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Full Length Research Paper

Water resources management for agricultural growth in dry lands in developing countries

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Water resources are critical for human consumption, agriculture and industrial development. They have been and will remain very important commodities for human survival and economic development. Addressing water resources management requires action at the local, national and international levels. The need to provide all people with adequate supplies of clean water is becoming a more challenging task. The need for water increases with increase in population, food production and the level of economic activities. A lack of water inhibits socio- economic development and economic progress. As economic development and population growth are taking an increasing toll on water resources in each and every country, water resources management becomes even more critical. High prices of water remains of concern in most developing countries as the majority of households are poor. This study explores issues related to water resources management for both human consumption and economic growth in developing countries, using secondary information obtained through a document methods study. The examination of such information assists in looking at water resources management in developing countries, holistically.

Key words: Water resources, management, agricultural growth, dry lands, developing countries.

INTRODUCTION

Water resources are critical for socio- economic development and the maintenance of healthy ecosystems (Day, 1998). The nature of water is integral and even more essential to all, if not, to most domains or institutions of society, namely: economic, social, political, religious, leisure and others (Alam et al., 2009) . Water is a social fact that takes concrete forms, even though physically, we conceive of it as a continuous and homogeneous substance (Strang, 2004) . Water connects domains of life such that, the water used in one will affect the water used in others. Water’s connectivity is mediated by levels of economic and social organizational complexity (Anderson and Tabb, 2002). Water is a good example of the values paradox. While nobody doubts its use value, water frequently has a low value. In contrasts, the price of diamonds is high while its use value is low for most households (Arntzer et al., 2000). Having water for use is, in fact, not simple, it depends on physical infras-tructure that is both extensive and complex, including bureaucracy ranging from the most local office of water-user association, or a village water works utility, to national authorities and international governance structures (Saleth and Dinar, 2004).

Water management and control also require legal systems, oversight agencies and courts of law to regulate water use and adjudicative violations or conflicts (Engelman and Leroy, 2001). A lack of proper water management in developing countries can have devastating socio-economic and ecological consequences, and will definitely undermine any development initiatives. Population and business growth generally increase the demand for water in all sectors of the economy (Engelman and Leroy, 2001). Growth in population requires that the amount of land under irrigation be increased in part because, the demand for food must be increased (Roudi-Fahimi et al., 2002).

Given the importance of agriculture in national economies of developing countries, the productivity and management of water resources use must be controlled and enhanced, to ensure that excess water crisis is avoided and to prevent any potential shortages of food, especially in dry lands (Dudu and Sinqobile, 2008). Available resources, skills, and technologies needed to respond to poor and extreme distribution of water resources by means of storage and transfer, are still not yet widely used in many developing countries (Boelens

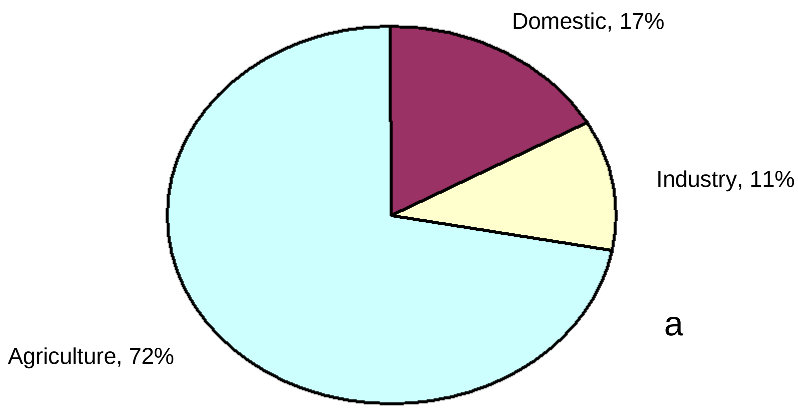

Figure 1a. Water withdrawals per sector: South Africa.

and Doombos, 2001). As a result, these countries are still experiencing poor access to water for domestic, agricultural and industrial purposes. Poor access to water has been singled out by many, as one of the leading factors hindering both socio-economic and sustainable development in dry, semi-arid and arid regions (Lyer, 2003). This study explores critical issues related to water resources management and pricing in developing countries from the existing literature. The research questions being addressed in study include the following:

(i) Why the management of water resources is important for socio-economic development?
(ii) How the pricing policy decisions affect water resources for socio-economic developments?
(iii) What strategies to be used to protect and increase the supply of water resources for human use and productivity?

METHODOLOGY

Information used in this paper was obtained through a document methods study where secondary sources of information were used (Bailey 1994, 1998). Developing countries used include: Morocco, Pakistan, India, Israel, Jordan, Mexico, Peru, Brazil and South Africa. Given the importance of water and consequently its value and price, the study first provides a theoretical description of the following concepts used, such as: Agricultural water demand in developing countries; water scarcity and stress; surface and ground water resources; climate change and water resources; strategies to deal with freshwater demand, as well as theoretical and analytical description of water resources management; and pricing in developing countries as discussed further.

Agriculture water demand in developing countries

Agriculture is the biggest employer of all times in any developing country with about 76% of people working in various aspects of activities. It accounts for the majority of water, about 70% of total water demand in any country, and its share of water demand in developing countries is as high as 95%. That is, even a marginal saving in water use for irrigation can still produce large amounts of water for the expansion of agricultural activities, including water to meet the demand for other sectors (Bruns and Meinzen-Dick, 2005). A key feature of agricultural sector in developing countries is that it accounts for a high proportion of the national workforce. Industry requires water for manufacturing and cooling processes, as well for removing wastes generated by these processes. Domestic use, which includes drinking, food preparation, washing, cleaning, and watering gardens, accounts for a small portion of total use in most countries (Roudi-Fahimi et al., 2002). Evidence sug-gests that the Economically Active Population (EAP) in agriculture varies between 13 to 27% of the national EAP (Roudi- Fahime et al., 2002). However, agricultural production only accounts for about 8 to 13% of the total GDP in most developing countries. Consequently, the need to increase the yield of production factors is very eminent, because the sector is facing dual challenge of increasing national food supply and providing for growth opportunities of agribusiness and exports (Kilbey, 2009).

Experience suggests that less than 4% of renewable water resources are withdrawn for agriculture, domestic use, industry, and sanitation in Africa. There are ample water resources available that if developed and managed sustainably, will enable the continent reach its water-related goals set for MDG's and the Africa water vision for 2025. This calls for an increase in water resources potential by 10% in 2015 and 25% in 2025 to meet the continent's increased water demand, which requires about US$ 20 billion per year. About 2/3 of African population live in rural areas, where water supply and sanitation services coverage is the poorest (Ademiluy and Odugbesan, 2008).

Figure 1a presents the distribution of fresh water per economic sector in South Africa, Bolivia and Peru, where the use has been characterised by inequality between urban and rural population (Metcalf -Wallatch, 2007). In South Africa, about 72% of water is used in agriculture, 17% for domestic use and 11% by industry (Figure 1a). Urban areas with more developed infrastructures are better served, however, a large proportion of its residents also lack access to safe water and adequate sanitation (Donkor, 2006).

Water distribution per sector in Bolivia is closely related to South Africa with 73% being used in agriculture, 14% by industry, and 13% for domestic use.

Freshwater distribution by sector in Peru is quite different from that of South Africa and Bolivia, with agriculture using 59% of freshwater, industry, 22% and domestic use, 19% (Figure 1c).

Evidence suggests that large-scale water projects have significantly contributed to poverty alleviation by providing for food security and opportunities for employment (Ademiluyi and Odukbesan, 2008). However, most rural poor communities have tended to experience inadequate water supplies, and as a result,

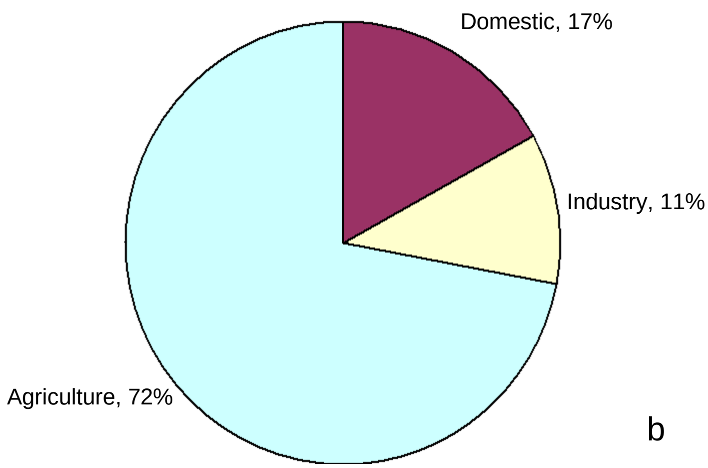

Figure 1b. Water withdrawals per sector: Bolivia.

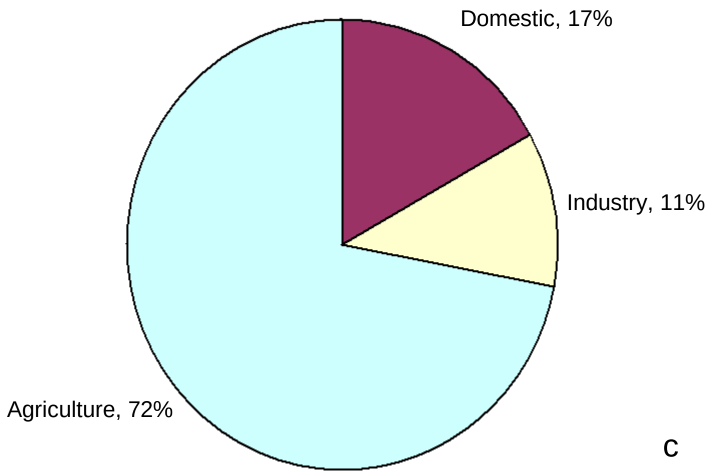

Figure 1c. freshwater withdrawals by sector in Peru, 2002.

they have remained unable to escape the vicious circle of poverty, disease and unemployment. Water resources promote socio-economic development and are closely linked to poverty reduction, especially in developing countries that are dependent on rural economy (CWC, 2004; UN, 2006). In order to respond to the growing demand for food, about 14% of more freshwater will need to be considered for agricultural production in years to come. In addition to the pressures on agricultural sector, there is an increased awareness on the value of water in maintaining environment and ecosystem (Orlove and Caton, 2010). A systematic approach to water productivity requires actions at all levels. Increasing the efficiency of water use and enhancing water for agricultural production at all levels in the production chains is critical for rapidly growing countries (UN, 2006).

Water scarcity and stress

About a third of all nations suffer from water scarcity and stress between 1000 and 1500 cubic meters per capita. With increases in world population, the demand for water has also tripled. Water scarcity and stress are being experienced as major development challenge in developing countries, in both its qualitative and quantitative manifestations. Water scarcity and stress can occur at any level of supply and demand (Atlas of African Lakes, 2006.)

The concept of water scarcity refers to the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors cannot be fully satisfied (UN, 2006). Water scarcity and stress can originate from various causes, for which some are natural while others are a result of human activity. Given that scarcity has its roots in water shortages, especially in dry, arid and semi-arid regions as a result of droughts, climate variability, and economic development, water scarcity has been a very critical issue in these regions (FAO, 2000). In dry lands of developing countries, people race toward their physical limits to fresh water expansion as the amount of water available for human consumption and agriculture has been a key concern (UN, 2006).

Renewable water resources are limited in dry lands (Naji and Maher, 2010). These regions have a population of about one third of the total population of a country, and the inhabitants are among the poorest people who depend totally on renewable resources for survival (Vergara, 2008). Poverty increases in these regions partially as a result of insufficient and inadequate availability of water for domestic consumption and for agricultural production. Together, these conditions have impacted negatively on the population by creating unsustainable agricultural sector, poor soil conservation, inadequate cultivation of steep slopes, poor fertilizer use, poor irrigation and inappropriate use of land (Irshad et al., 2007). Rainfall is more variable and highly unpredictable, thereby increasing the risks and uncertainty in agricultural production. The natural resource base of land, vegetation, and water, is highly fragile and highly vulnerable to degradation and destruction in drylands (Irshad et al., 2007). Water scarcity and stress is a serious problem in countries such as North Africa and the Middle East, including South Africa, Mexico, Pakistan, and India where about 90% of the water are used for agriculture. Often, the rate of water withdrawals is highly excessive than the rate of recharging (Manuel, 1998; FAO, 2000; UN, 2006).

To keep pace with the needs and requirements of water, water scarce countries need to focus on the efficient use of all water resources available. This includes groundwater, surface water and rainfall, as well as on water allocation strategies that maximise the economic and social returns to limited water resources, at the same time, they should enhance the water productivity of all sectors (UN, 2006) . The value of water can be negative when hazards such as flood, erosion and risks of waterborne diseases can be observed, and positive, when it is free from all hazards. The rights to water are associated with obligations to use water with care and to support water systems (Orlove and Caton, 2010).

Beside agriculture, industry, and economic growth, water scarcity has a direct negative impact on poverty reduction and food security on both irrigated and rain fed agriculture to, expand grain production, subsistence agriculture, livestock, fish and related foods, including the capacity to produce cheap food with greater impact on nutrition in rural and urban areas, to affect the achievement of the Millennium Development Goals. Evidence suggests that water scarcity is on the increase, and as a result, about one billion people will be affected and will be living in a water-scarce environment in decades to come (UN, 2006). Current demographic projections show that about 60% of the global population will be affected by water scarcity by 2025. Water demand will always increase while pressure on scarce water resources will be intensified in the future. Increased water security helps to eradicate poverty, stimulate agricultural growth and the creation of job opportunities (Qadir et al., 2006). Water scarcity impacts negatively on poverty eradication and economic growth by creating tremendous pressure on population and the environment (Irshad et al., 2007).

Surface and ground water resources

Different countries exhibit major geographical differences in the availability of natural surface waters. One of the most striking features of all countries is the paucity of natural surface waters of any size (Day, 1998; Schreiner, 1999). South Africa is among semi-arid developing country because its freshwater is the most limiting natural resource. The country receives only about half the average rainfall than that of other countries, and it is spread disproportionately across the country from east to west. Water availability in the present and future is heavily dependent on climate, water use, management and land-use practices. The country has only 8.6% of the rainfall available as surface water, one of the lowest conversion ratios in the world (Sonjica, 2010). The annual average runoff (MAR) is about 50 million square meters, and it is not distributed evenly throughout the country, with the Eastern seaboard having almost 80% of the country's runoff, whilst the Western regions tend to have low runoff, nor is it consistent over time, with great variability between years (Atlas of African Lakes, 2006). The water situation in South Africa compares to other countries such as those in the Middle East and North Africa where the demand for freshwater has been always high (Roudi –Fahimi et al., 2002).

Similar to surface waters, South Africa's groundwater resources are relatively limited compared to world averages. The scarcity of freshwater resources and highly variable hydrological conditions, have led to every major river being regulated in order to ensure adequate water supply. However, because of the spatial variability of water resources and the scarcity of water throughout the country, the need for water in many catchments exceeds the supply (South Africa, 1999; Sonjica, 2010).

In most rural areas of developing countries, people depend on groundwater for their supply. Generally, groundwater is not treated prior to its distribution, although, chlorine has been some times, added to the reservoir water. Groundwater in most South Africa's rural areas has high nitrate levels up to 23 mg/l (the maximum limit allowed in South Africa as set by the South African Bureau of Standards is 10 mg/l). In addition, high levels of calcium, magnesium and phosphates including high fluoride levels which can cause skeletal and dental fluorosis were also detected in groundwater from the boreholes. Excessive nitrate and salt levels in groundwater remains one of the main reasons for most ground-water to be declared unfit for human consumption. Unfortunately for many rural communities, it is the only available source of drinking water (van Vuuren, 2007).

Peru accounts for about 4% of the world's annual renewable water resources, and over 98% of its water is available at the east of the Andes, in the Amazon region. The coastal area of Peru, with most of economic activities and more than half of the population, receives only about 1.8% of the national freshwater renewable water resources. Economic and population growth are taking an increasing toll on water resources quantity and quality, especially in the coastal area (Claudia et al., 2000). Unlike South Africa, Peru has a large amount of water resources, with 106 river basins and a per capita availability of 68,321 cubic meters in 2006. The long-run average annual rainfall in Peru is 1,738 mm. There is also a significant seasonal variability in river run-offs, two-thirds of which occur between January and April (FAO, 2008).

CLIMATE CHANGE AND WATER RESOURCES

Climate change can be directly attributed to human activity that alters the composition of the global atmosphere which is in addition to natural climatic variability observed over comparable time period (UNFCCC, 1992). Since the late 19^{th} century, anthropogenically induced emissions of gases such as carbon dioxide (CO_2), that trap heat in the atmosphere in the manner of greenhouse, have contributed to an increase in global mean surface air temperatures of about 0.3 to 0.6°C. New estimate of climate change sensitivity predicts a further increase of 2°C can be expected by the year 2100. A review of climate change impact indicates large differences in the vulnerability of water resource systems to climate variables (Frederick, 1997). Recent studies suggest that most of these integrated systems are sufficiently robust and possess adequate institutional capacity to adapt to likely changes, not only in the climate but also in factors such as economic and population growth (Frederick, 1997).

WaterAid (2007) argues that climate change has the

Table 1. Climate change and financial needs in six selected developing countries.

Country	ODA's assistance for climate change (billion)
Bangladesh	0.22 - 0.53
Egypt	0.5
Fiji	6.9 - 10.8
Nepal	175 - 260
Tanzania	0.12 – 0.25
Uruguay	3.8 - 5.6

Source: WaterAid, 2007.

potential to compromise development spending by reducing effective progress towards the achievement of the Millennium Development Goals (MDG). For this reason, the Official Development Assistance (ODA) will have to increase its financial assistance to developing countries by US$ 50 billion in 2010 and 2011, since the international players and actors seek to reduce poverty in developing countries (Table 1).

It is estimated that in these six countries alone, climate change could undermine about US $ 1.5 billion in development assistance (WaterAid, 2007). Climate has negatively impacted on rivers in every continent to the point of drying out, threatening severe water shortages. The most affected rivers include the Yangtze, Mekong, Salween, Ganges and Indus (Asia); Danube (Europe); La Plata (America); Rio Bravo (Rio Grande); Murray-Darling (Australia), and Nile-Lake Victoria (Africa). Poor planning and inadequate protection of natural areas/ resources means that we will no longer have water to flow for ever (Pittock, 2010). The case of Nile River-Lake Victoria basin which flows within ten African countries is very serious. It is threatened by climate change due to heavy human extraction and high evaporation. Present rates of water withdrawals for irrigation are very high. Despites its size in dry periods, the river does not reach the sea. Climate warning models provide diverging pictures of future river flows in the Nile from a 30% increase to a 78% decrease. It is important for the governments to better protect river flows and water allocations to safeguard people's livelihoods (Pittock, 2010).

Climate change has negatively impacted on the sustainability of water resources of many countries, with the possibility of facing higher risks of water shortages by mid-century. More than 400 of these countries will face extremely high risks of water shortages. Climate change greatly increases the risk that water supplies will not keep pace with its demands in many countries. This has significant implications for the future water management and adaptation to planning efforts. The pressure on public officials and water users (households, farmers and industry) to manage demand and supply of water will be critical in the countries facing these highest risks (Spencer and Altaman, 2010).

Sea and river levels rise in response to thermal expansion of the oceans and rivers due to increased melting of glaciers and land ice by affecting water availability as a result of climate change. Experience suggests that the global sea level increased about 8 cm (7 inches) during the past century. Recent experience indicates that average sea level might rise another 15 to 95 cm (6 to 37 inches) by 2100. Higher sea levels and increased storm surges could adversely affect freshwater supplies in coastal areas. In terms of domestic water use, drinking, preparing food, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens accounts for about 8% of withdrawals and about 6% of consumptive use. However, water demand for gardening, lawn sprinkling, and showering are the most sensitive of these uses to climate changes (Fredrick, 1997; Trawick, 2003).

Peru will be among those countries that will be negatively impacted by the effects of climate change as a result of its geographic and demographic setting. Two thirds of its population lives in the main cities on the desert coast with little proportion of rainfall. They rely heavily on the fact that the country has 70% of the world's tropical glaciers (Claudia et al., 2000). The coun-try's main rivers are polluted, mostly by mining operations in the Andes Mountains, a fact that is common to most developing countries. Adding to this are the effects of El-Nino which cause drought and flooding (Collyns, 2009). The three concepts used in the analytical talk on water resources sustainability include: conservation, justice and governance; only governance plays an important role in climate change and water sustainability (Ernst, 2003; Ferguson, 2003; Lemon and Oliveira, 2004, 2005).

STRATEGIES TO DEAL WITH FRESHWATER DEMAND

Generally, population growth increases water demand in all economic sectors, as the demand for food also increases (Bossi, 2001). It is important for both planners, policy-makers, water management staff and consultants to investigate and understand factors that drive fresh-water demand using different strategies. To avert many problems related to freshwater demand, many countries have adopted different strategies to balance their scarce water resources and growing demand for freshwater. These options have been obviously directed by various factors including the high costs of these high-tech equipment that are available to most developing countries. Some strategies to respond to freshwater demands are briefly reviewed further.

Many countries have traditionally been increasing access to freshwater by locating, developing and managing new sources of water, despite high costs involved. Since new sources are becoming also scarce and more costly, many countries are considering other possible options, such as; desalination, treatment and re-use of wastewater, and the continual use of their traditional methods/strategies. Qanats/chain wells is a traditional strategy aimed at bringing water to surface, consists of a series of horizontal tunnels bored into a cliff or mountain region. These interconnected tunnels are sloped to allow water to drain out and create an oasis in an otherwise arid area. A big number of qanats is found in Iran, where this strategy has been used intensively. Rainwater harvesting is another traditional strategy for water collection from the roofs, cisterns, as well as other sources, which can divert runoff into ponds and reservoirs for agricultural use. This strategy has been mainly used in Egypt where farmers have restored degraded agricultural lands through runoff water in dry riverbeds that become ponds after heavy rains (also called "wadis"), by constructing earthen dikes **(**Roudi-Fahimi, et al., 2002).

Sequential water use is also an important strategy where water use involves capturing and treating water which has been used in one sector in order to be used in other sectors. Only clean water is useful for domestic use, therefore, the purpose of sequential water use is to have water for domestic use first and then, in other sectors including agriculture and industry. Water from urban areas, also known as "brown water" can also be treated and channeled from towns and cities to nearby farms, to increase crop yields and production, by reducing the need for fertilizers.

Evidence from Israel shows that, the majority of sewage waters are purified, and used in irrigation of farm land. Similarly, wastewater from Tunis is also used in the irrigation of citrus and olive orchards near the city, including golf courses and hotel gardens (CSWSME, 1999; Bosi, 2001).

Water resources management and pricing

Water is vital for life, better pricing policy enables the pressure on water resources to be restricted and infrastructures to be maintained (Mohayidini et al., 2009). A harmonised approach to water pricing is critical to avoid any distortions in competition arising from uneven application of economic principles on the internal markets (EC, 2000). Unfortunately, water pricing in developing countries has been political due to the asymmetry in information across stakeholders, created by self-seeking interest groups such as water departments, bureaucrats and contractors. This happens despite the fact that water bureaucracy is involved in the reform process. Often in the absence of a comprehensive water policy which can clearly provide the rights and entitlements of water resources for all sectors, the main problem in the smooth implementation of the reform initiatives lies (Tsur, 2005).

Water pricing in Cape Town (South Africa) had more impact on the consumption rates of the middle and upper classes, but not of the poor. Water pricing through increased tariff has mixed reactions. Knowledge of elasticity of water demand for different segments of the population is important in order to arrive at appropriate pricing strategies. In South Africa's lower classes, with exception of the extreme poor, water consumption do not go down noticeably as the price goes up due to a largely inelastic demand curve for basic water. Pricing decisions are often seen as political and are in most cases, impossible, therefore, users cannot avoid through excuses of lack of willingness and inability to pay for water (Jansen and Shult, 2006). Given the importance of water, consumers are willing to pay higher tariffs even if water resources endowment of the region is scarce or abundant. Evidence suggests that it is the willingness to charge rather than to pay that is blocking price reforms (DFID, 1999) . Evidence shows that some countries have been divided between the haves, and the haves not, in terms of access to freshwater. In main cities, water tariffs are higher than in poor communities, people pay up to ten times more than people in suburbs or middle class (Collyns, 2009).

Water price has the following objectives; i) sufficiency of revenue. ii) economic efficiency. iii) equity and fairness. iv) redistribution of income and conversion of resource. Water resources pricing is the only way to achieve the goal of meeting the demand for water for a growing population at an existing level of per capita water use (Tsur, 2005). When designing water price policies and tariff structures, consideration should be made to make the reforms possible and feasible. That is, accepted by the people, with political acceptability, simplicity and transparency, ease of implementation and net revenue stability, although, people and political acceptability may contradict the basic objectives of water pricing to some extent (Boland and Whittington, 2000). In order to achieve an economic efficient water allocation, with the highest return to given water resources, water price should be equal to its marginal cost of supply, plus its scarcity value. Generally, this results in the setting high tariffs structures, which are neither acceptable to the public nor to the politicians (Johansson, 2000). Due to differences in the availability of water resources, market practices and institutions around the world are applying a variety of water pricing which include these strategies: No

Table 2. Impact of water demand pricing in selected countries.

Country	Price mechanism	Impact on water demand
India	Price induced water scarcity	Farmers are responsive but water is not efficient
Sri Lanka	Arbitrary pricing	Not effective
China	Volumetric pricing	No incentive at the farmer level as the price is based on the area
Mexico	O & M cost recovery with tradable bulk water rights	No improvement at the farmer level, but overall improvement in water use efficiency due to internal trading
Peru	Volumetric pricing	Not used to reduce water demand
South Africa	Volumetric pricing with more taxes (O&M cost recovery)	Improvement in allocation of irrigation water. But not sustainable and effective for other purposes
Israel	(i)Block rate tariff (ii) Tiered system of pricing	7% decline in average water use and 1% reduction in output' Regulate water demand at the margin
Spain	Arbitrary pricing	Differential impacts due to regional, structural and institutional conditions
Turkey	O & M cost recovery	No improvement
France	Full financial cost recovery	Managers discourage water use beyond a subscribed amount
USA	Volumetric pricing	Quotas were more effective in times of scarcity

Source: Compiled from Reddy (2006). O & M = operation and maintenance cost.

domestic charges, flat- fee charges, volumetric charges, and increasing block tariffs (Wang et al., 2008). For domestic water supply, non volumetric schemes are sometimes used for pricing that do not include a fee, or set a fixed charge, independent of the amount of water consumed. Often, volumetric schemes can be structured as a two-part tariff, flat-block tariff, increasing/decreasing block tariffs (World Bank, 2007). Volumetric pricing is effective in conserving water and improving water use efficiency (Table 2).

This strategy is used in many countries, mainly due to the high costs associated with fixing water meters and monitoring them. As long as volumetric pricing is not equated with marginal cost pricing, pricing will not be an effective tool of demand management for two main reasons: i) marginal cost based pricing is in most cases, politically unacceptable; and ii) it is likely to impose undue burden on the marginal section of the community. The framework directive on water use should set out the guidelines for water policy by promoting the use of pricing and taxation as an incentive for consumers to use water resources in a more sustainable manner and to recover the cost of water services per sector of the economy (Reddy, 2006). While households with average disposal income in developed countries spend about 1.1% of their income for water and sanitation bills, households in developing countries spend on average about 2.6% or more, on water and sanitation.

This practice by developing countries suggests that such high price of water and sanitation bills are generally tolerated (Figure 2). Water price and household income are represented in Figure 2. While the water price increases faster in each and every year, household income increases at a very slow rate, suggesting that water expenses vary little with disposable income because it is an essential good. These expenses describe high proportion of the total consumption of the poor than of wealthy people. Often, water expenses donot reflect the real consumption by households and are not compared with their disposal income. This is important because the majority of households are poor, with much smaller disposable income. Given the difference among the haves and the haves not in our societies, only poor people will complain for high price of water, because of high inequality, deep poverty, and low disposable income. Increases in water prices impact negatively on poor household lives because they have little means. They could in principle, reduce their water

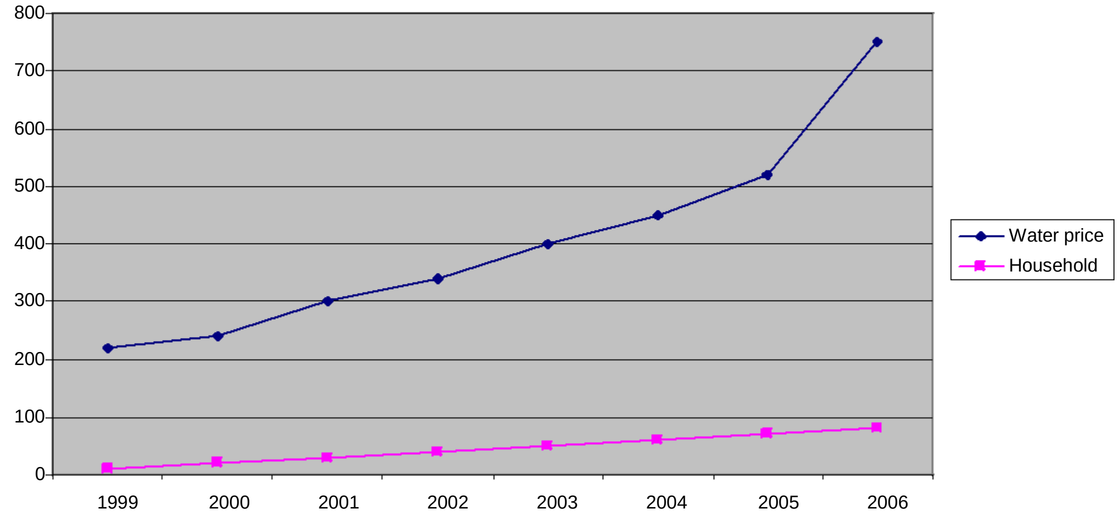

Figure 2. Households water use and price in developing countries, 1999-2006 (Source: Smets, 2000; Zhang et al, 2007; Author's calculations, 2010).

consumption, but this is something difficult to achieve because water consumption is really a basic need (Smets, 2008).

In contrast to high inequality and deep poverty, water price is higher than the increase in household disposable income in developing countries. Despite water subsidies, poor households pay up to US $ 200 (R 1900 or more SA currency) per month. Generally, this affects negatively the lives of many poor households in these countries. The analysis suggests that developing countries have accepted water prices and related expenses to exceed 7% of household disposal income. Some developing countries have decided to keep water supply for poor households not too expensive. This is the case in Morocco where the cost of water supply and sanitation of 3% has been considered appropriate (Smets, 2008).

The analysis of water pricing (Figure 2) is based on policy observations and measures taken by various water authorities in developing countries, and it is not based on theoretical concepts. Indications that water prices are high can also be attributed to other factors such as the amount of water losses, thefts, unpaid bills and unwillingness to pay the bills by consumers (unaffordability indicators). These indicators are not used at the international level because they all depend on institutional and historical factors.

Improving access to water use requires paying attention to water pricing, especially for poor households. Water consumption is standardised at 120 cubic meters per year per household connected to a supply network. Water bill is generally below costs, even small because of subsidies. However, because of various taxes imposed on consumers, water price is very high in developing than in developed countries (Arntzen et al., 2000). Often, water expenses are not reflecting the real consumption by households and are also not compared with their disposal income. This is very important because the majority of households are poor, with much smaller disposable income. Water prices and disposable income vary from one region to another. However, water expenses vary little with disposable income because it is an essential good (Smets, 2008).

Conclusion

This study explored issues related to water resources management for agricultural growth in developing countries using secondary information obtained through a document methods study. Water resources are critical for socio-economic development including the maintaining of healthy ecosystems. Water's connectivity is mediated by levels of economic and social organizational complexity. Having water is, in fact, not simple, it depends on a physical infrastructure that is both extensive and complex, including bureaucracy ranging from the most local office of water-user association or a village water works utility, to national authorities and international governance structures. Population and business growth generally increase the demand for water in all sectors of the economy, with agriculture and industry accounting for the majority of water demand in any country. Water resources promote development and are closely linked to poverty reduction, especially in developing countries that are dependent on rural economy. Water management is critical to avoid scarcity of freshwater, it depends mostly on various kinds of knowledge countries do have. Water prices are very high in developing than developed countries. Although water pricing policy enables the pressure on water resources to be restricted and infrastructures to be maintained, water pricing in developing countries has been political due to the asymmetry in

Table 3. Percentage of water connections and water losses in selected Southern African cities, 2003.

City	Connections that are metered (%)	Water unaccounted for (%)
Dar Es Salaam (Tanzania)	10	60
Gaborone (Botswana)	100	20
Greater Victoria (Seychelle)	100	26
Harare (Zimbabwe)	85	30
Kinshasa (Dem Rep of Congo)	76	47
Lusaka (Zambia)	44	56
Luanda (Angola)	40	60
Maputo (Mozambique)	100	34
Maseru (Lesotho)	97	32
Mbabane (Swaziland)	100	32
Port Louis (Moritius)	100	45
Windhoek (Namibia)	100	11

Source: Handbook for the assessment of catchment water demand and use: HR Wallingford and DFID UK, 2003.

information across stakeholders, created by self-seeking interest groups such as water departments, bureaucrats and contractors. To avert many problems related to freshwater demand, developing countries should adopt new strategies to balance their scarce water resources and its growing demand. In contrast to high inequality and deep poverty, water price is higher than the increase in poor household disposable income in developing countries. Despite water subsidies, poor households pay up to US $200 –US $250 per month. Generally, this affects negatively the lives of many poor households in these countries.

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