



The added value of a water footprint approach: Micro- and macroeconomic analysis of cotton production, processing and export in water bound Uzbekistan

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ARTICLE INFO

Article history:

Received 23 November 2011

Received in revised form 6 September 2013

Accepted 20 September 2013

Available online 27 September 2013

Keywords:

cotton

water use efficiency

value chain

input–output model

transition economy

ABSTRACT

Since independence from the former Soviet Union in 1991, Uzbekistan is challenged to consolidate its efforts and identify and introduce suitable agricultural policies to ease the threat of advancing land, water and ecosystem deterioration. On the one hand, irrigated cotton production provides income, food and energy sources for a large part of the rural households, which accounts for about 70% of the total population. On the other hand, this sector is considered a major driver of the on-going environmental degradation. Due to this dual nature, an integrated approach is needed that allows the analyses of the cotton sector at different stages and, consequently, deriving comprehensive options for action. The findings of the economic based value chain analysis and ecologically-oriented water footprint analysis on regional level were complemented with the findings of an input–output model on national level. This combination gave an added value for better-informed decision-making to reach land, water and ecosystem sustainability, compared to the individual results of each approach. The synergy of approaches pointed at various options for actions, such as to (i) promote the shift of water use from the high water consuming agricultural sector to a less water consuming cotton processing sector, (ii) increase overall water use efficiency by expanding the highly water productive industrial sectors and concurrently decreasing sectors with inefficient water use, and (iii) reduce agricultural water use by improving irrigation and conveyance efficiencies. The findings showed that increasing water use efficiency, manufacturing products with higher value added and raising water users' awareness of the real value of water are essential for providing water security in Uzbekistan.

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1. Introduction

The ongoing land and environmental degradation in the Aral Sea Basin is engraved by decreasing water security. Since the 1960s, a vast system of irrigation and drainage networks has been constructed by diverting river flows that used to feed the Aral Sea. In the past four decades, between 80 to 95% of water from the Amudarya and the Syrdarya rivers, with annual flows of around 75 km³ and 34 km³ respectively, have been used for irrigation purposes, especially for cotton (*Gossypium hirsutum* L.) production (Horinkova and Dukhovny, 2004).

In Uzbekistan, cotton production consumes around 41% of all irrigation water and about the same share of all irrigated land (Rudenko et al., 2012a). However, it is postulated that an increase in water demand in the upstream countries of the Aral Sea Basin could hamper irrigated agricultural production in downstream Uzbekistan, especially in the lower reaches of the Amudarya (Martius et al., 2008). In addition, it is predicted that as a result of climate change, the availability of water in the

Amudarya and the Syrdarya rivers may decrease by 30% and 40% respectively (Perelet, 2007). Since cotton continues to be a centerpiece of Uzbekistan's agriculture and as a cash crop accounts for 11% (as of 2009) of the national export revenues (UzStat, 2010), the country would benefit from cotton strategies that reduce its dependence on uncertainty in water availability. One way of attaining this can be through upgrading the cotton value chain by expanding the production of cotton-based products with higher value-added rather than relying on raw cotton production. The second option implies the development of alternative agricultural and industrial activities outside the cotton sector. This study therefore aims at estimating and comparing the development options of different cotton-based and non-cotton production activities.

Given the present economic and ecological situations, it is necessary to consider not only high returns to investments, as predominantly has been emphasized in the past, but also their relevance for environmental sustainability. Yet, such a comprehensive assessment demands a methodological approach that is able to consider financial and ecological aspects of regional development with a focus not on isolated sectors but on interrelated agricultural and subsequent industrial activities. To reach this objective, a combination of methods was selected suitable

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for different scales. The value chain analysis (VCA) and water footprint analysis (WFA) were employed for the financial and water use analyses of the cotton value chain. The VCA of cotton looked at the flow of cotton-based products and described the underlying production cycles for estimating financial gains along the cotton chain. This method was combined with the WFA to estimate water use in the entire chain of producing and processing cotton products starting from raw cotton at the field level and up to all processed products including cotton fibre, yarn, fabrics and ready-made garments. Furthermore, in the WFA, the concepts of virtual water use and water footprint are differentiated. According to the definitions of Chapagain et al. (2005), the virtual water content gives information on how much of water is used to make a product or service and is therefore mainly used in trade analysis. In contrast, the water footprint has a broader meaning and refers to the place, source, and type of water used at different stages of production. These definitions were adopted in this study. Although the VCA and WFA helped in analyzing the details of the entire cotton value chain (CVC) at a regional level, these methods are less practical to evaluate the returns, and direct and indirect water uses in all economic activities outside the cotton sector. Therefore, the environmentally-extended input–output model (IOM) approach was used for the analysis on a national level. Although several studies (Lenzen and Foran, 2001; Lenzen, 2003; Velazquez, 2006; Dietzenbacher and Velázquez, 2007; Zhao et al., 2009; Feng et al., 2011) had successfully applied IOM to track intersectoral paths of water consumption and to identify highly productive sectors of the economy in different countries, there are no studies yet on the case of the countries of the Aral Sea Basin.

2. Methodological approach and data

2.1. Study site

The detailed analysis of the cotton value chain was based on the cotton production and processing in the case study region — Khorezm.

While the analysis of cotton and non-cotton production activities was considered for the entire Uzbekistan.

The case study region Khorezm is located between 60.05 and 61.39 N and 41.13 and 42.02 E in the northwest of Uzbekistan (Fig. 1). The majority of the population resides in rural areas and their livelihoods depend on agricultural production. Agriculture in Khorezm is possible with irrigation only to compensate the difference between the low precipitation (annually 100 mm) and high evaporation rates (up to 1400–1600 mm) resulting from the continental climate. Annually 4.5–5 km³ of water are diverted from the Amudarya river, mainly for irrigation, whereas agricultural water consumption at a national level is 40–50 km³ for the entire country. However, the probability of receiving sufficient water for irrigation has been decreasing over the last decades (Müller, 2006). The recurrently mentioned water scarcity has been aggravated not only by external factors, such as river runoff reduction due to climate change and the growing water demand in upstream countries (Djanibekov et al., 2012), but also by internal factors, including the expansion of the production of water intensive crops such as cotton and rice and the poor condition of the irrigation and drainage infrastructure causing high water losses (Tischbein et al., 2012).

Cotton is the major crop in the study region and Uzbekistan accounting for more than 40% of the total irrigated lands (Table 1). The cotton self-sufficiency policy of the former USSR introduced since the 1950s led to an extensive expansion of the cotton production and specialization of the agricultural sector mainly to produce this crop in the Central Asian regions (Rudenko, 2008). Considering the importance of cotton production in export revenue generation, the dominance of irrigated cotton in agriculture continued after independence of Uzbekistan in 1991 despite that the sector was blamed for the desiccation of the Aral Sea, once the fourth largest lake in the world. Because of the strategic importance of cotton, a stable water supply is provided to cotton fields even in drier years though at the expense of other crops. This is evidenced for instance by cotton production levels in 2001, a drought year, which were nevertheless comparable to the cotton production



Fig. 1. Khorezm region in Uzbekistan.
Source: Müller (2006).

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