An Initiative of the Federal Ministry of Education and Research

GRoW

WATER AS A GLOBAL RESOURCE

POLICY BRIEF

Advancing the Water Footprint into an instrument to support achieving the SDGs

The water footprint has developed into a widely-used concept to examine water use and resulting local impacts caused during agricultural and industrial production. Building on recent advancements in the water footprint concept, it can be an effective steering instrument to support, inter alia, achieving sustainable development goals (SDGs) - SDG 6 in particular.

Within the research program "**Water as a Global Resource**" (GRoW), an initiative of the Federal Ministry for Education and Research, a number of research projects currently apply and enhance the water footprint concept in order to identify areas where water is being used inefficiently and implement practical optimization measures (see imprint for more information).

With this policy brief, we aim to raise awareness on the potential of the water footprint concept to inform decision-making in the public and private sectors towards improved water management and achieving the SDGs.

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DEVELOPMENT OF THE WATER FOOTPRINT – FROM GLOBAL VOLUMES TO LOCAL IMPACTS

Two billion people live in countries experiencing high water stress and more than four billion lack access to basic sanitation [1]. The "water crisis" is constantly ranked among the top 5 global risks reported by the World Economic Forum in its annual global risk reports [2]. The link between the global water crisis and our production and consumption of water intense products has been made transparent by concepts like "Virtual Water". The concept denotes the volumes of water used in the production of goods and services, differentiating ground and surface water (blue water), soil moisture (green water), and the pollution of freshwater (gray water). By revealing surprisingly high volumes, like 140 liters per cup of coffee [3], up to 15,500 liters per kilogram of beef [4] or 2,700 liters per cotton T-shirt [5], consumers have been made aware of the high "water footprints" (WF) of daily goods. Despite the relevance of global freshwater appropriation figures for awareness raising, such volumetric approaches have been criticized for the lack of environmental and socio-economic meaning as, e.g., 1 m^3 of rainwater consumption in Sweden does not compare to 1 m^3 of groundwater consumed in Egypt [6].

In order to advance the WF concept into an instrument that can support decision making, methods assessing local consequences resulting from water use have been developed within the scope of life cycle assessment [7]. Some of those impact assessment methods estimate the local consequences of water consumption based on existing freshwater scarcity [8]–[10]. Other methods allow to assess the effects of water consumption on:

- Human health and well-being (due to malnutrition [8], [11], [12] or infectious diseases [11], [13])
- Ecosystems (terrestrial [8], [14], [15], aquatic [16], [17], coastal [18], wetlands [19], urban [20])
- Freshwater resources [8], [21], [22]

The scientific advancement of the WF concept and relevance of global freshwater use has led to the development of an international WF standard (ISO 14046) which specifies principles, requirements and guidelines related to WF analyses of products, processes and organizations [23].

THE WATER FOOTPRINT – OPPORTUNITIES FOR ACHIEVING SDGS

Building on the advancement of the WF concept within the last 20 years, WF assessments today can support different stakeholders in achieving the SDGs, and in particular SDG 6.

Policy and planning

Modern WF methods and tools can inform policy decisions towards more sustainable use of water resources at various levels:

- As water intense products are shipped around the globe, water associated with their production is virtually traded between world regions, e.g. from developing countries to the European Union via cotton and textiles or mineral resources used for conventional and renewable energy production. **An analysis of this virtual water trade** can reveal the volumes of

The MedWater project investigates the flows of virtual water via imports and exports of a selection of crops to Israel, as well as the associated ecosystem services flows following the guidance framework outlined in Koellner et al. (2019) [25]. Such an analysis aims to provide a "water budget" of the country, accounting for the varying sources and sinks of water locally and globally. In addition to global data sources on crop virtual water trade, regional watershed scale Soil and Water Assessment Tool (SWAT) models enable a detailed freshwater sustainability assessment in the study areas. The SWAT models also provide outputs concerning surface and groundwater pollution due to fertilizer and pesticide application. This information offers decision makers a wider perspective on the nexus between land, water, energy, and food security.

water associated with trade and resulting impacts in the exporting countries [24], [25]. It can also show the extent to which water scarcity in a country is caused by its export of water intense goods. Thus, taking a global perspective, analyzing the WF and virtual water trade can inform national strategies and trade decisions.

- **On a national or regional level**, assessing the WF of agricultural production, energy generation and water intense industries can **guide sectoral policies and planning**. It can e.g. inform land-use planning by identifying areas where production is associated with high impacts on land and water resources, ecosystems and human health.
- The WF can also be applied to **identify trade-offs and synergies between strategies** to achieve water security (SDG 6), energy security (SDG 7) and food security (SDG 2) – also known as the water, energy and food security nexus [26] – which is of high relevance as the SDGs are strongly interrelated and can only be achieved in relation to one another. As the 2030 Agenda is an agenda of transformation [27], WF is a key concept to guide water-related transformation processes effectively.
- **On a more local level, the WF concept can inform policy decisions on how to achieve water-use efficiency** e.g. by demonstrating how improved use of green water can help to reduce water scarcity [28]. This might imply accepting lower yields for saving blue water resources, or deciding to import water intense products rather than producing them domestically.

The goCAM project uses water footprint calculations as additional information for a Multi Criteria Decision Analysis to support decision making on water management strategies in the water stressed region of Northwest Germany. It will be proved which kind of footprints can be calculated and if the water footprint can be used for visualising regional hotspots of water scarcity caused by certain production (agricultural and food processing sectors).

Producers

Modern WF methods and tools can support producers in determining their indirect water use and associated impacts in supply chains in addition to their (often comparably low) direct water use at production sites. Producers can use this knowledge to:

- **Design products** in a way which reduces the indirect water use in supply chains by e.g. substituting water intense materials or using secondary materials.
- **Broaden corporate environmental strategies,** which usually focus on site-specific water reduction targets. It can be economically more efficient and environmentally more beneficial to **save water at water hotspots in supply chains**.
- **Support sustainable procurement** by identifying where **water efficient raw materials and intermediate products** could be part of a company's environmental management strategy.
- **Reduce water risks** by identifying local hotspots in global supply chains to design appropriate measures **in cooperation with suppliers and local stakeholders**, e.g. through water stewardship approaches.
- **Promote more sustainable agricultural management practices**, e.g. changing crops or growing seasons to make better use of available green water resources, thereby alleviating the WF in agriculture and increasing the nutritional and economic water productivity.
- Identify potential **hotspots of water scarcity** in modern **electricity production supply chains**, e.g. concentrated

The WELLE project has developed an online tool (http://wf-tools.see.tu-berlin.de) enabling companies to determine their water consumption and resulting impacts on production sites and at all stages of their supply chains. Companies can thereby identify local hotspots in global supply chains and take actions to reduce their water footprint. Industry partners used results obtained by the tool to consider changing materials in their product design and integrating sustainable procurement in the company's environmental management systems.

The WANDEL project analyses if restrictions on water availability can delay the implementation of a global energy transition. Both fossil and renewable based energy generation, strongly rely on the extraction and refinement of mineral resources, e.g. Lithium, thereby abstracting and polluting significant amounts of freshwater often in conflict with other users. Water withdrawals along the entire supply chains of four case studies are evaluated with respect to the place of water use. Results allow for a comparison of the on-site and remote impact of different technologies on water resources in policy and planning. Finally, scenario analyses of natural water availability in 2030 show how climate change may affect the energy transition.

solar power, with a special focus on remote impacts induced by mining of mineral resources that are required in electricity generation.

The InoCottonGROW project evaluates the potential to communicate the water footprint of textiles to consumers by means of ecolabels. The aim is to raise the demand for goods produced under measures reducing water pollution and consumption, such as growing organic cotton and cleaning wastewater from textile production. By fostering the demand for sustainable textiles local producers are supported in implementing water saving technologies.

Consumers

The WF can raise awareness and inform consumers about the hidden water use and resulting impacts of daily products and services. Based on this information, unsustainable consumption of water intense products (e.g. fast fashion) or waste of water intense goods (e.g. food) can be identified and subsequently reduced. This can contribute to incentivising agriculture and industry to produce water efficient products - helping to achieve SDG 6, but also improving sustainable consumption addressed under SDG 12.

METHODOLOGICAL AND PRACTICAL CHALLENGES

Despite the scientific advancement of the WF concept, several challenges remain that may hamper its wider application.

- While several methodologies have been developed that allow evaluating the impacts of water use, most WF studies stay on a volumetric level and do not consider **consequences of water use**, such as impacts on human health, biodiversity or ecosystem services.
- Methodologies to assess impacts of water use on **water quality** have not yet been sufficiently developed. Impacts on water quality are often not addressed or only calculated based on a single quality parameter.
- Most studies merely focus on the **blue water scarcity** and blue water saving. However, assessing the **green water footprint** seems equally important, especially when addressing questions related to water scarcity, food security, and water saving potentials [24], [25].
- Comparing and linking assessments conducted **at different geographical levels or spatial scales** is a major challenge. Global models with high uncertainty can be used for identifying potential hotspots – however, local models with high complexity are more reliable to quantify local impacts [30], despite being difficult to upscale. Moreover, **missing inventory data** and **weak data quality** are sometimes leading to limited robustness of WF results and comparability.
- Studies analyzing the virtual water trade between countries [23]–[25] are often followed by rather narrowly focused recommendations, such as moving production sites to water abundant regions or putting taxes on water intense goods imported from water scarce countries [26]. However, such suggestions are often heavily criticized for causing economic damages in developing countries [27], [28].
- While the growing number of WF methods developed increases the knowledge on products' water use and a variety of associated impacts, it becomes increasingly difficult for practitioners to choose the most adequate method for the question to be answered.

The ViWA project applies a sustainability assessment that refines information on water scarcity hotspots in order to support decision making towards environmentally sustainable water use. Based on fundamental information from the WF, a Multi Criteria Analysis gives insights about the impacts on water-dependent ecosystems caused by changes of the natural water regime through agricultural water use. The ViWA project combines the WF approach with additional indicators implemented on a 1*1 km grid basis in order to reveal local consequences of water use on specific habitats. The approach is first tested in the Danube basin.

The InoCottonGROW project calculates the water footprint of cotton and textiles using the spatially and temporally explicit water consumption and scarcity data, which provides more robust results compared to existing models [30]. Furthermore, local cause-effect chains for the toxicity impacts resulting from water pollution are analysed. Local impacts associated with virtual water trade are therefore evaluated more precisely, which can support local decision-makers in identifying hotspots associated with the agricultural water use and developing water scarcity mitigation plans through better water allocation.

Conclusions / Recommendations

- **Take a holistic perspective on the water footprint:** In order to make meaningful use of the WF concept as a steering instrument to guide decision making at various levels, **the impacts of water use need to be assessed in addition to liters of water consumed.** The GRoW community recommends applying recently developed methods to assess local impacts resulting from both water consumption and water pollution.

- **Make use of the water footprint to identify where investment in more sustainable water use is most efficient.** For private companies as well as for governments, it might be environmentally more beneficial and often economically more efficient to invest in water use efficiency measures at suppliers or in exporting countries which face high water stress rather than focusing on production-site or domestic measures only.

- **Analyse virtual water flows and resulting impacts in order to identify hotspots, for instance associated with European imports,** and **develop specific policy measures mitigating local water stress in the exporting countries.** These could include providing incentives for more efficient water usage or steering specific technical development assistance. Policy measures based on virtual water trade analysis should consider local circumstances to prevent negative social and economic trade-offs, such as reduced income or unemployment.

- **Apply the water footprint to guide decisions on strategies to achieve SDGs interlinked with SDG 6 on water.** Measures and strategies to achieve SDGs, especially those related to energy (SDG 7), food security (SDG 2), but also climate change (SDG 12) and sustainable consumption and production (SDG 12) can have positive or negative impacts on water resources. The WF is a useful instrument to assess and consequently address such interlinkages.

GRoW Water Footprint Toolkit

The GRoW community develops a toolkit which guides users to the most suitable method according to the question to be answered when undertaking a water footprint assessment. Depending on the exact objective, different methods can be used:

- Methods accounting for the volumetric water use to raise awareness among consumers/stakeholders or for green vs. blue water use optimisation
- Methods considering water quality aspects in water footprinting
- Methods modelling impacts/depletion of water resources
- Methods modelling impacts on ecosystems
- Methods modelling impacts on human health

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THE GRoW PROGRAM

"Water as a Global Resource" (GRoW) is a research program that the German Federal Ministry of Education and Research (BMBF) has set up to help achieve SDG 6. Over 90 institutions active in research, business and practice are involved in the funding measure through 12 joint research projects. GRoW projects collaborate with partners in over 20 countries around the world and develop new approaches for improving sustainable water resources management and water governance structures. The joint research projects examine local and regional solutions, and produce improved global information and forecasts of water resources and demand. For more information and contact details see: www.bmbf-grow.de

WATER FOOTPRINT AS A CROSS-CUTTING TOPIC IN GRoW PROJECTS

This policy brief has been developed by a group of researchers involved in the various GRoW projects concerned with water footprint:

WELLE https://www.see.tu-berlin.de/menue/forschung/projekte/welle/parameter/en/
ViWA https://viwa.geographie-muenchen.de/
GlobeDrought https://grow-globedrought.net/
InoCottonGROW https://www.inocottongrow.net/
WANDEL https://wandel.cesr.de/en/
MedWater http://grow-medwater.de/home/
go-CAM https://www.tu-braunschweig.de/lwi/hywa/forschung-projekte/gocam/index.html

This policy brief has been developed by a group of researchers involved in the various GRoW projects concerned with water footprint and the GRoW Advisory Board member Dr Falk Schmidt, IASS Potsdam.

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