Water security and climate change adaptation as local challenges with global importance – addressing the gap between knowledge generation and best practice application

Content

Background

Climate Change

Mitigation and adaptation are both essential and inseparable in creating effective countermeasures to the climate crisis. However, they are fundamentally different in their characteristics, which need to be considered when designing and implementing policy and action:

Mitigation

- Global and anticipatory approaches are necessary
- Although immediate action is needed (actually already for decades), there is no immediate visible or direct tangible effect of such action
- The systemic response is temporally (and to some extent also spatially) decoupled from the operating entities, resulting in the risk of missing responsibilities (especially when decision-making processes are bound to usual legislative periods which are significantly shorter than the timeframe needed to comprehend the complete causality of climate change mitigation)
- But successful mitigating action is necessary to enable mid- to the long-term success of adaptation measures and to avoid maladaptation

Adaptation

- Locally relevant and short- and medium-term adaptive solutions are urgently needed (especially in the Global South)
- Immediate action, if successful, often results in tangible effects for short- or medium-term relief
- By more direct causality, social acceptance and political implementation potential in the usual election cycles is more probable; not least because economic consequences can be perceived in the short- to medium-term
- Effective adaptation is the requirement to enable lagging mitigation measures to become effective

Academia must play a crucial role in further addressing the gap between knowledge generation and best practice application.

Water Security

With 80% of the world's population already experiencing threats to water security (water quantity and water quality) according adaptation measures in all affected sectors (Fig. 1) are crucial. Especially coastal areas are at risk of more intense flooding and the contamination of freshwater sources from sea level rise and saltwater intrusion.[1]

[1] Synthesis Report of the IPCC 6th Assessment Report (AR6), 2023 https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_LongerReport.pdf

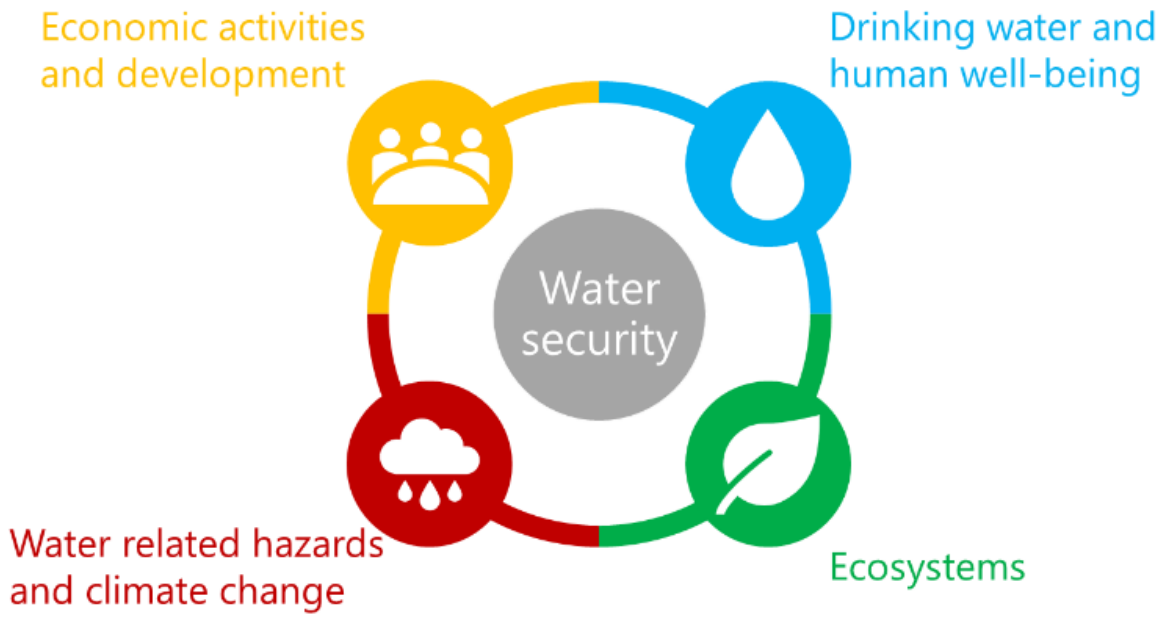

Figure 1. Water security dimensions based on the UN definition.[2]

Chances in Multilateral Cooperation

Whereas the impact of extreme weather events especially in the tropics is comparatively well known and described[3], also in Europe the frequency and magnitude are significantly increasing and the consequences are seen and felt[4]. Two devastating examples from the same year of 2021 are the floodings in Chennai (India) and the Ahr Valley (Germany).

Initiatives exemplify that multilateral academic exchange projects (Box 1) may overcome existing barriers like limited transfer of effective solutions by joint development and dissemination of adaptation measures. Hence, approaches should incorporate:

- transferability of the results to comparable regions
- support and promotion of collaborative efforts among the relevant stakeholders in the participating countries
- cooperation between science and industry
- dissemination of innovative environmental technologies among participating countries

Box 1.

The Global Water and Climate Adaptation Centre (ABCD-Centre) deals with climate adaptation measures in the Global South, especially in the water sector. It connects leading institutions of research and higher education in its partner countries (Germany, India, Thailand) to stakeholders from the water sector, national policy, and the UN system, and aims to establish a global model for the advancement of climate adaptation through dialogue and knowledge transfer between academia, society, and policy.

https://abcd-centre.org

[2] UN-Water. Water Security and the Global Water Agenda: A UN-Water Analytical Brief; UNU-INWEH, UN University: Hamilton, ON, Canada, 2013 https://collections.unu.edu/eserv/UNU:2651/Water-Security-and-the-Global-Water-Agenda.pdf
[3] Ozturk et al., 2022. How climate change and unplanned urban sprawl bring more landslides. Nature 608: 262-265. https://doi.org/10.1038/d41586-022-02141-9
[4] Europe's changing climate hazards — an index-based interactive EEA report 2021. ISBN 978-92-9480-407-5. ISSN 1977-8449 https://doi.org/10.2800/458052

There is evidence for the potential of such integrated approaches and proof that despite extreme weather hazards increased, the impacts were able to be addressed successfully by effective governance of risk and emergency management including transnational collaboration[5] – for which in reverse conclusion the results of integrated adaptation projects of higher education entities (like the ABCD-Centre) are a fundamental baseline.

Those should emphasize on broaden the participation in research and focus on existing gaps and biases by recognizing outputs leveraging different types of data and different ways of knowing. The majority of forthcoming research in water security in general will probably mainly focus on specific cases in individual places and communities and will not necessarily be generalizable. But multilateral integrated frameworks might be an opportunity to elevate pioneers in the field and bring in and magnify underrepresented voices such as local experts in the Global South (Box 2), where a better understanding of water security and social justice is long overdue[6].

Box 2.

The Centre for International Postgraduate Studies of Environmental Management (CIPSEM) has been implementing a postgraduate course program on environmental management for change agents in the Global South at TUD Dresden University of Technology since 1977. As this institution has produced more than 2700 alumni from 145 countries, it has not only created a global network of sustainability experts, but also forms a strong basis for analyzing the potentials and barriers for knowledge transfer from academia into practice and policy.

https://tu-dresden.de/cipsem

Multilateral and interdisciplinary actions should embrace both, *grey* (engineered) structures as well as *green* (nature-based) solutions when preparing to withstand extreme events. Furthermore, trade-offs between water use and decarbonization need to be investigated[7] and water-based adaptation must correspond to local realities – better *safe-to-fail* than *fail-safe* approaches should be the preferable choice[8]. Academia-led multilateral projects with established outreach to decision-making entities (political and economic) have the potential to foster effective water management as an essential part of adapting to climate change and therefore protect water resources, reduce disaster risks, lower greenhouse-gas emissions, and assure equitable access[9].

Session Summary

The communication of naturally complex issues like climate change, tipping points, socio-ecological systems, and their interaction with the hydrological cycle and water security is equally important as it is challenging. Beyond the complexity, the long-term and often delayed characteristics furthermore do not match with either political election cycles or quarterly business reports. Academic institutions

[5] Kreibich et al. 2022. The challenge of unprecedented floods and droughts in risk management. Nature 608: 80-86. https://doi.org/10.5880/GFZ.4.4.2022.002

[6] Hino and Nance 2021. Five ways to ensure flood-risk research helps the most vulnerable. Nature 595: 27-29. https://doi.org/10.1038/d41586-021-01750-0

[7] Miralles-Wilhelm 2022. Water is the middle child in global climate policy. Nature Climate Change 12: 110-112. https://doi.org/10.1038/s41558-021-01154-y

[8] Kim et al. 2019. The infrastructure trolley problem: positioning safe-to-fail infrastructure for climate change adaptation. Earth's Future 7: 704-717. https://doi.org/10.1029/2019EF001208

[9] Feisal Rahman et al. 2023. As the UN meets, make water central to climate action. Nature 615: 582-585. https://doi.org/10.1038/d41586-023-00793-9

are at the forefront to assess, reveal and understand such complex systems, but certainly more engagement is needed to effectively transfer the most urgent derivations in practice and policy on the one hand, but also invest into a continuing effort in creating a general understanding and susceptibility to crucial stakeholders of those characteristics on the other. Transformative interaction, and hence closing the gap between knowledge generation and best practice application needs to be eased down to an implementable level, but without any oversimplification. A prerequisite for such an approach in successful multilateral cooperation would be a common baseline – a mutual *Water Culture* among all stakeholders when addressing water security with meaningful climate adaptation measures.

The participants of this official side event took notice and refer to the concept note and the according Interactive Dialogue #2 "*Water for Sustainable Development: Valuing Water, Water-Energy-Food Nexus and Sustainable Economic and Urban Development*" – several aspects from the section on capacity development were incorporated and will be labeled as such [ID#2] in the following remarks.

Urban water security – assessment framework and application

As defined by UN-Water in 2013 (see also Fig.1) – water security comprises the capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.

This becomes more urgent especially in the urban context. Globally one out of four people live in high-risk flood zones and total urban population is projected to grow up to 70% by 2050. At the same time in cities and metropolitan areas economic growth is concentrated when using GDP as an indicator. Hence urban water security is of utmost importance and should be a high priority for governments across the globe to address these challenges.

For this *the need of established standards for measuring and monitoring water security indicators* [ID#2] is a prerequisite – because effective management depends on reliable monitoring. Since 2014 a comprehensive framework for estimating and monitoring urban water security with an emphasis on metropolitan areas in south- and south-east Asia has been established by the Asian Institute of Technology and partners. Since December 2022 city planners, practitioners, investors and academia can use a resulting online-based tool to estimate, inform, engage and make better decisions towards sustainable urban water security measures (Box 3).

Box 3.

WATSAT 1.0

The WATSAT framework has a three-layered structure – dimensions, indicators, and variables that culminate into a Water Security Index. This structure helps to keep the framework generic, while at the same time enables it to capture site-specific issues and challenges about water security. Hence, the dimensions and indicators are kept fixed for any city. The choice of the variables is up to the user, depending upon what they think is relevant for their city. WATSAT comprises with a list of potential variables to choose from.

http://www.watsat.org

The concept is subject to further development and applications to incorporate basin and household levels have been commenced. Additionally, the completion of a dissemination and training campaign is planned for 10 Asian countries. For continuing progress, the following emerging aspects should be in focus for further water security research:

- identifying an acceptable level of water insecurity risk
- the clime change and water security nexus
- quantifying the impacts of water security policies
- addressing contentious trade-offs
- more participation from governmental institutions and civil society
- utilize the potential of technological novelty (e.g. big data and artificial intelligence)

Contributions of higher education to climate adaptation and water security

Overall academia is developing new technologies and demonstrates the manifold transdisciplinary interactions of climate change aspects. Here universities often focus on lighthouse projects with high visibility and transfer potential. Nonetheless, there is an increasing necessity to not only concentrate on fundamental science, but also on an effective and sustainable transfer of knowledge, products, patents and procedures. This is a significant change of self-understanding of the Universities which also has an increasing financial perspective and novel opportunities for academic institutions. Proof for that is the fact, that all of the partners of the ABCD-Centre (Box 1) have some kind of innovation parks and business incubation facilities affiliated with the University.

The main duty of academia for society is excellency in research and teaching and being a driver for innovation and transformation. This is the very foundation, but more often than not rather detailed and specific, but sequentially becoming more and more inter- and transdisciplinary. Successful and sustainable climate change adaptation needs such holistic approach and the establishment of means to *address the target group of national/local authorities und (future) decision makers* [ID#2]. Within this framework, the further development of institution of higher education plays a fundamental role.

In a long-term perspective, the strategy of higher education institutions will be reflected in the public knowledge and public awareness for climate change adaptation and presumably will enable climate friendly decision making and policy. Emerging environmental leaders and transformative change agents are educated and will infiltrate society, having a profound impact. Recently, the sixth report period of IPCC makes it evident, how much time is needed to introduce changes in public awareness and climate policy. But please take into account that the ongoing climate change will affect the rise of sea water level for more than thousand years, maybe up to more than 5 m. There are ongoing discussions about the changes till the end of this century in the range of 0.3 to 0.8 m, but the impact will last far longer, since the effected processes like expansion of water are naturally delayed. This means, appropriate measures are required to avoid maladaptation and *systemic, long-term and forward-looking capacity development for complex water issues* [ID#2], as well es inclusive communication of those. The water-related challenges for society, agriculture, economy and nature are tremendously and countries need strategies for sustainable long term strategic funding of measures.

Without a doubt, interdisciplinary higher education programs in climate and environmental sciences are essential for the next generations to enable successful climate change mitigation and adaptation. Acceptance is bound to understanding and comprehension - but how much time is available, since every tenth of degree further warming-up will dramatically increase the consequences?

Water scarcity, sustainable climate-adapted and resilient water infrastructure and access to affordable existing solutions are the main challenges for many businesses. There still is a significant need for better and well-structured access to necessary information – often already existing – to promote local adaptive climate adaptation strategies. Meaningful climate adaptation for water security is required now!

The ABCD-Centre (Box 1) is a smart international scientific consortium. And of course, it is not alone: there are further Climate Centres, Disaster Management Centres, Consultancies, NGO etc. with different competences all over the world. There is an abundance of research results in the scientific community and there are also a number of good practice examples available. But the stakeholders, such as urban and peri-urban administration entities, the private sector and industry as well as agriculture urgently need better and faster access to knowledge to be enabled and empowered to analyze and understand their particular situation and to select from scalable best practice solutions. Hence, *additional courses on water for sustainable economic and urban development are crucial, because water is still often taken for granted by those mandated with realizing economic/urban growth* [ID#2]. The gap between knowledge generation and implementation of suitable and sustainable climate change adaptation is still huge and the potential of technological innovation such as big data and artificial intelligence must be taken into account.

Call for transfer measures

As confirmed by an abundance of results in business research, it is well known that on one hand designing concepts and frameworks for problem solving is key, but on the other hand that the importance and demand of implementing and applying those is still frequently neglected. Hence, *the demand for more than just training and the urgency for awareness on local conditions and a certain water culture necessary for effective transfer measures* [ID#2] – the development of such culture could be subsumed by the following guiding questions:

- → What are the barriers for ensuring water security?
- → What is the impact of women's responsibility for water issues?
- → Are wastewater treatment options available?
- → How nature-based solutions can be leveraged?
- → How do we value water?
- → What role does water play in education?
- → What can we learn from traditional ecological knowledge?

Traditional ecological knowledge is defined as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment"[10] – the concept comprises a framework of trade-offs between different levels of spirituality and risks; whereas examples of the latter include moral hazards (cultural values), material harms (e.g. misappropriation, overharvesting) and a lack of benefit sharing. Water related aspects as weather patterns or irrigation techniques for instance can be arranged in that concept according to

[10] Berkes et al. 2000. Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications 10: 1251-1262. https://doi.org/10.2307/2641280

their respective levels of spirituality and risk and hence form an initial approach for successful transfer strategies for adaptation measures to ensure water security.

This should be complemented by awareness of societal acceptance and the characteristics of the local economy to reflect the full spectrum of sustainability (ecology – society - economy). The general sequence from value proposition over value creation and delivery to value capture could and should be another component towards the development of effective adaptive action in the water sector by for example applying this established business model from waste water as a resource (value proposition) over partnerships (value creation) and tracking/distribution (value delivery) to reduce overall water costs by sustainable waste water use (value capture).

For the application of such models the identification of barriers is key to develop or adjust according strategies – these barriers include, but are not limited to: lack of objectives, lack of processes, lack of resources, lack of knowledge and lack of incentives; and they are varying among subject matters.

According to recent estimates we must at least quadruple our efforts to sustain a chance to achieve SDG-6 by 2030. Hence, we not only have to be aware, but we need to quantify the costs of further inaction – not taking the opportunity for transformative decisions in the setting of this UN 2023 Water Conference is a decision itself: a decision against water security.

Commitments

The speakers and panellists of this official side event of the UN 2023 Water Conference on "Water security and climate change adaptation as local challenges with global importance – addressing the gap between knowledge generation and best practice application" express the following commitments to the Water Action Agenda[11]:

I. Development of novel higher education courses, with innovations in content as well as organizational structure, allowing for more multilateral cooperation among universities
II. Continued execution of effective transfer measures and their evaluation as well as further research to identify and overcome transfer barriers
III. Preservation and extension of expert networks with emphasis on further organisational advancement on the establishment of crosslinks
IV. Support in condensation and concentration of available scattered resources (data, experts, best-practice examples, funding options) for better access for successful implementation of adaptation measures for water security

[11] Water Action Agenda https://sdgs.un.org/conferences/water2023/action-agenda

Speakers/Panel

Prof. Dr. Edeltraud Günther – UNU FLORES

Prof. Dr. Edeltraud Guenther is a globally recognized expert in environmental management and sustainability assessment. She assumed the position of Director of United Nations University Institute for Integrated Management of Material Fluxes and of Resources (UNU-FLORES) in Dresden, Germany on 1 September 2018.

In 1996 she was appointed the Chair of Business Management, Sustainability Management and Environmental Accounting, at the Faculty of Business and Economics at TUD Dresden University of Technology (TU Dresden). She founded the Centre for Performance and Policy Research in Sustainability Measurement and Assessment (PRISMA) in 2016 and has acted as the Centre's Chair since then.

Prof. Guenther was also one of the establishing Directors and the first Chair for UNU Water Network, which was initiated in 2019. In 2020, she was appointed UNU Senior Official for the Environmental Management Group (EMG).

Together with the director of the German Environment Agency she started the journal *Sustainability Nexus Forum* (Springer Nature) in January 2023 and shares the role of Editor-in-Chief.

Prof. Dr. Jürgen Stamm – TU Dresden

Prof. Dr. Stamm holds the Chair of Hydraulic Engineering at TU Dresden. His main research interests include hydraulics of hydraulic engineering installations like dams, reservoirs and dykes, but also stream hydraulics with a focus on urban scenarios and the interaction between flow, vegetation und morphology. Waterway engineering and eco- and etho-hydraulic processes like fish migration aids are also within the scientific portfolio of Prof. Stamm.

Since 2018 he also is the Dean of the Faculty of Civil Engineering and since 2020 fulfills the role of the Speaker of the School of Civil and Environmental Engineering at TU Dresden, which includes the Faculties of Architecture, Environmental Sciences, Transport Sciences and Economics besides his own faculty and comprises 140 chairs and approx. 8000 students.

Prof. Stamm leads the Global Water and Climate Adaptation Centre, which was established in 2021 in collaboration with RWTH Aachen and UNU-FLORES in Germany, the Indian Institute of Technology Madras in Chennai/India and the Asian Institute of Technology (AIT) in Bangkok/Thailand. The Centre was named ABCD-Centre in short, referring to the initial letters of the cities all participating partners are located in.

Prof. Dr. Mukand Babel – AIT

Prof. Babel is a Professor of Water Engineering and Management at the Asian Institute of Technology (AIT). In addition, he is leading the Climate Change Asia (CCA) initiative at AIT for catalyzing capacity for action to address climate change issues in the region.

Prof. Babel specializes in hydrologic and water resources modeling as applied to integrated water resources management. His interest areas are very much diverse and include watershed modeling and management, water resources allocation and management, water resources and socio-economic development, water supply system and management, and climate change on hydrology and water resources. Research related to groundwater resources management and drought analysis, forecasting and management are also of interest. In 2014 Prof. Babel was appointed as a Member of the Advisory Committee of the World Water Quality Assessment, an initiative of UN-Water Group led by UNEP and GEMS/Water. Furthermore, he has been a Board Member of the Asia Water Council and received the 2018 International Award by the Japan Society of Hydrology and Water Resources.

Prof. Dr. Kensuke Fukushi – UNU-IAS

Prof. Fukushi is an Academic Program Advisor at the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS). He is also Professor and Vice Director of the Institute for Future Initiatives (formerly Integrated Research System for Sustainability Science, IR3S) at the University of Tokyo (UTokyo), of which he is a founding faculty member.

Kensuke is a civil-environmental engineer and holds appointments at the UTokyo Graduate Schools of Engineering and Frontier Sciences, where he organizes the Urban Sustainability Science Laboratory. He is also a Distinguished External Faculty member at AIT.

Hasmik Barseghyan – EYPW

Hasmik Barseghyan is a professional in solar energy and environmental management fields, with seven years of working experience in project management in different sectors. She has specific interest in policies and regulations in energy and various environmental aspects. Ms. Barseghyan has been a fellow of the US State Department PFP exchange program at the Oregon State Capitol (2018) contributing to the work of environmental and renewable energy committees. Afterwards she has been a fellow at the Centre for International Postgraduate Studies of Environmental Management (CIPSEM) at TU Dresden in Germany, where she did a comparative research-study on policy making in solar energy. Since 2019 she is the President of the European Youth Parliament for Water (EYPW). Ms. Barseghyan is an active supporter of the ABCD-Centre and an ambassador of the work of CIPSEM.

Dr. André Lindner – TU Dresden

Throughout his professional career Dr. Lindner covered a range of fields from basic research on biodiversity, to applied and development-oriented aspects of climate change adaptation, to postgraduate education for sustainable development in environmental management, especially in developing countries. Since 2020 he has been working as Managing Director of the School of Civil and Environmental Engineering at TU Dresden and also fulfills the role of an International Advisor.

Before that Dr Lindner was active at CIPSEM - the course program there is characterized by their multi-stakeholder composition, which means experts from government, non-governmental organizations, science, and business come and work together. The courses are designed as a platform for a sustainable North-South and South-South exchange.

A recent focus of the work of Dr. Lindner is the cooperation within the ABCD and further develop academic mobility and innovative education approaches. The topic of water obviously plays a central role and it builds on the internationally renowned expertise and the resources available in the field of construction and the environment at the TU Dresden and the partners involved.