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Report on the first Space4Water stakeholder meeting

(Vienna, 27 and 28 October 2022)

I. Introduction

1. The Office for Outer Space Affairs and the Prince Sultan bin Abdulaziz International Prize for Water organized the first Space4Water stakeholder meeting, held in Vienna on 27 and 28 October 2022.

2. In view of the fact that this was the first meeting, it was decided to hold it in person to allow the community of stakeholders and professionals to meet face to face and interact to the fullest extent possible. The meeting was hosted at the Vienna International Centre.

3. The present report describes the objectives of the meeting, provides details of attendance and summarizes the presentations given, discussions held, conclusions reached, observations made and decisions taken. The report also includes information on input and objectives for future development, with the aim of strengthening the community.

II. Background and objectives

4. The first stakeholder meeting provided the Space4Water community with an opportunity to meet in person, get to know each other and discuss activities and expectations with regard to the project. The meeting was held four years after the launch of the Space4Water Portal in October 2018.

5. The meeting had the following objectives:

(a) To identify shared objectives for the Space4Water project and community;

(b) To better understand how members of the community were assessing user needs in the water-related sectors, including the identification of what actors in the water sector needed from the space sector and what approaches the Space4Water community could adopt;

(c) To identify effective approaches to facilitate the matching of stakeholders, professionals and young professionals;

(d) To identify effective ways to find space-based solutions to water-related challenges;

(e) To determine the next steps to achieve the objectives listed above.

6. The Space4Water community consists of five stakeholder groups, namely, representatives of academia, government, intergovernmental organizations, the private sector and industry, and civil society. With a total of 87 stakeholders, each group could ideally be represented by about 17 actors.

7. The meeting was designed to be highly interactive, to allow members of the community to learn about each other's experiences, discuss their respective expectations and define future activities collaboratively.

8. The meeting provided an opportunity for stakeholders to listen to diverse views and to put forward suggestions regarding the use of space-based technologies to better monitor and manage water on Earth.

9. The unique role of water as a connecting factor between Earth system dynamics and across the Sustainable Development Goals was highlighted.

III. Attendance

10. A total of 80 individuals, a quarter of whom were women, applied to attend the meeting. A total of 16 individuals representing Space4Water stakeholders, professionals and young professionals actually participated in the meeting, of whom 37.5 per cent were women. While the participants affiliated with the Space4Water stakeholder organizations acted as representatives of those organizations, the professionals and young professionals participated in their individual capacities.

11. Individuals from the following 14 countries attended the meeting: Bulgaria, Costa Rica, Democratic Republic of the Congo, Egypt, Ethiopia, Germany, India, Kenya, Philippines, Poland, Romania, Russian Federation, Sri Lanka and Zimbabwe.

12. Organizations from the following 11 countries were represented: Austria, Bulgaria, Egypt, France, Germany, Hungary, India, Kenya, Netherlands, United States of America and Zimbabwe.

13. The following stakeholders were represented at the meeting:

(a) One intergovernmental organization: the Inter-American Institute for Cooperation on Agriculture;

(b) Five from academia: Central European University, Govind Ballabh Pant University of Agriculture and Technology, the IHE Delft Institute for Water Education, the University of Zimbabwe and Vienna University of Technology;

(c) Four from government: the Egyptian Space Agency, the Kenya Space Agency, the Zimbabwe National Geospatial and Space Agency and the government of Meghalaya;

(d) Two from the private sector and industry: b.geos and Mozaika.

14. One Space4Water professional and four young professionals participated in the meeting in an individual capacity. The Space4Water professional was affiliated with the Schmid College of Science and Technology, Chapman University, and had recently become the Vice-President of the Egyptian Space Agency. The four young professionals were enrolled in PhD programmes at the following institutions: the Centre national d'études spatiales, France; the Wegener Centre for Climate and Global Change, Austria; the University of Texas at Arlington, United States; and the Technical University of Munich, Germany.

15. There was a high degree of interest and experience among the participants in water resource management, hydrology, Earth observation, data analytics and machine learning. In contrast, there was a medium to low amount of interest and experience in aerospace engineering, satellite communication and global navigation satellite systems. That information could be used to help interpret or contextualize decisions taken at future stakeholder meetings attended by only a small number of stakeholders.

IV. Programme

A. Overview

16. The meeting was held over two days. There were a total of 21 speakers, of whom eight were women and 13 were men. Five of the speakers were from the Office for Outer Space Affairs or the Prince Sultan bin Abdulaziz International Prize for Water.

17. The majority of presentations given by the speakers will be made available on the "Meet a Professional", "Meet a Young Professional" and "Stakeholder" profile pages of the Space4Water Portal.

18. The programme comprised presentation sessions, round-table discussions and interactive sessions. In the interactive sessions, participants paired up with the objective of developing approaches to finding space-based solutions for water-related challenges and to place the stakeholders' and professionals' projects and initiatives on political and climate maps of the world and on a model of the water cycle – a successful way to identify regional or thematic overlaps among those projects and initiatives.

19. On the first day, the various aspects of water-related challenges on Earth and space-based solutions to those challenges were presented and discussed.

20. The second day was very interactive. The participants discussed user needs relating to the Space4Water project and approaches that could be taken to assessing such needs in various water-related sectors. The identification of means of collecting and communicating needs at the local, national, regional and international levels were also addressed. In addition, the participants learned about the design of missions in the space sector and the importance of continuous user needs assessments in that regard. Lastly, the participants carried out the map- and model-based exercises referred to above and defined shared community objectives.

21. The map- and model-based exercises were conducted using a design thinking methodology, which facilitated communication via prototypes and the eliciting of information that would not have become visible otherwise.

B. Opening remarks

22. The meeting began with a welcome address by the Chief of the Space Applications Section of the Office for Outer Space Affairs. He highlighted the role that Earth observation activities could play in water management and recalled the importance of water for life on Earth. He spoke about the connection that water had to issues related to poverty, education and gender. Water was a cross-cutting issue within the Sustainable Development Goals. Lastly, he highlighted that there were now more possibilities to integrate in situ and satellite data, notably because more data and more data processing tools were available online.

23. A welcome address was also delivered by the Secretary-General and 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 prizes awarded had been designed to cover the whole range of water-related research topics. Nominations for the eleventh award were open until 31 December 2023, and the tenth awards ceremony would be held at the Vienna International Centre in December 2022.

24. A representative of the Office for Outer Space Affairs gave a presentation on the Space4Water Portal, which currently had around 7,000 users per month. After providing statistics on the representation of stakeholders and on the number of

resources per type of resource shared on the Portal, she provided an overview of new features, including the mapping of Space4Water actors, as well as local perspectives and case studies and the development of an interview-based podcast series for the purpose of science communication and to raise awareness of the potential of space-based technologies to address water-related issues.

C. Stakeholder presentations

25. Space4Water young professionals gave presentations on the following topics:

(a) The large-scale spatio-temporal variability of the Congo Basin surface hydrologic components from space. The presentation provided information about a validated surface water storage data set consisting of both satellite data and in situ measurements of discharge and water level. A tool was being used to make policy decisions regarding river basin management and development and to monitor climate change effects. The young professional who gave the presentation worked with the Congo Basin Water Resources Research Centre, which was also a Space4Water stakeholder;

(b) The Hierarchical Data Format for Water-related Big Geodata (HDF4Water) project. Ways to combine water-related geographical data with a new hierarchical data format (HDF5) were presented. The aim was to deliver high-quality technical guidelines and a water-based data repository that would ultimately enable deep learning techniques to be applied to the data. The advantages of the approach included compression while keeping metadata intact and multi-models of data;

(c) Research to assess the impact of compounded hydrological extremes over Eastern Africa. The research shed light on how combinations of multiple drivers such as weather, climate processes and hazards had an impact on society or the environment. For example, a heatwave followed by wildfires that caused severe economic loss in the Russian Federation resulted in increased wheat prices in Northern Africa and further ripple effects. Focusing on droughts, the research conducted by the young professional assessed change, risks and vulnerabilities and defined inputs for adaptation strategies in various sectors;

(d) Nature-based solutions for sustainable water management in watersheds through forest conservation. The presentation provided information about the potential of “green” rather than “grey” infrastructure to solve issues in a sustainable manner. For example, a nature-based solution to mitigate floods focused on the role of forestry in watersheds to increase water retention. The value of space-based data in assessing temporal and spatial changes was highlighted.

26. Space4Water stakeholders representing governments and the private sector and industry delivered presentations on various topics under their thematic focus, including the construction of a Birds-5 satellite for monitoring water, which was designed by the Zimbabwe National Geospatial and Space Agency and was launched on 7 November 2022 as the country’s first satellite.

27. The Kenya Space Agency provided information about its Earth observation programme, focusing on natural resource management, disaster management and agriculture. Examples of the Agency’s work included investigation of the causes of a 16 per cent rise in water levels in the Rift Valley lakes from 2016 to 2020, which had submerged villages and islands, and the design of projects on flood and wetland mapping, borehole mapping in arid and semi-arid areas and the design of early warning systems.

28. The Egyptian Space Agency gave a presentation on the interplay between data science and Earth observation and their potential to address water-related issues. The presentation also highlighted the Agency’s plans for missions and announced the hosting of the African Space Agency at its premises.

29. The Soil and Water Conservation Department of the government of Meghalaya, India, gave a presentation on water harvesting in Meghalaya State, which although it was the rainiest place on Earth, had started to experience water stress. The government foresaw payments for ecosystem services in order to protect catchments. Satellite data were used to monitor protected areas, map springs and tag water bodies. The government expressed its wish to cooperate on data exchange and best practices.

30. Two companies from the private sector and industry also gave presentations. The private research institute b.geos covered the monitoring of Arctic lakes, the mapping of lake ice and the measurement of gas emissions in ice using synthetic aperture radar data and multispectral remote sensing. The institute collaborated with the Austrian Polar Research Institute and international partners. Mozaika provided information regarding its development of information systems for water resource management, with interfaces designed to improve decision-making. The company automatized routine tasks with historical, satellite and geographical information system data and provided forecasts, for example in relation to river dynamics.

31. Space4Water stakeholders representing academia and intergovernmental organizations delivered presentations on various research topics and projects under their thematic focus.

32. The IHE Delft Institute for Water Education provided information on its development of Earth observation applications for climate change, on its digital portal for data[1] and on trends of data presentations. Its joint project with the Food and Agriculture Organization of the United Nations, entitled “Water productivity through open-access of remotely sensed derived data”,[2] focused on monitoring water data for purposes such as water accounting. Furthermore, the Institute offered many courses, including specific courses on remote sensing for agriculture water management.

33. The Global Gravity-based Groundwater Product, presented by the Department of Geodesy and Geoinformation of Vienna University of Technology, monitored groundwater, which comprised 33 per cent of all fresh water. Groundwater had been declared as an Essential Climate Variable by the Global Climate Observing System, but Copernicus, the Earth Observation Programme of the European Union, did not yet have a product that monitored groundwater. Two billion people depended directly on groundwater as their primary water source. Poor in situ monitoring (through boreholes) and sparse or non-existent data in many parts of the world had led to ongoing efforts to develop the Global Gravity-based Groundwater Product, with the aim of combining GRACE and GRACE-Follow On satellite gravity data with water storage data to estimate total water storage. The presentation also provided information on anthropogenic groundwater depletion hotspots and on the calculation of groundwater storage anomalies using in situ measurements. A model that provided reliable estimates in that regard had been developed.

34. The Department of Construction and Civil Engineering of the University of Zimbabwe shared information on three water management projects being conducted at the post-graduate level. These included the development of data analysis tools and projects using space-based data, notably in relation to geographical information system applications for floods and related disease outbreaks, such as cholera. Further developments would include precision farming and climate-smart agriculture applications to monitor crops and a database of small-scale reservoirs to improve water management and support local water management authorities. A geospatial dashboard on the Harare suburbs enabled users to identify leaks in the water network and take action.

35. The Environmental Systems Laboratory and the In-Service Information and Communications Technology Training for Environmental Professionals initiative of Central European University provided training at the professional level, in

[1] Available at www.eiffel4climate.eu.

[2] Available at https://wapor.apps.fao.org/home/WAPOR_2/1.

cooperation with United Nations entities, for practitioners whose work relates to water.

36. Lastly, a presentation on the assessment of water and soil resources using geospatial techniques at the watershed level in the Himalayan region of Uttarakhand State was presented by Govind Ballabh Pant University of Agriculture and Technology. The research focused on soil and water conservation technologies in northern India. Information was provided on a project called “Agrifood”, in which data on water quantity, water quality, soil erosion, carbon pools and sequestration were acquired by satellite data. Other projects carried out by the University included initiatives to monitor the watershed, study soil erosion and map water ecosystem services in mountainous areas using space-based data.

37. The representative of the Inter-American Institute for Cooperation on Agriculture, a specialized agency of the Inter-American System with 35 member States, which focused on regions where agriculture was a specific challenge, spoke about how the Institute developed digital fabrication technologies to teach end users how to create their own solutions. The representative highlighted that people living in rural areas not only had a better understanding of the problems they faced, but also a better perspective on the best solutions. Cooperation must not rely on using solutions developed in an office far away, but on involving users in developing solutions. Examples included the use of global navigation satellite system data tools to map water infrastructure in remote communities and soil moisture sensors to improve crop efficiency.

D. From water-related challenges to space-based solutions

38. The importance of addressing water-related challenges on the ground and the difficulty of getting reliable information from the ground were highlighted, and potential ways for the international community to act upon those challenges were discussed.

39. Participants were invited to play a “serious game” to analyse how water-related challenges could be addressed by space-based solutions. The Office for Outer Space Affairs provided descriptions of 34 challenges based on input collected through research and from stakeholders and professionals through the “Local perspectives and case studies” feature of the Space4Water Portal. Participants were paired up on the basis of their expertise, to ensure that they had the relevant skillset to address the challenge assigned to them.

40. The teams were asked to define the problem, develop success criteria and identify suitable technology for solving the problem, define the requirements for a service to be designed, set a time frame for the implementation of the chosen solution and recommend actors and resources, if they were aware of any. Participants delivered potential solutions to the following nine challenges, which would be added to the Space4Water Portal in the near future:[3]

(a) Challenge 5: Flooding in Pakistan caused by heavy monsoon rains, heatwaves and melting glaciers – addressed by the IHE Delft Institute for Water Education and the University of Texas at Arlington;

(b) Challenge 6: Degradation of wetland ecosystems – addressed by the Inter-American Institute for Cooperation on Agriculture and Central European University;

(c) Challenge 8: City droughts – addressed by the Kenya Space Agency and the government of Meghalaya;

[3] The identification numbers of the challenges are provided in the present report for future reference. They can be used to find information on the Space4Water Portal such as actions and space-based solutions to address a challenge of that kind.

(d) Challenge 9: Groundwater depletion – addressed by Mozaika;

(e) Challenge 12: Lowering of the groundwater table and limited information about water availability amid conflict, in combination with the refugee and famine crises in Yemen – addressed by the Egyptian Space Agency and Vienna University of Technology;

(f) Challenge 20: Soil erosion and sedimentation in Tanzania – addressed by a young professional and the Zimbabwe National Geospatial and Space Agency;

(g) Challenge 29: Compounded hydrometeorological extremes in India – addressed by the University of Zimbabwe and a young professional;

(h) Challenge 32: Lack of hydrological data exchange for better water resource management (submitted by the World Meteorological Organization) – addressed by a young professional and Govind Ballabh Pant University of Agriculture and Technology;

(i) Lastly, the Office shared a briefing on water-related challenges faced by a First Nation in Canada with b.geos.[4]

E. The Space4Water community

41. A comparison of the stakeholders represented at the meeting with current Space4Water actors showed the following:

(a) Intergovernmental organizations, which were the biggest group of stakeholders, were well represented in the context of the Space4Water community, comprising 19 of the 87 stakeholders (17 per cent). However, they were underrepresented at the meeting, with only one of the 19 international organizations present (5 per cent);

(b) Government institutions made up 13 of the 87 stakeholders (11 per cent) and were therefore underrepresented among the stakeholders. Four of the 13 government institutions (31 per cent) were represented at the meeting;

(c) Academia was well represented in the stakeholder community, comprising 21 of the 87 stakeholders (18 per cent). The group was represented at the meeting by five of those 21 stakeholders (23 per cent);

(d) The private sector and industry were well represented in the Space4Water community, comprising 20 of the 87 stakeholders (17 per cent). They included three stakeholders who indicated they wished to be represented as private research institutes and four who indicated that they were non-profit organizations. At the meeting, the private sector and industry group was represented by two of the 20 stakeholders (10 per cent);

(e) Civil society, which comprised six of the 87 stakeholders (5 per cent), was not represented at the meeting. Civil society institutions had expressed an interest in attending and had registered for the meeting; however, no funds had been available;

(f) The remaining eight stakeholders (7 per cent) did not indicate which stakeholder group they belonged to when applying to be a stakeholder of the Space4Water community. The Office will follow up with them to better reflect the actual representation of all groups at meetings.

F. Assessment of user needs in relation to the space sector

42. The session was opened by the Office for Outer Space Affairs with a short presentation on the engineering of space-based services. The importance of determining, documenting and maintaining requirements based on user needs and

[4] This challenge has no number because it was discussed on an ad hoc basis.

clarifying those requirements in a quantitative manner was highlighted. The next step was to translate user requirements into requirements for a service and, if necessary, to define the requirements for a new space mission. It was underlined that users needed to be involved from the very beginning of the design process for any new satellite mission, as part of feasibility studies, until the preliminary design had been consolidated. To ensure that the service fit the requirements, the design process must involve users and future service providers in studies and decisions on design options.

43. The IHE Delft Institute for Water Education presented the Water-ForCE project to develop a road map approach for future Copernicus-led explorations for water. The project was investigating user needs for modelling or forecasting and was identifying areas in which the Copernicus framework could be used effectively. It was also identifying gaps and defining needs in relation to the development of a European Union portfolio, taking the following questions into account:

(a) What remote sensing products could be used to assess water quality?

(b) Where in the water cycle could those products be used?

(c) Who needed such products?

(d) What problems needed to be solved?

(e) How could modelling, water accounting and other processes be carried out?

44. The above approach could improve remote sensing services from the point of view of the user. In the context of the Water-ForCE project, a literature review of academic survey results had also helped to identify gaps and provide answers on whether user requirements had been met. The need for skilled personnel and the lack of validated remote sensing data sets was highlighted.

45. The activities carried out by Space4Water stakeholders to identify user needs included the following:

(a) The Kenya Space Agency had started stakeholder mapping in order to identify user needs and areas where the Agency could provide support;

(b) The Zimbabwe National Geospatial and Space Agency had a steering committee and a technical working group responsible for implementing projects for organizations.

46. The Office for Outer Space Affairs had sent space agencies an online survey to gather information about how they assessed user needs. To date, space agencies had replied that they assessed user needs through surveys, participatory workshops and other meetings. The agencies had indicated that they had involved intergovernmental organizations, the private sector and industry, government and civil society, in various combinations. None of them had involved academia. All of them had focused on water resource management; none of them had looked at hydrology or meteorology. When asked in which areas of application they would like to know user needs, water quality ranked highest, followed by precipitation, wetlands, surface water, groundwater and evapotranspiration. A total of 43 per cent were interested in receiving user feedback on the use of Earth observation; 29 per cent were interested in receiving user feedback on satellite communication; and 14 per cent were interested in receiving user feedback on spin-off technology and satellite navigation. All agencies that had completed the survey had indicated that they would like to participate in the development of a framework for assessing the needs of users in the water sector in relation to the space sector. The Office would further distribute the survey in order to get more representative results.

G. Matching of stakeholders

47. In this session, several exercises took place to match stakeholders. The first exercise involved sharing information on the projects that a stakeholder or young

professional had been implementing in different regions of the world and drawing or pinning them on a political map and a climate map. In the second exercise, participants described the projects that they were working on and added cards displaying their logo and a QR code that linked to their profile page on the Space4Water Portal to a 3D model of the water cycle. The water cycle was also published as an interactive graphic on the Space4Water Portal.[5]

48. By using that method, participants were able to identify thematic and regional overlaps between their work. In the session on Space4Water community needs, participants highlighted that the most relevant resources for stakeholders included information on projects, initiatives, programmes and community portals and on software, webapps, tools and application programming interfaces. The exercise would enable the Office to match stakeholders through their thematic and regional focus areas, even without having detailed information on their projects.

H. Space4Water community objectives

49. Members of the Space4Water community present at the meeting indicated that the community had the following objectives:

(a) Annual in-person meetings, possibly on the margins of a larger meeting;

(b) More frequent online meetings (about two a year based on the feedback received from the meeting participants) and the potential hosting of a webinar series in which stakeholders could present aspects of their work, such as the use of space technology to address a specific water-related topic. The series could also include the presentation of good practices developed by stakeholders and professionals (see item (d) for further information);

(c) The establishment of working groups in the context of the Space4Water project;

(d) The development of training materials, such as good practices;

(e) The definition of a thematic focus for certain time frames to motivate the community to contribute under that theme (and the setting of deadlines);

(f) The addition of information on projects, initiatives, programmes and community portals and on software, webapps, tools and application programming interfaces to the Space4Water Portal as a first so-called “sprint” until the next Space4Water Stakeholder Meeting;

(g) The identification of ways to assess the needs of users in water-related sectors. Most stakeholders, professionals and young professionals who participated in the meeting were willing to use their networks and contacts to engage local actors;

(h) More frequent updates, preferably through email rather than through newsletter software, on the conferences and meetings of the Office for Outer Space Affairs (34 per cent), new features (24 per cent) and summaries of added content (41 per cent).

50. A number of participants agreed to help Indigenous communities with specific issues such as root zone soil moisture, surface water extent, land use and land cover, digital elevation models, the mapping of water change in wetlands, boreal forests and winter-travel ice, and with aerospace technologies such as satellites and uncrewed aerial vehicles. Many participants expressed an interest in being part of the jury for a hackathon.

51. Furthermore, participants committed to developing good practices on the following topics:

(a) The harmonization of satellite data time series;

[5] Available at http://space4water.org/taxonomy/term/1490.

(b) Hydrological engineering standards;

(c) Radar altimetry for measuring water level variations;

(d) The standardization of remote sensing technologies;

(e) Science communication strategies;

(f) Water harvesting and storage;

(g) Soil moisture validation practices;

(h) Watershed management;

(i) Training for rural communities;

(j) Nature-based solutions.

V. Conclusions and outlook

52. The meeting demonstrated that there was a high level of interest in developing a community that focused on the potential of space-based technology to address a wide range of water-related issues. Presentations delivered by Space4Water professionals, young professionals and stakeholders showed the complementary skillsets of this community. While the participants represented only a subset of the much larger Space4Water community, interest in future meetings had been expressed not only at the meeting but also by other community members.

53. The first Space4Water stakeholder meeting was a success, judging from both oral feedback and from the content of feedback forms. Participants gave the event a rating of 4.8 points out of 5. In particular, they had valued the interactive elements of the meeting. Participants were willing to collaborate and actively contribute content to the Portal and knowledge to the community. They had expressed a wish to hold several meetings a year, either online or in person.

54. It was recognized as highly positive that decisions on future collaboration had been taken, and expressions of interest in various Portal features were shared. Among the shared input was a decision to develop and share good practices on the use of space-based technologies for water and to match water-related challenges with space-based solutions by stakeholders on the Portal. Furthermore, it was decided to identify ways to conduct appropriate user needs assessment in the field of space-based technologies and data within water-related sectors by relying on stakeholders' local professional networks.

55. It was important to highlight that government and civil society were underrepresented in the Space4Water stakeholder community. The Office for Outer Space Affairs and the Space4Water community needed to be more proactive in inviting those groups to be part of the community and to attend meetings, in order to ensure that all stakeholder groups were represented equally.

56. The Office for Outer Space Affairs planned to hold the second stakeholder meeting in a virtual format in the second quarter of 2023 and the third meeting in person in 2023.