Copernicus For Water Management Workshop

Framework Contract 386/PP/2014/FC

Copernicus User Requirements Framework Contract

Prepared for:

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1 INTRODUCTION

The European Commission (EC), overall manager of the Copernicus programme, has initiated actions aimed at gathering user requirements for the Next Generation of the Copernicus Space Component.
This workshop, organised in the framework of the User Requirements study "NEXTSPACE", intended to explore the relevance of the Copernicus Space Component and the Copernicus Services (and their planned evolutions) with respect to a number of Water Management issues, with reference to the Water Framework Directive and the Marine Strategy Framework Directive. In particular, the workshop has:

- Provided an overview of the user needs related to the domain of Water Management at global, EU, and National/Local level
- Summarised the current (and planned) Copernicus offer
- Discussed how to address the identified gaps

115 people registered for the workshop and around 100 attended.
The agenda is available in Annex 1.

2 HIGHLIGHTS AND OUTCOMES

2.1 Welcome speech by DG GROW

The workshop was opened by **Catharina Bamps, DG GROW Directorate I (Space Policy, Copernicus and Defence)**, who welcomed the attendees and introduced the Commission's proposal establishing the space programme of the Union for the period 2021-2027 which has been adopted on 6 June 2018.

The Regulation is aligned with the Communication from the Commission of 26 October 2016 to implement the Union Space Strategy for Europe by putting the Union's space programme on a firm and stable footing during the 2021-2027 multiannual financial framework.

The Space strategy stresses the importance of long-term commitments. For Copernicus, this means:

- Enhanced continuity of current data and information
- Continuity of the full, free and open data policy

In addition to enhanced continuity, it is of outmost importance to identify current observation gaps and investigate how Copernicus could fill those gaps with upgrades to the Space Component: it is the case of the so-called Expansion Missions identified by ESA leveraging on the User Requirements study managed by DG GROW:

- Anthropogenic CO2 emissions monitoring
- Land Surface Temperature at high spatio-temporal resolution
- SAR L-band
- Hyperspectral imagery
- Passive Microwave imagery
- Polar Ice & Snow topography

The upcoming MFF offers the opportunity to evaluate which of these missions can be fully funded and join the operational Copernicus family in the period 2025-2030.

For what concerns the specific domain of water management, several Copernicus services are active in distributing relevant products:

- Copernicus Land Monitoring Service (CLMS)
- Copernicus Climate Change Service (C3S)
- Copernicus Emergency Management Service (EMS)
- Copernicus Marine Environment Monitoring Service (CMEMS)

The current offer is summarised in chapter 2.4, which provides an overview of the presentations given by the Entrusted Entities.

On another note, there are water-related user needs currently unmet by Copernicus. As a consequence, this workshop represented a timely opportunity to list them and consider for the potential evolution of the Services and the Space Component.

2.2 SESSION I: Setting the scene at EU and international level

The first presentation of Session I was given by **Joaquim Capitão, DG ENV**, who introduced the challenges linked to the **Water Framework Directive (WFD)** and **the concept of Integrated Water Resources Management (IWRM)**. The WFD fosters a **holistic approach to protect the river basin**: protecting all surface and ground water bodies, including transitional waters and coastal waters, covering all pressures and impacts on waters and encouraging the active involvement of all interested parties in the implementation of the Directive and development of **river basin management plans**. For each river basin district, a "river basin management plan" has to be established and updated every six years. The aim of the WFD is long-term sustainable water management based on a high level of protection of the aquatic environment. For what concerns the surface water bodies, the ecological status (in addition to the classical chemical status) is the fundamentally new concept of the WFD, distinguishing the Directive from other water directives. Examples of important parameters include:

- Composition and abundance of aquatic flora
- River continuity
- Nutrient conditions
- Transparency

As of today, gaps exist in terms of information available to monitor all relevant ecological and chemical parameters. Member States are encouraged to improve and expand monitoring and assessment tools to ensure a statistically robust and comprehensive picture of the status of the aquatic environment. In appendix to his speech, Mr Capitão introduced also the **Floods Directive**, which creates a framework for the assessment, mapping and management of flood risks. It aims to reduce the adverse consequences for human health, economic activity, the environment (such as protected areas for bathing, drinking water abstraction), and cultural heritage. In light of the several overlaps and commonalities between the WFD and the FD, **a coherent and harmonious implementation of both Directives** is seen as fundamental.

The second presentation was given by **Dr Sun She, Danish Meteorological institute**, who completed the picture of the WFD and FD by summarising the main aspects and challenges of the **Marine Strategy Framework Directive (MSFD),** with a focus on **coastal water management**. According to Dr Shu, an **integrated use of space-based and *in situ* data together with solid modelling techniques** is needed an, in order to achieve this objective, existing institutional, sectorial and technical barriers should be broken. **Tailored products from current Copernicus services** are useful for MSFD implementation but **should be further developed** in cooperation with the actual users. Sentinels provide chlorophyll and data about ocean optical properties with good resolution for coastal waters; new satellites SWOT and CFOSAT will also enhance coastal water monitoring in sea level, waves & winds. At national level, strong modelling capabilities have been developed and offer resolutions in the range of 100 m for biogeochemical variables, which is what the coastal users are asking for, while **emerging modelling capabilities** are under development **for plastic litter, underwater noise, and suspended particulate matters transport**. As a consequence, for what concerns the **Copernicus Services, enhanced resolution to sub-kilometric scale should be the way forward**, in synergy between the Entrusted Entities and the Member States.

After Dr She's presentation, **Elena Višnar Malinovská, DG CLIMA**, expanded on the impact of and adaptation to climate change in water issues. Potentially, all elements included in the definition of the WFD with regards to **qualitative and quantitative status of water** are sensitive to climate change. This includes: **water availability** (river flows and groundwater levels); **water demand** (especially peak demands during droughts); **intensity and frequency of extreme events** (floods and low flow episodes); **water quality** (including temperature, salinity, nutrient and contaminant concentrations; sediments**); and biodiversity of aquatic ecosystems**. When coming to the FD, Member States have to undertake a preliminary flood risk assessment, draw up flood hazard and risk maps, and flood risk management plans addressing prevention, protection and preparedness. **River basin management plans and floods risk management plans have to include Climate change projections** in the assessment of pressures and impacts, the occurrence of floods, monitoring programmes and appraisal of measures. Moreover, increasingly unpredictable weather patterns, including severe droughts, are likely to have negative consequences on both the quantity and quality of freshwater resources. In relation to bridging the knowledge gap, the Copernicus programme helps in modernising the use of climate data. As a consequence, DG CLIMA has established and will continue to establish ad **hoc working groups with** the Copernicus Climate Change Service (**C3S**) in order to evaluate **potential uses of Copernicus data for the different Climate-related policies**.

The concluding speech of Session I was given by **Dr Aleix Serrat-Capdevila, World Bank**, who presented the **World Bank initiative** called "**Earth Observation for Water Management**". There is great potential for EO to enhance the capability to monitor the Earth's vital water resources, especially in data-sparse regions of the globe. Despite this potential, EO data products are currently underused in water resources management. One key reason for this appears to be the lack of familiarity among the water management community with available EO products and the ways in which they can be used to address water-related issues. This is the main reason behind the decision of the World Bank to create a **body of knowledge to summarise the most relevant EO applications for water** (link to the report). In addition to the potential of EO, the report also identifies 7 large global challenges:

- Real-time hydrometeorological monitoring and forecasting (synergy between satellite data, met forecasts and models)
- Global flood monitoring and analysis
- Field-scale periodic Evapo-transpiration estimation over large areas of interest globally
- Water quality monitoring and analysis
- Reservoirs & transboundary systems
- Riparian ecosystems monitoring
- Water point functionality

The World Bank and other development banks, United Nations agencies such as the World Meteorological Organization, and other international entities could play a role in closing the gap between science application efforts and operational decision-making needs. In addition, they could promote and facilitate data sharing, capacity-building strategies, and the co-production of knowledge by scholars and practitioners.

2.3 SESSION II: Water challenges and user needs

Session II was opened by **Dr Stefano Mariani, Italian National Institute for Environmental Protection and Research (ISPRA)**. ISPRA has recently developed a **GIS-based procedure**, named "BIGBANG – Nationwide GIS-based regular gridded hydrological water balance on a regular grid**", to evaluate on a monthly scale the components of the water balance for the entirety of the Italian territory**. BIGBANG calculates the water balance equation on the 1-km EEA grid by making use of the following parameters:

- Total Precipitation
- Actual Evapotranspiration
- Runoff
- Groundwater recharge
- Variation of the soil water content

As of today, Sentinel-1 and -2 are used to estimate:

- Water index
- Habitat mapping
- Water discharge
- Sediment size classes (in synergy with aerial photography)

The second presentation was given by **Concepción García Gómez, Water Directorate of the Spanish Ministry of Agriculture, Fisheries, Food and Environment**. Mrs García discussed about the issues related to **water scarcity and droughts** bringing the Spanish perspective. Water scarcity can be identified by water supply reliability criteria for each water use, taking into account water availability. On another note, Droughts are difficult to identify in time and to quantify in terms of intensity, magnitude, duration and surface extension. **Copernicus services provide high-value inputs to water scarcity management and planning.** However, there is a need for making products and services more accessible to policy making, in particular for water management and planning. **Accurate estimation of evapotranspiration is an essential component in the water balance**. As a consequence, **future Copernicus sensors should be able to provide the necessary observations to properly measure that**. Moreover, additional research is needed in order to a better uptake of EO-based indexes for characterisation, impact assessment and prediction of droughts.

While Mrs Garcia provided a national and EU perspective on **water scarcity and droughts**, **Dr Michelle van Vliet, Wageningem University & Research (WUR)**, brought the **global challenges** for these matters. It is important to rethink water scarcity. Usability of water depends on:

- **Sufficient water quantity**
- **Suitable water quality**
    - Water temperature, linked to the cooling of power plants
    - Salinity and nutrients, linked to irrigation and drinking water

As a consequence, there is a need for new water scarcity-indicators and model information systems including water quality. **Drought and water scarcity indicators** should be tailored to the user needs. Users need reliable, accurate and easily accessible data of droughts and water scarcity:

- Soil moisture, groundwater, surface water availability
- Sector water use
- Water quality

The next presentation was given by **Jorge J. Malfeito-Sánchez, R&D Director at Acciona Agua (Spain)**, who presented the perspective of his company within the context of the FP7 project SmartWater4Europe (SW4EU). SW4EU, now completed, aimed to promote **innovative solutions for smart, efficient, and sustainable water management.** In the next 10 – 30 years large parts of water distribution networks have to be rehabilitated. Based on their own experiences (Thames Water: € 1 billion/year; The Netherlands: € 270 mln/year), extrapolating these to Europe and taking into account the **state and performance of distribution networks**, Vitens and Thames Water estimate that € 20 billion/year are needed in Europe to upgrade the distribution networks. Prioritisation and optimisation of these investments is needed urgently.

Furthermore, in many countries **water quality needs improvement.** Frequently, the **European directive on drinking water is not met** with respect to microbiological and chemical parameters, thus posing a threat to human health.

Finally, **resources for water production and water distribution need to be used more efficiently**. Mostly water distribution networks and assets are not managed actively on a real time basis. Production, pressure management, water quality and leakage events are dealt with in a reactive way based on laboratory analysis, complaints from customers and signals of health authorities. Continuous optimisation does not take place and hence, vast resources are spilt on:

- Water leakage (water losses ranging from 5 – 50 % of total water produced)
- Sub-optimal asset management and water production;
- Sub-optimal pressure management (savings potential 10 – 15 % of energy usage for distribution; further savings: reduced number of leakages as high pressure and transients are a cause of leakages)

Satellites cannot support all aspects of the water management cycle. Nevertheless, they are critical for several applications. One of them is the management of desalination plants, which is one of Acciona Agua business lines. **Satellite data on currents, algae blooms, sea surface temperature, are merged with geological data, weather forecast information, and *in situ* data from desalination plants** themselves. So, again, **an integrated approach** is deemed essential.

The following speech was given by **Dr Stéphane Isoard, European Environmental Agency (EEA)**, who highlighted the significant progress that has been made in European waters in terms of pollution reduction. "Blue" elements (rivers and coast) are being re-discovered as valuable parts of a city landscape. Challenges remain for urban and industrial wastewater and restoring rivers, lakes and coastal waters in cities. Many **European cities** have developed broad visions and **strategies to promote more integrated management of their water bodies**, especially in terms of restoring their rivers and lakes. Activities on the restoration of urban rivers and lakes are likely to expand further as urban development continues and demand for a better, more sustainable quality of life increases. Then, coming to Copernicus, the real challenge is the link with the stakeholders making the reportings which are due according to policies. An example is the reporting on the quality of EU waters. There is a lack of understanding of what the Copernicus products actually are and can do. All in all, **the link between the Copernicus services and the policy cycle is still fragile**, and efforts should go in that direction in the coming future.

After Dr Isoard's speech, the floor was given to **Dr Adriano Battilani, Irrigants d'Europe**, who expanded on the **issue of water use and wastewater management**. The largest EU associations managing water in agriculture have created Irrigants d'Europe. Founders include the national associations in charge of irrigation water management of the Member States where irrigation is most relevant (Italy, Spain, France, Portugal). **Irrigation and water management are the keys to sustainable agriculture in a circular economy context, responding to the challenges of climate change and food security**. Several parameters have to be measured regularly and with the right accuracy:

- Soil properties
    - Texture
    - Moisture (with a resolution < 50 m)
    - Organic carbon, salinity, and carbonates
- Vegetation indexes
    - Pattern and crop mapping
    - Mapping of photosynthetic and non-photosynthetic vegetation

Moreover, from a practical point of view, targeted actions to better integrate information products into existing irrigation and water governance management tools are needed. Remote sensing could offer viable solutions for the new CAP payment criteria based on results achievement and performances.

The last speech of Session II was given by **Dr Livia Peiser, FAO Land and Water Division**. Dr Peiser focused on the **water-energy-food *nexus***. The rationale behind the *nexus* leverages on:

- Increasing and competing pressures on resources for socio-economic development
- Policies and development strategies still very much sector-driven
- Difficulties to apply integrated approaches: need for an approach based on cross-sectoral dialogue

In a world of increasing demands, the consequences of not taking cross-sectoral approaches are more significant now than a generation ago. Satellites play a central role in providing support information on:

- Irrigation and actual evapotranspiration (ETa) monitoring
- Land use (crops)
- Land productivity (biomass, yield)

- Water productivity (yield/actual ET)

This leads to the following needs in terms of space-based observations and products:

- Land Surface Temperature, at appropriate temporal (< 5 days) and spatial resolution (< 50 m, 10-20 m ideal)
- Meteorological forcing (Air temperature, humidity, pressure, wind speed)
- Scaling up reference data collection and ground truthing
- Enhanced computing power, easy-to-use exploitation platforms
- Capacity development
- When developing tailored products, take into account the unreliability of bandwidth in many non-industrialised countries

The last speech of Session II was given by **Hugues Van Honacker, DG MOVE**. **Inland navigation goods transport** in main European river basins accounts for 145 billion Tonne-kilometre (tkm), with the Rhine being by far the most important European basin per volume of good transported (with a share of 2/3 of European volumes transported by Inland Waterways Transport on this river). Today's main challenges for inland navigation in this regard are:

- Low water periods (restrictions in vessels' loading degrees)
- Floods (halt of navigation or restrictions for vessel speed)
- Ice conditions (halt of navigation)

The needs of inland navigation can therefore be summarized as follows:

- Short, medium and long-term weather forecasts and derived from these
- Predictions of available fairway depth
- Outlooks on annual discharge (dry year vs. wet year)

2.4 SESSION III: How the Copernicus Services meet the water challenges

Session III was opened by the presentation of **Dr Carlo Buontempo, ECMWF**. Water and Climate are by nature linked and this is why the Copernicus Climate Change Service (C3S) has funded and is funding several key projects related to water issues and challenges. Currently, one of the most important ones is SWICCA (**Service for Water Indicators in Climate Change Adaptation**). SWICCA offers readily available climate-impact data to speed up the workflow in **climate-change adaptation of water management across Europe**. The project serves as a proof-of-concept for a Sectorial Information Service (SIS) on water management to C3S. The aim of the project is to bridge the gap between institutes who provide climate-impact data on one side, and water managers and policy makers on the other side. In terms of general future needs:

- A common framework to deal with all terrestrial ECVs across time-scales (from historical reconstructions, to multi-decadal projections) is needed
- There is a clear need for a coordinated approach to water across the Copernicus Services
- The quality of the observational record for terrestrial ECVs should be improved
- It is important to find the right balance between the service provision and the requirements in order to maintain a lively downstream market

The second presentation of Session III was given by **Dr Peter Salamon, DG JRC**, who presented the **water-related products of the Copernicus Emergency Management Service** (CEMS). He focused on the European Flood Awareness Service (EFAS) and the European Drought Observatory (EDO), together with the Rapid

Mapping and Risk & Recovery Mapping services in relation to water. 35% of all Rapid Mapping activations since 2012 have been for floods, specifically for flood extent and related damages to assets and affected population. EFAS provides complementary flood forecast information to relevant stakeholders supporting flood risk management at national, regional and global level. For all products, please refer to the EFAS website. In terms of next steps, the following potential evolution is proposed:

- Integration of new drought indicators
- Expansion of the seasonal outlook also to the drought observatories
- Increase spatial & temporal resolution of forecast systems
- Use of gravity-based indicators for flood and drought monitoring - tested already in the H2020 project EGSIEM
- Automatic global scale flood monitoring
- Linking of current and future Copernicus products to EMS (snow, lake water level, etc.)
- Coastal storm surge forecasting

At the end of his speech, Dr Salamon announced that there is a DG GROW – DG JRC effort on-going called “Copernicus for EC Policies (C4EC)”, which is aimed at filling the gap, common to many policy areas, of the direct usability of Copernicus data and information for policy reporting documents on:

- Environmental monitoring
- Compliance

The audience welcome the news since the issue of linking in a direct way policies and Copernicus data and information is indeed a relevant one in the water domain.

The following speech was given by **Dr Tobias Langanke, EEA**, who expanded on the **water-related products of the Copernicus Land Monitoring Service (CLMS)**. The directly relevant current products are:

- Riparian zones (local component)
    - Delineation of Riparian zone through the use of VHR Land use/Land cover (LU/LC) mapping (updated every 5 years)
- Water and Wetness (high resolution layer)
    - Classified Water & Wetness product (20m)
    - Water Wetness Probability Index from 2009 to 2015 (20m)
    - Aggregated 100m and national projection products
- EU-Hydro (reference data)
    - Database for all EEA39 countries providing:
        - Photo-interpreted river network derived from VHR data
            - Water bodies and wide rivers
        - Drainage Model derived from EU-DEM
            - Catchments and drainage lines and nodes
        - Update with improvements and error corrections in late 2018

The indirectly relevant ones are:

- Planned coastal zone product (expected to be operational by Q4 2018)
    - VHR LC/LU mapping of approximately 60 classes of the coastal zone (10 km landwards buffer)

  - Coastal erosion and dynamics
  - Riverine water discharge
- Planned snow and ice product (expected to be operational by Q4 2018)
  - Snow Cover High-Res (20 m)
  - Lake ice cover
- Planned high-resolution phenology product

The following presentation, still focused on CLMS products, but only those at Global scale, was given by **Joël Dorandeu, CLS,** who presented **the "Water & Cryosphere" CLMS service (Global Component),** which was launched in the first half of 2018 to answer global societal challenges:

- Water Governance: facilitate the contributions of the different actors to integrated water resources management
- Risk Management: flood risk prevention
- Agriculture: development of irrigation/drainages and mitigation of environmental impact
- Energy: Hydro, nuclear, thermal power plants (they all need water for production or cooling systems)
- Drinking water: water supply is essential and involves actors at several scales
- River navigation/transportation: security of river traffic
- Civil Engineering: dams, dikes, reservoirs
- Health: degradation of water quality can affect both aquatic life and human uses of water
- Integrated Management of Estuaries: these areas of high economic activity are likely to induce pollution and modify the ecosystem. Moreover, the link with Coastal and Marine Environment is strong and delicate

The available products include:

- Snow Cover Pan-EU at 500 m daily, Snow Cover Northern Hemisphere at 1 km daily, Snow Water Equivalent at 5 km daily
- Lake Ice Extent at 250 m daily, Lake Surface Water Temperature at 1km every 10 days, Lake Water Quality (reflectance, turbidity, Trophic State) at 1km/300m/100m every 10days
- Area of water bodies at 1km/300m daily
- Lake and Reservoir Water Level every 1 to 10 days, River Water Level every 10 to 27 days

The following presentation was given by **Edmée Durand, Mercator Ocean**, who summarised **the offer of the Copernicus Marine Environment Monitoring Service (CMEMS).** In the specific case of water management, the most interesting products are the coastal ones. In coordination with CLMS several products are planned. On CMEMS side, the following recommendations should be taken into account:

- Better processing (i.e. specific algorithms) of satellite observations is required to improve the quality of coastal products
- New satellite products to better characterise the state of the coastal zone (e.g. coastline, coastal erosion) and its evolution (e.g. on seasonal to annual basis) should be proposed
- Improved Digital Elevation Models (DEM) and Bathymetries are basic core requirements for the coastal zone

- The monitoring and short- and long-term prediction of sea level close to the coasts should be improved. This is required for a wide range of applications (flooding, coastal erosion, coastal zone management)
- Stronger interfaces between CMEMS and downstream coastal marine monitoring systems should be developed. This includes harmonisation and standardisation issues (e.g. formats, quality assessment methods, documentation, data distribution) and of the use of consistent and improved bathymetry, atmospheric forcing and river inputs
- Links/interfaces with EMODnet portals and activities (e.g. bathymetry, seabed habitats, chemistry) should be reinforced
- Products from national/member states coastal monitoring systems could be made available through CMEMS, CLMS or Copernicus (e.g. DIAS) data portals (coproduction EU & Member States).

2.5 SESSION IV: The Copernicus Programme and its evolution

The last session of the workshop was opened by **Pierluigi Silvestrin and Dr Mark Drinkwater, ESA/ESTEC**, who provided an overview of:

- Current water-related challenges
- Current space-based capabilities
- Future space-based capabilities

Major challenges include:

- Inland/ Coastal/Ocean Water quality Monitoring
- Pollution/Wastewater management
- Eutrophication/Harmful Algal Blooms (HABs)
- Invasive Species/Biodiversity
- Waterborne diseases
- Ground Water recharge/abstraction and quality management
- Irrigation Management
- Flood Risk Management
- Climate change challenges: water availability (droughts)
- Extreme Events/Emergency response (Flooding)

Current Copernicus space-based capabilities include:

- Optical sensors (at varying spatial/spectral resolution and sampling) measuring coastal and lake water quality (e.g. Chlorophyll concentration, turbidity, water temperature, HABs), Snow Cover, Snow Water Equivalent, Land Use / Land Cover, Land Surface Temperature
    - Sentinel-2 MSI
    - Sentinel-3 OLCI / SLSTR
- All weather imaging sensors (at varying spatial resolution/temporal sampling and frequency)
    - C-band SAR (Sentinel-1)
        - River mask
        - Wet snow maps

        - Dyke stability
    - Scatterometers
        - Soil Water Index
- Geodetic / Metrological sensors
    - Altimetry (S-3, CryoSat, S-6)
        - River and lake water level
    - Gravimetry (in synergy with InSAR when possible)
        - Groundwater resource management

Then, looking at the future, ESA, leveraging on the user requirements study managed by DG GROW, proposed six High-Priority Candidate Missions (HPCM) and five of them provide useful data for water-related applications:

- High Spatial/Temporal Resolution Land Surface Temperature
    - Agricultural productivity and Water Resource Management
- Polar Ice & Snow Topography
    - Sea, river and lake water level
- Passive Microwave Imaging
    - Soil moisture and Snow Water Equivalent (SWE)
- Hyperspectral Imaging
    - Agriculture/food security, forestry, raw materials, soil properties and biodiversity, water quality
- L-band SAR
    - Natural hazards, soil moisture, water extraction

In addition to these missions, it is important to highlight the importance of **gravimetry, especially for the monitoring of groundwater resources.** Gravimetry data enable the monitoring of seasonal to inter-annual variability and trends in changes in freshwater availability. Moreover, they are fundamental to evaluate and predict emerging threats to water availability, as well as support early warning for flood risks.

To conclude, in terms of open challenges for space-based observations and service products for Copernicus we have:

- Time/space sampling requirements
- Access to total drainable water/water storage (per catchment)
- Improved detection beneath vegetation canopy (longer wavelengths)
- Improved DEM required for self-consistent image orthorectification, classification, downscaling and hydrological basin definition
- Automation of processing to develop time series/statistics (incl. use of mixed ascending/descending data)
- Integrated use of different sensor technologies (radar/optical/gravity)
- Further development of modelling tools/frameworks to bridge time-space sampling, and to synthesise multi-sensor data

ESA's speech was followed by that of **Dr Jochen Grandell, EUMETSAT**, who gave an overview of EUMETSAT's satellite products in support of water management. EUMETSAT has a dedicated **Satellite Application Facility**

(SAF) supporting operational hydrology and water management. The H-SAF, led by the Italian Meteorological Service (ITAF Met Service), produces and distributes products focused on:

- Precipitation
- Soil moisture
- Snow parameters
- Utilisation of these parameters in hydrological models and Numerical Weather Predictions

Moreover, the Ocean and Sea Ice SAF (OSI SAF) routinely produces and disseminates products characterising the ocean surface:

- Sea Surface Temperature and the energy fluxes
- Information on the sea ice characteristics (extend, concentration, …)
- Wind speed from Scatterometry

The last presentation of the day was given by **Dr Mark Dowell, DG JRC**, who discussed the Copernicus evolution in support of **global scale mapping of surface water dynamic** at high resolution. The objective is to answer the following questions:

- Where has surface water occurred over the past 3 decades?
- When do water bodies fill and empty?
- What about their inter and intra-annual variability?
- How likely is it to find water in any given place and month?
- When and where have new/ex water-bodies formed/disappeared?
- What form did changes take, in terms of seasonality and persistence?
- What about trends?

Measuring long-term changes at high resolution remains a challenge. By using three million Landsat satellite images, changes in global surface water over the past 32 years at 30-metre resolution have been quantified. The months and years when water was present have been recorded, as well as where occurrence changed and what form changes took in terms of seasonality and persistence. Between 1984 and 2015 permanent surface water has disappeared from an area of almost 90,000 square kilometres, roughly equivalent to that of Lake Superior, though new permanent bodies of surface water covering 184,000 square kilometres have formed elsewhere. All continental regions show a net increase in permanent water, except Oceania, which has a fractional (one per cent) net loss. Much of the increase is from reservoir filling, although climate change is also implicated. Loss is more geographically concentrated than gain. Over 70 per cent of global net permanent water loss occurred in the Middle East and Central Asia, linked to drought and human actions including river diversion or damming and unregulated withdrawal. This globally consistent, validated data set shows that impacts of climate change and climate oscillations on surface water occurrence can be measured and that evidence can be gathered to show how surface water is altered by human activities. This data is freely available and will improve the modelling of surface forcing, provide evidence of state and change in wetland ecotones (the transition areas between biomes), and inform water-management decision-making.

2.6 Concluding remarks

The concluding remarks were given by **Catharina Bamps, DG GROW,** who reinforced the message that the Commission is intending to address the water sector and the needs of its user community. The topic is important and challenging at the same time. **This workshop highlighted the cross-sectorial nature of this domain: water directly affects all six Copernicus domains** (Land Monitoring, Emergency Management, Marine Environment Monitoring, Climate Change, Atmosphere Monitoring, Security). As a consequence, an outstanding need is to **identify and exploit the synergies between the services** and investigate the **possibility of producing and distributing tailored products vis-a-vis the needs of the end users and their applications.**

Moreover**, the link between the Copernicus evolution and the water-related EU policies** (e.g. environmental monitoring, reporting and compliance assurance, international conventions, SDGs) **should be reinforced and tools created in order to allow an operational use of Copernicus products from the DGs and the Member States** (for example for their reporting obligations). Efforts are on-going, e.g. the DG GROW – DG JRC initiative "Copernicus for EU Policies", nevertheless, this remains an open challenge and represents a relevant issue to be tackled in the future.

On another note, the downstream sector plays a relevant role in providing critical information to the end-users. It is therefore crucial to understand which products for water management should be delivered by the Copernicus services and which by the downstream sector. It is important for the users that this distinction is better clarified.

In terms of near-future opportunities, the Commission looks forward to the launch of the five Data and Information Access Services (DIAS) platforms, which will facilitate access to Copernicus data and information from the Copernicus services. By providing data and information access alongside processing resources, tools and other relevant data, this initiative is expected to boost user uptake, stimulate innovation and the creation of new business models based on Earth Observation data and information.

2.6.1 Summary of the workshop presentations, discussions and conclusions

This workshop showed that Copernicus can already contribute to the water sector by providing supporting data and information for several applications. Nevertheless, the users are requesting enhanced continuity of the current Space Component featuring, for example, higher revisit time and spatial resolution, of existing assets (for water, mainly S-1, S-2, and S-3). In addition, several presenters stressed the benefits of a potential Sentinel mission for high-resolution (10-30 m) Land Surface Temperature measurements, which is part of the six ESA-proposed High-Priority Candidate Missions. Then, an important space-based measuring technique for water that Copernicus should evaluate for the future is gravimetry, especially useful for the monitoring of groundwater resources. Gravimetry data enable the monitoring of seasonal to inter-annual variability and trends in changes in freshwater availability. Moreover, they are fundamental to evaluate and predict emerging threats to water availability, as well as support early warning for flood risks.

Lastly, open challenges include the automation of processing to develop time series/statistics, the integrated use of different sensor technologies (radar/optical/gravity), as well as further development of modelling tools/frameworks to bridge time-space sampling and synthesise multi-sensor data.

As a way to conclusions:

- The Copernicus Space Component and the Copernicus services already offer a wide range of products responding to the requirements arising from the water management community
- Several gaps exist in terms of space-based observations and service product information. Enhanced continuity as well as the introduction of new observation capabilities (e.g. Thermal Infra-Red) are looked at with great interest
- The water sector is highly differentiated and multifaceted. The set of requirements emerging from it have to be considered when looking at the next generation of Copernicus as well as near-term service evolutions
- There is a growing demand for tailored products and dedicated applications, which should relieve the user from the burden of dealing with overwhelming quantities of data. The question has been raised whether these tailored products and applications should be provided by the Copernicus services or better left to downstream operators. Not forgetting that the main purpose of these in-between steps is to simplify the use of the data and bring Copernicus closer to the users

- A last critical point: the link between the products offered and the addressed policies, be it for information, monitoring, compliance, or others, should be transparent, self-evident. Moreover, the direct usability of specific Copernicus products for policy-related obligations should be improved

ANNEX 1 WORKSHOP AGENDA

European Commission

COPERNICUS FOR WATER MANAGEMENT WORKSHOP

29 May 2018, Brussels

09:00 - 09:30 Registration and welcome coffee

09:30 - 09:45 **Welcome and introduction**

Welcome and introduction
Catharina Bamps, DG GROW, European Commission

Agenda and objectives of the workshop
Copernicus Support Office

SESSION I: SETTING THE SCENE (EUROPE AND INTERNATIONALLY)

09:45 The Water Framework Directive
Joaquim Capitão, DG ENV, European Commission

10:00 Copernicus for coastal water management in MSFD: potential uses and future challenges
Dr Jun She, Danish Meteorological Institute

10:15 Guidance on the impact of and adaptation to climate change in water issues
Elena Višnar Malinovská, DG CLIMA, European Commission

10:30 Water resources challenges and operational remote sensing applications
Dr Aleix Serrat-Capdevila, The World Bank

10:45 - 11:05 Coffee break

SESSION II: WATER CHALLENGES AND USER NEEDS

11:05 Integrated Water Management (IWM) and coastal waters
Prof. Andrea Taramelli and Dr Stefano Mariani, Italian National Institute for Environmental Protection and Research

11:20 Water scarcity and droughts: a European perspective
Concepción García Gómez, Water Directorate of the Spanish Ministry of Agriculture, Fisheries, Food and Environment

11:35 Water scarcity and droughts: a Global perspective
Dr Michelle van Vliet, Wageningem University & Research (WUR)

11:50 The needs of the drinking water sector, the Acciona Agua perspective
Jorge J. Malfeito-Sánchez, R&D Director at Acciona Agua (Spain)

12:05 The EEA perspective on water-related user needs
Dr Stéphane Isoard, EEA

12:20 Water use and wastewater management
Dr Adriano Battilani, Irrigants d'Europe, EIP Water AG WIRE, CopaCogeca, ANBI, CER

12:35 Food Energy Water nexus
Dr Livia Peiser, FAO Land and Water Division

12:50 **Open discussion on user needs**

13:00 - 14:00 Networking lunch

Space

Copernicus
Europe's eyes on Earth

SESSION III: HOW THE COPERNICUS SERVICES MEET THE WATER CHALLENGES

14:00 The Copernicus Climate Change Service (C3S)
Dr Jean-Noel Thepaut and Dr Carlo Buontempo, ECMWF

14:15 The Copernicus Emergency Management Service (EMS)
Dr Peter Salamon, DG JRC, European Commission

14:30 The Copernicus Land Monitoring Service (CLMS)
Dr Tobias Langanke, EEA

14:45 The CLMS Global Component offer for water
Joël Dorandeu, CLS

15:00 The Copernicus Marine Environment Monitoring Service (CMEMS)
Edmée Durand, Mercator Ocean

15:15 **Open discussion on the Copernicus offer and the gaps identified**

15:40 - 16:00 **Coffee break**

SESSION IV: THE COPERNICUS PROGRAMME AND ITS EVOLUTION

16:00 Water management and the evolution of the Copernicus Space Component: challenges and capabilities
Pierluigi Silvestrin and Dr Mark Drinkwater, ESA/ESTEC

16:20 Overview of EUMETSAT's satellite products in support of water management
Dr Jochen Grandell, EUMETSAT

16:35 Copernicus service evolution towards Global Scale Mapping of surface Water Dynamics at high resolution
Dr Mark Dowell, DG JRC, European Commission

16:50 **Open discussion on the evolution of the Copernicus Programme and its relevance to Water Management issues, with a view to filling the identified gaps**

17:20 - 17:30 **Concluding remarks**
Catharina Bamps, DG GROW, European Commission

Space

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