POTENTIAL OF WATER MANAGEMENT THROUGH PAKISTANI PROVINCIAL TRADE OF AGRICULTURE COMMODITIES

Mamona Sadaf, and Asad Zaman

International Institute of Islamic Economics (IIIE), International Islamic University, Islamabad (IIUI), Pakistan

ABSTRACT

Alarmingly decreasing per capita water availability coupled with growing food demand and persistent mismanagement of water resources is putting extra burden on Pakistani waters. Government of Pakistan is emphasizing the infrastructural, financial and institutional measures to tackle the problem of water management. Financial as well as social constraints occur as matchless obstacles for effective considerations. Current study calls forth the alternative strategies to reduce the pressure over local water resources. Virtual water trade has been used as a strategic policy option within or between nations as an alternative or supplement to the physical water transfers. Concerning Pakistan, within country virtual water trade is worthwhile due to the existence of it's' regions with different water endowments and agro-climatic conditions to deal with the issue of scarce water resources. Water footprint methodology is used to analyze quantification of virtual water flows for major agricultural commodities between Pakistani provinces by putting them in the context of water availability to seek the existence of trade patterns according to the Comparative Advantage Theory. By doing so, global water saving is assessed. The analysis shows that 17% of agriculture water usage is outsourced to the provinces in the form of agriculture commodities. Total virtual water flow (VWF) in Pakistani interprovincial trade is found as 7.7 billion m^3 for the year 2004-08. Furthermore, the largest negative virtual water balance is found in KPK followed by Baluchistan. Interprovincial virtual water flow has improved water resource situation in Pakistani provinces, as they are found utilizing large amount of more water than their agriculture water usage from internal resources. Moreover, interprovincial trade in agricultural commodities resulted in substantial amount of water saving and vindication of Comparative Advantage Theory in term of 'water endowments' and 'opportunity cost of producing alternative crops' is found to be partially true in case of virtual water trade between Pakistani provinces. Present study recognizes the need to address the issue of water management by emphasizing upon the least water scarce provinces to realize their comparative advantage to enhance water productivity over most water scarce provinces. Moreover, the relatively drier provinces can also realize their potential for water management through comparative advantage in producing the crops in which they are more productive in terms of water than other provinces. Therefore, this study calls forth the inclusion of virtual water trade in water management approaches as the conscious choice to confront the issues related to water scarcity.

Keywords: Virtual Water Flow, Comparative Advantage Theory, Water footprint Methodology, Water Endowments, Opportunity Cost, Water Saving

1 INTRODUCTION

Pakistan is an agrarian country with the well developed irrigation system. 93% of Pakistani water is being utilized in agriculture even though its demand for agriculture is getting more acute as a result of continual mismanagement of water resources coupled with decreasing per capita water availability. In case of persistent implication of the existing policies for water management; irrigation water requirement for the year 2024-25 is projected as 255 billion m^3. While, it was found as 163 billion m^3 for the period 1994-95 (Ahmed, s., et al, PEC 70th annual session proceeding)

Water resources of Pakistan are 172 billion m^3 (IWASRI, 1998) that cannot fulfill the all the water demand and leads to the shortfall of irrigation water as 83 billion m^3 for 2024-25 period. Virtual water trade may prove useful which calls forth an alternative strategy works to reduce pressure over local water resources in Pakistan. Prof. Tony Allan; introduced the term 'virtual water'; referring to the water required in the production of the commodity or imbedded in it (Allan, 1992, 1993, 2003).Virtual water is considered as a thriving source for mitigation of water scarcity in water deficient nations.

2 TRADE IN VIRTUAL WATER

Water resources of one place can be indirectly affected by the inhabitants of other places. Trade in commodities is a one significant and silent mechanism that creates a link between water demand and its usages at different places. International and regional trade in commodities entails long-distances virtual water (VW, henceforth) transfers (Hoekstra & Chapagain, 2008). Virtual water trade (VWT, henceforth) adds a new dimension in understanding water scarcity and its management(Kampman, 2007; Hakimian, 2003).VWT concept is in practice to account potential gains from regional and international trade in perspective of factors of production and factor's endowments to address the problem of food to mitigate indigenous water scarcity (Allan, 2003). Many Middle East countries have recognized the importance of VWT, as more water flows in to the Middle East each year as 'virtual water' than flows down the Nile into Egypt for agriculture. VWT has been considered by many nations as an alternative to physical water transfers (El-Sadek, A., 2011).

Water management at different levels as global, administrative, basin, sector and commodity level has been investigated by many researchers. Many researchers have emphasized within country VWT more important for water management. It is important to consider within country VWT to form judicious national polices on water and its usage (Mubako, 2011). Within country analysis can be more advantageous in case of international dependencies, favored agricultural growth, ecological impacts, and logistic issues (Horlemann and Neubert, 2007).

VWT analysis in case of Pakistan seems worthwhile due to the existence of the regions with different water endowments and agro-climatic conditions. It has subtropical and semi-arid climate that contains the regions with varying average rainfall from 1500mm and 50mm. (Randhawa, H. A., 2002).

Strategic importance of VWT is advocated by many researchers as to apply the concept in comparative advantage tradition of economic thought (Allan, 1998, 2003). It's being reckoned that VWT can lead to improve comparative advantage and disadvantage in water endowments (Allan, 1994, Horlemann and Neubert 2007). Nations are advised to recognize their absolute or comparative advantage over water resources and their sustainable usage to glean monetary compensation and to lessen regional dependencies as comparative advantage theory of trade suggests (Lenzen and Foran, 2001; Wichelns, 2004; Hakimian, 2003).

Substantial amount of literature has considered different entities as an appropriate unit for the analysis of virtual water trade as a source to address stressed water management. Many researchers have considered VWT analysis as advantageous or disadvantageous for country, global or at regional level. Some researchers have conditioned the scope of VWT analysis as to include economic social and political factors other than water. Within country VWT analysis is found imperative by many researchers due to the existence of disparities in agro-climatic condition and water endowments within country Ma et al., 2006, Guan & Hubacek, 2007, Kampman et al., 2007, Mubako et al, 2011 Bulsink F. et al, 2010 have quantified VWT for China, India, U.S. and Indonesia respectively. Analysis shows that North china (Water scarce) is exporting 52 billion m^3 of VW to South China which is more than the direct water transfer volumes (Ma et al., 2006). VW flow between Indian states in primary crops is estimated as 106 billion cubic meter per year (Kampman, 2007). Similarly, Mubako (2011) has quantified VWT between U.S states as 19 cubic gigameter in primary crops and

live stocks collectively. Interprovincial VWT for the primary and processed crops within Indonesian provinces is found as 32 billion meter cubic per year (Bulsink et al, 2010). Furthermore, VWT analysis in case of Pakistan seems worthwhile as huge differences prevails between its regions for instance it consists of the places with varying average rainfall from 1500mm and 50mm (Randhawa, H. A., 2002).

3 INTERPROVINCIAL VIRTUAL WATER FLOW (VWF, henceforth) AND WATER SAVING IN PAKISTAN

Sadaf (2013) has used water footprint methodology for the quantum of VWF between Pakistani provinces to put them in context of water availability to seek the existence of trade patterns according to the comparative advantage theory. By doing so, implication of comparative advantage theory in water endowments and opportunity cost of water use perspective has been analyzed. Trade in 18 selected agricultural crops covers about 90%, 80% and 87% of the total agricultural water usage, production value and land utilization respectively. Gravity model of trade (In provincial context) complimented with certain assumptions is followed to estimate interprovincial trade and water embedded in them.VWF in Pakistani interprovincial trade is found as 7.7 billion m^3 for the period 2004-08. This is about 17% of the total water used by provinces in the same period. Interprovincial and Internatational trade in agriculture commodities is responsible for the largest negative virtual water balance of KPK as 8 billion cubic metre followed by Baluchistan as 1.8 billion cubic metre. While, Punjab and Sindh have positive virtual balance as 13 billion m^3 and 0.04 billion m^3 respectively. Above scenario is clearly depicted in Figure 3.1. Provinces with lower water endowments are found importing more water than the provinces relatively rich in water resources.

Virtual water trade as supposed to govern by water endowments as trade theory suggests is partially vindicated in between Pakistani provinces. VWT as estimated by Sadaf (2013) in most of the commodities is found flowing from comparatively advantageous provinces in water endowments to the less water endowed provinces.

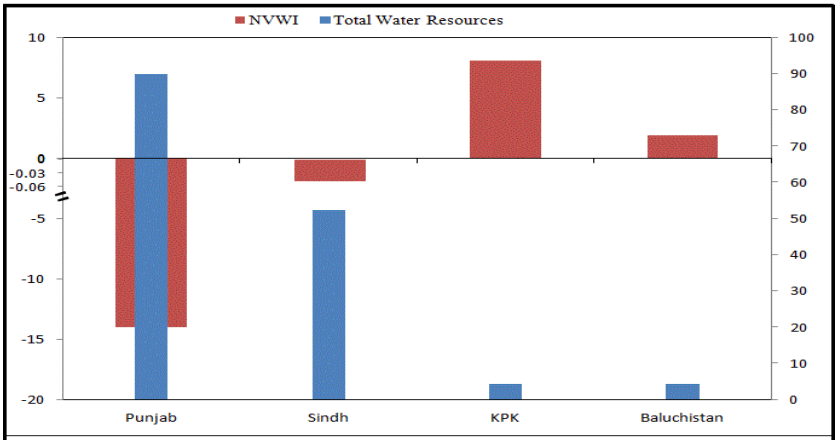

Figure 3.1. NVWI and Agriculture Water Used (billion cubic metre) as quantified by Sadaf (2013)

Punjab is found the net exporter of virtual water to all other provinces and enjoys comparative advantage in water endowments over KPK and Baluchistan. Comparative advantage theory proves true in case of interprovincial trade of Punjab with KPK and Baluchistan. However, water resource endowments' perspective is not being addressed in Sindh's trade with Punjab and Baluchistan. Since, Punjab and Baluchistan are disadvantageous provinces in water endowments over Sindh. Summing up, comparative advantage theory in water endowments perspective is partially validated in case of interprovincial trade of virtual water in the county as Sadaf (2013) has showed.

Assessment of Global water saving (GWS, henceforth) following opportunity cost theory of International trade in perspective of water usage for alternative crops by provinces is made. Water saving is caused by interprovincial trade only in the case when water volume used by exporting province is lower than that of importing province. Sadaf (2013) has found that GWS in response to VWT in Pakistani provinces as 1.5 billion metre cubic for the period 2004-08. This is due to the trade of cotton lint, refined sugar, maize, barley and pulses from high water productive to the low water productive provinces in these crops. Interprovincial trade for refined sugar that has caused global water saving of 0.9 billion m^3 for instance is presented in Figure 3.2 as per Sadaf (2013).

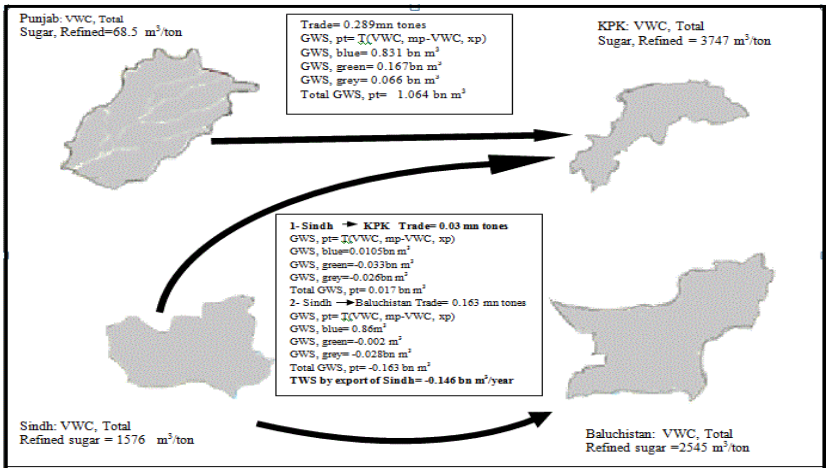

Figure 3.2. Global water saving in provincial trade of refined sugar (2004-08) as per Sadaf

VWC of sugarcane crop is higher in Sindh relative to Baluchistan so imports of sugar from Sindh by Baluchistan has caused global water loss of -0.146 billion cubic metre. In total, refined sugar trade between Pakistani provinces is responsible for 0.9 billion cubic metre of water savings for the period 2004-08. Figure 3.3 shows the types of water saving or loss through interprovincial trade of agricultural commodities. Net GWS as mentioned earlier is found by Sadaf (2013) as 1.5 billion cubic meter out of which 51%, 20% and 29% is attributed to blue, green and gray water saving respectively.

Trade of wheat for instance has caused major loss in global water saving as 2.8 billion m^3. This is due to the lower VWC of wheat in major importing province KPK as compared with the exporting province Punjab. As 93% of wheat trade is found flowing between KPK and Punjab. Largest global water saving is caused by the trade of maize between provinces as 3.2 billion cubic metre. Opportunity cost perspective of trade is being addressed in Pakistani provincial trade as it leads to substantial water savings.

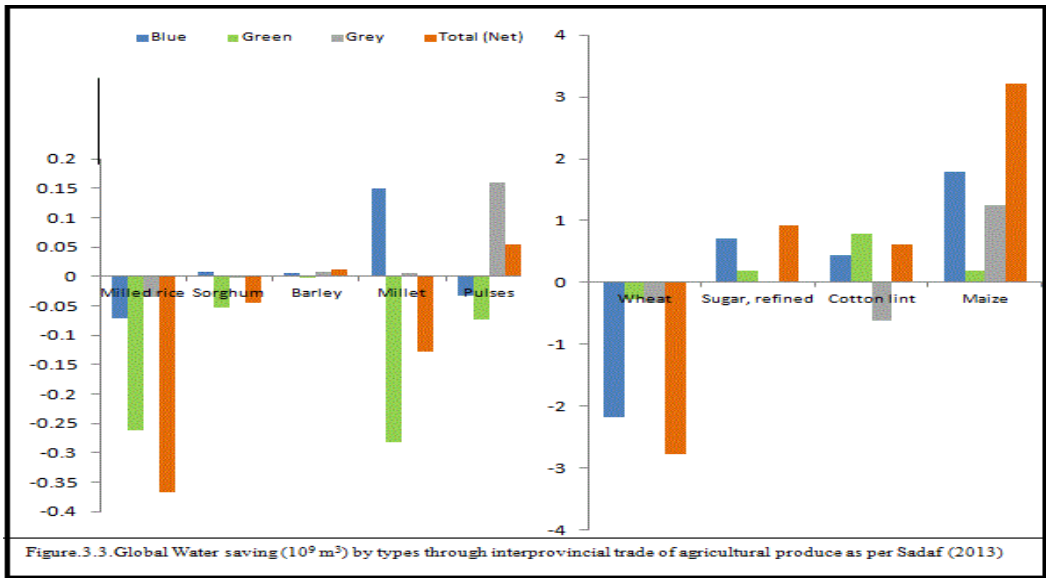

Figure.3.3.Global Water saving (10^9 m^3) by types through interprovincial trade of agricultural produce as per Sadaf (2013)

Potential of water savings can be analyzed through opportunity cost of producing alternative crops in term of water. Table 1 represents the comparison made between provinces for some of the same season's growing crops in water productivity. Opportunity cost of producing a ton of wheat as compared with barley and pulses is higher in KPK than the exporting province Punjab. So, KPK has a potential to increase its production in pulses and barley. It may has no need to import from other provinces Elimination of import of wheat by KPK may cause 2 billion cubic meters of global water savings for the period 2004-08. In the same way, Sindh has a potential to improve its production in barley and pulses and cotton. Furthermore, Punjab has a potential to increase its production of rice, maize and sugarcane. In the same way, analysis can be made for other crops and provinces as well.

Table 1. Comparison of Opportunity Costs b/w Crops growing in the same season as per Sadaf (2013)

Crops	Punjab	Sindh	KPK	Baluchistan
1 ton of wheat	2.12 tons of barley	1.83 tons of barley	8.6 tons of barley	1.9 tons of barley
1 ton of wheat	1.14 tons pulses	0.55 tons of pulses	6.4 tons of pulses	1.69 tons of pulses
1 ton of cotton	1.04 tons of rice	0.48 tons of rice	0.60tons of rice	0.72 tons of rice
1 ton of cotton	0.01 ton of sugarcane	0.03 ton of sugarcane	0.11 tons of sugarcane	0.07 tons of sugarcane
1 ton of rice	0.001 tons sugarcane	0.072 tons sugarcane	0.10 tons sugarcane	0.06 tons sugarcane
1 ton sugarcane	203 tons of maize	23 tons of maize	7 tons of maize	21tons of maize

CONCLUSION

Interprovincial virtual water flow has improved water resource situation in Pakistani provinces. KPK, Baluchistan and Sindh have found utilizing 22%, 3% and 0.36% more water than their agriculture water usage from internal resources respectively. Substantial amount of water saving is also caused by virtual water flow. Potential of water savings from interprovincial trade is also shown as Baluchistan and KPK are relatively dry regions; they can save their water resources for more water productive or less water intensive crops. Moreover, both of the provinces can be encouraged to enhance the production of the crops which entails less water than other provinces as wheat, pulses and millet. It is also necessary that least water scarce provinces as Sindh and Punjab should also recognize their comparative advantage to enhance their water productivity over most water scarce provinces.

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