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Committee on the Peaceful Uses of Outer Space
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Vienna, 31 May–9 June 2023
Item 10 of the provisional agenda**
Space and water

Report on the Second Space4Water Stakeholder Meeting, Online, 11–12 May 2023

I. Introduction

1. The 2nd Space4Water Stakeholder Meeting was hosted by the United Nations Office for Outer Space Affairs with its partner, the Prince Sultan Bin Abdulaziz International Prize for Water online 11–12 May 2023. 31 participants from 20 countries met to exchange knowledge and collaborate on addressing water-related issues with space-based technology and data, both in theory and practice. Fifteen technical presentations were delivered in 4 sessions. In the interactive session "Matching water-related problems with space-based solutions", participants collaborated to outline approaches to address water-related issues observed and faced by Indigenous communities represented at Space4Water or other members of the Space4Water stakeholder community.

II. Objectives

2. The objectives of the meeting included:

(a) Demonstrating activities and thematic areas of the Space4Water community's work;

(b) Fostering knowledge exchange between the Space4Water stakeholders, professionals, young professionals, and Indigenous voices;

(c) Matching water-related challenges and space-based solutions;

(d) Identifying topics, structure and publication modalities for good practices to be developed by the community;

(e) Identifying ways to assess user needs in the water-related sectors; and

(f) Discussing and identifying requirements of in-situ data collection, capacity-building and coordination mechanisms to this end.

* Reissued for technical reasons on 6 June 2023.
** A/AC.105/L.333.

III. Attendance

3. In total, 31 participants from 20 countries met to exchange knowledge and collaborate on addressing water-related issues with space-based technology and data. Participants were from: Afghanistan, Bahrain, Belgium, Brazil, Colombia, Costa Rica, Democratic Republic of the Congo, Ethiopia, Germany (2), Ghana (2), India, Kenya (3), Luxembourg, Malawi, Morocco, Nepal, Netherlands (Kingdom of the), New Zealand, Nigeria (2), Pakistan, Peru, Russian Federation, Sri Lanka, Sweden, and Zimbabwe. Thirty per cent of the participants were women.

4. Participants came from academia, the private sector, government and intergovernmental organizations. The stakeholder group that was not represented was civil society, as none registered.

5. In total, 8 of the 31 participants belonged to the group of professionals and young professionals. Two of them were members of Indigenous communities and among the stakeholder groups representation looked as listed below.

6. The following 19 stakeholders were represented at the meeting:

(a) Two intergovernmental organizations: the World Meteorological Organisation; the Inter-American Institute for Cooperation on Agriculture;

(b) Nine from academia: Central European University, Govind Ballabh Pant University of Agriculture and Technology, the University of Zimbabwe; Chouaib Doukkali University, Morocco; Universität München; University of the Punjab; Tribhuvan University; University of Energy and Natural Resources, Sunyani, Ghana; University of Zimbabwe;

(c) Two from government: the National Space Science Agency, Bahrain; and the Kenya Space Agency; and

(d) Six from the private sector and industry: b.geos, constellr GmbH, Deltares, GLOBHE, RSS-Hydro and the Flemish Institute for Technological Research – Remote Sensing (VITO).

IV. Programme

A. Opening Remarks

7. The meeting was opened a representative of the United Nations Office for Outer Space Affairs. She highlighted the objectives of the meeting and the importance of water, as well as the role Earth observation activities could play in water management.

8. A welcome address was also delivered by the Executive Director of the Prince Sultan bin Abdulaziz International Prize for Water, highlighting the collaboration between the Office for Outer Space Affairs and the International Prize dating back to 2002. Under that long-standing partnership, a series of international conferences on space technologies for water management had been held since 2008. In 2016, the partnership had been formalized through a memorandum of understanding, followed by the establishment of the Space4Water project. The opening remarks ended with a video on the 10th Awards ceremony of the Prince Sultan Bin Abdulaziz International Prize for Water held at the Vienna International Centre in December 2022.

9. The representative of the Office for Outer Space Affairs gave a presentation on the Space4Water initiative. She started by highlighting how alarmingly off track the water agenda and SDG 6 is and continued speaking about the intrinsic and interconnecting role water plays across the SDGs. Examples on the use of space technology to attain various of the goals were shared. This introduction was followed by information on the three pillars of the Space4Water Project: The conference series, the portal and the community. The successful hosting of the Fifth international conference on space technology for water resource management was mentioned, as

well as an overview of the portal's functionality along with actor, user and content statistics were shared.

B. Technical Presentations

10. Fifteen technical presentations were delivered in four sessions (listed below).

(a) Space technology to monitor water quality/pollution;

(b) Space technology for water resources management and hydrology;

(c) Data structures and portals in support of water resources management and hydrology; and

(d) Capacity-building needs.

11. The National Space Science Agency Bahrain presented an Oil Spill Detection System for the Arabian Golf, based on an Azure machine learning approach. The project uses Synthetic Aperture Radar (SAR) data to detect oil spills, which have severe impacts on marine life and coastal environment. Data from the European Space Agency (ESA) were acquired to increase the data set for the machine learning model. A distinction if in image contains an oil spill or not can be made with 94 per cent accuracy. A prediction system taking into account weather and currents affecting water movement was presented as an outlook for the project.

12. In the session on space technology for water resource management and hydrology, the Remote Sensing, GIS and Climatic Research Lab of the University of the Punjab presented geospatial indices as a measure of influence and managing the priority situation of groundwater storage anomaly (GWSA). The study area covered India, Pakistan and Afghanistan. A Groundwater Management Index was presented, and the importance of individual controlling variables for GWSA and its temporal variation over time was highlighted.

13. A Space4Water professional from Lima University presented on flood analysis in Peru using Sentinel-1 radar imagery. The goal of the study was a prevention plan in case of floods. Rainfall was assessed in two locations heavily affected from floods in the past (Chosica and Piura), and image processing included radiometric calibration, speckle filtering, terrain correction, histogram plotting and image binarization. Resulting maps can lead to better decisions by authorities.

14. GLOBHE presented on flood risk mapping and search rescue with insights from cyclone Freddy in Malawi. The stakeholder reported that UNICEF Malawi engaged GLOBHE to assess flooded areas with Unmanned Aerial Vehicles (UAV). Operators on site worked with stakeholders such as the Red Cross and police forces among others. Drones were used to check for missing people in affected areas. The drones provided Synthetic Aperture Radar (SAR) videos, pictures, mapping photos and ortho-mosaics. Challenges included the accessibility to areas of interest and coordination with the committee on the ground and the community.

15. A young professional working at the Centre national de la recherche scientifique (CNRS) presented his PhD on how to monitor hydrological changes – extending and complementing in situ data with satellite data in the case of an African Basin. The lack of in-situ data in African basins and the high dependency of populations on water resources was highlighted. Satellite data were presented as a way to complement in-situ data in the monitoring of hydrological processes and water cycle assessments in the Congo and Ogooue River Basins. Radar altimetry was used to measure water level variability, and water streamflow to have a near real-time result and a hydrological model (MG) helped simulate hydrological processes. With a long-term series of over 20 years, space-based data complemented the information base and allowed discharge analysis of up to 40 years.

16. Another Space4Water professional presented on Nature-based solutions for sustainable water management, the reservoir cascade system. Cascade system are

interconnected irrigation systems. In Sri Lanka most of these systems are not functioning due to lack of maintenance. Earth observation data can contribute to identifying the source of the problems such as water flow or sediment deposition, among others.

17. In the session on data structures and portals in support of water resources management and hydrology five technical presentations were delivered. The University of Munich presented the Database for Hydrological Time Series of Inland Waters (DAHITI), satellite-derived hydrological products for monitoring the global water cycle. The speaker introduced the database they developed and their data products for the Global Climate Observing System. DAHITI includes data about water level, surface area, volume variations and river discharge. The stakeholder presented and compared the different products derived from the database.

18. The Inter-American Institute for Cooperation on Agriculture presented the use of Digital Twins to train rural communities to mitigate water resources impact due to extreme weather events. The twins were related to water supplies in an Ecuadorian town as well as tracking of maintenance and illegal activities related to the water sources.

19. The Flemish Institute for Technological Research - Remote Sensing (VITO) presented Earth observation satellite data in support of hydrological research: An introduction to the Terrascope and Explore VN project, which is based on open Copernicus data. An overview of available datasets was followed by various interfaces Terrascope offers such as: online viewers, virtual machines, Jupyter notebooks, web services, and the openEO API. Some of the resources are provided to PhD students for free. Furthermore, VITOs engagement in and some details on the Water-ForCE Project were presented.

20. constellr presented their global water monitoring for a growing planet project. The problems faced, particularly in agriculture, with water monitoring were highlighted by the notions of water quantification, temperature and carbon balance. constellr presented its goal to make early systems of plants stress observable before their damage, using earth observation data. Biophysical and chemical footprints were addressed as a way to monitor the amount of water used to keep plants in a good health. Economic, water and CO_2 savings were underlined.

21. Tribhuvan University presented on spring water sources of Pokhara valley and importance for planning and scientific monitoring. The need to monitor resources during spring due to climate warming was accentuated and the University of Tribhuvan presented the methodology of their project.

C. Interactive session: the Space4Water community – developing space-based solutions to address water challenges

22. In this session a few observed or identified water-related challenges were presented by members of Indigenous communities (who had taken part in the Participatory workshop for Indigenous women on their roles and responsibilities related to water)[1] or by other members of the Space4Water community.

23. **Water shortages and quality issues for domestic use in Platfontein South Africa were presented by an Indigenous Voice from the region:** the water in Platfontein is contaminated. The origin of pollution is assumed to be mining activity in Kimberly, a nearby mining town. People in the region are suffering from health problems and there is a need for water purification systems. Furthermore, Platfontein is an arid place and the local soil conditions are not suitable for agriculture. Locals need to be educated on what kind of crops are suitable to grow in the area, when to plant, how to prevent the soil from further drying up.

[1] www.space4water.org/news/participatory-workshop-indigenous-women-their-roles-and-responsibilities-related-water.

24. **Lacking historic knowledge on vegetation cover and surface water extend/river course:** Land and river are especially important to indigenous Māori tribes. The challenges faced by the community include that they have no knowledge of the vegetation covering their lands about 60 years ago. Time series data is required on surface water extent and vegetation mapping so that planting activities by the community can help stabilize riverbanks and bio-ecosystems, including getting back eel populations that used to live in their river. One side of the river is forested, and one side is deforested, which is leading to many water quality and other related issues. A Space4Water Young Professionals presented an approach to address above-described issue (see description that follows below).

25. **Vegetation classification for land of Māori community:** This is one of the first space-based solutions currently collaborated on. Due to the lacking historic knowledge of river/land use/land cover, and water quality issues, a hybrid approach using historic Earth observation data, but also doing a social community survey was suggested. The survey is important to document and conserve the knowledge of the elderly about previously existing vegetation cover and plant species. The solution's outline consists of the below steps:

(a) Earth observation (EO) data to map the vegetation and water bodies;

(b) Social community survey (is a must for historical data);

(c) Knowledge documentation; and

(d) Watershed management.

26. **Samburu tribe in Kenya lacks access to safe drinking water:** the Samburu community in Kenya are pastoralists as they keep animals which is their main source of livelihood. They move from place to place in search of adequate pasture lands and water. Due to a recent dry spell, water sources are dry and there is no water. Both women and girls are walking long distances of about 20 kilometres per day to search for water. This search usually goes on from day until night. In order to save the water they bring back home, some women and girls bath wherever they find the water. The long journeys they partake on in search for water and carrying the water for long distances has impacted their wellbeing. Some of them are suffering from backaches. In addition, the water they collect is not so clean to be suitable for drinking, but because they have no other options, they consume this water resulting in them suffering from water-related illnesses. School children have to bring their own water in one or two litre bottles from their homes to school because there is no water in school. Ground water mapping is needed in Samburu, Kenya. We need to identify steps necessary to - map the area to identify potential sources for access to drinking water for the community.

27. **Droughts and floods over the same region:** a Space4Water stakeholder representative and professional described that Pakistan received below normal (-21.6 per cent) rainfall from January to April 2022. As a result of climatic anomalies manifesting as an abrupt increase in daily maximum temperature and limited irrigation water availability for Kharif crops, a drought-like situation developed and continued to worsen until June 2022, badly affecting agriculture, water resources, and livestock. Contrastingly, since the start of the monsoon season in mid-June 2022, the country witnessed exceptionally heavy rainfall, receiving about three times as much precipitation as the 30-year average. The consequences unfolded in the form of severe floods that affected over 33 million people, damaged 1.5 million homes and 800 medical institutions, and killed 1,400 people. 3.6 million acres of crops were devastated, and 800,000 animals perished. Being the most recent example, the floods of 2022 are notable; however, recurring floods have been a norm for several decades in Pakistan. Water scarcity episodes followed by flooding events demands human intelligence and technological intervention for proper administration, to protect lives and valuable resources needed to sustain life. Consequences in case of inaction can include deaths, health issues, food scarcity, ecological and economical damage.

28. The presented solution suggests determining sites for rainwater harvesting and potential of rainwater harvesting structures, by using data on landcover/land-use, elevation and topography, but data on geo-chemical formation of soils, stream runoff and various hydro-meteorological variables are also required. High quality data of landcover/land-use, elevation, stream identification, water potential of individual watersheds, and slope with fine spatial resolution can be derived from space-based satellite imagery. Although stream runoff and hydro-meteorological variable statistics with sufficient accuracy can only be obtained through ground based in-situ sensors, these measurements also need space-based location services to use them as input into the spatial analysis along with the satellite derived products.

29. Ohneganos: A lightning talk was given by the PhD supervisor of one of the Space4Water professionals. She shared her experience working with Indigenous communities on water issues. The project focused on the use of low-cost sensors to collect local data to calibrate Earth observation models. Details are accessible at the Ohneganos website.[2] A suggestion to think about cross-learning with Indigenous communities in other countries was made. The presenters view well reflected one of the results of the workshop OOSA hosted for Indigenous women in 2022, who claimed the need for co-creation of knowledge. In context of the Ohneganos project, Western Science, information and data as well as Indigenous knowledge teachings can lead to co-created experiences and solutions.

30. Participants were invited to pick a water-related challenge which is thematically interesting or related to their work and to collaborate on developing outlines for space-based solutions addressing the challenges.

31. A team formed to work on the historic vegetation cover and water quality challenges faced by the Māori tribe. It was identified that mapping needs to take place even outside of the area of interest, upstream within the watershed. Resources, such as publications and datasets were shared and have been linked from the draft solution published on the Space4Water Portal.[3] Many of the available data sources are not available at a high-enough resolution to map the small stream, but rather to work on a regional scale. Nonetheless, the team developed some maps of the watershed live during the session.

32. The challenge on droughts and floods over the same region was selected by a young professional. He identified that access to raw data in 10 m resolution would be useful to address the issue. Backscattering effects of urban areas could be problematic.

33. b.geos outlined several solutions to challenges faced by the Mikisew Cree First Nation in Canada and indicated that a lot of research has been done on the glaciers in the area. Identified researchers are a potential source for unpublished additional data that can benefit addressing the challenges faced by the community. Concerning the challenge expressing a need for data on snow quality which is assumed to be affected by runoff and emissions from industrial use the researcher suggested using LIDAR, glacier monitoring, wind data and particle distribution, as well as sampling snow and chemical analysis to gain more insights. She also pointed out that the private sector might have the information and resources on the runoff. On the challenge Need for wetlands inventory, a need for a high quality yearly repeated land cover product, and high-resolution Sentinel 1 and 2 imagery are needed. Both challenges would require modelling and field research.

34. The challenge faced by the Samburu tribe was picked up by the Kenya Space Agency. NDVI and a topographic map, as well as a geological map are the first steps to learn about the potential groundwater zones.

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[2] www.ohneganos.com/virtual-reality.

[3] www.space4water.org/space-based-solution/vegetation-classfication-land-maori-communtiy-development.

35. The Office for Outer Space Affairs will follow up with identified relevant members of the Space4Water community to foster collaboration on and develop space-based solutions to address the identified water-related challenges.

V. Capacity-building needs

36. The World Meteorological Organisation (WMO) presented capacity gaps for hydrology date exchange. The stakeholder representative shed light on how the WMO addresses gaps. WMO, as a standard setter, hand out certifications. When standards are not followed, WMO collects data from different data brokers. Then WMO harmonizes and standardizes the data. Once harmonized, they make the data available to different data users. Capacity gaps are assessed by sending questionnaires to various user groups, not just focal points, and then compare answers with those of similar organizations such as the World Bank. However, most experience on the status of capacity-building needs is collected during implementation of their systems in a country. WMO tailers trainings to meet the specific needs of users. Identifying existing experts within the region/country who can continue with the training was also highlighted as important. The identification of quality trainers who are then trained by WMO in a train the trainers approach was described. Finally, it was highlighted that technical training needs to involve both, hydrologists and IT staff.

37. Space technology and water professionals was presented by the National Space and Research and Development Agency, Nigeria. Suggestions for capacity-building delivered in this presentation included the provision of space-based data for free, or at low cost, accessible data sharing platforms and approaches such as “catching them young”,[4] training of trainers, friendly education, and the furthering of water related academics.

38. The discussion evolved around how to train policy and decision makers, the role of researchers in policymaking (science diplomacy) and that policies need to benefit the public. Hence, any information collected to this end should be published in an understandable formation, understandable for the masses.

39. Finally, the University for Energy and Natural Resources presented on the need for capacities for emerging Earth observation uptake in universities. The presentation concerned curriculum development and respective national and regional needs. Universities are sitting as silos, not receiving inputs from government saying X, Y and Z must be covered in the water management curriculum, otherwise universities are just working on theory.

40. The discussion continued and now evolved on how capacity-building needs are assessed in the country (Ghana). Capacity-building needs are based on certain development agenda of the country, e.g. in Ghana, mining is an example. University courses are developed according to a draft proposal. The next step is approaching faculty and management of a university to implement it. A national council further reviews and ensure it is in line with national interest. A question from the audience concerned investments and whether they are advised to invest in EO equipment or validation equipment? Panel members replied that one needs to link how the instrument is helping to further the national agenda. Both, EO and validation equipment are important, e.g. Ghana is losing biodiversity due to forest fires and the fire departments do not have the data to monitor the loss. Universities produce a wildfire product that provides data to the fire department.

41. A question from WMO concerned the links of universities with industry. Universities host industrial partner meetings and sometimes industry partners also deliver trainings based on their experience.

[4] Expression used by presenter to say, setting the foundations for STEM education at an early age, can lead to great results later on.

VI. Space4Water Community Objectives

42. The text below is a short summary of the interactive session on community objectives. A complete list of results is provided in Appendix A.

43. The session on community objectives showed that participants appreciate the interaction across stakeholder groups and sectors, including with very local actors. Potential seen in the community includes skill-sharing, capacity-building, collaboration across regions, sharing methodologies to aid decision-making, as well as collaboration on projects with impact on human and environmental life. The participation of local actors was highlighted several times as a chance to verify remotely sensed or researched phenomena with reality on the ground.

44. Challenges concerning the community can include lagging behind technologically, developing results-oriented active working groups including finding resources to implement solutions or the knowledge needed to that end.

45. Focus would preferably go to delivering webinars by stakeholders and professionals, followed by matching water-related challenges with space-based solutions, assessing user needs and developing good practices.

46. When asked what other services Space4Water could provide the community with, a lot of attention was given to collecting and grouping challenges, matching them with solution providers to finally develop and fund opportunities.

VII. Conclusion and outlook

47. Presentations delivered by Space4Water professionals, young professionals and stakeholders showed a large variety of topics on the use of space technology to address water issues, including disasters such as oil spills, floods and droughts, but also the interplay of in-situ and EO data in hydrology, the production and distribution of water-related data products and digital twins.

48. Numerous local water-related challenges were discussed and participants collaborated to identify outlines for space-based solutions that can address the challenges.

49. The second Space4Water stakeholder meeting received positive feedback in writing and in via feedback forms. The meeting was rated at 4.8 points out of 5 by the participants. The feedback on the meeting demonstrated interest maintaining the community of practice focused on the using space-based technology to address water-related issues.

50. The discussion on capacity-building shed light on the important and delicate position universities can have. They educate the future generations and equip them with much needed skills. Curricula can be driven by economic needs or a national agenda. Among represented actors engaged in capacity-building, both, the catch them young and train the trainers approaches considered as promising and important apart from those who are provided for by academic training.

51. The Third Space4Water Stakeholder Meeting will be convened at the Vienna International Centre, 27–28 October 2023 in person.

VIII. Testimonial by a workshop participant: What did you like the most?

"*The collective wisdom to identify the issues, think of the solution and feeling of thinking out of the box for the sake of humanity*".

IX. Appendix A: Community Objectives Survey Results

1. What potential do you see in the Space4Water Community?

(a) Validation of EO products by the communities / with local in situ data (2);

(b) Connection of global satellite data research community (academic and private sector) with local stakeholders;

(c) The stimulation of general engagement across relevant sub-sector entities; enabling skill sharing, networking, partnerships, etc.

(d) Connect stakeholders and researchers with different regional focus;

(e) Share methodologies to build spatial database to aid water decision-making;

(f) Cross-community projects involvements and capacity-building;

(g) Collaboration on shared projects focused on human and environmental impact objectives;

(h) Capacity-building, data sharing, and networking (2);

(i) Interdisciplinary involvement for better solution and sharing new technology;

(j) Consolidating the data portal and having one place for capacity relevant materials and finally having road map for consumption of the PhD research outcomes; and

(k) Have local stakeholders in the meeting because they could help with observational data and related site challenges.

2. What challenges do you see in the Space4Water Community?

(a) The community itself lag behind in terms of digital technology;

(b) Grouping, access to the materials;

(c) Results-oriented vibrant and active working groups;

(d) Needed capacity to carry out projects; and

(e) Resource mobilization to implement solutions to the challenges.

3. Do you think we should focus more on?

(a) Webinars delivered by stakeholder and professionals (4.3);

(b) Match challenges and solutions (4.2);

(c) Approaches to Assess User Needs (4.1);

(d) Developing Good Practices (3.8);

(e) Science Communication (2.6);

(f) Regular online meetings of stakeholders (2.6).

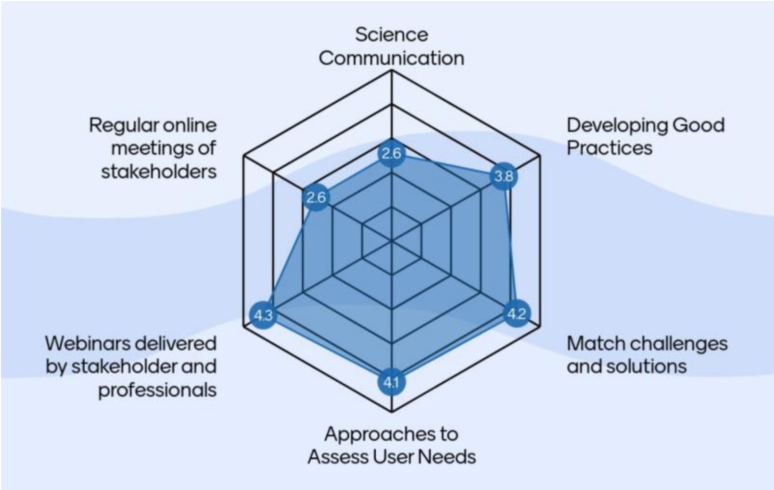

Figure 1: Spider diagram on focus areas

4. **What needs to be included in good practices on the use of space technology and data for water?**

(a) Projects for young professionals to collaborate and carry out;

(b) Brief tutorials with examples (including example data and code if needed);

(c) It is good to validate with observation or compare the data with other techniques;

(d) Free Open-Source Software and Open Data;

(e) Trainings and tutorials;

(f) Using space technology to solve challenges faced in the community;

(g) Focus on guidelines for bankable technologies.

5. **What other services can we provide the community?**

(a) Upcoming conferences, projects, research opportunity etc;

(b) Funding for indigenous communities to attend meetings;

(c) Training, funding bankable;

(d) Projects;

(e) Funding for local projects;

(f) Matching challenges with solution providers and funding opportunities;

(g) Training workshops, and projects for collaborating. Sharing of results from our research with the community;

(h) Identify the most common problems, design and create a pack of tools to solve the problem;

(i) Posting challenges for stakeholders and invite volunteers professionals if they want to;

(j) contribute.

6. **What other features do you want on the portal?**

(a) Dashboard of the available resources;

(b) Data sources and steps to download; and

(c) Success stories (best practices) matching challenges and solutions and their implementations.

7. Ranking of most important Space4Water Resources

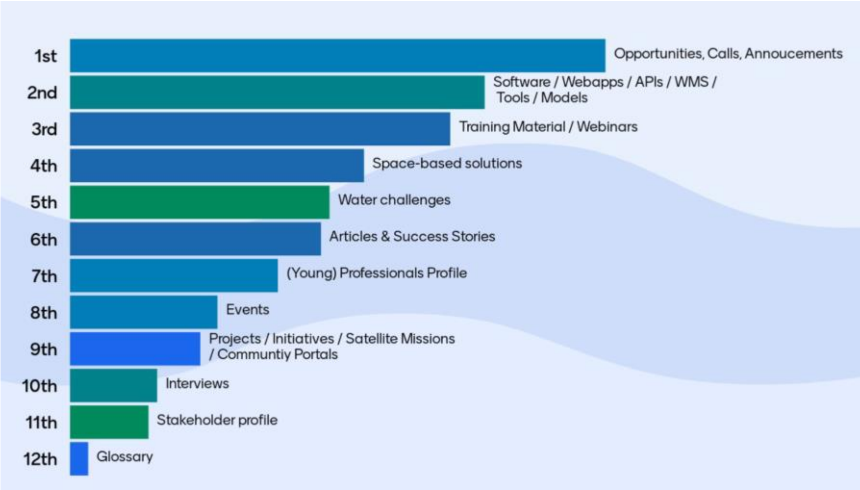

Figure 2: Space4Water resources ranked by preference

8. What does the portal need to have to make you visit it regularly?

(a) It should post challenges;

(b) Dashboard, subscription to relevant materials;

(c) Direct contact through email list highlighting new features on the portal;

(d) Voting for challenges, competitions;

(e) Frequent updates, our research findings on the portal.

9. How can Space4Water help you to get meta-information on your resources on board?

(a) Reminders (maybe 1–2 times per year);

(b) Frequent reminders.

10. I am willing to contribute to space-based solutions if in my area of expertise

(a) 4 out of 11 participants active in the session at this point.

11. I am willing to be part of a hackathon jury next year

(a) 3 out of 11.

12. My strengths and interests

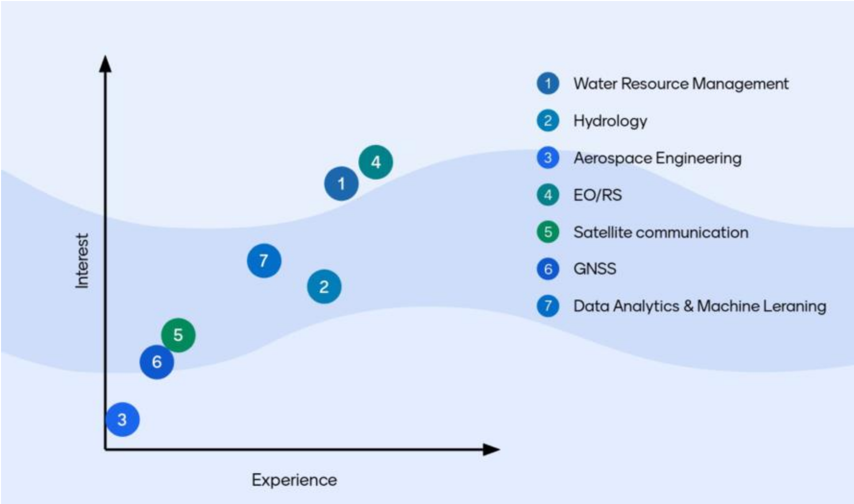

Figure 3: Thematic strengths and Interest of participants