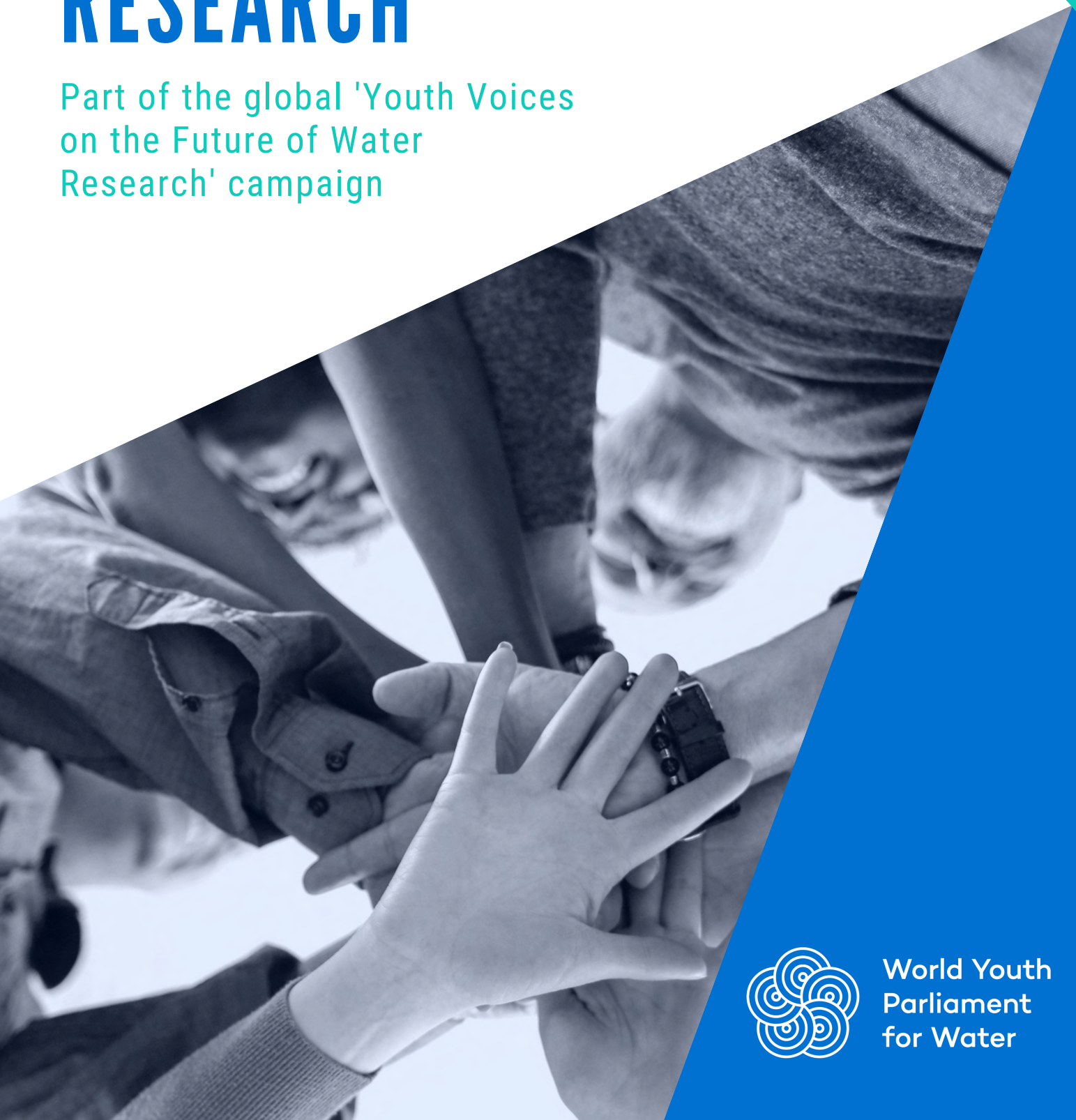
A YOUTH VISION FOR INCLUSIVE WATER RESEARCH

Part of the global 'Youth Voices on the Future of Water Research' campaign



World Youth Parliament for Water

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About the World Youth Parliament for Water

The World Youth Parliament for Water (WYPW) is a network of passionate young people from over 80 countries. We are your 'Leaders of Tomorrow,' making waves of change in the water sector. Our members take action on water issues at all levels; from concrete actions in local communities, to advocacy for youth leadership in the water sector at the United Nations General Assembly.

Learn more about WYPW at youthforwater.org

About the WYPW Research Group

The WYPW Research Group is one of several working groups within WYPW. It aims to empower young and early career researchers and to conduct and promote youth-led research related to the water sector. Its core objectives are:

- Foster collaboration between young water researchers across both geographic and disciplinary boundaries.
- Conduct original research on youth-related issues in the water sector and produce knowledge that can influence decision-making processes on multiple levels.
- Raise awareness about the scientific contributions of young and early-career researchers as well as the added value of transdisciplinary and citizen-based research approaches in the water sector.

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1 Introduction

1.1 Youth in water research

Young people play a central role in the implementation of the Agenda 2030 Sustainable Development Goals (SDGs). Following the definition of 'youth' as those below 35 years of age, they now contribute more than 55% of the global population. As such, they are major beneficiaries and partners for the implementation and monitoring of the SDGs, including SDG 6 on clean water and sanitation. A number of recent reports[1] have highlighted the value young people can add to the water sector, including building resilience in their communities and bringing diverse perspectives and fresh ideas to water discussions on various levels. At the same time, structured and meaningful youth involvement in the water sector is still limited, due to various reasons that range from the lack of widespread support to the absence of proper platforms that sustain youth participation.

Youth involvement is crucial in an era of shifting powers and realities, as they are not constrained by the boundaries of how things *'should be'* or confined by the phrase *'this is how it's always been done.'* Instead, youth have the capacity to identify and challenge existing power structures and barriers to change, and to expose contradictions and biases. Young people can and do play an important role in transforming societies. Similarly, they can be agents of change in the water sector, influencing both how we manage water systems and how we study them.

Youth can revolutionize water research. Young people can be connectors between the research community and their own local communities. They can and want to bring new ideas from research to local populations, and implement projects on the ground. Young people are also innovators, promoting a paradigm shift from approaching water research primarily in technocratic, disciplinary terms to approaching it in an interdisciplinary fashion and understanding the complexities and interconnections inherent to water. This particularly includes issues of water governance and the important role young people can play in next-generation diplomacy, including science diplomacy. And young people are, quite literally, the

[1] See for instance: Global Water Partnership (2015). *GWP Youth Engagement Strategy*. Stockholm, Sweden. Available at https://www.gwp.org/globalassets/global/about-gwp/strategic-documents/gwp_youth-strategy_web.pdf; Sundman, V., Dadvar, I. & Yaari, E. A. (2021). *Making Waves: Youth Engagement in Water Diplomacy*. Stockholm International Water Institute. Stockholm, Sweden. Available at https://siwi.org/wp-content/uploads/2021/03/siwi_working_paper_making_waves_youth_engagement_in_water_diplomacy.pdf; Vojno, N., ter Horst, R., Hussein, H., Nolden, T., Badawy, A., Goubert, A., Sharipova, B., Pedrero, F., Peters, S. & Damkjaer, S. (2022). Beyond barriers: the fluid roles young people adopt in water conflict and cooperation. *Water International*, *103*(2). Available at https://doi.org/10.1080/02508060.2021.2021481

future of water research. As a new generation of water researchers enters the profession, they will start to look for ways to implement their own visions for how water research should be conducted.

1.2 'Youth voices on the future of water research' campaign

This working paper summarizes first insights from the 'Youth voices on the future of water research' campaign by the World Youth Parliament for Water. It outlines key messages by the participating young water researchers and presents our shared vision of inclusive water research for the 9th World Water Forum in Diamniadio (Dakar), Senegal. In the first phase of the campaign, students and young water researchers from 25 countries around the world (Figure 1) shared their thoughts on the current state of water research, on challenges they face as young researchers, and on their vision for future water research.

Next to their input to the working paper, participants submitted video messages in which they shared their experiences and ideas. The videos are available online via the YouTube channel of the World Youth Parliament for Water (Box 1).

Box 1: 'Youth voices on the future of water research' video messages

Video messages from young water researchers around the world are published in a dedicated playlist on the World Youth Parliament for Water's YouTube channel at https://www.youtube.com/playlist?list=PL9BrlaSliWv8baIQgtkdaPgDHL0V_T6g6.

Submissions to the campaign remain open and new videos will be added to the playlist on a rolling basis. Students and young researchers are invited to submit their messages via the following form: https://forms.gle/KAhr2N4dNVT8AXZx8.

Video messages from the 'Youth voices on the future of water research' campaign

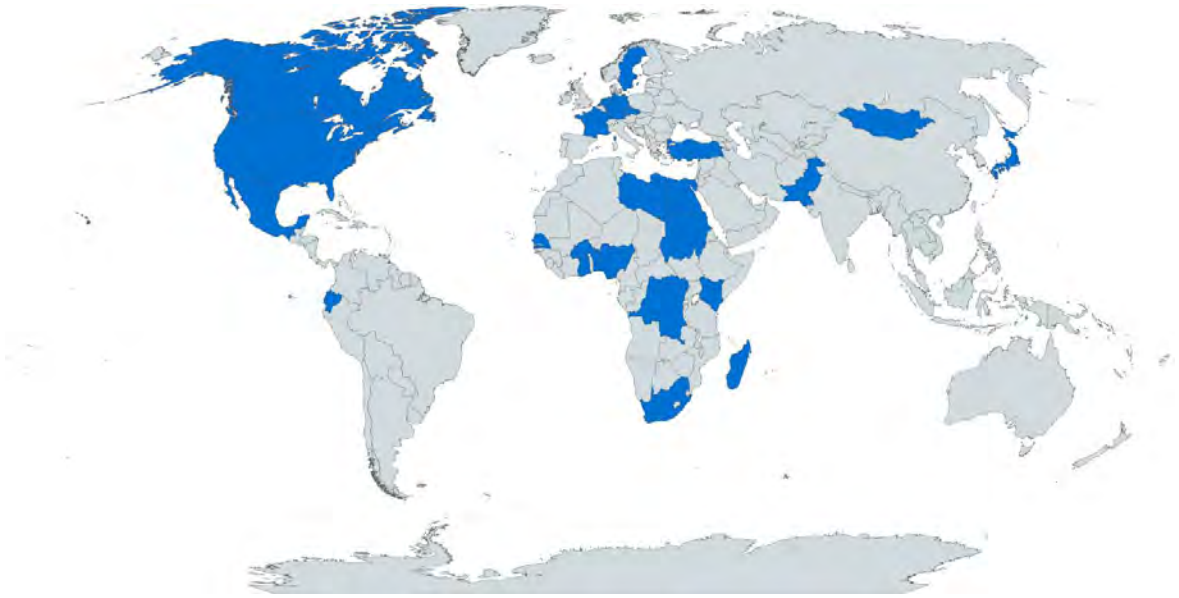

Figure 1. The countries represented within the first phase of the 'Youth voices on the future of water research' campaign.

2 Emerging water research themes

Water research covers a wide range of issues, with research priorities shifting along with global developments and new insights into water resources management. In this section, we highlight a number of research themes that were commonly mentioned as deserving of more scientific attention throughout the campaign. We explore their relevance within and beyond the water sector and the role young people might play in closing the research gaps.

2.1 Water and climate

Water is at the heart of climate change. Many climate impacts are water-related, affecting the quantity and quality of water available for human and environmental needs. These impacts are very likely to exacerbate water scarcity in areas already struggling with it, with implications for sustainable development, livelihoods, and local ecosystems. At the same time, many climate adaptation strategies depend on sound water management, both locally and regionally. While this close link between water and climate is well established[2], some significant knowledge gaps remain, limiting the adaptive capacity of certain populations.

Areas that are particularly vulnerable to climate impacts need to receive more attention in water research. The exposure to climate impacts is not homogeneous around the globe, with countries in the Global South, particularly in regions close to the equator, bearing the brunt. Some of the most vulnerable areas include small island developing states, arid and semi-arid lands, and coastal communities across the Global South. Many of these have not received much scientific attention with regards to impacts on their water resources and possible adaptation strategies in the water sector. Conflict-affected and politically unstable countries constitute another under-researched group of highly vulnerable areas. Politically instability has been linked to unsustainable water management and a sharp decline in adaptive capacity, however, more research is needed to understand causal relations and identify adaptation strategies for conflict-affected communities and forcibly displaced populations[3].

[2] UNESCO & UN-Water (2020). *United Nations World Water Development Report 2020: Water and Climate Change*. Paris, France. Available at https://www.unwater.org/publications/world-water-development-report-2020/

[3] International Committee of the Red Cross & Red Cross Red Crescent Climate Centre (2021). *Climate and conflict: Why do we need to better understand how combined climate risk and conflict situations exacerbate people's vulnerability?* The Hague, Netherlands. Available at https://www.climatecentre.org/wp-content/uploads/Climate-and-conflict-research-agenda_FINAL.pdf

"The stagnation of ocean currents due to rising ocean temperature should receive more scientific attention. These currents are vital for healthy marine ecosystems and the ocean's ability to self-clean. I contribute to research projects in this area, but we face challenges related to insufficient financial and human resources for oceanographic research due to a lack of social awareness. With these limitations, many investigations are restricted to small areas or can only focus on one locality, like the ocean floor. This makes it hard to systematically survey climate impacts on ocean currents and their consequences for marine biodiversity."

– Jin Tanaka (Japan)

Learn more about Jin Tanaka's experiences and vision for water research: https://youtu.be/9PPfvA4yNHg

Climate impacts on oceans and marine ecosystems are an important part of the conversation on water and climate. While water-related research is often understood to be focused on freshwater systems, their interactions with oceans are crucial in predicting and adapting to climate impacts. In particular, oceans play an important role in the acceleration of the hydrological cycle due to climate impacts, including, for instance, the higher occurrence of tropical storms in various parts of the world. In addition, climate impacts on marine ecosystems can have far-reaching consequences for regions in which livelihoods are dependent on fishery and other ecosystem services.

2.2 Water-energy-food nexus

The water-energy-food (WEF) nexus is one of the key interdisciplinary water research topics and central to addressing the global climate and resource scarcity crises. The intricate connections between the three sectors and their influence on each other means that focusing on only one of them without taking into account the others is no longer an effective strategy. Instead, the WEF nexus opens up potential for cross-sectoral research and the development of innovative approaches to tackling resource scarcity on different levels. In combination with global stressors like overpopulation and overconsumption, the interconnections within the nexus pose new research questions related to a range of different SDGs.

Climate change intensifies tensions within the WEF nexus. Climate impacts affect the water, energy and food sectors in myriad ways, such as changes to the demand and availability of water for irrigation and electricity production. At the same time, many climate mitigation and adaptation strategies are positioned within the WEF nexus and have

implications for all three sectors, for instance to grow crops for biofuels in order to replace fossil fuels in the energy sector. More research is needed on the implications of such strategies in the context of the WEF nexus, to balance trade-offs between sectors and to identify synergies that can provide opportunities for innovative solutions.

Research challenges associated with the WEF nexus limit its use in addressing the global climate crisis and resource scarcity on different levels. This includes the complexity of the interdependencies between the various sectors, which make it difficult to fully comprehend and model WEF nexus dynamics. The lack of suitable data across the sectors on the different levels additionally poses a challenge to the applicability of potential solutions[4]. Opportunities to address these challenges can be found in inter- and transdisciplinary research approaches that aim at the collaboration across sectors and with stakeholders outside of the scientific community, for instance to close data gaps in public monitoring systems. WEF nexus insights can also be integrated in projects outside of the research sphere, with practical applications including, for instance, new architectural and urban projects that utilize green and clean technologies.

2.3 Groundwater

Groundwater is a crucial water source in many areas around the world, necessitating close monitoring of resource extraction and availability to ensure sustainable use. It is a particularly important resource in arid and semi-arid regions where surface water availability is limited. While groundwater consumption is rapidly increasing with population growth in many urban areas of the world, climate change is imposing additional stress on local water resources. Analyses on how groundwater storage may change in response to both climate-driven and anthropogenic effects is therefore crucial. New technology-driven approaches to detect, monitor, model and simulate groundwater movement and quality can support the quest for better understanding and visualization of these complex resource systems. There is also the need to deepen studies into groundwater pollution, and work towards coordinated research in soil and surface water pollution, and on the diversity and dynamics of contaminants over time. This will enable researchers to effectively develop workable remediation measures and to prevent the underlying health risks linked to water pollution.

Groundwater-related research must go beyond hydrogeology to include questions of resource and data governance. A paradigm shift from approaching groundwater research only in terms of hydrogeology towards an interdisciplinary approach is required. This particularly includes more research on transboundary aquifers. Where data gaps present barriers to evidence-based groundwater management, those gaps not only need to be closed by producing the required data, but robust monitoring and data storage structures need to be put in place to avoid future issues.

[4] Scott, M. & Larkin, A. (2019). Geography and the water–energy–food nexus: Introduction. *The Geographical Journal*, *185*(4), 373–376. Available at https://doi.org/10.1111/geoj.12331

2.4 Technological innovation in the water sector

Recent technological advancements provide new opportunities for more efficient and inclusive water management. Big-data-related applications, including machine learning and predictive modeling approaches, can be useful in optimizing water service provision and water treatment processes. Box 2 presents current research on the contributions of blockchain technology in urban water supply, supporting not just monitoring operations, but also transparency and trust-building between consumers and utility. The potential of different new technologies throughout the water sector needs to be more thoroughly assessed within the field of hydro-informatics and beyond.

Further development of existing technologies provides an increased potential for community-led water management. Progress on small-scale applications for wastewater treatment or desalination allows for decentralized or independent water systems that are more resilient against external shocks than large-scale, centralized facilities. Advances in geographic information systems (GIS) software, particularly related to cloud-based applications, can additionally support more extensive participatory mapping processes, for

Box 2: Strengthening systems-based leak prevention in Ciudad de México through blockchain

This research project at the University of Texas at Austin explores novel opportunities to utilize blockchain to strengthen trust and harmonize efforts between the various stakeholders that are involved in maintaining Mexico City's piped water infrastructure through validated water distribution data. By facilitating an integrative approach to leak prevention, the project seeks to mitigate the 40% of Mexico City's water that is lost through leaks along thousands of miles of pipes transporting water from source to end-user, contributing to the water scarcity issues the city and its 21 million inhabitants face. In particular, the project explores opportunities to use smart contracts to streamline operations and maintenance, facilitate financing through green bonds, improve customer billing, and increase transparency. This addresses an under-researched theme in water that acknowledges that technology alone cannot replace the need for effective, accountable, and adequately funded institutions to operationalize the insights gained from smart infrastructure. The research also seeks to expand on how technology can work in tandem with institutional reform to strengthen enabling environments for sustainable water service delivery – bridging gaps between the potential of technology and capacity of the stakeholders that utilize it.

Learn more about this project via Water Science Policy[a] and in the WYPW publication 'Innovation for Water: Youth Perspectives on Technological Advances in the Water Sector'[b].

[a] Patel, N. & Truong, H. (2021). Strengthening systems-based leak prevention in Ciudad de México through blockchain. *Water Science Policy*. Available at https://watersciencepolicy.com/article/strengthening-systemsbased-leak-prevention-in-ciudad-de-mxico-through-blockchain--1091c7aab398?language=English

[b] Gautam, A., Khorchani, N., Patel, N., Suliman, M. M. & Truong, H. (2021). *Innovation for Water: Youth Perspectives on Technological Advances in the Water Sector.* World Youth Parliament for Water. Available at https://youthforwater.org/app/uploads/2021/05/WYPW_Innovation-for-Water_GA-2021.pdf

example in disaster risk assessment. However, to fully realize the potential of such technologies for community empowerment, appropriate governance structures need to be developed and put in place. Research at the interface of water-related policy and technology can support these processes.

At the same time, technological advancements have also presented new challenges to the water sector which are not yet fully understood. The increasing reliance on comprehensive supervisory control and data acquisition (SCADA) software and other information technology in water service provision presents new cybersecurity risks for water facilities, particularly in highly industrialized areas. New materials and chemical compounds, such as materials in nanotechnology, are often not sufficiently analyzed with regards to their potential negative effects on terrestrial and aquatic ecosystems, and are difficult to detect in water bodies due to their size and low concentration. Better monitoring systems are needed to reliably assess environmental impacts.

2.5 Governance barriers to innovative and participatory water management

Water governance is a prominent field of research, as recognition grows that many water crises are attributable primarily to governance failures rather than resource scarcity. Recognizing, measuring and expressing water's various values, and incorporating them into decision-making, are fundamental to achieving sustainable and equitable water resources management. The resulting transformation of governance structures in the water sector and the inclusion of new models for policy and practice has been shown to cut directly to the heart of many persistent challenges being experienced in the sector.

Governance structures need to be developed in such a way as to break down institutional barriers for innovative technologies and water management concepts. This includes ensuring that innovation receives the necessary support, from the research and development phase until the eventual long-term implementation. Innovative technologies and concepts for water and wastewater systems already exist, but they have been mostly implemented as pilot projects so far, mainly as a result of the institutional barriers they face. Such barriers include the common fragmentation of administrative responsibility around water and sanitation in the absence of integrated management approaches, and financial considerations regarding initial investments and long-term costs that affect the affordability of water services through new technologies[5]. Targeted research on the governance requirements for the effective and efficient implementation of innovative water management strategies, as well as on the needs and resources of targeted communities, can help close the gap between innovation and policy-making and identify opportunities for participatory water management.

Participatory water management structures need to ensure active and meaningful community participation. The inclusion of groups that have historically been marginalized

[5] Cipolletta, G., Ozbayram, E. G., Eusebi, A. L., Akyol, Ç., Malamis, S., Mino, E. & Fatone, F. (2021). Policy and legislative barriers to close water-related loops in innovative small water and wastewater systems in Europe: A critical analysis. *Journal of Cleaner Production*, *288*(15). Available at https://doi.org/10.1016/j.jclepro.2020.125604

in the water sector, such as women and youth, is of particular importance. These groups face unique challenges in their access to water that need to be taken into account in water-related decision-making and management strategies. Further research into such challenges will support the development of appropriate management and governance structures.

3. Challenges faced by young researchers

While young researchers are eager to contribute to our knowledge on water, they also face challenges that limit their ability to become productive members of the scientific community. We discuss key challenges in this section, along with potential solutions that can improve the position and capacity of young researchers worldwide. Although we specifically focus on water research in this working paper, many of these challenges are experienced by young researchers in other fields as well.

Throughout this section, it will become clear that these challenges disproportionally affect young researchers in the Global South. What is considered 'good academic practice' in scientific research has historically been determined by research institutions in the Global

"Throughout history, women's work in science has often been in support of, and then eclipsed by, the work of a more visible man. For decades, women have faced a gender bias – some on an almost daily basis – from others in their field. Being a woman in science, especially in an area that is more physics-oriented where men are more dominant, has been very difficult. I constantly have to prove myself to show that I am just as capable, if not more, as a woman in science. The effective participation of a more diverse set of actors can greatly influence and improve the outcome of water governance, however, individuals or groups from indigenous communities, women, and youth groups are often not included, not considered 'relevant,' or for other reasons impeded from participating in relevant decision-making processes."

– Mendy Shozi (South Africa)

Learn more about Mendy Shozi's experiences and vision for water research: https://youtu.be/aN1nGDM_lBk

North. In combination with wider socio-economic global inequalities, this puts young researchers in the Global South at an inherent disadvantage compared to their peers in the Global North. Young women often face additional challenges, particularly in patriarchal societies and when trying to enter predominantly technical research fields. While the amount of young female researchers in these fields is cause for hope for the future, there is a stark lack of female role models and mentors for them to work with and learn from.

3.1 Availability and access to water data

Water-related data is a prerequisite for research that can lead to better understanding and management of water. While in theory, there are many sources of water-related data, including official hydrological measurements, earth observation data and model simulations, as well as data collected by water authorities, utilities and private businesses, the global availability of water data has worsened, particularly in countries of the Global South. After a peak in the reporting of hydrological data during the last decades of the 20th century, only 83 countries are currently publicly reporting data on water quality and only 40 countries on streamflow. The availability of data related to socio-economic and environmental uses of water is equally limited, due to a lack of systematic collection, compilation, and analysis[6]. These growing water data gaps undermine the ability of all scientists to conduct high-quality research.

The lack of open-access water data particularly affects young researchers and those without institutional affiliation. Access to high-quality water data is often only available via expensive subscriptions with private data companies. Such paywalls limit data access for researchers without affiliation to a research institution that is already subscribed to the required service or to a project with sufficient funds to afford the subscription. Once again, this particularly affects young researchers and researchers from the Global South, who usually have less funding support in their work. Limitations to data access restrict young people's opportunities for practical, project-based learning and research[7].

Where data is available, the quality and accuracy of the data is not always clear. Platforms like the FAO's AQUASTAT database[8] play an important role in making as much water data available and accessible as possible. However, they also show the challenges inherent in water data management – data collection and sharing are not standardized, monitoring protocols by different authorities are not always clear, and measurement periods are often disrupted for various reasons, leaving data gaps in the timeline. Measurements of the same data published by different organizations can differ, drawing into question the accuracy of both datasets. In the absence of clear standards related to the collection and provision of water data, young researchers need to be trained to critically assess the quality and accuracy of data provided by third parties for their research projects.

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[6] UNESCO & UN-Water (2021). *United Nations World Water Development Report 2021: Valuing Water*. Paris, France. Available at https://www.unwater.org/publications/un-world-water-development-report-2021/

[7] Davids, J. (2019). *Mobilizing Young Researchers, Citizen Scientists, and Mobile Technology to Close Water Data Gaps: Methods Development and Initial Results in the Kathmandu Valley, Nepal.* PhD dissertation. Delft University of Technology, Delft, Netherlands. Available at https://doi.org/10.4233/uuid:9d6f4c39-2439-46cc-bf1a-ba42674bd101

[8] https://www.fao.org/aquastat/en/

3.2 Funding for youth-led research

Access to funding is one of the main challenges faced by young researchers around the globe. Funding agencies are more far likely to fund projects led by senior researchers than by young ones. In many cases, it is even required that a senior researcher leads the proposed project and submits the funding application. On the one hand, it is understandable to prefer research experience and publication records when considering which projects to fund. On the other hand, this practice restricts access to funding for young researchers without support by more established colleagues and limits the independence of young researchers to pursue innovative research projects in general. According to the Global Young Academy, lack of funding opportunities and research grants is widespread across the Middle East and Africa, where around 70% of the young researchers face this challenge. The Americas, Asia, and Europe followed in the assessment with 67%, 62%, and 54% of young researchers, respectively[9]. Far more than half of the world's young researchers thus struggle to access research funds. This calls for serious action to support and provide them with the needed resources.

Small grants tailored to young researchers and student-led projects could help break down funding barriers. Youth-led research projects are often small-scale studies, focused on a specific community or the application of a certain new technology. Such projects can be made possible with relatively small amounts of funding, which constitutes a low barrier and low risk for both funding agencies and the young researchers themselves. Lately, more funding opportunities along these lines have become available specifically dedicated for young researchers. However, there is still a long way to go until these funding mechanisms are widespread enough to systematically support youth-led innovative research.

3.3 Getting published as a young scientist

Scientific publications are used as a key performance indicator within academia. Getting their work published in reputable scientific journals is therefore important for students and young researchers who want to pursue an academic career. Master theses or term papers are common starting points for students looking to draft their first scientific article. However, the publication process is often challenging, particularly for students and young researchers in the Global South. As a consequence, the scientific community is missing out on the work and perspectives of many young scholars.

Researchers from the Global South of all ages experience limitations to their ability to publish in high-impact journals. A recent analysis[10] of the leading climate science articles between 2016 and 2020 found that authors were overwhelmingly affiliated with universities and other research institutes in the Global North. Barriers to publishing encountered in the Global South that were cited in the analysis include the lack of funding for large-scale, innovative research projects that qualify for publication in high-impact journals, the lack of training opportunities to practice academic writing or English language skills, particularly in

[9] Friesenhahn, I. & Beaudry, C. (2014). *The Global State of Young Scientists – Project Report and Recommendations*. Global Young Academy. Berlin, Germany. Available at https://www.interacademies.org/sites/default/files/publication/gya-glosys-report-webversion.pdf

[10] Tandon, A. (2021). Analysis: The lack of diversity in climate-science research. *Carbon Brief*. Available at https://www.carbonbrief.org/analysis-the-lack-of-diversity-in-climate-science-research

Box 3: Meliora Student Sustainability Journal – Getting published as an undergrad or master student

Undergraduate and taught postgraduate degrees require commitment, time, and in general a lot of hard work. Much of the research submitted as coursework by students as part of their degrees is of excellent scientific quality and contributes to sustainability research that goes towards changing the world for the better. So why is more of it not published? And how can students go about promoting their efforts?

Meliora International Journal of Student Sustainability Research is an open access academic journal helping to fill this niche by offering publication of student's independent research work in the broad sphere of sustainability. A diverse range of articles are published in order to reflect the interdisciplinary nature of sustainability, incorporating perspectives of a social, cultural, economic, or environmental dimension. Submissions of research papers that cut across traditional academic boundaries are welcome, but equally considered are articles that focus clearly on one defined or niche subject area.

Professor Simon Kemp (University of Southampton, UK) is the founder of this venture, with a strong belief that student research is just as important as that of academics. Apart from himself, the journal is run solely by student ambassadors, and applications for new submissions are always open. He named this journal Meliora, from the Latin translation 'for the pursuit of the better', in the knowledge that students should be not just the voices of tomorrow, but also today.

Learn more about Meliora on their website: https://meliora.soton.ac.uk

The student speakers and journal ambassadors of the Meliora 2019 International Sustainability Symposium, showcasing the wide range of SDGs covered in student research. Photo Credit: Simon Kemp.

countries where English is not commonly spoken, and the publication costs charged by high-profile journals, particularly for open access publications. Indeed, open access journals have recently been found to show a lower geographic diversity due to their high article processing charges[11]. These factors create significant obstacles for researchers in the Global South, often forcing them to publish in low-profile journals, and limiting the visibility of their work within the scientific community.

Universities need to offer support to students and young researchers who want to take their first steps into an academic career. This includes skill-building programs related to academic publishing, covering the publication process, journal selection, and academic writing skills. Language editing services provided by universities can additionally support students in writing their first publications in a second language, often English. Dedicated student journals, like Meliora (Box 3), can offer students a platform to publish their first academic works in a supportive environment, providing constructive reviews and mentorship.

3.4 Participation in the international scientific exchange

International scientific exchange is critical in solving current and future water challenges. Cross-border collaboration and knowledge exchange is an important tool to identify opportunities for joint learning and test the applicability of established approaches in new contexts. This includes the involvement of local researchers and research institutions in studies on their countries, particularly in the Global South, in order to empower them to represent their own countries and work within the international scientific community, which is currently still heavily biased towards research done at universities in the Global North.

Access to this international exchange for young researchers and students remains limited. Opportunities are often connected to the young person's institutional affiliation, including ongoing research projects and memberships in international research consortia, as well as mentorship opportunities by senior researchers within the same university. For students or young researchers at less well-connected universities, particularly in the Global South, these opportunities are scarce. Young people without university affiliation often struggle even more to connect with established researchers or research groups, sometimes for reasons as mundane as not having an institutional email address for electronic communication.

Senior researchers have a responsibility to actively welcome young people to the scientific community and support them in engaging in the international exchange. By mentoring and including younger generations in their ongoing research, senior researchers ensure the future of their own lines of research. However, such efforts cannot only be focused on their own institutions. Instead, mentorship programs need to be open to young researchers from around the world, and senior researchers need to keep an open mind to taking on mentees from outside of their narrowly defined institutional supervision mandates.

[11] Smith, A. C., Merz, L., Borden, J. B., Gulick, C. K., Kshirsagar, A. R. & Bruna, E. M. (2022). Assessing the effect of article processing charges on the geographic diversity of authors using Elsevier's "Mirror Journal" system. *Quantitative Science Studies*, *2*(4), 1123–1143. Available at https://doi.org/10.1162/qss_a_00157

“The future of water research is in our hands, but sadly we do not receive a lot of support to advance our own research, neither in terms of mentorship, nor in terms of funding. Many senior researchers are too pre-occupied with their own work to take the time to mentor young scientists. I am a passionate researcher, but I have been forced to use online learning and personal funds to maintain this ambition and continue my own research independently. Lack of mentorship obstructs growth in young scientists and keeps us from building the competences we need to contribute to high-level publications and secure substantive grants for future work.”

– Esther Maina (Kenya)

Learn more about Esther Maina’s experiences and vision for water research: https://youtu.be/cW4lR4h98Hw

4. Towards inclusive water research

Throughout our campaign, students and young researchers around the world called for more inclusive and participatory research in collaboration with local communities. In this section, we outline three key areas of action to support this transition, changing how we design, conduct and communicate about water research projects.

4.1 Shift towards transdisciplinarity

Water research often takes place across and between traditional disciplines. An interdisciplinary approach to water research has long been considered indispensable for understanding the multifaceted issues surrounding water. However, water knowledge exists beyond the scientific community, necessitating the participation of stakeholders and citizens in water research and management. Transdisciplinary research approaches support the inclusion of multiple forms of knowledge and the associated stakeholders in scientific research, and aim to address societal problems as they are experienced by non-academic stakeholders. Transdisciplinarity allows challenges to be framed and viable solutions to be found with broad and equal contribution by all the stakeholders.

Transdisciplinary research is particularly relevant for the study of complex issues related to sustainable development, including water. Researchers from different disciplines work together with societal actors in a collaborative learning experience to co-produce knowledge and solve complex socio-ecological problems[12]. It is crucial to actively involve stakeholders from relevant sectors in all stages of transdisciplinary research, starting from the problem definition to the knowledge production itself up to the application of research results to solve real-life problems. Next to the inclusive nature of transdisciplinary research approaches, they thus also allow a more practical and problem-driven perspective to real-world challenges and complexities[13].

[12] Hirsch Hadorn, G., Bradley, D., Pohl, C., Rist, S. & Wiesmann, U. (2006). Implications of transdisciplinarity for sustainability research. *Ecological Economics*, *60*(1), 119–128. Available at https://doi.org/10.1016/j.ecolecon.2005.12.002

[13] Özerol, G., Schillinger, J. & Abu-Madi, M. (2018). Transdisciplinary Research and Development Cooperation: Insights from the First Phase of the Palestinian-Dutch Academic Cooperation Programme on Water. *Water*, *10*(10). Available at https://doi.org/10.3390/w10101449

Box 4: drinkPani – participatory water supply and quality monitoring

Adequate water quality in drinking water supply is a global challenge, with numerous adverse health impacts. In Nepal, about 80% of prevalent communicable diseases are due to poor sanitation and lack of access to water of sufficient quality. At the same time, there is no proper data available on water quality. Studies have explored the potential of including water, sanitation, and hygiene (WASH) practices in schools and possibilities of involving schools in 'Water Safety Plan' programs, but systematic methods and models to integrate students or youth and information and communication technologies (ICTs) in drinking water quality monitoring are yet unexplored.

The 'drinkPani' initiative aims to enhance drinking water security using a youth-led participatory approach in a pilot study area in Pokhara Metropolitan City (PMC), Nepal. It is based on doctoral research intends to bridge the gap between water utilities and communities in the information flow on water supply and water quality, with youth as key actors and using ICTs as the main tool. The initiative follow the Iterative Design Cycle (TMPI: Think, Make, Play, and Improvise) and has launched its own app and website, which reflects the continuous iteration process up to this point[a]. drinkPani is planning to upscale its model and activities in the foreseeable future, to further advance participatory water supply and quality monitoring and assist policy makers with evidence-based decision-making.

Learn more about drinkPani in the WYPW publication 'Innovation for Water: Youth Perspectives on Technological Advances in the Water Sector'[b] and on their website: https://www.drinkpani.net/

Students receiving intensive training in the field, July-August 2019, Lekhnath-Pokhara, Nepal

[a] drinkPani. (2020). *drinkPani: Youth-led Participatory Sensing Model to enhance drinking water security, Nepal CaseStudy* [Video]. YouTube. Available at https://www.youtube.com/watch?v=ir-inn2rlC0

[b] Gautam, A., Khorchani, N., Patel, N., Suliman, M. M. & Truong, H. (2021). *Innovation for Water: Youth Perspectives on Technological Advances in the Water Sector.* World Youth Parliament for Water. Available at https://youthforwater.org/app/uploads/2021/05/WYPW_Innovation-for-Water_GA-2021.pdf

4.2 Participatory water knowledge production

Water knowledge originates from many sources, from local traditions to modern technology. Throughout history, societies decided on the ways of managing the water resources available to them, and passed on their knowledge and practices to following generations. Many communities, particularly among indigenous peoples around the world, still use such traditional practices to maintain sustainable water management. Understanding their traditions and considering their local knowledge can provide valuable perspectives next to quantitative water data collected by modern monitoring systems[14]. It also opens up spaces for the involvement of local communities in water-related research processes and decision-making.

Citizen science approaches further strengthen the role of communities in knowledge production. Citizen science refers to active public participation in the process of research to generate science-based knowledge, from setting the research agenda by asking research questions, to collecting data or analyzing the results[15]. Recent technological developments have particularly opened up spaces for citizen science in data collection, allowing laypeople to gather and report local water data via their smartphones and other distributed technologies. In this way, citizen science contributes to closing water data gaps, related both to the observation of water resources and ecosystem health and to the monitoring of water service provision. Including local populations in the knowledge production also increases the transparency and trust in local water data. At the same time, standard guidelines and structured local capacity development programs are important to implement ahead of citizen science projects, in order to ensure the quality and accuracy of the reported data. Youth can play a key role in facilitating and leading such programs within their communities. Box 4 provides an example of a youth-led citizen science project that mobilizes school children to monitor water quality in their communities in Nepal.

4.3 Science communication

Science communication is a critical tool for inclusive research and evidence-based decision-making. Communicating research processes and results to the broader public supports the uptake of new knowledge in society and policy processes by making this knowledge available and accessible for laypeople. In addition, science communication allows the public to engage with the scientific community, shows the added societal value of research projects, and can create transparency regarding the use of public funds in research. Given these important aspects, science communication needs to be recognized as part of a researcher's basic set of tasks. Research institutions should allocate time and funds for researchers to engage with communication and outreach activities, and provide relevant skill-building opportunities.

[14] UNESCO & UN-Water (2021). *United Nations World Water Development Report 2021: Valuing Water*. Paris, France. Available at https://www.unwater.org/publications/un-world-water-development-report-2021/

[15] Brouwer, S., van der Wielen, P., Schriks, M., Claassen, M. & Frijns, J. (2018). Public Participation in Science: The Future and Value of Citizen Science in the Drinking Water Research. *Water*, *10*(3). Available at https://doi.org/10.3390/w10030284

The media landscape has fundamentally changed over the past few decades, with new opportunities for science communication. The widespread use of social media networks and online news outlets has lowered the barriers for science communication. Instead of having to rely on traditional media outlets and relationships with established journalists, researchers are able to communicate about their work more directly. A range of blogs and online magazines specialized in various water-related topics, such as the 'Water Science Policy' platform (Box 5), are nowadays available to promote new research results to specific target groups. Young researchers play an important role in this revolution of science communication, as they enter the scientific career path with a new set of digital and media skills built growing up in the 21st century.

As researchers get to take a more active role in communicating about their work, they also need to be aware of the responsibilities related to it. Maintaining a balance between the clarity and necessary simplicity of the communication on one side and the accuracy of the information provided on the other is a key challenge in science communication. Again, training programs can help researchers to build the required skills.

Box 5: Water Science Policy

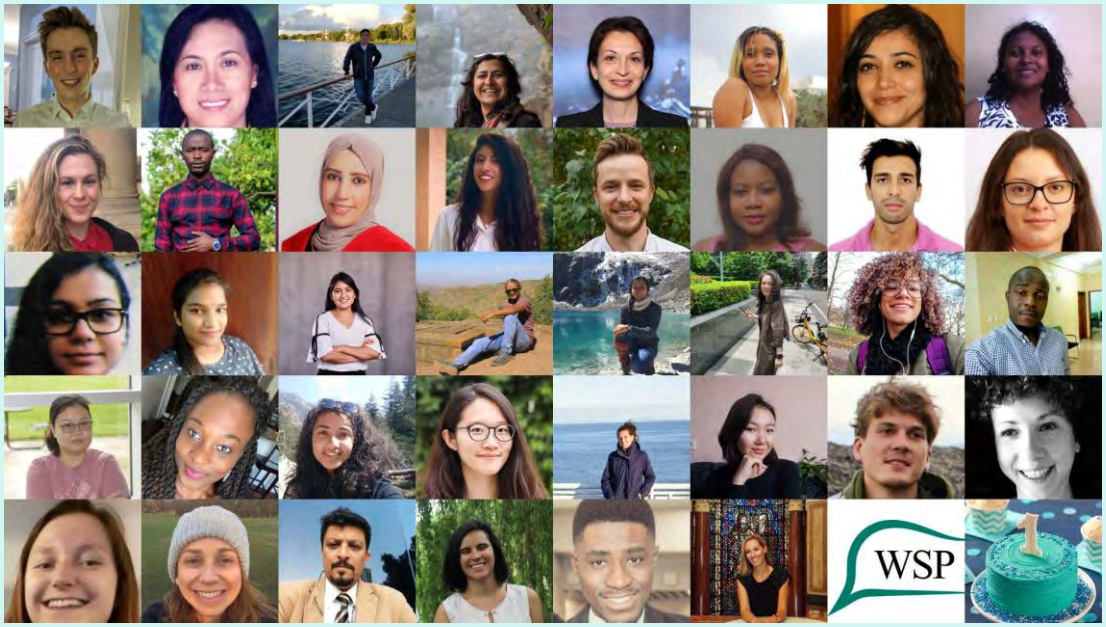
Water Science Policy (WSP) is a global, multilingual platform delivering original and multilingual content around water to a global audience. It offers a broad range of views about the most fundamental element of life at the intersection of the economy, climate, health, nature and society's issues.

Founded in May 2020 as non-profit organization and non-governmental organization by a graduate cohort of the University of Oxford's School of Geography and the Environment, WSP now comprises over 100 volunteers from more than 25 different countries. WSP publishes and translates original articles into more than a dozen languages, and produces educational and engaging photostories, videos and interactives.

WSP's goal is to ensure that the public – regardless of their financial or technical resources – can access thought-provoking analyses to form their own opinions about the biggest water and sanitation challenges and opportunities the world faces today. As a general rule, everyone can publish on WSP, from academics to journalists and laypeople. All content on the website is shareable and reusable under the Creative Commons License C BY-NC 4.0.

Water Science Policy strives to build meaningful partnerships and projects, and this regard has collaborated with the United Nations Educational, Scientific and Cultural Organization (UNESCO), supporting their call to action to accelerate gender equality in the water domain[a], with 360info to produce an interactive scrolling experience, highlighting the story of the Mekong river ('arteries.blue')[b], and with the International Water Resources Association, the Global Water Partnership, 360info and the World Photography Organisation to host a Groundwater Photostory competition[c].

Learn more about Water Science Policy on their website: https://watersciencepolicy.com/



The Water Science Policy team

[a] https://watersciencepolicy.com/impact/UNESCO-world-water-assessment-programme-2021
[b] https://arteries.blue/
[c] https://watersciencepolicy.com/impact/groundwater-photostory-competition

5. A youth vision for water research

Students and young researchers from around the world shared their perspectives on current research, and their hopes and ideas for the future. Based on their input, we imagine future water research as an inclusive process, conducted by a diverse community of scientists and other stakeholders. **Our shared vision of inclusive water research is based on three pillars:**

- **Participatory:** Participatory research is close to the communities it concerns, addressing priority issues brought forward by local populations. It embraces the principles of transdisciplinarity and provides opportunities for active involvement throughout the research process, from the problem definition over data collection and knowledge production to the dissemination and practical application of research results. Throughout the process, participatory research ensures that there is equal opportunity for participation for all stakeholders, irrespective of age, gender, disability, education, or socio-economic background.
- **Open access:** Research and research results need to be open access. This includes sharing research data and making publications freely available to the broader public. Science communication plays an important role in ensuring that research is not only accessible, but also understandable for the communities it concerns.
  The scientific community needs to be 'open access' as well, free of barriers that limit the access for young researchers from around the world. Diversity among researchers is a key asset in solving current and future water challenges; and academic structures need to be transformed to actively support this diversity.
- **Future-oriented:** Future-oriented research is acutely aware of current and future challenges, like climate-related stresses in the water sector. It acknowledges the complexity and dynamic nature of socio-ecological interactions surrounding water, and its interlinkages with other sectors such as food and energy. Future-oriented research also takes note of future opportunities that can advance our understanding of water and offer practical solutions, for instance related to technological advancements.

Water is at the heart of climate action and sustainable development. Water research is therefore in a prime position to address pressing societal issues in communities around the world. As young researchers and future leaders of the scientific community, we are ready to work on these challenges, together with our colleagues from around the world.

6. Turning water research into action

Water research is one of the most crucial types of research, due to its significance across all disciplines. Academia, water industries, and policymakers have conducted an enormous amount of research, including recognizing a great pool of innovative sustainable solutions, especially by young professionals. However, implementation of these solutions generated through research is either ineffective or not taking place at all. Various aspects of research and challenges encountered during some stages of implementation have hindered effective outcomes. Some of these challenges are:

- Ongoing discussions within the sector on whether research should guide policy development or research come after policy development;
- Lack of inclusion of all stakeholders, especially local communities (beneficiaries), during research and pilot studies;
- Inadequate practical research adoption in academic curricula as research in academia does not always produce actionable knowledge;
- Ineffective and unsustainable knowledge transfer at grassroots level, including lack of monitoring and evaluation of capacity building practices during implementation phases;
- Poor data quality and outdated information found in research results, which are seldom validated before project implementation, and the exclusion of indigenous knowledge during research and information validation;
- Contextualization of educational research findings and scale of research which often lead to misinterpretations, policy contradictions, or difficulties in understanding the findings at a very localized scale, making it much harder to transfer results into practice, especially for young professionals.

Noting the above challenges and more; building a more sustainable, innovative, and inclusive water sector that can effectively turn water research into action will require collaboration among all stakeholders, while simultaneously prioritizing young professionals and local communities across all phases of research and the stages of planning, design, implementation, monitoring, and evaluation of the various practices. In addition, turning water research into practice requires ensuring that research brings societal impact to the community and for the end-users to understand the social context. In simple terms, laypeople language is key for science communication.

Funding for water research should focus more on funding research aimed at solving real-life problems and not only research for publications. The issue further requires researchers to shift from academic mindsets to conducting more impact-driven research approaches and ensure intergenerational knowledge transfer in academia and industry. Most importantly, entrepreneurship hubs should be created in universities to provide capacity-building

platforms for young innovators and researchers on how to create social businesses from their research findings. These entrepreneurship hubs will help create more growth within the sector, facilitate the co-designing of research studies and implementation of outcomes, and the creation of sustainable businesses from research. Also, policies compelling government industries to set up research and development departments that are funded by a percentage of the industry's profit need to be formulated. This will promote the contextualization of research and nurture a political will to continue to improve industry practice through research.

All stakeholders in the value chain of the water and sanitation sector need to make accountability a priority, to develop and ensure a transparent and sustainable relationship between funders, researchers, industry, and end-users. Likewise, young professionals need to be recognized and engaged as leaders in sustainable development, as they are more interconnected, digitally inclined, and well-positioned to accelerate the growth of the water sector.

World Youth Parliament for Water

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