Research Paper

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Research Theme: Water Futures & Solution

STRATEGIC IMPORTANCE OF WATER GOVERNANCE AND VIRTUAL WATER TRADE

(CASE STUDY OF INDIA AND SOUTH AFRICA)

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Ms. Sumbul Fatima

Strategic importance of water governance and Virtual Water Trade

(Case Study of India and South Africa)

ABSTRACT

The 'water crisis' the world community faces today is largely a governance crisis. Securing water for all, especially for vulnerable populations, is often not only a question of hydrology (water quantity, quality, supply, demand) and financing, but equally a matter of good governance. Managing water scarcity and water-related risks (floods, natural disasters, etc) requires resilience institutions, collaborative efforts and sound capacity at all levels (WWF 2012:5 in Goldin, Sneddon and Harris 2013).Virtual water is becoming a more important tool as it offers better water solutions for the future for the arid and semi arid areas like South Africa. This study considers the prevailing water governance phenomena in India and South Africa with a particular focus on virtual water trade policy measures. Virtual water trade is becoming an important component of water management globally, particularly in water scares countries. The study aims at analyzing the extent and pattern of virtual water trade in South Africa and India employing a systems analysis approach based on secondary data and drawing on desktop information from various published sources. Virtual water trade has been calculated by multiplying commodity trade flows by their associated virtual water contents. The study provides useful insights as to how to achieve more efficient allocation of water resources. In particular, this study provides a clear picture of the patterns and extent of virtual water trade in the regions and of the way in which the economic value of water in agricultural production system provides an efficient and low water intensive cropping system for import substitution. It also discusses the virtual water trade and policy implications for managing cereal production, trade and food security. The study can be instrumental in addressingwater and land management domestically, in fostering food management strategies and in improving transboundary resource management so as to ensure overall food security.

Keywords: virtual water trade; agricultural trade; food products, food security, India, South Africa

1. INTRODUCTION

Water is one of the scarce resources that is very important for the production of agricultural and non-agricultural products being consumed and traded all over the world (Mohanty and Chaturvedi, 2006; Kumar and Jain, 2007; Gupta, 2008). As environmental concerns are growing and the risk of managing water resources for sustainable development of production systems, water has become a dominant factor in different trade agreements at the regional and multilateral levels. All over the world virtual water trade is becoming an important component, particularly in food deficit and water scarce countries (Kumar and Singh, 2005; Kumar and Jain, 2007; Chapagain and Hoekstra, 2008; Novo, *et al.*, 2009). To have knowledge on the actual water scarcity of a country, knowledge on the virtual water flows entering and leaving a country is of much importance. Jordan, for example, imports about 5–7 billion cubic metres (BCM) of virtual water per year (Chapagain and Hoekstra 2003, Haddadin 2003). 'Water footprint', a concept introduced by Hoekstra and Hung (2002) and subsequently elaborated by Chapagain and Hoekstra (2004) shows the impact of consumption of people on the global water resources. The water footprint of a nation can be elaborated as the total volume of fresh water that is used to produce the goods and services consumed by the inhabitants of the nation. Chapagain, *et al.* (2005) argued that many water scarce nations save domestic water resources by importing water-intensive products and exporting commodities that are less water intensive.

Virtual water flows are the flows of water embedded in commodities and they have relevance to water stress, water scarcity, and food security, as they reduce the requirement of water for food production in importing countries and increase the requirement of water in exporting countries. According to Allan (1997) the virtual water content of a product refers to the volume of water used in its production. Empirical evidence clearly shows that virtual water trade with respect to food products has largely been viewed as a tool for reducing the risk of food production due to water scarcity in water deficit regions across the world (Allan, 1997; Hoekstra, 1998; Earle and Turton, 2003). Therefore, to manage food security, virtual water trade as a water policy instrument is encouraged. Since largest percentage of water is consumed in agricultural production, most of water deficit countries depend on increased food imports to meet their needs. Within the food security context, there is an urgent need to assess how the growing food deficit can be met under water constraints and what role virtual water can play in maintaining food security. Between availability of water and increment in food production there is a challenge to meet the challenge of increasing food demand for growing population. The aim of this paper is to examine the virtual water trade flow and its importance in informing water governance strategies. The analysis shows that including virtual water as a policy option requires a thorough understanding of the impacts and interaction of virtual water trade within regions and across continents (case study i.e. India & South Africa).

Objective of the study

- To study the water policy and regulatory system in context of developing countries: the case study of India and South Africa.
- To study the volume and direction of virtual water embodied in the trade of agricultural commodities for the particular case study of countries i.e. India and South Africa.
- To examine the ways in which water governance does or could affect volumes and direction of virtual water trade in these two countries i.e. India and South Africa.

2. DATA & METHODOLOGY

2.1 Research Approach

The research approach for this study is to gather secondary data to determine the relationships between the strategic importance of water governance on the one hand, virtual water trade on the other hand and their potential interrelationships. We deploy a three-tier systems analysis approach (Figure 1) and apply it to selected case-study countries, namely India and South Africa. First water governance is analysed at the global level and locally for the case study countries. We then analyse virtual water trade for each of the two focus countries by calculating extents of virtual water embedded in imported and exported agricultural commodities (termed 'global virtual water trade' in Fig. 1) as well as the specific water trade between the two countries. Using this analysis of water governance and virtual water trade we focus in the discussion on the systems analytical aspects in terms of additional data and analysis required for achieving meaningful elements of the strategic importance of water governance and virtual water.

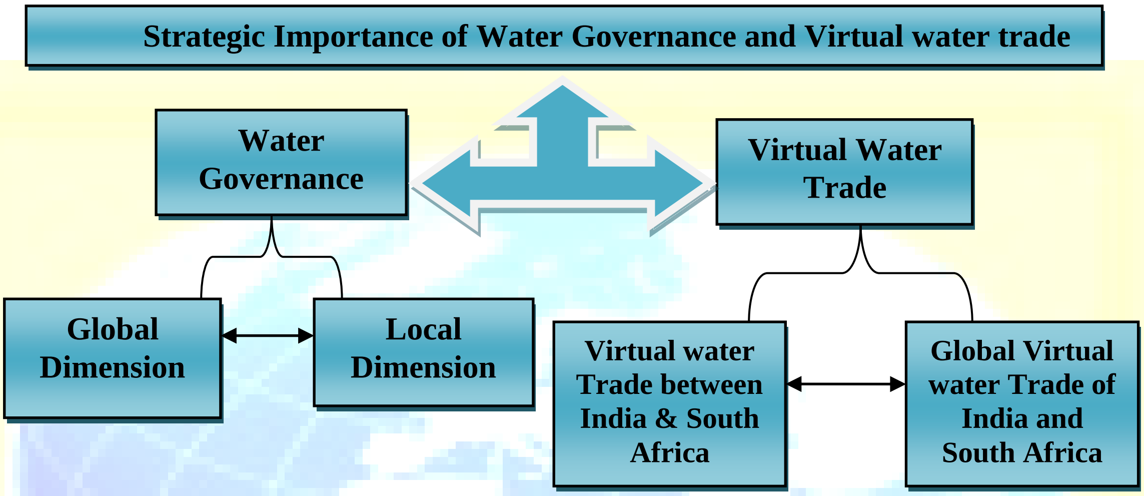


Figure 1.Systems analysis diagram of the employed research approach

2.2 Data

This study is based on secondary data and draws on information from various published sources such as the Ministry of Commerce, Government of India, Food and Agricultural Organisation of United Nations (FAO), Economic Research Service (ERS), United States Department of Agriculture (USDA) and World Development Indicators Database, the World Bank. Data of agricultural production, total import of major agricultural products and export of agricultural commodities of South Africa and India have been collected from Databases of FAO and USDA.

2.3 Calculation of virtual water trade

The estimation of virtual water has primarily been done with the help of available literature on water contents in agricultural and livestock produces (See Allan, 1993; Haddadin, 2003; Chapagain and Hoekstra, 2003; Chapagain and Hoekstra, 2004). The concept of virtual water was introduced by Allan in the early 1990s (Allan, 1993, 1994) when considering the option of importing virtual water as a partial solution to problems of water scarcity in the Middle East and Africa. He elaborated on the idea of importing virtual water as a tool to release the pressure on the scarcely available domestic water resources. Various estimates indicate that to produce one kilogram of grain, grown under rain-fed and favourable climatic conditions, there is need of about one to two cubic metres of water i.e. about 1000 to 2000kg. For the same amount of grain grown in arid regions, where the climatic conditions are less favourable, the requirement of water is estimated to be as high as 3000 to 5000kg (Chapagain and Hoekstra, 2003; Fraiture, *et al.*, 2004; Hoekstra and Hung, 2005; Burke, *et al.*, 2008). Livestock and livestock products are more water intensive and contain 5 to 20 times more virtual water per kg than crop products (Chapagain and Hoekstra, 2003). Virtual water trade has been calculated by multiplying commodity trade volume (tonne/ year) by their associated virtual water content (m^3/ tonne). Virtual water trade is thus calculated as:

$$VWT_t = \sum_{i=1}^{n} \left(QT_{it} \times VWC_{it} \right)$$

Where,

VWT_t = Total volume of virtual water traded by importing i^{th} agricultural/ livestock produce in time *t*.

QT_{it} = Quantity imported (tonne/ year) of i^{th} agricultural/ livestock produce in time *t*.

VWC_{it} = Virtual water content (m^3/ tonne) by i^{th} agricultural/ livestock produce in time *t*.

2.4 Scope, limits & assumptions

- Only agricultural crops have been considered for this study. The vast majority of water embodied in trade is in crops.
- Virtual water coefficients of less than 10% of traded crops are not available.
- Global virtual water content coefficients were applied.

3. RESULTS

3.1 Agricultural sector

Table 2 gives an overview of general socio-economic indicators and the agricultural sector of the two chosen countries for case study i.e. South Africa and India, for the period 2000-2011. In both countries the economy has been growing at higher rate than population growth resulting in increasing income developments as detailed by the Gross National Income per capita.

Yet income levels in India with its large population of over one billion is less than half as compared to South Africa with population of 52 million. The agricultural sector in India plays a much greater role in the overall economy as compared to South Africa. Productivity in the agricultural sector is higher in South Africa as reflected by the higher value added of an agricultural worker in South Africa, which has been 8-9 times higher as compared to India. Agricultural land use in India is dominated by arable land for crop production whereas in South Africa the bulk of agricultural land is permanent meadows and pastures. Both countries are endowed with significant amounts of arable land including significant areas equipped for irrigation. In India a striking 38% of arable land is irrigated compared to 13% in South Africa.

Table 1 . Selected water resource indicators

	South Africa (2000)	India (2010)
Water Withdrawal by sector		
Total (cubic km) *of which for:*	12	761
Agricultural use	57%	90%
Municipal use	36%	7%
Industrial use	7%	2%
Water Withdrawal by source		
Surface water withdrawal	1	510
Groundwater withdrawal	12	251
Pressures on water resources		
Total freshwater withdrawal as % of ARWR	24%	34%
Agricultural water withdrawal as % of ARWR	15%	36%

Source: AQUASTAT

Table 1 shows the amount of water withdrawal by the three main sectors agriculture, municipal and industrial water use. Agricultural water use highly dominates in India amounting to 90 % of total water use (2010). In South Africa agriculture is also the largest water user requiring 57 % (2000) of total water withdrawals. In South Africa all water withdrawal is almost from groundwater resources to as compared to only one third in India.

Table 2: Comparative analysis of the agricultural sector of South Africa and India

Parameters	South Africa				India			
	2000	2006	2011	ACGR	2000	2006	2011	ACGR
General socio-economics								
Population (million people)	44.0	48.2	51.5	1.44%	1042	1143	1221	1.5%
Population growth (annual %)	2.48%	1.12%	1.18%	-6.49%	1.67%	1.42%	1.28%	-2.38%
GNI per capita, PPP (current international $)	6640	8970	10460	4.218%	1540	2460	3650	8.161%
GDP growth (annual %)	4.15	5.60	3.46	-1.66%	3.84	9.26	6.64	5.10%
Agricultural land use								
Agricultural land (000 sq. km)	981	969	964	-0.16%	1826	1800	1798	-0.14%
of which:								
Arable land (000 sq.km)	138	126	120	-1.25%	1627	1587	1574	-0.30%
Permanent crops (000 sq.km)	3.8	3.6	4.1		92	108	124	
Permanent meadows & pastures	839	839	839		107	105	101	
Total area equipped for irrigation	14.9	19.2	16.0		604.3	652.1	667.5	
Agricultural area irrigated	n.d.	n.d.	16.0		n.d.	604.1	n.d.	
Agricultural sector								
Agriculture, value added (% of GDP)	3.3	2.9	2.5	-2.56%	23.0	18.3	17.5	-2.44%
Agriculture value added per worker (constant 2005 US$)	3688	4257	5666	3.98%	528	580	657	2.01%
Food exports (% of merchandise exports)	8.47%	7.11%	7.98%	-0.55%	0.1	0.1	0.1	-3.18%
Food imports (% of merchandise imports)	4.68%	4.36%	6.11%	2.45%	4.66%	3.04%	3.74%	-1.98%

Source: World Bank Data

South Africa

South Africa stands at second in the world to be confronted by a debilitating water deficit (the first was, according to Turton 2000, the Middle East and North Africa). Population in South Africa is growing at almost 2% per year. The population which was 49 million in 2009 is expected to reach to 82 million by the year 2035.

Within the African Continent South Africa stands out as one of the most water scarce country. The country is also known for extremely variable rainfall, both geographically and over time. In 12% of the country that is suitable for the production of rainfed crops, making farming a challenging business. Farmers will find it increasingly difficult to increase productivity for meeting the growing demand for food. This highlights the need for good cropping and rangeland production practices to retain soil integrity despite of predicted intense rainfall events.

South Africa has a dual agricultural economy, with both well-developed commercial farming as well as smaller scale communal farming (located in the former homeland areas). The share of agriculture is relatively small in total GDP, but is important in providing employment and earning foreign exchange. The commercial agricultural sector has grown by approximately 14% per year since 1970, while the total economy has grown by 14.5% over the same period, resulting in a decline of agriculture's share of the GDP to 2.5% in 2008 due to the continuous increase in the share of the GDP of other sectors. However, there are strong backward and forward linkages into the economy, so that the sector is estimated to actually contribute about 14% of the GDP (Agriculture statistics, 2008).

Social and economic changes have occurred in South Africa, with fundamental structural reforms resulting in a more open and market oriented economy. Some of these changes were intended, while others are the result of the country's integration into the global economy following the end of apartheid era sanctions. The changes in policy were intended to remove the socialist control of agriculture prevalent under the Nationalist Government, improves the condition of farm labourers, and address land inequalities. Closing agricultural marketing boards, phasing out certain import and export controls and introducing certain import tariffs all changed a stagnant and state controlled sector into a vibrant market economy. Dismantling state support to farmers combined with low import tariffs did, however, leave many South African farmers unable to compete with certain commodities, such as wheat and milk, against farmers from developed countries who receive handsome state subsidies (Gbetibouo & Ringler, 2009). On the other hand, initiatives taken by the government to increase irrigated farmland have enabled other farmers to successfully grow crops such as fruits, especially grapes and citrus which are high value export items. The agricultural exports volume increased significantly, and the currency of exports increased from 5% of agricultural production in 1988 to 51% in 2008 (SA Yearbook 2008/9). Decrease in the area under production for staple low value crops such as wheat and maize, and a dramatic increase in the export of high value crops is the net result.

India

Agriculture has played and will in the foreseeable future continue to play a dominant role in the growth of the Indian economy. Agriculture accounts for around 28 percent of GDP and is the largest employer providing more than 60 percent of the jobs. Development plans of the country ensure high priority for agriculture sector due to these factors together with a strong determination to achieve self-sufficiency in food grains production. The progress in agriculture has successfully eradicated critical dependence on imported food grains. Only 5 percent of the total food grains available in the country were imported in 1950's.

Indian agriculture has progressed a long way from an era of frequent droughts and vulnerability to food shortages to becoming a significant exporter of agricultural commodities. This becomes possible due to continuous effort to improve the potential of land and water resources for agricultural purposes. India shows a quite impressive record of progress in agriculture over the past four decades. The rising demand for food has been successfully met by the agriculture sector. The contribution of increasing land areas under agricultural production has declined over time. In the past two decades increase in production has been almost entirely due to increased productivity. Agricultural growth has helped to feed the poor, enhanced farm income and provided opportunities for both direct and indirect employment. Availability of farm technologies resulted in drastic increase in productivity in 70s and 80s which was named as the Green Revolution era. The major sources of agricultural growth during this period were the spread of high yielding varieties of seeds, intensification of input use and investments which led to expansion in the irrigated area.

In areas where 'Green Revolution' had major impacts, there growth has become slow now. There is needed for new technologies for increasing the yield frontiers, to utilize inputs more efficiently and diversify to more sustainable and higher value cropping patterns. At the same time the potential of rain fed production should be used in a better way for meeting targets of agricultural growth and poverty alleviation.

Given the wide range of agro-ecological setting and producers, Indian agriculture is faced with a great diversity of needs, opportunities and prospects. Future growth should be at a higher pace, more widely distributed and better targeted. These challenges have strong implications for the way farmers' problems are seen, researched and transferred to the farmers.

On the one hand agricultural research will increasingly be required to address location specific problems faced by the communities. An increasingly competitive environment to generate and adopt cutting edge technologies to bear upon the solutions facing a vast majority of resource poor farmers is the need for the agricultural production systems.

Irrigation development was the cornerstone of the strategy to increase the agricultural production and become self reliant in food production. During the period 1950-51 to 1965-66 development of irrigation through canals grew from 7.2 million ha to 9.8 million ha – a growth rate of 2.1 percent per annum. During 1970s this rate dropped slightly to 1.9 percent. In 1980s the pace of increase dropped significantly to 1.1 percent per annum. The growth of tube-well irrigation, however, increased significantly from 4.5 million ha in 1970-71 to 9.5 million ha in 1980-81 and then to 14.3 million ha by 1990-91.

In 1970-71 the net irrigated area was 31 million ha which increased to 53.5 million ha in 1995-96 which corresponds to 22 percent of the net sown area in 1970-71 and 37.63 percent in 1995-96. As irrigation efficiency has improved, the gross irrigated areas have increased to 71.51 million ha. The percentage of gross cropped area service by irrigation increased from 18.3 percent in 1960-61 to 23.0 percent in 1970-71 and to over 38 percent at present (Brooks, 2007).

3.2 Prevailing Concepts of water governance in India & South Africa

Efficient management and the proper allocation of water resources is known as Water governance. It relates to the range of political, social, economic and administrative resources and the delivery of water services at different levels of society systems that are in place to develop and manage water (Rogers & Hall, 2003). Or water governance can be explained as the set of systems that control decision-making with regard to water resource development and management. Hence, water governance is much more about the way in which decisions are made (i.e. how, by whom, and under what conditions decisions are made) than the decisions themselves (Moench et al., 2003).

Different answer has been given by different schools of thought to this question. From a holistic, supranational perspective, there are four reasons for global governance. First, the Earth has one hydrological system. Second, climate change and loss of biodiversity and their underlying causes are global in nature. Third, problematic global trends can be the result of cumulative local challenges. Fourth, the direct and indirect impacts of water use may have global implications. Hence, based on challenges emerging from global water governance, there is need to structure global water science. Water governance talks about the manner in which allocative and regulatory policies are exercised in the management of water and other natural resources, and broadly accept the formal and informal institutions by which authority is exercised. Distributed governance is relatively the new term for discussing this combination of formal and informal institutions. The 'water crisis', which the world community faces today is largely a governance crisis. To secure water for all, especially for vulnerable populations, is not only a question of hydrology (water quantity, quality, supply, demand) and financing, but also a matter of good governance.

Table 3:-Existing Constitutional provision in India & South Africa

• **Entry 17 of List II (State List) of the 7th Schedule**
"Water, that is to say, water supplies, irrigation and canals, drainage and embankments, water storage and water power subject to provisions of entry 56 of List I."
• **Entry 56 of List I (Union List) of the 7th Schedule**
"Regulation and development of inter-state rivers and river valleys to the extent to which such regulation and development under the control of the Union is declared by Parliament by law to be expedient in the public interest."
Article 262 Disputes relating to Water - Adjudication of disputes relating to waters of inter-State rivers or river valleys 1. Parliament may by law provide for the adjudication of any dispute or complaint with respect to the use, distribution or control of the waters of, or in, any inter-State river or river valley. 2. Notwithstanding anything in this Constitution, Parliament may be law provide that neither the Supreme Court nor any other court shall exercise jurisdiction in respect of any such dispute or complaint as is referred to in clause (1)
 	
• **Water quality management Acts:** Water (Prevention and Control of Pollution) Act 1974 Environmental Protection Act 1986
• **Authorities:** Central Pollution Control Board, Central Ground Water Authority, Water Quality Assessment Authority
• **Major role of Union Ministry**
Overall policy and planning ,Technical support Appraisal of project proposals, Monitoring of important projects, International co-operation
  • **Key institutions in water governanceinclude**: Central Water Commission (CWC)
  • Central Ground Water Board (CGWB)
  • Ministry of water Resources.
  • Ministry of Drinking water/ Sanitation
  • Ministry of Rural Development
  • Central ground Water Authority
  • National & Water development Agency.
	• **S.24 of the Constitution of the Republic of South Africa, 1998 (the Constitution)** secures the right to an environment not harmful to health or well-being and to have the environment protected, for the benefit of present and future generations, through legislative and other measures that: prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development.
	• **S.27 (1) (b)** provides that everyone has the right to have access to sufficient water. Government must take legislative and other measures to achieve the progressive realisation of this right.
	
	• **Key institutions in water governance include:**
	The Minister of **WEA** and the **DWA**, responsible for implementation of the **NWA**;
	CMAs (s.78 of NWA), in order to delegate **WRM** to the regional or catchment level and to involve local communities, within the framework of the **NWRS**;
	WUAs (s.92 of NWA), which operate at a restricted localised level, and are effectively cooperative associations of individual water users wanting to undertake water-related activities for their mutual benefit;
	CMFs, **voluntary bodies**, not specifically mentioned in the **NWA**, but dealt with in the **NWRS**. **CMFs** address local water management issues, and provide a focus for pub consultation and for integrating the water-related activities of other **NGOs** and **CSOs**;
	Water Service Authorities, defined in the **WSA** as municipalities responsible for ensuring access to water supply and sanitation services. Provision is made in the **WSA** for Water Boards to provide water supply and sanitation services to **Water Services Institutions (which include Water Service Authorities);**
	The Water Tribunal (s.146 of the NWA) hears appeals against certain decisions; and **the Department of Environmental Affairs (DEA)**, responsible for implementation of **NEMA**.

Managing water scarcity and water-related risks (floods, natural disasters, etc) requires resilience institutions, collaborative efforts and sound capacity at all levels (WWF 2012:5 in Goldin, Sneddon and Harris 2013). The following table 3 given above highlights Constitutional priorities that have been established in India and South Africa respectively. As far as the prevailing institutional system in South Africa is concerned, both the countries are seeking sustainable development solutions and efficient management of water resources. They are achieving this through:

- Participatory approach and Integrated basin level planning .
- Integrated development and a management basin / sub-basin approach to planning through local level water user's association.
- Existence of national water policies at constitutional level (including health, equity and environment).
- Highest priority for drinking water, emphasizing physical and financial sustainability, rationalization of water charges, well targeted and transparent subsidy on water rates for disadvantaged and poorer sections, encouragement for private sector participation.

Although the government of both the countries are making continuous efforts, the policies and regulatory system were supply driven and although the ongoing institutional system is focussing more on the equitable access to water by all the citizens of these countries, due to an inadequate attention to demand country achievements lag behind.

Some dimensions have been considered in this study for evaluating the parameters which makes a good governance system approach. The principle of good governance (adapted from European Union 2001) mentioned in box 1 has been taken into account to describe the current approach of institutional water governance strategies in which the definition of each principle is clearly mentioned. According to these notions, for the issues of water governance the government of South Africa is playing more important role than the Indian water governance system.

Box 1: Principles of good governance (adapted from European Union, 2001)

- **Openness**: Governance institutions should work in an open manner. They should actively communicate about what they do and the decisions that are taken. They should use language that is accessible and understandable for the general public.
- **Participation**: The quality, relevance and effectiveness of policies, legislation, regulation and practice, depend on ensuring wide participation throughout the policy chain – from conception to implementation. Improved participation is likely to create more confidence in the end result and in the institutions which deliver and implement policies.
- **Accountability:** Roles in the legislative and executive processes need to be clear. Each institution must define and takes responsibility for what it does. There is also a need for greater clarity and responsibility from all those involved in developing and implementing policy at whatever level.
- **Effectiveness**: Policies must be effective and timely, delivering what is needed on the basis of clear objectives, an evaluation of future impact and, where available, of past experience. Effectiveness also depends on implementing policies in a proportionate manner and on taking decisions at the most appropriate level.
- **Coherence**: Policies and actions must be coherent and easily understood. Coherence requires political leadership and a strong responsibility on the part of the institutions to ensure a consistent approach within a complex system.
- **Democratic:** Democratic values in respect of the sharing of power, representation and participation are essential.
- **Integrity:** Leadership that is honest, faithful and diligent, and that protects human rights and freedoms, is critical.

The degree of decentralisation, participation, openness, effectiveness is more seen in the South African water governance institutional framework and a stabilized feasible water governance system is yet to be achieved in India. Apart from these differences, both countries have been investing financial and human resources to secure water resources and its equitable distribution. But, neither country has been able to reach their goals nor for this reason, does virtual water trade offer a solution that may overcome the problem of upcoming water crisis in future and might help to secure water resources.

The complexities of water management are increasing with growing demands from development sectors such as agriculture, industry, energy, transportation and communication. These business sectors also interconnect with social sectors like education, health and environment. The environment is a complex one because each of these sectors operates at multiple scales (national to local). Water can no longer be examined or managed in isolation and any attempt to achieve equitable distribution, poverty alleviation and sustenance of ecosystems requires concerted efforts across and within sectors. Hence, a coordinated development of water management in the form of IWRM or such integrated approach where the focus is on river basins through Integrated River Basin Management (IRBM) must necessarily include multiple stakeholders who touch down at different points around water issues and negotiate the different needs that must be met.

The spectacular economic growth in India, like South Africa over the past two has increased the demand on the water sector. Like South Africa this makes India to realise that there cannot be a solution to water management unless water is managed according to principles of financial viability, environmental sustainability and social equity.

Catchment management and the equitable use of water is the main idea of South Africa's National Water Act (1998). IWRM calls for integration at a regional, national and local level, and implementation of its policies and strategies to promote sustainable development in South Africa. The SADC Protocol on Shared Watercourses promotes regional and basin-wide cooperation. Eleven of the nineteen Water Management Agencies (WMA's) in the country share international rivers so in South Africa this approach is imperative. A good example of implementing an integrated river basin and watershed management strategy is that of the ORASECOM (Harsha, 2012). India is going at a slower pace, but surely, in the same direction. In line with the above principles, the IWRM policy emphasizes the following:

- Multi-disciplinary, multi-sectoral, water planning, allocation and management;
- Establishment of a regulatory framework for managing water resources, including the full range of sector environment issues;
- Reorientation of government water institutions, coupled with increased participation of the private sector through farmer's managed WUAs and other private sector entities;
- Adopting modern management practices, such as financial management, programming and budgeting, and human resource management;
- Improving water and water related service delivery with an increased focus on high quality, cost effective and financially sustainable irrigation and drainage services through commercial oriented farmers' managed entities;
- Enhancing technical services through training and education;

In the first section global trade patterns have been examined. The next section will examine virtual water and how water is embedded in agricultural products.

3.3. Virtual water embedded in agricultural products

Currently, the agricultural sector accounts for about 85% of global freshwater consumption (Shiklomanov, 2000; Hoekstra and Chapagain, 2007). Many nations save domestic water resources by importing water-intensive products and exporting commodities that are less water intensive. National water saving by importing water intensive products can imply water saving at the global level when the flow of water embedded in commodities occurs from high water productivity regions to sites with lower water productivities.

This study focuses on two selected case study countries, India and South Africa. We present virtual water trade, here confined to water embedded in imported and exported agricultural commodities for the period 2000-2011. In the past decade, India's agricultural sector has been increasingly integrated into global economies resulting in a general increase in virtual water trade (Table 4, Figure2). Trend lines of growth rates show that virtual water exports and imports have been increasing by 20 % and 6 %per annum respectively.

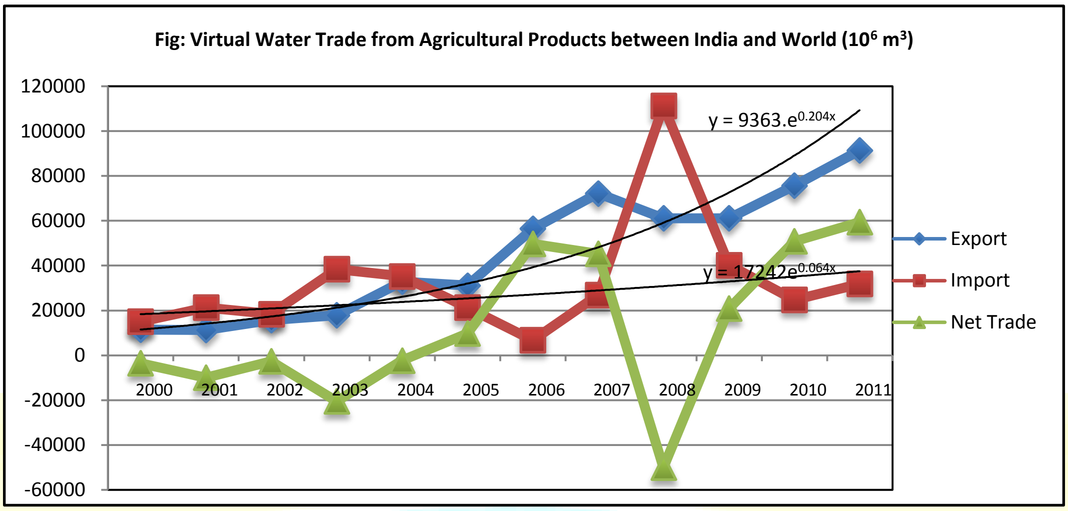
In 2005 India has turned from a net importer of virtual water embedded in agricultural commodities to a net exporter.An exception is the year 2008 when India imported large amounts of vegetable oil making the country a net importer. Imports of vegetable oils dominate India's virtual water imports throughout the period (Figure 3). The most important exported agricultural commodities with significant amounts of embedded water include oil crops (exported both in the form of vegetable oil for food and cakes for animal feed) and cotton.

South Africa plays a minor role in India's total virtual water trade accounting for less than 2% of total virtual water imports or exports (right side of Table 4). In the second half of the studied period virtual water exports to India exceeded virtual water imports from South Africa.

Table 4: Virtual water trade between India and the world, South Africa and percent Share of South Africa in India's Virtual water trade by agricultural products.

Year	Global Trade: India's Export and Import to all countries [cubic km]			Share of South Africa in India's Global Virtual water Trade [%]	
	Export	Import	Net Trade	Export	Import
2000	114	149	-35.	0.27	1.28
2001	112	212	-99.	0.21	0.31
2002	157	183	-26.	1.66	0.40
2003	178	383	-205.	0.54	0.46
2004	329	352	-23.	0.32	0.28
2005	310	213.	97.	0.20	0.42
2006	564	671	497.	0.32	0.04
2007	722	268	453.	0.29	0.02
2008	611	111	-501.	0.48	0.01
2009	611	402	209.	0.32	0.19
2010	756	247	509.	0.28	0.10
2011	914	319	595.	0.26	0.05

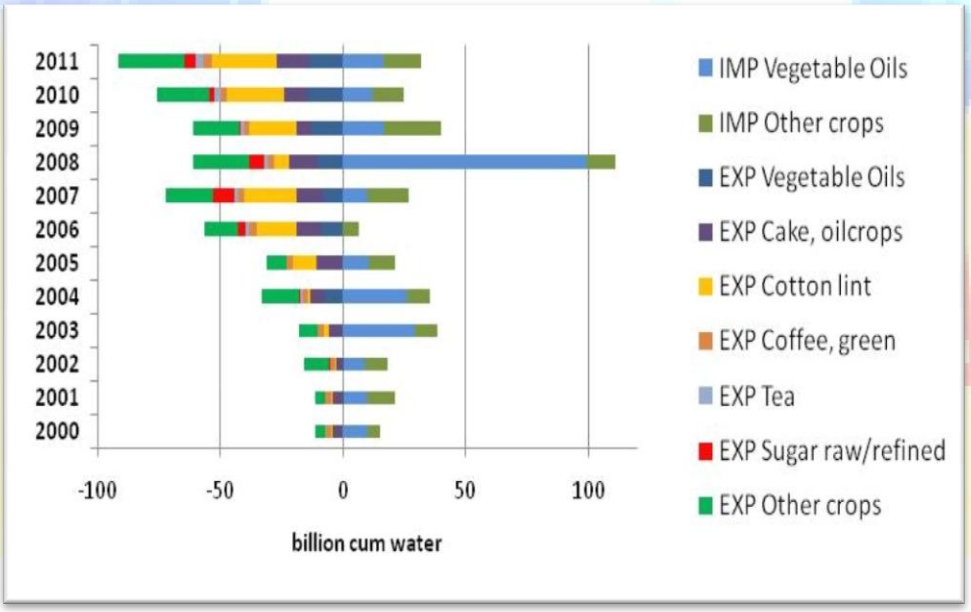
Source: Own calculations based on FAOSTAT



Source: Own calculations based on FAOSTAT

Fig 2: Virtual water trade from agricultural products between India and world ($10^6 m^3$)

The major commodities around which virtual water export and import are taking place, is also a matter of concern. A product where the virtual water export is high may have the large amount of water embedded in it. On the one hand, a product with large amounts of embedded water is being traded and on the other hand one large quantities of a product may be traded with low virtual water content.



Source: Own calculations based on FAOSTAT

Figure3: Water embodied in imports and exports of India's crop trade, 2000 – 2011

These two are extreme cases where large amounts of water are exchanged through embedded water in a product. Figure 3 shows water embodied in imports and exports of India's crop trade (2000 – 2011). In this figure a major export of embedded water is in a product (for instance cotton lint, cakes oil crops etc).On the other hand, major virtual water import is taking place through vegetable oils.

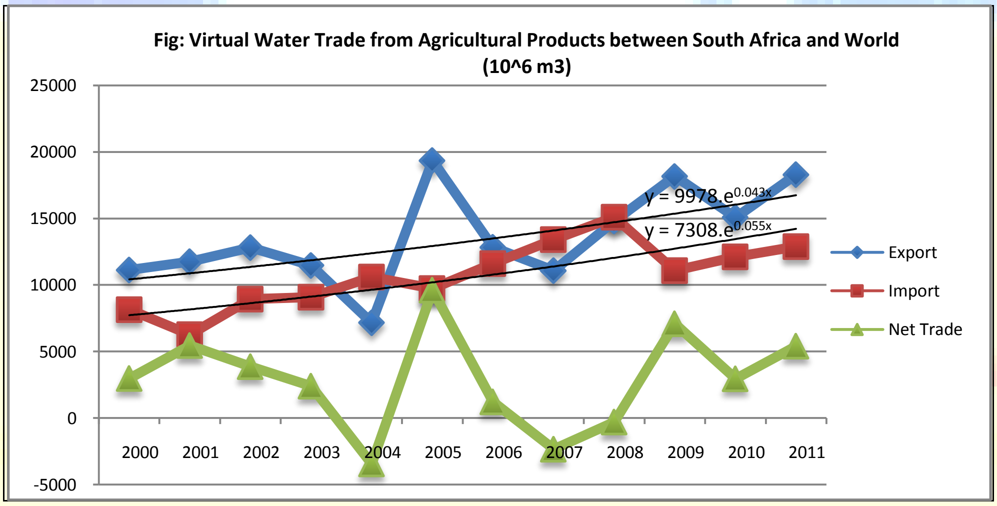
Table 5: Virtual water trade between South Africa and world,

India and percent share of India in South Africa's Global Virtual water agricultural trade

Year	Global Trade: South Africa's Export and Import to all countries (cubic Km)			Share of India in South Africa's Global Virtual water Trade (%)	
	Export	Import	Net Trade	Export	Import
2000	111.	81.	29.	1.7	0.4
2001	117.	62.	54.	0.6	0.4
2002	128.	89.	38.	0.6	2.9
2003	114.	90.	23.	1.5	1.1
2004	71.	106.	-34.	1.4	1.0
2005	193.	97.	96.	0.5	0.6
2006	128.	116.	12.	0.0	1.5
2007	110.	134.	-23.	0.0	1.6
2008	148.	151.	-2.	0.0	1.9
2009	181.	110.	70.	0.4	1.7
2010	150.	121.	29.	0.2	1.8
2011	182.	128.	54.	0.1	1.8

Source: Own calculations based onFAOSTAT

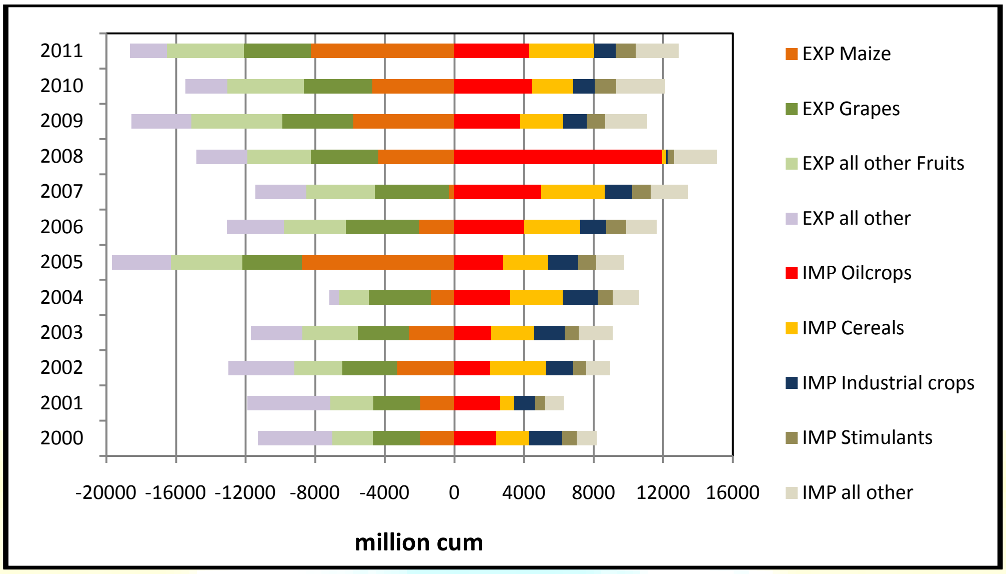
Table 5 and Figure 4 highlight virtual water trade patterns for South Africa. Like India virtual water trade has increased in the past decade although at lower growth rates of about 4% to 5% annually. South Africa has always been a net exporter of virtual water embedded in agricultural commodities except for a few years.



Source: Own calculation based on FAOSTAT

Figure 4: Virtual Water Trade from Agricultural products between South Africa and World ($10^6 m^3$)

Figure 5 highlights the export and import of major commodities, due to which water in embedded in a product is taking place in South Africa. Oil and cakes from oil seeds, cereal, stimulants (cocoa, coffee, tea) and some industrial crops are the major virtual water importing products and maize, fruits (grapes and other fruits) are the major virtual water exporting product.



Source: own calculation based on FAOSTAT

Figure 5: Water embodied in imports and exports of South Africa's crop trade, 2000 – 2011

3 Discussion

In sustainable development, including poverty reduction, water plays a pivotal role. Over the past decades the use and over-exploitation of precious water resources has increased significantly, reaching a point where water shortages, water quality degradation and aquatic ecosystem destruction are seriously affecting prospects for economic and social development, political stability and ecosystem integrity (UNDP, 2007a). Currently, over 1 billion people lack access to water and over 2.4 billion lack access to basic sanitation. Access to clean water is lowest in Africa, while Asia has the largest number of people with no access to basic sanitation. Given the importance of water to poverty alleviation, human and ecosystem health, the management of the water resources becomes of central importance (Hope, 2007).The main reason for increasing water challenges is not related to natural limitations of water supply or lack of financing and appropriate technologies, even but is the outcome of profound failures in water governance (UNDP, 2007b).

It is relevant to focus on water embedded in traded agricultural commodities termed 'virtual water' by discussing whether and in what ways, virtual water could be considered in water governance strategies. This requires a systems analysis approach where there is an integration of all potential elements affecting and affected by virtual water trade in regional and global water systems. This concept of virtual water also provides a new lens to the quantitative framework for the study of water used for agriculture and livestock production worldwide, and the water exchanges hidden in the food trade. In addition to this aspect, by calculating the virtual water content of various foods, scientists have highlighted the voluminous need for water for the production purposes especially, food grain production(Fatima, 2015).

Virtual water trade between nations is one means of increasing the efficiency of water use in the world. As Hoekstra and Hung (2002; 2005) argue, there are three levels of water use efficiency. At a local level, where the focus is on the water user, water use efficiency can be increased by charging prices based on full marginal cost, stimulating water-saving technology, and creating awareness among the water users of the detrimental impacts of water abstractions. At the catchment or river basin level, water use efficiency can be enhanced by re-allocating water to those purposes with the highest marginal benefits. Finally, by using their comparative advantage or disadvantage in terms of water availability to encourage or discourage the use of domestic water resources for producing export commodities at the global level, the nations can increase their water use efficiency (respectively stimulate export or import of virtual water). Whereas much research effort has been dedicated to study water use efficiency at the local and river basin level, little efforts has been made to analyse water use efficiency at a global level.

Virtual Water Trade is – as Allan (1993) puts it –Importing virtual water reduces self-sufficiency and may disguise the need to take important reform measures for sustainable use of water resources. Exporting virtual water generates economic revenues but may intensify other water challenges especially when competition for water across sectors is tight and returns are not redirected to solving most urgent other water needs.

Currently both political decision-makers and international development co- operations do not focus much on virtual water trade and they focus on measures to improve water management locally. The Integrated Water Resource Management (IWRM) model is an important one in this context. As our discussion above has shown, IWRM is built on three pillar stones. It is implemented in, many countries, including India and South Africa. Integrated Water Resources Management (IWRM) is ‘a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment. Indian water policies have adopted current water management paradigms such as Integrated Water Resources Management (IWRM) and Integrated River Basin Management (IRBM) as early as 1987 and in 2002. This was mainly to cope with increasing challenges of water sector as a result of economic growth, increasing population and limited water resources.

It is important to know first that what causes a country’s water scarcity. Appropriate measures must be taken Depending on whether it is a question of absolute water scarcity or whether institutional inadequacies or economic poverty are the main causes. Inadequate management or the unequal allocation of resources across sectors and regions often causes water shortages. Virtual water trade strategy is suitable rather as a complement to other necessary steps in sustainable water management but tends to be harmful as a separate (trade) policy strategy (Brooks, 2007). Virtual water trade is potentially appropriate as a support measure when costly and unsustainable projects for increasing water supply can be avoided. Dams built for irrigated agriculture or pipelines resulting in energy-intensive transport of water from distant areas are some of the examples.

Importing virtual water may be justified where, for example, other resource management strategies fail or it may be an attractive option for water-poor industrialized countries or countries well on the way to industrialization. Countries which are already well on the way to industrialization and therefore have good infrastructure and having alternative non-agricultural employment opportunities, virtual water trade is more feasible. These are, in particular, the emerging economies but also some small newly industrializing countries. However, the concept of virtual water trade is socially tolerable only if it is introduced cautiously and well aligned to principles of good governance. Introduction of virtual water trade is likely to have a negative impact with detrimental ramifications that affect the poorest of the poor if these conditions are not satisfied.

Food production requires more water than simply water for drinking and hygiene and trading in agricultural commodities is increasingly being viewed as a useful mechanism for the redistribution of water in large volumes, allowing also for the saving water in the country of import (Delgado, et al., 2003). So, food trade as the key transmitter of water resources from one region to another. Many argued that virtual water import is considered as an important global policy option to tackle the issue of food and water security (Wichelns, 2001; Mori, 2003; Wichelns, 2004; Hoekstra and Hung, 2005). Chapagain and Hoekstra (2008) argue that from a water resources point of view one might expect a positive relationship between water scarcity and water import dependency, particularly in the regions of high water scarcity.

Despite this fact, discussions on critical water issues, that takes heed of virtual water trade, have been noticeably absent from the food and trade debate. With the growing population pressure coupled with the necessary intensification of agricultural activity under projected climate change scenarios, and the resultant pressure on freshwater environments worldwide, research is required on the sustainability of water use for all types of food production.

Unsustainable use of freshwater resources has economic, environmental and social causes and impacts. The withdrawal of groundwater at rates greater than nature's ability to renew it is widely documented in many parts of the Middle East, India, Mexico, China, the former Soviet Union and the United States (e.g. Falkenmark & Lannerstad, 2003; UN, 2006). The high-profile example of wasteful over-abstraction in Central Asia for irrigated cotton and wheat production has involved almost the entire flow of the Amu Darya and Syr Darya Rivers (Glantz, 2005) and has become a symbol of what can go wrong when trans-boundary water is mismanaged.

India case of cotton export

Cotton is the most important natural fibre used in the textiles industries worldwide. Today, cotton takes up about 40% of textile production, while synthetic fibres take up about 55 % (Proto et al., Soth et al., 1999). During the period 1997-2001, international trade in cotton products constitutes 2% of the global merchandise trade value.

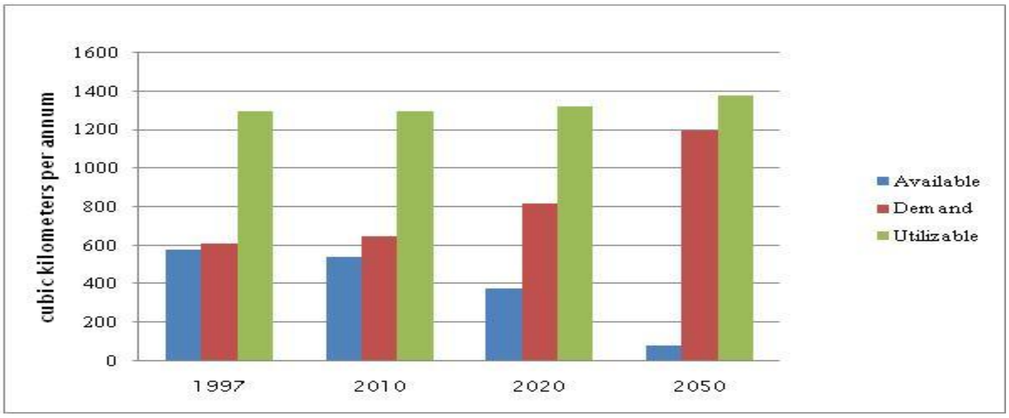
The impacts of cotton production on the environment are easily visible and have different faces. On the one hand there are the effects of water depletion, on the other hand the effects on water quality. In many of the major textile processing areas, downstream riparian's can see from the river what was the latest colour applied in the upstream textile industry. The Aral Sea is the most famous example of the effects of water abstraction for irrigation. In the period 1960-2000, the Aral Sea in central Asia lost 60% of its area and 80% of its volume (Glantz, 1998; Hall et.al., Pereira et al., 2002; UNEP, 2002; Loh and Wackernagel, 2004) as a result of the abstraction of water from the Amu Darya and the Syr Darya- the rivers which feed the Aral sea to grow cotton in the desert.

India is the second largest producer of cotton in the world after China accounting for about 18% of the world cotton production. It has the distinction of having the largest area under cotton cultivation in the world ranging between 12.2 million hectares and constituting about 25% of the world area under cotton cultivation. The yield per hectare is however, the lowest against the world average, but over the last two years it has shown a promising potential to reach close to the world average production level in the near future.

The major producing area of cotton is Gujarat followed by the Rajasthan, Andhra Pradesh. The case of Gujarat requires careful consideration. Gujarat is one of the driest states in the country, facing important water scarcity problems. Around 939 villages in the state were facing a water crisis and 2,979 villages were declared partially affected.Out of 202 water reservoirs in Saurashtra region, 72 are totally dried up, 89 are almost empty and water level has fallen to 25 per cent of its capacity in another 41(Water scarcity raises political temperature in Gujarat, 2013).Some important statistics related to cotton production in India are:

- The crop water requirement is 810mm.
- Effective rainfall in India is 405mm.
- The blue water requirement is 405mmm.
- The irrigated share of area is 33%.
- Total consumptive water use is 538mm.
- Volume of water use is 48Gm^3/year
- The average production of cotton in India is 5,544,380 ton/yearvirtual water content
- The virtual water content of cotton crop is 8662 m$^{3/}$ton (highest virtual water content compared to other cotton producing areas)

On March 26, the state government conceded in the Assembly that there was a severe problem of drinking and irrigation water in parts of the state and declared that around 4,000 villages in 10 districts were facing water scarcity. Cotton production accounts for around 20% of the total production and employs 60 percent of the population. The cotton crop is basically an irrigated crop requiring a major irrigation system that includes drip irrigation, micro irrigation, and canal irrigation.

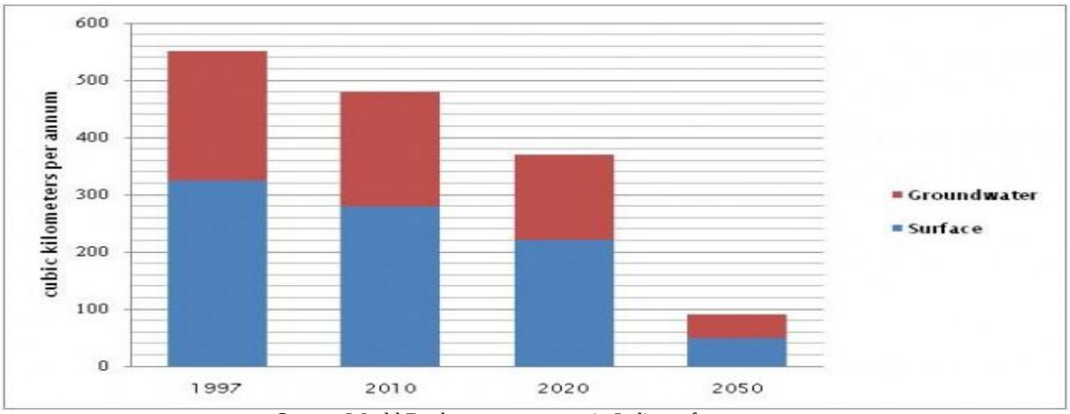


Source: World Bank Report on Water inIndia

Figure 6: Available Water, Demand of Water and Utilizable Water

The major irrigation is taking place through ground extraction. Thus, the ground water table is going down steadily, leading to severe water shortage.

India's agricultural sector currently uses about 90% of total water resources. Irrigated agriculture has been fundamental to economic development, but unfortunately caused groundwater depletion. Due to water pollution in rivers, India draws 80% of its irrigation water from groundwater. As water scarcity becomes a bigger and bigger problem, rural and farming areas will most likely be hit the hardest.



Source: World Bank report on water in India surface water
Figure 7: Availability of Ground water and surface water

Thus far, food security has been one of the highest priorities for politicians, and the large farming lobby has grown accustomed to cheap electricity, which allows extremely fast pumping of groundwater. This ease of extraction is not easily traded for the sake of water conservation. If India wants to maintain its level of food security, farmers will have to switch to less water intensive crops. If not, India will end up being a net importer of food, which would have massive ramifications for the global price of grain.

Around 53% of irrigated cotton of the global cotton production is mainly grown in the Mediterranean and other warm climatic regions, where freshwater is already in short supply (Soth et al., 1999). Irrigated cotton is mainly located in dry regions: Egypt, Uzbekistan, and Pakistan. In Pakistan and the North of India a major portion of crop water requirements of cotton are met by supplementary irrigation. As a result, in Pakistan, already 31% of all irrigation water is drawn from ground water and in China the extensive freshwater use has caused falling water tables (Soth et al., 1999). Nearly 70% of the world's cotton crop production is from China, USA, India, Pakistan and Uzbekistan (USDA, 2004). Most of the cotton productions rely on the furrow irrigation system. Sprinkler and drip irrigation systems are also adopted as an irrigated method in water scarce regions. However hardly 0.7% of land in the world is irrigated by this method (Postel, 1992).

The water used for producing export commodities can be significant and contribute to changes in regional water systems. While reduced river flows, depleted groundwater aquifers, and deteriorating water quality are resulting in significant adverse ecological and social impacts, freshwater shortages for domestic and productive means are threatening economic growth and poverty reduction efforts.

4. Conclusion

Water has socio-economic-political significance inter-regionally, internationally and globally. Today, the water crisis challenge has taken a very dominant position at the global level. In some parts of the world the scarcity of water is near to an exhaustion level despite the fact that in some parts of the world, water may be available. Even in cases where there is no scarcity, there is all too often scarcity of proper water governance strategies.

Bearing in mind the water security issue of South Africa it is of vital importance that the water transferring from the country has to be conserved. The average annual rainfall amount in this region is 464 mm - compared with a world average of 860mm – it is one of the lowest mean annual precipitations to Run-off conversion ratios in the world. A water-deficit country like South Africa must execute some smart planning to assess the trade-offs of using water for agriculture (and agricultural export) or using it for the domestic sector (households) or domestic industry (and potential industrial export) Agriculture based countries often use water in big proportions for irrigation, Same in the case of South Africa where extracting is around 63% of the country's available surface water (Water Accounts for South Africa, 2000)

Water governance theories are mostly supply driven, focusing on the equitable distribution, accessibility to water resources and allocation of water among different sectors – but from the top till bottom, these are not demand driven approaches. Resemblance could be drawn with cotton production in India where it's pretty much supply driven. The major cotton growing regions in India lacks proper water management given that the State is making concerted efforts to provide water for irrigation, by providing different irrigation systems i.e. canal irrigation, drip irrigation, micro irrigation systems etc. These measures are being taken even though they jeopardize ground water table recharges and aggravate water scarcity problems in a given area. Cotton production is successful but the price being paid is diminished and degraded water resources.

This evidence clearly speaks out the urgency to adopt appropriate national strategies for food and nutritional security and the need to incorporate these strategies within an Integrated Water Resources Management (IWRM), Water Efficiency Plans (WEP) and Poverty Reduction Strategies (PRS) plan. Time demands better collaboration between existing land-use and ecosystems planning and water management.

In adopting an IWRM approach, it is important to take into consideration the prospects and concerns of food trade (i.e. trade in virtual water). Virtual water trade can be a boon for a country and a good policy measure to engage in a global conversation around water. Embedded water - in a product – constitutes a large amount of water and results in transference of water from one place to another. This water needs to be accounted for and requires strict governance structures that align themselves with IWRM principles. Thus, the concept virtual water trade which is proposed by Allan in the 1990s plays an important role in the sustainable water development debate. So far, virtual water trade is not yet well aligned within water governance systems.

Virtual water trade surely has bright prospects to enhance inter-regional, intra-regional and cross-sectoral co-operation and presents an adequate way to save water for upcoming generations. IWRM has brought about a major change in the way that water is managed and proposes governance structures to ensure social equity, financial viability and environmental sustainability. Virtual water trade is not taking place within this paradigm and there are obvious disconnects between how the Virtual water trade is introduced at a national, regional or international level and current progressive discourses around IWRM.

Figure 8: Virtual water trade as a policy measure for ensuring food security and at the same time water security,[1]

In the result section the analysis of major water embodied within crop trade is presented in figure 3 and figure 5, presenting water intensive crops and the large volumes of water that are exported to other countries. Identifying virtual water trade as another water governance strategy is likely to contribute towards sustainable development. Virtual water trade puts our attention to the idea of volumes of invisible water that has been used for the production of a commodity and draws attention to the cost that production has on other water use. South Africa stands on 30th position in the list of driest country in the world and has less water per person than countries widely considered being much drier, such as Namibia and Botswana. India is in the same position – and both countries require careful attention to Virtual water trade.

Strategies around virtual water trade need to be better integrated within existing land-use and ecosystems planning and aligned with water management within the context of IWRM. The implementation process should preferably be at the river basin level and include both green and blue water resources. Increasing 'virtual water trade' between nations is about water governance at the global scale. Virtual Water is a latest concept that encourages a country to view its agricultural crops in terms of the amount of water required to produce those crops, with a view to implementing trading policies that promote the saving of scarce water resources. South Africa has no surplus water and all future development will be constrained by this fact. Farmers will have to double their use of water by 2050 if they are to meet growing food demands using current farming practices. To avoid a crisis, water supply needs to be enhanced and water use efficiency increased.

Virtual water trade is also inevitable for those countries which suffer from extreme water scarcity and have no other options for producing food in sufficient quantities themselves, for example countries such as Egypt, Israel, Yemen and Jordan.

[1]These ideas fit well with a systems approach. The paper has not gone into detail on the systems approach but makes the assumption that attention to water trade is within a 'system' where there are many elements interlocked and interdependent

This paper provides the opportunity to give a serious thought about water security, food security and poverty – as well as impact of climate change– through the lens of virtual water trade and to use this concept to contribute to the better management of water. Condition today is deteriorating with more than one fourth of the global population living in water-stressed watersheds. This number would likely to rise because of the climate change and population growth. Water has become the number one food production limiting factor in parts of both Asia and Sub-Saharan Africa. Feeding world population of nearly 9 billion in 2050 is a long-term challenge which has increased pressure on the world's limited fresh-water resources. Rapid economic change further intensifies the competition for distribution of resource in between agriculture, households and industry. South Africa and India has no surplus water and all future development will be constrained by this fact. Farmers will have to double their use of water by 2050 if they are to meet growing food demands using current farming practices. To avoid a crisis, water supply needs to be enhanced and water use efficiency increased. Virtual water flows, i.e. water embedded in traded commodities could play an important role in balancing local, national or global water resource management.

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