations were provided to ESA and to the expert dealing with water in the Sentinel-2 Next Generation Ad Hoc Expert Group in January 2022 and September 2022, respectively. During the hybrid Water-ForCE workshop on Shallow Water and Floating Matter Remote Sensing (September 20-21 2022, CNR, Milan) we further discussed the need of new spectral bands from the perspective of different water quality applications (shallow water, floating material, carbon fractions, water constituents mapping, recognising of harmful algal blooms, etc.). These findings are included in D2.4 and D2.5 and the preliminary recommendations provided in D2.2 in terms of new spectral bands were updated in D2.5.

Some of the Water-ForCE participants (Claudia Giardino-CNR, Tiit Kutser-UTARTU, Els Knaeps-VITO) are in the ESA Earth Explorer 12 candidate mission GALENE (the first satellite mission specifically designed for inland (and coastal) water research) Science Team. The recommendations of Water-ForCE were delivered also to this team.

The main recommendations on sensor features can be summarised as follow: hyperspectral sensor with **contiguous bands from UV to NIR** with an average **band width of 5 nm** possibly **augmented by a SWIR** imaging spectrometer with a **spatial resolution from 5 up to 33 m;** as spectral and spatial resolution are the core sensor priorities the **temporal resolution needs to be as high as is financially possible**. A 4°-5° fixed westward tilt is also recommendable for glint avoidance, multi-angular polarimeter and night observations have been also suggested within the ESA Earth Explorer 11. The value of **multi-mission/multi-sensor capabilities** was also discussed to cover the variety of resolutions needed to observe aquatic ecosystems.

Work to be carried out in the on-going tasks of the WP2:

All remaining deliverables of the WP2 were due in December 2022 and have been delivered in time. The main task remaining for the WP2 in 2023 is providing input to the Roadmap (Milestone MS4). Task leaders already started to transfer the main outcomes of the WP2 in the relevant chapters of the Roadmap. Completion of this remaining task is planned by the end of April 2023 to reach MS4.

Deliverable/ Milestone	Title	Lead Beneficiary	Due Date [months]	Status
D2.1	Water Quality Working Group	VITO	5	Approved by the EC
D2.2	Recommendations on Copernicus products - Water Quality	FVB-IGB	5	Approved by the EC
D2.3	Atmospheric corrections	VITO	24	Delivered
D2.4	Higher-level biogeochemical products	UTARTU	24	Delivered
D2.5	Technical needs for future Sentinels	CNR	24	Delivered
MS3	WP2 participants workshop	UTARTU	5	Achieved
MS4	WP2 Input to the Roadmap	UTARTU	28	On-going

Table 3. WP2 deliverables and milestones' status until M24.

WP number\ Beneficiary	UTARTU	ST DOTSPACE	ANTEA	PML	FVB-IGB	GEOECOMAR	USTIRLING	IHE DELFT	EMU	NIRDBS	VUB	3edata	CNR	VITO	BOKU	CREAF	SINERGISE	WI	Total PM
WP2	9.00	0.18	0.90	2.42	2.25	0.71	0.72	0.54	1.89	1.00	1.00	1.43	2.50	8.44	1.67	1.37	0.91	0.97	37.90

Table 4. Draft workload in person months inside of WP2 until M24.

1.2.3 Work Package 3 – Water Quantity

The overall objective of WP3 is to provide insight on the Copernicus products and services supporting water management and modelling (floods, drought, surface water extent, soil moisture, ice, precipitation) including state-of-the-art and gap analysis using existing knowledge by building a community of water quantity experts.

There were five deliverables and one milestone until M24:

The content and the results of the deliverables achieved during the M13-24 period are described below.

D3.1 International working group in water quantity remote sensing (submitted M3. resubmitted M15)

D3.2 Copernicus products - hydrological (submitted M6. Approved by the EC)

D3.3 Copernicus products and services - water management (submitted M24)

D3.4 Water resources modelling (submitted M24)

D3.5 Sentinel missions for inland water quantity (draft version submitted M25)

MS3.1 WP3 participants Workshop (achieved M3)

The main partners involved in WP3 are VUB as the work package leader, Antea, IHE-DELFT and CREAF as task leaders. UTARTU, ST DOTSPACE, isardSAT, PML, FVB-IGB, GEOECOMAR, ICCS, U STIRLING, EMU, NIRDBS, 3edata, CNR, VITO, BOKU and SINERGISE as contributors.

D3.3 Copernicus products and services - water management

For this deliverable, WP3 performed a literature review on water management applications for remote sensing products, in order to identify ongoing applications, while gathering common gaps and recommendations by end users that can be considered towards the Roadmap.

The report starts with an overview of different frameworks and directives that are crucial for water management in Europe and the world, and ways in which remote sensing is currently applied for their compliance. Later on, a summary of ongoing projects related to the Water Framework Directive, floods, droughts, climate policies and other actors is presented, to showcase examples of how remote sensing is actively being used for water management. Finally, a gap analysis is presented, in which the shortcomings of current remote sensing products were gathered from the literature review. Recommendations were then formulated based on the gaps found.

The main results showed that despite the plethora of remote sensing products on water management that are available, there is a limited use of RS products for water management. There is a need for more suitable products to better monitor the status of the water bodies (e.g. from future SWOT missions) and to provide more data on human interactions in the water cycle, especially in data scarce areas. At the same time, the biggest bottleneck is to make the data FAIR (Findable/Accessible/Interoperable/Reusable). Our analysis highlights the importance to better harmonise the data, to involve and train the end users and to integrate the use of remote sensing data in water policy implementations.

The report has been delivered as of December 2022 and it is currently under internal revision.

D3.4 Water resources modelling

For this deliverable WP3 team aimed to review the latest state-of-the-art in data processing and identify how much from the modelling needs are addressed with the current satellite EO services. The outcome of this report was further used in WP5, specifically in D 5.4 to identify the ways models need to adapt in order to make extended use of the current available services. The report, D3.4 starts with an introduction presenting the scope of Water-ForCE project, followed by a section on modelling principles, and model structures. As modelling water quantity requires specific vocabulary a set of definitions for the notions on modelling used in the report is provided. Next section provides an overview of the most used tools for water quantity modelling, along with those tools used for water allocation. As there are a variety of tools developed by different schools, the section ends with a list of other available tools. A literature review of the last 5 years publications on the use of RS as data inputs for the modelled case studies with the presented tools is also shown in the report. Section 4 of the report shows the available Copernicus services that could be used as data inputs for water quantity modelling, as they have been identified and presented in deliverables 3.2 and 5.2. The report ends with Conclusions, where recommendations for the Water-ForCE final roadmap are provided.

In general, hydrological models are the standard tools used for understanding and exploring what is happening in hydrological processes. Models can be applied from small catchments to large ones and eventually as global models, depending on how they have been defined during development. Each model has its own unique characteristics and consequently they are valid for specific applications. Some models use the physics of the underlying hydrological processes and are distributed in space and time, requiring large amounts of data that are not always available from in-situ monitoring stations or surveys. RS data and services should be used. There are a lot of RS services and data, not all used in modelling. Deliverable 5.4 of Water ForCe shows which RS services in general, and in particular which ones of Copernicus are used by modellers to support decision making and policy development. This deliverable gives an overview of what Copernicus services and data are available for modelling.

The models are used for the modelling of both gauged and ungauged catchments, are used for flood forecasting, water resources management, erosion and sedimentation, nutrient and pesticide circulation, land use and climate change etc. Each model has various drawbacks like lack of user friendliness, large data requirements, absence of clear statements of their limitations etc. In order to overcome the stated drawbacks, it is necessary that models include rapid advances in remote sensing technologies.

The task was accomplished 100%,, as of December 2022 and the final version of deliverable D3.4 is currently under internal revision.

D3.5 Sentinel missions for inland water quantity

The deliverable 3.5 reviews firstly the main features of the current and planned Sentinel missions, the Expansion missions and the Next Generation of Sentinel missions. A second part explains the technical requirements collected in the Task 3.5 activities. Finally a crossed analysis between both parts allows to conclude specific recommendations in the water quantity domain for future Sentinel missions.

The main goal of task T3.5 is to collect technical requirements to make future Sentinel missions more suitable for water quantity monitoring. The activities developed with this aim to provide valuable information have been: workshop of the Water Quantity working group, literature review, dedicated survey to the working group members and additional external experts, attending relevant related sessions in conferences, such as ESA Living Planet, EGU and Copernicus webinars. Other used sources of information are: previous WaterForCE deliverables (mainly D5.2) and dedicated scientific papers on

journals or proceedings which present, review and discuss the existing technical specifications, the comparison with similar non European missions and those suggest potential improvements.

The task was accomplished 80%. In January 2022 we generated a draft version (uploaded to the EC portal). The skeleton of the deliverable is defined, some sections are almost completed (they need a review) and others have just some references or "raw" content which need to be filtered , analysed and better described.

Work carried out in the on-going tasks of the WP3:

All deliverables of the WP3 were due in December 2022 and are now in a final draft version just following the last steps of the review process. The main tasks remaining for the WP3 in 2023 is the finalisation of the deliverables and providing input to the Roadmap (Milestone MS6).

Deliverable/ Milestone	Title	Lead Beneficiary	Due Date [months]	Status
D3.1	International working group with water quantity remote sensing	ANTEA	3	Re-submitted M15
D3.2	Recommendations on Copernicus products related to the hydrological water balance	ANTEA	5	Approved by the EC
D3.3	Copernicus products and services – water management	VUB	24	Draft Delivered M25
D3.4	Water resources modelling	IHE DELFT	24	Draft Delivered M25
D3.5	Sentinel missions for inland water quantity	CREAF	24	Draft Delivered M25
MS3	WP3 participants workshop	ANTEA	3	Achieved
MS6	Input to the Roadmap	VUB	28	

Table 5. WP3 deliverables and milestones' status until M24.

WP number\ Beneficiary	UTARTU	ST DOTSPACE	isardSAT	ANTEA	PML	FVB-IGB	GEOECOMAR	ICCS	USTIRLING	IHE DELFT	EMU	NIRDBS	VUB	3edata	CNR	VITO	BOKU	CREAF	SINERGISE	Total PM
WP3	2.00	0.23	1.50	9.90	0.72	1.50	0.49	1.70	0.42	0.42	1.00	1.00	10.55	0.27	0.75	0.52	0.49	4.97	0.98	39.41

Table 6. Draft workload in person months inside of WP3 until M24.

1.2.4 Work Package 4 – Aligning *in situ* and Earth observation activities

The focus of the WP4 is the better alignment of *in situ* and remote sensing communities to deliver a wide range of water quality and water quantity products for research, industries, policymakers and statutory monitoring bodies and to ensure that both communities can mutually benefit from data collection and sharing. It is essential that the *in situ* and satellite data are comparable at absolute levels. This requires a coordinated strategy for sampling and deployment of *in situ* infrastructure as well as access to the same planning tools and historical records. This WP fosters that the data from *in situ* measurements become available and interoperable for calibration and validation of space-based sensors across different systems and sites in the inland water domain, meanwhile securing principles of data ownership for long-term sustainability of observation networks. This will ultimately lead to recommendations on the inclusion of optical-biogeochemical water quality and water quantity reference data sources in the Copernicus *in situ* Component framework.

There were six deliverables and one milestone until M24

D4.1 An international "live" working group for *in situ* and satellite EO monitoring (submitted M5. resubmitted M15 - reported in the first periodic report)

D4.2 *In situ* data-intensive monitoring (planned to be submitted on M24. Draft submitted on M25)

D4.3 Combining *in situ* and earth observation data (planned on M24. Draft submitted on M25)

D4.4 Alternative monitoring methods (planned to be submitted on M24. Draft submitted on M25)

D4.5 New higher-level products (planned to be submitted on M24. Submitted M25)

D4.6 Standardization and open science (planned to be submitted on M24)

MS7 Workshop of *in situ* data networks for satellite cal/val working group (achieved M2, reported in the first periodic report)

The content and the results of the deliverables D4.2; D4.3; D4.4; D4.5 and D4.6 achieved during the M13-24 period are described below.

The deliverables 4.2 and 4.4 were submitted in an almost final draft format to be able to gather all the needed input from the WP4 Experts Working Group for *in situ* and satellite EO monitoring.

D4.2 SOPs for the *in situ* networks and data-intensive monitoring devices

Task 4.2 "Strengthening the *in situ* component of Copernicus for calibration and validation" objective is to summarise gaps and recommendations towards harmonised *in situ* observations which can be used to build sustainable support for Copernicus Water services, and vice versa. The task is 80 % accomplished with drafting D4.2. Task leaders have provided the outline document and requested contributions from Copernicus and ESA CCI teams working on the identified hydrological and biogeochemical domains. It has been reviewed and improved by other WP4 partners. The timeline to delivery has been extended by two months to accommodate further input and provide time for public consultation. This has no impact on WP6 because the document primarily informs *in situ* communities of practice rather than roadmap activities, and the draft document is available to the WP6 team.

Earlier activities in this task revolved around the expert workshop which was reported on in the first year, and further analysis of survey results with key limnology communities (90% done).

The final report of this deliverable provides an initial standard of practice for the design of *in situ* network nodes, including definitions and concepts, essential variables and recommendations from satellite product providers to the *in situ* observation community, and requirements for efficient data sharing and dissemination.

Partners involved (during this reporting period): PML (lead), EMU, U STIRLING.

Deviation from the Work Plan: No major deviations. The delivery plan is extended by two months to accommodate all potential input from the expert community. This will have no knock-on effects on WP6 because the draft is already available.

New date of delivery: planned Feb 2023 (extended by 2 months to allow for expert consultation).

D4.3 Report on best practices for combining *in situ* and earth observation data

Task 4.3 "Data integration within and between observation networks" objective is to compile the information on the currently available databases for storing *in situ* data which could be used for calibration and validation of remote sensing based water products. Existing *in situ* databases are reviewed for their existing or potential use with satellite-EO data. The task is 70 % accomplished with drafting D4.3. Task leaders have provided the outline document and requested contributions from the WP4 members. The draft report summarises the optimal data information and framework coupling *in situ* data and satellite-EO products relating to water quality and quantity. Through a review of existing *in situ* databases and interviews with data managers, needs for the future organisation and storage of *in situ* data for use with satellite-EO products were identified. Actions that may facilitate the wider use of *in situ* data within satellite-EO projects were emphasised.

Partners involved (during this reporting period): U STIRLING (lead), EMU, FVB/IGB, VITO, GEOECOMAR, ICCS, PML, NIRDBS.

Deviation from the Work Plan: No major deviations. The delivery will be 1 month later than expected. This will have no knock-on effects since the draft is already under construction and is being completed by the same group that is working on WP6.

New Date of delivery: Extended by 1 month. The report is being finalised for internal review and submission in January 2023.

D4.4 Report on recommendations for the uptake of alternative monitoring methods

Task 4.4 "Integration of alternative data sources" objective is to create an inventory of available alternatives technologies and methods which can be used to build sustainable support for the calibration and validation of products within the future Copernicus water services. 80% of the task is accomplished in M24, with 2 workshops and public consultations made to gather the needed information from international external experts. The last workshop (Citizen Science for the CAL/VAL of satellite aquatic products) took place in M22, the outcomes are published in the Water-ForCE Zenodo Community. The Deliverable 4.4 is focused on the potential that the uptake of data from UAVs, Citizen Science, Smartphone solutions and Water Quality and Quantity sensors can have inside of water-related Copernicus Services and the Copernicus in situ component. The outline and draft of the Deliverable is shared with the WP4 partners.

The document contains the identification of this potential alternative data sources and the foreseen synergies with satellite Remote Sensing (RS) and hence with the Copernicus Services, identifying when possible what needs or gaps previously identified in Water-ForCE (WP1 and other technical WPs) can benefit from this additional data layer. Every alternative or innovative data source has its own section in this document, in which the current knowledge is being summarised or duly referred to other review documents, highlighting the state of the art in data acquisition, limitations and potential uptake in Copernicus Programme. The data management and main recommendations are described in the two last sections, being the recommendations sorted into four different groups: Technology, Data Management, Coordination and Funding.

The consultation with experts showed that Citizen Science through official programs and UAV with commercial hyperspectral and multispectral sensors or with built-in imaging sensors were the most valued alternative data sources when they were asked whether these data sources could add value to satellite calibration and validation. The main recommendations for the uptake of alternative data sources in the technology section are related to the need of intercomparison exercises and standard protocols to use UAV, sensors and Citizen Science data for calibration and validation. The data management recommendations highlighted the need for standardisation of metadata and data QA/QC protocols to build confidence in these data sources.

Partners involved (during this reporting period): FVB/IGB (lead), 3edata, EMU, VITO.

Deviation from the Work Plan: No major deviations. The delivery date has been extended 1 month which will not affect any further activity inside of the project. No mitigation measure taken. The final delivery date has been delayed to have the needed time to make a public consultation with the Experts Working Group of WP4. This delay will not affect the Roadmap advance, as the final input (MS8) must be done in April 2023 and all the intermediate versions will be made available to the WP6 through the Water-ForCE common workspace.

New Date of delivery: January 2023. Extended by 1 month to get feedback from the WP4 Experts Working Group

D4.5 Factsheets outlining the potential new higher-level products

Tast 4.5 “Innovative combinations of existing *in situ* sensors to provide higher level biogeo-chemical products for lake monitoring, research and management” objective is to find out which new possible higher-level products can be developed based on *in situ* data (buoys, ASVs and AUVs). This information served as an input for D2.4 where we analysed which of these new *in situ* products can be delivered using current Copernicus products as input or which one could be delivered if the new generation of Copernicus satellites will be available. In M24 95% of the task is accomplished. We have offered 3 possible new products which could be established for near future Copernicus water related services. The products that were recommended to Task 2.4 (i.e. those that can be delivered using satellite data as input) are:

- primary production
- dissolved organic carbon (DOC) and partial pressure of carbon dioxide (pCO2)
- total phosphorus

The report has passed the WP4 internal review and was sent to the Water-ForCE consortium internal review on the 20th December 2022. One reviewer (IsardSAT) sent the recommendations for changes and edits on the 27th of December, second reviewer were pending at the end of M24. Last updates

from the both reviewers were made in M25 and deliverable was submitted at the beginning of the year 2023.

Partners involved (during this reporting period): EMU (lead), UTARTU, 3edata, FVB/IGB, PML, U STIRLING, VITO, WI, CNR, IHE, isardSAT, VUB.

Deviation from the Work Plan: NO major deviation occurred, NO mitigation measures taken.

New Date of delivery: revised and submitted on 9th January 2023.

D4.6 Guidelines to enable interoperability of *in situ* networks and connection with GEOSS

Task 4.6 "Standardisation and open science" objective is to describe the guidelines in standardising the *in situ* and remote sensing databases inside of the Copernicus water-related Services, for these databases to be compliant with the FAIR principles and interoperable even when they are coming from different sources, including suitable metadata standards. A self-developed tool based on Phyton programming language was implemented to automatically check any existing database against a FAIRness test. In M24, 80% of the task is accomplished. The main Copernicus databases have been checked according to the FAIR principles using this automated tool implementation which calls 3 in built automated tools (1. FAIR-Checker; 2. FAIR-Enough; 3. F-UJI) to assess the resources.

The overall results give the highest scoring inside of the Copernicus resources to the marine one (CMEMS), with a total score of 1.73. The Atmosphere and Climate Services have the same score because they use the same CMS, while the Land SErvice has the lowest score. The PANGAEA, with the most complete FAIR implementation, has a score of 3.51 out of 4. We identified metatags and implementation specific details for the Copernicus databases so that the FAIRness automated checking could reach significantly higher scores (which leads to higher standardisation and interoperability of data). We have also provided a comprehensive list of metadata that can make the data interoperable and has connections with GEOSS.

Partners involved (during this reporting period): NIRDBS (lead), EMU.

Deviation from the Work Plan: No major deviations. The delivery date has been extended 1 month which will not affect any further activity inside of the project. No mitigation measure taken.

New Date of delivery: Jan 2023. Extended by 1 month.

Work carried out in the on-going tasks of the WP4:

All remaining deliverables of the WP4 were due in December 2022, some of them have an expected delay between 1-2 months. The only remaining task for the WP4 in 2023 is providing input to the Roadmap (Milestone MS8). Task leaders already started to transfer the main outcomes of the WP4 deliverables in the relevant chapters of the Roadmap. Completion of this remaining task is planned by the end of April 2023 to reach MS8.

Before the final input to the Roadmap, the Experts Working Group of WP4 will have the opportunity to give feedback to the WP4 deliverables, which will be implemented in the Draft deliverables before the final internal review and subsequently reflected in the Roadmap.

WP4 has been actively working with the COINS project (Copernicus Observations *In Situ* Networking and Sustainability) through several dedicated meetings during 2022. One of the main outcomes of this cooperation was a plenary talk given by Water-ForCE representatives in the GLEON All Hands' meeting

2022, explaining the needs and value of *in situ* data for Copernicus. A good engagement was obtained and assessed during the meeting with a Mentimeter question. A follow up action already planned is the delivery of a coordinated questionnaire and webinar for GLEON members (planned for February 2023). This is part of the actions to better align *in situ* and remote sensing communities as a needed step to achieve the expected impacts of Water-ForCE.

Deliverable/ Milestone	Title	Lead Beneficiary	Due Date [months]	Status
D4.1	An international "live" working group for *in situ* and satellite EO monitoring	EMU	5	Re-submitted M15
D4.2	SOPs for the *in situ* networks and data-intensive monitoring devices	PML	24	Draft delivered M25
D4.3	Report on best practices for combining *in situ* and earth observation data	U STIRLING	24	Draft delivered M25
D4.4	Report on recommendations for the uptake of alternative monitoring methods	FVB-IGB	24	Draft Delivered M25
D4.5	Factsheets outlining the potential new higher-level products	EMU	24	Delivered M25
D4.6	Guidelines to enable interoperability of *in situ* networks and connection with GEOSS	NIRDBS	24	Pending
MS7	Workshop of *in situ* data networks for satellite cal/val working group	EMU	5	Achieved
MS8	*In situ* data collection, calibration and validation recommendations for the Roadmap	EMU	28	Ongoing

Table 7. WP4 deliverables and milestones' status until M24.

WP number\ Beneficiary	UTARTU	ST DOTSPACE	isardSAT	ANTEA	PML	FVB-IGB	GEOECOMAR	ICCS	USTIRLING	IHE DELFT	EMU	NIRDBS	3edata	CNR	VITO	BOKU	SINERGISE	WI	Total PM
WP4	3.00	0.10	0.80	0.75	2.36	4.00	0.66	0.49	3.38	0.64	5.17	1.18	4.60	1.13	1.25	1.59	0.68	0.80	32.58

Table 8. Draft workload in person months inside of WP4 until M24.

1.2.5 Work Package 5 – Modelling and Data Assimilation

The overall objective of WP5 is to build on the knowledge acquired in WP1-WP4 and identify the potential for future use of different satellites in modelling of water resources for support of decision makers towards adaptive management of water resources and policy implementation.

There were four deliverables and one milestone until M24

D5.1 Copernicus EO needs for modellers and decision makers (submitted M18)

D5.2 Copernicus Services and Products - Modelling (submitted M22, internally reviewed and resubmitted in M24)

D5.3 AI for accurately correcting systematic forecast errors (submitted M23, internally reviewed and resubmitted in M24)

D5.4 Integration of satellite EO and modelling (Draft submitted M25)

MS9 WP5 participants Workshop (achieved M3)

The content and the results of the deliverables achieved during the M13-24 period are described below.

D5.1 Report on needs assessment for Copernicus EO needs for modellers and decision makers, including an overview of the main stakeholders identifying these needs (submitted M18)

Deliverable 5.1 report provides the current use of Remote Sensing data (RS) for modelling water quality and water quantity such that model outcomes are useful to decision makers. The aim of the report was to look at RS services in general, however the report gives special attention to Copernicus services, in order to better formulate recommendations for the Water-ForCE final Roadmap. The report is structured in four main parts, followed by annexes. Report analysis is based on a defined methodology for collecting data from literature and through surveys. Analysis of the findings from the literature review and specific questionnaires and interviews is used for the recommendation of a set of possible improvements to current Copernicus services.

The main recommendation for the Roadmap is to highlight the need of EO and RS for modelling water quantity and water quality in support of decision making, while a special emphasis should be made on the Copernicus data. A total of 12 recommendations are given related to the need of more spatial data coverage, frequency of datasets update and ease of usability, accessibility and uncertainty reporting.

All gathered data through surveys, literature review and extracted information from literature review is available at the end of the report in annexes.

D5.2 Technical recommendations report on Copernicus services and the related data in order to improve the monitoring and modelling of water bodies (submitted M24)

This deliverable analyses and evaluates the availability and suitability of Copernicus products and services for water modelling, both for the case of water quantity and water quality, and comprising all types of use of EO data in modelling (forcing data, calibration data, validation data, evaluation data, assimilation data), and makes recommendations for improvement that can be incorporated in the Water-ForCE Roadmap. This deliverable builds the information gradually, first identified **EO needs** in water modelling, are presented based on the outcomes of *D5.1.* Next, a screening of existing Water

EO products for modelling at Copernicus Services is presented along with the availability of variables identified in the needs section. The spatial coverage, data discovery and access, file data formats, validation reports, uncertainty indicators and spatial and temporal resolutions and their utility in the mentioned types of water modelling was analysed. The analysis of existing Water EO products for modelling at non-European agencies is also presented, in order to give a picture of what is available outside Copernicus for modelling.Main conclusions of the work point to the lack of bathymetry and evapotranspiration as well as some specific water quality products, the need of finer spatial resolution for chlorophyll-a in coastal zones and for soil moisture, surface water and snowmelt products, higher temporal resolution for river discharge and groundwater and water quality variables, the need of validation, increase the coherence between in-situ and remote sensing observations and to provide more quality and uncertainty information. Other demands are to uniform marine and lake products, a global (or at least Pan European) coverage for some local/regional products, improvements in data access and data delivery of new formats, and continuous and consistent long-term archives of vegetation and land cover products.

D5.3 AI for accurately correcting systematic forecast errors (submitted M24)

This deliverable presents the topic of Artificial Intelligence (AI) for EO in general and a more conceptual framework, focusing on providing an overview on the current status of the use of AI by the EO community (their attitude towards implementing AI) and ideas/visions on how AI can be of further support to the needs of the end user. The latter indicating bottlenecks for the end user, limiting the implementation of AI for EO purposes and therefore limiting the optimal exploitation of EO data. Deliverable 5.3 explains the different definitions used when entering the world of artificial intelligence. An overview on the implementation of AI in various EO domains or projects and how it supports achieving today's UN Sustainable Development Goals (SDGs) is provided as well. An overview on AI/ML (machine learning) approaches currently used in the (pre-) processing of EO data (including challenges & pitfalls) is shown along with different types of end user needs of the EO community and the usage of AI in order to support the exploitation of EO data are discussed. The bottlenecks with regard to AI implementation and the Technological Readiness Level of techniques and applications are presented in the end of the deliverable.

It was found that the number of projects and initiatives focusing on the need of the integration of EO data processing, -assimilation and application building and artificial intelligence techniques is significant and rising. Important bottlenecks limiting the use of AI for optimal exploitation of EO data are the lack of labelled datasets, the volume of data and the explainability/causality of events. Among others, streamlined platforms and initiatives and a focus on a holistic approach for the implementation of AI for EO are recommendations for guiding different stakeholders to the relevant information.

D5.4 Report on integration of satellite EO and modelling aspects for providing better decision support and operational management, including recommendations (Draft submitted M24)

This report presents the different use of Copernicus data for policies at national and international level. The overall use of RS data is presented followed by the use of them in European agencies. The use of Copernicus data in water management, by decision makers at European country level are presented followed by the use of EO data that are not Copernicus, in different International agencies. The document ends with a series of recommendations for the Roadmap.

At EU level water policy in all member states is based on the relevant EU Directives, most important of which are the Water Framework Directive (WFD) and the Flood Directive (FD). These have been translated into corresponding national legislation, and have led to development of River Basin Management (FRM) and Flood Risk Management (FRM) plans. Implementation of these directives, in

particular the development of RBM and FRM plans have involved extensive modelling of the water systems, mostly with data from existing in-situ monitoring networks. Some recent initiatives for demonstrating the usefulness of Copernicus data in monitoring and assessing progress with implementation of WFD. However, such examples come from research centres and actors actively engaged in Copernicus uptake, and expansion to regular water management activities is yet to be realised. This report makes an extensive overview of the use of Copernicus data at national levels.

Work carried out in the on-going WP5 tasks:

All the remaining deliverables of the WP5 were due in December 2022, just one of them was delivered in a very advanced draft format and will be uploaded in the final version within M25. The only remaining task for the WP5 in 2023 is providing input to the Roadmap (Milestone MS9). Completion of this remaining task is planned by the end of April 2023 to reach MS9.

Deliverable/ Milestone	Title	Lead Beneficiary	Due Date [months]	Status
D5.1	Report on needs assessment for Copernicus EO needs for modellers and decision makers, including an overview of the main stakeholders identifying these needs	IHE Delft	M18	Delivered
D5.2	Technical recommendations report on Copernicus services and the related data in order to improve the monitoring and modelling of water bodies	CREAF	M22	Delivered
D5.3	State of the art and recommendations on applying AI for accurately correcting systematic forecast errors and predict the time evolution of geophysical parameters from satellite and other geophysical inputs	Antea	M22	Delivered
D5.4.	Report on integration of satellite EO and modelling aspects for providing better decision support and operational management, including recommendations	IHE Delft	M24	Draft submittedM 25
MS9	Workshop of modelling and data assimilation working group (Delft)[	IHE Delft	M03	Achieved
MS10	Modelling and data assimilation WP related recommendations for the Roadmap	IHE Delft	M28	Not started

Table 9. WP5 deliverables and milestones' status until M24.

WP number\ Beneficiary	UTARTU	ST DOTSPACE	ANTEA	PML	FVB-IGB	GEOECOMAR	ICCS	USTIRLING	IHE DELFT	EMU	NIRDBS	VUB	3edata	CNR	CREAF	SINERGISE	WI	Total PM
WP5	1.00	0.22	4.10	0.83	1.00	0.44	0.41	0.14	3.09	1.83	1.00	1.00	0.45	0.75	5.00	0.27	0.78	22.31

Table 10. Draft workload in person months inside of WP5 until M24.

1.2.6 **Work Package 6 – Roadmap for Copernicus Inland Water Services**

The main objective of WP6 is delivering the actual Roadmap for Copernicus inland water services and how this fits into the research and innovation opportunities across Europe and internationally. This WP is building on the information provided by the other WPs and externally to identify the gaps (technological, capacity) and the stimulants needed to deliver on the economic opportunity and societal benefits that Copernicus and EO can offer in water-related sectors.

This WP includes recommendations for future Copernicus products and funding calls that will stimulate economic growth and the co-development of bespoken services that are tuned to the regional and global needs.

There are 5 deliverables and 1 milestone. The tasks are;

D6.1 Capacity Building Requirements for Copernicus Inland Waters (submission changed from M24 to M27)

D6.2 Priorities for Research and Innovation for Copernicus (submission in M28)

D6.3 Opportunities for Business and Innovation and Service Delivery for Policy (submission in M28)

D6.4 First Draft: Roadmap for Copernicus Inland Waters Service (planned to be submitted on M30)

D6.5 Final Draft: Roadmap for Copernicus Inland Waters Services (planned to be submitted on M36)

M6.1 Workshop to test the Water-ForCE Roadmap (Stirling) (planned to occur in M30 or M31 depending on holiday season in different countries)

Notably, WP6 also provided input (through consultation and active participation) to most activities carried out (workshops, deliverables) during this reporting period.

WP6 activities officially started in month 18 although the discussions on the Roadmap took place in every event organised by the Water-ForCE project. There was one deliverable until M24

D6.1 Capacity Building (to be submitted in M27)

Task 6.1 identifies the skill and technology gaps, and the optimal mechanisms and stimulants required to deliver on the economic opportunity and societal benefits that the EO, and Copernicus in particular, can offer in the water sector.

A questionnaire focusing on capacity building needs was developed and it has been rolled out to current or potential users of satellite-EO based water quality products. The initial results are currently being analysed. The collation of relevant materials has also commenced. This includes the work presented in other deliverables and webinars. Part of the necessary work from other WP's is not yet submitted.

We found that it will be necessary to move the deadline of this deliverable from M24 to early M27. This delay is caused by the difficulties experienced by the lead partner in hiring staff for the project and the fact that very many deliverables of other WPs finished also in M24. There is now a dedicated person leading this task and most of the other WPs have submitted their deliverables. Thus, the delay with the D6.1 will not require amendment of the GA.

Work carried out in the on-going WP6 tasks:

D6.2 Priorities for Research and Innovation for Copernicus (submission in M28)

This deliverable will map the developments identified in ongoing R&D and services against the user needs identified in WP1 and associated WPs 2-5. The gaps are then prioritised by community need and sector (policy, industry and research), and the technical feasibility of solutions will be evaluated, such as satellite platform development, and associated with either core Copernicus service development or as opportunities for business innovation for key sectors (in parallel with T6.3). This task will ultimately make recommendations for the next generation of Copernicus Services and the technical requirements for satellite platforms and in situ sensor networks.

The task has started with a collation of materials from WPs 1-5 and relevant workshops and contributed webinars. A joint-up analysis is planned with U STIRLING (T6.3) in January 2023.

D6.3 Opportunities for Business and Innovation and Service Delivery for Policy (submission in M28)

This deliverable identifies the future opportunities for business innovation and service delivery for policy within the satellite-EO inland and coastal water domain. In particular, the R&D activities identified by D6.2 will be considered, and questions will be asked as to where value can be added or where there are missed opportunities. Focus will be placed on business innovations or services that can complement existing or anticipated policy requirements, which are feasible and have a demand (as recognised in previous WP's), within Europe and internationally. This task will result in a foresight document, highlighting these future opportunities.

Relevant business innovations and policy-related services revealed from the work in WPs 1-5 have been noted and will be the starting point for this task. A joint-up analysis is planned with U STIRLING (T6.3) in January 2023.

D6.4 First Draft: Roadmap for Copernicus Inland Waters Service (planned to be submitted on M30)

In progress towards the First Draft, an outline of the Roadmap has been delivered (July 2021) and was circulated to all partners and Advisory Board members for comments. The Roadmap outline was also delivered to the invited experts of the Workshop: Copernicus water component evolution – policy expert (20-21st October 2021) and disseminated during the event. The Roadmap outline was discussed and edited during the virtual project WPs meetings (October - November 2021) and during the progress meeting in Tallinn (December 2021). All partners had the opportunity to review the Roadmap outline. The draft was also discussed with the Advisory Board (May 2022, Bonn) and at the Joint Research Centre (September 2022, Ispra)

The purpose of the Roadmap outline is to ensure that:

- activities remain aligned with the final roadmap delivery
- WP6 receives consistent information from the remaining WPs and
- any potential gaps or overlaps are uncovered.

D6.5 Roadmap for Copernicus Inland Waters Services (planned to be submitted on M36)

The Final Roadmap will be produced taking into account the comments and suggestions collected during an international workshop to be organised on M30 or M31 in Brussels.

M6.1 Workshop to test the Water-ForCE Roadmap (Stirling) (planned to occur in M31)

The workshop dates and agenda will be discussed at the General Assembly (February 28- March1, 2023), after which the workshop planning will commence.

Deliverable/ Milestone	Title	Lead Beneficiary	Due Date [months]	Status
D6.1	Capacity Building Requirements for Copernicus Inland Waters	U STIRLING	M24	Ongoing
D6.2	Priorities for Research and Innovation for Copernicus	PML	M28	Ongoing
D6.3	Opportunities for Business Innovation and Service Delivery for Policy	U STIRLING	M28	Ongoing
D6.4	First Draft: Roadmap for Copernicus Inland Waters Service	UTARTU	M30	Ongoing
D6.5	Final Draft: Roadmap for Copernicus Inland Waters Service	UTARTU	M36	Not started
MS11	Workshop to test the Water-ForCE Roadmap		M31	Not started

Table 11. WP6 deliverables and milestones' status until M24.

WP number\ Beneficiary	UTARTU	ST DOTSPACE	isardSAT	PML	USTIRLING	IHE DELFT	EMU	VUB	3edata	Total PM
WP6	1.50	0.27	0.34	0.22	1.96	0.18	0.05	1.00	0.13	5.65

Table 12. Draft workload in person months inside of WP6 until M24.

1.2.7 **Work Package 7 – Dissemination and Communication**

This WP started at the KO and will run until the end of the project. It evolves nominally.

The main objective of WP7 is to design and put into action effective communication with stakeholders and dissemination of project results. Water-ForCE stakeholders include scientific and operational users, policy makers, commercial users and space agencies. WP7 is divided into 4 main tasks:

T7.1 Development of a stakeholder engagement, dissemination and communication plan. (**isardSAT**, all others)

T7.2 Project webpage and outreach tools and materials. A Communication toolkit – with corporate image and leitmotiv including key messages and visuals as well as suggested materials for use by local, national and EU levels (**isardSAT**, all others)

T7.3 Supporting the organisation of users and stakeholder workshops in WP2-WP4 and the two major open International Workshops. (**isardSAT**, all others)

T7.4 Dissemination of project results and scientific communication. (**isardSAT**, all others)

Concerning T7.1, the establishment of a concise communication strategy with a predetermined scope and carefully defined goals is essential in order to develop communication activities in an efficient way. This strategy was designed during the first year. The communication strategy includes the definition of communication goals, target groups, communication channels and materials as described in the deliverable D7.1 Dissemination and Outreach plan Document submitted on July 30th, 2021 (v1), the updated version following recommendations was submitted on March 28th, 2022 (v2).

Concerning T7.2, a project reference identity, a dedicated web site and common layouts were developed during 2021. The project web page (https://waterforce.eu/) was up and running by March 15th, 2021 and was updated following the first year evaluation. The website is maintained and kept up to date by isardSAT, as the lead on WP7.

Concerning T 7.3, the Water-ForCE dissemination team has supported the organisation of users and stakeholder workshops. During the first 24 months of the project, we have contributed to the following Water-ForCE Workshops:

1. “On the use of remote sensing for monitoring and modelling the water cycle” |March 15th 2021|Online event https://waterforce.eu/workshops/on-the-use-of-remote-sensing-for-monitoring-and-modelling-the-water-cycle
2. Stakeholder Input on the Evolution of Copernicus Water Services | April 20th, 2021 | Online event https://waterforce.eu/workshops/stakeholders-workshop-how-stakeholders-can-support-the-evolution-of-copernicus-water-services
3. *In situ* calibration and validation of satellite products of water quality and hydrology | May 17th, 18th and 20th, 2021| Online event https://waterforce.eu/workshops/in-situ-calibration-and-validation-of-satellite-products-of-water-quality-and-hydrology
4. Copernicus water component evolution – policy expert | October 20th and 21st 2021 | Hybrid: Online and Phoenix Copenhagen Hotel https://waterforce.eu/workshops/copernicus-water-component-evolution--policy-expert
5. Shallow water and floating matter remote sensing | September 20th and 21st 2022 |Online event https://waterforce.eu/workshops/shallow-water.
6. Citizen Science for the CAL/VAL of satellite aquatic products | October 11th, 2022| Online event https://waterforce.eu/workshops/citizen-science
7. Water Quality Continuum Atmospheric Correction Workshop |October 20th, 2022 | Online event https://waterforce.eu/workshops/water-quality-atm (54 participants)

During 2022, we have also organised monthly webinars. The organised webinars are the following:

1. Water and Agriculture (January 26th, 2022). https://waterforce.eu/webinars/water-and-agriculture
2. SDG6 clean water and sanitation (February 23rd, 2022) https://waterforce.eu/webinars/sdg6-clean-water-and-sanitation
3. Copernicus for Africa (March 30th, 2022). https://waterforce.eu/webinars/copernicus-africa
4. Public-Private partnerships for Copernicus water services (April 27th, 2022). https://waterforce.eu/webinars/public-private
5. EU Funding 4 Copernicus Water Applications (June 1st, 2022). https://waterforce.eu/webinars/eu-funding
6. Summer edition: Copernicus 4 Recreational Inland Waters (June 29th, 2022). https://waterforce.eu/webinars/recreational-inland-waters
7. Technical Need for Copernicus Inland Water Monitoring Service (October 26th 2022). https://waterforce.eu/webinars/inland
8. Copernicus for Inland Water Biodiversity Monitoring (November 30th 2022). https://waterforce.eu/webinars/inland-biodiversity

Finally concerning T7.4, the Water-ForCE team has participated in the following conferences presenting the project objectives:

1. ASI: Hyperspectral Remote Sensing Workshop 2021: PRISMA Mission and beyond, March 13th-14th 2021

2. 4th SENTINEL-2 validation team meeting, March 15th-17th 2021
3. Hydrospace GEOGloWS 2021, June 7th-11th 2021, hosted as a Virtual Event from ESA- ESRIN, Frascati, Italy, https://hydrospace2021.org/
4. Water Innovation Europe organised by Water Europe, June 14th-18th 2021, Virtual Event https://watereurope.eu/water-innovation-europe/
5. Symposium for European Freshwater Sciences (SEFS), July 25th-30th 2021, Dublin. Workshop organization (30 Participants)
6. AIT 2021 X International Conference AIT (Italian Association of Remote Sensing), September 13th-15th 2021
7. GEO AquaWatch webinar, October 3rd 2021
8. Global Lake Ecological Observatory Network (GLEON), October 4th-8th 2021. Workshop Organization (50 paritcpants)
9. 11th Congress of the Balkan Geophysical Society, October 10th-14th 2021| Virtual Event
10. Copernicus Emergency Management Services week (CEMS week 2021), October 25th-29th 2021, https://emergency.copernicus.eu/mapping/ems/cems-week-2021
11. Black Sea International Day 2021, October 28th 2021
12. GEO Week 2021, November 23rd-26th 2021 https://earthobservations.org/geoweek2021.php?t=wag
13. BELSPO Stereo III TIMBERS Steering Committee
14. United Nations/Ghana/PSIPW - 5th International conference on the use of space technology for water resources management. Accra, Ghana, 10-13 May 2022
15. Cross-sectoral PROCLIAS/ISIMIP Workshop meeting, 16. - 19. May 2022, Potsdam, Germany
16. Living Planet Symposium 2022 (LPS2022), 23-27 May 2022, World Conference Center Bonn, Bonn, Germany
17. EARSeL SIG IS 2022
18. European Geosciences Union General Assembly 2022 (EGU 2022)
19. EARSC SeBS user workshop on water quality management
20. Nationales Forum für Fernerkundung und Copernicus. 21. – 23. June 2022, Berlin
21. Flood Knowledge Summit
22. 36th Congress of the International Society of Limnology
23. 73rd International Astronautical Congress
24. Ocean Optics XXV
25. 44th Meeting of Water Framework Directive Common Implementation Strategy Working Group on Ecological Status (ECOSTAT)
26. MSCA InventWater training course

27. UNESCO IHP Open Science Day
28. 2nd Workshop on International Cooperation in Spaceborne Imaging Spectroscopy
29. Ocean from Space V
30. 1st stakeholder meeting of Space4Water, of UNWater
31. Global Lake Ecological Observatory Network, GLEON 2022 All Hands' Meeting, 30 October - 4 November 2022 at Lake George, NY
32. XIV Annual Assembly of LTER-Italy

Additionally, the following publications have been made in peer-reviewed journals:

1. Cesana, I., et al. Preliminary Investigation on Phytoplankton Dynamics and Primary Production Models in an Oligotrophic Lake from Remote Sensing Measurements. Sensors 21.15 (2021): 5072, https://www.mdpi.com/1424-8220/21/15/5072
2. Amadori, M., et al. Multi-scale evaluation of a 3D lake model forced by an atmospheric model against standard monitoring data. Environmental Modelling & Software 139 (2021): 105017, https://www.sciencedirect.com/science/article/pii/S1364815221000608
3. Amadori, M., et al. Monitoring Lakes Surface Water Velocity with SAR: A Feasibility Study on Lake Garda, Italy. Remote Sensing 13.12 (2021): 2293, https://www.mdpi.com/2072-4292/13/12/2293
4. Pinardi, M., et al. Exploiting high frequency monitoring and satellite imagery for assessing chlorophyll-a dynamics in a shallow eutrophic lake. Journal of Limnology 80.3 (2021), https://jlimnol.it/index.php/jlimnol/article/view/2033
5. Free, G., et al. Shorter blooms expected with longer warm periods under climate change: an example from a shallow meso-eutrophic Mediterranean lake. Hydrobiologia (2022), https://link.springer.com/article/10.1007/s10750-021-04773-w
6. Alikas, K., Kangro, K., Kõks, K-L., Tamm, M., Freiberg, R. and Laas, A. (2023) Consistency of six *in situ*, in vitro and satellite-based methods to derive chlorophyll a in two optically different lakes. Front. Environ. Sci. 10:989671. https://doi.org/10.3389/fenvs.2022.989671

One publication has been made in popular press:

1. Constantinescu, A. H2020 WaterForCE – un nou proiect pentru îmbunătățirea instrumentelor folosite în studiul și managementul apei, https://www.edupedu.ro/h2020-waterforce-un-nou-proiect-pentru-imbunatatirea-instrumentelor-folosite-in-studiul-si-managementul-apei/?fbclid=IwAR05iMfxXbtcPzfO0Li3ue1hXqK36Tg0E1h0Yxiz-38CTp3nL9rnmATm_Sk

Deliverable / Milestone	Title	Lead Beneficiary	Due Date [months]	Status
D7.1	Public communication and dissemination plan	isardSAT	M6	Resubmitted M15
D7.2	Website and communication tools	isardSAT	M3	Resubmitted M15
D7.3	Workshops materials	isardSAT	M12	Approved M12. Updated M24
D7.4	Events dissemination and communication	isardSAT	M24	Delivered M25
MS12	International stakeholder workshop	isardSAT	M6	Achieved
MS23	Final Workshop	isardSAT	M33	

Table 13. WP7 deliverables and milestones status until M24.

WP number\ Beneficiary	UTARTU	ST DOTSPACE	isardSAT	Lobelia	ANTEA	PML	FVB-IGB	GEOECOMAR	USTIRLING	IHE DELFT	EMU	NIRDBS	3edata	CNR	VITO	BOKU	CREAF	SINERGISE	WI	Total PM
WP7	1.20	1.11	5.50	4.16	0.65	0.67	0.80	0.33	0.01	0.23	0.37	0.35	0.60	0.93	0.98	0.57	0.53	0.13	0.38	19.50

Table 14. Draft workload in person months inside of WP7 until M24.

1.2.8 **Work Package 8 – Coordination and Management**

The main objective of the WP8 is taking care of the smooth running of the Action and of the fulfilment of all the obligations stated in the GA. This includes the coordination of legal, financial, scientific and technical parts of the Water-ForCE project (tasks defined in the Article 41.2 of the GA) and the organizational, administrative and documentary management.

The defined structure and tasks to achieve this objective are summarized below:

T8.1 Project Coordination Overall leading of the project activities, represents the project for other authorities/institutions.

T8.2 Project Management: administrative management of the project, handling of legal issues, IPR issues, GDPR issues, creation, maintenance and amendment of CA

T8.3 Project progress monitoring: management of deadlines, workflows, scheduling meetings and appointments and other day-to-day operations of the project, making sure the consortium members are aware of deadlines and tasks that they are responsible for.

T8.4 Documentation and data management: All the scientific and technical documentation of Water-ForCE CSA is collected, archived, maintained, version controlled and made available timely and in the proper format to the consortium members and also to external experts or Workshops Participants when needed.

T8.5 Facilitate internal communication between the members of the consortium: A system for management of digital documentation has been established. Organization and attendance to all the internal Management Structures meetings (Coordination Team, Executive Board, General Assembly) and kick-off meeting.

T8.6 Facilitate communication with external advisors or collaborators: Organization of 2 major meetings with relevant stakeholders and end-users

T8.7 Financial management: Compile financial information from consortium partners. Distribute EU funds. Fulfil all obligations according to the GA.

T8.8 Communication with the European Commission (EC): Clear and timely communication with the assigned Project Officer by meetings, both scheduled or ad-hoc. Represent Water-ForCE at relevant EU meetings and conferences.

There were six deliverables and two milestones until M24 (see Table 19):

D8.1 Management Structures (submitted M21)

D8.2 Interim Technical report (This report. to be submitted after Interim Review. M25)

D8.3 Templates (submitted M5. Resubmitted M15)

D8.4 Project Implementation Plan (submitted M2. Resubmitted M15)

D8.7 Data Management Plan. First version (submitted M6. Approved by EC)

D8.8 Data Management Plan. Second version (submitted M21)

The content and the results of the deliverables achieved during the M13-24 period are described below.

D8.1 Management Structures (M1 - Delivered M21):

The Water-ForCE consortium consists of 20 partners. The action is ruled by an organisational structure with the following main components:

- Coordination (WP8, Coordinator, Project Manager and EMU)

- Executive Board (EB)

- Advisory Board (AB)

- General Assembly (GAs)

As it is reflected in the Grant Agreement (GA) and Consortium Agreement (CA), the **Coordinator** coordinates legal, financial, scientific and technical part of the Water-ForCE project; the **Project Manager** is responsible for the organisational, communication, administrative and documentary management of the project; the **General Assembly** is the ultimate decision-making body of the Consortium and all the members have an appointed representative; the **Executive Board** is the project's formal supervisory body for the execution of the project and shall report to and be accountable to the GAs. It is composed by the WP leaders and monitors, with the support of the Coordinator and Project Manager, the project progress and consensus-based decision-making. Finally, the **Advisory Board** supports the EB providing state-of-the-art knowledge and experience from scientific, policy and practical points of view, thereby helping to direct the activities in relation to stakeholder and end-user requirements.

The appointment of the EB and GAs members was made during the Kick-off meeting of the Water-ForCE action, held virtually from January 26th to 28th 2021. The EB members were appointed based upon leadership in WPs. In those WP where the Coordinator was in a leading role (WP2 and WP8), the co-leader in terms of work effort was selected as member of the EB, ending with a total of 9 EB members. The GA is composed of 1 representative of each institution member of the consortium, with a total number of 20 representatives.

The AB of Water-ForCE has evolved during the course of the action. In the GA the initial Ab was formed by:

* Prof. Arnold Dekker. GEO AquaWatch. Sat Dek pty ltd

* Bastian Ibelings. GLEON Chair. Univ. Genéve.

* ESA representative.

* EEA representative.

This initial AB met with the Consortium during the Kick off meeting and were appointed by e-mail. During M5 (May 2021) a first change was made in the AB composition, being the ESA Representative substituted by Mr. Giuseppe Ottavianelli. In M18 (June 2022) a second change was made in the AB membership, being the initial EEA representative substituted by Henrick Andersen, representing the same institution. A new member was also added to this management structure: Luca de Felice, representing the Joint Research Centre. European Commission (JRC). Both new members were appointed during the Water-ForCE GA held in Delft on 28th and 29th July 2022.

The current members of the EB and AB are:

EXECUTIVE BOARD

Beneficiary	**Leaded WP**	**Name**
dotSPACE	WP1	Linda Van Duivenbode
VITO	WP2	Ils Reusen
VUB	WP3	Ann Van Griensven
EMU	WP4	Alo Laas
IHE	WP5	Ioana Popescu
U STIRLING	WP6	Andrew Tyler
IsardSAT	WP7	Maria José Escorihuela
3edata	WP8	Carmen Cillero
U TARTU	Coordinator	Tiit Kutser

Table 15.- Executive board members.

ADVISORY BOARD

Institution	**Name**
Global Lake Ecological Observatory Network - GLEON	Bastiaan Willem Ibelings
European Space Agency - ESA	Giuseppe Ottavianelli
European Environmental Agency - EEA	Henrik Andersen
Sat Dek pty ltd	Arnold Dekker
Joint Research Center. European Commission	Luca de Felice

Table 16.- Advisory Board Members

There was delay in the submission of the Deliverable D8.1 due to the need of one of the AB members to send the consent form to the Legal Department of the EEA; for him to be allowed to sign it, allowing

to show his name and institution in the public documents of the Water-ForCE mentioning the AB, as a GDPR requirement. This was solved with the new configuration of the AB.

Nevertheless, all the Management Structures were working smoothly during the course of the project. The meetings' schedule followed for the EB and AB up until M24 has been:

- Meeting 1 EB: 26th February 2021
- Meeting 2 EB: 7th June 2021
- Meeting 3 EB: 19th October 2021
- Meeting 4 EB: 14th December 2021
- Meeting 5 EB & 1 AB: 28th February 2022
- Meeting 6 EB & 2 AB: 26th May 2022
- Meeting 7 EB: 13th Sep 2022
- Meeting EB and AB member from JRC: 22nd September 2022
- Meeting 8 EB: 25th Nov 2022
- Next scheduled EB meeting (in person): 17th January 2023.
- Next second meeting is planned for March 2023, after the delivery of most of the Technical Deliverables and the start of the final version of the Roadmap.

The Coordination team of Water-ForCE is in continuous contact through email and virtual calls and face-to-face meetings to ensure the smooth running of the action and a proper implementation, monitoring and quality evaluation.

D8.2 Interim Technical report (M24)

The interim technical report is the present document, which will be uploaded to the system before the Interim Technical Review has taken place (January, 18th Brussels) and all the recommendations and suggestions from the reviewer and the Project Officer will be implemented afterwards.

D8.3 Templates (submitted M5. Resubmitted M15)

As part of the duties of the Coordination of Water-ForCE, and as it is reflected in the Project Implementation Plan (D8.4); internal technical reviews are planned twice a year; intended to help in the internal organisation of every WP and also to detect any deviation from the expected quality or scheduled timing, thus helping to have any risk timely addressed and mitigated or solved.

The D8.3 included the "Templates for task planning and for WP Progress Reports" of Water-ForCE CSA. During the course of the action other templates were also created as a joint action of the Coordination and Dissemination teams (Meeting Agenda and Minutes, Letter, Presentations, Deliverables and Timesheets). Moreover, for the purpose of the internal Financial review, a template for the financial reporting was also developed and shared with the Consortium Members.

All the templates are in a dedicated shared unit inside of the cloud system for digital documentation management put in place by the Project management.

The D8.3 was delivered in M5 and reviewed after the first periodic review of Water-ForCE (M12). This reviewed second version, submitted M15, included a KPIs table and a Risk assessment template following the advice of the reviewer. These were used for the project monitoring.

D8.4 Project Implementation Plan (submitted M2. Resubmitted M15)

The Project Implementation Plan (PIP) (formal Deliverable D8.4) of the Water-ForCE CSA aims to be a reference document for the consortium members during the implementation phase of the action. It is the guidance for the beneficiaries of the Water-ForCE CSA during the operational implementation phase of the action to achieve a delivery according to the Description of Action (DoA) included in the GA.

This document summarises all the needed practical information for successfully executing the action. The PIP develops the operational part of the action, based upon the information included in the Water-ForCE GA and CA; thus, aiming at guiding, in a practical way, all the steps and processes to be taken by the beneficiaries until the end of the action.

The document was submitted during M2 and a second version was re-submitted in M15, revised and changed according to the EC review report considerations in 9.2 and 9.3 sections; related to updated risk management and mitigation solutions , impact KPIs (targeted and achieved values), Open Science practices and IP management issues.

D 8.8 Data Management Plan V.2 (submitted M21):

The Water-ForCE project main goal is to get a comprehensive understanding of the global water cycle within the scope of Copernicus Services and find the best long-term mission concept to cover current and future, both opportunities and information needs, related to this valuable resource. To achieve this goal, the Water-ForCE consortium proposed to develop a Roadmap for Copernicus water services.

For the continuous development of the Roadmap along the 36 months of duration of the action, the Water-ForCE consortium collects and analyses information from different sources; but being a CSA, Water-ForCE is not expected to produce any new research data to meet these objectives.

Water-ForCE is collecting and analysing already existing datasets in various forms (scientific publications, existing reports, other relevant project's deliverables, etc.) and also gathers the own knowledge of the Consortium members following the IPR management guidelines agreed by the Consortium and established both in the GA and in the CA.

The only sources of new data foreseen during the first version of the DMP were the workshops and questionnaires that Water-ForCE put in place to gather the opinion, knowledge, concerns and needs from different types of end users, stakeholders and experts inside of the water continuum community. This is still valid, and as an addition to this second version, we also included the information gathering through the organisation of periodic Webinars, a new dissemination and communication procedure established during 2022. A total of 8 webinars ran on the last Wednesdays of every month from January-April, June, and October-November 2022.

Water-ForCE Action participates in the Open Research Data (ORD) Pilot. As it is set out in the Article 29.3 of the GA, the legal requirements for projects and beneficiaries participating in this ORD Pilot are:

• to deposit the data in a research data repository so that it is possible to access, mine, exploit, reproduce and disseminate the data, free of charge for any user. Water-ForCE has created a Community in Zenodo for this purpose.

• to formulate a Data Management Plan (DMP) to define what datasets the project will generate or process, whether and how these data will be made accessible, and how they will be curated, stored and preserved. The DMP should also provide information on the measures taken to safeguard and protect sensitive data.

The Deliverable 8.8 is the second version of the aforementioned DMP of the Water-ForCE project. The DMP is considered a living document, and as such, it is evolving during the course of the action. The Water-ForCE consortium (through the CT) will review and update the DMP at any time it is required as the project progresses and whenever any work plan changes arise, to make sure that it still meets Water-ForCE needs.

The second version of the DMP covers the data management scheme of the Water-ForCE describing the types of data and the procedures to make them findable, openly accessible and interoperable; to increase the data re-use, and the allocation of resources and data security. It also describes the planned Water-ForCE datasets and the ethics compliance measures taken regarding personal data collection and processing. The only change regarding the first version was the addition of the periodic webinars as a new source of data.

Work carried out in the on-going WP8 task:

Most of the tasks inside of the WP8 are continuously running throughout the project, to ensure a smooth running of the activities and the whole action.

T8.1 Project Coordination and T8.2 Project Management are activities that have been developed as planned in the task description, continuously by the CT since M1.

The quality monitoring of the project has been implemented through:

1) Continuous feedback with the WP leaders through virtual calls, face-to-face meetings and emails.
2) A scheduled review organisation by which they have been established 2 internal reviewers for each planned deliverable of the project, besides the Project Coordinator. A clearly defined procedure for draft delivery, review and approval is also described in the PIP. The internal review procedure was set in advance, since M6. The 2 WPs in charge of every deliverable were decided and the responsible person was selected by WP leaders. This information about the deliverables date and review procedure was available in a common folder for all the consortium members to be ready on time and was also remembered by the Project Manager during the meetings.
3) The evaluation of the project is also described through a set of specific KPIs developed for the project since M15.

T8.3 Project progress monitoring. The Coordination is running two types of monitoring procedures:

- Continuous monitoring: by which the Coordination of Water-ForCE maintains continuous feedback with all WP leaders either attending the WP meetings or through dedicated communication by email or virtual calls.

- During 2022 a new monitoring procedure was put in place; adding monthly regular online meetings every first Wednesday of the month, to which all the consortium members are expected to attend. They will run until the end of the project.
- Periodic monitoring (Technical and Financial): Internal technical reviews are planned twice a year. During the M13-M24 reporting period these procedures were run during M18 and M23 and the results were analysed in the following or concurrent EB meetings and shown during the GAs. The Financial Reviews were launched in M18 (internal) and M23 (for formal reporting to the EC during the Interim Technical Review). Both were launched successfully on time, providing instructions and templates to the consortium.
- All the information regarding technical progress of the tasks inside of every WP is timely updated with the information provided by the WP leaders in each technical review and reflected inside an interactive Gantt Chart coordinated by the Project Manager, which includes a map of dependencies and percentages of completion of every task. This Gantt chart is analysed by the Coordinator and Project Manager and shared periodically with the Consortium Members to evaluate the progress of the action and timely identify potential risks. The updated Gantt Chart was shown to the whole consortium during the GA (M18) and the monthly general meeting of January 4th, 2023.
- The Water-ForCE foreseen risks and their evaluation until M24 are described in the table below.

Description of risk	Proposed risk-mitigation measures in GA	Influenced	Measures taken
Delays in WP1 activities	Safe time frames have been established to absorb incidents in this WP	NO	NO
Failure in the engagement of European Level decision makers (due to Agenda)	Organize WP6 meeting in Brussels	NO	NO
Failure in the engagement of the technical part of Copernicus Services/Components	Organize an initial (WP1) meeting in Denmark, near EEA headquarters	YES	Two meetings were organized. Hybrid format has been put into place to facilitate engagement
Failure in the engagement of the National Authorities	The partners who need it have a separate budget for the national stakeholders engagement inside of WP1 (other direct costs). Support from these entities has been gathered in the proposal stage (Support Letters)	NO	NO

A partner withdrawing from the consortium (Low due to earlier cooperation between the partners)	Process outlined in the Consortium Agreement. In most WPs there is enough expertise overlap to allow timely delivery of products	NO	NO
Physical meetings can not take place or need to be delayed because of the virus. People can not travel between the countries.	Project has the possibility of delaying the meetings for some months. If the delays can not take place, the leaders of WP and other members of the consortia have gained a lot of experience with videoconferences. Nowadays technology and experience will help us to have the meetings through video bridge.	YES	All workshops and meetings were held as virtual activities during M1-M12. In the M13-M24 more physical meetings have taken place but the virtual ones were also maintained, gaining in communication inside of the Consortium
COVID 19 restrictions on travel and face-to-face meetings affecting the engagement of the key stakeholders and users through workshops and meetings.	Transform face-to-face meetings into virtual or hybrid formats.	NO	NO

Table 17. Risk assessment and mitigation measures until M24

Following the recommendation from the reviewer, we propose KPIs with targeted values and achieved values for impacts evaluation and project progress monitoring, and especially for communication/ dissemination monitoring.

The values achieved for M24 are in the table 18.

The analysis of the KPIs for M24 shows higher delays than expected in the delivery of the reports. It is worth noticing that most of them had delays lower than 15 days, so we consider that this delay will not affect the final results and expected impact of the project. All the milestones were achieved on time and the Consortium bodies met regularly. The on-line meeting options allowed for more meetings than previously expected.

The engagement activities of Water-ForCE are performing as expected. During the last years it is expected to meet the targeted numbers.

The stakeholders' engagement and interest have been very successful during the second year, mostly due to the success of webinars and workshops already outperforming our expectations by the end of the project. The numbers increased more than 4 times (from 208 to 852) during the last year, but they did not declare the type of activity they conduct in a systematic basis.

The experts' input to the Roadmap targets have to be met during the last 12 months, which was expected given that this is the period for the final drafting, test and finalisation of the document.

The geographical scope of the project outperformed the expected goal and it is even considered to be better than the KPI's shown. We could improve the engagement with Africa and also the attendance and participation of Water-ForCE in several international activities, some of them of global scope, has given global visibility and contacts to the project.

Regarding the communication and dissemination, we have outperformed our expectations in this area but have to stress our presence in Twitter, Linkedin and vimeo, which will be done based upon the drafting and test of the Roadmap the last 12 months.

Objective/Impact	KPI	Definition	Achieved 2ndt reporting period	Target at the end of the project
Project Execution				
	Deliverables -KPI 1	Nº of submitted deliverables	37	47
	Deliverables -KPI 2	Expected *vs.* actual delivery dates (difference in days: positive values reflect delay)	519	500
	Milestones	Nº of Milestones achieved on time	11	18
	Consortium bodies meetings (GA – EB)	Nº of meetings	12	15
Project Performance				
Engagement activities				
	Workshops	Nº of workshops	**7**	8
	Webinars	Nº of webinars	**8**	18
	Newsletters (external)	Nº of Newsletters	**2**	5
	Links with other relevant projects/initiatives	Nº of projects contacted	40	50
Increased coverage of EU Policies. Engagement of different stakeholders' typologies/Key users' identification				
	Total stakeholders engaged	Nº of people registered through Hubspot	**852**	600
	Sector activity: Science/ research	Nº of people declaring activity	37	100
	Sector activity: Water management	Nº of people declaring activity	41	100
	Sector activity: Environment management	Nº of people declaring activity	19	100
	Sector activity: Private/Industrial	Nº of people declaring activity	21	100
	Sector activity: Policy/regulator	Nº of people declaring activity	16	100
Interest from stakeholders/key users				
	Project outcomes/documents	Nº of downloads of project outcomes	1166	500
	Attendance to WP1 stakeholder workshop	Nº of people attending workshop	150	150
	Attendance to webinars	Nº of people attending webinars	479	300
Experts input to the Roadmap. Interactions with Non-EO Communities.				
	Working Groups engagement	Nº of experts	80	100
	Non-EO Communities engagement	Nº of Non-EO experts	28	50
	Working Groups activity 1- meetings	Nº of meetings of each WG	1	3
	Working Groups activity 2- attendance	Nº of experts attending the meetings	80	100

	Attendance to the 2 major international workshops [MS12 & 13]	Nº of attendees	40	200
	Attendance to technical workshops (WP2-3-4-5)	Nº of attendees	317	300
Geographical scope				
	Links with global initiatives	Nº of links	13	5
	Links with Africa	Nº of links	37	5
	Links with Asia	Nº of links	25	5
	Links with N America	Nº of links	30	5
	Links with S America	Nº of links	12	5
	Links with Australia/New Zealand	Nº of links	9	5
Communication and Dissemination				
	Communications to conferences/workshops	Nº of communications	32	20
	Journal Papers	Nº of papers	6	5
	Special Sessions in Conferences	Nº of Special Sessions. Delivered	3	6
	Website visits	Nº of unique website visitors	26.000	4000
	Followers on Twitter	Nº of followers	255	300
	Twitter activity	Nº of tweets	55	80
	Followers on Linkedin	Nº of followers	44	200
	Linkedin activity	Nº of posts	8	30
	Followers on Vimeo	Nº of followers	4	100
	Activity on Vimeo	Videos produced	17	50

Table 18. Water-ForCE KPIs with targeted values for the project and achieved values until M24.

T8.4 Documentation and data management: All the scientific and technical documentation of this CSA is collected, archived, maintained, version controlled and made available timely and in the proper format to the consortium members. The Project Management has established a cloud system (Google Drive Shared Units) with a document storage structure and different accessing levels, described in the PIP.

T8.5 Facilitate internal communication between the members of the consortium: The internal communication is considered a key activity inside of Water-ForCE project due to the needed close interaction between WPs. The Coordination team has put in place the following actions:

- A shared document space in the cloud using Google Drive Shared Units feature. It is used for all official project documentation, calling notices, agenda, meeting minutes, working documents and deliverables.
- A contact list of the consortium members was created and distributed to all partners through the shared Google Drive Space. This list is available as an excel worksheet. The contact list is maintained by the Project Manager and includes email addresses of all the people involved in the project. It also Includes Information about the role of every participant regarding their WP involvement; the professional profile inside of the project (Technical/Administrative-Financial/Dissemination and Communication); membership of Management Structures and access details to the common Google Drive Shared Space.
- Conference Platforms: 3edata has at the disposal of the project 3 different professional conferencing platforms (Zoom, Google Meets and Microsoft Teams). The most suitable platform is used in every meeting depending on the preferences/needs of the majority of the attendees.
- A common calendar (Water-ForCE calendar) has been enabled (Private Google Calendar) with access to all partners. This serves as a tool for facilitating the communication, information sharing and collaboration between consortium members and between WPs. All the important dates are added to this common calendar by the Project Manager: reporting periods, meetings, workshops, conferences and major events considered important for the project.
- A periodic internal Newsletter: Since April 5th, 2021, a periodic Newsletter has been sent by email to the consortium members covering all the important dates, events, meetings and deadlines related to the project. It has developed through the course of the action adding new sections. It will run until the end of the project as it has been proven as an effective tool to maintain the whole consortium updated and working together.

T8.6 Facilitate communication with external advisors or collaborators: the coordination team was directly involved in the overall organisation of the different workshops and meetings organised in the M13-M24 period by different WPs:

- Space4Water meeting and communication. Organised by UNOOSA in partnership with the Prince Sultan Bin Abdulaziz International Prize for Water (PSIPW) during the United Nations / Ghana / PSIPW - 5th International Conference on the Use of Space Technology for Water Resources Management. The United Nations Office for Outer Space Affairs (UNOOSA) and the Government of Ghana jointly organised a conference with the support of the Prince Sultan Bin

Abdulaziz International Prize for Water (PSIPW) to promote the use of space technology in water management to the benefit of developing countries. The Conference was held in Accra, Ghana, from 10- 13 May 2022, hosted by the University of Energy and Natural Resources on behalf of the Government of Ghana. The coordination team participated with 2 oral talks about Water-ForCE and as panellist in one session dedicated to Stakeholders. The connection with the Space4water portal is still maintained by the Coordination Team.

- Shallow water and floating matter remote sensing. 20-21 September 2022 | CNR, Via Corti 12, Milan, Italy
- JRC & Water-ForCE Meeting. 22 September 2022 | Ispra (Italy)
- Citizen Science for the CAL/VAL of satellite aquatic products. 11 October 2022 13:00 - 15:30 CEST | Online
- Water Quality Continuum Atmospheric Correction Workshop. 20 October 2022 | Online

The CT also maintains the collaboration with other relevant projects through meetings, exchange of ideas and participation in events. From M13 to M24, Water-ForCE CT was maintaining this relationships with:

- COINS Project
- PRIMEWater
- WQeMS
- GLEON Network
- GEO Community

The management of the project also included the facilitation, for all the partners, of the needed communication tools (conferencing platforms) and help in the organisation of the sectorial workshops led by the WPs.

T8.7 Financial management: The Coordination team has compiled the financial information of the partners needed to distribute the EU funds. The distribution was made in due time by UTARTU after receiving the first payment from the EC.

The CT also performed an internal financial review for the first 6 months of the project and performed the needed Financial Review at the end of the First Periodic Review (31/12/2021) as it is stated in the GA.

Once the Financial statements were approved by the EC after the first periodic review, during M18, and the interim payment was received, UTARTU successfully distributed the funds among the partners.

Internal FInancial reviews were launched in M18 and M23.

T8.8 Communication with the European Commission (EC): The coordinator and the CT have had a clear and timely communication with the assigned Project Officer by meetings, both scheduled or ad-hoc.

The coordinator and CT have represented Water-ForCE at relevant meetings and conferences, namely:

- United Nations / Ghana / PSIPW - 5th International Conference on the Use of Space Technology for Water Resources Management. Accra, Ghana, 10- 13 May 2022
- Nationales Forum für Fernerkundung und Copernicus. 21. – 23. June 2022, Berlin

- 36th Congress of the International Society of Limnology (SIL). Water-ForCE convened a special session entitled "The next 100 years of inland water sensing – combining remote sensing, *in situ* data and modelling"
- GLEON (Global Lake Ecological Observatory Network) All Hands Meeting. Lake George, New York State (USA) on October 30th – November 4th 2022. The Water-ForCE representatives promoted Water-ForCE in the GLEON network and Copernicus Programme through the Remote Sensing Working Group convening and moderation and a plenary talk promoting the collaboration between COINS (Copernicus *in situ* project) and Water-ForCE.

Deliverable/ Milestone	Title	Lead Beneficiary	Due Date [months]	Status
D8.1	Management Structures	UTARTU	1	Delivered
D8.2	Interim Technical Report	3edata	24	Draft Deliv. M25
D8.3	Templates	3edata	5	Resubmitted M15
D8.4	Project Implementation Plan	3edata	2	Resubmitted M15
D8.5	Reports on WP meetings	3edata	30	ongoing
D8.6	Reports on Major Workshops	3edata	32	Started
D8.7	Data Management Plan V.1	3edata	6	Approved by EC
D8.8	Data Management Plan V.2	3edata	18	Delivered
D8.9	Data Management Plan Final	3edata	36	Not Started
MS14	Kick-off Meeting	UTARTU	1	Achieved
MS15	EB and AB 1st Meeting	UTARTU	2	Achieved
MS16	EB and AB 2nd Meeting	UTARTU	17	Achieved
MS17	Interim Report	UTARTU	18	Achieved
MS18	EB and AB 3rd Meeting	UTARTU	30	

Table 19. WP8 deliverables and milestones' status until M24.

WP number\ Beneficiary	UTARTU	ST DOTSPACE	isardSAT	ANTEA	PML	FVB-IGB	GEOECOMAR	USTIRLING	IHE DELFT	EMU	NIRDBS	VUB	3edata	CNR	VITO	BOKU	CREAF	SINERGISE	WI	Total PM
WP8	3.10	0.73	0.63	0.65	0.56	0.50	0.52	0.94	0.63	1.69	0.25	1.00	18.56	0.50	0.65	1.26	0.50	0.32	0.32	33.31

Table 20. Draft workload in person months inside of WP8 until M24.

1.2.9 Work Package 9 – Ethics requirements

The Protection of Personal Data (POPD) is an essential part of the ethics appraisal process in EC funded projects through the Horizon 2020 Framework Programme. This process is enabled to safeguard the basic rights to privacy and data protection in all H2020 funded projects, like Water-ForCE.

The work done in WP9 was reported in the first periodic review and entails the management of POPD process in Water-ForCE, which is based on the General Data Protection Regulation (GDPR, Regulation (EU) 2016/679), and described in the D9.1, D9.2 and D9.3.

There were 3 deliverables in this WP.

D9.1 POPD requirement Nº2

D9.2 POPD requirement Nº3

D9.3 POPD requirement Nº4:

All of them were delivered in M4. Deliverables 9.1 and 9.2 were accepted by the EC during the first reporting period and the D9.3 had to be amended because of a minor mistake in the identification page of the document. This was solved and the D9.3 was re-submitted in M15.

Deliverable/ Milestone	Title	Lead Beneficiary	Due Date [months]	Status
D9.1	POPD - Requirement No. 2	UTARTU	3	Approved by EC
D9.2	POPD - Requirement No. 3	UTARTU	3	Approved by EC
D9.3	POPD - Requirement No. 4	UTARTU	3	Re-submitted M15

Table 20. WP9 deliverables and milestones' status until M24.

1.3 Impact

As it has been explained during the WPs work description, the activities have been developed as planned, so we consider that all the information on expected impacts included in the section 2.1 of the DoA is still relevant.

The delays in the delivery of some deliverables does not affect the expected impact of the project.

2 Update of the plan for exploitation and dissemination of result (if applicable)

NA

3 Update of the data management plan (if applicable)

The first version of the Data Management Plan was delivered in M6 as D8.7. The mid term review of this plan, was updated and submitted as a second version (DMP V.02).

There were no changes in our data collection procedures, just a small addition of a new source of data (personal data and questionnaires) coming from the above-mentioned periodic thematic Webinars organised by Water-ForCE dissemination Team together with WP1.

4 Follow-up of recommendations and comments from previous review(s). [Review Report 28.02.2022]

During the first review process, the consortium has been given a series of recommendations. These recommendations were implemented during this reporting period. The explanations and answers are given below:

Recommendation: to take specific actions to keep stakeholders engaged for the duration of the project. The SDGs address many challenges related to water quantity and quality management, thus associating African local and regional stakeholders could bring relevant additional information for the roadmap for Copernicus inland water services.

To keep people involved and interested, Water-ForCE organised a series of webinars (detailed in section 1.2.6) with a total number of 291 attendants.

Also relevant was the organisation of 2 webinars with specific impact in Africa:

- SDG6 clean water and sanitation (February 23rd, 2022) https://waterforce.eu/webinars/sdg6-clean-water-and-sanitation
- Copernicus for Africa (March 30th, 2022). https://waterforce.eu/webinars/copernicus-africa

To increase the outreach and involvement of stakeholders in Africa, the Water-ForCE team has also taken the following actions:

- Water-ForCE has engaged with Africa related workstreams of World Water Quality Alliance during the first year of the project and maintained this relationship during the second year.

- Water-ForCE participated in the United Nations/Ghana/PSIPW - 5th International conference on the use of space technology for water resources management ACCRA, GHANA, 10-13 MAY 2022.

- Water-ForCE is now part of the Space4 Water portal and the engagement with this platform and UNOOSA continues.Water-ForCE members (U STIRLING) attended the 1st stakeholder meeting of Space4Water, of UNWater. Currently some content is being produced for the WWQA website which will also be delivered at the UNWater23, including an information article and an Eposter.

Recommendation: physical workshops are expected (if sanitary aspects is possible) for the next years, so the consortium should carefully check that most of the members associated during the first year (and maybe more) will reach the workshops.

Three workshops were organised during the second reporting period:

- Shallow water and floating matter remote sensing | September 20th and 21st 2022 |Hybrid event https://waterforce.eu/workshops/shallow-water.
- Citizen Science for the CAL/VAL of satellite aquatic products | October 11th, 2022| Online event https://waterforce.eu/workshops/citizen-science
- Water Quality Continuum Atmospheric Correction Workshop |October 20th, 2022 | Online event https://waterforce.eu/workshops/water-quality-atm

The community at large has got used to on-line workshops, so we organised online and hybrid workshops for not losing already engaged stakeholders. This gave us the opportunity to make those more successful. Two of the organised workshops were done only in on-line format and one in hybrid format, choosing the majority of the attendants this last option, showing the good engagement of choosing a hybrid format.

Recommendation: WP5 should pay specific attention to the management of uncertainties related to both the input data (quantitative and qualitative data) and to the models themselves (propagation of uncertainties).

Although the main focus of WP5 is assessing the value of current Copernicus Services for modelling water quantity and quality and identifying needs for new services, the issue of uncertainty needs to be recognised. In the working group with the modelling experts, the issue of uncertainties were specifically raised, and also during the surveys that were carried out for D5.1. Recommendations regarding the uncertainties of RS data for modelling and their impacts were reported in D5.2 under Chapter 6 of the report; as well as in D3.4 in Section 2 of the report.

Recommendation: to communicate on the risk management and mitigation measures

The Water-ForCE foreseen risks and their evaluation until M24 are described in the task 8.3.

Recommendation: to propose KPIs with targeted values and achieved values for impacts evaluation, and especially for communication/ dissemination monitoring.

Following the reviewers request we have developed a set of **specific KPIs** with targeted and achieved values for the project, including communication and dissemination. The values achieved for M24 and expected for the project were described and commented in T 8.3.

5 Deviations from Annex 1 and Annex 2 (if applicable)

5.1 Tasks

We have solved a deviation acknowledged during the first reporting period. The late submission of the **Deliverable 8.1. (Management Structures).** This deliverable describes the Management Structures of the Water-ForCE and the names and affiliations of the members of the Boards. This delay was caused

by the delay in achieving the signed agreement to make publicly available one of the Advisory Board Members name and institutional affiliation as it was explained in the last report.

As a Personal Data Protection procedure (GDPR compliance) we asked for the express consent of all the AB members through a consent form to make their name and affiliation public as a Water-ForCE AB member.

This was solved with the new configuration of the Advisory Board and the deliverable was submitted to the EC.

We have faced delays in the submission of some deliverables, In most of the cases there was a delay of less than 15 days. We do not consider that this situation will cause any delay in the drafting of the Roadmap and the achievement of the expected impacts, as all the intermediate drafts are available for the WP6 team and the deliverables will be finalised on time to give the needed input before April 2023.

5.2 Use of resources until M24

Overall, the average workload (in person month) in most of the working packages was close to 65% (varying between 60.9 and 86.3 %) except in the WP6 where it was 21.7%. The highest numbers are for WP1, which concentrated most of its work during the first 2 years of the project. The lowest workload was in WP6, because its activities officially started in M18, as it was explained in section 1.2.6.

With the provisional figures we currently have delivered with this draft report, the use of resources in Water-ForCE is explained below:

Direct personnel costs:

The overall figures show a total of 1,382,683.54€ (a+c, Table 19), which gives a 65.92% of expenditure related to what was described in the GA. We consider this adequate, given that some of the WPs tasks had small delays and therefore some work will be concentrated at the beginning of the 3rd year, as well as WP6 as the most workload planned to the last year of the project.

Other Direct Costs:

In overall the project has underspent in this category. The total cost is 98,547.04 €, which is still a lower percentage of the use of resources (32.63%) than was expected at the beginning of the project. This deviation was due to the COVID-19 pandemic situation in the year 1 and partly in year 2. The costs of organising face-to-face workshops and travel to different meetings were included in the budget. Large amount of the meetings had to be replaced by virtual meetings during the first half of the project. We expect to use these funds during the last year where larger face-to-face meetings (e.g. the Roadmap Workshop) are planned.

As unforeseen costs we can list the purchase of a yearly subscription to HubSpot, a CRM tool to manage the project contacts (Personal Data) and registration to project events in a GDPR compliant way, which was considered especially important once most of the events and contacts with relevant stakeholders have been made on-line. This has proven to be a very effective tool, therefore we have decided to maintain this cost all over the lifetime of the project.

The virtual exhibitor booth of Water-ForCE hosted by Water Europe, used for interacting with all Water Innovation Europe conference's participants through chat, video calls and face-to-face meetings was

also not considered in the GA, the cost of this activity was in total 950.0 €. This was a corrective measure applied as a solution in case of the organisation of the International Stakeholders Workshop (MS12), which could not be done as planned due to COVID restrictions.

There was no transfer of costs categories.

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	TOTAL PM
1 - UTARTU	2.00	9.00	2.00	3.00	1.00	1.50	1.20	3.10		22.80
2 - ST DOTSPACE	10.56	0.18	0.23	0.10	0.22	0.27	1.11	0.73		13.40
3 - isardSAT	2.00		1.50	0.80		0.34	5.50	0.63		10.77
· Lobelia							4.16			4.16
4 - ANTEA	0.90	0.90	9.90	0.75	4.10		0.65	0.65		17.85
5 - PML	0.83	2.42	0.72	2.36	0.83	0.22	0.67	0.56		8.61
6 - FVB-IGB	2.00	2.25	1.50	4.00	1.00		0.80	0.50		12.05
7 - GEOECOMAR	1.29	0.71	0.49	0.66	0.44		0.33	0.52		4.44
8 - ICCS	2.91		1.70	0.49	0.41					5.51
9 - USTIRLING	4.24	0.72	0.42	3.38	0.14	1.96	0.01	0.94		11.81
10 - IHE DELFT	1.45	0.54	0.42	0.64	3.09	0.18	0.23	0.63		7.18
11 - EMU	1.00	1.89	1.00	5.17	1.83	0.05	0.37	1.69		13.00
12 - NIRDBS	1.00	1.00	1.00	1.18	1.00		0.35	0.25		5.78
13 - VUB	1.00	1.00	10.55		1.00	1.00		1.00		15.55
14 - 3edata	1.01	1.43	0.27	4.60	0.45	0.13	0.60	18.56	0.57	27.62
15 - CNR	1.25	2.50	0.75	1.13	0.75		0.93	0.50		7.80
16 - VITO	0.91	8.44	0.52	1.25			0.98	0.65		12.75
17 - BOKU	1.50	1.67	0.49	1.59			0.57	1.26		7.08
18 - CREAF	1.14	1.37	4.97		5.00		0.53	0.50		13.51
19 - SINERGISE	1.00	0.91	0.98	0.68	0.27		0.13	0.32		4.29
20 - WI		0.97		0.80	0.78		0.38	0.32		3.25
Total Person/Months	37.99	37.90	39.41	32.58	22.31	5.65	19.50	33.31	0.57	229.21

[WPx]: Work Package number x; **[ACTUAL]**: Dedicated person months until M24

Table 21. Summary workload inside of all WPs by each beneficiary until M24.

	A. Direct Personnel Costs (*)										
	A1 Employees (or equivalent) A.2 Natural persons under direct contract A.3 Seconded persons						A.4 SME owner without salary A.5 Beneficiaries that are natural persons without salary				
Form of costs	Actual			Unit			Unit				
	a	a%-GA	a-GA	Total b	b%-GA	Total b-GA	Nº hours	Total c	Nº hours-GA	%Total c-GA	Total c-GA
Total consortium	**1,356,472.74**	**65.69%**	**2,065,100.00**				805.00	26,210.80	1,000	80.5%	32,560.00

	B. Direct Costs of Subcontracting		*[C. Direct Costs of Financial Support]*	
			[C.1 Financial Support] *[C.2 Prizes]*	
	Actual		Actual	
	d	d-GA	*[e]*	*[e]-GA*
Total consortium				

	D. Other direct Costs						
	D.1 Travel D.2 Equipment D.3 Other goods and Services			*[D.4 Cost of large research infrastructure]*		*D.5 Cost of of internally invoiced goods and services*	
	Actual			Actual		Unit	
	f	% f-GA	f-GA	*[g]*	*[g]-GA*	Total h	Total h-GA
Total consortium	**98,547.04**	**32.63%**	302,000.00				

	E. Indirect Costs		
	Flat rate 25%		
	h = 0,25 x (a +b+c+f+g +[i1]+[i2]-p)	% h-GA	h-GA
Total consortium	**370,307.65**	**61.73%**	599,915.00

	Total Costs			Reimbursement rate %	Maximum EU contribution	Requested EU contribution
	j = a+b+c+d +[e]+f+g+h +[i1]+[i2]	% j-GA	j-GA	m	n	o
Total consortium	**1,851,538.23**	**61.73%**	2,999,575.00	100%	2,999,575.00	2,999,575.00

Water-ForCE is a CSA that has received funding form the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101004186.

Table 22. Draft summary of the total costs until M24.

All the personnel costs that all the Water-ForCE partners have reported are the real costs.

5.2.1 Unforeseen subcontracting

N.A

5.2.2 Unforeseen use of in kind contribution from third party against payment or free of charges

N.A

HISTORY OF CHANGES		
VERSION	PUBLICATION DATE	CHANGE
V.1	25/11/2022	First template version released and checked by the WP Leaders
V.2	04/01/2023	First version populated by the WP leaders. To be discussed during the monthly general meeting.
V.3	11/01/2023	Last version submitted to the portal as Del 8.2 and send to the EC for review.
V.4		
V.5		
V.6		
V.7		
V.8		