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2nd GRoW-Workshop on the „Water Footprint“

Brief summary report

Date: 27 September 2018

Place: Chair of Sustainable Engineering, TU Berlin

Participants: 13 (from the projects: go-CAM, InoCottonGRoW, MedWater, ViWA, WANDEL, WELLE), see also participants list in Appendix A

Responsible Person/ Moderator: Dr. Markus Berger, Dr. Falk Schmidt

Introduction and welcome by Markus Berger

- After a short introduction of all participants, Mr. Berger outlined the objective of the second workshop in this cross-cutting topic of the Water Footprint (WF) to further investigate the questions identified at the first workshop and identify possible synergies of joint work along these questions:
  - How to link water footprint with economic and social impacts (e.g. consumer health, consumer/ societal costs)?
  - How can trade influence water stress in certain regions or vice versa? What are the links to mitigation strategies?
  - How can water quality/water pollution be addressed within water footprint?
- The main aim is to facilitate knowledge exchange and serve as a platform for discussion and dissemination of the working results.

First input presentation

“How can trade influence water stress in certain regions or vice versa? What are the links to mitigation strategies?” (Dr. Markus Berger)

- Due to global trade, water is “virtually” traded across country borders. There are many studies showing that some countries are net exporters (like USA, mainly because of agricultural products and biofuels) and some are net importers (like Germany).
- Trade can increase local water stress, if water scarce countries export water intense products, e.g. cotton from Pakistan. Trade can also reduce local water stress, if water scarce countries import water intense goods, e.g. Saudi Arabia.
- Vice versa water availability hardly seems to influence global trade patterns compared to other economic factors such as production prices.
- In order to use the WF as a steering instrument the impacts of water use need to be assessed beyond the expression of liters of water consumed.
- There are a number of proposed measures to reduce the WF or the negative impact of virtual water trade such as: international water label, more realistic water prices or virtual water taxes.

Questions discussed:

- ***Which political and economic instruments are available to steer the virtual water flows between nations?***
- ***Can we develop a GRoW internal position on the existing approaches to steer virtual water trade?***
- ***Can we think of new approaches to steer virtual water?***

Main points of discussion:

- Water labeling:
    - Traditional water labelling (number of liters on the product) is seen as non-feasible in terms of steering virtual water trade, because the numbers are often not comparable and don't allow for conclusions about the local consequences. But it appears to be a useful tool to raise awareness.
    - Positive labelling such as a certification could be used to raise awareness that a specific product has been produced under certain positive conditions. This could raise incentives for continuous improvement in critical regions.
- The power and responsibility should not only be given to the end consumer. Insights from behavioral economics show that consumers do not necessarily mitigate and therefore also political intervention needs to be promoted. It appears to be more useful to develop instruments (e.g. WF) to identify hotspots to steer the decision making, e.g highlight where water use efficiency could be increased.
- The proposed instruments are only related to physical aspects, excluding social aspects (such as food sovereignty). It was proposed to include social aspects in WF methodologies.
- Power relations, sub-national differences in local water scarcity and environmental impact were suggested parameters to include in the WF.
- There is a difference between physical and economic water scarcity. It is also a question of whether a country has the economic means to use the available water.
- Generally there is a high sensitivity amongst developing countries (e.g. Pakistan) on WF and virtual water trade topics because they fear a misinterpretation of pointing out inefficient or unsustainable water use and hence economic consequences.
- It was suggested to differentiate between established trade structures and potential future trade structures (e.g. if we promote electrical power). For new structures possible impacts could already be considered in the planning phase. However, there was no consensus on this point.
- Instruments for a hot-spot approach should be focusing more on local circumstances. However data availability and complexity set a limit for a comprehensive geographical assessment.
- A cost-benefit index (CBI) could be considered to express local socio-economic benefits resulting from water use. Developing a CBI is only useful in cases where benefits and costs are significant and known. The first step would therefore be to look at what to actually measure (e.g recipients of benefits).

Conclusion

- Participants generally expressed scepticism about the proposed measures „to fix virtual water trade":
    - Policy suggestions can result in major inefficiencies

  - Water is only one sustainability aspect → Trade-offs to social and economic aspects
  - Proposals deny the ability and maturity of developing countries to make trade decisions in their own best interest (Gawel and Bernsen 2011)-> "Eco-imperialism"
- Monitoring of global virtual water flows would be usefull to
  - Use them as one aspect in decision making on future trade flows
  - Identify local hotspots in global trade flows and start mitigation measures at places where it is most efficient
- A path forward could be a carefully structured water label to incentivize improvements.
- Existing current state of knowledge on the WF is very useful but requires better channelling into political processes.
- The role of GRoW could be to support decision making for the future and provide recommendations on effective identification of water hot spots.

Next Steps

- It was proposed to develop a position paper critically reflecting/discussing the proposed options for the use of WF information and create a synthesis publication on how to use WF for achieving the SDGs (DDS, hot spots analysis). These activities could raise awareness among policy and the broader water community.
- A publication by GRoW could indicate that water community has WF instruments which have been refined over the last decade. The publication could also identify concrete intervention points for fostering improvements for water related consumption issues addressed in SDG 12.

Second input presentation

"Water quality in water footprinting" (Natalia Finogenova)

- Water quality aspects are closely related to social and environmental aspects. This is also reflected in the SDGs, where SDG 6.3 for water quality issues is closely linked to SDG 12, 15 and 3.
- There are different models to include water quality in water footprinting. However, there is no consensus on which quality parameters to use (inventory) and how to model impacts (impact assessment). Concerning the inventory, the challenge is that the relevance of quality aspects depend on the industry type (e.g. N and P for agriculture, heavy metals and COD for textile production etc). For the impact assessment, high data needs often hinder the applicability of the methods.
- One major problem in low income countries is, that even though water might be heavily polluted people will use the water rather than facing water scarcity.
- Although strict legal standards for water quality exist in many countries, often there is no sufficient implementation and enforcement of laws and regulations.
- Water quality aspects are included in the ISO standard for WF (ISO 14046). However, in reality water quality is often not considered in the WF.
- For agricultural production, if considered, pollutants mostly include nitrates (N) and sometimes phosphorus (P), while pesticides are usually not considered, although their impacts on health are much higher.
- Water quality can be considered in the life cycle inventory (by parameters and measurements) and in the life cycle impact assessment: *Distance-to-target* (measuring

how far the current situation deviates from a specific (political) target), f*unctionality (*scarcity connected to functional class of water use for a specific user), *live cycle assessment (*quantifying eutrophication, human toxicity, eco-toxicity using life cycle impact assessment (LCIA) models).

- On the one hand the approach of "grey WF" is easily applicable and easy to understand. On the other hand grey WF is usually only based on one pollutant depending on the quality standards in palce and implies that there is enough water for dilution. Actual impacts on human health and ecosystems cannot be modelled using this method.

Main points of discussion:

- ***How do you address water quality in water footprinting in your project?***
- The projects consider differing types of water quality parameters:
  - **go-CAM:** Salinity in freshwater
  - **MedWater:** N, P (calculated with SWAT)
  - **WANDEL:** grey WF
  - **InoCottonGRoW:** Pollution is linked to health impacts using the LCIA models. The goal is to develop a region-specific impact assessment model which reflects local impact pathways and can demonstrate how technological interventions can reduce negative impacts on local population and ecosystems.
- The discussion showed that within GRoW there is no "one size fits all" solution to measure water quality. There was common understanding that different needs require different methodological approaches.
- It was agreed that considering water quality is important, e.g in contexts where volumetric amounts (low water footprint in terms of water consumption) are small but a high water pollutant concentration exists (high water footprint in terms of water pollution) (e.g. textile manufacturing in Pakistan).
- Instead of measuring different pollutants, one could also use ecological indicators such as species population decrease and species population changes to express water pollution.
- The European Waters Report (2018) has defined 5 priority substances which are the reason why a majority of rivers fail good ecological status (amongst others nitrate is listed). It was suggested that a standardised method for these 5 pollutants could be developed.

Conclusions:

- Water quality in the WF is not yet explored to its full potential. However, sufficient scientific knowledge is at hand. Hence, it is a question of the translation of knowledge into methods.
- It became clear that many of the projects do consider different water quality parameters.
- Water quality should be considered in the projects and grey WF is useful to make people aware of the problems arising from water quality issues. However, for region-specific contexts more advanced assessments are needed.

Next Steps:

- GRoW could aim to create a decision tree for which conditions specific quality related parameters could be considered or which method could be applied.

Third input presentation

"The interplay of Water footprint and social impacts" (Iana Dantas)

- The topic of WF related to social impacts is so far very rarely subject to scientific research.
- There are numerous indicators for water scarcity, but many just relate to blue water. However, the focus on water volume does not capture social aspects.
- There is room to develop a social index and to define social impacts.

Main points of discussion:

- There are some end point methods to model (social) impacts in LCA (e.g. water consumption -> water scarcity in agriculture -> malnutrition). Nevertheless, these models are usually established with a very low spatial resolution (country level) and rely upon general parameters (e.g. Human Development Index (HDI), GDP) which cannot reflect situation on a local level or address impacts of specific population groups. Water related impact indicators, such as water pollution to human health damage, can be translated into DALY (Disability adjusted life years). However this level of aggregation implies a high degree of uncertainty.
- One could also consider using ecosystem services to model impact pathways particularly with regards to benefits and foregone benefits.
- InoCottonGRoW aims at linking WF to SDGs by modelling region-specific cause-effect-chains for the impacts on human health and ecosystems and then relating them to the SDG indicators.

Conclusions:

- There was a common understanding that specific local impacts need to be considered in WF.
- A “”water footprint” toolbox could be established to guide practitioners to existing volumetric methods (like virtual water) or impact assessment methods (for human health and ecosystems) depending on the question they have.

Closure

- The next workshop of the cross-cutting topics is planned to take place in spring 2019.
- For this workshop, it is planned to identify a set of problems worked on in GRoW projects and the different models and tools used to identify potential best-practice approaches.
- The outcomes could be clustered around certain types of questions or a decision tree kind of guideline.
- For the dissemination of the results from the working group it was suggested to first start with a position paper summarizing main points of discussion. The aim of this position paper would be to critically discuss the quantitiative approach to WF, highlight which factors should be included in the WF and how this can be done, and the potentials of the WF – what can it be used for and what not, based on scientific discussion from the perspective of GRoW.

Next steps

- Results of this second workshop will be presented at the next status conference February 2019.
- GRoWnet (adelphi) facilitates the update on the inventory of the tools related to the WF, which are used by the different GRoW projects.
- The proposition to develop a position paper which critically reflects the discussed options for the use of WF information and informs about how to use WF for achieving the SDGs will be initiated.

- GRoWnet (adelphi) writes a first draft structure of the position paper, comprising the main topics, sections and key arguments and will share the document with the core group. After the core goup added additonal content, the draft position paper will be discussed in an online meeting with a larger group.

Appendix

A) List of participants

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B) Background documents

How can trade influence water stress in certain regions or vice versa? What are the links to mitigation strategies?

Dr. Markus Berger

Background

By means of water footprinting, water use along the supply chain of products can be analyzed. Since products are traded globally, also water is virtually traded from exporting to importing countries.

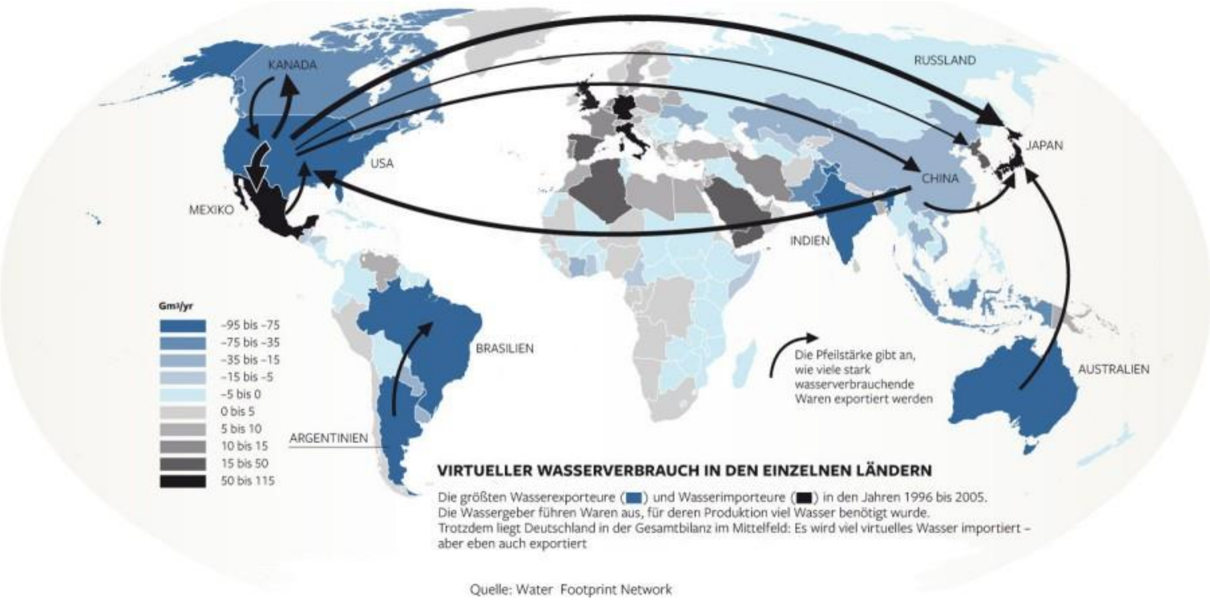

Figure 1: Virtual water in- and exports of global trade (Water Footprint Network)

On the one hand, the export of virtual water can increase water stress in exporting countries. On the other hand, it can also reduce water stress if dry countries import water intense products from water abundant regions. Studies analyzing the virtual water trade between countries (e.g. Hoekstra and Hung 2002; Hoekstra and Mekonnen 2012; Suweis et al. 2013) are often followed by rather simple recommendation, like moving production sites to water abundant regions or putting taxes on water intense goods imported from water scare countries (Hoekstra 2013). However, such suggestions are often heavily criticized by economist for causing economic damages in developing countries (Gawel and Bernsen 2013; Wichelns 2015).

Questions to be answered before the workshop

- How is your project related to virtual water trade? Which products and countries are involved?
- Can virtual water trade contribute to achieving SDG6?

- Which trade-offs to other SDGs exist?

Questions to be answered during the workshop

- Which political and economic instruments are available to steer the virtual water flows between nations?
- Can we develop a GRoW internal position on the existing approaches to steer virtual water trade?
- Can we think of new approaches to steer virtual water trade to achieve SDG6?

Literature for background reading

Gawel E, Bernsen K (2013) What is wrong with virtual water trading? On the limitations of the virtual water concept. Environ Plan C Gov Policy 31:168–181. doi: 10.1068/c11168

Hoekstra AY, Hung PQ (2002) Virtual Water Trade: A Quantification of Virtual Water Flows between Nations in Relation to International Crop Trade. In: Value of Water Research Report Series 11. UNESCO-IHE, Delft, The Netherlands

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Suweis S, Rinaldo A, Maritan A, D'Odorico P (2013) Water-controlled wealth of nations. Proc Natl Acad Sci U S A 110:4230–3. doi: 10.1073/pnas.1222452110

Wichelns D (2015) Virtual Water and Water Footprints: Overreaching Into the Discourse on Sustainability, Efficiency, and Equity. Water Altern 8:396–414

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Water quality in Water Footprinting

Natalia Finogenova

Background

Growing water use does not affect only the volume of water available, but also its quality. So far, there is no consensus on how to address water pollution in water footprinting. Inventories used to evaluate water quality are also not unified (e.g. for agricultural, only N or N, P, K or also pesticides are considered). Furthermore, global models often do not reflect local conditions (e.g. fate of the contaminants in the environment).

There are different approaches to address water quality issues in water footprinting:

- Distance-to-target (DtT): the most known method is the grey water footprint[1] which denotes the amount of water needed to dilute water pollution (most penalizing pollutant) to a certain quality threshold. Pros: easy to apply. Cons: no impact assessment (amount of water needed for dilution does not reflect the impacts of water contamination), only one pollutant is evaluated (e.g. nitrates), however other contaminants (e.g. heavy metals) may be more relevant in terms of impacts; the results depend on the quality threshold selected
- Functionality[2]**:** water is classified in functionality types according to its quality (several parameters), e.g. domestic water, industrial, agricultural, fisheries. It is then assumed that freshwater pollution can reduce its functionality. Pros: all relevant quality parameters are considered. Cons: difficult to apply because of the high effort to gather the data; criticized because humans and ecosystems use also contaminated water if other water sources are not available[4]
- LCA impact categories[3]: The pollution of freshwater is considered separately as an additional impact to water consumption in impact categories like eutrophication, acidification, human and eco toxicity[4]. Pros: a comprehensive impact assessment. Cons: relative high modelling effort (fate of the contaminants in the environment, exposure of the population); global models often do not reflect local conditions.

Questions to be answered before the workshop

- Please fill in the table on the water quality parameters considered in your project

Questions to be answered during the workshop:

- Is it possible to standardize water quality parameters to measure water pollution in water footprinting (e.g. for agriculture, different industry types) within GRoW and/or beyond?

- How can local conditions (fate in the environment, intake by the population) be considered in the water pollution assessment?
- Should we pay specific attention to groundwater (e.g. long-term pollution)?

Literature for background reading

1. Franke, N. A., Boyacioglu, H. & Hoekstra, A. Y. *GREY WATER FOOTPRINT ACCOUNTING. TIER1 SUPPORTING GUIDELINES*. *Value of Water Research Report Series 65* (2013).
2. Boulay, A. M., Bouchard, C., Bulle, C., Deschênes, L. & Margni, M. Categorizing water for LCA inventory. *Int. J. Life Cycle Assess.* **16,** 639–651 (2011).
3. ISO. *Water footprint — Principles, requirements and guidance. International Organization for Standardization, Ed.* (2014).
4. Caldeira, C. *et al.* Water footprint profile of crop-based vegetable oils and waste cooking oil: Comparing two water scarcity footprint methods. *J. Clean. Prod.* **195,** 1190–1202 (2018).

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The interplay of Water footprint and social impacts

Ianna Dantas

Background

Natural and social challenges have entered the 21st century in the urge for global collaboration to promote human and environmental sustainability. In times of technological progress and economic growth, water deserves special attention since it is the base for human and environmental sustenance (Biswas, 2004). Yet, almost one quarter of the global population still lacks water for basic needs (Komnenic, Ahlers, & Zaag, 2009), and 2.4 billion people lack basic sanitation (UNDP, 2004). Water is *per se* a complex element able to alter its physical state but also is unevenly distributed in time and space, which may worsen water scarcity across regions (Biswas, 2004; Kummu, Ward, de Moel, & Varis, 2010).

Water use is intertwined to issues of poverty, malnutrition, governance, and sustainable management of natural resources (Rijsberman, 2006). Levels of water scarcity and water pollution should not only be analyzed from a natural but also from a social perspective, insofar as economic factors hold back water and sanitation facilities (UNDP, 2004). In fact, the global water sector does not account with efficient infrastructure to economize water, preventing pollution, promoting better water allocation and technology innovation (Berrittella, Rehdanz, Roson, & Tol, 2005; UNDP, 2004). Fresh water represents a significant small share of water resources (Jackson, et al., 2001) and it is the base to sustain ecosystems and economic activities. Agriculture uses 70% of the total global fresh water (Calzadilla, Rehdanz, & Tol, 2008) but households and industries also demand and pollute significant shares (Hoekstra et al., 2011). Water consumption, however, is not only given via direct use of water, but also by consuming products that likewise demanded water through their whole supply chain (Hoekstra et al., 2011). In this sence, recognizing the different water resources and how they are consumed along the suppy chain of products, is an important tool to assess hotspot regions facing water scarcity and pollution. Following this attempt, the Water Footprint (WF) indicator provides comprehensive ways to spur water management strategies (Hoekstra et al., 2011).

The WF indicator is often expressed in volume of water used and polluted along the production value chain of commodities (Hoekstra, 2015). Having a multidimenssional character, the WF assesses water use and pollution by producers, consumers, processes, and products in a region at specific time (Chapagain & Tickner, 2012). The WF may take a single volumetric value but is also breaks down into green, blue and grey WF (Hoekstra, 2015). These terms are directly related to the definitions of green, blue and grey water. Green water is a concept introduced by (Falkenmark, 1995) to represent the water enclosed in plants and ecological systems, present in soil moisture due to precipitation (Savenije, 2000). Blue water is the content of rivers, lakes and aquifers (Savenije, 2000), and grey water purports the level of water pollution (Chapagain & Tickner, 2012).

Following from that, blue WF measures the water enclosed in a product that was abstracted from surface and groundwater resources, or reintegrated the system in another time or location (Chapagain & Tickner, 2012). It is often exemplified by industrial and domestic activities and irrigated agriculture, which often captures water directly from rivers. Green WF in turns, is often exemplified as rainfed agriculture, the content of water in soils and is not made available to other activities, but is particularly important to agricultural goods. Lastly, the grey WF indicates the amount of clean freshwater necessary to dilute pollutants present in the water (Chapagain & Tickner, 2012), it denotes how severe the pollution of a certain water source is, by measuring the amount of freshwater needed to dilute existing pollutants (Hoekstra, A. Y.; Chapagain, A.K.; Aldaya, M.M.; Mekonnen, 2011).

Applying such measurements to raise better understanding of water use towards social issues is of high relevance. According to the UNDP (2004) the relationship between poor civilians and water resources is given in three main domains, namely, health, vulnerability, and livelihoods. Pollution and lack of sanitation facilities create a cycle of illness, impose high personal cost, and affect workforce. Water pollution jeopardizes food security, production and income. As natural resources are often the main source of livelihood to poor people, rampant water utilization, pollution and inappropriate management, trigger instabilities in economic activities and natural cycles.

Over the decades many indicators were developed to assess global water scarcity, however, considering only blue water, while few bring about green water and water quality (Liu et al., 2017). The WF indicator, however, has shown increasing development over the years to adapt to present and furute demands. When addressing sustainability, the WF indicator offers a broad concept on tracking the sustainability of different water footprints in relation to a productive process and consumption. Figute 1 portraits the water foorprint sustainability evaluation. In a gepgraphic limit, blue and green water may be required to a process of production. The process might be evaluated unsustainable when one or more WF are likewise unsustainable, during a period of time or river basin. Moreover, it also holds when the process itself may present high levels of blue, green, and grey WF.

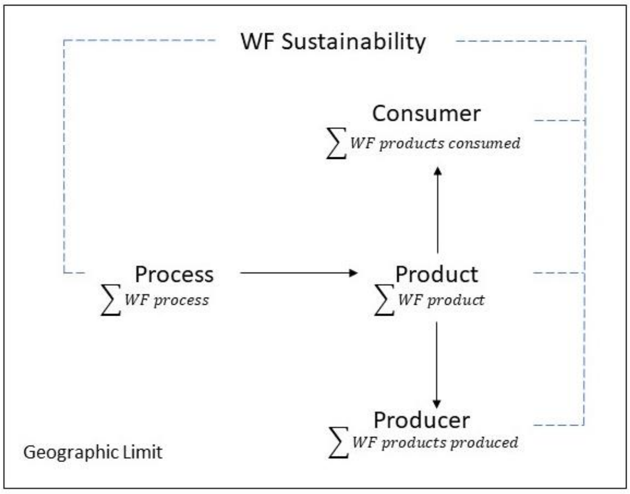

Figure 1 Water footprint sustainability

As for the product, it might be unsustainable when one or more WF is unsustainable. It dependes directly on how sustainable the production process is. The water footprint sustainability of producers and consumers, in turn, depend on the product WF. It is because the WF of consumers and producers are given respectively by the sum of all WF of products consumed and produced. As explained by Hoekstra et al., (2011) the WF sustainability of such elements are related to the geographic limit in which they are accounted, and a single unsustainable element is often not representative when it comes to the outbreak of scarcity and pollution. Such problems are given insofar as unsustainable WF are accumulated over the whole system, and WF sustainability are intertwinned to one another.

Sustainability is a broad concept and take different way of analysis. In order to assess the sustainability of a river basin catchment, Hoekstra et al., (2011) proposed a four steps analysis able to point out primary and secondary impacts of water use.

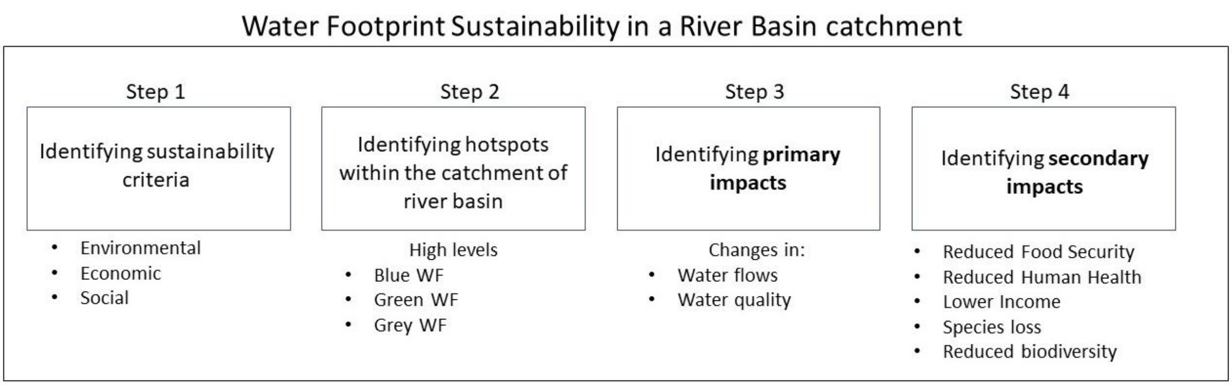

Figure 2 Water footprint assessment

The first step is deciding which sustainability criteria should be evaluated. One can notice that despite social issues are direct related to environmental and economic matters, this evaluation could tend to a more social outcome. The second step aims at identifying the hotspot regions in the river basin or sub-catchment in periods that WF values are unsustainable. This means that in this specific period inefficiencies, unfairness, and social conflicts may characterize water allocation. Additionally, water scarcity and water pollution might be pronounced.

Primary impacts purport the direct influences in water. This way, one could attain to levels of blue water footprint, compare the current water quality to natural conditions of water without human influences, and evaluate the environmental flow requirements. This makes it possible to understand disruptions triggered by humans to level and quality of water. Subsequently, secondary impacts represent the results from natural disorders in the river basin. Examples are loss of endemic and non-endemic species, altered biodiversity, human health affected by water pollution, food insecurity, lower income and lower production potential for activities that require water, lower sanitation, water scarcity for basic activities.

Questions to be answered during the workshop:

- Are these WF indicators sufficient to bring about social impacts?
- Would it be possible to create a WF indicator specially to account social issues?
- If so, which criteria and which measurements should be considered?

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