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

Water-ForCE

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26/04/2021	V1	Concept report

19/05/2021	V2	Revision
14/03/2022	V3	Final version, including processed comments Periodic Review Report

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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).

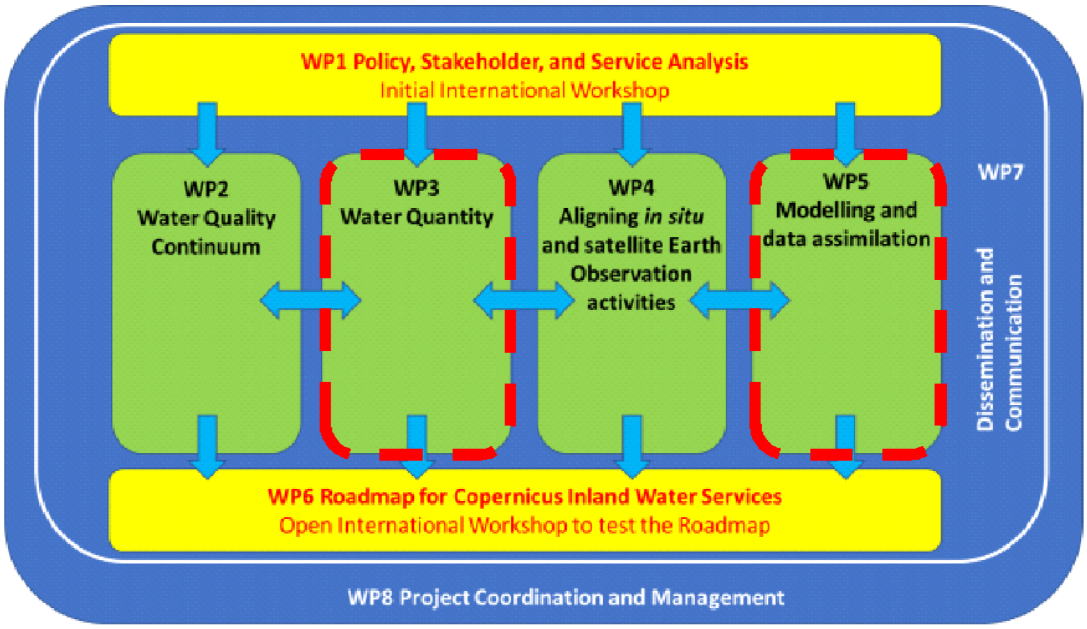


Figure 1 : Organizational structure of the different work packages in the Water-ForCE project.

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 5 : 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 6 : 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.

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

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])
- ...

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

[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/).

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

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

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
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 (***Annex 4 : Participant list***).
- 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.

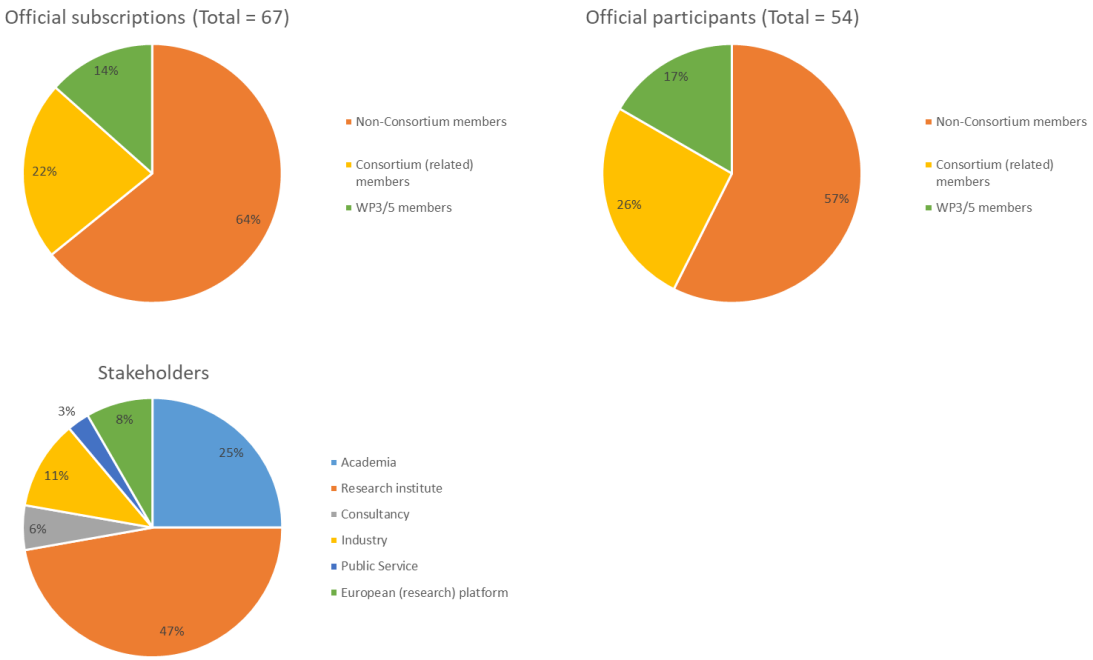


Figure 2 : Participant statistics.

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 : Participant list

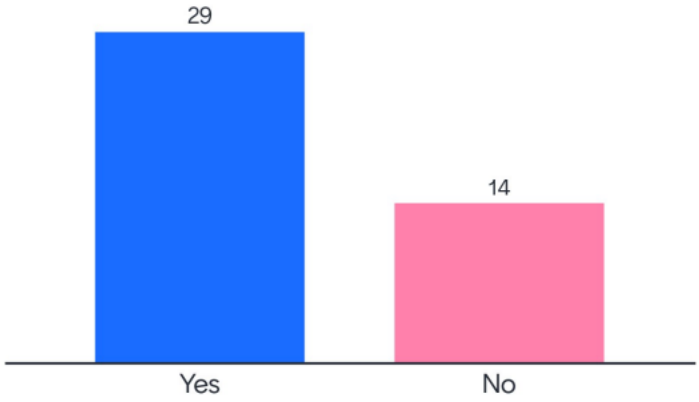
Table 7 : Participants of the workshop to be engaged in the expert working group (explicit consent to share contact details)

First name	Last name	Organization	Country
Nicholas	Taburet	CLS	France
Septimiu	Szabo	Romanian Waters	Romania
Rafael	Marcé	ICRA	Spain
Lionel	Zawadzki	CNES	France
Fredrik	Wetterhall	ECMWF	Germany
Vera	Thiemig	JRC	Italy
Julian	Haas	GFZ Potsdam	Germany
Björn	Baschek	Federal Institute of Hydrology	Germany
Diana	Pascual	CREAF	Spain
Irina	Dinu	GeoEcoMar	Romania
Florian	Lindenberger	BAW	Germany
Andreas	Gütner	GFZ German Research Centre for Geosciences	Germany
Chiara	Cagnazzo	ECMWF	Italy
Claudia	Ruz Vargas	IGRAC - International Groundwater Resources Assessment Centre	The Netherlands

Annex 5 : Mentimeter

Do you know the Land Service products/tools ?

Mentimeter



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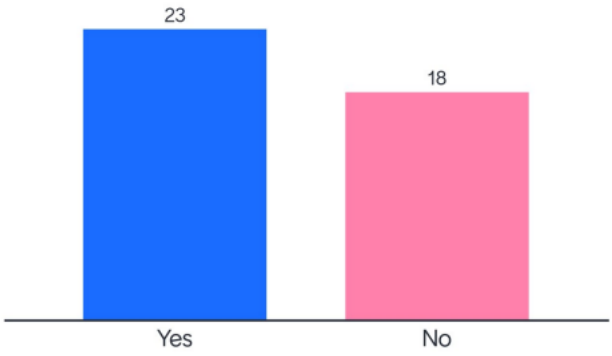
Have you used any data from the Global Land Service?

Mentimeter



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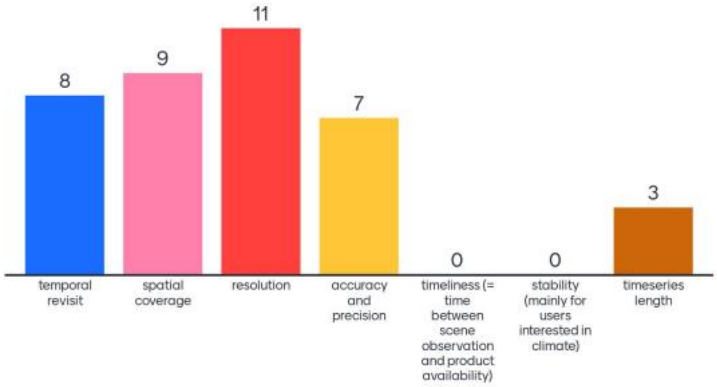
What are your most important needs in terms of the following :

Mentimeter



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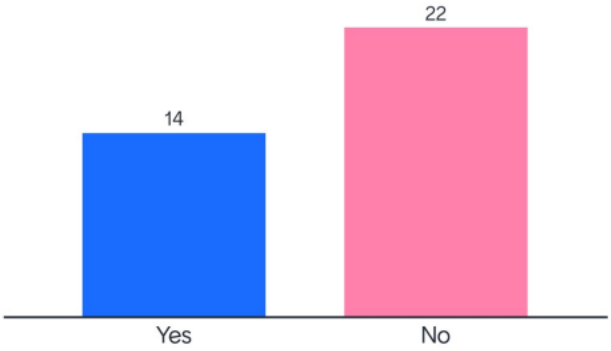
Do you know the Emergency Service products/tools ?

Mentimeter



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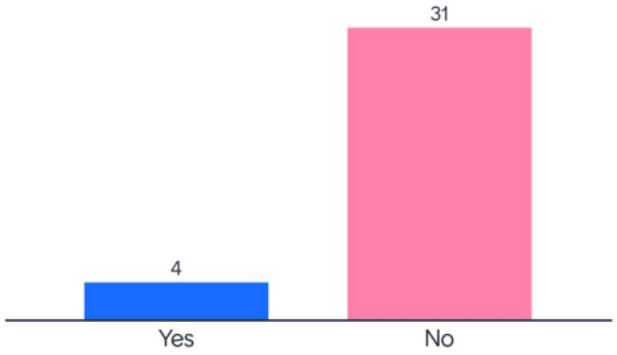
Do you use these Emergency Service products/tools ?

Mentimeter



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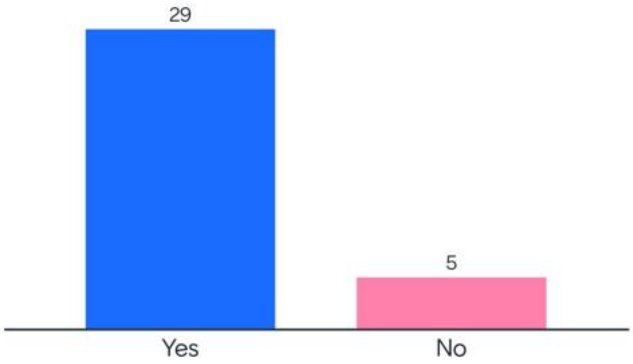
Has this presentation made you more likely to use Emergency Service data/tools?

Mentimeter



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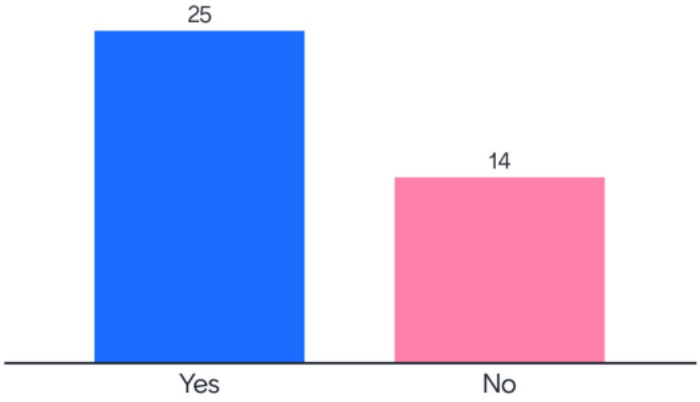
Were you aware of the Climate data store?

Mentimeter



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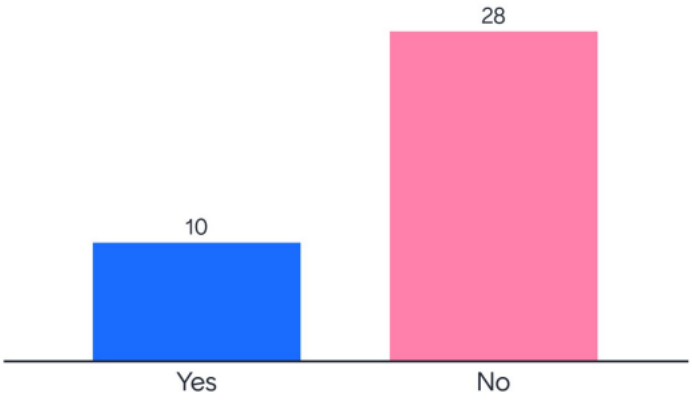
Have you used any data from CDS?

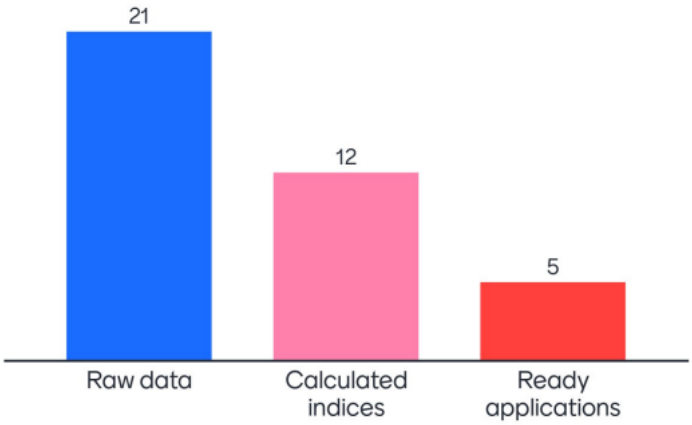
Mentimeter



38

What format would you be interested in?

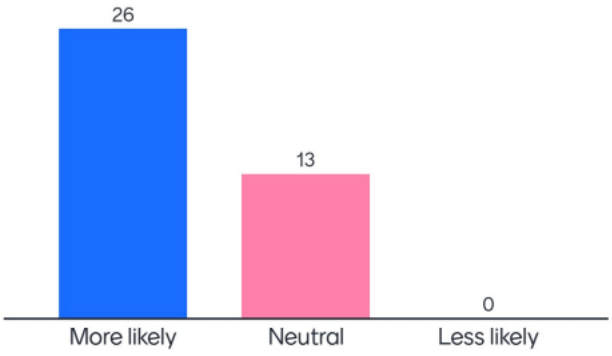
Mentimeter



38

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

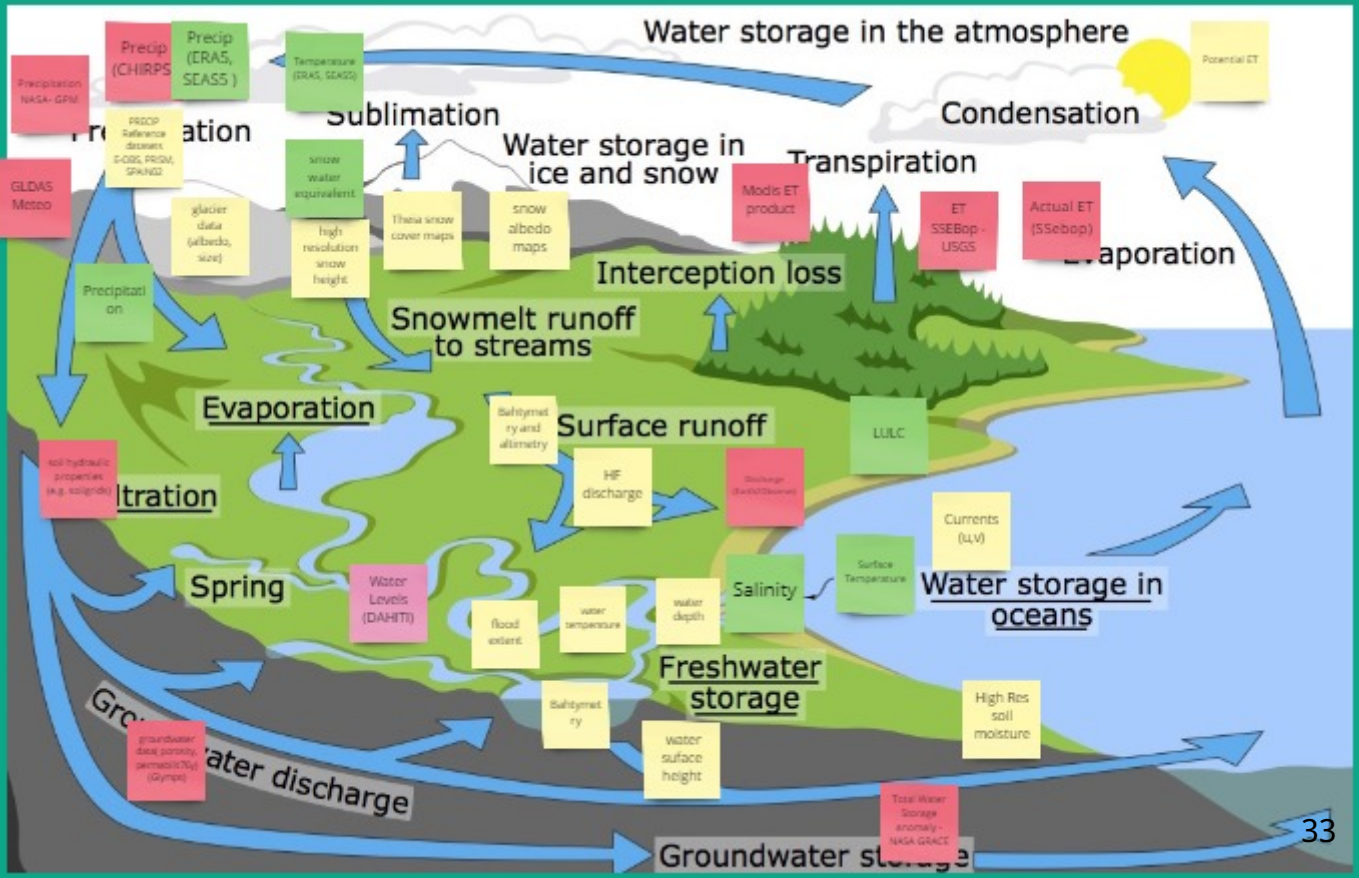
Mentimeter

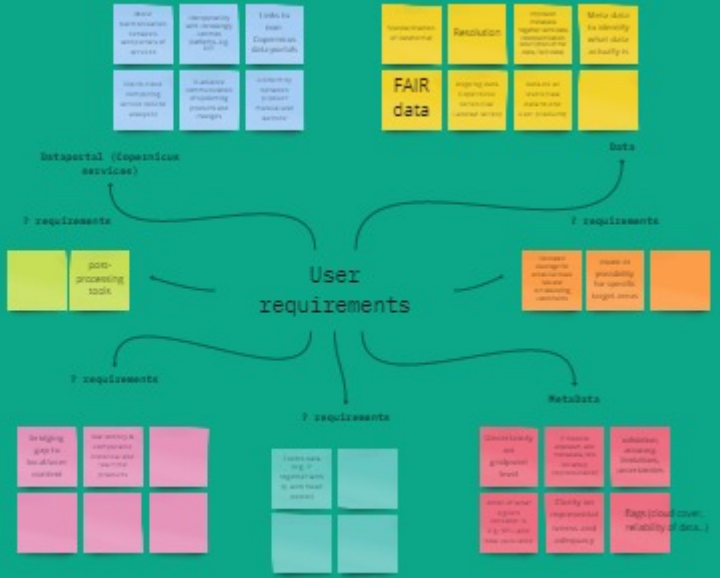


39

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 6 : 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
Interception loss
Precipitation
high resolution snow height
Snowmelt runoff to streams
Evaporation
Surface runoff
Bathymetry and altimetry
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)

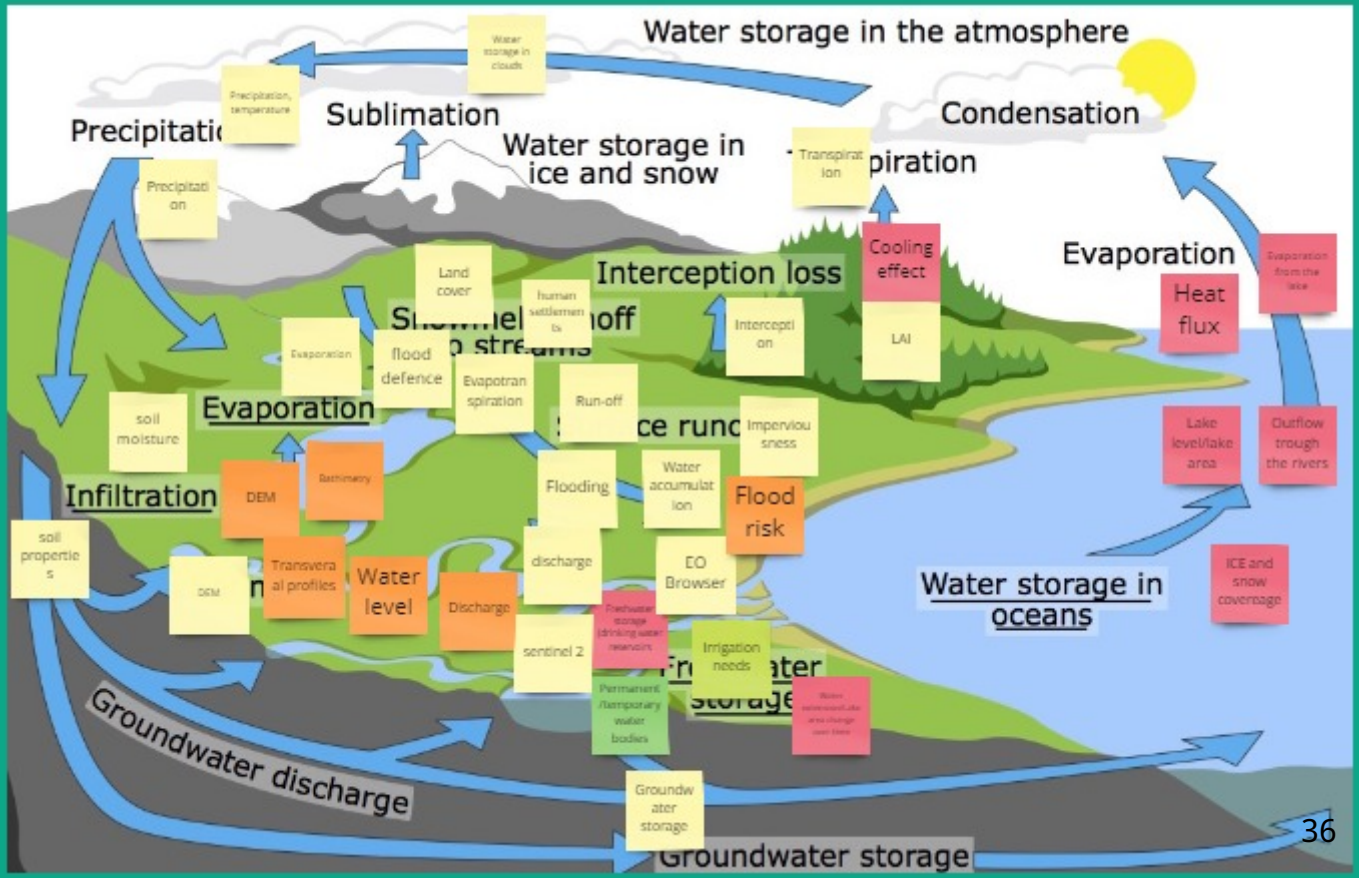
LISFLOOD model (emergency service)

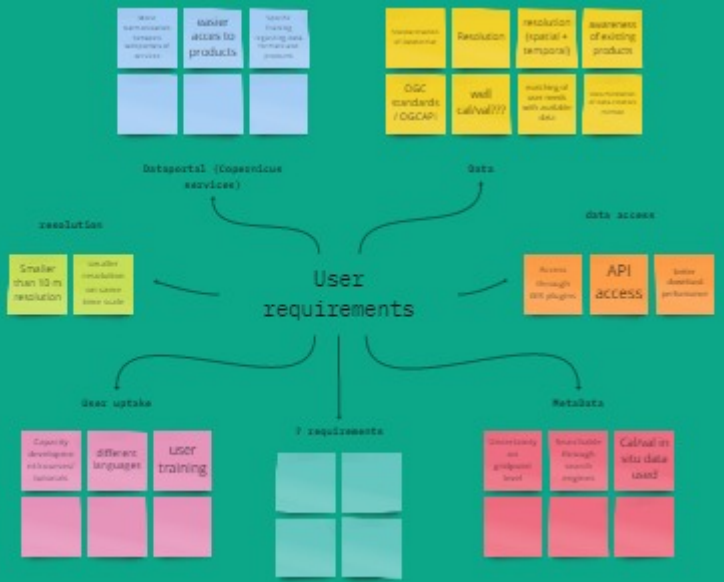
Drought Toolbox (United Nations CCD)

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
Water storage in ice and snow
Condensation
Transpirat ion
piration
Cooling effect
LAI
Evaporation
Evaporation from the lake
Heat flux
Land cover
human settlemen ts
Interception loss
Intercepti on
Evaporation
flood defence
Evapotran spiration
Run-off
Imperviou sness
soil moisture
Evaporation
Infiltration
Rasterinary
DEM
Flooding
Water accumulat ion
Flood risk
Lake level/lake area
Outflow trough the rivers
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
Groundwater discharge
Groundw ater storage
Groundwater storage



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

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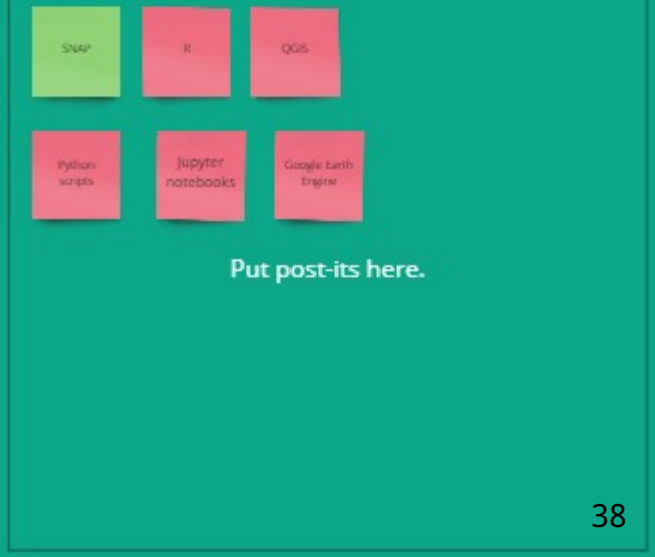
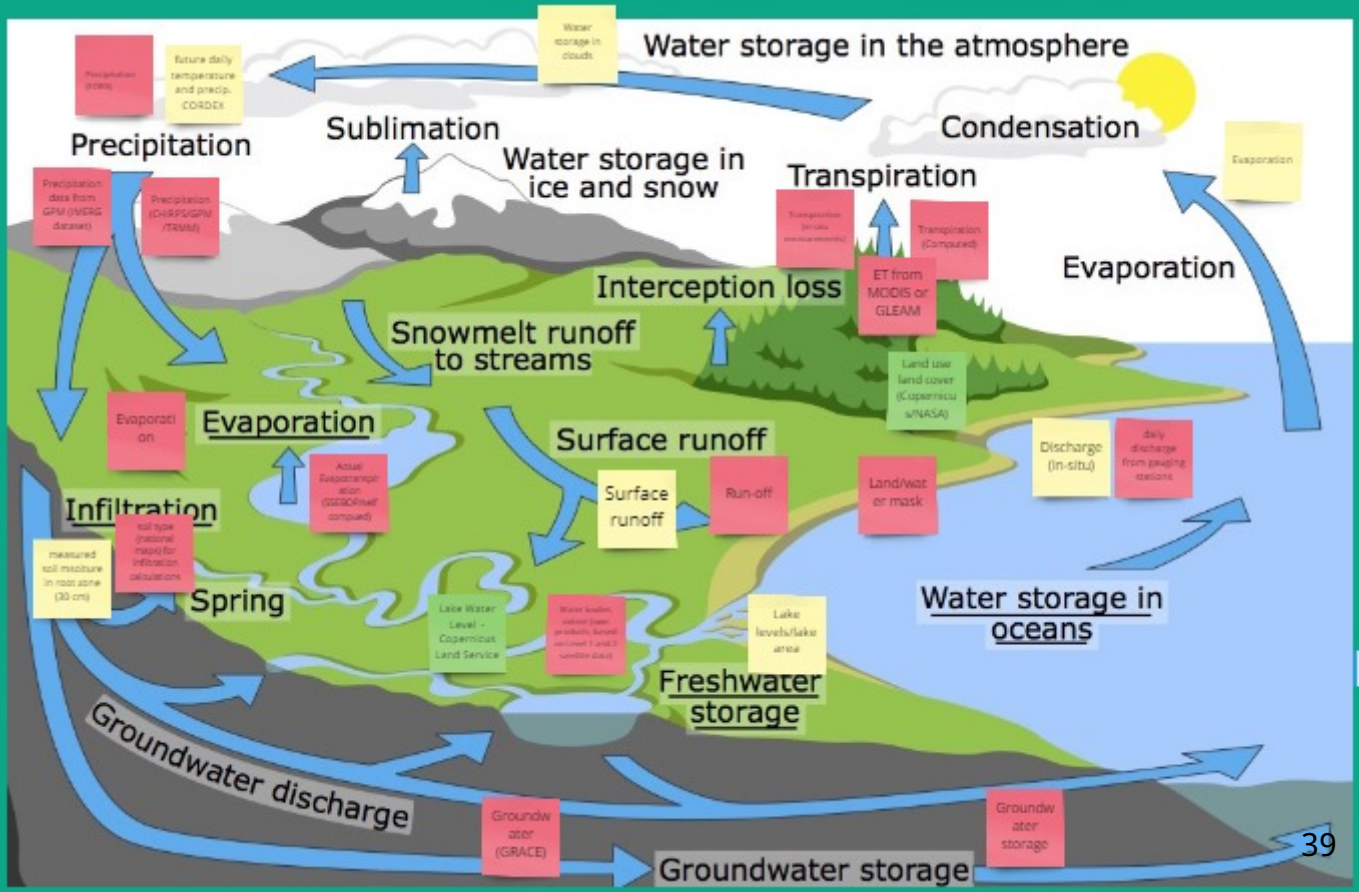
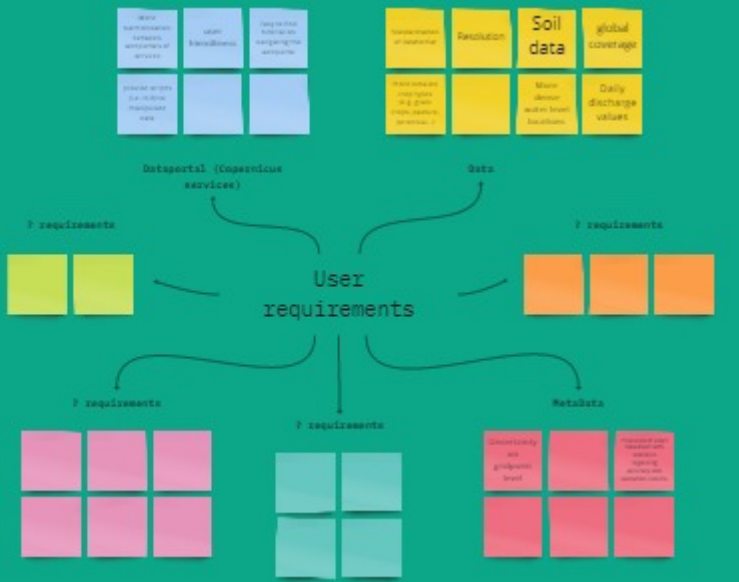
(Write it on a post-it and put it in the box below. Green = Copernicus tool/service, Red = tool/service form other source)




Water storage in the atmosphere
Precipitation
Sublimation
Condensation
Water storage in ice and snow
Transpiration
Evaporation
Interception loss
Snowmelt runoff to streams
Evaporation
Surface runoff
Infiltration
Spring
Water storage in oceans
Freshwater storage
Groundwater discharge
Groundwater storage



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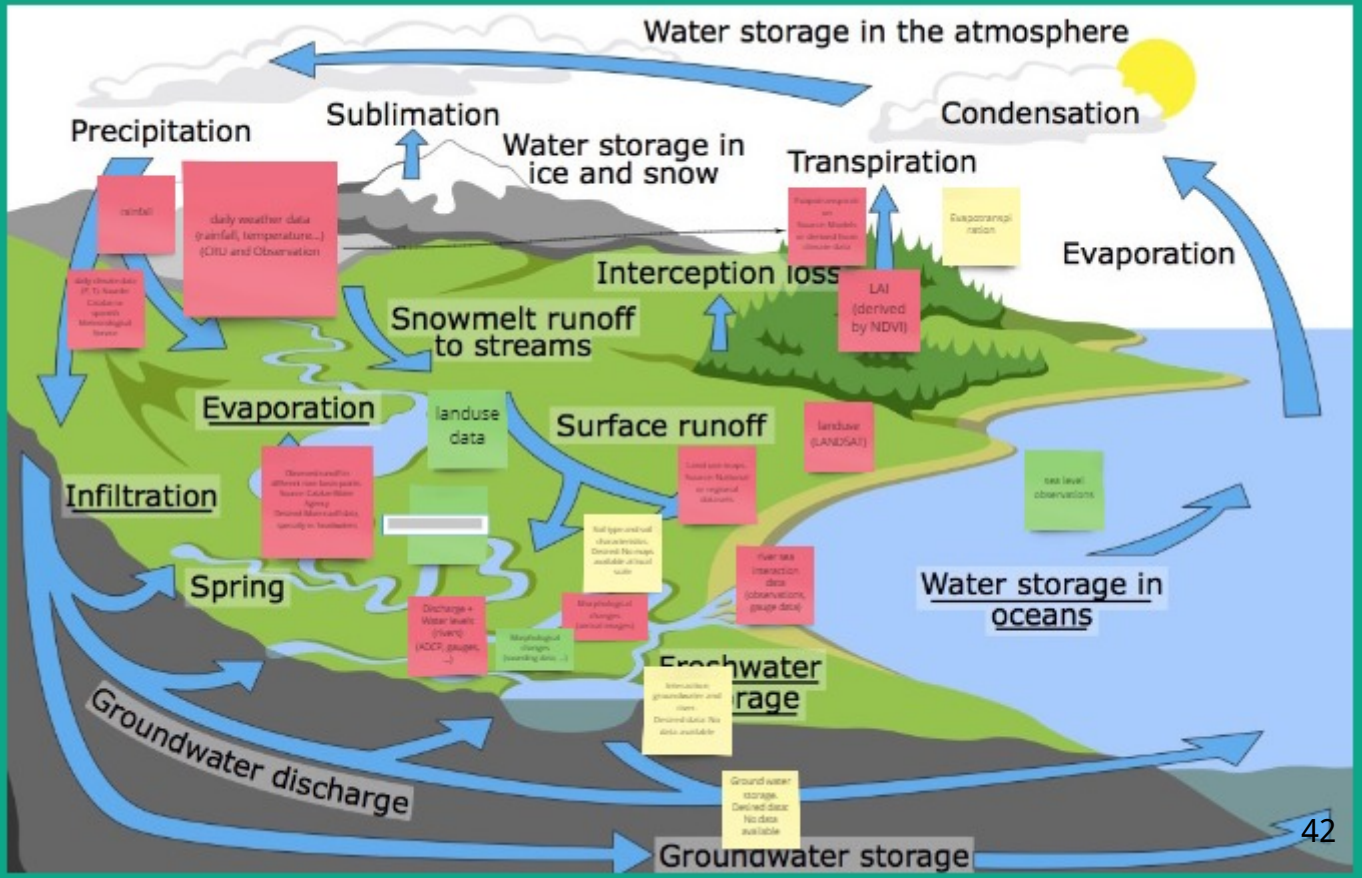
(Write it on a post-it and put it with the correct type of user requirement. Add/change types of user requirements where necessary.)

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
Evaporation
landuse data
Surface runoff
Infiltration
Spring
Water storage in oceans
Groundwater discharge
Groundwater storage
daily weather data (rainfall, temperature...) (DWD and Observation
LAI (derived by NDVI)
landuse (LANDSAT)
sea level observations

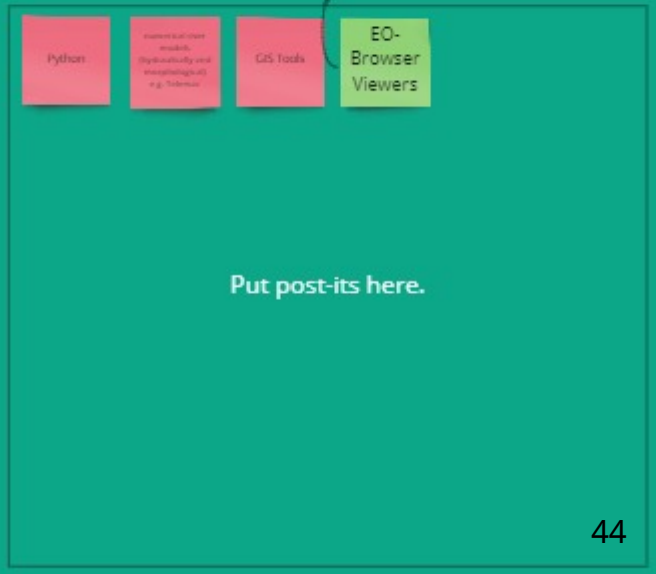
What are the user requirements you need or you need to see enhanced?

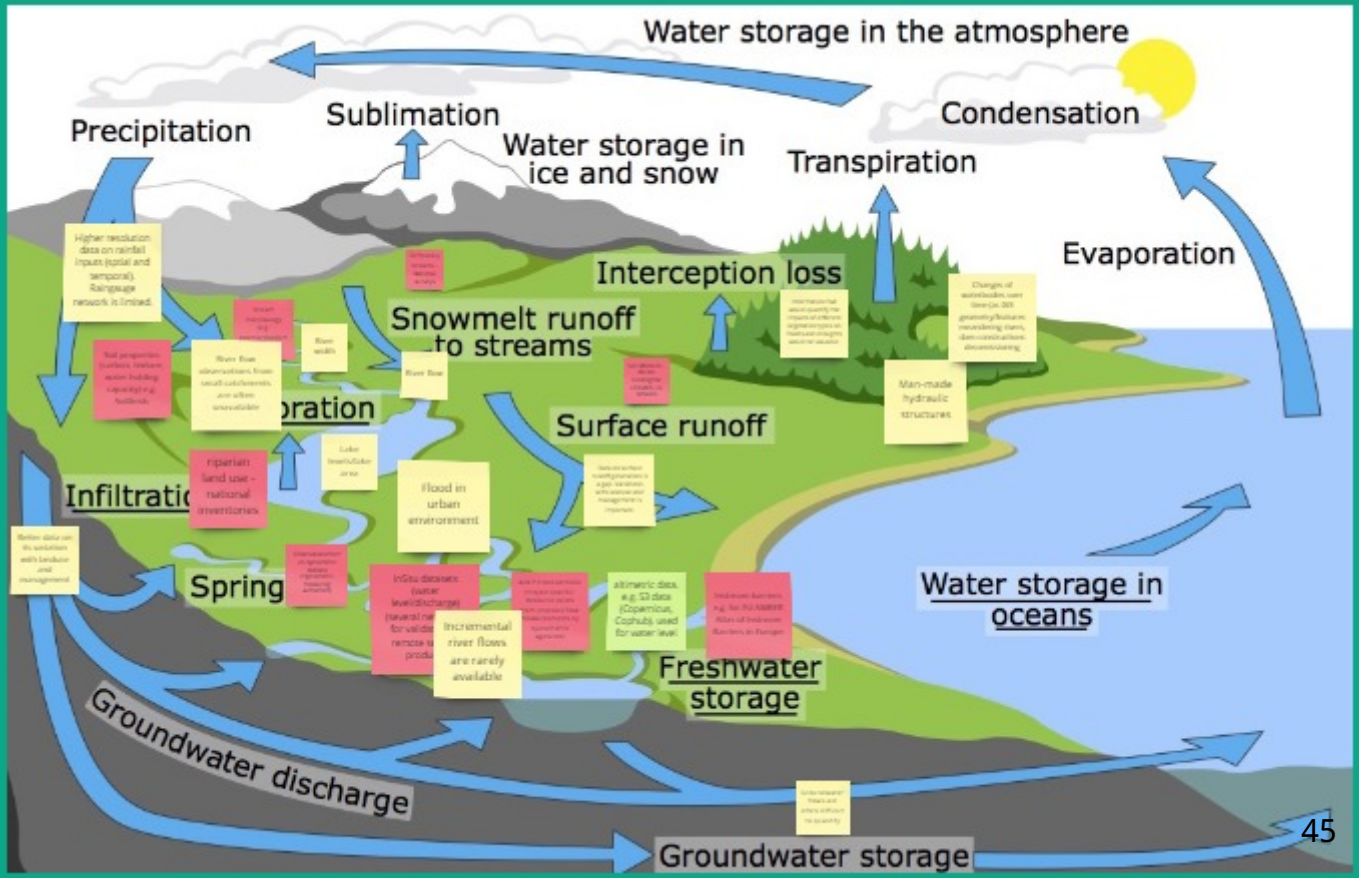
(Write it on a post-it and put it with the correct type of user requirement. Add/change types of user requirements where necessary.)

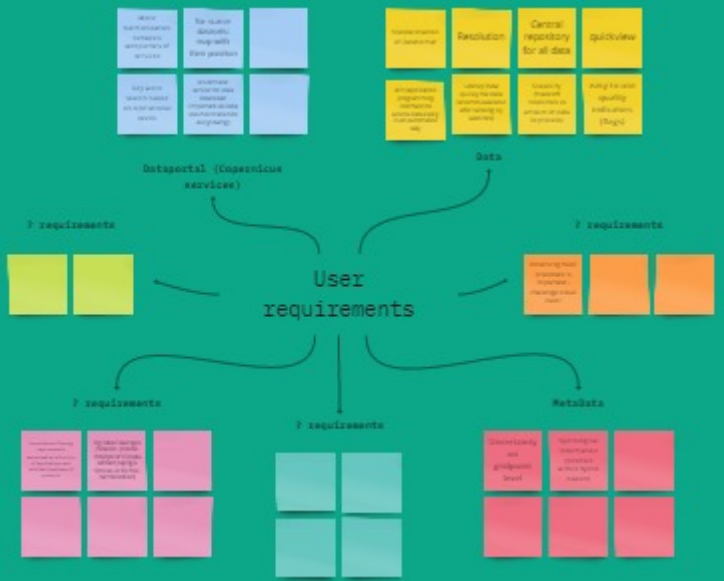
overall -> mucher higher spatial resolution (thinking in river width scale not in ocean scale :-)

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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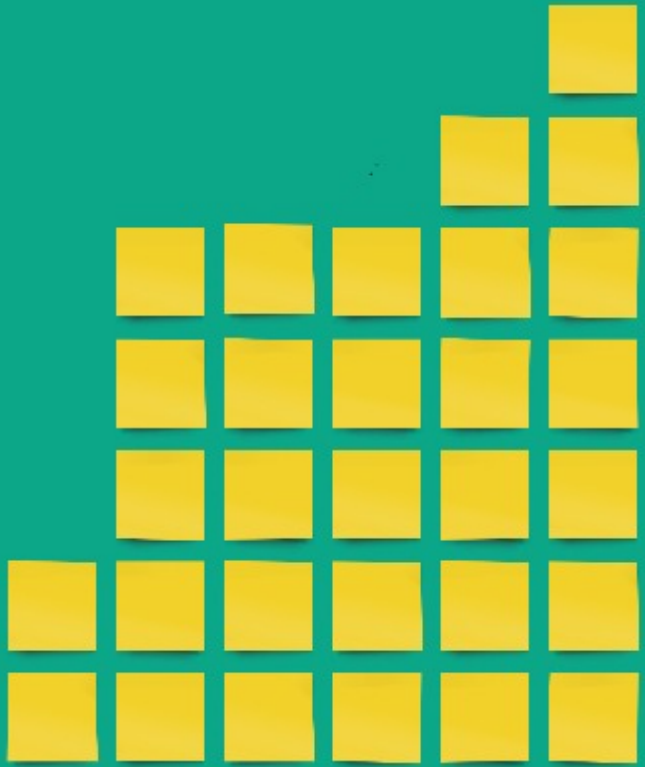

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QGIS

Global Surface Water Explorer

availabilit of altimetric datasets (Cophub)

Global Flood Awareness Systems (Emergency service)

LISFLOOD model (emergency service)

R

Put post-its here.

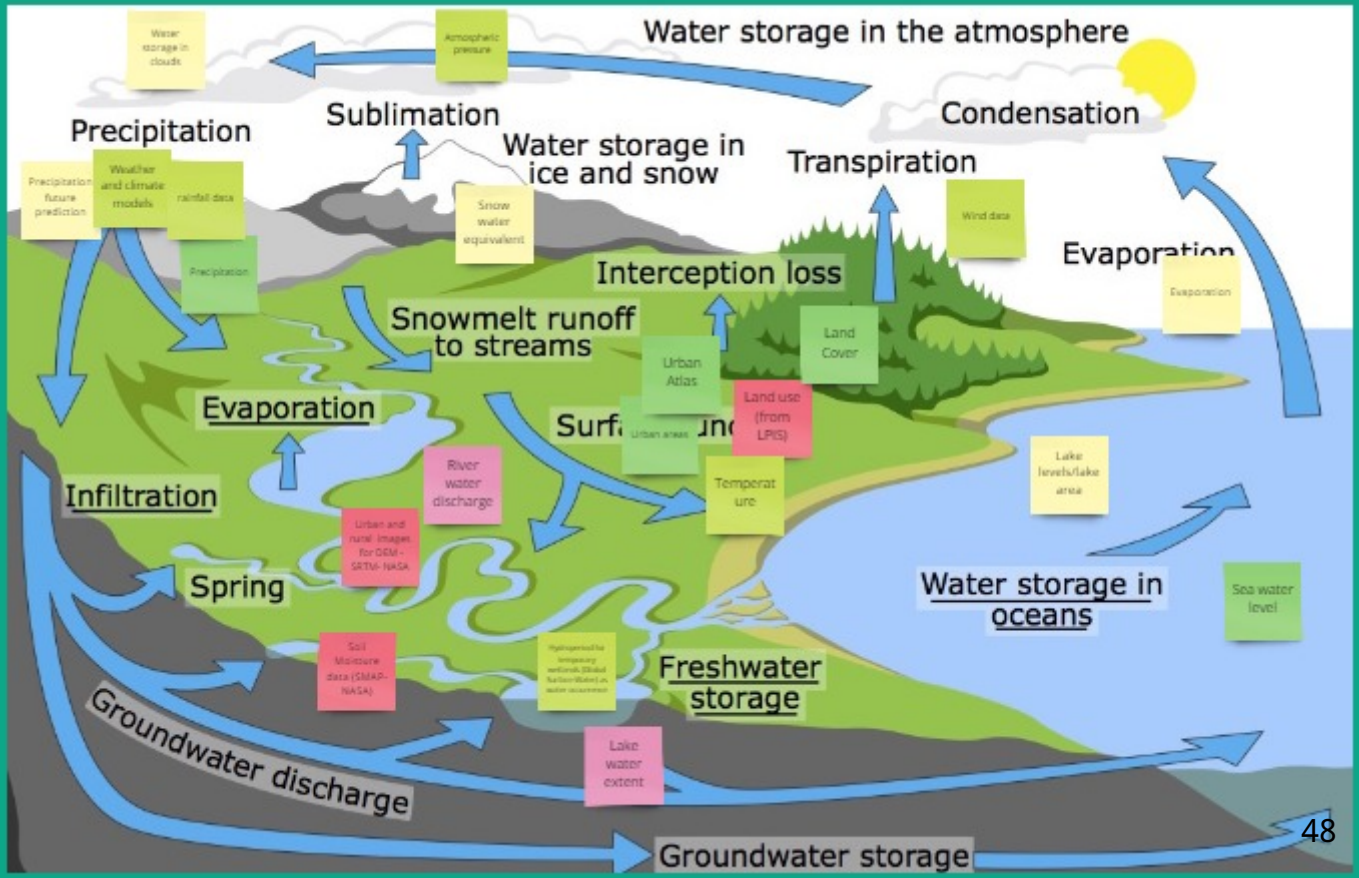
Google Earth Engine

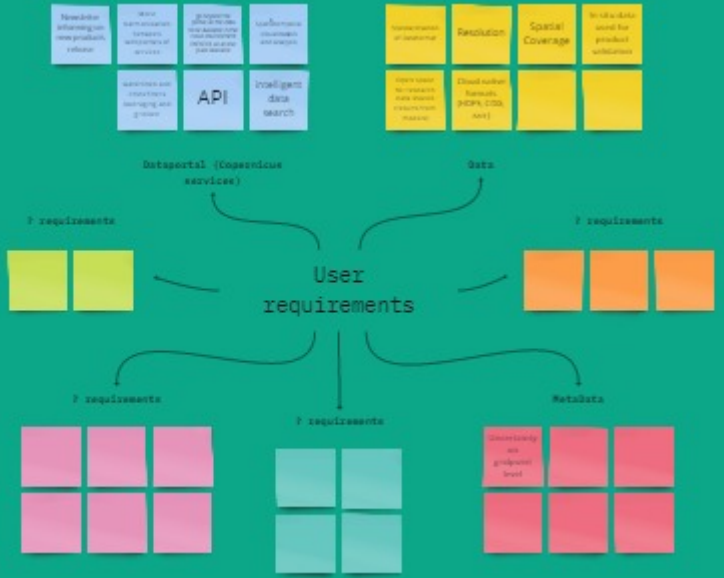
Drought Toolbox (United Nations CCD)

Python / Jupyter / Colab

GIS mapping tools are used but I do not do this myself

UKCEH has developed a number of portals to view spatial data


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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