ARTICLE

TRANSFORMING THE RURAL AGRICULTURAL LANDSCAPE THROUGH GROUNDWATER OPTIMISATION: EXPLORING A CHINESE-SOUTH AFRICAN PARTNERSHIP

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ABSTRACT

The majority of the South African rural populace is directly or indirectly engaged in agricultural practices to earn a livelihood. However, impediments such as climate change, water shortages, and inadequacy of institutional support have undermined these once thriving subsistence farming communities. Furthermore, poor leadership in hydrology, coupled with a lack of depth in skills at all government levels to facilitate the understanding of the importance of groundwater, has made it near impossible for subsistence farmers to benefit optimally from groundwater. The 2012 drought experienced in South Africa paralysed several subsistence farming communities in KwaZulu-Natal. To revamp subsistence farming and assist these farmers across South Africa, the Department of Water and Sanitation launched interventions, but despite the enormous resources expended, indicators (e.g. unsustainable farming practices, poor crop yield, pitiable living conditions, and poor standards of living) provide evidence that these interventions have not yielded the desired results. This paper seeks to suggest practicable interventions aimed at reducing the vulnerability of subsistence farmers in KwaZulu-Natal. The study pursued a qualitative approach in that it solicited the views of experts on groundwater and in related fields to gain an in-depth perspective. Some of the core challenges undermining the sustainability and growth of subsistence farming in the study area were found to be the inadequacy of experts on groundwater, water shortages, institutional deficiencies, lack of political will, and lack of coordination among stakeholders. Pragmatic recommendations are made to address these challenges, among other things to encourage a South African-Chinese partnership in the hydrology sector.

Keywords: subsistence farming; groundwater optimisation; resource-poor farmers; hydrology; rural

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LIVELIHOOD IN RURAL COMMUNITIES

A conservative estimate in 2015 put the global rural population at 3.7 billion. This figure denotes half of the current world population of 7 billion (Siegel 2016, 4). Although rural communities across the globe may vary in a number of ways, they share various commonalities, for instance, high dependency on natural resources, dependency on agriculture as a main source of livelihood, high incidences of poverty, poor infrastructure, underdevelopment, and sparsely populated communities (Dasgupta et al. 2014; Goldblatt 2010; United Nations 2014). Empirical studies affirm that a vast majority of poverty-stricken households are in rural communities. According to the WHO/UNICEF Joint Monitoring Programme (2015, 66), over 1.1 billion people worldwide (constituting one-sixth of the world's population) live in abject poverty. The majority of these underprivileged people live in rural communities (De Hoyos and Medvedev 2011, 22). A similar survey claims that 75 per cent of the world's poorest people are found in rural communities (Raidimi 2014, 10). This estimation is consistent with the report by the WHO/UNICEF Joint Monitoring Programme (2015, 433) which acknowledges that 73.6 per cent of the world's poorest individuals are found in rural communities.

The main source of livelihood among rural communities, particularly in Africa, is subsistence farming. According to a report by the UN World Water Assessment Programme (UN WWAP 2015), an estimated 400 million people out of the 1.2 billion inhabitants on the African continent are directly or indirectly involved in agricultural practices in the form of subsistence farming. Among the dominant factors undermining the sustainability and growth of this source of livelihood are climate change, water shortages and inadequacy of institutional support. Not only African and underdeveloped nations but also developed nations experience similar challenges in their rural communities. The European Rural Parliament (2015, 14) acknowledges that rural communities are very concerned about the constrictions of rural economies, lack of employment opportunities, loss of the young population to urban communities, decline in rural services, and many other day-to-day challenges. The situation in the rural Asia-Pacific region is the same: among its estimated 3.5 billion inhabitants, 63 per cent live in rural communities (Chauhan 2012, 2). Though several million of the inhabitants in this region have escaped poverty as a result of rural developmental initiatives, the majority are still caught in abject poverty. The socio-economic disparities between rural and urban areas are widening and creating tremendous pressure on the social and economic fabric of many developing Asian economies (Chauhan 2012, 2). This situation emphasises that rural development across the globe is imperative.

Against this background, the current study explored approaches through which the landscape of the predominantly subsistence farming rural populace of the KwaZulu-Natal province of South Africa could be transformed through the optimisation of groundwater usage.

NEXUS BETWEEN AGRICULTURE AND RURAL DEVELOPMENT

Numerous studies have drawn attention to the close relationship between agriculture and rural development (Aliber and Hart 2010; Bhatti, Koike, and Nasu 2012). Some studies indicate that a high percentage of rural households are directly or indirectly involved in farming practices (Daniels et al. 2013; Jagals 2012). On the African continent, an estimated 400 million among the 1.2 billion inhabitants are directly or indirectly involved in farming practices (UN WWAP 2015). Many studies emphasise that rural development can be accelerated mainly through the development of the agricultural sector (Daniels et al. 2013; Dasgupta et al. 2014**)**. However, several agricultural regions, particularly in underdeveloped and developing countries, seem to be moving in the opposite direction as their agricultural sectors have been on the decline. The governments of some developing countries are beginning to shift attention from the agricultural sector to either extractive sectors (oil, gas, mining) or manufacturing, communication, wholesale and retail, and finance and business services. On the other hand, developed nations have transformed their previously highly labour-intensive farming practices into mechanised farming practices. For example, in the United States of America, farming employment declined from 15 per cent in 1969 to six per cent in 2015 (C-FARE 2016). A number of other factors have added to a decline in the agricultural sector, for instance, lack of political assertiveness, climate change, rural-urban migration, desertification, urbanisation and low income of farmers (Calzadilla et al. 2013; Goldblatt 2010).

Exacerbating the lack of agricultural development in several rural communities is the poor sustainability of natural resources. Often, natural resources such as forest timber, groundwater, soil, and fauna are not preserved or used sustainably. In some instances, groundwater is overextracted for mining activities or farming practices.

Rural development analysts argue that the most realistic and practical approach to rural development is through the development of the agricultural sector (Chauvin, Mulangu, and Porto 2012). However, other analysts argue that, inasmuch as the agricultural sector can be a first phase in rural development, the non-agricultural sector (e.g. tourism, manufacture, and retail) can be used to supplement the agricultural sector and accelerate rural development.

A variety of challenges undermine the agricultural sector in rural communities across the globe, but one that is prominent and faced by almost every rural community is the insufficiency of water for agricultural purposes. This predicament is forecasted to exacerbate in the future as global water resources keep shrinking, while the world faces an unprecedented population growth. In view of this challenge, the current study explored groundwater resources and how these resources could be sustained and used optimally for the advancement of rural development.

EXPLORING GROUNDWATER RESOURCES

The inexorable population growth across the globe has raised concerns about food security in the near future. This concern is deepened by the fact that 1 400 million rural inhabitants rely on subsistence farming or subsidised food imports. Bearing in mind that increasing amounts of water are required for food production both in subsistence and commercial farming, questions have been raised about the sustainability of agricultural practices in the long run, even more so because the world's water demand far outstrips the water supply in various regions. While rainfall can sustain crops in regions with high humidity, this is not possible in other regions where optimal production requires irrigation. At present, the agricultural sector consumes an estimated 70 per cent of the world's withdrawal of water supply and 85 per cent of the world's water resource consumption (International Association of Hydrogeologists [IAH] 2015**)**. Further, an estimated 43 per cent of the water used for irrigation is being sourced from groundwater. Groundwater for irrigation purposes has been significantly developed in North America and South Asia where it supplies 54 per cent and 57 per cent respectively of the demand (IAH 2015). The 250 per cent increment in food production during the green revolution of 1970–2000 was only achievable due to water sourced from groundwater. Up to the present, groundwater still plays a critical role in every region. Table 1 illustrates groundwater usage across different regions.

Table 1: UN WWAP (2015) statistics on groundwater use for agricultural irrigation

Region	**Groundwater irrigation**		
	Area (Mha)	**Volume used (Km^3/a)**	**Proportion total**
South Asia	48.3	262	57%
East Asia	19.3	57	34%
South-East Asia	1.0	3	5%
Middle-East and Central Asia	11.9	76	38%
Europe	7.3	18	38%
North Africa	2.5	16	24%
Sub-Saharan Africa	0.4	2	7%
North America	19.1	100	54%
Latin America	2.2	88	19%
Australia	0.9	3	21%
Global Total	112.9	545	43%

Note: Mha = millihectares; Km^3/a = cubic kilometres per annum

Source: *Adapted from IAH (2015)*

As highlighted in Table 1, sub-Saharan Africa has the lowest proportion of groundwater usage. Various authors (Calzadilla et al. 2013, 211; Falkenmark 2013, 11; Mati 2007, 3) affirm that groundwater in the sub-Saharan region is underutilised. Ironically the region is characterised by high population density and high incidences of poverty. The groundwater resource, if optimally utilised for agricultural purposes, may possibly help millions of poverty-stricken people in rural communities to break out of the poverty cycle. However, limitations such as hydrological skill shortages, lack of funds, lack of data, lack of technical and managerial expertise, poor interaction among researchers, hydrologists and other stakeholders, infrastructural deterioration, poor practices, and unsustainable abstraction have often impeded the optimal usage of this valuable resource.

Figure 1 depicts groundwater availability on the African continent, whereas Figure 2 indicates the extracted depth in groundwater and aquifer productivity.

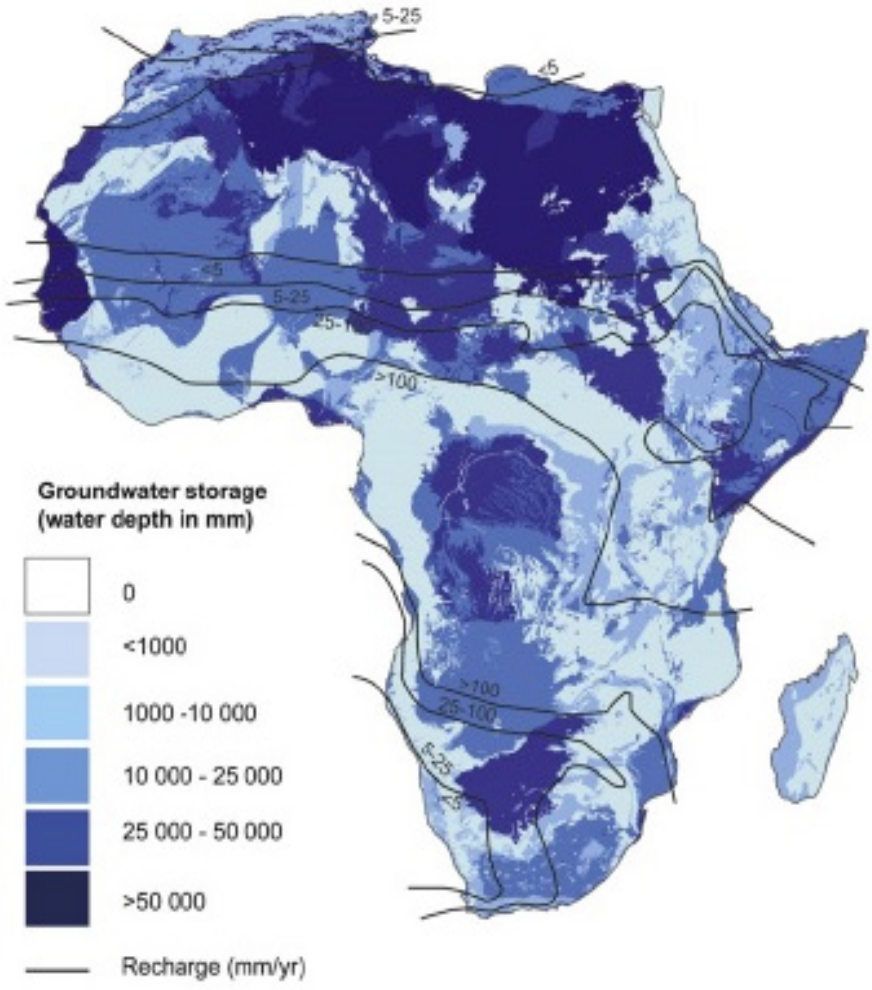

Figure 1: Groundwater availability in Africa

Source: *MacDonald et al. (2012, 4)*

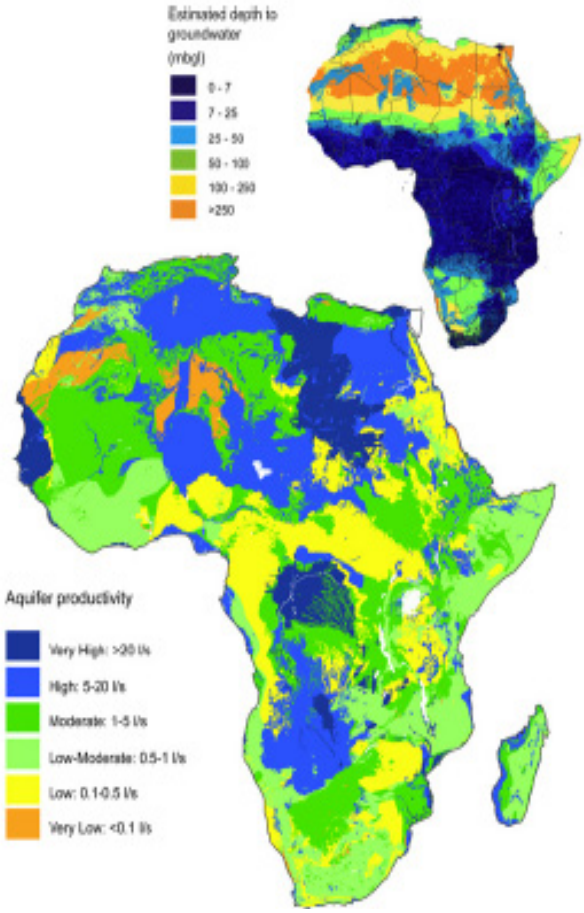

Figure 2: Extracted depth in groundwater and aquifer productivity

Source: *MacDonald et al. (2012, 5)*

Water is a crucial resource for development, particularly on the African continent where development and growth are much needed. Nevertheless, only as little as five per cent of the available water resources has been utilised on the African continent (Braune, Adams, and Fourie 2014, 2). Hydrologists generally agree that groundwater will play an increasingly strategic role on the African continent particularly among the rural communities who are often also vulnerable to climatic variations (Braune, Adams, and Fourie 2014, 2). A recent estimate puts the total volume of available and renewable groundwater in South Africa at 7 500 million m^3/a (under drought conditions) and the utilisable groundwater exploitation potential at 10 300 million m^3/a. However, South Africa has only utilised between 2 000 and 4 000 million m^3/a of this valuable resource (Braune, Adams, and Fourie 2014, 2). While the majority of the senior personnel at the

Water Resource Planning unit of the Department of Water and Sanitation are cognisant of the enormous potential of groundwater, managers and planners at regional and grassroots levels do not share the same view. The latter group perceives that groundwater should be used as a last resort or during emergencies (Braune, Adams, and Fourie 2014, 11). Further to this disagreement among stakeholders (which hampers development) is the inadequacy of information and lack of knowledge among decision-makers in the fields of climate change and rural development (Braune, Adams, and Fourie 2014, 11). On the other hand, there is general agreement that the lack of human and financial resources is the reason for the non-optimal usage of groundwater (Binswanger-Mkhize 2009; Conrad, Nel, and Wentzel 2005; Knüppe 2011; Levy and Xu 2011).

As proven empirically, South Africa's groundwater resources are yet to be optimally tapped into (Knüppe 2011). This underutilised resource can possibly be optimally used through tailor-made investments, expert involvement, and addressing institutional inertia. Thus, a strengthened Chinese-South African partnership may potentially reinvigorate institutional action, address skills shortages, and provide much-needed funds for groundwater development for rural developmental purposes. These issues are further expounded in the section where recommendations are made.

GROUNDWATER: OBSTACLES TO OPTIMAL UTILISATION

A number of impediments have obstructed the maximal usage of groundwater in South Africa. Some of these impediments are also experienced in other sub-Saharan countries and on the African continent as a whole (MacDonald et al. 2012; Sorensen et al. 2015). Table 2 summarises the main obstacles affecting the optimal utilisation of groundwater for subsistence farming. This list is, however, not exhaustive, but highlights the most prominent issues affecting the optimal usage of this resource in the area of study. Some of the constraints identified either impact directly or indirectly on the optimisation of this valuable resource.

Table 2: Obstacles to optimal utilisation of groundwater

S/n	Obstacle	Discussion
1	**Hydrological skills shortage**	The lack of skilled hydrologists, particularly at municipal level, has resulted in the non-identification of aquifers, the overabstraction of aquifers in some instances, and the inability to sustain aquifers for a long period of time (Department of Water and Sanitation 2016)

S/n	Obstacle	Discussion
2	**Lack of funds**	Lack of funds for the development and sustainability of groundwater is often a concern among rural communities of KwaZulu-Natal. In addition, there has often been a lack of providing funds for experts' fees for the development of groundwater usage (Department of Water and Sanitation 2016).
3	**Lack of data**	At present, records of several boreholes in South Africa are yet to be captured, and limited data characterising either the volumetric consumption of aquifers or the recharge and discharge of different aquifer types are available. This insufficiency of information has resulted in the underutilisation of aquifer systems, and to overextraction in some instances (Knüppe 2011, 72).
4	**Poor understanding and perception**	Groundwater has been undervalued for a long time and this has often resulted in the non-optimal usage of this valuable resource. More so, the rural perception has often been influenced by ethical and cultural patterns. Thus, rural farmers only explore groundwater usage in extreme circumstances, such as during drought. Furthermore, the invisible nature of aquifer systems has compounded the poor understanding and perception around groundwater (Knüppe 2011, 72).
5	**Lack of technical and managerial expertise**	The lack of managerial expertise and technical skills has undermined the pace of development of using groundwater as a resource in South Africa. A case in point is the reduction in 2012 of the proposed 19 catchment management agencies to only nine due to a lack of managerial expertise and technical skills (Braune, Adams, and Fourie 2014, 8).
6	**Poor monitoring**	A number of scheme failures, for instance the schemes at Delmas (2005) and Dinokana (2014), have been reported over the past 12 years. These failures have been largely attributed to poor monitoring (Braune, Adams, and Fourie 2014, 46). Poor monitoring of groundwater is also a concern in KwaZulu-Natal as only four compliance enforcement officers are assigned to monitor the entire province.
7	**Poor interaction among stakeholders**	Empirical studies have shown that the main actors often work in isolation. There is rarely any interaction between rural farmers and hydrologists or between researchers and policy-makers or politicians.

S/n	Obstacle	Discussion
8	**Registration**	Rural farmers often do not understand the registration process required for groundwater usage, nor are they being enlightened on how to go about the registration process in circumstances where they need to extract more than 2 000 cubic metres of water daily. Also, many white commercial farmers are reluctant to register the water they use for irrigation because they consider groundwater as their personal asset and not as a national asset (Braune, Adams, and Fourie 2014, 12). To address these concerns, the Department of Water and Sanitation may have to launch more campaigns to enlighten users about water use licence applications. This is expected to affect planning and sustainability in respect of the use of groundwater as a resource.
9	**Plantations**	Timber and sugarcane plantations occur across parts of the northern axis of the KwaZulu-Natal province, for instance in the region of Mtubatuba. Trees in particular consume large quantities of groundwater. Over the years, more and more plantations have been cultivated on large stretches of land.
10	**Contamination**	Mining activities are common in several provinces of South Africa. Contamination of groundwater through mining activities has often made this resource unsuitable for domestic or farming purposes. The operations of the Tendele Coal Mining company at Mtubatuba have been a major concern over the years as they contaminate surface water and groundwater, making both unsuitable for agricultural or domestic purposes (Bakre 2015, 4).
11	**Infrastructural deterioration**	Failure of groundwater schemes is often attributed to the failure of infrastructure. For example, pumping regimes could be unsuitable, such as when high-rate pumps are used over a short period of time or when borehole screens are blocked. A pumping regime which draws groundwater levels down excessively for short periods of time can introduce air into the aquifer, resulting in bacteria growth and the eventual malfunctioning or non-optimal performance of infrastructure (Braune, Adams, and Fourie 2014, 46).

S/n	Obstacle	Discussion
12	**Poor practices and unsustainable abstraction**	The insidious salinisation of groundwater is a major concern in several regions worldwide. This occurs when groundwater bodies become depleted and their natural discharge is eliminated. Hence, they tend to serve as the basins for salts leached from arid land and fractionated in irrigated soils. This unresolved concern has resulted in the excessive infiltration of soil, water logging, and salination (IAH 2015, 3)

Note: S/n = Serial number

If the abovementioned obstacles to the optimal usage of groundwater are adequately addressed, the water shortages that the vast majority of historically disadvantaged individuals are experiencing can be drastically reduced. In addition, this will reduce the vulnerability of subsistence farmers to a large extent, particularly during periods of drought. The pathways to addressing these obstacles are suggested in the subsequent sections.

REQUIREMENTS FOR OPTIMISATION OF GROUNDWATER

Ten pathways to achieve the sustainable and optimal use of groundwater are summarised in Table 3. These points are not exhaustive but are the most relevant ones for this study.

Table 3: Requirements for the optimisation of groundwater

S/n	Requirement	
1	**Political assertiveness**	Strong leadership to establish communication and give guidance is imperative. A bottom-up approach should be advocated.
2	**Capacity development**	Capacity development should be stimulated through technical training by skilled Chinese hydrologists as South Africa currently has few hydrologists.
3	**Awareness and sensitisation campaigns**	Awareness campaigns should be launched when required to change the negative overall perception of groundwater. It is necessary to improve knowledge and skills and expand the existing groundwater database.
4	**Collaborative efforts among stakeholders**	Stakeholders must work collectively and in harmony. These collaborative efforts should be manifested in policy implementation. Collaboration will facilitate communication between local actors and policy-makers at different levels.

5	**Consultation with experienced hydrologists**	Farmers should consult with experienced hydrologists to gain technical perspectives regarding the availability, quantity, and quality of groundwater. These consultations may prevent or dissuade the overabstraction of groundwater.
6	**Understanding regulations**	Understanding regulations will prevent overabstraction and ensure full compliance among the users of groundwater.
7	**Research**	Determining groundwater allocation based on good scientific understanding and adherence to sound sustainability and social equity principles are critical (Ebrahim and Villholth 2016, 763).
8	**Monitoring**	Monitoring should be promoted as a means to create a better understanding of groundwater systems and their dynamics.
9	**Climate change and adaptation mechanisms**	Cutting-edge mitigations should be used to alleviate the impact of climate change on groundwater.
10	**Conjunctive use of groundwater and surface water**	It should be taken into account that the spontaneous conjunctive use of shallow aquifers in irrigation canal commands is driven by the capacity for groundwater to buffer the variability of surface water (Foster and Van Steenbergen 2011)

Note: S/n = Serial number

QUALITATIVE VALUATION OF GROUNDWATER SUSTAINABILITY: METHODS

The summarised findings presented in this section are based upon the responses obtained from 10 South African experts who are directly or indirectly involved in the field of groundwater resources. Structured interviews were conducted with these individuals to obtain their expert opinion on the subject matter and to gain an in-depth knowledge about strategies and possible approaches through which available groundwater could be optimised for farming purposes. The need to conduct interviews with the selected experts was driven by the need to benefit from their years of experience and skills gained in the field of groundwater resources. The qualitative approach employed was judged suitable for the current study as it provided the researchers with *in-depth knowledge* and generated *rich, detailed, and valid data that contributed to an in-depth understanding of the context* (Hathaway 1995, 554; Ramrathan 2005, 36).

Table 4 provides a synopsis of individuals interviewed for the study.

Table 4: Experts consulted

S/n	Sector	Organisation	Designation	Number of interviewees
1	Provincial governance	Department of Water and Sanitation (Durban)	Water Resource Manager	1
2			Deputy Director: Water Use	1
3			Scientist (Groundwater)	1
4			Control and Environmental Officer	1
5	Local government	Department of Rural Development (Mtubatuba Municipality)	Scientist (Water)	1
6	Local government	uMkanyakude (Water supplier for Mtubatuba Municipality)	Supervisor of Gunjaneni area	1
7			Director of uMkanyakude	1
8			Technical Supervisor	1
9	Local government	Department of Agriculture, Environmental Affairs and Rural Development (Mtubatuba Municipality)	Local Director	1
10			Soil and Water Scientist	1
			Total number of participants	**10**

Note: S/n = Serial number

RESULTS

The responses obtained from respondents highlighted some of the fundamental issues relating to constraints in the optimal usage of groundwater and to the core challenges that subsistence farmers in the area under study experienced. Furthermore, the results suggested pathways to the sustainable and optimal utilisation of groundwater for farming purposes. Inasmuch as this study focused primarily on the KwaZulu-Natal province, the challenges identified are shared by the majority of subsistence farming communities across South Africa, Southern Africa and the African continent as a whole. Six core findings emerged from the structured interviews, and were categorised into the following themes:

Stakeholders Working in Isolation

The identified key stakeholders in the Mtubatuba community in KwaZulu-Natal were the Department of Water and Sanitation; Department of Land Affairs; Department of Agriculture, Environmental Affairs and Rural Development; and farmers' cooperatives. Although these stakeholders might have slightly different agendas, the two agendas that drive these stakeholders are rural development and poverty alleviation. As mentioned earlier, a significant percentage of community members in this locality are directly or indirectly involved in subsistence farming as their means of livelihood; hence, it can be argued that developing this mode of farming will no doubt enhance rural development and mitigate poverty. However, due to the lack of synergy among the said stakeholders, some of the initiatives planned to fast-track rural development have stagnated and there has been little progress. For instance, personnel at the Department of Water and Sanitation provided evidence of bureaucratic delays in the Department of Agriculture, Environmental Affairs and Rural Development when the Department of Water and Sanitation required environmental impact assessments to be done before any activities, such as drilling of boreholes, could be undertaken. Although stakeholders serve on the Coordinating Committee on Agricultural Water, and meetings take place once in a while, insufficient information and ideas are exchanged at these meetings.

Furthermore, the interaction between the soil scientist, soil analyst, farmers, councillors, *indunas* (traditional leaders) and the hydrologist in this locality is minimal, which undermines the effectiveness of their working collectively as a team. A well-orchestrated allocation of groundwater resources, sharing of expertise and exchange of ideas could lead to the maximal use of available groundwater for farming purposes.

Communal Discord

Interviewees made assertions that suggested the existence of communal discord among the farmers in this locality. With a view to organising and coordinating farming projects in the area, the Department of Water and Sanitation liaises with a chairperson who is

chosen by the farmers. However, the farmers often do not cooperate with the chairperson; thus, he is unable to control and organise the farmers. More so, farmers often fight about irrelevant concerns stemming from jealousy and arrogance. To address this, capacity-building and enlightenment campaigns about the importance of farming projects in this locality are highly imperative, which should involve the *amakosi* (chiefs) and indunas to mediate in community disputes. Furthermore, cases of theft and vandalism of water infrastructure have been reported recently in the Empangeni farming community: community members allegedly stole electricity cables worth R50 000. Such acts can be partly attributed to lack of cooperation among community members to sustain farming projects, leading to these projects being undermined further.

Inadequacy of Monitoring and Supervision

Some farming projects in Mtubatuba and others in KwaZulu-Natal have failed mainly due to poor monitoring and supervision. For instance, an estimated R3 000 000 was spent on the Malenge Irrigation Scheme, the Kwa-Biyela Irrigation Scheme 1 and Scheme 2, and the Nkwaleni WUA project, but within two to three years they did not function optimally due to inadequate monitoring and supervision.

Additionally, the Department of Water and Sanitation, who initiated these farming projects, does not review these projects, nor are personnel assigned to review or access these farming projects occasionally. Hence, the enormous investments intended to address farmers' vulnerability have not yielded the desired result. Furthermore, this has adversely impacted on water infrastructure in this locality.

Tables 5, 6 and 7 indicate some of the investments made between the 2013 and 2015 financial years. The aim of these investments was to improve the lives of the historically disadvantaged in Mtubatuba and in other communities in KwaZulu-Natal. Because of poor monitoring and evaluation, these capital projects have not yielded the desired outcomes.

Table 5: Resource-Poor Farmers (RPF) projects implemented in the 2013/2014 financial year

NAME	LOCATION	PROJECT TYPE	BUDGET
Malenge Irrigation Scheme	uMzimkhulu	Rehabilitation of main canal	R500 000.00
Ekupuleni Irrigation Scheme	Newcastle	Study and design	R275 000.00
Kwa-Biyela Irrigation Scheme	Empangeni	Study and design	R275 000.00
Nkwaleni WUA	Eshowe	Operations and maintenance	R50 000.00
TOTAL BUDGET			**R1 100 000.00**

Source: *Department of Water Affairs (2013, 9)*

Table 6: RPF projects planned for the 2014/2015 financial year

NAME	LOCATION	PROJECT TYPE	BUDGET
Malenge Irrigation Scheme	uMzimkhulu	Rehabilitation of main canal	R500 000.00
Kwa-Biyela Irrigation Scheme 1	Empangeni	Installation of irrigation infrastructure	R2 000 000.00
Kwa-Biyela Irrigation Scheme 2	Empangeni	Installation of transformer	R400 000.00
Nkwaleni WUA	Eshowe	Operations and maintenance	R100 000.00
TOTAL BUDGET			**R3 000 000.00**

Source: *Department of Water Affairs (2013, 10)*

Table 7: Rainwater Harvest Technique (RWHT) implemented in the 2013/14 financial year

NAME OF DISTRICT MUNICIPALITY	NO. OF TANKS*	PROPOSED AMOUNT
uMkhanyakude	438	R1 100 000.00
uMzinyathi		
Harry Gwala		
uThukela		
uThungulu		
Ugu		R2 500 000.00
TOTAL	**438**	**R3 600 000.00**

Note: * 5 000-litre tanks
Source: *Department of Water Affairs (2013, 10)*

Hence, to make these water-related investments fruitful, the Department of Water and Sanitation needs to delegate a unit that will occasionally monitor and supervise these projects.

Hydrological Skills Shortage

A prominent challenge undermining the utilisation of groundwater for subsistence farming is closely linked to the lack of appropriate capacity at municipal and institutional levels. Many rural municipalities in South Africa do not have hydrological experts. This lack of expertise has made it near impossible to optimally tap into the groundwater resource. The skills shortage and poor leadership in hydrology at all government levels have been core challenges in driving the understanding of groundwater resources. Additionally, the inadequacy of experts who can provide advice on the quantity of

groundwater that may be abstracted has often resulted in the overabstraction of aquifers. This has resulted in the depletion of some aquifers and the unsustainability of others. At the time of this study, the Mtubatuba Municipality in KwaZulu-Natal lacked skilled personnel in hydrology.

Championless Agenda

The responsibility for groundwater matters is often outsourced or is assigned temporarily to personnel who also have other responsibilities at the local municipality. There is a lack of people who can champion, drive, and develop the use of groundwater resources at national, provincial, and local governance levels. To strengthen the level of understanding and development of the groundwater resource, champions are required at municipal and institutional levels to drive and promote a sustainable groundwater agenda. Developing and sustaining South Africa's groundwater resources will require personnel who are primarily employed to monitor, evaluate, and develop groundwater resources. Having champions at every level could result in the optimal use of groundwater for subsistence farming.

Inadequacy of Data and Information

A challenge recognised with the drafting of the National Water Act (Act 36 of 1998) was that an estimated 100 000 boreholes that were drilled on a yearly basis in South Africa mostly by commercial farmers and industrial companies were not reflected in the National Groundwater Archive. Some users did not register or obtain licenses for groundwater usage as they believed this resource was a personal and not a national asset (Braune, Adams, and Fourie 2014, 35). This misconception has resulted in the inadequacy of data, which has affected planning and governmental decisions. Additionally, the lack of information regarding the quality and quantity of groundwater in aquifers constrains the optimal utilisation of this valuable resource.

CHARTING THE WAY FORWARD

To initiate a transformational progression of the rural agricultural landscape through groundwater optimisation, this paper puts forward four pragmatic and forward-looking approaches to making this a reality. These are elaborated below.

Reinvigorating Rural Communities of South Africa through a Chinese-South African Partnership

The Chinese Government has over the years had bilateral relationships with countries on the African continent. Relationships exist in the political sphere and in military, economic, social and cultural domains. These Chinese relationships (partnerships)

have been notable in South Africa as well. From an economic perspective, the Chinese Government has invested significantly in the extractive, services, and manufacturing sectors. Furthermore, the Chinese Government has made significant investments in infrastructure, focusing on the transport and energy sectors. However, segments much in need of investments—groundwater development and subsistence farming—have been neglected by foreign investors. Tailor-made investments (in the context of this study, by the Chinese) in groundwater development and subsistence farming (among the rural populace of South Africa) can possibly transform defunct subsistence farming in communities into a viable activity and give rural households the opportunity to escape the poverty cycle. Braune, Adams, and Fourie (2014, 25) acknowledge the need for international cooperation to boost the widely neglected groundwater resource. However, developing groundwater resources will require a well-coordinated plan among local, national, regional, and international entities to optimise the use of this resource in the medium and long term.

Institutional Transformation through Capacity and Infrastructural Development

The capacity challenge within the South African water sector lies at an institutional level. The skills shortage among critical stakeholders, particularly at grassroots level, has often resulted in the underutilisation or undervaluation of groundwater. In a report by SAdcorp (a South African human resource company), it is alleged that nearly 830 000 jobs requiring highly qualified technical professionals are vacant in South Africa (Lovells 2017). This highlights the dearth of skills in the country. This shortage of skilled and experienced professionals is more prominent within the public sector. The South African public sector has a daunting task in retaining highly skilled personnel. To create a strong and vibrant institution for the achievement of rural development through groundwater development, human and institutional capacity development is imperative. Experts, such as hydrologists, in the private sector should be enticed to fill vacant positions in the public domain. Moreover, capacity development should be fostered through skills and knowledge transfer in the water sector from Chinese experts to subsistence farmers and other stakeholders in South Africa. Furthermore, groundwater infrastructural investments by the Chinese Government will be a necessity to tackle infrastructural deficits.

Champions at National, Provincial and Local Levels

No personnel in the Department of Water Affairs have been specifically assigned to champion groundwater initiatives. Initiatives are often outsourced or they are assigned to employees in the department who have other duties. The fact that the agenda in respect of groundwater issues is “championless” at all government levels is a major

impediment to the advancement and sustainability of this resource. To strengthen the level of understanding and development of the groundwater resource, champions are required at grassroots, regional, provincial, and national levels to drive and promote a sustainable groundwater agenda. As posited earlier, developing and sustaining South Africa's groundwater resources will only be feasible if personnel are employed primarily to monitor, evaluate and develop groundwater resources. Having champions at every stratum could result in the optimal usage of groundwater for subsistence farming. Also lacking are national leadership and a directorate of geohydrology. Such leadership can drive transboundary aquifer management in a bid to strategically support stakeholders and concretise efforts regionally, nationally, and internationally. Assertiveness in implementing a groundwater agenda in the form of strong leadership and concerted efforts can progressively result in optimising groundwater usage for agricultural purposes among rural communities, which in turn may diversify the rural economy.

Collaboration among Stakeholders and International Corporations

The lack of the integration of plans among stakeholders has been one of the factors impeding the pace of development as far as groundwater is concerned. To facilitate transforming the approach to groundwater from one that is centralised to one that is strongly devolved and collaborative, a greater synergy among key stakeholders is imperative. Collaborative efforts should equally drive the agenda of information sharing. Making this doable will require carrying out more research on groundwater and capturing accurate data on this resource. Hence, it will be necessary to have a groundwater information system to drive and maintain the entire process. Furthermore, the data collected will need to be continuously updated and adapted. The stakeholders that form part of this collaborative effort should include the Council for Scientific and Industrial Research, the Council for Geosciences, the Department of Water and Sanitation, the Water Research Commission, the South African Local Government Association, and, most importantly, a team of Chinese hydrologists. The proposed team of stakeholders should follow a bottom-up approach to make sure that benefits reach the vulnerable subsistence farmers in rural communities.

CONCLUSION

The South African Government has devised various strategies to address the challenges of poverty, inequality, and marginalisation among the rural populace of South Africa. Apart from earlier initiatives to accelerate rural development, recent efforts launched include the Resource-Poor Farmers and Water Allocation Reform initiatives. However, indicators, such as poor standards of living and the high income disparity between rural and urban households, are evidence that the agenda set at the dawn of the South African democracy in 1994 has not been achieved.

Having identified institutional inertia, inadequate funding and lack of appropriate capacity among critical stakeholders in the groundwater spectrum as the dominant challenges, it is posited that a stronger Chinese-South African partnership in the groundwater domain could possibly transform the current situation. The transformation of the rural agricultural landscape could be achieved if the use of available groundwater resources is optimised through institutional capacitation, investment in groundwater, and the involvement of Chinese hydrologists through skills transfer.

Hence, as an agenda to optimise groundwater usage for subsistence farming and to provide a better means of livelihood for some of the 19 211 230 rural inhabitants of South Africa, this paper advocates a reinvigorated and tailor-made partnership between China and South Africa in the field of hydrology. Such a partnership should be orchestrated to transfer skills from the Chinese to subsistence farmers of South Africa and to increase investment in developmental groundwater initiatives. Initiatives should be aimed at strengthening geohydrological skills, underpinning technical training capacity, facilitating interactive participation among stakeholders, and initiating participatory action research to optimise available groundwater resources in KwaZulu-Natal. These strategies should be planned and coordinated to achieve sustainable and viable subsistence farming practices in the predominantly rural (subsistence farming) communities of KwaZulu-Natal.

The authors are of the view that, if the suggested agenda could be pilot tested in the community where this study was carried out, its success may later be replicated among other subsistence farming communities in KwaZulu-Natal as well as in other South African communities where the amount of groundwater is substantial enough to justify championing a pro-poverty campaign.

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