# Workshop WP3/5 - water quantity and modelling and data assimilation

# Water-ForCE

| Project Identification | |
|---|---|
| **Project Full Title** | Water Scenarios for Copernicus Exploitation |
| **Project Acronym** | Water-ForCE |
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|---|---|
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## History of Changes

| Date | Version | Comments |
|---|---|---|
| 26/04/2021 | V1 | Concept report |
| 19/05/2021 | V2 | Revision |
| | | |

# Table of Contents

# 1. Introduction

## Project & Work package introduction

The **Horizon2020** project **Water-ForCE** (Water scenarios For Copernicus Exploitation) will develop a Roadmap to better integrate the entire **water cycle within the Copernicus services**, thereby addressing current disconnects between remote sensing / in situ observation and the user community. Clarity in terms of the needs and expectations of both public and private sectors from the core Copernicus Program and the wider research and business innovation opportunities will be delivered. The Roadmap will then also advise on a strategy to ensure effective uptake of water-related services by end users and further support the implementation of relevant directives and policies.

The Water-ForCE consortium is led by the University of Tartu (Estonia) and consists of 20 organisations from all over Europe. It will bring together experts on water quality and quantity, in policy, research, engineering and service sectors. Through close collaborations with these communities, Water-ForCE will among others:

- To analyse EU policies to identify where the Copernicus services can improve monitoring programs and how the Copernicus data can be more effectively used in developing and delivering the next versions of the directives.

- To specify the requirements for future Copernicus missions (e.g. optical configuration of Sentinel-2E and onward, hyperspectral sensors).

- To optimize future exploitation for inland water monitoring & research and, consequently, (a) enlarge the service portfolio and (b) improve the performance of current services.

The project is divided in eight work packages (WP), each of them focusing on a specific problem and/or target of the Copernicus Service (see figure underneath).

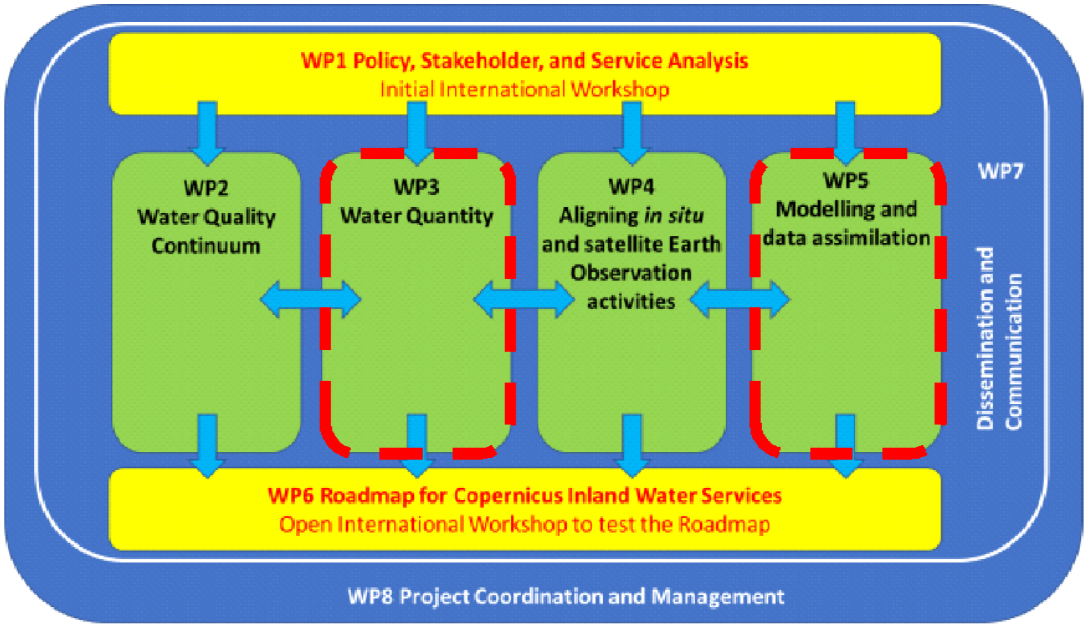



*Figure 1 : Organizational structure of the different work packages in the Water-ForCE project.*

This report focuses on the workshop of:

- **WP3 Water Quantity**: The overall objective is to provide insight on the Copernicus products (floods, drought, surface water extent, soil moisture, ice, …) and services supporting water management and modelling. It includes a gap analysis using existing knowledge by building a community of water quantity experts.

- **WP5 Modelling & Data assimilation**: The goal is to identify the potential for future use of different satellite EO in modelling of water resources for support of decision makers towards adaptive management of water resources and policy implementation.

## Objectives

The overall objectives of the workshop are:

- Raise and examine public awareness on Copernicus services, data products and tools.
- Discuss current availability of data products, their availability within the Copernicus services and/or by other external sources (NOAA, JAXA etc.).
- Discuss user needs, data requirements and user wish lists.
- Establish an international working group, consisting out of water quantity remote sensing specialists and water resources experts. Also inland water specialists and modellers are to be included. This working group will continue to grow and evolve during the rest of the project and along the project's needs. The working group will in the first instance have an advisory role in the future WP 3/5 project progress and interpretation.

These objectives will support and give input to upcoming project & work package deliverables and the overall project progress.

## Workshop Program

The workshop program consisted out of a morning plenary- and interactive session and an afternoon plenary session.

The morning plenary session gave an introduction on the Water-ForCE project and the objectives of work packages 3 & 5. Three Copernicus services were presented:

- ***Land Service*** by dr. Nicolas Taburet (European Commission, Joint Research Centre)
- ***Emergency Service*** by dr. Vera Thiemig (European Commission, Joint Research Centre)
- ***Climate Service*** by dr. Fredrik Wetterhall (European Centre for Medium-Range Weather Forecasts)

These presentations focussed on product availability, product use and user needs.

During the interactive breakout sessions several small groups were formed to discuss Copernicus products and tools. A comparison was made between current product availability versus a product wish list. The public awareness on current Copernicus services was tested and opportunities and (dis)advantages of the current services were discussed.

The highlights of the different breakout sessions were summarized during the afternoon plenary session. This was followed by a delineation of future project planning (project

website) and a more elaborated explanation on the working group for WP3 and 5. The session concluded with an open platform discussion.

The detailed program of the workshop can be found in ***Annex 2 : Program workshop***.

# 2. Output

## 2.1 Copernicus Services: CGLS, EMS and C3S

Three Copernicus Services were introduced with a focus on both current and future data products related to water quantity. A short summary is provided underneath, while presentations can be found on the project website.

**Global Land Service**: was introduced by dr. Nicolas Taburet (JRC). The CGLS is a component of the Land Monitoring Core Service (LMCS). The service supports end user applications in various socio-economic domains (agriculture, drinking water, water governance, civil engineering, …) by providing geographic data on e.g. land cover (changes) and the water cycle. The presentation focused on products of the Global Land Service (CGLS) as properties of - among others - lake ice extent, areas of water bodies or snow cover extent were discussed in detail. The land service announces new evolutions in the data by providing higher resolutions, uncertainty estimations, more extended geographic regions and the extended use of satellites (e.g. exploitation of Sentinel-3 SLSTR/OLCI L1C synergy data for Lake Ice Extent and addition of Sentinel 6A).

**Emergency Management Service**: was presented by dr. Vera Thiemig (JRC). This service focuses on providing information on natural and man-made disasters, for all aspects of disaster risk management. Provided products, such as Rapid mapping (to support emergency response), Risk & Recovery mapping (to support risk prevention and recovery efforts), EFAS/GloFAS and the European and Global Drought Observatories, make use of earth observation, model- and in-situ based disaster management data. In addition to extensive datasets also models, e.g. LISFLOOD, are open source access. General product updates and - developments are announced, among others in-situ data collection will be expanded to global levels, there will be an introduction of additional variables (reservoir related parameters) and product updates and - developments to EFAS/GloFAS will include increased spatial resolutions and the introduction of a coastal flood forecast component.

**Climate Change Service** : was introduced by dr. Fredrik Wetterhall (ECMWF). The Climate Change Service offers climate indicators on sectoral impacts and tools to, not only use and analyse datasets, perform climate change assessments. User driven applications and indicators are build based on stakeholder consultations. Data is available on the Climate Data Store (CDS): a data portal with free and open access to climatic data which include global reanalyses, seasonal forecasts and climate projections. The portal provides among others, analysing tools, climate indicators,

climate change assessments and a user requirements database. The latter is used for continuous service evolution. In addition to the current products the service is also working on a case study to monitor and project river flow changes and effects on costs of inland waterway transport on the Rhine river by using C3S climate data,10 CEMS-Floods datasets for EFAS/GloFAS (*available now on CDS*) and hydrology related climate impact indicators from 1970 to 2100 derived from bias adjusted European climate projections[1] (*available May 2021*).

The different speakers each managed to increase awareness on the Copernicus services, what they stand for and which data products and tools they are offering. During the presentations feedback of the audience was also asked by the presenters by means of Mentimeter polls. A complete overview of the Mentimeter polls is provided in ***Annex 4 : Mentimeter***

## 2.2 Break-out session

In the interactive session 3 questions related to water quantity data products, user needs and data requirements were addressed by the use of Miro boards (***Annex 5 : Miro boards***). The answers for each question can be found below.

### Question 1 *: Use of Copernicus and non-Copernicus data products related to water quantity.*

An overview of the different data products used by the participants of the workshop in their daily work can be found here. The table only shows the products used from providers other than Copernicus. The list also includes "wish list" products, these are products participants would like to have, however that are not yet available or on which the awareness of their existence is very low. A link on where to find these same parameters on the Copernicus website is provided in the final column.

During the discussions it became clear that specific parameters for water bodies, soil properties, snow & ice and water storage were in high demand. Although e.g. evaporation parameters are offered by the Copernicus Services and are frequently used by the participants, only non-Copernicus providers were mentioned at the workshop. Possible causes are:

- Awareness
- Low accessibility of the data
- Specific parameter is not available (e.g. resolution)
- Not enough metadata available
- Data does not meet user requirements (e.g. FAIR[2])
- …

[1] More information on these products can be found here : Data product_ECMWF_presentation

[2] FAIR data : "FAIR Guiding Principles for scientific data management and stewardship". These are "guidelines to improve the Findability, Accessibility, Interoperability, and Reuse of digital assets" (https://www.go-fair.org/fair-principles/).

A detailed *inventory of available and upcoming Copernicus data products related to the hydrological water balance* (Deliverable 3.2 of WP3 of the Water-ForCE project) will be publically published in June 2021. The output of the workshop (used data products, bottlenecks, wish lists,…) will be used as extra input for this inventory.

This combined work will act as a basis for future deliverables of WP3/5 and will give input for other work packages of the Water-ForCE project.

### Question 2 : *User requirements for Copernicus services. Which user requirements are needed and which have to be enhanced?*

Participants were asked to indicate their most important user requirements with regard to the Copernicus data portal, data itself and metadata. User requirements for the data portal all related to communication, data access and -processing, trainings and access to other platforms. Table 1 gives an overview on proposed actions in order to enhance those requirements.

The most challenging requirement is the data access. A lot of suggestions were made to enhance the search options for available data together with its accessibility. Furthermore there is a high demand on (post)processing tools.

A general deficiency for users would be the lack of training material & tutorials on "how to use the portal". Additionally, a newsletter on upcoming products and product updates would be of interest to the participants. Momentarily news can be found on the news webpage of Copernicus and the different services. Please note that a general newsletter, aside service-specific news, is available for which you can subscribe:

- Copernicus general newsletter : https://www.copernicus.eu/en/news/news (subscription at the bottom of the webpage)
- Land service : https://land.copernicus.eu/@@register (registration)
- Climate service : https://climate.copernicus.eu/news (subscription)

*Table 1 : Overview on user requirements related to the Copernicus data portal.*

| | **Data portal (Copernicus services)** |
|---|---|
| Access to other platforms | Interoperability with increasingly common platforms - e.g. GEE |
| | Links to non-Copernicus data portals |
| Communication | In advance communication of upcoming products and updates |
| | Newsletter informing on new products release |
| | Different languages |
| | Awareness of existing products |
| Trainings | Specific Training regarding data formats and products |
| | Trainings (general) |
| | Tutorial on "how to use the portal" |
| | Capacity development/courses/tutorials |

| | |
|---|---|
| Data access | Intelligent data search |
| | User guide for data accessibility |
| | Easy to find tutorial on navigating the webportal |
| | Key word search based on operational needs |
| | On demand service for data download (important as data volume/resolution are growing) |
| | All data to be available in the cloud environment |
| | watershed and cities filters (averaging and gridded |
| | API access |
| | Cloud native formats (HDF5, COG, zarr) |
| | Uniformity between product manual and website |
| | Access through GIS plugins |
| | Better download performance |
| | Standardization of parameter names |
| | Central repository for all data |
| | Quickview |
| Data processing | Scripts (i.e. in R) to manipulate data |
| | Link to cloud computing service (online analysis) |
| | Spatiotemporal visualization and analysis |
| | Open space for shared research data (results from models) |
| | Post-processing tools |
| | Big Data Challenges (how do I process Petabyte of EO data without paying a fortune, or for free, harmonization) |

User requirements related to the data itself and metadata are shown in Table 2 and Table 3. Participant's concerns focus on the data standards and quality of the data. The data should comply with OGC[3] and FAIR standards. Data quality flags and a more detailed information on validation, accuracy, limitations and uncertainties of the data is wished for. Information on- and availability of in-situ data, used for validation, appears to be a bottleneck.

*Table 2 : Overview on user requirements related to Copernicus data.*

| **Data standards & quality** |
|---|
| FAIR data |
| Data on all levels (raw data to end user products) |
| Ongoing data Copernicus series (like Landsat series) |
| OGC standards / OGCAPI |
| Comparable historical and real time products |

[3] OGS standards : https://www.ogc.org/domain

| **Resolution** |
|---|
| Smaller than 10 m resolution |
| Smaller resolution on same time scale |
| Global coverage |
| **Various** |
| Events data (e.g. P together with Q, with flood extent) |
| Long continuous datasets with quality data |
| Long-term timeseries |

*Table 3 : Overview on user requirements related to Copernicus metadata.*

| **Metadata** |
|---|
| Metadata info on setup (reproducibility) for modelled datasets |
| More information on validation, accuracy, limitations, uncertainties of the data |
| Detailed information of what a given indicator is. e.g. SPI - and how it is calculated |
| Clarity on representativeness and adequacy |
| Quality flags (reliability of data...) |
| Which in-situ data is used for calibration/validation |
| Short datasheet with statistics regarding accuracy and validation results |
| Improved metadata together with data (standardization description of the data, FAIR data) |
| High accuracy (coupling in-situ + remote sensing) |
| Latency information (how quickly the data becomes available after sensing by satellites) |
| Searchable through search engines |

*Question 3: Copernicus and non-Copernicus tools to view, access and process remote sensing data. Which different tools do you use in your daily work?*

After assessing data products and user requirements, a final question concerning the use of Copernicus and non-Copernicus tools to view, access and process remote sensing data was posed to the participants. An overview on the type of tools (Copernicus/non-Copernicus) that are used is provided in Table 4.

In general the tools could be classified into 4 types: Notebooks, data processing & -modelling tools, toolboxes/indicators and browsers. A majority of the participants indicates Jupyter notebooks as commonly used. For data processing & -modelling it is clear that a lot of different tools (non-Copernicus) are used. They concern programming languages and modules (R, Python, Matlab …), GIS software (Arc GIS, QGIS) and (open source) models (HEC-HMS, Telemac, FEWS…). In the category toolboxes/indicators it were SNAP (Copernicus ESA) and Google earth Engine that are most frequently used, aside a lot of other toolboxes, indices and monitoring systems. In contrast to the category data processing & -modelling tools, Copernicus services offer a significant amount of toolboxes and viewers, which are frequently used, aside non-Copernicus programs.

A list of abbreviations is provided in ***Annex 1 : Abbreviations***.

*Table 4 : Overview on Copernicus and non-Copernicus tools to view, access and process remote sensing data.*

| | **Notebooks** | **Data processing & modelling** | **Toolboxes and indicators** | **Browsers** |
|---|---|---|---|---|
| **Copernicus** | OpenDAP access | LISFLOOD model (emergency service) | Sentinel-2 toolbox | EO-Browser Viewers |
| | | | Global Flood Awareness Systems (Emergency service) | |
| | | | SNAP | |
| | | | CDS toolbox | |
| | | | CopHub | |
| | | | Global Surface Water Explorer | |
| **non-Copernicus** | Colab | R & Rstudio | Drought Toolbox (United Nations CCD) | Sentinel Hub EO Browser (provided by Sinergise, free access) |
| | Jupyter | Python | SPI and SPEI indices | |
| | AI libraries for modelling | IHEWACollect (python scripts for downloading RS data) | WEAP (Water Evaluation and Analysis Program) for watershed management | |
| | | GDAL | Google Earth Engine | |
| | | SeaDAS | SeaDAS | |
| | | SHYFEM | Theia Hydroweb portal | |
| | | Mike She and DHI software | Panoply | |
| | | HEC-HMS and HEC-RAS | SWAT | |
| | | Telemac | WaPOR | |
| | | Specific vendor platforms (e.g. Delft FEWS) | | |
| | | RHESSys | | |
| | | SWMM (Urban modelling of floods) | | |
| | | CDO's | | |

| | | | | |
|---|---|---|---|---|
| | | Arc GIS | | |
| | | QGIS | | |
| | | Matlab | | |
| | | Octave | | |
| | | Rainfall-Runoff-Inundation (RRI Model) | | |
| | | Data Cube tools | | |
| **Wish list** | | Existing models be available as an open-source | Open source tools? | |
| | | Portals (e.g. UKCEH has developed a number of portals to view spatial data) | | |
| | | QGIS (OGC or plugins such as SCP) | | |
| | | R access to CDS? | | |

..

The highlights of the break-out sessions can be summarized as follows :

- High demand on groundwater and soil moisture data, evapotranspiration data and data for agricultural applications. Data on man-made structures is lacking (dams,…).
- Higher spatial resolutions and long term timeseries are needed
- More in-situ data products and information (metadata) on how data validation was performed.
- A better harmonisation and standardisation of the different data portals is desired.
- An easy access data approach. Better overviews on what is available, e.g. by intelligent data searches and/or trainings, and a better organisation of the metadata is asked for.
- A linkage to Google Earth Engine or similar, and to other data platforms.
- Suggestion to establish a user community group where information on scripts, tools,… can be shared.
- For data assimilation the time delay for data products makes it impossible to create forecasting products. A solution is asked for.

# 5. Conclusions

In general the following can be concluded :

- The presentations concerning the Copernicus services Land, Emergency & Climate increased the awareness of users towards available data products & upcoming or updated products. The speakers highlighted available tools and applications, freely available.

- The Copernicus services offer a significant amount of data products and tools, however a lot of other non-Copernicus sources are used for the same data products (parameters)/tools. This is mainly due to :
    - Low product awareness by end users
    - Not meeting user requirements, especially easy data accessibility is a bottleneck. Furthermore, meeting data standards and offering more insight in validation processes is desired.
    - Limited availability of data products for certain parameters (e.g. groundwater, soil properties and evapotranspiration) is listed as an important issue.
    - Low spatial resolution, increasing product resolutions remains top priority.
- The output of the workshop (used data products, bottlenecks, wish lists,…) will be used as extra input for a detailed *inventory of available and upcoming Copernicus data products related to the hydrological water balance* (Deliverable 3.2 of WP3 of the Water-ForCE project) which will be publicly published in June 2021.

- The majority of the participants indicated they want to remain involved as an expert in the continuation of the project. They will be part of the WP working group.
- This combined work (workshop + inventory) will act as a basis for future deliverables of WP3/5 and will give input for other work packages of the Water-ForCE project. This in order to create a Roadmap For the Copernicus platform and incentivize users to exploit Copernicus Services.

# 6. Recommendations

- Future *online* workshops should be shorter (max. 3-4 hours) or divided over 2 days. The figure underneath gives an overview of elements to take into consideration for future workshops.

# Annex

## Annex 1 : Abbreviations

*Table 5 : Abbreviations of Services, institutes, tools and products.*

| Abbreviations | |
|---|---|
| **C3S** | Copernicus Climate Change Service |
| **CDO** | Climate Data Operators |
| **CDS** | Climate Data Store |
| **CGLS** | Copernicus Global Land Service |
| **CHIRPS** | Rainfall Estimates from Rain Gauge and Satellite Observations |
| **DAHITI** | Database for Hydrological Time Series of Inland Waters |
| **EMS** | Emergency Management Service |
| **E-OBS** | Daily gridded observational dataset for precipitation, temperature, sea level pressure and global radiation in Europe |
| **GPM** | Global Precipitation Measurement |
| **GRACE** | Gravity Recovery and Climate Experiment |
| **HEC-HMS** | Hydrologic Engineering Center - Hydrologic Modeling System |
| **IMERG** | Integrated Multi-satellitE Retrievals for GPM |
| **JAXA** | Japan Aerospace Exploration Agency |
| **JRC** | Joint Research Centre |
| **LPIS** | Land Parcel Identification System |
| **NOAA** | National Oceanic and Atmospheric Administration |
| **RHESSys** | Regional Hydro-Ecologic Simulation System |
| **SHYFEM** | Shallow Water Hydrodynamic Finite Element Model |
| **SNAP** | Sentinel Application Platform |
| **SRTM** | Shuttle Radar Topography Mission |
| **SWAT** | Soil & Water Assessment Tool |
| **SWMM** | Storm Water Management Model |
| **TRMM** | The Tropical Rainfall Measuring Mission |
| **USGS** | U.S. Geological Survey |
| **WaPOR** | Water Productivity Open-access portal |

# *Annex 2 : Program workshop*

## Agenda (*Times are in CET)*

**9:00 – 9:10 :** Welcome

**9:10 – 11:15** ***: Plenary session***

**9:10 – 9:20** : Introduction Water-ForCE project – *Linda Van Duivenbode*

**9:20 – 9:30** : Introduction WP3/5 – *Ann Van Griensven/Ioana Popescu*

**9:30 – 11:10** : Introduction of several services of interest

**9:30 – 10:00** : Land service - *Nicolas Taburet*

**10:00 – 10:10** : ***Break***

**10:10 – 10:40** : Emergency service - *Vera Thiemig*

**10:40 – 11:10** : Climate service - *Fredrik Wetterhall*

**11:10 – 11:15** : Technical explanation Miro

**11:15 – 11:30** : ***Break***

**11:30 – 12:40** ***: Interactive breakout sessions***

Products & tools : Wishlist vs. availability

**12:40 – 13:30** : ***Lunch***

**13:30 – 15:00** : ***Plenary session***

**13:30 – 13:35 :** Welcome back
**13:35 – 14:00 :** Wrap-up breakout sessions : overview & highlights
**14:00 – 14:05 :** Future project planning and working group explanation
**14:05 – 15:00 :** Open platform for Discussion

## Annex 3 : Participant statistics

Figure 2 gives an overview of the official registrations, actual participants and participating stakeholders at the workshop. A distinction was made between: (a) experts which are not part of the Water-Force consortium, (b) members of the consortium with a further division to (c) members of WP3 or WP5.

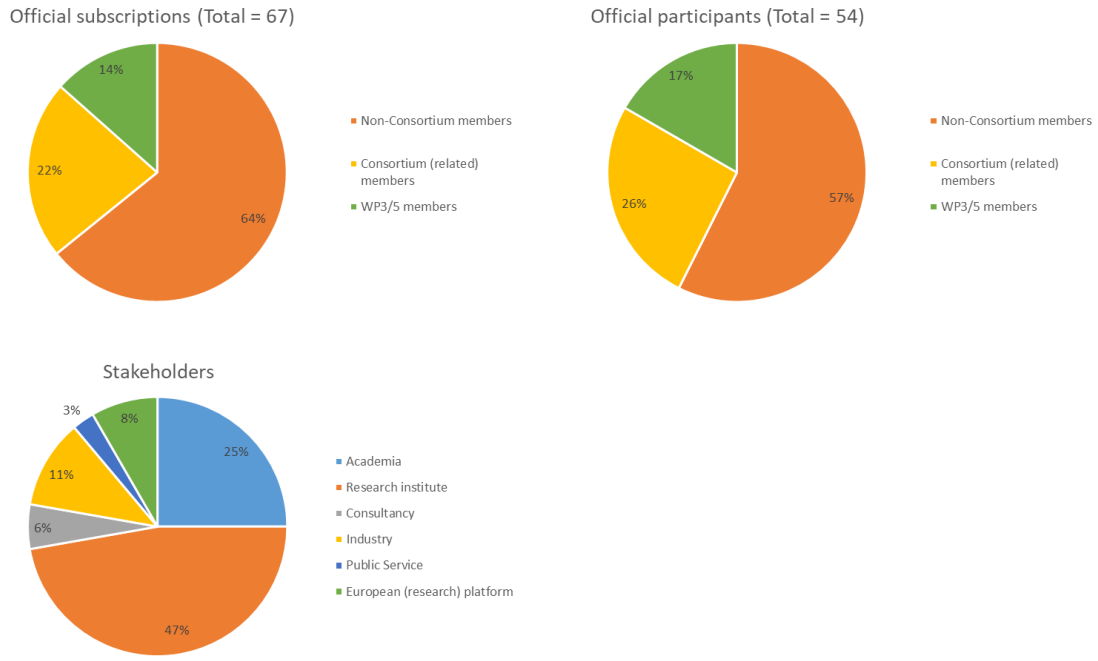


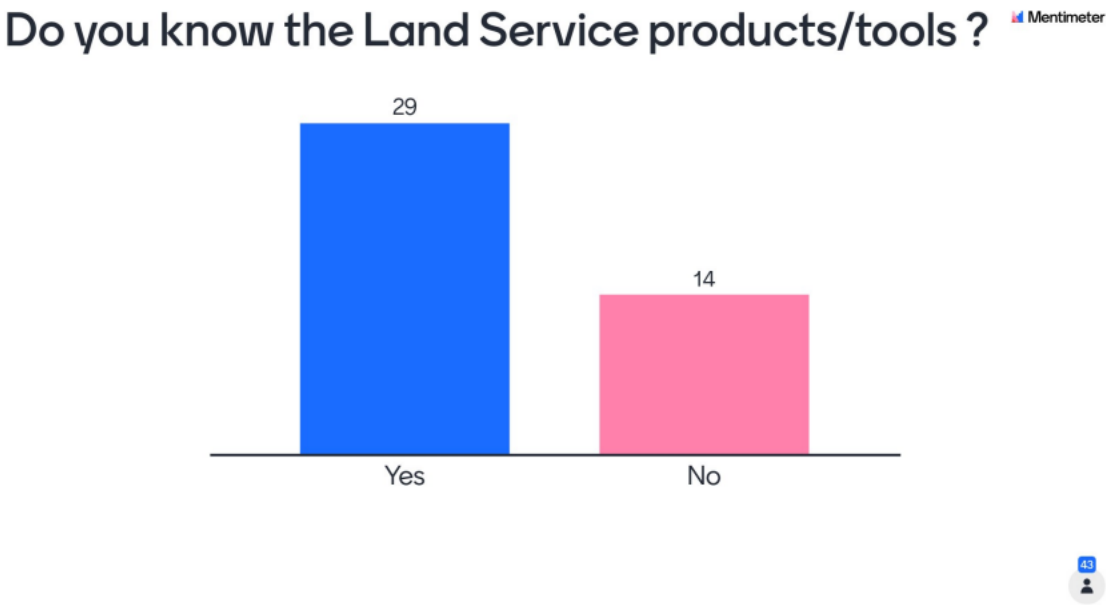

*Figure 2 : Participant statistics.*

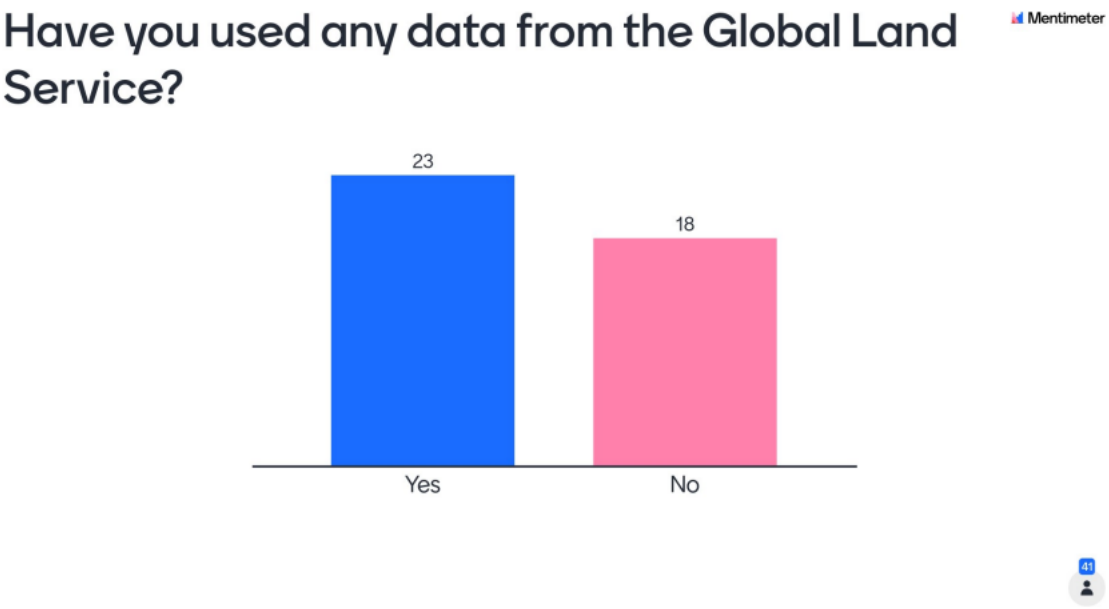
The institutes represented by all participants are shown in Table 6. Please note that, in order to be GDPR compliant, we do not list individuals.

*Table 6 : Abbreviation list.*

| Institute abbreviation | Institute name |
|---|---|
| Antea Group Belgium | Antea Group Belgium |
| BAFG | Federal Institute of Hydrology - Germany |
| BC3 | Basque Centre for Climate Change |
| BOKU | University of Natural Resources and Life Sciences |
| CLS group | Collecte Localisation Satellites |
| CNES | Centre Nationale d'Etudes Spatiale - France |
| CREAF | Centro de investigacion ecologica y aplicaiones forestales |
| CSIC - EBD | El Consejo Superior de Investigaciones Científicas - Estación Biológica de Doñana |
| CSIC- IPE | El Consejo Superior de Investigaciones Científicas - Instituto Pirenaico de Ecología |
| Danubius-RI | International Centre for Advanced Studies on River-Sea Systems |
| DUTH | Democritus university of Thrace |
| ECMWF | European Centre for Medium-Range Weather Forecasts |
| EGR | Michigan State University - College of Engineering |
| EMU | Estonian University of Life Sciences |
| FORIM | Forest research, inventory and monitoring |
| Geoecomar | Institutul national de cercetare-dezvoltare pentru geologie si geoecologie - Marina-geoecomar |
| GFZ (Potsdam) | German Research Centre for Geosciences |
| ICRA | Institut Català de Recerca de l'Aigua |
| IHE | IHE Delft Institute for Water Education |
| IIASA | International Institute for Applied Systems Analysis - Austria |
| IRTA | Institute of Agrifood Research and Technology |
| isardSAT | isardSAT |
| ISMAR-CNR Venice | Istituto Di Scienze Marine - Italy |
| JRC | Joint Reasearch Centre (European Comission) |
| Romanian Waters | Department of Ministry of Waters and Forests Romania |
| Royal Haskoning DHV | Royal Haskoning DHV |
| SAVBA | Slovak Academy of Sciences |
| STUBA | Slovenská technická univerzita v Bratislave |
| TerraSigna | National ground motion monitoring - Romania |
| Tour du Valat | Institut de recherche pour la conservation des zones humides méditerranéennes |
| UKCEH | UK Centre for Ecology & Hydrology |
| UNESCO-IHP | Intergovernmental Hydrological Programme |
| VITO | Flemish Institute for Technological Research |
| VUB | Vrije universiteit Brussel |
| WCL | WasserCluster Lunz |
| WULS | Warsaw University of Life Sciences, Division of Hydrology and Water Resources |

## *Annex 4 : Mentimeter*



## What are your most important needs in terms of the following :

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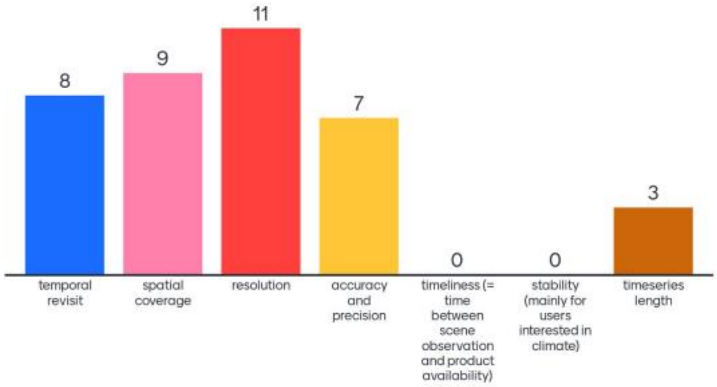


38

## Do you know the Emergency Service products/tools ?

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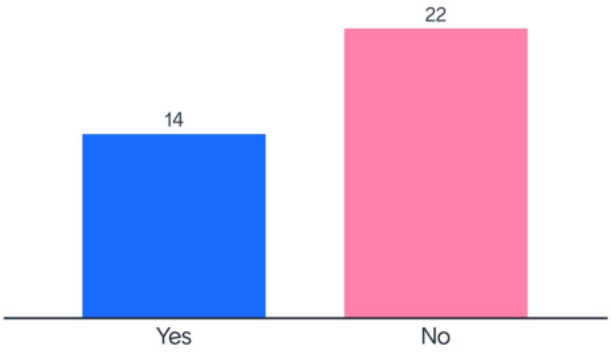


36

## Do you use these Emergency Service products/tools ?

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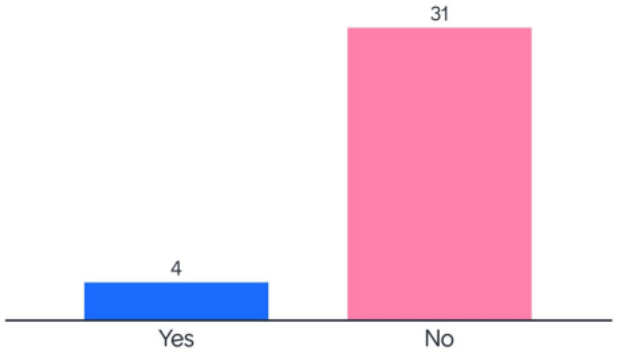
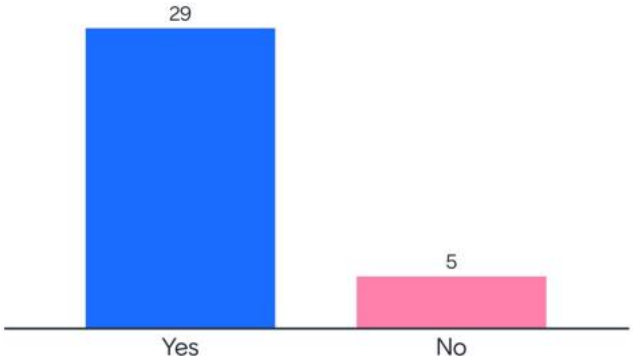



35

## Has this presentation made you more likely to use Emergency Service data/tools?

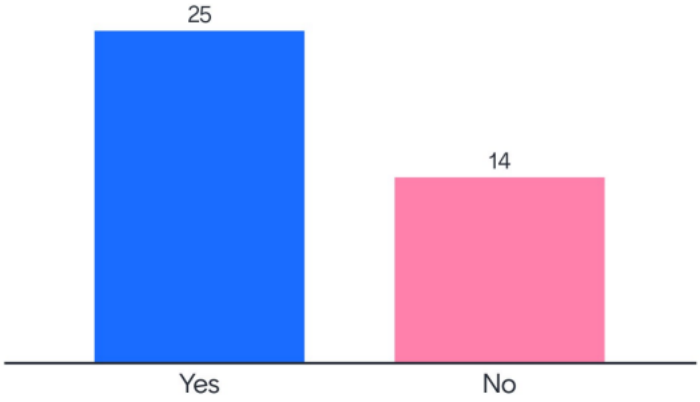
Mentimeter




34

## Were you aware of the Climate data store?

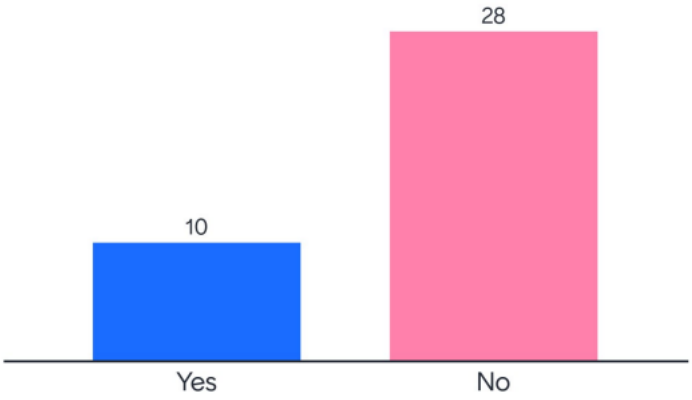
Mentimeter




39

## Have you used any data from CDS?

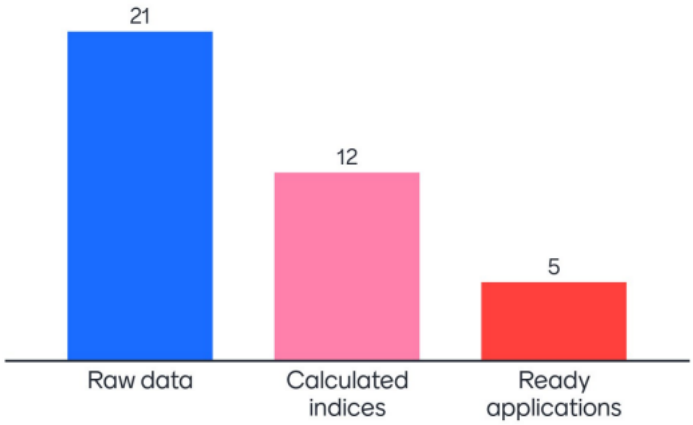
Mentimeter




38

## What format would you be interested in?

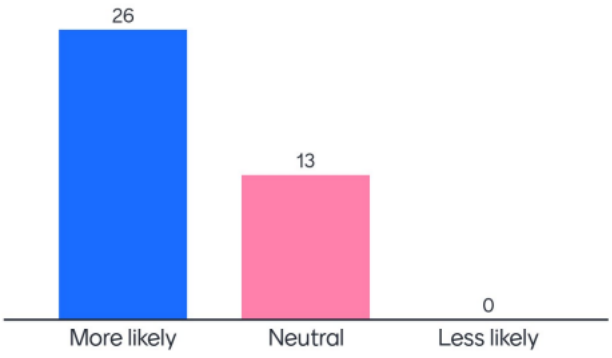
Mentimeter




38

## Has this presentation made you more likely to use CDS data?

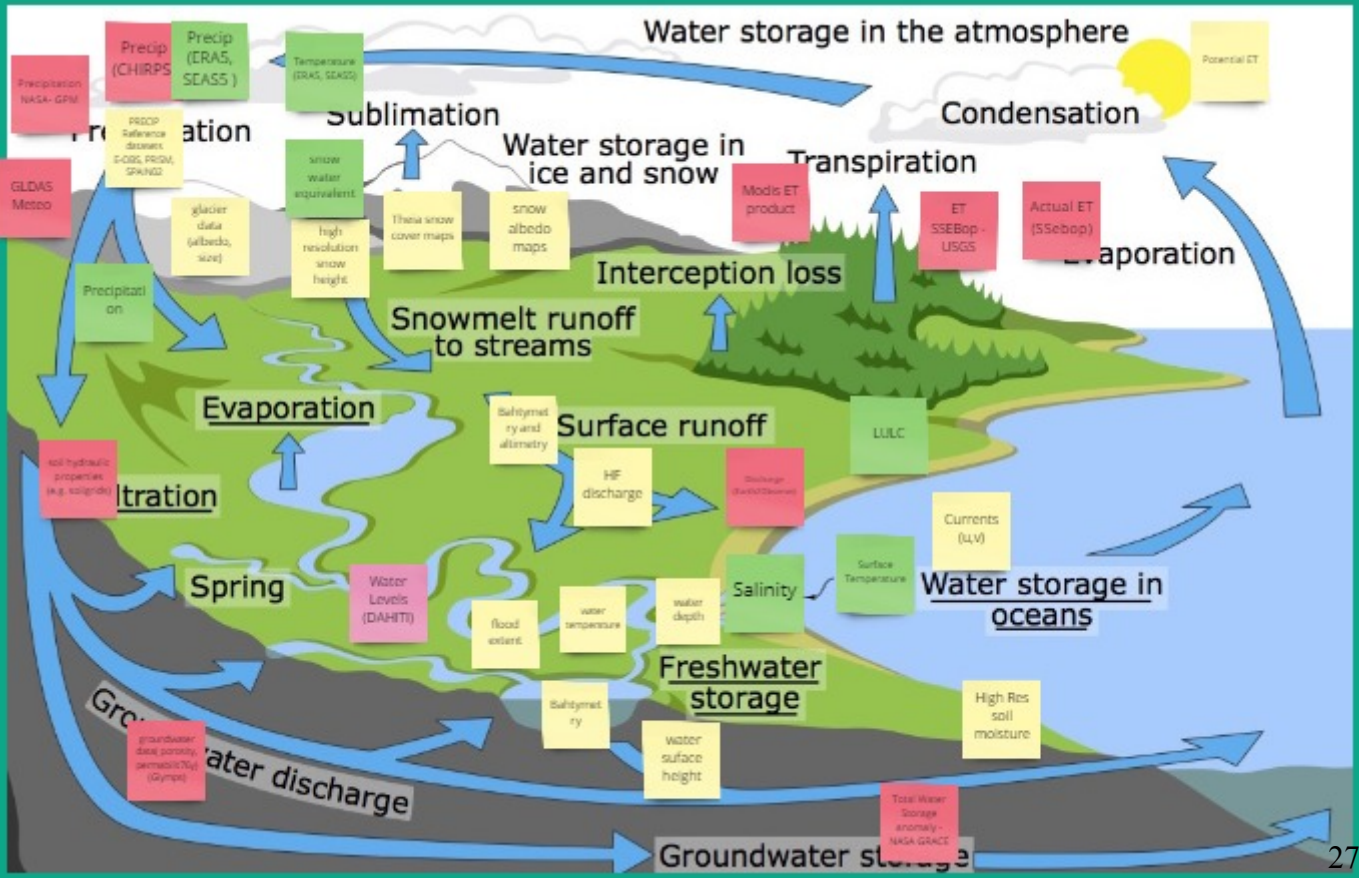
Mentimeter

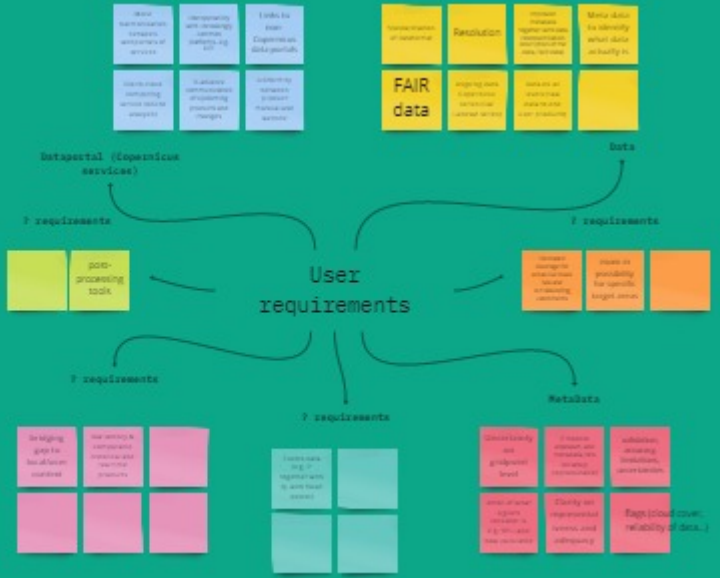



39


*Figure 3 : Mentimeter polls. Indication of the awareness of people towards offered Land, Emergency and Climate service data products & tools. Indication on how often these services data is used and the effectiveness of these presentations on stimulating people to use Copernicus service data.*

## *Annex 5 : Miro boards*


Water storage in the atmosphere
Precip (CHIRPS
Precip (ERA5, SEAS5 )
Temperature (ERAS, SEAS5)
Potential ET
Precipitation NASA- GPM
Sublimation
Condensation
Water storage in ice and snow
Transpiration
GLDAS Noah
snow water equivalent
Modis ET product
ET SSEBop - USGS
Actual ET (SSebop)
glacier data (albedo, size)
Thasa snow cover maps
snow albedo maps
high resolution snow height
Interception loss
Precipitation
Snowmelt runoff to streams
Evaporation
Bathymetry and altimetry
Surface runoff
LULC
soil hydraulic properties (e.g. soilgrids)
HF discharge
Currents (U,V)
Spring
Water Levels (DAHITI)
Salinity
Surface Temperature
Water storage in oceans
flood extent
water temperature
water depth
Freshwater storage
Bathymetry
High Res soil moisture
water suface height
Groundwater discharge
Groundwater storage




**What are the user requirements you need or you need to see enhanced?**

(Write it on a post-it and put it with the correct type of user requirement. Add/change types of user requirements where necessary.)

Global Flood Awareness System (Emergency service)

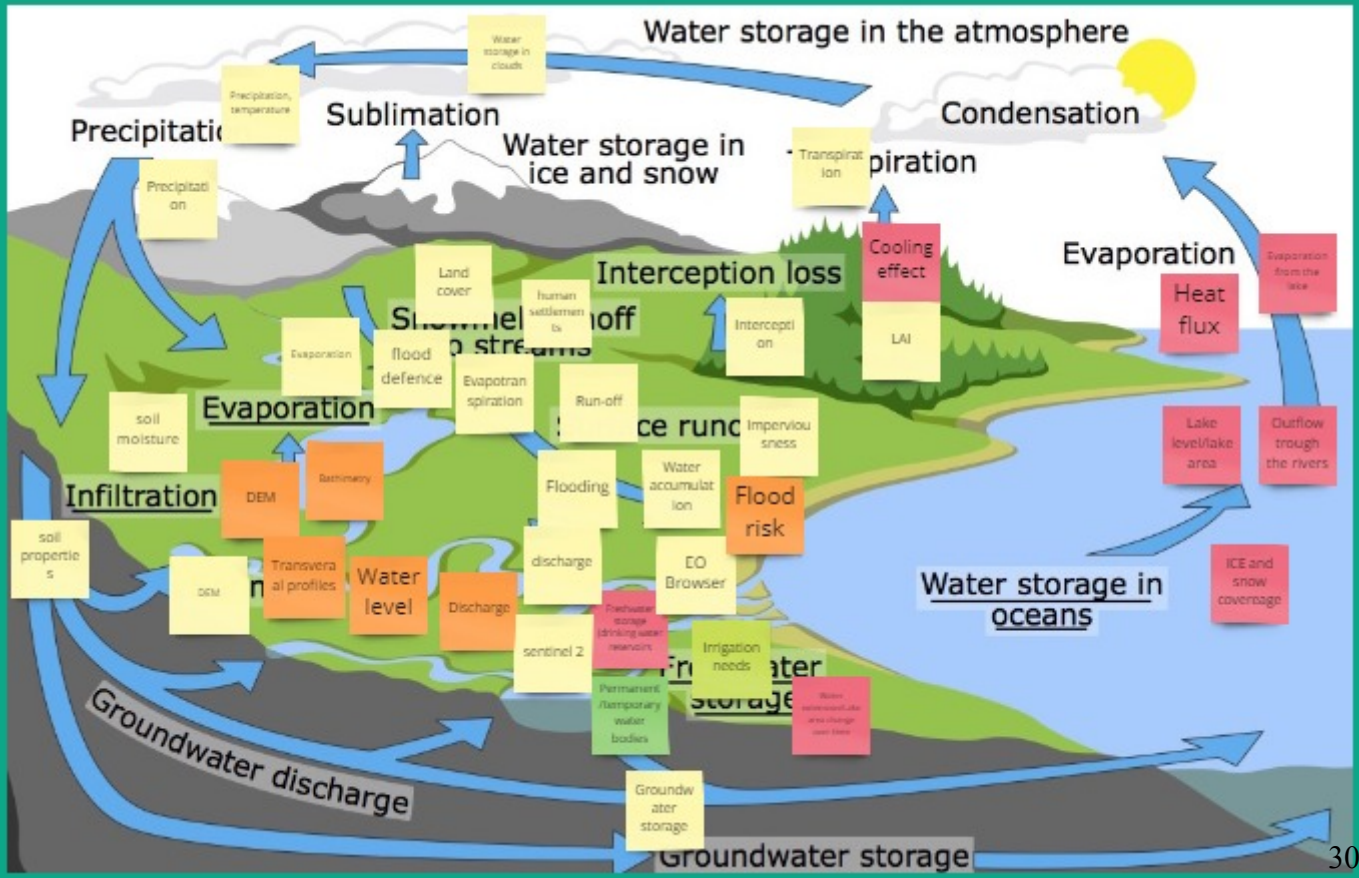
LISFLOOD model (emergency service)

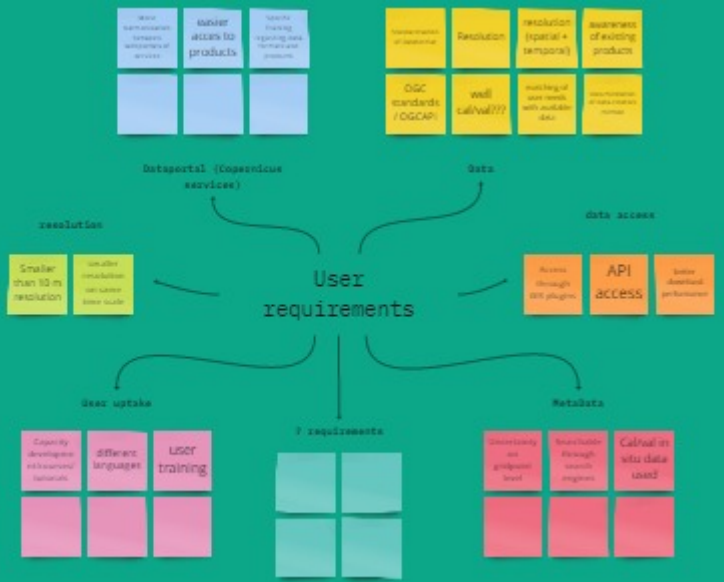
Drought Toolbox (United Nations CCD)

**Which different tools to view, access and process the RS data do you use in your daily work?**

(Write it on a post-it and put it in the box below. Green = Copernicus tool/service, Red = tool/service form other source)

Should we use open source tools?


Water storage in the atmosphere
Water storage in clouds
Precipitation, temperature
Precipitati
Precipitati on
Sublimation
Condensation
Water storage in ice and snow
Transpirat ion
piration
Cooling effect
Evaporation
Evaporation from the lake
Heat flux
Land cover
Interception loss
human settlements
Intercepti on
LAI
Evaporation
flood defence
Evapotran spiration
Run-off
soil moisture
Evaporation
Imperviou sness
Lake level/lake area
Outflow trough the rivers
Infiltration
DEM
Bathimetry
Flooding
Water accumulat ion
Flood risk
soil propertie s
DEM
Transvera al profiles
Water level
Discharge
discharge
EO Browser
ICE and snow coverage
Water storage in oceans
sentinel 2
Irrigation needs
Permanent /temporary water bodies
Groundwater discharge
Groundw ater storage
Groundwater storage

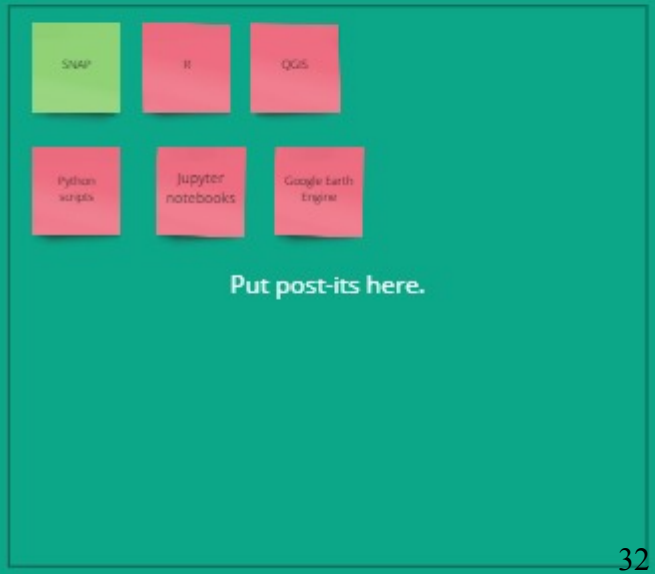


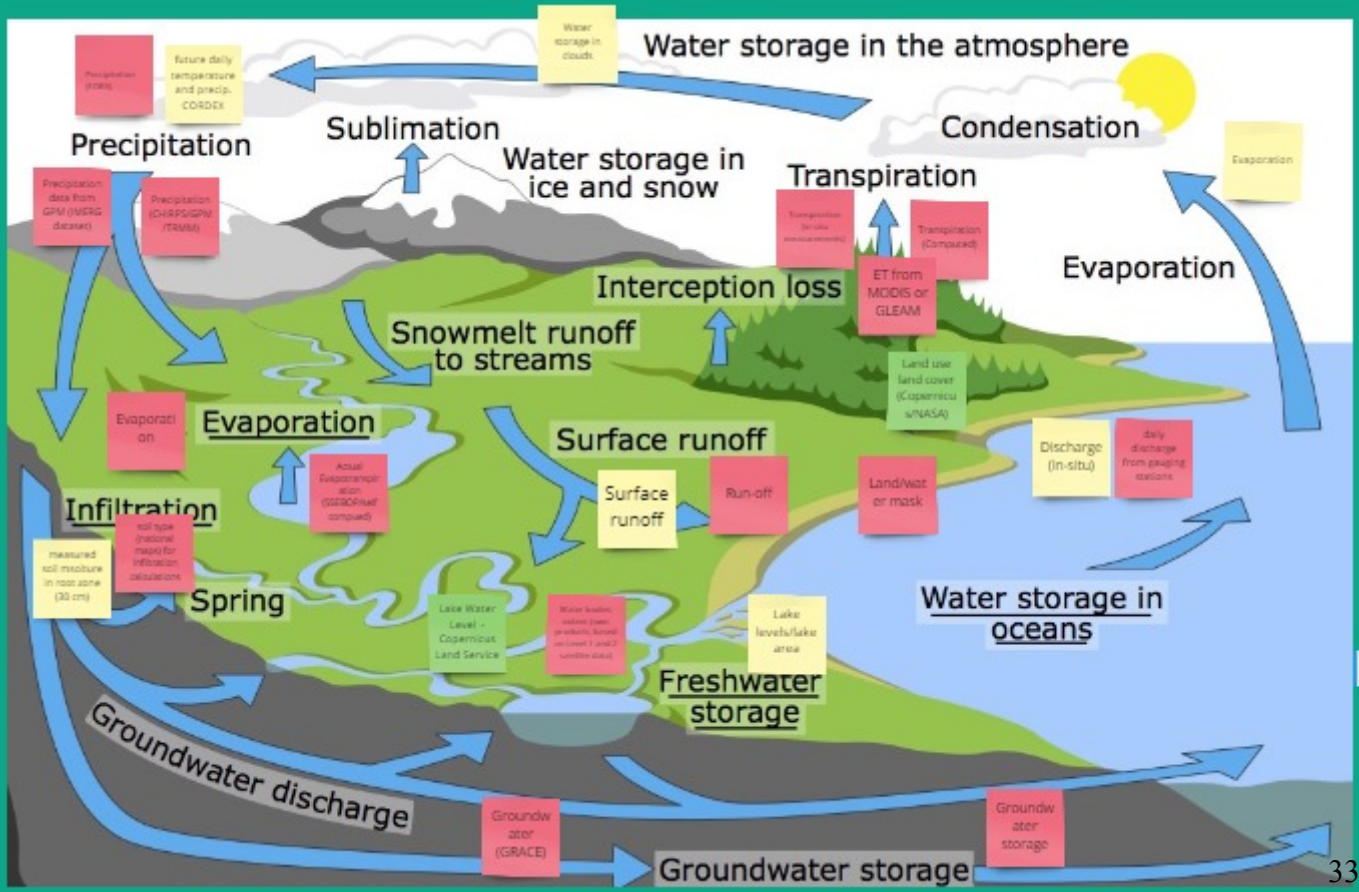

**What are the user requirements you need or you need to see enhanced?**

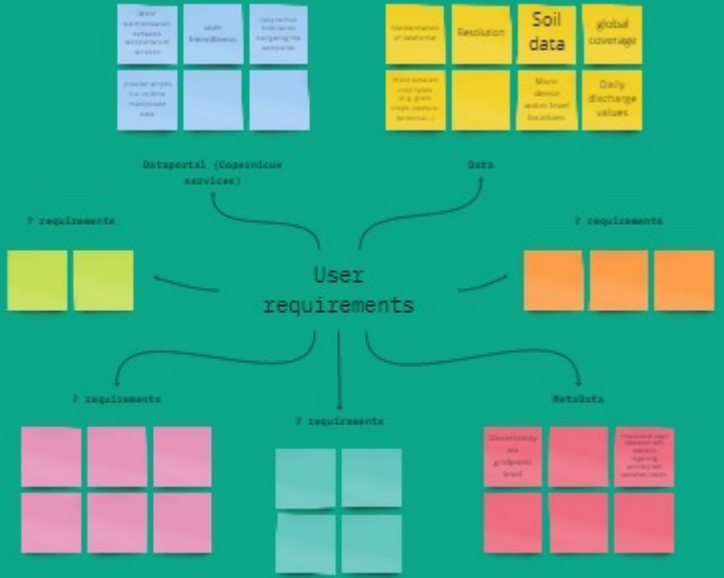
(Write it on a post-it and put it with the correct type of user requirement. Add/change types of user requirements where necessary.)


**Which different tools to view, access and process the RS data do you use in your daily work?**

(Write it on a post-it and put it in the box below. Green = Copernicus tool/service, Red = tool/service form other source)




Water storage in the atmosphere
Water storage in clouds
future daily temperature and precip. CORDEX
Precipitation
Sublimation
Condensation
Water storage in ice and snow
Transpiration
Evaporation
Precipitation data from GPM (IMERG dataset)
Precipitation (CHIRPS/GPM /TRMM)
Transpiration (Computed)
ET from MODIS or GLEAM
Interception loss
Snowmelt runoff to streams
Land low land cover (Copernicu s/NASA)
Evaporati on
Evaporation
Surface runoff
Discharge (in-situ)
daily discharge from gauging stations
Actual Evapotranspir ation (SSEBOP/set computed)
Surface runoff
Run-off
Land/wat er mask
Infiltration
soil type (national maps) for infiltration calculations
measured soil moisture in root zone (30 cm)
Spring
Lake Water Level - Copernicus Land Service
Lake levels/lake areas
Water storage in oceans
Freshwater storage
Groundwater discharge
Groundw ater (GRACE)
Groundw ater storage
Groundwater storage



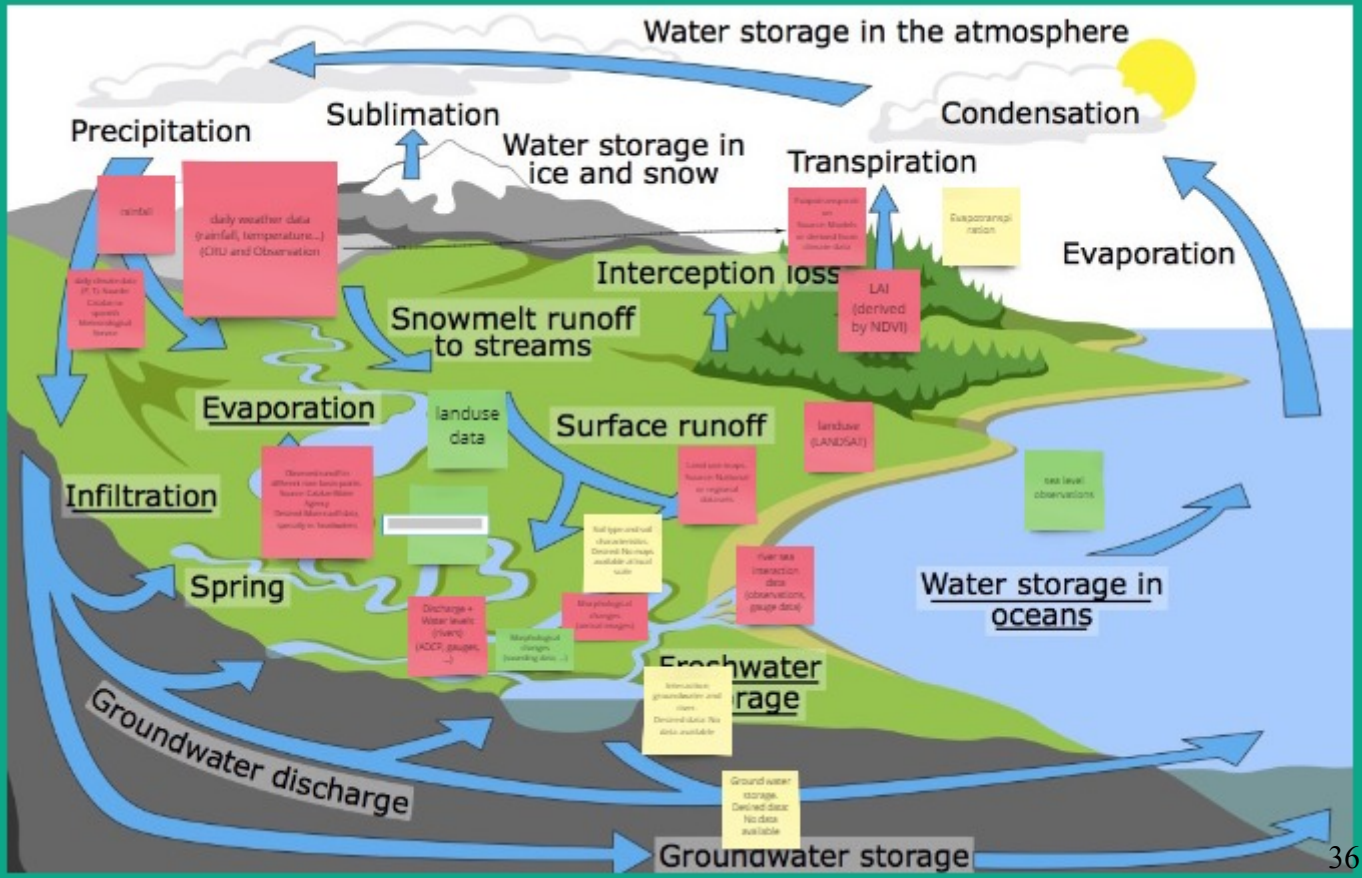

**What are the user requirements you need or you need to see enhanced?**

(Write it on a post-it and put it with the correct type of user requirement. Add/change types of user requirements where necessary.)


**Which different tools to view, access and process the RS data do you use in your daily work?**

(Write it on a post-it and put it in the box below. Green = Copernicus tool/service, Red = tool/service form other source)

Put post-its here.


Water storage in the atmosphere
Precipitation
Sublimation
Water storage in ice and snow
Condensation
Transpiration
Evaporation
Interception loss
Snowmelt runoff to streams
LAI (derived by NDVI)
Evaporation
landuse data
Surface runoff
Infiltration
Spring
Water storage in oceans
Groundwater discharge
Groundwater storage

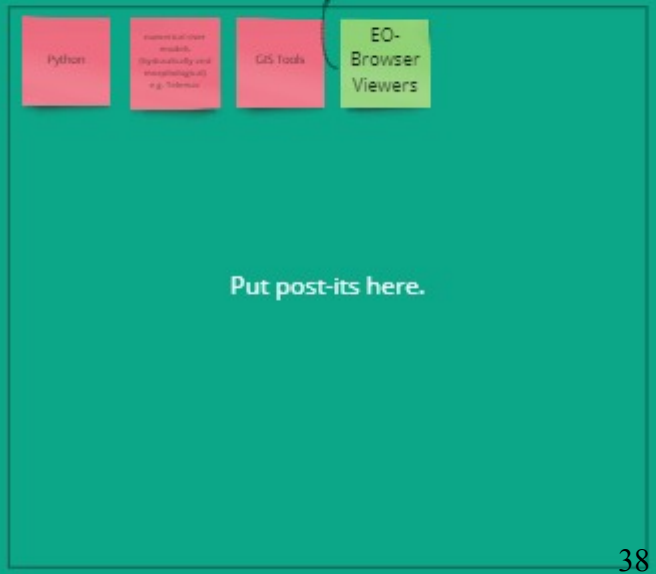

**What are the user requirements you need or you need to see enhanced?**

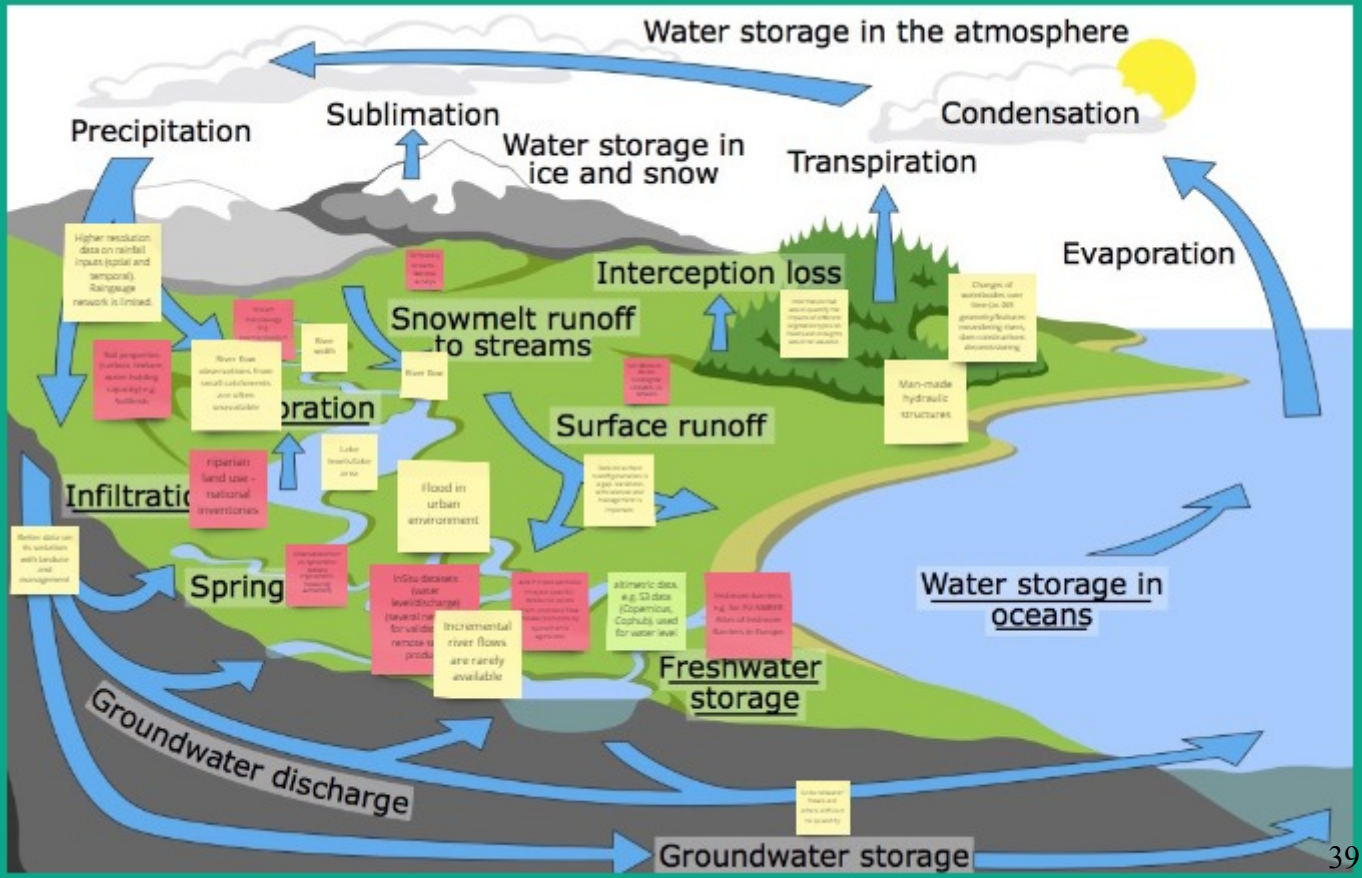
(Write it on a post-it and put it with the correct type of user requirement. Add/change types of user requirements where necessary.)

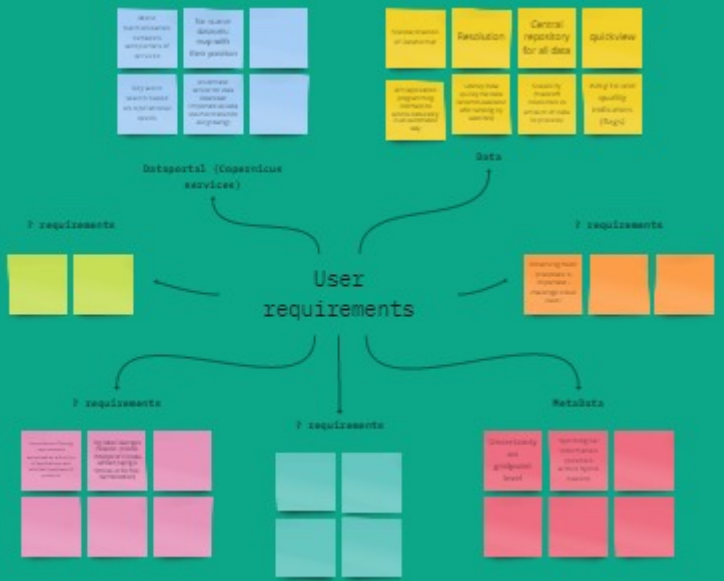
overall -> mucher higher spatial resolution (thinking in river width scale not in ocean scale :-)


**Which different tools to view, access and process the RS data do you use in your daily work?**

(Write it on a post-it and put it in the box below. Green = Copernicus tool/service, Red = tool/service form other source)




Water storage in the atmosphere
Precipitation
Sublimation
Water storage in ice and snow
Condensation
Transpiration
Evaporation
Interception loss
Snowmelt runoff to streams
Surface runoff
Infiltration
Spring
Flood in urban environment
Incremental river flows are rarely available
Water storage in oceans
Freshwater storage
Groundwater discharge
Groundwater storage

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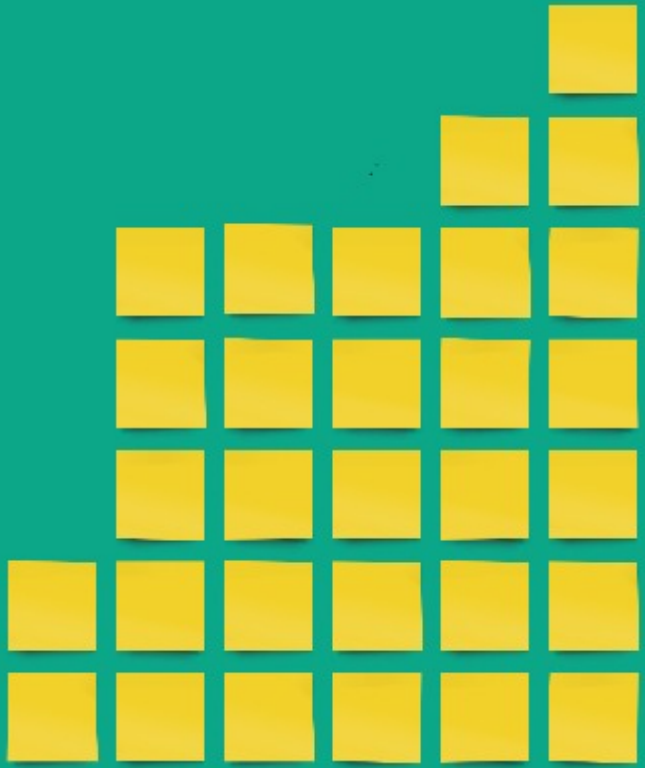

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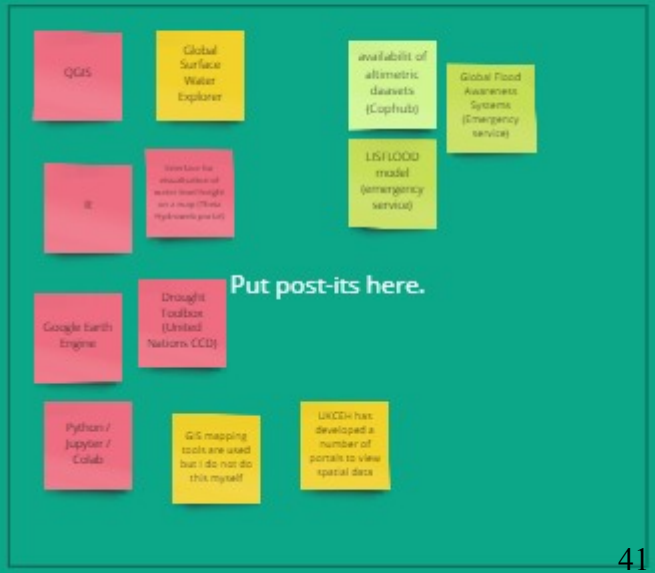
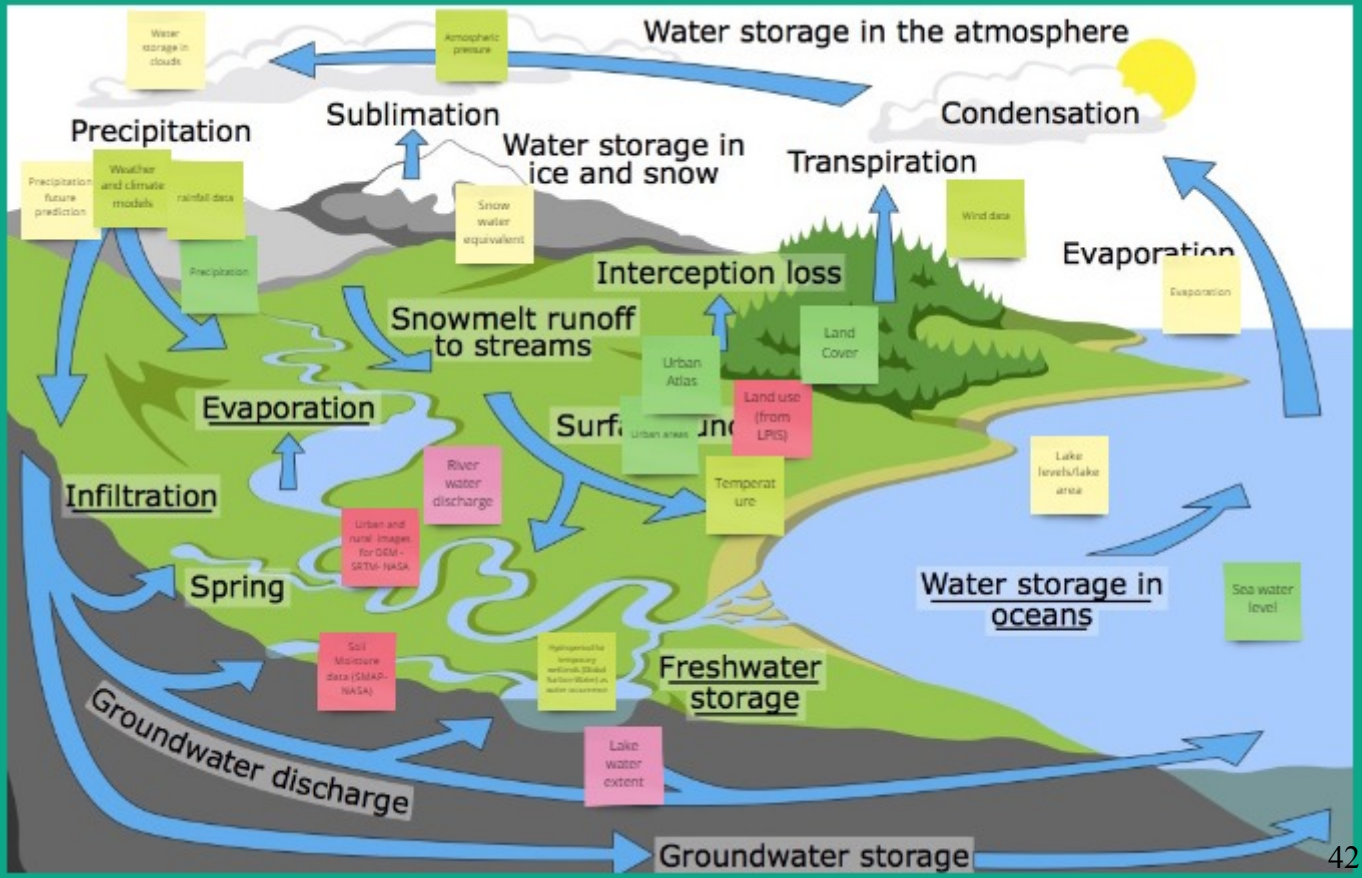
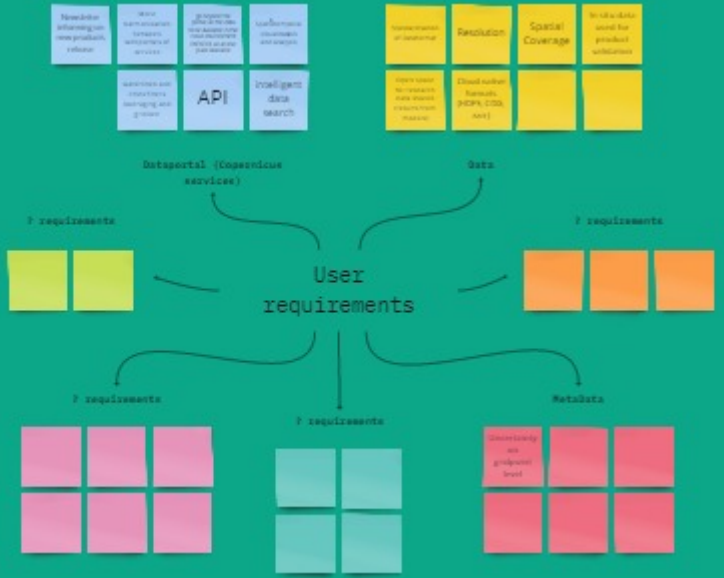



Water storage in the atmosphere
Water storage in clouds
Atmospheric pressure
Sublimation
Condensation
Precipitation
Water storage in ice and snow
Transpiration
Precipitation future prediction
Weather and climate models
rainfall data
Snow water equivalent
Wind data
Evaporation
Precipitation
Interception loss
Evaporation
Snowmelt runoff to streams
Land Cover
Urban Atlas
Land use (from LPIS)
Evaporation
Surf
Urban areas
Infiltration
River water discharge
Temperature
Lake levels/lake area
Urban and rural images for DEM - SRTM- NASA
Spring
Water storage in oceans
Sea water level
Soil Moisture data (SMAP-NASA)
Freshwater storage
Groundwater discharge
Lake water extent
Groundwater storage

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