Fresh Water Supply and Utilization by The Global Food System:

Regulation of Water Appropriation in Developing Countries by Explicitly Addressing Green Water Grabbing within Multilateral Environmental Agreements.

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Executive Summary

Water scarcity has become one of the most challenging issues for developing countries, as they are economically dependent on agricultural institutions that continue to appropriate water supply within and beyond the basin scale. From assessing the existing governance of two main regulated global water convention frameworks, the UN Convention on the Law of the Non-navigational of International Watercourses (UNWC) and the United Nations' Economic Commission for Europe (UNECE) Water convention, there are gaps within these frameworks resulting in a lack of policy on 'invisible' water sources creating multiple avenues for green water grabbing that is detrimental on water supply. Thus, policies must be implemented to understand land acquisition problems from a hydrological context to provide sustainable water regulation without jeopardizing economic growth in developing countries. Thus, it is suggested that a Multilateral Environmental Agreement should be adopted explicitly addressing green water and water grabbing by implementing policies that mitigate water related risks of LSLA in both sustainable land and water managements/practices.

Foundational Science: Discussion & Analysis

Water is highly regarded as the most essential natural resource on this planet and according to the planetary boundary for Global freshwater use, it is perceived to be operating in a safe space as shown in green on Figure 1 (Rockstrom, et al., 2009). Nonetheless, one-fifth of the global population lives in areas with physical water scarcity and even more persons are affected by economic water scarcity (te Wierik, et al., 2020). In the 2000s alone, 4.8 billion of the world's

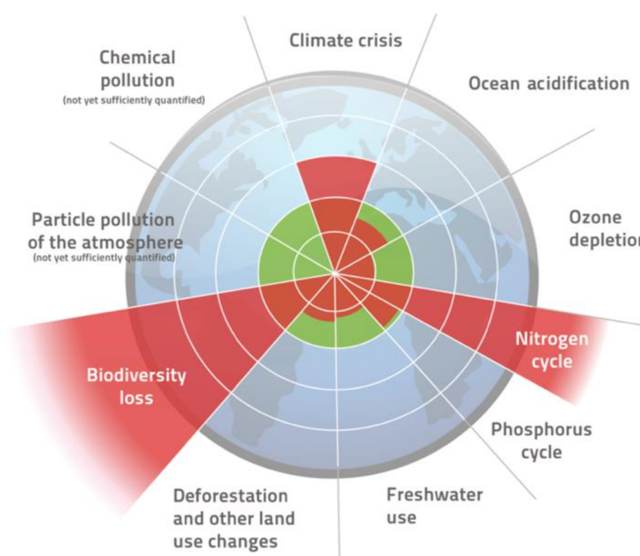

Figure 1: Planetary Boundaries, illustrates a limited operating space for ontologically objective resources in the context of the Anthropocene (Rockstrom, et al., 2009).

population lived in areas where either human water security and/or biodiversity loss exceeded the 75th percentile (Vorosmarty, et al., 2010), and by 2025 it is estimated that two thirds of the global population will be living in areas experiencing water stress (UNW-DPAC, 2011) (Breu, et al., 2016).

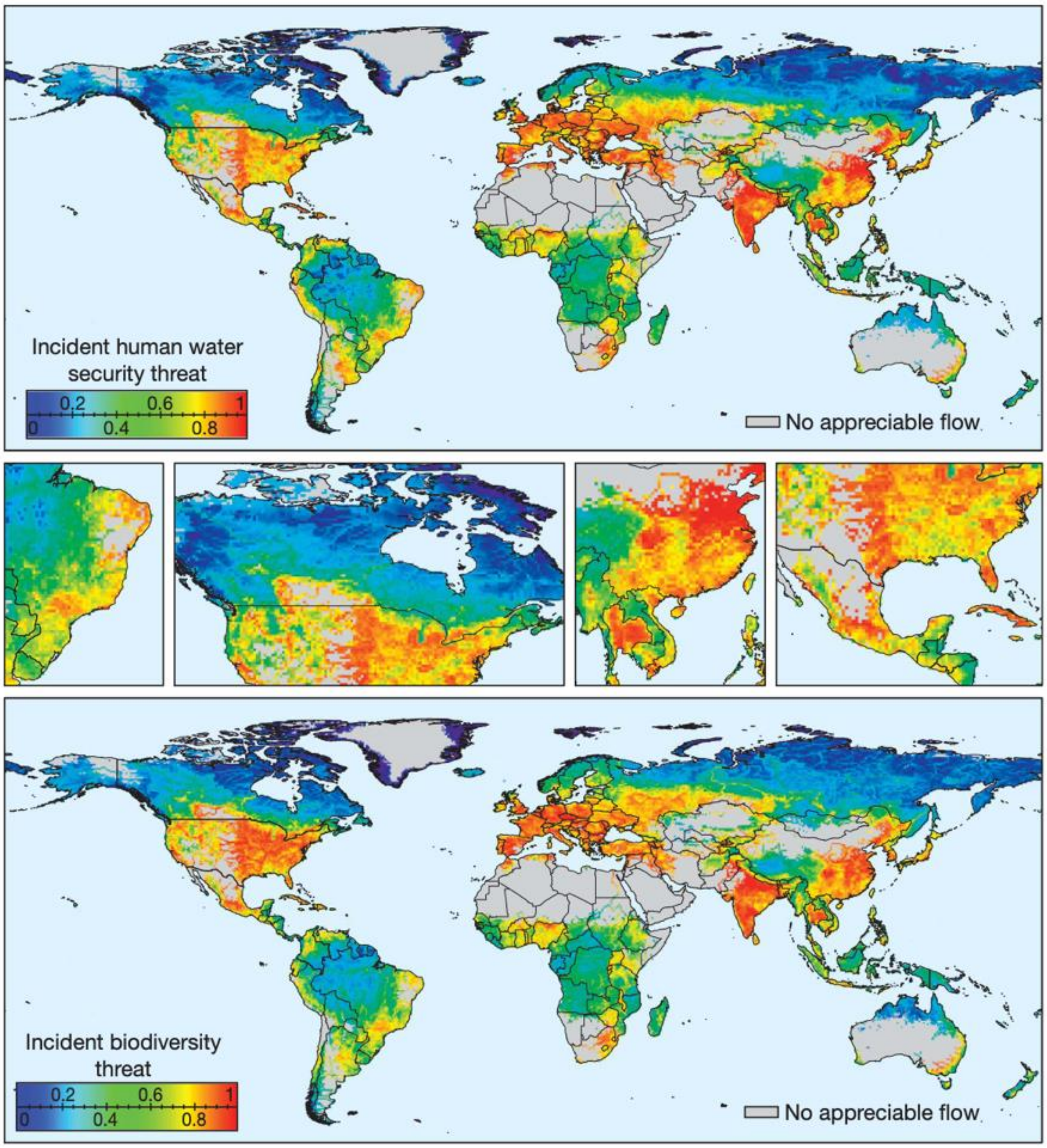

Figure 2: Global geography of incident threat to human water security and biodiversity (Vorosmarty, et al., 2010)

This is particularly a crisis for developing countries as they are economically dependent upon international virtual water flows through the increasing globalization of the world's agricultural sector (Hoekstra & Hung, 2005); this being the trade of agriculture commodities that require the consumptive use of all freshwater resources (te Wierik, et al., 2020). However, the benefits of water provision to economic productivity are followed with biodiversity and ecosystem impairment, resulting in more sever, but unquantifiable, cost (Vorosmarty, et al., 2010). Although, from a global perceptive, the trade of agricultural commodities has saved approximately 369 Gm^3/yr of freshwater between 1996 and 2005 (Mekonnen & Hoekstra , 2011; Breu, et al., 2016). Since the 1980s the global food system has gained greater power and influence over transnational corporations (Allan, 2015; te Wierik, et al., 2020) and has shown that these globalization dynamics negatively influence water resources in developing countries (Dell'Angelo, et al., 2018).

Approximately, 26.2% of water consumption in lower-middle income, lower income and least developed countries are from large scale land acquisitions (LSLA) from high-income countries (Breu, et al., 2016). With 7.2% of all LSLA-induced water consumption occurring in host countries, and around one half of the water consumption induced by developed high income countries taking place in developing countries (Breu, et al., 2016), with only 17.7% of these LSLAs taking place in countries with low water risk. Thus, the global trade infrastructure for agricultural commodities elicits rich developed countries to appropriate developing countries by putting additional pressure on regional blue and green water sources, to reduced high domestic ambient stressors (Vorosmarty, et al., 2010). This concept of appropriation is known as water grabbing and can be defined as the quantified amount of water, predominantly green and blue water sources, that are appropriated globally, mainly through crop production in the acquired land which directly and indirectly have potential effects on water and food security in the developing countries affected by these land investments (Dell'Angelo, et al., 2018).

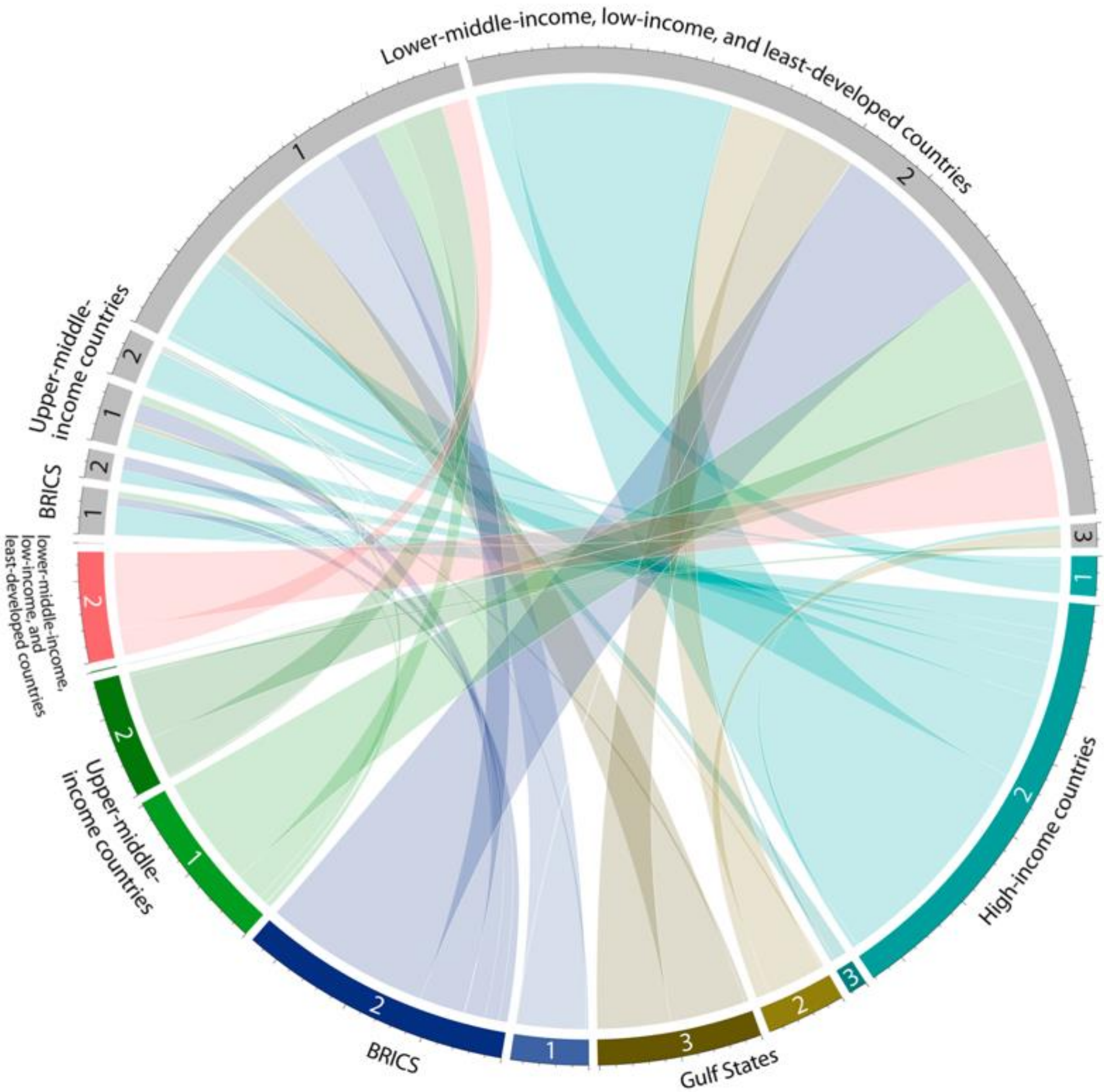

Figure 3: Different water flows induced by LSLA (Gm^3) between investor and host countries categorized by water risk. Investor's countries are illustrated with color whilst host countries are in grey. Water risk indices are defined by three categories: (1) low water risk – (3) high water risk (Breu, et al., 2016).

Furthermore, the hydrological vulnerability of acquisitive land is amplified due to the lack of representation of 'invisible water sources' such as green and atmospheric water within freshwater management in comparison to blue water sources (te Wierik, et al., 2020). Particularly, green water is essential within the context of water grabbing as it is defined as the upward vertical flux of evaporation and transpiration from the terrestrial surface (te Wierik, et al., 2020). Thus, green water sources are essential for the global food production as it is directly tied to land due to ecosystem services such as nutrient recycling, soil functioning and carbon sequestration (te Wierik, et al., 2020). With this being said, the global trade infrastructure therefore possesses a greater risk on green water grabbing through virtual water trade. As shown in Table 1, the modeled 475 LSLA projects would consume 91.9 Gm^3 of water annually and disaggregated data on green, blue, and grey water illustrated that 73% of the water consumed required for land deals was from green water, 8% from blue and 3% from grey water (Breu, et al., 2016).

Investors' region of origin	Number of land deals	Contracted or intended LSLA area [ha]	Water consumption of LSLAs in host countries [Gm^3/y]	Water consumption if LSLA crops were produced domestically in investor countries [Gm^3/y]	Contribution to global water savings [Gm^3/y]
Asia	261	16,209,377	55.6	79.0	23.4
Africa	42	2,698,258	9.5	12.1	2.6
South America	15	1,546,956	5.9	2.7	-3.2
North America	49	2,633,264	9.4	21.2	11.8
Europe	102	2,476,477	9.3	7.0	-2.2
Oceania	6	827,682	2.2	1.9	-0.3
Total	475	26,392,014	91.9	123.9	32.1

Table 1: LSLA and their contribution to the global water balance by investor countries (Breu, et al., 2016).

Assessment of Existing Governance

The UN Convention on the Law of the Non-navigational of International Watercourses (UNWC) and the United Nations Economic Commission of Europe (UNECE) Water Convention are the two primary international regulated global water conventions that provide frameworks operating at a global scale consisting of customary legal foundations for transboundary water cooperation

(Kinna, 2019). The UNWC as a worldwide framework tool, focusses on facilitating and sustaining transboundary water cooperation at a local and global scale, whilst ensuring reasonable utilization, development of infrastructure, conversation and watercourse protection and management at a region, basin, and international scale (SMA, 2015; Kinna, 2019).

Similarly, the UNECE Water Convention, comprises of a three-pillar framework which focuses on:

i. the active prevention and control of transboundary harm
ii. justifiable utilization of water source
iii. emphasis on equal cooperation

Both conventions in general, are mutually reinforcing similar objectives (Kinna, 2019) and act as a package approach (Rieu-Clarke & Kinna, 2014). Although these global water conventions have been, on an international level, responsible for 900 transboundary water agreements, they explicitly focus on eliminating the appropriation of blue water sources and do not consider the 'invisible water' resources such as green water and atmospheric water that withstand equal or more challenges and yet receive little to no attention in terms of governance (te Wierik, 2020).

- Within the UNECE Water convention there has been the implementation of the Water-Energy-Food (WEF) nexus (UNECE, 2018), which focuses on the interactions between all three systems to provide insights into the implications across different strategies within one sector (Laspiduo, et al., 2020). Nevertheless, the nexus's defined area of work within the UNECE Water convention focuses solely on the transboundary water bodies with relation to connecting resources for food and energy (UNECE, 2018). The application of the nexus approach within the UNECE water convention reflects the lack understanding of the complex dynamics of all water sources in relation to land and energy (Laspiduo, et al., 2020).

Correspondingly (Martin, et al., 2012), the neglect of specific governance on green and atmospheric water creates inefficiencies within these conventions as they are neglecting key aspects of the hydrolytic cycle (Dell'Angelo, et al., 2018). Thus, this lack of explicit proactive and preemptive governance of green water specifically will become detrimental, particularly for developing countries in a neocolonial context as it creates new avenues for water grabbing that impact water supply beyond the surface level (te Wierik, 2020).

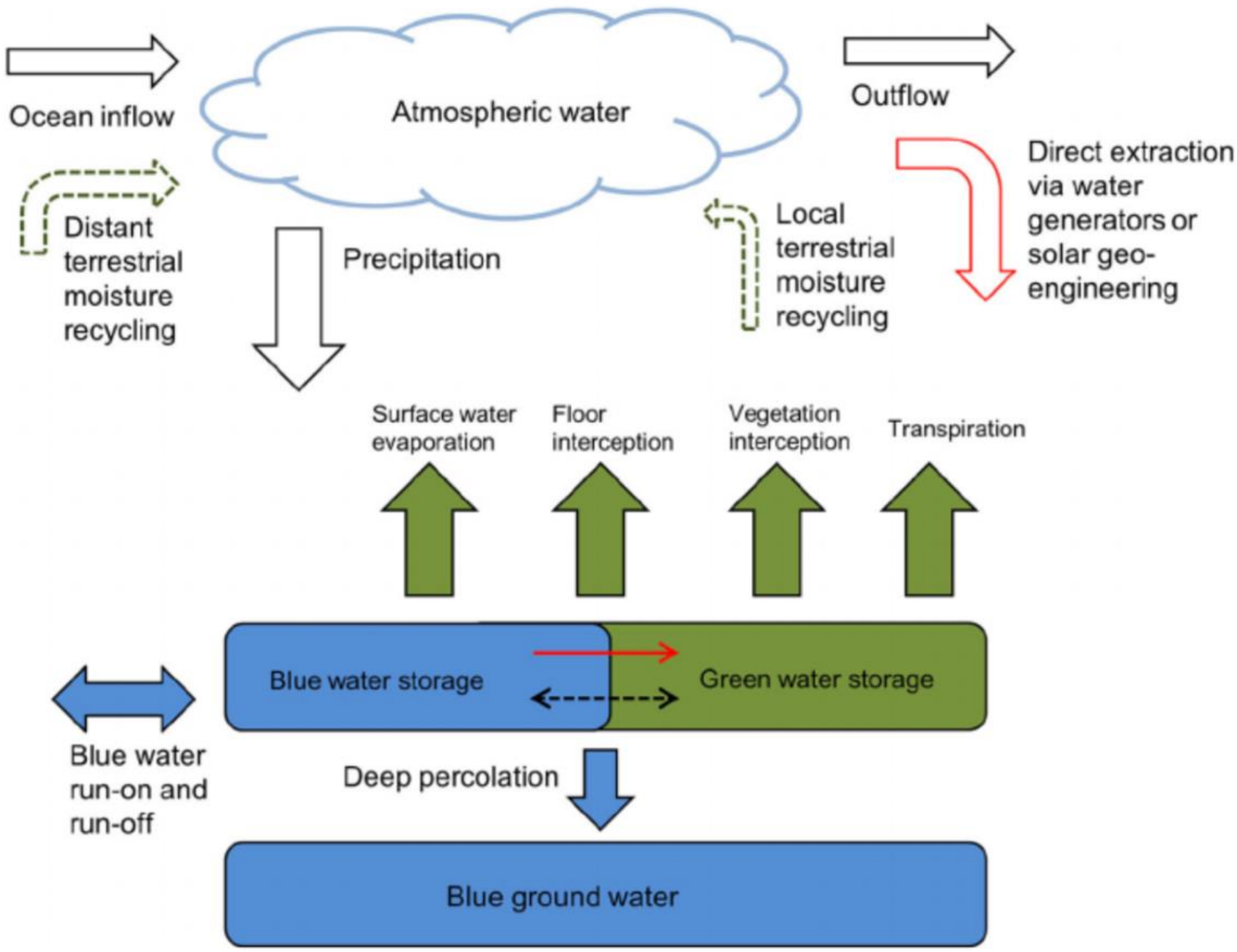

Figure 4: Systematic nature of blue, green, and atmospheric water with land-use change (te Wierik, et al., 2020).

Furthermore, this is amplified considering the concept of water grabbing is neither used officially within these water conventions nor unofficially by international development organizations. Even the adopted Agenda 2030 and Sustainable Development goal contain blind spots that are ambiguous and explicitly neglect policies, principles, and instruments for green water governance:

- SDG 6, ensuring the availability and sustainable management of water and sanitation for all, yet fails to address water sources needed for agricultural commodities (te Wierik, et al., 2020; Rulli, et al., 2013)

- SDG 2, eradicating world hunger, fails to address the appropriation of green water, through water grabbing by the global agricultural trade, despite water scarcity being a significant constraint on food production (te Wierik, et al., 2020; Rulli, et al., 2013)

Overall, water governance needs to move beyond the management, protection, and utilization of blue water sources by focusing on the quantification and management of invisible water sources. Therefore, considering the interdependent relationship between land use change and the systematic nature of blue, green, and atmospheric water sources, new governance must consider the implications of LSLA when addressing water supply (Rist, et al., 2016). By understanding land acquisition issues through hydrological lenses, this provides an alternative pathway for transnational land deals without jeopardizing developing countries water scarcity while still benefiting from the economic gain the international viral water flow provides (Dell'Angelo, et al., 2018).

Governance Recommendations

An important avenue for addressing the issue of green water grabbing within an international arena, involving multiple parties is through the action of a multilateral environmental agreements (MEAs) (Harrould-Kolieb & Hoegh-Guldberg, 2019). There are a few MEAs that have acted in response to freshwater security, predominately the two aforementioned conventions. Nevertheless, there is no explicit treaty and/or single instrument that focuses on the appropriation of green water by LSLA and no coordinating node guiding the governance of green water sources (Dell'Angelo, et al., 2018). Considering, that MEAs are implemented for a geographic scope wider than a bilateral agreement, the implementation of an MEA that explicitly addresses issues surrounding green appropriation is crucial in order to provide a global voice for developing countries and protects them by breaking the economic power dynamic between the developed and developing countries (Allan, 2015).

Considering the following:

i. The interconnected nature of the hydrologic system and land-use change (Dell'Angelo, et al., 2018); and
ii. Current water governance lacks the direct control and formal decision-making power provided by intergovernmental governing bodies (Baumgartner & Pahl-Wostl, 2013).

An MEA must contain frameworks with coordinated strategies that contain polices that mitigate water related risks of LSLA in both sustainable land and water managements/practices (Breu, et al., 2016). Water management technologies such as flood water harvesting, mulching, crop rotation, minimum till and rainwater trapping provides mechanisms that increases the availability of both blue and green water sources, whilst limiting off-site effects on LSLA in order to promote locally adapted management practice of commodities and encourage inclusion of corresponding provision in LSLA contracts (Breu, et al., 2016), (Hering, et al., 2015).

Promising ways of mitigating green water policy within land-use change management include:

1. Through the principles of subsidiarity, thus polices implemented at a local scale are complemented with regional/global regulations whilst containing binding frameworks on investments in agriculture which include specific provisions for water related issues beyond the basin level (Breu, et al., 2016).

2. Developing a water taxation scheme on a quantified amount of water appropriated through the acquired land’s production process. Thus, providing a further financial incentive for more sustainable green and blue water usage while providing economic growth opportunities for the acquired country (te Wierik, et al., 2020). However, the employment of taxation has only been shown effective when there is effective monitoring and

enforcement system put in place, thus it is crucial that these infrastructures are integrated within a water taxation scheme (Martin, et al., 2012).

- An example of a similar scheme is the Green Water Credit scheme in Kenya which provided financial incentives for poor upstream land and water users to enhance their land management practice and improve their virtual water usage (Lal, 2013) (te Wierik, et al., 2020).

3. Implementing a land-water license consisting of user fees within a sustainable cost recovery policy that are directly reinvested into efficient water usage maintenance and operation cost (UNEP, 2010).
    - Improvements in data collection for green water usage through developing international data protocol and data-sharing agreements that can be used to establish water footprints for different countries and corporations. The establishment of water footprints can be used within the application for land-water licenses and can be used to produced annual reports to document the amount of water being used whilst acquiring a license.
    - Enforcement of tax rebates in the form of discounted license fees when sustainable technologies and management are employed by trading agricultural commodities and transnational land investments.

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