

Review

An Overview of Water Markets in Southern Africa: An Option for Water Management in Times of Scarcity

Greenwell Matchaya^{ID}, Luxon Nhamo^{*}^{ID}, Sibusiso Nhlengethwa^{ID} and Charles Nhemachena^{ID}

International Water Management Institute (IWMI-SA), 141 Cresswell St, Weavind Park, Silverton, Pretoria 0184, South Africa; g.matchaya@cgiar.org (G.M.); s.nhlengethwa@cgiar.org (S.N.); c.nhemachena@cgiar.org (C.N.)

* Correspondence: l.nhamo@cgiar.org; Tel.: +27-12-845-9100

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Abstract: Southern Africa faces acute water scarcity challenges due to drought recurrence, degradation of surface water resources, and the increasing demand of water from agriculture, which has to meet the growing food demands of an increasing population. These stressors require innovative solutions that ensure the sustainability of water resources, without which the consequences could be dire for a region exposed to a host of vulnerabilities, including climate change. This review outlines the role of water markets in water management in times of water scarcity, highlighting the drivers of water markets in southern Africa, such as water scarcity, transboundary nature of water resources, and their uneven distribution. The review further discusses the role of water markets in climate change adaptation. Related institutional and legal frameworks as well as water allocation mechanisms are explored, aiming at improving water markets governance. The impact of adaptation to new water regimes in the face of scarcity are assessed by considering characteristics of current markets as related to future opportunities. In a diverse region such as southern Africa with unevenly distributed water resources, advancing the concept of water markets could play an important role in mitigating water scarcity challenges and promoting regional integration through coordinated transboundary water transfers. The emergence of water markets in the region is influenced by the continued depletion of water resources, which is resulting in the adoption of innovative water marketing strategies, such as inter-farm sharing or farm joint venture systems and inter-basin and intra-basin water transfers. As the concept is new in the region, it still has challenges that include general market inefficiencies, high transaction costs, market information asymmetries, imperfect competition, and weak or absent robust institutional frameworks that can facilitate market development.

Keywords: drought; water transfer; adaptation; water scarcity; water rights; water security; resilience

1. Introduction

The challenges of water scarcity and continued depletion and degradation require a paradigm shift in current water governance strategies and a move towards the adoption of innovative approaches that reduce risks and help communities to live within biophysical limits. Methods used to manage the risks associated with water scarcity and reallocation are demand-side management and supply augmentation [1]. Demand-side management promotes awareness measures (provision of information on reducing domestic and agriculture water consumption), regulatory and/or planning processes (governance structure within a catchment and its water-sharing mechanisms), and economic incentives (water marketing initiatives that improve water-use efficiency and water management) [2]. Improvements in infrastructure (dam and weir construction) or substitution (desalinated water) have been promoted by research and decision-makers, as they play an important role in addressing demand gaps [3]. However, the effectiveness of infrastructure and substitution measures hinges on the integration of demand and supply response mechanisms through market-based governance frameworks. Formal water markets

emerged as a result of water scarcity or uneven distribution, thus they are intended to reduce the gap between the ever-growing demand and the limited water supply in water scarce areas [4,5].

While the challenges brought about by water scarcity are threatening sustainable development, water markets are envisaged to play a role of mitigating those challenges [6]. The presence of water markets is noticeable when there is transfer of water from a lower to a higher value user on temporal or permanent basis [7]. The absence of water markets is normally due to the under-pricing of water, as it is regarded as a social good rather than an economic good [8]. For example, in the 1980s, South Africa used to price water at 30% of the operation and maintenance costs [9,10]. However, water markets are fast growing, stimulating water pricing from an opportunity cost perspective through the interaction between demand and supply forces [11]. This has the benefit of ensuring the best use of water. However, the development of water markets entails three basic factors: (i) existence of water scarcity, (ii) structure of ownership of water and property rights of water are well defined or established, and (iii) regulatory aspects of rights are conducive for functioning of water markets [3]. In well-established water markets, users—and particularly farmers—can change to lower intensity irrigation systems and sell surplus water in line with the theory of opportunity cost of water [12]. In southern Africa, demand management strategies such as water marketing are necessary to alleviate scarcity through the transfer of the resource to its highest valued use while the market attaches an opportunity cost to that water, which in turn provides incentives for conservation [3,13]. Thus, water has an opportunity cost whereby both buyers and sellers adopt water conservation technologies, although buyers may be more frugal, as the opportunity cost they face may be slightly higher due to transactional cost [14]. The introduction of markets and property rights in the water sector facilitates the transfer of the water rights to take place until the net benefits from a reallocation are exhausted for all water users (until marginal values, net of transactions, and conveyance costs are equal among water users) [15]. In a water market environment, water is sold until the marginal benefit is equated to the marginal cost of keeping the water unsold, and similarly, the buyers continue to purchase water until the marginal benefit of water purchases is equal to the marginal cost of water purchases. This discourages unnecessary extraction of water resources, results in huge water savings, and enhances climate change adaptation [16].

As already alluded to, water markets are influenced by both supply and demand and are mainly practised in areas experiencing water scarcity [17]. Thus, water market refers to the voluntary trading of water in some measurable form, a temporary or long-term water exchange, or the right to use water from one user to another by any means of exchange or lease [3,18]. Their main objective is to get maximum economic benefits from available water resources, and that water is availed to where it is needed the most [17]. Thus, water markets benefit water management by increasing water allocative efficiency, availing water to users with the highest possible returns. In general, users appreciate the value of the resource, and there is more production with fewer water resources [19]. The production of more outputs with less water is considered an improvement in water productivity [20]. A study done in Australia by Grafton et al. in 2011 indicates the importance of water markets in improving water productivity [21]. In general, water markets do not involve investing in new infrastructure [22].

Three types of water markets include: (a) temporary transfers for immediate use, (b) medium-term leasing of water rights that gives the user security to water resources for a period, and (c) permanent water rights at a fixed quantity [23]. The marketing could either be informal (arrangements between users) or formal (institutionalised and managed by authorities) [3,24]. In formal water markets, there are regulations and processes to protect the interests of all stakeholders. In essence, the benefits of water markets are (a) an effective way of reallocating water from lower to higher value uses and (b) cost effective alternatives to mitigate water insecurity challenges [25]. Thus, the transfer of water resources on a supply-demand basis is the best financial, political, and environmental means of managing scarce water resources [26].

Thus, water markets are a catalyst of water use efficiency for sustainable societies and are considered as demand-management approaches, as they deal with water insecurity challenges [27,28].

They are not about setting biophysical limits to water-use, but they play an important role in mitigating water scarcity constraints and help in keeping water-use within limits at the lowest possible cost [3]. The benefits of water markets include (i) minimising the cost of restoring the health of the water system [29], (ii) reconciling the widening gap between supply and demand, which is expected to increase as global water extractions are projected to increase by 55% by 2050 [30], (iii) they sustain livelihoods during scarcity and reduce the widening gap in water accessibility between agriculture and other competing sectors [31], (iv) they reduce the volume of unaccounted water [21], (v) they remove inefficiencies from the water supply system [32], and (vi) farmers produce more with less water, valuing water and hence its opportunity cost [15].

Water markets could be very relevant for southern Africa, as 75% of the region is arid and characterised by high climate variability and unpredictable rainfall patterns worsened by the recurrence of intense droughts [33]. A regional mean annual runoff (MAR) volume of 650 km³ is considerably low for a region that relies on rainfed agriculture and hydropower [34,35]. Both surface and groundwater resources are unevenly distributed throughout the region [33]. These factors contribute to water scarcity challenges in southern Africa. Water scarcity refers to lack of sufficient available freshwater water resources to sustainably meet the demands of water usage within a region [4,36,37]. The concept of water scarcity embraces other concepts such as water stress, water shortage or deficit, and water crisis, and it is usually caused by growing freshwater use and depletion of usable freshwater resources [38–41]. Faced with the need to meet the growing demand for water resources, the Southern Africa Development Community (SADC) has put in place several legal and institutional frameworks aiming to manage water resources in a sustainable way. These frameworks include: (i) SADC Protocol on Shared Watercourses [42], and (ii) the SADC Regional Water Policy [43].

While water markets have improved water use efficiency and reduced the impacts of water scarcity in countries with operational legal and institutional frameworks, such as Chile, Australia, and the United States of America, in southern Africa, they are still in their infancy [44]. In southern Africa, water marketing is driven by the need to reallocate existing resources efficiently due to increasing demand in the midst of scarcity. Their success in southern Africa hinges on the availability of specific governance structures. This review discusses the baseline status of water markets in southern Africa, outlining opportunities and constraints. The aim is to provide evidence on the pros and cons of water markets.

2. Materials and Methods

2.1. The Study Area

The study covered southern Africa, which comprises 16 countries: Angola, Botswana, Comoros, Democratic Republic (DR) of Congo, Swaziland, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia, and Zimbabwe (Figure 1). These countries form the Southern Africa Development Community (SADC), which aims to achieve economic and political integration as governed by the SADC Treaty, the overarching legal document framework for the region. The region also aims to attain economic growth, peace, and security, and to alleviate poverty and improve the livelihoods of the people [45]. The region aspires to achieve regional integration through water trade from areas with high water resource endowments to those with low water resources endowments [43]. To date, the region has ratified a number of policies and institutions that are driving the political will towards integration. These policies include the SADC Water Policy and the Protocol on Shared Watercourses [35].

Seventy five percent of the region is arid and characterised by highly variable and uneven rainfall regimes. Annual rainfall oscillates between 100 mm in the driest areas and 2500 mm in the wettest regions [46]. Climate varies drastically from desert through temperate, savannah, and equatorial [47]. Negative changes in moisture regimes as impacted by climate change threaten the production of about 95% of agricultural land in southern Africa, as it is rainfed [48]. Projections indicate that southern

Africa will be subjected to increased physical and/or economic water scarcity by as early as 2025 [49]. Agriculture is the largest sector, as it sustains the livelihoods of about 60% of the population and also consumes more than 70% of the available freshwater resources [50,51]. The importance of agriculture has promoted the region to target increasing the irrigated area by 100% by 2025 from the baseline value of the year 2000 [51]. The estimated cost of increasing the irrigated area is \$37 billion USD, while infrastructure operation and maintenance would require a further \$31 billion USD [51]. However, irrigation expansion would mean allocating more water resources to agriculture, a scenario that favours water markets out of necessity. Water scarcity is creating uneven demand-supply pressures, promoting water markets in the process. Marketing in water is evidently concentrated in the southern parts of the region because of acute water scarcity. In contrast, northern countries (DR Congo and Zambia) are endowed with abundant water resources.

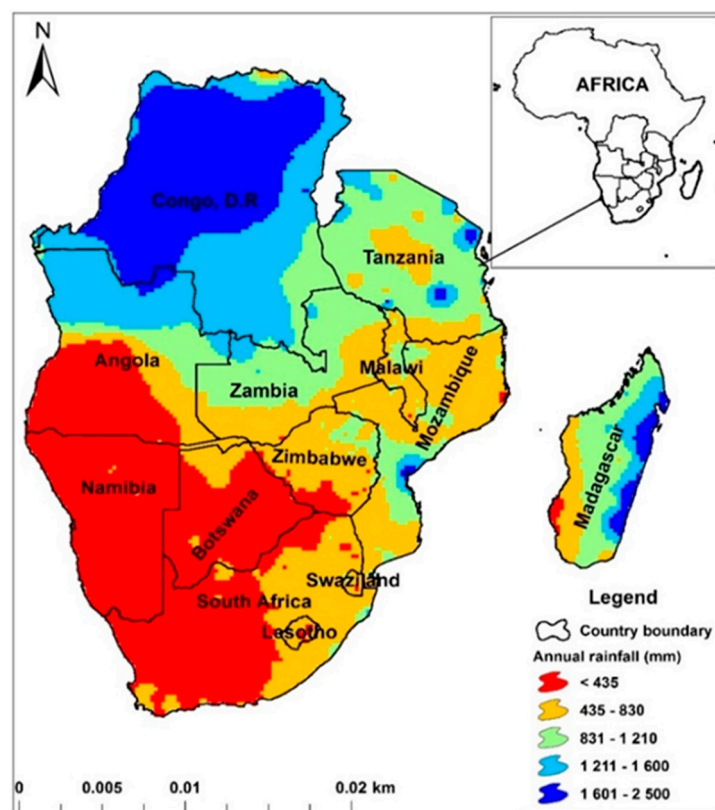


Figure 1. Locational map of southern African showing annual rainfall distribution. Source: Developed by authors.

2.2. Methodological Framework

Although the concept of water marketing is still in its infancy in southern Africa, there is evidence of rapid growth, as shown by the increasing water transfers and joint ventures [52,53]. We sourced 38 water market publications that focused on the region, 15 of which were from South Africa, six from Zimbabwe, three from Tanzania, and the rest were shared among the other 13 Member States of the SADC region. The publications were sourced through Web of Science and Google Scholar using keywords such as “water markets”, “water trading”, “southern Africa”, “water scarcity”, “inter-basin water transfer”, and “joint ventures.” The publications focused mainly on water security, investment in water infrastructure, water rights and allocation, irrigation schemes joint venture, risks in water markets, and water balance. We also consulted grey literature from Watercourse Commissions and SADC Water Sector. Previous studies compared water markets in southern Africa with those in countries where the concept is already advanced, such as Australia, the United States, and Chile, as well as showcasing case studies of water markets at farm level. This review focuses on the role

water marketing can play in water management, highlighting their characteristics and trends in the region. The review also focuses on governance structures of water markets as well as their risks. The paper provides evidence of success stories from regions where the concept has been practised and recommends available options for southern Africa. The study also highlights the drivers of water markets, such as climate change, underlining the risks associated with water insecurity. Existing water markets are also outlined, as shown in (Figure 2). The aim is to develop resilient waters for southern Africa in an environment of scarcity and uneven distribution and to promote regional integration.

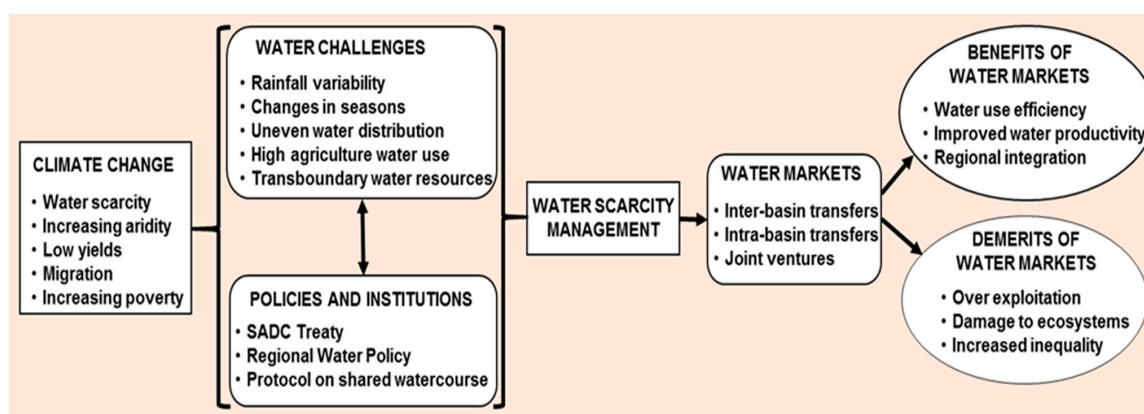


Figure 2. Methodological framework used in this study. Source: Developed by authors.

Figure 2 is a graphical representation of the methodological framework used to develop this review. The methodology is motivated by the need to provide evidence on a water management framework that would address the unevenly distributed and scarce water resources in southern Africa. The region is evidently divided into two zones according to water availability—the north with abundant water resources and the south, which is water scarce. It is also built on the region’s aspiration to achieve regional integration through its common culture, shared water resources (fifteen river basins are transboundary) and similar challenges such as depleting resources, drought recurrence, urbanisation, and spiralling population growth [51].

3. Need for Water Markets in the Southern Africa

3.1. Water Resources Distribution in Southern Africa

Apart from the uneven spatial distribution of water resources across southern Africa, the conversion ratio of mean annual precipitation (MAP) to mean annual run-off (MAR) is the lowest in the world [54]. Figure 1 is a map of southern Africa displaying the unevenness in the distribution of water resources in terms of rainfall and showing the two hydrological zones, the wet northern part and the dry southern parts. The nature of distribution of water resources in southern Africa can either play an important role of promoting regional integration through its trade and alleviating poverty, or may actually be a catalyst to regional conflict if not well managed, not considering downstream countries [35,55]. Fifteen of the major river basins in the region are transboundary (Figure 3), and five countries have a water resources dependency ratio of over 50%, meaning that they depend on water originating from outside their political boundaries to meet more than half of their total water requirements [35,56]. In summary, water resources in southern Africa need to be managed well to avoid conflicts and to ensure that they promote regional integration, economic development, build resilience, enhance adaptation, and improve the livelihoods of the people in a region exposed to a host of vulnerabilities [43].

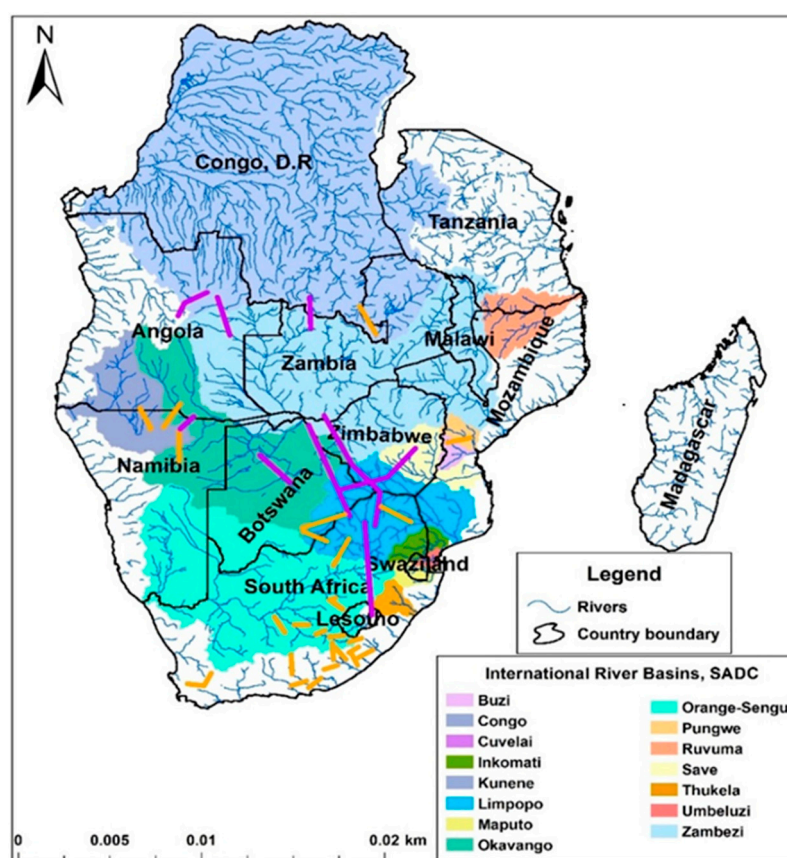


Figure 3. Planned and current inter-basin water transfers. Orange lines indicate current transfers; purple lines indicate planned transfers. Source: Developed by authors.

The increasing water scarcity challenges in southern Africa may have dire consequences if not well managed. One important characteristic associated with water resources is that 80% of the arable land is rainfed, yet 60% of the population relies on agriculture for their livelihoods [50]. The increasing frequency and intensity of drought is another challenge affecting the agriculture sector and forcing people to migrate from rural areas to urban areas or across borders [33,49]. Urbanisation and migration are now the major regional challenges affecting the agriculture sector, yet agriculture provides about 17% of regional gross domestic product (GDP) (increasing to above 28% when middle-income countries are excluded) and contributing about 13% of the total export value [57]. These stressors are increasing the poverty levels of the already marginalised rural people of the region. Water markets could play an important role in agriculture water management by making sure that water is used for its highest value, availing water to other sectors, and improving on crop yields.

Figure 3 is a map of southern Africa showing the transboundary nature of river basins as well as existing basin water transfers (current and planned) of the region. The transboundary nature of river basins and the uneven distribution of water resources (Figure 1), coupled with droughts recurrence, population growth, and the need to allocate more water resources to agriculture due to the need to feed a growing population, require innovative water management strategies at basin level to avoid conflicts and promote regional integration. There are already water sharing and water marketing initiatives in the region, some already going on whilst others are still at planning stages. These initiatives are now being accelerated due to the continuing depletion of water resources and the recurrence of extreme weather events of droughts and heatwaves. Droughts reduce the availability of water resources due to lack of recharge, and heatwaves increase evaporation from water-bodies.

3.2. Variations of Water Resources in Southern Africa

The greatest climate change impacts in southern Africa are being felt through water resources and are manifesting through rationed water supplies as well as through water and food insecurity [58]. The challenge of water insecurity poses the greatest threat for the region to meet its developmental targets and attain the 2030 Global Agenda for Sustainable Development [59]. The anticipated decreases of about 20% in annual precipitation by 2080 in southern Africa will result in the reduction in water resources and cause challenges in hydropower generation and crop production [49,60].

Figure 4 is an aridity map of southern Africa, where there is evidently acute water scarcity. All the area designated as arid or semi-arid is water scarce. The average climate moisture index (CMI) of the region is -0.80 , qualifying the region to be arid and water scarce [33]. The worsening aridity in southern Africa is also confirmed by previous studies that show an increasing level of aridity [61]. The aridity is worsened by recurring drought frequency and intensity [33].

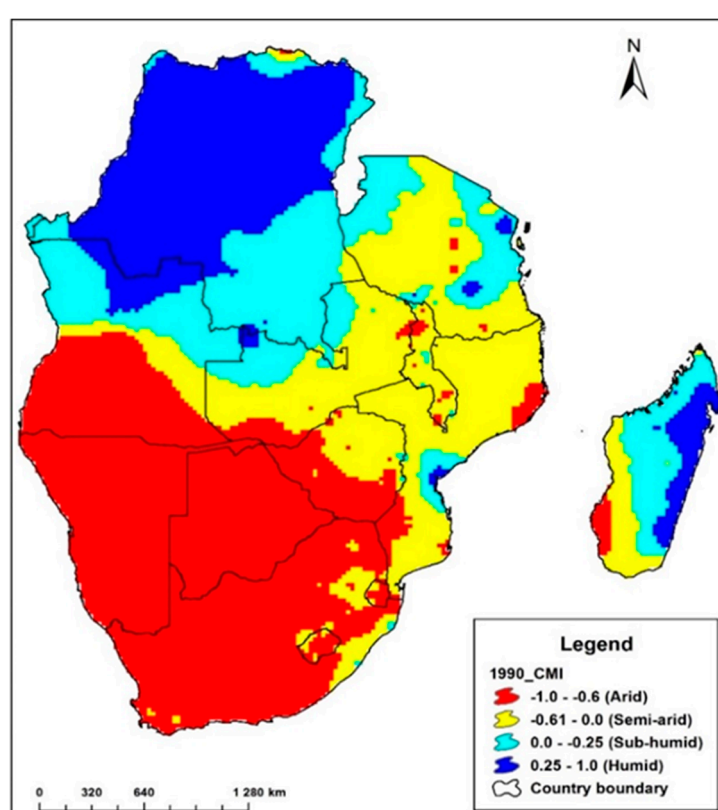


Figure 4. Water scarcity and aridity levels and distribution in the Southern Africa Development Community (SADC) region. Source: Developed by authors.

4. Types of Water Markets Practiced in the SADC Region

Water markets in southern Africa are not only existent in the agriculture sector, but they encompass other sectors as well. For example, water resources are being transferred from one country or from one basin to the other to support an area of economic development in another country, benefiting both regions in infrastructural development and alleviating water scarcity challenges, respectively [62]. A successful example is the transfer of water from Lesotho to Gauteng Province, which is the economic hub of South Africa. Such water transfers are starting to grow because, generally, in southern Africa, major centres of economic and social development are located in areas where water is scarce, a situation promoting inter and intra-basin water transfer schemes. Inter or intra-basin water transfer refers to the transfer of water from basins of relative abundance to basins experiencing scarcity [63]. Although it is still a relatively new concept in the region, water marketing is growing, and the main forms of water

markets already being implemented include inter-basin water transfers, intra-basin water transfers, and joint ventures.

4.1. Inter-Basin Water Transfers

As already alluded to, in an inter-basin water transfer, water is transferred from one basin to the other under specified water regulations that provide the written instruments that allow the passing of water from a basin of abundant water resources to alleviate water challenges in another basin [64]. There are already established inter-basin and intra-basin water transfers that are done across national borders or across river basins. These transfers have resulted in the functioning of horizontal cooperation and the implementation of various water agreements, which have given birth to many inter-basin water transfers (Figure 3). One such successful inter-basin water transfer arrangement is the Lesotho Highlands Water Treaty [64,65], which culminated in the formation of the Lesotho Highlands Water Project. In the transferring of water in an inter-basin transfer environment, water is transferred through clearly defined volumetric allocation based on known flows.

Intra- and inter-basin water transfers are a form of water markets in which water is transferred in known volumetric measurements from an area of abundance to meet the water requirements of an area experiencing scarcity for a cost [66]. The revenue from the transfers benefits the source, whilst the transferred water alleviates water scarcity challenges of the recipient area. Thus, in inter-basin water transfers, the maximum value of water is recognised, thereby improving on water productivity. In the case of the Lesotho Highlands Water Project, the transferred water alleviates South Africa's water scarcity challenges through the trading of some of Lesotho's abundant freshwater resources to the Gauteng region [64]. The revenues from the project are enabling Lesotho to develop its hydropower capacity and improve water distribution within the country [67]. The project has benefited Lesotho by improving its GDP growth from 3% per annum in the pre-project period to the current 5.5% per annum. The project has also resulted in Lesotho experiencing minimal power outages, more job creation, and improvements in infrastructure such as roads, telecommunication, and sanitation facilities [68]. On the other end, South Africa is benefiting from the project through the transfer of quality and reliable water for both domestic and industrial use in the Gauteng region, in addition to job creation and improved infrastructure [68]. Thus, in basin water transfers, water is a commodity that is being traded at a cost.

Other examples of inter-basin water transfers are the Vioolsdrift and Noordoewer Joint Irrigation Scheme Agreement, which was entered between South Africa and Namibia [69], and the Inco-Maputo Agreement [70] between South Africa, Swaziland, and Mozambique. In these agreements, water is viewed as a stock with a known volumetric magnitude, which is shared among riparian countries, much like the slices of a pie [55]. The region needs to build on such transboundary transfers to address water scarcities in countries such as Botswana, South Africa, and Namibia, which face acute water shortages. Practical examples of inter-basin water transfers in the region can be found at www.limpopo.riverawarenesskit.org.

4.2. Intra-Basin Water Transfers

With intra-basin transfers, bulk water is transferred from one area to the other within the same basin to address the severe water shortages in the receiving areas [71]. For example, water imported from the Usutu, the Vaal, and the Komati Rivers in South Africa is used to meet the high water demands of the power stations that are in the Upper Olifants River basin. Water transferred from the Vaal in the Orange-Senqu River basin combined with the reuse of return flows in the Crocodile River is providing sufficient water in the Crocodile and is further used in the Mogalakwena, the Mokolo, and the Olifants River basins.

4.3. Joint Venture System

The joint venture system is a form of a business structure with flexible terms and conditions and is less formal than either a partnership or a corporation requires. In the case of farming ventures,

small-scale farmers own the land and water rights, but they have limited resources to practice full-scale commercial farming [52]. They then enter into an agreement with established commercial farmers, where the smallholders rent their land and water rights to the commercial farmers, who then cultivate the land for a certain period and share the proceeds with the smallholder farmer. These are supposed to benefit both parties. Examples of such agreements are between smallholder farmers in irrigation schemes with state of the art irrigation equipment, which are leased to commercial farmers, for example, in the Flag Boshielo Irrigation Scheme in South Africa. The smallholder farmers transfer their land and water rights to established commercial farmers for a particular period of time, and both parties benefit from the agreement. Thus, for these ventures to take place, there has to be someone with rights to water and/or land. Thus, it turns out that property rights and the manner in which they are defined are pre-requisites for the development of water markets.

Joint ventures have been successful to some extent, as they have improved the livelihoods of smallholder farmers, and they end up growing crops at a large scale after having learned from the established large-scale commercial farmers. However, there have been instances where the agreements of the joint venture are vague, resulting in smallholder farmers not benefiting from anything due to a lack of understanding of the terms and conditions of the agreements. In such instances, the governments intervene to rescue the disadvantaged smallholder farmers [72,73].

5. Legal Frameworks Related to Water Markets in the SADC

The SADC region has rectified a host of protocols and treaties as it moves towards integration and poverty alleviation. The SADC Treaty is the principal regional legal framework from where all other legal frameworks are derived and where regional targets—achieving economic development, peace, security, and growth, as well as alleviating poverty and improving the livelihoods of the people—are outlined [45]. Coordinated water marketing in the SADC region, governed by legal frameworks, are vital in seeing the region meet regional objectives. For water markets to be effective in the region, there is need for specific water markets' legal frameworks to guide policy and decision-making. As it stands, the concept of water markets is embedded in general and broad frameworks related to water and agriculture. Although each country has its own legal frameworks, these are aligned to the regional policies to avoid conflicting targets and policy spillovers. To date, the region has ratified the following legal frameworks and institutions that can govern water markets.

1. The Regional Strategic Action Plan IV (RSAP IV) [74] is derived from the SADC Water Policy and Strategy and fosters equitable and sustainable utilisation of water, which benefits both human requirements and the environment. The policy also highlights the need for regional integration and economic benefit for present and future generations. The RSAP IV stresses on the need for infrastructure development and water resource management for food security, as well as an urgency to act on climate change. As water resources are transboundary in nature in the region, the RSAP IV is well positioned in driving water markets by encouraging intra-basin water transfers.
2. The SADC protocol on shared watercourses [42] stimulates regional cooperation for sustainable and coordinated management, protection, and utilisation of shared watercourses, as well as advancement of regional agenda on integration and poverty alleviation. Shared river basins have basin agreements that oversee the management of those basins. Shared river basin agreements include the Limpopo Watercourse Commission (LIMCOM), the Orange-Senqu River Commission (ORASECOM), and the Zambezi River Basin Commission (ZAMCOM). Watercourse commissions are well positioned to promote water markets by encouraging coordinated water development within basins and agreements among riparian countries on equitable water use.
3. The SADC Regional Agricultural Policy (RAP) [57] promotes integrated planning in water resources management. The policy stresses the need to improve agriculture production to ensure food and water security. The SADC's Regional Indicative Strategic Development Plan (RISDP) [51], derived from the Africa-wide Comprehensive Africa Agricultural Development

Programme (CAADP), advocates for the doubling of irrigated area from 3.5 to 7% by 2025. The RAP is important for ensuring water and food security through the promotion of equitable and integrated land and water use. The RAP can promote the transfer of water from regions with abundant water resources to regions experiencing scarcity but with agriculture potential.

6. Benefits of Water Markets

Reliance on markets may present some challenges owing to market failures and negative externalities that are associated with markets. However, the challenges of water management in times of scarcity can benefit from water markets by relaying water from places of surplus to those of deficit. As water markets facilitate voluntary water allocation to areas where it is optimally needed and used [18,27], they can improve water productivity. Water rights are the basis for water marketing, and they are an incentive for increased productivity, efficiency, and allocation of rights to where they are needed most. Moreover, without well-defined and secure rights to water, the latter has no value and an investor seeking to invest in water resources development has no incentive because it would be difficult to recoup the value of his water investments [75]. Therefore, water markets require well-defined and enforceable water rights that are a source of secure tenure of water and stimulate investment in water-saving technologies [76].

Water marketing reduces uncertainty for users and at the same time provides security against the effects of uncertainty [3]. In the case of southern Africa, users in water scarce regions are assured of water supply to meet their needs, as water is transferred from low value uses to high value uses [62]. For example, a study by Louw [15] estimated the factual value of water in the Berg River Water Management Area in South Africa from a water market perspective, looking at efficiency and utilisation of water. The study found that the value of water in irrigation varies considerably between areas in the basin, with the marginal value of water ranging from zero to 20 ZAR/m³ (ZAR = South African Rand). These differences show some considerable gains from allocative mechanisms.

The acquisition of water rights from other water users is an assurance of water security in times of scarcity and other local or temporal supply disruptions [26]. The transfer of water rights allows users to shift costs to those capable of bearing them, thereby reducing the overall costs of such unforeseen supply disruptions [26]. For southern Africa, water markets are vital for:

- Promoting regional integration. The region has established watercourse commissions to oversee water uses by riparian countries in shared river basins. Watercourse commissions such as the Limpopo Watercourse Commission (LIMOCOM) and the Zambezi Watercourse Commission (ZAMCOM) are spearheading regional integration and cooperation by overseeing sustainable water use within respective river basins to avoid conflicts [42]. Water cooperation is evidenced through intra-basin water transfers.
- Promoting awareness. Water marketing can be an advocacy and awareness tool that helps communities to appreciate the value of water as a secure asset and obtain finance against its value. In the case of inter-basin transfers, the source of water supply is benefiting from the revenue by improving infrastructure such as roads, building health facilities, and improving electricity distribution, whilst meeting the water requirements of the where it is being transferred [68].
- Encouraging water-use efficiency by allowing holders of water rights to temporarily sell or lease those rights for the benefit of all. Where water marketing is being practiced, water productivity and water use efficiency have improved, availing water to other sectors [77].
- Allowing holders of water rights who want to stop production to trade their rights at a defined cost without selling their land. Where there are operational legal and institutions frameworks, holders of water rights in joint ventures generally improve their livelihoods and gain new farming knowledge and experience [78].

- Improving water use efficiency. Water markets improve water use efficiently without affecting the environment or other water users or without compromising food and water security. Thus, water markets are an option in building resilience [27].
- Facilitating water transfers. Water markets facilitate the transfer of water use from lesser value crops to relatively higher value crops and promote the use of advanced irrigation techniques, thereby promoting the objective of efficiency and flexibility in water allocation [26,79].

7. Risks Associated with Water Markets in Southern Africa

Although water markets play an important role in water management in water scarce areas, they are not a panacea to water scarcity challenges. While it is acknowledged that well-functioning water markets are important in alleviating socioeconomic impacts of reduced water availability, they do not completely remove the adverse impacts of water scarcity. Effective water markets are dependent on the nature of the markets and governance structures within which they exist.

Although water transfers ensure effective water allocation and distribution, there are potential risks associated with them. One major risk of long-term water transfers from the countryside to cities is that they may result in the conversion of rural areas into suburbs and cause ecological risks [80]. Intra-basin water transfers may exacerbate inequality between the water poor and the water rich households or regions in the absence of regulations that emphasise on some minimum levels of equity [81]. Furthermore, water markets may bring in other externalities, including over-exploitation of water resources in pursuit of profits [82]. Furthermore, inter-basin water transfers can lead to adverse environmental consequences if not well managed. Large-scale and long-distance inter-basin transfers present the risk of decreasing runoff volumes of river basins and may cause the salinisation of soil and salt-water intrusion at the estuary, thus affecting water quality [68]. In terms of health and sanitation, inter-basin or intra-basin water transfers may stimulate the spread of waterborne diseases such as typhoid, dysentery, cholera, and bilharzias as water is transferred from one region to the other. The open nature of canals in inter-basin transfer may result in the increase in animal mortality, as canals act as an animal traps [83]. Inter-basin water transfers may also be an avenue of invasive alien species on affected river systems because of the disturbances in the biogeographic barriers between river basins [84].

Regulated and institutionalised water marketing is more effective to close all loopholes as users, particularly farmers, sell their surface water but exploit groundwater resources to meet their own needs [80]. One other challenge of water marketing in southern Africa is the issue of national sovereignty. The benefit sharing or inter-basin transfers can be interpreted as interference by upstream or water-rich countries, and that can delay regional integration. However, there are more positives than negatives that could be drawn from regulated water sharing at regional level. For example, in the case of southern Africa, the shared nature of water resources could contribute to regional integration rather than conflicts if water resources are managed at a regional level rather than at a national level [35].

Despite these limitations and risks, water markets play a pivotal role in enhancing water management. Water markets increase water use efficiency, as users recognise the true value of water, thereby enhancing adaptation strategies [27]. In their study, Loch et al. [27] highlighted how water markets are benefiting climate change adaptation in Australia by availing water to where it is needed the most. However, the benefits of water markets in climate change adaptation will only be realised when water is seen in equal terms with other compelling sectors of energy and agriculture. Thus, the water-energy-food (WEF) nexus analytical framework will guide on how water markets can be implemented without negatively affecting other sectors [35,85]. In a WEF nexus environment, the three essential resources of water, energy, and food are analysed systematically and in a holistic and cross-sectoral way. The WEF nexus analytical framework provides policy and decision-making with decision support tools on areas of priority intervention, performance of resource utilisation, and management [86]. The essence of the WEF nexus in resource management is that it accounts for synergies, trade-offs, and conflicts, as resources are seen in equal terms [35].

8. Conclusions

Although water markets are relatively new in southern Africa, they are fast growing and presenting huge potential for fostering the best use of very limited water supplies and increasing opportunities to improve water productivity and water use efficiency. With the growing demand of water resources in the whole agriculture value chain and rapid urbanisation in the face of depletion, water marketing has shown some usefulness in water management. Although there are benefits that are derived from water markets, there are also risks associated with them. Before implementing water markets such as inter-basin water transfer, environmental impact assessments must be done for preparedness of any eventualities. Effective water markets are only possible where there are relevant and functional institutions and legal frameworks. In southern Africa, water markets are governed by broader water related frameworks. Successful water markets have benefited whole communities, as proceeds from water transfers are channelled back to the communities to improve infrastructure and livelihoods. However, unlike water transfers, joint ventures are characterised by benefits of water rights owners, as they hold the privilege to trade their rights. Due to the uneven distribution of water resources in southern Africa, their transboundary nature, and the shared challenges among regional countries together with the regional goals of integration and poverty alleviation, water markets can contribute towards achieving regional targets and improving the livelihoods of people. Going forward, there is need for policy makers to focus on externalities, market information, equity, and institutional frameworks that can facilitate water markets development.

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