



Water security in rural Eastern Cape, SA: Interrogating the impacts of politics and climate change

Amos Apraku^{a,*}, Benjamin Apraku Gyampoh^b, John F. Morton^c, Akosua Bonsu Karikari^d

^a Department of Languages and General Studies, University of Energy and Natural Resources, P. O. Box 214, Sunyani, Ghana

^b Department of Fisheries and Watershed Management, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

^c Natural Resources Institute, University of Greenwich, Kent ME4 4TB, United Kingdom

^d Department of Clinical Microbiology, School of Medicine, University for Development Studies, Tamale, Ghana



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ABSTRACT

Achieving water security remains one of the central challenges to many developing countries today. According to the South African Water Research Commission, the availability of safe and affordable water is crucial in ensuring a healthy and productive life for all. Despite the national standards set to measure the quality of water in South Africa, the sources and 'quality standards' of water in rural Eastern Cape remain a major concern. Based on empirical research with 140 respondents and interactions; this paper highlights that most rural residents in the Eastern Cape still access water from dams, rivers and streams for domestic and agricultural purposes. Again, the availability of water throughout the year is not guaranteed due to changing global climatic conditions with both humans and livestock accessing water from same sources. The paper concludes that climate change and politico-administrative 'negligence' compound water insecurity in most of South Africa's rural communities.

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Introduction

The African National Congress (ANC) government of South Africa inherited a number of service delivery backlogs from the Apartheid regime – particularly in the rural, poor and black settlements – after taking over power in 1994 (The National Planning Commission [32]). Nationally, the ANC-led government has taken several measures and strategies under different development programmes since 1994 to rectify the various service delivery imbalances inherited with special focus on quality water and reliable electricity supply to rural areas and previously disadvantaged communities [33]. The starting point of such rectification measures included the incorporation of the fundamental human rights to adequate and sustainable water supply to all in the constitution of the Republic of South Africa [28] (see the Bill of Rights, section 27,1b, [28]). Despite the good objectives of such water supply and social intervention measures directed at rural and informal settlements by successive ANC government, institutional structures [14] would be a key barrier to achieving rural water security in South

* Corresponding author.

E-mail address: amos.apraku@uenr.edu.gh (A. Apraku).

Africa [13]. Thus, various integrated climate assessment models indicate that climate change remains a critical variable to the demand and supply of water in South Africa [33]. It is further envisaged that the situation could worsen by 2050 if the current trend of changes in global climatic conditions continues with corresponding low adaptive capacity [6,13].

This paper focuses on the impact of climate change on rural water security in the Eastern Cape Province of South Africa, in a political and administrative context. In this study, water security is defined as the availability of an acceptable quantity of quality and healthy water for livelihoods, health, ecosystems and socio-economic production as well as an acceptable level of water-related risks to people, environments and economies ([8]:545; [36]). The UNU-INWEH [34] adds that water security also involves the capacity of the population to protect and maintain sustainable access to adequate quantities of acceptable quality water for sustainable livelihoods, human well-being and socio-economic development. In this context, water is defined as one of the natural resources which is deemed necessary in order to sustain a living, maintain environmental wellness as well as to sustain food production and food security [36].

South Africa is classified as water-stressed country; *i.e.*, supply of water drops below 1700 mm per capita per year. Demand for water in South Africa exceeds supply in many towns, cities and rural areas [36]. This situation is exacerbated by climate change which impacts precipitation patterns and quantities [27] as well as the lackadaisical approach on the part of some politicians and key public office holders in handling water related issues in the context of changing global climatic conditions – particularly in the rural parts of the country. Bates, et al. [3] noted that climate change will severely impact water availability and access; arguing that climate change will affect water security; which indeed is happening now in most parts of the Eastern Cape communities and alike across South Africa and beyond.

The Eastern Cape Province was chosen because evidence shows that its rainfall patterns and volumes have drastically changed over the last few decades resulting in emerging water availability and access challenges due to climate change [2] without any major change in administrative procedures and process towards addressing the problem. The objectives of this study, therefore, were to identify the major sources of water to the residents of the study communities; explore the negative impacts of climate change on water availability and access in the same communities; and finally interrogate the role of politics in the complex water resources and climate change menace in rural Eastern Cape of South Africa.

Observed and projected changes in climate of South Africa

The hydrological cycle of South Africa as a country is closely linked with changes in the radiation balance and the atmospheric temperature of the Southern Africa sub-region as a whole [35]. Thus the climate change noticed over the past decades in South Africa is consistently associated with changes in a good number of components of the hydrological systems and cycles like changing precipitation patterns, increasing atmospheric water vapor, increasing evaporation variations in soil moisture, etc. [36].

Geographically, the Southern African sub-region as a whole is characterised by variations in geo-ecological features ranging from arid in the west, semi-arid in the east, and semi-arid, humid and sub-humid in parts of the north and central zones [13]. The climate of the sub-region, according to experts is to some extent influenced by the wind systems prevailing in the arid and semi-arid regions. Relative to Hurlbert et al., [11] predictions, the IPCC [12] indicates that the Southern Africa sub-region has already experienced an average increase in temperature of over 0.5 °C in the last century alone and a relative decline in the volume of rainfall with recurrent isolated droughts. It is on record that the mean rainfall volume in South Africa has declined by 1.5 mm per month – representing 3.7% decline per decade – since 1960 [18]. The mean decline in rainfall per decade is estimated to reach 6.6% decline by 2060 [18]. While rainfall volumes are decreasing in the country; the mean annual temperature is projected to increase by 1.1 °C to 2.4 °C by the 2060s; and 1.6 °C to 4.3 °C by the 2090s ([18]:2). These projections in temperature values in the decades ahead are somewhat validated by a revelation that currently; temperatures in South Africa can sometimes rise above 32 °C during summer and can drop several degrees below freezing point in higher elevation regions of the country during winter (Jiménez [14]).

Kam et al., [17] indicate that between 2015 and 2019 for instance, water supply to various sectors of the South African economy was reduced by 20% with a corresponding 25% decline in agricultural yields due to extreme high temperatures and low average rainfall volumes attributed to changes in global climatic conditions. It is further projected that there is a high likelihood of extreme dry and hot weather conditions in South Africa in the decades ahead as a result of climate change and its related events; thereby reducing the availability and supply of water to key sectors of the county's economy [17]. Similarly, a multi-method attribution and analysis projects that there is a high likelihood of extended rainfall deficit in the Western and Eastern Cape Provinces of South Africa exceeding the current capacity of water supply to various communities in those regions due to the continuous changes in climatic conditions [22].

Relatedly, it is again estimated that by the end of the 21st century – in line with current trend of changes in global climatic conditions – South Africa would experience severe and relatively longer meteorological droughts due to less rainfall, decreased precipitations, increased evaporation, prolonged dry spells and reduced stream flow because of changes in climatic conditions ([14]:250). The likely corresponding effects of all these projections on society is a stress on water supply systems and water dependant economic activities. Moreover, the availability of potable water in South Africa is projected to decline drastically by the year 2060 due to the adverse impacts of climate change on water quality and security. For example, the quality of lakes and dams water could be affected by the presence of algae-producing toxins [23]. It is important to note at this point that the projected rise in temperature in the decades ahead is expected to exacerbate the already high possibility

of drying arable lands and further counteract any possible increase in rainfall through increased evapotranspiration ([18]:3) and would eventually lead to overall adverse effects on water resources.

These prevailing and projected adverse impacts of climate change on rural South African settlements therefore require a multi-stage stakeholder engagement to ensure efficient water resource management and the protection of freshwater bodies as literature suggests that sustained climatic variability trends could by 2050 lead to a fall of about 1.5% in the nation's Gross Domestic Product [4]. The next section of the paper looks at changes in global climatic conditions and water resources in South Africa.

Climate change and water resources in South Africa

One of the major channels through which the adverse impacts of climate change can be felt by the environment, ecosystem and humans is water resources [7]. The average annual rainfall for South Africa is about 450 mm/year; below the world average of 860 mm per year (Botai et al., 2018). This, therefore, classifies South Africa as a water scarce country marked by high evaporation rates [9]. The IPCC [13] accordingly identifies South Africa as one of the most vulnerable countries in Africa to climate change due to its peculiar geophysical traits and level of dependency on rainfall for various socio-economic activities and livelihood systems. As discussed in the previous sections, climate change is believed to have changed rainfall volumes and patterns (due to changes in precipitations), increased the occurrence of extreme weather events (flooding, droughts, storms, etc.) increased uncertainties and stress on available water resources in South Africa [9,13]. To corroborate the above submission, the South African Department of Environmental Affairs and Tourism (SA-DEAT) identifies climate change as one of the major environmental challenges facing agriculture and water resources in the country [7]. The adverse effects of climate change on freshwater resources in the country is mainly due to rising temperature levels, evaporation and fluctuating rainfall volumes and patterns [9].

It is estimated that pollution levels (a key variable in the determination of healthy water as imbedded in water security) in South African water sources could rise as a result of reduced river flows and levels in wetlands and lakes due partly to climate change ([7]: 84). The South African Weather Services [29] submits that the negative impacts of climate change on water resources in South Africa could include inaccessibility to healthy and quality water for human and animal consumption, reduction in biodiversity and ecosystems loss. It will again threaten food security and could lead to an increase in the spread of various forms of diseases [13]. Even though the general impact of climate change on water resources and other key sectors in the country, particularly agriculture, could be widespread; the national impact on livelihood systems and water resources varies from one region or community to another due to different mitigation and adaptation strategies instituted and the level of commitment shown by leadership in ensuring that such strategies work [10]. In localising and operationalizing the global and national climate change debate, it is understood that the preparedness on the part of public office holders to formulate and implement climate risk management policies and practices is key to ensuring rural water security in the Eastern Cape province of South Africa. It is further highlighted that majority of the water in South Africa is either stored or gotten from dams, lakes, lagoons, streams, rainwater harvesting and groundwater which are all prone to climate change and its related issues [29].

Some of the major challenges associated with dams, lakes, lagoons and groundwater use in South Africa are treatment reticulation problems, drought conditions, over-abstraction, contamination and insufficient supply of water itself to such sources/storage facilities [29]. These problems are further exacerbated by climate change and its ramifications including pollutions, population increase, wastage and poor water storage and infrastructure in most of the rural settlements [36]. It is on records that rivers constitute approximately 60% surface water in Africa [36]. The uneven distribution of water resources as a result of variations in rainfall pattern and volumes has necessitated the transfer of water within catchment areas to augment the availability of water for all.

The Eastern Cape province is projected to experience substantial reductions in both annual and daily precipitation in the coming years (Mahlalel et al., 2020) with an estimated levelling of the annual rainfall cycle over the Eastern Cape. The region is expected to experience a higher frequency of extreme rainfall events and drier conditions. This, coupled with the high dependence of livelihoods in the region on climate, particularly rainfall; the region is arguably one of the most vulnerable areas to climate change in the Southern Africa sub-region. This is partly due to its fragmented climatic conditions, relatively low coping and adaptation mechanisms, and high dependency (over 60%) on agriculture for livelihoods ([12,30]; Zinyengere, 2013:119). The negative impacts of climate change on water resources and agriculture in the Eastern Cape Province therefore pose a great threat to the socio-economic development and the general livelihood improvement of people because of the close relationship between weather events and the major socio-economic activities in the region (agriculture, ecotourism and transport).

In addition to crops and livestock production which are highly rainwater dependant; another aspect of agriculture which is highly vulnerable to climate change and quality water resources in South Africa is marine species conservation and aquaculture as a whole. The projected trend in rising sea levels due to climate change is argued to eventually lead to salinization and contamination of freshwater streams, rivers, springs, and all other coastal aquifers along the coasts [24]. The high levels of salinization as a result of rising sea levels are gradually leading to poor water quality in communities next to coastal areas [24]. Infertility in agricultural lands and the extinction of some plant and animal species means an imminent economic decline due to climate change. A classical scenario to support the above submission was reported in Mauritius in the year 2009. In 2009 for example, the government of Mauritius (GoM) (one of the major tourism destinations in the sub-region)

reported that the continually rising sea levels will eventually submerge some of the low lying coastal areas such as the coastal wetlands and mangrove areas which are crucial for nursing fish and other forms of marine species, leading to loss of revenues and decline in GDP (GoM, 2009 cited in [26]). The growing body of literature on climate change points to the fact that decline in agricultural productivity in most underdeveloped and developing countries persistently alters the structure and performance of the economies of such countries and general international trade (Zinyengere, 2013). This suggests that the continuous changes in climatic variables would continually and negatively affect general livelihood systems in South Africa as a country because of the close intimacy between rainfall (water security) and key economic activities.

Relating the various climate change discussions to the Eastern Cape Province of South Africa, Johnston and Schultze [15] have simulated climate change projections and potential impacts in the province. They note that the province is experiencing increased frequency of extremely hot and cold days; higher evaporation rates due to increase in temperatures; and up to 10% reduction in runoff water (water security is affected). All these factors make the Eastern Cape one of the most vulnerable provinces to climate change, thereby threatening water security and sustainable livelihoods in the province, especially in rural areas and peri-urban settlements [15]. The salient question here is: have public office holders in the Eastern Cape and beyond shown enough commitment to satisfactorily and sustainably manage the impact of climate change on water resources in the rural settlements of the province? The next section of the paper looks at climate change and water security in South Africa from a theoretical perspective.

Climate change and water (in)security in South Africa: a theoretical discussion

As a form of theoretical discussion, this paper hinges on the Integrated Water Resources Management (IWRM) framework and the economic water scarcity theory to look at climate change and water security in rural Eastern Cape. The integrated water resources management (IWRM) framework promotes the coordinated management of water, land and related resources, in order to maximise its resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems [16]. The IWRM framework is anchored on four pillars [5].

The first pillar is: it regards fresh water as a finite and vulnerable resource, essential to sustain life, development and the environment. This principle assigns a river basin or a catchment area to be a water management unit, which is the so-called hydrographical approach to water management. Secondly, the framework regards water as an economic good which has economic value in all its competing uses. Thirdly, water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels. Fourth pillar of the theory is that, women play a central role in the provision, management and safeguarding of water. From the foregoing it is clear that within the IWRM framework, sustainable water management, economic efficiency and stakeholder participation/commitment are considered to be critical in the sustainable management of water resources. Given that this paper interrogates the close linkage between political commitment and rural water security in the face of changing global climatic conditions; it is thus appropriate and logical to use the IWRM framework as a tool to guide further discussions in the paper. The IWRM principles would therefore be central in discussing the impact of climate change on rural water resources in the Eastern Cape, vis-à-vis the commitment shown by public office bearers in managing such impacts.

In conjunction with the integrated water resources management (IWRM) framework, the paper also draws on the strength of the economic water scarcity theory to discuss the key issues in the paper. The economic water scarcity theory argues that water insecurity is not caused by absolute unavailability of water but is rather caused by a lack of the needed investment in the water sector. In other words, water is not scarce in a physical sense but rather in an economic sense (Anton 1995 in [20]:7). Large parts of Africa suffer from economic water scarcity, largely because of the region's inability to develop water infrastructure and water retention technologies ([20]:7). The theory also goes on to argue that governments are simply not investing enough money in water infrastructure to improve the water security situation, especially in the rural areas. This theory is relevant to this paper because it goes beyond the basic underlying causes of water insecurity (insufficient rain, droughts, etc.) as the only causes of water insecurity to offering a holistic explanation that also includes economic and political reasons behind water insecurity.

The economic water scarcity theory is robust because it correctly argues that water shortages are not only caused by the absence of physical water bodies locally but also by the inability to draw water from underground water bodies and from distant water sources [19]. Furthermore, Noemdoe et al. [21] observes that resolving economic water scarcity however requires more than just investment in new water infrastructure. It also requires socio-political interventions that will address some of the structural challenges that are an obstacle to water security. For example, proper administrative and political management of water resources could be a socio-political intervention that can partly contribute towards realising water security in most of the rural settlements of the Eastern Cape Province.

Methodology

This paper is developed from a broader study that set out to assess the impact of climate on key sectors of rural Eastern Cape and the level of commitment shown by political office holders and stakeholders alike in addressing such impacts. The study was conducted between 2020 and 2021. The study triangulated different qualitative data collection methods and visual sociology to validate the results of the study. Focus group discussions (FGDs), observations, questionnaires, interactions and various forms of interviews helped the researcher to access the impact of climate change on water security in some selected

communities in the Eastern Cape Province. Key informant interviews were conducted with selected Ward Councillors and teachers teaching in the communities.

A total of 140 respondents participated in the study (at that figure, a theoretical saturation point was reached). Strauss and Corbin ([31]:212) explain theoretical saturation as a situation that occurs when the researcher establishes that no new or relevant data seem to be emerging from the respondents, and that enough applicable information has been gathered to satisfactorily and empirically answer the research questions. The 140 respondents were selected through a combination of both probability (simple random) and non-probability (purposive) sampling methods from the study communities. As a qualitative study, the selection of the sample size was not based on established statistical methods and procedures; it was rather determined by the principle of theoretical saturation.

The focus persons for the questionnaire administration, discussions and interviews were residents (male or female) of the study communities older than 30 years who truly understand the water supply story of their communities vis-à-vis the political messages relating to service delivery preached by political office holders during electioneering campaign seasons. The older persons (30 or above) were found to be apt as their long-term direct experience and socio-economic development and service delivery knowledge came handy. The Ward Councillors helped the researcher to ascertain the level of commitment shown by both local and provincial governments in service delivery. Teachers teaching in schools found in the communities were very helpful in validating the data given by the community members and political office holders. Their interactions with the learners and community members on daily basis as well as their relative neutrality in the political dynamics of their working communities enabled the teachers to give a fair account of the level of service delivery as whole to the people by the various government structures. A content-analysis process and basic statistical tools were used to analyze the data by first coding the major themes that emerged. Pie charts and photographs (Visual Sociology) were used where necessary to give clear photographic images of some of the situations in the study communities. It is important to mention that data were not analyzed along gender, age or racial lines.

The study site

The study area falls within latitude 32°47'–33°46' S and longitude 25°29'–27°59' E (an area which covers East London and some peripheral parts of Uitenhage in the Eastern Cape Province of South Africa (South African Weather Services [29]). The study communities around East London were Jongilanga, Zozo, Tuba, Phindweni (All in Kwelera) and the Ncera villages (villages 2–7). In Uitenhage, the selected communities were Kwanobuhle, Tireville Lapland and Vastrap.

Socio-economically, the Eastern Cape Province is classified by Statistics South Africa as one of the poorest regions among the nine provinces of the country, with less than 15% of the total provincial population having an educational level higher than high school (Stats SA, 2011; Government of SA, 2013). Relatedly, service delivery is one of the main challenges to the people in the province with only 71% of households having access to piped water as against the national percentage of 90 [25]. Even though the provincial percentage on access to piped water as given by Stats SA looks fairly good on paper; the reality on the grounds indicate that the greater part of the coverage of water supply is in the urban and peri-urban communities – this factor would be discussed further in the discussion section of the paper. Thus despite the efforts by the government in improving service delivery to most communities across the country: various reports by Stats SA in recent times indicate that basic services – particularly water supply – have not reached many of the poorest and rural/informal communities. Using selected communities in the Eastern Cape Province of South Africa, this paper interrogates how combined powers of politics and climate change are denying residents access to sustainable quality and healthy water in rural Eastern Cape.

Results

The study found interesting stories and narratives about the water situation in rural Eastern Cape vis-à-vis the commitment and dedication of public office holders in managing the available water resources and related infrastructure (water governance) in the face of changing global climatic conditions for the well-being of humans and animals, as well as ecosystems and biodiversity conservation. Even though the findings are not presented on community-by-community basis, where necessary, names of communities or places are mentioned for purposes of clarity. In line with objectives of the study, the findings are presented under various headings to address the following thematic issues: sources of water and quality, the impact of climate change on water resources and rural water security and governance (politics).

Sources of water and quality

In an attempt to analyze the impact of climate change and governance on rural water security in the Eastern Cape Province of the Republic of South Africa, the study started first by identifying some of the major sources of water to residents of the study communities through the administration of questionnaires. It was found that residents of various rural settlements of the province access water from a variety of water sources depending on one's geographical location and what is available at that material moment. The diagram below captures the main sources of water to the people as given by the respondents through questionnaires and various forms of interviews.

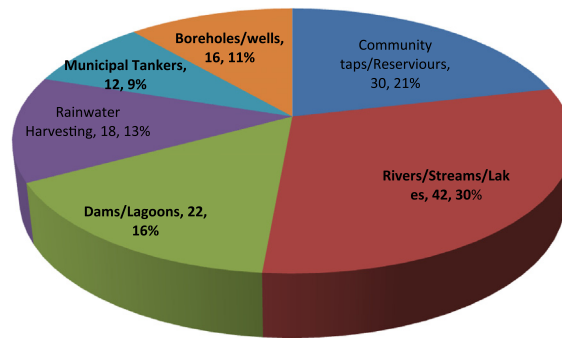


Fig. 1. Sources of water.

Source: Fieldwork (questionnaires and various interviews), 2021

As shown in Fig. 1 above, 51% of the of the total of 140 respondents indicate that they access water from rivers, streams, lakes and community taps and/or reservoirs; whilst the remaining 41% of the respondents mentioned that their main sources of water are boreholes/wells, municipal water tankers, harvested rainwater and dams or lagoons. It was pervasively indicated that none of the various sources of water to the people – as mentioned above – can be describes as a reliable source of water given the extended dry weather conditions they are experiencing in recent years and the level of environmental pollution which affects all manner of water bodies and quality. To buttress the low quality of water for both domestic and agricultural use in the ‘traditional’ water sources, a 53year old man in Zozo village of Kwelera during an interview session lamented as follows:

My children – referring to the research team –, the water situation in this village and many other villages around us is very bad. At this era of civilization and development in the world, can you believe that we still draw water from streams and rivers where we sometimes share the same water source with our livestock? The water from the community taps is too salty that you cannot use it to do anything in the house or even water your garden. It is even worse during dry seasons when we do not have the option of harvesting rainwater. The only source of good water during the dry seasons is the municipal water tankers which bring us water. We sometimes scramble over our stored water with our animals. I do not think you these young people from the city can survive here [sic]. (In-depth interview, 2021).

The long verbatim narrative from a respondent quoted above and many similar other ones give a clear picture of the main source of water to people of Kwelera in the Eastern Cape and its surrounding villages with similar geographical and development features and the quality of water found in those sources thereof. Responses like this and many other ones which present similar situation point to the fact that most of the rural communities in the study area are at risk of experiencing severe water insecurity if the status quo does not change. The respondents mentioned that even though there are community water taps in almost all the study communities; some residents still access water from streams, rivers, harvested rainwater and dams for both domestic and agricultural use either because of the salty nature of the water from such taps or the inconsistent flow of water from the taps. Unfortunately, the availability of water from these ‘traditional’ water sources (dams, lakes, rivers streams, lagoons, etc.) is directly dependant on certain weather conditions and is therefore affected by climate change. The risk associated with the traditional water sources is that the continuous decrease in annual rainfall averages and changes in precipitation patterns alongside rising temperature levels due to climate change will place water security in rural areas of the Eastern Cape at risk as these water sources are directly dependant on rainfall. The quality and condition of the already depleted water supply becomes highly questionable as streams, dams and rivers are contaminated or polluted in the midst of the scramble for water by humans and animals or from industrial waste. Additionally, due to extended dry weather conditions and increase in wind speed, dusty roofs contaminate harvested rainwater and conserving tanks.

The availability of water for all residents at all times and the quality of this water are some of the key variables that define water security. It is argued that achieving sustainable water security is determined by, among other factors; hydrological cycles of given localities and changes in future environmental conditions (climate change), socio-economic parameters, political willingness to invest in resources, and efficient public administration systems (SAWRC, 2014). However evidence gathered by this study suggest that water availability, accessibility and its quality cannot be guaranteed in some rural settlements in the Eastern Cape due to the degree of changes in climatic variables, specifically rainfall, and prolonged dry weather conditions. The plate below corroborates the narrative that humans share water with their livestock in Ncera village 4, even in storage facilities at home.

The impact of climate change on water resources

Another interesting finding of the study was how local residents – without any form of formal training or scientific measuring tool/model – were able to give various forms of narratives to elaborate the adverse impacts of changes in global climatic conditions on the available water resources year-on-year (a key function of water security). In chorus, the respon-

dents indicated in various forms that indeed the current and projected trends of climate change are taking a toll on their livelihoods as such changes have affected, and continue to affect surface water (rivers, streams, lakes, etc.), ground water (wells, boreholes) and rainwater (rainwater harvesting). They lamented that the decreased changes observed in annual rainfall volumes have affected the flow levels of rivers, streams and other surface water bodies, as well as the quality of available water for various uses. Similarly, ground water is affected as there is no enough surface water to recharge groundwater due to decreased annual rainfall volumes as a result of changes in precipitation patterns. Consequently, rainwater harvesting has reduced and is no longer a sustainable means of getting water for both domestic and agricultural purposes. At various interview, discussion and interaction sessions, residents gave various narratives to buttress their observations and predicaments. During a face-to-face interview and interaction session with a 58year old woman in her garden at Phindweni Location of Kwelera, she had this to say:

My children (*referring to the research team*) let me tell you the truth. The issue of climate change and water security is a serious issue we must all pay attention to. If care is not taken and things continue this way, then very soon we will start drinking sea water as the only option left (*she laughed briefly*). Let me tell you something: when we were young, we used to go swimming and washing of clothes in the river down there (*pointing at the Zozo River down the valley*). Sometimes it even became dangerous to go there as the river used to overflow its banks during the summer rainfall season. There was enough rainwater for both domestic and agricultural purposes. Aquatic life was flourishing all year long. However, what is happening today baffles some of us. Look at the same river that used to overflow its banks during the same summer time like now (*pointing again at the same Zozo River*). All the rocks in the river bed are now showing and animals are even grazing there because there is no water in it because of climate change, yet we are in summer. Probably people like you (*referring to the research team*) who are highly educated are the best people to explain what is happening to some of us [sic]. (In-depth interview, 2021).

This view point was expressed by many other respondents across the study communities who lamented about the decline in the available water resources due to changes in climatic conditions. The Eastern Cape Province is part of the summer rainfall regions of South Africa (see [2]) and therefore local residents are aware that they should be receiving heavy rains during the summer period, but the opposite is what is happening.

The stories shared by respondents on surface water scarcity as a result of climate change in Phindweni Location were not different from those shared on how the same phenomenon has affected ground water in the rest of the study communities. At a focus group discussion session in Jongilanga, a 52year old man lamented as follows:

Let me add something small to what my colleagues have already said. We are facing a lot of problems in this village, but the issue of water security is the most critical one because our entire life depends on water. Apart from the community taps you see around, we also depend on hand-dug wells so much to water our gardens and for our livestock. But because of the extended dry weather conditions these years, one can dig as deep as 6–7 m underground and would still not get water. This was not the case in some years back when some of us were in our youthful ages. Even our old wells where we used to get water in abundance have all dried up now; you can even go down there and check for yourselves (*pointing to a valley where the research team could find some of the dried-up hand-dug wells*) [sic]. (Focus group discussion, 2021).

The next key source of water to the people as captured in Fig. 1 which is also highly affected by climate change is rainwater harvesting. Drawing on the various lamentations of the respondents as presented so far, it was not surprising when they further complained about the low level of rainwater harvesting due to the generally decreased rainfall volumes. During an in-depth interview with a 63year old livestock farmer at Tuba, the man shared his experience of climate change and water resources as follows:

As you can see in this village and many other villages around us, every household has got a poly-tank connected to edge/rain gutters of the roofing. They are not for decoration but to harvest every single drop of rainwater for both domestic and agricultural purposes. It is very painful to tell you that those tanks are gradually becoming useless as we do not get enough rains these days and the little we get too is either contaminated or polluted by the dusty roofs and polluted air. You people (*referring to the research team*) can go around the whole village and ask people about the story of rainwater harvesting and they will tell you the same thing I am telling you now if not worse [sic]. In-depth interview, 2021).

True to the words of the respondent quoted above, many other respondents the research team spoke to on the issue of rainwater harvesting in Tuba and other villages indeed confirmed that the quantity and quality of water they used to harvest and store in the tanks have all reduced due to climate change related environmental factors. To sum it all in the context of changing global climatic conditions and available water resources, a 67year old retired factory worker at Kwanobuhle (an informal settlement around Uitenhage) went a step further to define climate change in his own way before linking it to water resources. His-narrative is captured as follows:

Climate change is about the smoke from the factories, which makes the weather hot every day and gives us skin and chest diseases. We do not even get enough rains again to plant crops in our gardens or to feed our animals. We used to drink rainwater when we were young, but we cannot do that nowadays because of the polluted nature of the air. Look at that company at Motherwell [*pointing at the direction of a tyre factory*] processing rubber and manufacturing car tyres and the amount of smoke and smell it releases every day. Why would not there be climate change if we have more of such factories in the world, considering the amount of smoke and dangerous gases they release in a day? (In-depth interview, 2021).

Even though his narrative borders more on environmental pollutions vis-à-vis the anthropogenic causes of climate change; however, the old man's ability through observations and experience to link the whole phenomenon of climate change to both the quantity and quality of available water resources was very fascinating.

Rural water security and governance (politics)

As indicated earlier in this paper, rural water security encompasses many other things, the availability of an acceptable amount of quality and healthy water for livelihoods, health, ecosystems and socio-economic production in rural and informal settlements of a given society. In all these, the role and commitment of both public and private office holders and other relevant stakeholders is very critical in managing the impact of climate change on rural water security as such management procedures and strategies borders on – among other things – sustainable policy initiatives, improved water technology and committed water infrastructure investments. In analysing the complex role of governance/politics in rural water security in the study communities; views were sort from different categories of respondents. From the community members' perspective, a 63year old man in Tuba said:

When it comes to our politicians and how they handle the water problem in this village and many other villages surrounding us, you can see that they are just playing with us and are only interested in our votes. They only come around here all the way from Bisho (*the provincial capital*) and Pretoria (*the national capital*) to promise us so many things, but after voting for them they seems to forget about us and we do not see them until the next election when they will resurface to come and promise us on the same things they mentioned the previous years. They do not take us serious and are not ready to solve the water and other problems we have in this village [sic]. (FGD, 2021).

This sentiment was expressed by almost each and every respondent the research team interacted with as it was a hymnal verse of a particular religious sect to register their level of disappointment and dissatisfaction about the level of commitment and its corresponding investment in addressing the various water related problems in the villages. From the political class and governance perspective, a ward councillor representing the ANC in the same Tuba village could not agree less with the residents and indicated that:

I know you have heard a lot of negative comments about politicians and the way they are handling developmental issues in this village and the whole of the Eastern Cape Province. This province has produced a lot of the Freedom Fighters and ANC leaders including Nelson Mandela, Walter Sisulu, O.R Tambo, Govan Mbeki, Thabo Mbeki and the rest; but we do not have the same level of development in the province to commensurate the kind of political leaders it has produced. However, we are still doing our best to give our people the kind of service they need. I think we are doing far better than the Apartheid government did. The next time you come here, things will be better than you are seeing now, I can promise you that [sic]. (Key informant interview, 2021).

In the midst of the water challenges residents were highlighting, the political 'animal' in the ward councillor was still forcing him to give new promises. The admission of guilt embedded in the ward councillor's response as quoted above indicate that indeed there is a problem in how political office holders in the province are responding to key developmental issues in the province, particularly climate change. The arbiter's response came from a male teacher at Jongilanga High School who is not a resident of Kwelera, but travels from East London every day to Kwelera to teach. He said:

In fact even though I am not from here and I do not stay here either, but I sincerely feel the pain of residents here and how they suffer to get good water. Here in the school where we feel that the government has done well with the provision of water; we can still not use the tap water to do anything apart from flushing toilets and watering the lawns. The water is very salty and therefore one cannot drink it or use it for cooking. Those children who cannot afford to buy bottled water from the tuck shop are forced to drink harvested rainwater stored in the tanks over there (*pointing at some water storage tanks behind the administration block*). Whether that water is still good for human consumption or not is a story for another day. When you talk about all these things here in the school and its surrounding communities, then you are accused of trying to make the government unpopular but the truth needs to be told. (Key informant interview, 2021).

The next section of the paper presents discussion on the key findings and the salient themes emerging in the context water security, climate change and governance/political systems in managing the climate change and water security nexus in the Eastern Cape.

Discussion

For easy and in –depth understanding, further discussion on the findings of the study is given below under different headings.

Sources of water

Rainfall is the primary source of water to the people of Eastern Cape Province and the country as a whole as it recharges all the other sources of water as captured in Fig. 1. However, fluctuations in the volumes and patterns of rainfall as a result of changing precipitation patterns due to climate change as demonstrated by literature and various climate change models affect water resources in the province. Residents reported that over the years, there has been a declining trend in the water levels in the various dams, lakes, lagoons, streams, rivers and other rain-dependant water sources in the study communities.

Without any formal coaching, they further attributed the low water storage in the various water sources to the corresponding low amount of rainfall recorded over the years due to climate change. Locally constructed windmill technology is used in the local communities to pump water from wells and lakes for both domestic and agricultural purposes. However, due to the variability in groundwater distribution from one village/location to another and the growth in population with steep increase in demand, the paper highlights that residents' access to water through the traditional sources is no longer sustainable. They complained that some of the wells and lakes are drying up due to extended dry weather conditions. This finding corroborates the first pillar of the Integrated Water Resource Management (IWRM) framework which sees water as finite and vulnerable natural resource that could easily be affected by both environmental and human factors. It further confirms Edokpayi [7] submission that the key factors for the increase demand for water and affect quality water supply in a given settlement are variations in weather conditions and increase population growth with its associated requirement for food and livelihood systems. These factors and activities increase the collective usage of water per household.

Rainwater harvesting

The study critically analyzed rainwater harvesting as one of the key sources of water to the rural residents of the study area vis-à-vis its relation with the observed fluctuations in rainfall patterns and volumes as a factor of changes in global climatic conditions. The paper specifically looks at rainwater harvesting because apart from the natural sources of water (rivers, streams, lakes, lagoons and the rest) and state provided water infrastructure; it is considered as a locally created means of preserving water for future use. However, it is important to highlight that per the findings of the study rainwater harvesting is no longer sustainable and cannot be relied upon as a source of healthy and quality water to the people. Even though rainwater harvesting has the potential of supplementing water supply to the rural parts of the Eastern Cape, it is important to note that rainwater harvesting is no longer feasible under the current and projected global climatic conditions. This is so because of the decline in rainfall volumes recorded by various sources (see for example [12,13,36]) as well as the level of pollution in the air which in turn affects the quality of water harvested and water security as a whole. To continuously rely on rainwater harvesting as a supplement and/or alternative water supply to the people; further and more detailed studies are required to obtain more and in-depth knowledge and clarity on the physical and chemical impact of climate change on the quality and quantity of rainwater.

Quality of water and efficient usage

It is evident that in Africa water is a major factor in agricultural production. The intricate linkage between climate change, water and agriculture and the need to understand this tripartite relationship and formulate appropriate policies to respond to climate change impacts and design programmes that will build a formidable resilience to climate variability in both the long and short term in Africa is imperative. Water resource management and efficient use of quality water is therefore a major ingredient in boosting agricultural productivity and general livelihood in the face of current climatic conditions in arid regions. Despite some degree of success recorded by both local and national governments in providing clean and safe in most parts of the Eastern Cape Province of South Africa – especially under the Amatola Water Project – many of the rural and informal residents of the study communities still depend on rivers, boreholes, dams, wells, lagoons, rainwater harvesting and municipal water tankers as sources of water. The key issue here is that, many of such water sources are either not properly treated for human consumption or in some cases not treated at all – for instance in the cases of rivers, streams, dams, lagoons and harvested rainwater – which could pose some degree of health risks to the residents (waterborne diseases). The WRC-SA (2021) indicates that the quality of water resources consumed in South Africa varies from one place to another depending on a number of factors. Key among such factors is the source of the water and the level of treatment before consumption as water in its natural form is said to contain a number of substances – whether dissolved or undissolved. Again, the efficient use of the available water as an economic good as preached by the IWRM framework is another key issue. This submission gives credence to the common narrative that water resources in a relatively pristine environment tends to have better quality than those exposed to anthropogenic factors. Thus the geology of the source of the water resources is a key driver to the chemical and microbiological quality of the said water ([7]:90). Building on this premise, the quality of water from the various sources found in the study communities; how such water is used and what it is used for leaves much to be desired as majority of the respondents complained of either the taps/reservoir water being too salty or the water from the dams and lagoons being too dirty and cannot be used for cooking or drinking or anything productive. The presence of salt in water is reported to be common factor in South Africa as a country because of the geology of river catchments [36]. The study found salinization as one of the key issues that affect the quality of water in most of the rural and peri-urban settlements in the Eastern Cape.

Again, anthropogenic activities like crude agriculture practices and manufacturing together with their associated chemicals and natural events like flooding and storms were found to be the main source of pollution to water resources in the study area which in turn affect water security in the context of water quality. Similarly, pollution of surface water sources (especially faecal and chemical contamination of runoff water) was found to have adverse impact on various aquatic organisms in the river and stream systems as some local species of frogs and fish were mentioned to have gone into extinction as a result of the pollution levels in the rivers and streams. With the possible high level of contamination as well as the dwindling volumes in traditional water source like rivers and streams due to fluctuations in precipitation and rainfall volumes;

the paper highlights that dependants of such water sources in the Eastern Cape Province and provinces alike are exposed the risk of contracting several waterborne diseases and acute water insecurity in the years ahead.

Climate change and water resources in the Eastern Cape

The water sector together with its related activities is one of the most affected areas by climate change in South Africa. In the Eastern Cape Province, the study from which this paper was developed established that the impact of climate change on hydrological cycles of the province and the nation as a whole has changed the onset of river/stream flow because of changes in precipitation patterns. This has also affected the amount of water in all the various storage sources of water to the rural residents, including runoff water. The Water Research Council of South Africa [36] corroborates this finding by noting that approximately, an 8% reduction in rainfall in South Africa could result in a 30% and above reduction in surface water in South Africa. This therefore cements the IPCC [13] submission that climate change factors like rainfall, evapotranspiration, high temperature and surface runoffs are the major drivers of the hydrological systems of a given locality. Local narratives as quoted in various sections of this paper confirm what literature from different sources has already established in the context of precipitation patterns and the quality and quantity of catchment runoff. Thus an increased precipitation with corresponding increase in rainfall volumes leads to an increase in the amount of water residents receive in rivers, streams, dams and other auxiliary water storage facilities available to them.

As country characterised by arid to semi-arid climatic conditions (see [13]), Honkonen [9] indicates that approximately 60% of South Africa's rainfall forms runoff to rivers, lakes and streams; whilst about 5–7% recharges ground water. Apart from surface water, this paper highlights that groundwater faces a decline in the study area like all the other key sources of water to the residents due to the continuous decrease in rainfall volumes in the province as a result of changes in climatic conditions. Residents lamented that it is difficult get or reach water when one digs wells manually unless one uses mechanized system of digging. All these are testimonies to demonstrate that indeed climate has affected, and continues to affect water resources in the Eastern Cape.

Water security, governance and climate change

Water plays a critical role in the socio-economic development, livelihood systems and dynamics and poverty reduction outcomes in a given society. A good number of climate scientists, water resource experts and various institutions have highlighted a number of times that governance and water resource management strategies in Africa should adopt a transformative and strategic planning paradigms to incorporate a deep knowledge on climate change and water resource management intersection [7]. Thus sustainable water usage for the purposes of both human consumption and agriculture is critical in reducing climate change-induced water insecurity in South Africa as a whole. Inasmuch as water security covers quantitative and qualitative aspects of water; it also includes the role of interest groups and key stakeholders at different levels of government and private institutions. In line this view point, the economic water scarcity theory argues that water insecurity is not necessarily caused by absolute unavailability of water but is rather caused by a lack of the needed investment in the water sector and infrastructural management and maintenance. In rural Eastern Cape for instance, effective governance based on sustainable policies, proper water infrastructural development and strict legislations with punitive measures are needed to help handle the various water related risks posed by climate change and further aid in preventing pervasive water insecurity in the days ahead given the current trend in changing global climatic conditions.

As mentioned earlier, changes in stream and river flows, poor water storage facilities, reduction in surface and ground waters and pollution of runoff water are some of the key water-related problems attributed to climate change either directly or indirectly in the study area. Furthermore, the climate change impacts on fresh water resources identified vary from the demand for water and its utilization (agricultural, domestic or industrial), the geography of the source of the water, management and maintenance strategies of water facilities to governance structures and preparedness of state institutions to ameliorate the adverse effects climate change on water resources in rural Eastern Cape.

Governance and adaptation to climate change impacts on water security

“The management of water resources is affected by various policies, laws, enforcement and legislative frameworks, which may negatively impact health, environment and economic outcomes on a scale that constraints development and poverty reduction efforts” ([7]:105). In pursuit and subsequent achievement of number six (No.6) of the Sustainable Development Goals (SDGs) which targets at ensuring the availability of healthy and quality water for all as well as the sustainable management of water resources and sanitation; the United Nations enjoins the international community and all United Nations member countries to formulate policies and further design governance systems that would ensure that all citizens have equal access to clean and potable drinking water as well as proper management of ecosystems and biodiversity. It is indicated that proper management of water resources and its related infrastructure in rural Eastern Cape would resonate very well with some of the key climate change adaptation objectives globally as water security plays a critical role in poverty alleviation and equity. The interconnectivity between water security, safe energy, good governance and sustainable development is critical in the complex analysis of the potential challenges related to climate change and its ripple effects on food security and general wellbeing of people. This supports the Water Research Council of South Africa's [36] argument that

given the ever-growing human population, ineffective state institutions, and lack of committed investment in water infrastructure and poor governance accounts for water insecurity in many parts of South Africa, especially in rural and peri-urban communities. Political commitment and proper management of water resources is therefore critical in the Eastern Cape as they affect local livelihood systems of most rural residents – particularly agriculture. One of the key administrative issues identified by this paper in context of governance and water security has to do with the social price residents pay before accessing water. Even though the national government has a policy of giving free water to the poorer population segment in the country; such category of people sometimes end up paying more for water than their richer counterparts as a result of lack of proper investment in water supply infrastructure in the poorer communities.

In the Eastern Cape Province for example, this unfortunate situation is probably part of the negative legacies of the apartheid regime that biased water supply and other essential services decisions against non-white communities (National Planning commission - NPC, 2016). It is important to mention that developing sustainable water resource management system in the Eastern Cape to properly address the adverse effects of climate change on water supply to the rural areas requires the active involvement of multiple private and public institutions and actors to coordinate the various water users into an integrated water planning and management framework. This is exactly what the IWRM framework and the Economic Water Security Theory preaches. Thus an increased in stakeholder participation and balanced water-related decision making process through local communities spearheaded by local government officials would be a good starting point to ensuring quality, healthy and productive water for all in the face of changes in global water conditions. Environmental controls, control of pollutions and increased in water infrastructure investments and management could be some of the effective administrative and governance instruments that can reduce the risk of water insecurity in the rural areas of the Eastern Cape with climate change firmly in mind to bring about the desired growth and development in the affected areas. This feeds aptly into the African Union's Agenda 2063 policy framework which aims at among other things, sensitizing governments and their agencies, private sector stakeholders, media houses and relevant civil society organizations on the need and urgency to harness all forms of continental endowments – including water resources – to effect equitable and people centred development on the continent of Africa [1]. This makes both scholarly and policy meaning because water in its quality form is very key to critical socio-economic activities in Africa.

Major conclusions on key findings

The paper concludes that the major source of water to most rural residents of the Eastern Cape Province of South Africa still remains rivers, dams, streams lakes lagoons and many other traditional means of accessing water. Therefore rainfall is a major driver in understanding the impact of climate change on water resources/catchments in the Eastern province as it has a direct and indirect relationship with surface and ground waters respectively. Again, the geological area as well as the socio-economic environment where a water resource is found or located in the Eastern Cape is a major factor in determining the physical, chemical and microbiological quality of the said water resource to the people – particularly in the rural, informal and peri-urban settlements. Moreover, climate change and its related variables/phenomena have become not only environmental problem, but a developmental challenge to all facets of development in the Eastern Cape and beyond as all the key socio-economic development activities are somewhat climate changes dependant. The level of government's commitment through various state institutions in addressing the impact of climate change on water resources in the Eastern Cape leaves much to be desire.

Conclusion

One of the key sectors of South African communities highly affected by climate change is the water sector. Various studies highlight that the sources of water and its quality standards in rural communities of South Africa are suspected, from a health point of view (see WRC-SA, 2014). Most rural residents of Eastern Cape rural communities still access water from dams, rivers, lakes, rainwater, and streams for varied domestic and non-domestic purposes. Even so, water reserves in streams, rivers, dams and other water bodies for irrigation, human and animal consumption are diminishing day-by-day due to a decrease in annual rainfall volumes and increased evaporation levels associated with climate change, which further poses a great threat to water security in the affected areas. The risk of water insecurity posed by climate change to local residents of the study communities further exacerbates the issue of declining agricultural productivity and its subsequent effects on food security in the region due to high dependency on rainfall for crop and livestock production by local farmers. It has been established that the high variability of climate related variables like temperature and rainfall adversely affect water resources around the globe. Locale specific studies are therefore necessary to highlight the extent of impact of climate change on quality of water to the people vis-à-vis the preparedness and commitment of public office holders to formulate policies that would lessen the impact of climate change on water security as whole. This paper demonstrate that the Eastern Cape Province in South Africa is highly exposed to climate change risk in the context water related socio-economic activities and livelihood systems; yet the political administration of the province is inadequately prepared to initiate and implement mediatory actions to leverage water-sensitive sectors like agriculture against climate change.

Climate change adaptation planning is required at both local and national levels through various frameworks supported by law to help integrate climate sensitive sectors into national development planning. This would help to develop formidable



Plate 1. Thirsty cattle drinking from a barrel of water meant for humans.
Source: Fieldwork, 2021

and sustainable water management practices and governance structures across the various provinces and communities with multiple actors.

The nexus lenses used in this paper has helped to demonstrate that sustainable investment into water and its related infrastructure has direct and indirect socio-economic effects on the general welfare of the people as the water sector as whole has a transformative impact on other sectors like agriculture and manufacturing. Sustainable management of water resources for the purposes of both human consumption and agriculture is a key issue for the prioritization of climate-induced impacts on water security in rural Eastern Cape. The prioritization of water use itself – if properly managed – can be adopted as an approach to manage water resources in the Eastern Cape and further establish different water uses to reduce conflicts between competing uses. This is so because experts believe that water security goes beyond the quantitative aspects of water demand for human wellbeing and ecosystems security to include national security and political stability issues. This therefore suggests that different categories of stakeholders in leadership and governance have different roles to play at different levels in ensuring that water resources are sustainably managed through legislations and regulatory frameworks to prevent eminent water insecurity in the Eastern Cape given the current trends in changes in global climatic conditions.

The observed changes in stream/river flow and general reduction in surface and groundwater in the Eastern Cape are some of the key climate change related risks to water security which borders on governance and institutions. Generally, water security and water resource management are conceptualised in relation to the wellbeing of people and therefore require committed and dedicated efforts from institutions (both private and public) to promote sustainable policies and practices that could lessen the adverse impacts of environmental conditions on available water resources as well as smoothening the socio-political and administrative challenges in water resources use and sustainable planning.

In terms of policy significance, this paper has a potential to inform policy makers about the effects of climate change on water as well as rural livelihoods across various communities in Africa. It can also influence policy makers to build a strong relationship with local communities in terms of water related climate change adaptation strategies in poor communities. Finally, the findings and key conclusions presented in this paper could assist local municipalities in identifying gaps on existing water management policies and strategies. Specific suggestions for policy considerations are given in [Plate 1](#).

Policy recommendation

Based on the key findings of the study, the paper suggests the following policy and practice options for consideration by policy makers and practitioners alike:

- Creation and adoption of new and innovative water saving technologies and general education on water usage and pollution levels in the Eastern Cape are highly recommended.
- There should be a concerted effort to integrate weather forecast into water management frameworks in the province as a means of identifying early warning signs to take proactive measures in forestalling water-related socio-economic problems. The integration of water-related risks communication into political administration and governance has the potential of enhancing the adaptive capacity of relevant agencies, institutions and communities.
- Integrated water resources management could be an apt approach that would mediate water-ecosystem-livelihood nexus by way of reviewing existing policies and practices to address various socio-political and administrative bottlenecks relating to water resource planning and usage in the Eastern Cape Province.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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