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COMMENTARY

Cascading socio-environmental sustainability risks of agricultural export miracle in Peru

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Abstract
This commentary sheds light on the integration of cascading environmental, economic, and social risks into conscious sustainable development strategies. For this, we investigated the Andean Trade Preference Act (ATPA), which was established in 1991 to simultaneously fight against the production, processing, and trafficking of illegal drugs while also developing alternative industries to expand economic opportunities in the Andean countries (Bolivia, Colombia, Ecuador, and Peru); which are being faced with decades of narcotic violence and corruption. Accordingly, we unfolded the chains of mechanisms by which, cascading like toppling dominoes, the ATPA has led to a profitable economy but unsustainable environment and social inequality in the hyper-arid region of Ica in Peru. To pioneer Peru in sustainability risk management in Ica, hence, it is recommended to act towards regional sustainable irrigation expansion by employing efficient water-saving irrigation technologies. Finally, we indicated that freshwater should be considered as both natural and human rights in sustainable alternative development strategies.

Keywords Alternative development · Andean Trade Preference Act (ATPA) · Groundwater · Peru · Sustainability · Water Scarcity

Andean Trade Preference Act (ATPA)

With vigorous bipartisan support, the U.S. Congress in 1991 (P.L. 102–182, title II) voted to enact a new policy, known as "America's Drug War", with an overall intention to reduce drug supplies. At the core of this drug policy, the "Andean Trade Preference Act (ATPA)" (ATPA 1991) was established to simultaneously fight against the production, processing, and trafficking of illegal drugs while also developing alternative industries to expand economic opportunities in Bolivia, Colombia, Ecuador, and Peru; which are being faced with decades of narcotic violence and corruption (USITC 2018; CICAD 2019). Evidence suggests that neither the flow of cocaine has been reduced (Briones et al. 2013; UNODC 2019), nor has the alternative development goal been met (Buxton 2015; Grisaffi and Ledebur 2016). Meanwhile, the drug policy and the ATPA have endangered the livelihoods of indigenous people, threatened biodiversity, and caused forest loss in the Andean and transit countries (Bradley and Millington 2008; Briones et al. 2013; McSweeney et al. 2014; Wåhlin 2018; Damonte and Boelens 2019). Improving our knowledge about the unforeseen cascading sustainability risks of alternative development strategies (e.g. ATPA) can play a crucial role in achieving the 2030 Sustainable Development Goals (SDGs) adopted by the United Nations (UN) in 2015 (UN 2015).

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Coinciding ATPA and water scarcity

The ATPA aimed at eradicating cocaine production in the “Silver Triangle,“ which is located in the Amazon basin of Peru, Colombia, and Bolivia. Soon after the ATPA was enacted, water scarcity started to become a challenge in the “Ica-Villacurí” aquifer (Damonte and Boelens 2019), which is located on the other side of the Andes, in the coastal zone of Peru. This begs the question: How are the two connected?

Water scarcity is often caused by multiple drivers, such as low water endowments, socio-economic development, weak governance, social transformation, political conflicts, urbanization, and climate change (Bytaert and De Bievre 2012; Damonte, 2019). In the case of the “Ica-Villacurí” Aquifer, the agribusiness expansion in the Andean countries during the 1990s, which was greatly facilitated by the reduction in tariffs through the ATPA, was a key driver in accelerating the abstraction of groundwater. This alternative development strategy (ATPA) has indirectly accelerated water demand by creating a market for high-value, but water-hungry crops, and consequently became a powerful water scarcity driver in its own right: One clue to this connection lies in the robust relationship between the location and timing of increases in water abstraction and the “agricultural export miracle” (Damonte 2019), following the ATPA. It encouraged companies to produce high-value crops, such as asparagus and grapes for the international market (Damonte and Boelens 2019). The mild and sunny weather along the coastal region of Peru provides favorable conditions for grape and asparagus production. However, there is hardly any rainfall in that region, less than 10 mm per year. Therefore, crop production entirely depends on irrigation, utilizing two sources of water: The Ica River and the three aquifers of Ica, Villacurí, and Lanchas.

In the 1990s, asparagus and grapes production started to boom in the Ica region (Damonte 2019). With a spring-like climate year-round, this region has the advantage of being able to produce first-class asparagus and grapes for the high-income markets of the Northern Hemisphere, particularly during their off-season. A combination of the favorable business environment, relaxed land ownership rights, relatively low labor costs, and new trade agreements signed with other countries in the early 2000s facilitated the further expansion of asparagus and grapes as the golden cash export crops in Ica. For example, Ica produces 45% of all Peruvian asparagus (Moore 2017), which generates about US$250 million per year in export revenue for this country (Carrasco 2019). However, the large increase in asparagus (from ~410 to > 10,000 ha) and grapes (from ~3000 to > 5000 ha) cultivation between the early 1990s and 2013 (Damonte 2019) has considerably accelerated water demand and consequently created a water crisis in this region, which is classified as hyper-arid zone according to the United Nations Environmental Program (UNEP) aridity index (AI) (e.g., Sohoulande et al. 2022).

Compared to the grapes, hence, asparagus has played a superior role in driving up water use in Ica, due to its large total production area and naturally high-water demand. Asparagus requires between 15,000 and 17,000 m^3 of water per ha and year (Fernández-Escalante et al. 2020), which is about 25% more than grapes (Schwarz and Mathijs 2017).

The Ica-Villacurí Aquifer supplies ~88% of the total water used in the region and ~75% of the agricultural production depends on it (ANA 2015). There was a heavy increase (~150%) in annual groundwater extraction, from 225 hm^3 in 2002 to 550 hm^3 in 2009, which coincided with the expansion of asparagus and grape crops (ANA 2015). In 2004, groundwater extraction of 315.8 hm^3 from this aquifer overexploited its recharge rate of 252.3 hm^3 by 63.5 hm^3. By 2013, groundwater extraction reached 409.3 hm^3 (Schwarz and Mathijs 2017). This estimate is lower than the 550 hm^3 reported for 2009 (ANA 2015), but still 62% above the recharge rate (Schwarz and Mathijs 2017). As shown in Fig. 1, the increase in asparagus production goes hand in hand with the decline in the water table. Thus, the booming asparagus cultivation has pushed the water balance in Ica into an unsustainable state during a concernedly short period.

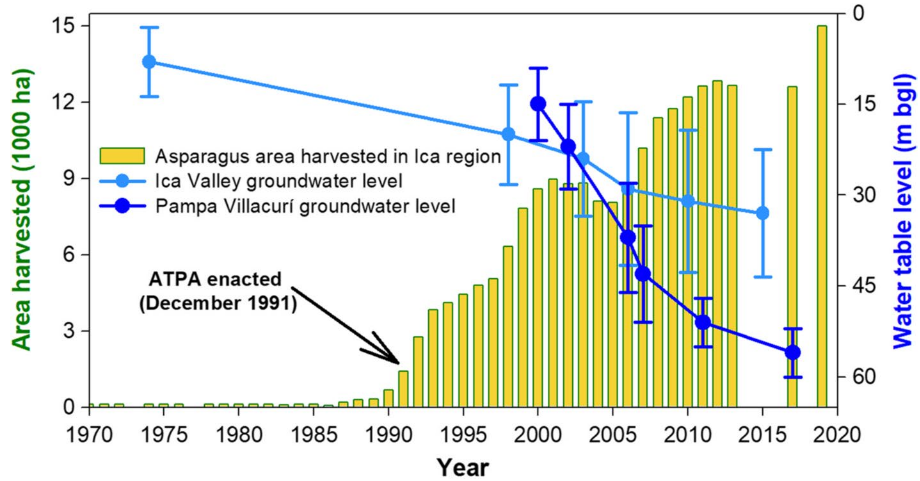
Profitable economy, unsustainable environment, and social inequality

According to various studies, following the ATPA introduced in the early 1990s, five interrelated mechanisms might have been involved in the acceleration of groundwater scarcity in Ica as an unexpected result of the agroindustry development in generating foreign currency in Peru:

First, groundwater resources are overexploited for the large-scale production of non-traditional export crops, particularly asparagus and grape, and associated population growth in Ica.

Second, large-scale producers benefitted most from exporting high-value luxury crops thanks to an institutional framework created by the government in order to foster economic development (Schwarz et al. 2016). Such reforms led to the establishment of different institutions, policies, laws, certificates, and agreements that: (i) facilitate access to natural resources, most importantly land and water; (ii) build new and promote existing export infrastructures; (iii) improve the quality of crops for meeting international standards; (iv) attract both foreign and domestic investors; (v) lower the tax burden for agricultural export companies; and (vi) secure a stable international market demand by signing new free trade agreements (FTAs) with other partners

Fig. 1 Trends in annual asparagus area harvested and groundwater table levels in the two main aquifers underlying the Ica region in Peru (Sources: Gómez and Flores 2015; Moore 2017; Fernández-Escalante et al. 2020). For each year, the lowest and highest levels of the groundwater table are indicated by the lower and upper bars, respectively, while the mean level is by the filled circle



(most notably the U.S., the EU, and China) that, for example, reduced the tariffs for the Peruvian fresh asparagus from 66% to 1990 to 3.4% in 2011 (Schwarz et al. 2016). These structural economic adjustments for agricultural export-led growth focused on the agroindustry. Clear evidence is the World Bank's Structural Adjustment Program which has granted multimillion-dollar loans to the Peruvian asparagus industry since the 1990s. This program was supposed to consider environmental and social issues, but has seemingly failed; particularly in the context of water conservation in Ica. It has also favored the development of large-scale, export-oriented, and foreign companies, but not small, poor, and domestic producers. This has led to substantial increases in social inequalities and a significant deepening of poverty for local farmers at the bottom of the social structure in Ica (Martin-Preve and Kim 2015), e.g., smaller farmers cannot afford, or face regulatory constraints, to deepen their wells once they dry up (Fernández-Escalante et al. 2020).

Third, acting towards sustainable economic growth has laid the foundation for dramatic water scarcity in Ica just after a few years. Massively expanding already available or new agricultural land for growing crops for export has intensified pre-existing pressures on water availability. In the search for additional water resources, the agricultural export companies decided to: (i) purchase the dilapidated wells that were successively restored; (ii) purchase land with pre-existing wells for transferring the rights of extraction; and (iii) drill new underground wells (Damonte et al. 2014; Damonte and Boelens 2019). In Ica, consequently, the groundwater level declined up to 1.5 m per year during 1968–2009, and in some spots dropped to more than 100 m below the surface (ANA 2012). To slow down such overexploitation of the aquifer and restore its sustainability, in 2005, the regional government banned the drilling of new boreholes. On different occasions, the National Water Authority (Autoridad Nacional de Agua or ANA) endorsed, renewed, and reinforced this ban. However, the ANA has experienced serious challenges in monitoring and approving the operations of the main groundwater extractors, who successfully stabilized their position as the key economic and political actors in Ica (Damonte 2019).

Fourth, a coalition between the leading agricultural export companies, government institutes, and local leaders has enabled the agribusiness elite in Ica to consolidate and sustain almost unlimited access to groundwater. It encompasses three different dimensions of power: (i) economic capacity for acquiring land, groundwater, and advanced technologies to generate profit from production; (ii) advanced technical knowledge and know-how and (iii) coercive capacity in the form of physical violence, discrediting the reputation of individuals or impeding government attempts for monitoring and regulating groundwater extraction (Wåhlin 2018; Damonte 2019). The agribusiness elite has established control over both surface and groundwater resources in Ica in order to increase crop (mostly asparagus and grape) production regardless of environmental concerns.

Fifth, the booming of asparagus production and processing has generated considerable employment opportunities in Ica. Although the wage of labor in such agricultural export activities is about 30% higher than that on the local farms, there still exists high social inequality. The relatively higher wages have encouraged poor laborers and farmers to migrate from the Peruvian Highlands, called Altiplano, to Ica, increasing its population by 190% between 1981 and 2017 (Damonte et al. 2014; Damonte 2019). About 80% of the people settled in the urban and peri-urban areas, significantly increasing drinking water demand that intensified water scarcity along with the expansion of agricultural exports. The present drinking water supply system in Ica (EMAPICA) does not ensure equal access: It provides 12-h service during a day to upper-class areas and only a couple of hours to mostly poor neighborhoods. The deterioration of drinking water quality has also posed public health challenges such as anemic, chronic, and acute diarrheal diseases (Wåhlin 2018).

Sustainable irrigation expansion: a science-based actionable recommendation

In the context of supply-side drug eradication policies, the cultivation of profitable cash crops was encouraged about 30 years ago through the ATPA to provide an alternative legal economic opportunity for cocaine producers and transit countries in the Andean region (Buxton 2015; USITC 2018). Triggering favorable FTAs, this strategy not only caused a boom in the cultivation of water-hungry asparagus but also attracted poor agrarian laborers from different parts of the country (including the so-called Cocaine Valley) to the hyper-arid environment of Ica in Peru. Accordingly, poverty levels are lower in the Ica region than in the Altiplano, but already existing freshwater scarcity got exacerbated through the groundwater overexploitation for irrigation. Hence, the supply of drinking water is limited, and consequently, people are exposed to diseases caused by contaminated water (Wåhlin 2018). This seriously threatens not only SDG6 ("Clean Water and Sanitation") but also SDG1 ("No Poverty"), since freshwater resilience (Rockström et al. 2014) plays a key role in agricultural export development, one of the main pillars of Peruvian economic growth.

As a mid-term intervention in water-related factors for achieving water security (Irannezhad et al. 2021), sustainable irrigation expansion can assure sufficient freshwater resources required for human activities (rights to water) and nature (rights of waters) (Jenkins et al. 2021). The term "sustainable irrigation" indicates a situation in which freshwater consumption does not surpass freshwater availability while protecting both freshwater storage and environmental flows (Rosa et al. 2020). In response to significant increases in competition for freshwater in the hyper-arid environment of Ica, moving towards sustainable irrigation expansion needs to swiftly emerge in adopting both efficient (EITs) and water-saving (WSITs) irrigation technologies. The EITs ensure irrigation freshwater availability along with effective low-volume irrigation technologies, while the WSITs employ traditional as well as household- and community-based approaches to conserve freshwater in agriculture (Rouzaneh et al. 2021). In its sustainability risk management, particularly in Ica, Peru can learn many lessons from semi-arid or arid countries like Israel and China in which different EITs and WSITs, respectively, have revolutionized the agricultural sector (e.g., Saini et al. 2021) by supporting sustainable irrigation expansion. For example, Peru can particularly increase agricultural water use efficiency in the Ica region by breeding more drought-resistant asparagus or practicing supplementary instead of full irrigation techniques for asparagus production.

Rights to water and rights of waters in the context of sustainable development

In Peru, the agricultural export miracle is becoming endangered by its own success. The Ica region in Peru is the best empirical evidence for the negative externalities of unconscious alternative development strategies. Accordingly, socio-environmental fragility or collapse (Falkenmark et al. 2019) in arid regions with high economic dependency on the cultivation of high-value but water-intensive crops should be added to the unintentional consequences resulting from the overwhelming focus on economic growth policies. This is an important reminder for governments that national, regional, and international agribusiness expansion agreements (like ATPA), as a profitable alternative development strategy, must also consider both rights to water and rights of waters, particularly in arid and semi-arid regions. Hence, careful interdisciplinary and transdisciplinary research is required to comprehensively assess both direct and cascading environmental, economic, and social concerns about the alternative development strategies, especially for agricultural sustainability in different parts of the world. Such a conscious rethinking of the agribusiness expansion policies and agreements could successfully act towards achieving the SDG1 ("No Poverty") and SDG6 ("Clean Water and Sanitation") (UN 2015), particularly in the Andean region.

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Declarations

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this commentary.

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