

Analysis of adaptation strategies of water insecure coastal communities of Tanzania by gender: *Case of Mlingotini village in Bagamoyo district*

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Abstract

Climate change is a global phenomenon that requires significant responses. Its impacts are already being felt and projected to affect adversely the security of water in coastal areas. To develop effective adaptation plans, policies and strategies require disaggregated data on both men and women's response to climate change. Therefore, this paper fills this knowledge gap by analyzing adaptation strategies of water insecure coastal communities of Tanzania in a gender perspective. Purposive sampling procedure was used to identify 97 households from village households register for a household survey. It was also used to select study area, key informants and discussants for focus group discussions. Results indicated that the problem of water insecurity has been increasing in the study area compared to the past 30 years. Most of response strategies pursued by women in the study area are different from those employed by women in semi-arid regions while to men most of response strategies are similar. The study recommends that climate change adaptation measures, plans and policies should take into account differences between men and women's responses to water insecurity. Furthermore, climate change adaptation interventions to water insecurity should address gender vulnerabilities at the household level.

Key words: Coastal communities, water insecurity, adaptation strategies, gender

Introduction

Climate change is a global phenomenon that requires significant responses (Brody, 2008; University of Oslo, 2013). Its impacts are already being felt and are projected to increase in sectors essential for human and economic development, such as coastal freshwater systems (Bates, Kundzawicz & Palutikof, 2008). Evidence from various literature such as UNEP (2007) and Bonte & Zwolsman, (2010) and Tobey *et. al.*, (2013) indicates that freshwater systems along coast areas can potentially be adversely impacted by climate change due to sea level rise, increase in surface and ambient air temperatures,

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unpredictable precipitation and ocean acidification. The 5th IPCC Assessment Report (2014a) added that impacts of climate change on freshwater systems are mainly associated with increases in sea level rise, increases in temperatures, changes in local precipitation and changes in variability of their quantities. The combination of all these changes may have far reaching consequences on water in terms of its quality and quantity together with availability and accessibility, which are important dimensions of water security (Bates *et. al.*, 2008; Nkonya, 2010; United Nations, 2010).

As a whole various studies on hydrological changes such as those of Hay & Mimura (2005); UNEP (2007) IPCC (2007, Bonte & Zwolsman (2010) and IPCC (2014a, 2014b) indicated a decrease in streamflows and surface and groundwater recharge due to extreme temperature and decreased precipitation. Also, global mean sea level has already risen by 0.19 meters between 1901 and 2010 and is projected to increase sea flooding, saltwater intrusion into groundwater aquifers, surface water and coastal river systems, patterns, decreasing freshwater availability for ecosystems and human systems in coastal areas. The most observed change in water quality include saltwater intrusion into groundwater aquifer and surface water due to sea level rise. Linzey (2011) affirmed that the decrease in rainfall and increase in drought events in coastal areas has decreased groundwater recharge, resulting in the landward flow of saltwater from the sea. Other observed changes to water quality include increase in sediment loads in river systems and suspended solids into lakes, as well as water reservoirs due to heavy precipitation (IPCC, 2007; UNEP, 2007; Bonte&Zwolsman, 2010; Tobey *et. al.*, 2013; IPCC, 2014). Extreme temperatures, increased precipitation and flood events are projected to exacerbate many forms of water pollution, including pathogens, pesticides, salt and thermal pollution. Such patterns can lead to increased bacteria, fungi and algal blooms, which affect water borne diseases (Bonte&Zwolsman, 2010). For example, higher water temperature and floods in Tanzania have been associated with cholera and diarrheal disease outbreaks (Mboera, Mayala&Kweka, 2011). Also Wandiga and colleagues (2006) indicated that high cholera epidemics in Lake Victoria areas coincided with higher temperatures and high flow peaks before and during *El Niño* years.

In Tanzania, for example, despite abundant water resources, the country has poor water quality. In addition, pollution is a common problem causing drinking water supplies to sometimes fail to meet the requirements of water safety (Nkonya, 2010). At the same time, projections have shown that by 2025, the

availability of freshwater in Tanzania will be reduced to half of the rate of 1990 (Shemsanga, Omambia & Gu, 2010).

Changes in water quality and quantity are of greatest concern for the poor as it is widely agreed that climate change will hit them the hardest, as this group has a low capacity to respond (Olmos, 2001). Marginalized groups (e.g., elders, children, poor and women) will experience the greatest impacts of climate change due to limited access to assets, technology, education, skills, information, management capabilities and economic status (IPCC, 2001; Neelormi & Ahmed, 2011). Different groups within the community differ in their ability to adapt and that these differences translate into differential abilities to respond (Kates, 2000). For example, impacts of climate change on water may increase distance and time of travelling to fetch freshwater; may deepen the depth of reaching groundwater (Bates *et al.*, 2008); and therefore may escalate the costs of accessing freshwater (United Nation, 2010). It is clear that men and women's response to such impacts will vary due to the different roles and responsibilities assigned to them (Cutter, 1995; Denton, 2002). Gender roles define what is expected and appropriate for men and women. They determine how men and women should behave relating to activities for which they are individually and jointly responsible as men and women at a household level (FAO, 2007). Roehr (2007) citing examples from industrialized countries showed that women and men in respect to their social roles differ in response to climate change. While men trust in technical solution, women tend to vote more strongly for lifestyle changes.

To develop effective adaptation plans, policies and strategies require disaggregated data on both men and women's response to climate change (Hagen *et al.*, 2016). UNDP (2009) and UNFPA (2009) indicated that effective climate change policies should take into account differences between men, women, boys and girls during policy formulation. Also, Okuli and colleagues (2012) further added that in attaining successful and effective adaptation, it is important to ensure the participation of both men and women in adaptation planning and policy making.

Previous research (e.g. Tobey *et al.*, 2012; James *et al.*, 2013; Mkama *et al.*, 2013) has focused more on how coastal communities of Bagamoyo District responded to climate change impacts on fisheries, agriculture and tourism with little attention to water insecurity. However, there are some studies that link climate change and gender (e.g., Nelson & Stathers, 2009; Okuli *et al.*, 2012). Most are focused more on semi-arid regions. Although climate change is a

global phenomenon, adaptation is fundamentally local (e.g., Pauline, 2015; Pauline & Grab, 2018). Therefore, identified response strategies may be suitable for semi-arid and not for coastal communities due to different levels of exposure, sensitivity and adaptive capacity to climate change.

This paper fills this knowledge gap by analyzing adaptation strategies of water insecure coastal communities of Tanzania using a gender perspective. In so doing, firstly, the authors established the trend of water insecurity through both historical recounts and observed records in the study area. Secondly, the researchers analyzed the response strategies of men and women to water insecurity in the study area. This nuanced analysis of responses by men and women provides a fuller sense of how water insecure coastal communities live and respond to climatic stresses.

The context of water security

Water security is defined by Global Water Partnership (2000) as an overarching goal where every person has access to enough safe water, at an affordable cost to lead a clean, healthy and productive life, while ensuring that the environment is protected and enhanced. In this paper, water security is defined as a condition that exists when all people, at all times, have physical and economic access to sufficient and safe water for an active and healthy life. Water security does not only include availability of water for the household, but also other dimensions like accessibility and its quality. The community or a household is water secured if all three components are met (United Nations, 2010).

Water availability is defined as the physical presence of water within the household in an acceptable quantity for domestic purposes and healthy life (Water Aid, 2012). United Nations High Commission for Human Rights (2010) indicates that the amount of water available for the household should conform to World Health Organization (WHO) guidelines. WHO suggests that a minimum of 20 liters per person per day are needed for personal consumption and sanitation (Guy & Jamie, 2003). WHO further notes that at such level of water availability, there are medium health risks because not all requirements may be met (UN, 2010.). Gleick (1998) estimated that 25 liters of water are needed per day for personal consumption and sanitation but further 25 liters are needed per day for food preparation and bathing, making a total daily requirement of 50 liters per person. This paper used 50 liters per person per day as the criteria for an acceptable quantity of water with a low health risk.

Water accessibility refers to the way people within the community and household obtain and control water as a commodity (Webb, n.d.). Accessibility to water can be measured by the amount of time people within the household spend in a round trip to reach safe water (Nkonya, 2010; Urama&Ozor, 2010). Water is considered inaccessible if it requires people to travel more than one kilometer, travel more than 30 minutes per round trip, as well as spend more than 3 percent of household income for water (Nkonya, 2010; United Nations, 2010; WaterAid, 2012).

Water quality is the term used to refer to water, which is clean, free from micro-organisms, chemical substances and is therefore, safe for domestic use and personal consumption (United Nations, 2010). Safe, quality water must also be acceptable in terms of colour, odour and taste for each person, including domestic use (Nkonya, 2010). The above mentioned water security attributes are used as a lens to gauge how coastal communities respond when they are confronted by climate change related stressors which affect in access to good quality and safe water.

Methodology

The study area

The study was conducted in Mlingotini village of Bagamoyo District in Pwani Region. The village is situated between latitude 6° and 7° to the south of Equator and longitude 37° and 39° to the east (Bagamoyo District Council, 2006). The district experiences a humid tropical climate and has bimodal rainfall pattern. The short rain season starts from October to December, while the long rain season starts from March to May. Total rainfall ranges between 800 – 1200 mm per annum and seasonal average temperatures range from 13° C to 30° C. The driest months are from June to September when rainfall is less than 50 mm per month. The district is divided into two ecological zones, namely, coastal strip and upcountry. The coastal strip is characterized by savannah and bushes, while the eastern, northern and western upcountry is mainly covered with natural dense forest. The coastal strip receives relatively higher precipitation than the up-country part (Bagamoyo District Council, 2006).

The major economic activities include artisanal fisheries, which employ over 50 percent of coastal villagers in the district, seaweed farming, agriculture, livestock keeping, salt production, trade and tourism activities. Agricultural activities are largely subsistence but also involve the growing of fruit, cotton,

cashew nuts and coconuts as cash crops. Food crops grown in the district include maize, cassava, legumes, sweet potatoes and sorghum (Bagamoyo District Profile, 2006).

Map of Bagamoyo District showing Mlingotini village

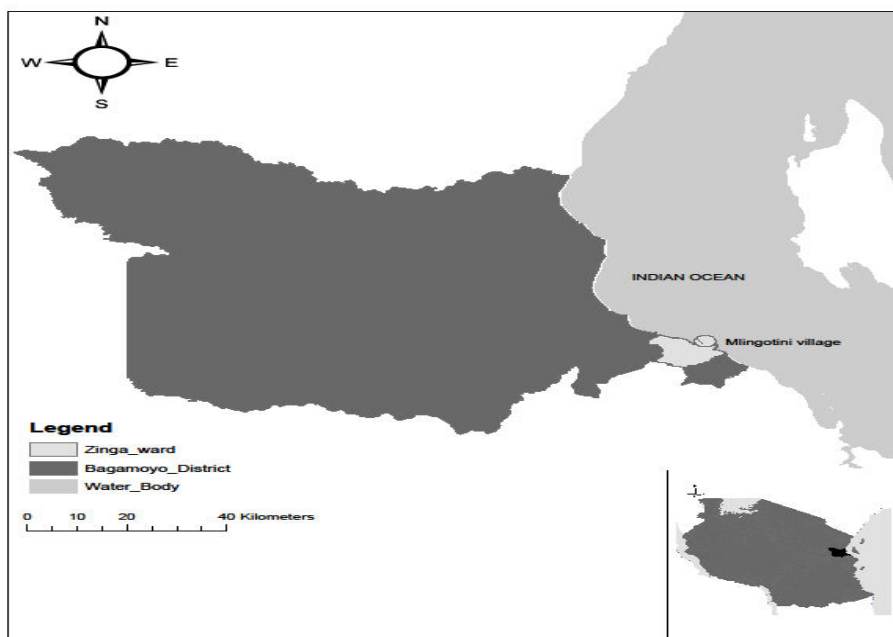


Fig. 1: Map of Bagamoyo District showing Mlingotini village

Sampling procedures, design and size

The study employed a mixed research approach to collect both qualitative and quantitative data. Purposive sampling procedure was used to obtain the study sample. A comprehensive list of households in the villages was obtained from the village households register to make up the sampling frame. Using this list, a purposive sampling procedure was used to obtain the study sample. During the process village leaders were requested to help to identify households with members who had long experiences regarding village history; only households in which their heads lived in the village for at least 40 years and above were considered for a household survey. The process continued until the sample size reached 10 percent (97 households) of the total 976 households contained in the list. This is a representative sample as observed by Babbie (1983) that 10 to 12.5 percent is a good representative sample size of the entire population for social sciences. In this study, a household is defined as a group of individuals living under the same roof. It consists of one or more people who live in the same dwelling and also share meals or accommodation.

In addition, purposive sampling procedure was used to select the study area, key informants and discussants for focus group discussions (FDG). Factors like long experience regarding village history (40 years and above) were considered for the selection of key informants and discussants for FDGs. Hence, only villagers aged between 55 years and above were considered for key informant and FDGs. Moreover, accessibility and location in proximity to the ocean shoreline were considered in selecting the study area.

Data collection and analysis

Data were collected in three phases. In the first phase, data were collected through a household survey using a semi-structured questionnaire. The data collection method was used to collect information such as household size, past climate variability and changes in the study area as well as observed changes pertaining to water quality, availability and accessibility. It was also used to collect data on household response strategies and household water security. Questionnaires were prepared and administered to 97 household heads. In addition, face-to-face interviews were conducted with 38 household heads (men) and in some cases, 59 representatives of household heads were interviewed (women).

Phase two of data collection involved FDGs and key informant interviews guided by a checklist of questions. Two FDGs were conducted; the first one involved women only and the second one involved both men and women. Village leaders were requested to help to identify 10 village members for the FDG comprising an equal number of men and women, who had long experiences regarding the village history. Topics discussed included security of water between the present and past 30 years. They dwelt on changes in water quality (such as taste, colour, odour and water borne diseases), availability (getting 50 litres of water per person per day and enough water for all household activities) and accessibility (in regard to costs, distance travelled and time used to fetch water per round trip). Other topics were discussed such as past climate variability and change with the resultant impacts on water security in the village, as well as men and women's response to the situation within the households. Moreover, six informants, including three elderly male village leaders and three elderly women, were interviewed to capture changes in water security between the present and past 30 years. Furthermore it was used to capture the differences in responses between men and women in water insecurity.

The last phase of data collection involved the collection of rainfall and temperature data. Daily temperature data covering 30 years were obtained from Dar es Salaam International Airport Meteorological station. The reason for using data from the station was because of lack of temperature records in Bagamoyo District. Also this station is the nearest place to Mlingotini and was not far from the Indian Ocean. Daily rainfall data covering 30 years were collected from Bagamoyo rainfall station.

Water accessibility data, including rainfall and temperatures data, were subjected to descriptive analysis. Rainfall and temperature data were analyzed using Microsoft excel program whereby linear trend lines covering 50 years for rainfall and 30 years for temperatures were drawn to indicate whether the rainfall or temperature had been decreasing or increasing. Data related to perception of household water security, as well as trends of water quality, were analyzed using *IBM* Statistical Package for Social Sciences (SPSS) version 20. Qualitative data were analyzed using content analysis.

Results

Observed changes to water security over the past thirty years

Changes to water quality

During FGD respondents reported that there was no problem of saltwater intrusion in the past 30 years but currently, it is a common problem. Due to reduced rainfall and increases in dry spells, the water table has dropped, making it difficult to reach groundwater. Respondents (both men and women) added that if they dig a traditional well (a hand dug well), they cannot get water and if they manage to get water it will be very little. In order to get enough water, they have to drill a deep well, and most of these wells were reported to have saltwater. The problem of saltwater was more highly reported in drilled wells compared to traditional wells. During key informant interviews with village leaders, the same information was reported. However, it was added that drilling wells cannot be avoided because without going 60 meters deep, they could not obtain enough water.

Another issue that was reported which was reducing water quality was saltwater intrusion into springs along the shoreline. Sea level rise was thought to be the source of the problem. The villagers reported that in the past 30 years, they used to go to the coast where they dug shallow holes using their hands and got enough freshwater, which was used for domestic purposes but presently most

springs are covered by sea water and some are salinized as well as covered by the sea.

Changes to water availability

The key informants in the study area reported that rainfall has been decreasing in volume and timing, while temperature has been increasing, leading to recurrent drought events. It was further added that the rainfall has become less frequent and uncertain compared to the past 30 years. In the past, long rains were very high, adequate and reliable, falling early and ending late in the dry season but presently, they are unpredictable. Villagers associated such events with the early drying of local dams and Kasiki River found in the village. In the past (before 1999), it was reported that dams and the river retained water throughout the year but due to unpredictable rainfall and increases in the dry season, such water bodies presently have been drying earlier. The said water sources provided water, which was used for watering crops, building, washing clothes, livestock and bathing. Nowadays, people have to buy water for washing clothes, bathing and building.

The household surveys indicated that despite the importance of traditional wells, for most of families, water has decreased due to the decline in rainfall, frequent droughts and increase in extreme temperatures, resulting in lower water tables. For example, Omari Hussein well was reported to dry out because of drought and decreased rainfall. For Chemsu well, it was reported that water levels have decreased compared to the past. Drying and decreasing of water in wells were reported to cause long queues especially when there was no water supply in standpipes for long periods. Women and girls spend more such time waiting to collect drinking water.

All these conditions were reported during FGDs, and resulted in villagers being unable to obtain sufficient water to meet the needs for all their household activities. Also the household survey indicated the same results, which are presented in two cases (Quotation 1 & 2).

Quotation 1

This household had five members. The main sources of water used within the household were drilled wells, piped water, hand dug wells and spring water. The household head rated household water insecurity to be worsening because of the low quantity of water the household gets per day compared to household size and all household activities. The household fetches 140 litres every day. However, it was reported that this amount was insufficient for all household

activities. The household further explained that if they had enough money, they could have drilled their own well to ensure that they obtain efficient water. "The amount of water we are getting is not enough but we are trying to economize and reduce costs," the woman argued. It was reported that sometimes when the household had no money for purchasing water, they went to fetch spring water along the shorelines. They dug shallow holes along the shoreline and extracted freshwater. The time used per round trip for fetching water from springs was reported to range between 30 to 40 minutes. They also reported that due to the increase in water temperature in both drilled and hand dug wells resulting from extreme temperature, water cannot quench their thirst until it is mixed with ice. "Drinking water has been a problem in the household," one respondent reported.

Quotation2:

This case is from a married woman during household survey. She has lived in the village for 35 years. Her household had five members and the main sources of water in the household were drilled wells and piped water. The quantity of water which was sufficient for all household activities per day was 200 litres. The household water security was reported to be worsening even though the household managed to obtain all 200 liters daily. Reasons reported for water insecurity in the household included a large effort and energy used for fetching water, changes in water taste and an increase in waterborne diseases. The respondent further argued that nowadays, she needs to use a lot of effort and energy to fetch water because of increasing frequencies in fetching water per day.

During the household survey, it was revealed that the majority of households fetch water within the distance of 100-200 meters (Table 1). In spite of the water being very near, most households reported that the large percent of water they are fetching is saltwater from drilled wells because pipe water is very expensive and sometimes it may last for only a short time due to water rationing. Villagers claimed that pipe water is unpredictable and they can stay up to a month without supply. It was reported that the problem increases during drought conditions. Villagers also added that in the past 30 years even though they travelled long distances, they could not fetch saltwater and water was free of charge compared to the present.

The time spent fetching water per round trip was reported to be less than 30 minutes for the majority of households because standpipes and drilled wells are very near. However, in some cases, much time was spent fetching water per

round trip. During the FGDs, respondents reported that when there was no supply of pipe water for a long time they were forced to queue at hand dug wells to fetch drinking water. It was reported that during such times, many people had to depend mostly hand dug wells to obtain drinking water. Hence, long queue ensued and forced people to wait up two hours to obtain water. Furthermore, it was reported that one bucket of 20 liters cost 200 and 100 Tanzanian shillings for freshwater and saltwater respectively. A third (30.6%) of households reported that the quantity of water they were fetching per day was not enough for all household's activities, but they were fetching that amount to minimize cost. Another respondent during household survey reported that in her household, they had no water for three days because they did not have money to buy water.

Table 1. Distance travelled to fetch water in present time and past 30 years (n=97)

Distance	Present time	Percentage	30 years back	Percentage
Less than 50 meters	12	12.4	0	0
100-200 meters	85	87.6	13	13.4
1 kilometer	0	0	53	56.6
More than 1 kilometer	0	0	31	32
Total	97	100	97	100

Source: Field Survey, 2016

Rainfall trends

To corroborate the validity of data collected from FGDs, key informant interviews and household survey, 30 years (1985-2015) of data were used. The Analysis indicated a normal trend ($R^2=4E-06$) with high inter-annual variability over time (Figure 2). Furthermore, the analysis revealed that with exception of year 1988, the total annual rainfall between the years 1985 and 2000 was not less than 800 mm, while between 2000 and 2015, there were six years in which rainfall decreased to below 800 mm.

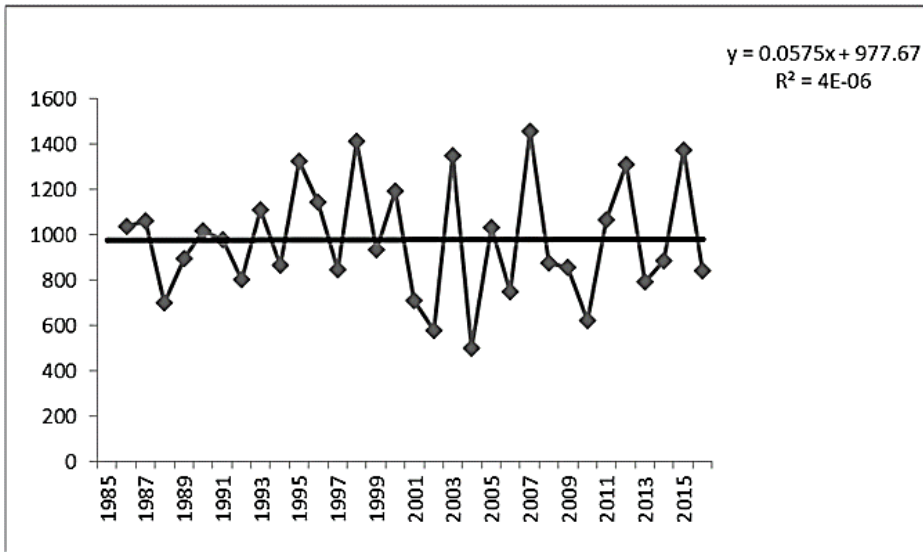


Figure 2 Annual rainfall trend in Bagamoyo (Tanzanian Meteorological Agency, 2016)

Further analysis of mean monthly rainfall indicated shifts in timing and peaks of rainfall (Figure. 3). Long rains decreased in April and May between the years 2000 and 2015 and were less frequent. Also short rains decreased in October and increased in December between the same years. Such results match with respondents’ perceptions, which showed that rainfall has been decreasing in terms of amount and the timing has been changing, as well as unpredictable since 1999.

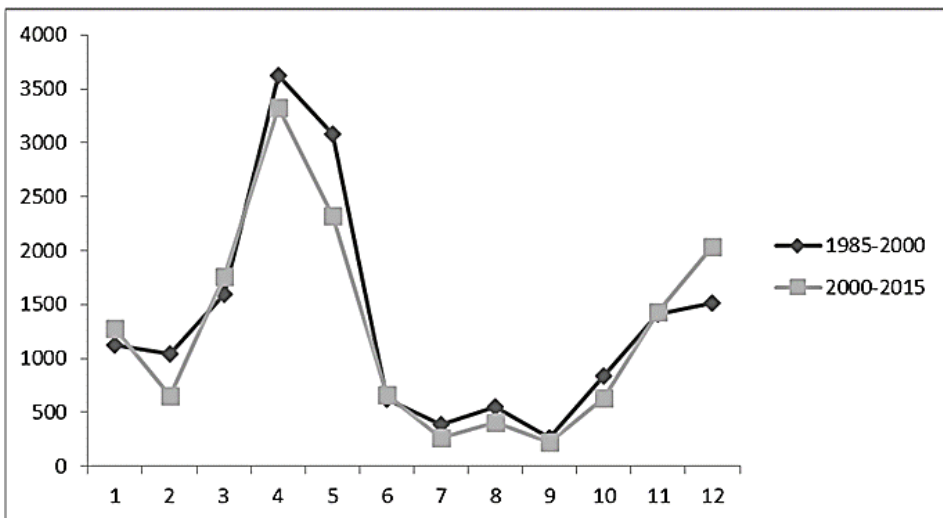


Figure 3 Mean monthly rainfall in Bagamoyo (TMA, 2016)

Temperature trends

Most of studies (e.g. Fayeret *al.*, 2002; Kundzewicz *et al.*, 2007 & United Nation, 2010) indicate that increasing in water temperature influences increase of pathogens into water sources hence accelerating water borne diseases and impairing drinking water. In addition, other studies (e.g IPCC, 2007; Bonte & Zwolsman, 2010) have added that extreme temperatures can contribute to decrease in streamflows, surface water as well as ground water recharge. In the light of this situation, temperature data were collected and analysed.

An analysis of data covering 30 years indicated that both minimum (Figure 4) and maximum (Figure 5) temperatures have been consistently increasing. A trend line drawn using Microsoft excel shows that annual average minimum temperatures increased at a rate of 0.006 ($y=0.0648x+20.58$) per decade and average maximum temperatures by 0.004 per decade ($y=0.0481x+30.318$).

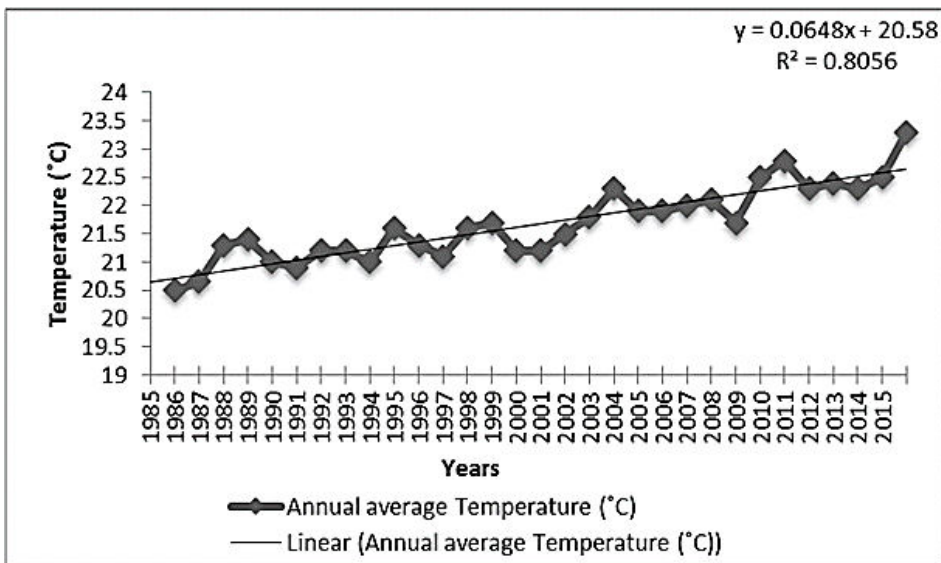


Figure 4 Minimum annual average Temperature (TMA, 2016)

Furthermore, an analysis showed that the minimum temperatures have been above 22.3°C from 2009 to 2015 (Figure 4). Also annual maximum temperatures show inter-annual variability from 1985 to 1999 and increased above 30.8°C from 2000 to 2015 (Figure 5).

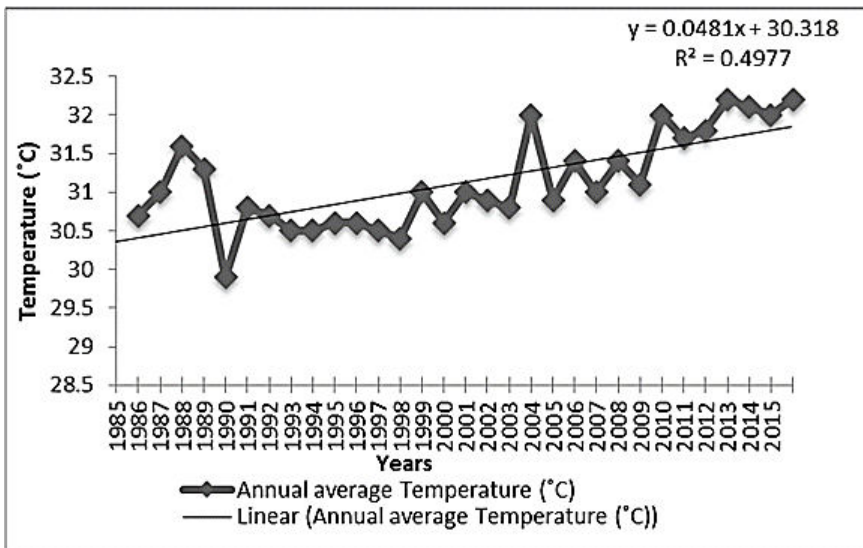


Figure 5 Minimum annual average Temperature (TMA, 2016)

Responses of men and women to water insecurity in the study area

Table 2 shows that women’s response to water insecurity is different from that of men. During the household survey women reported that because managing water was their responsibility they were supposed to check water regularly in their households. They were supposed to ensure that their households had enough water for all indoor purposes such as cooking, drinking, bathing and washing dishes. Women described various ways strategies including regular checking of water, reminding their husbands to budget for water and increased frequencies of collecting water per day.

In cases where there was no supply of pipe water for a long time (i.e. a month or several weeks) women reported that they were forced to find drinking water from hand dug wells. Women explained that during such times, they had to walk long distances with their daughters to find water, while boys and their fathers use mostly bicycles or motorcycles to obtain water from nearby village sources.

Furthermore, it was revealed that during extremely high temperatures, women placed drinking water outside their houses at aerated cool places to reduce evaporation. They further reported mixing ice with saltwater to reduce salinity, as well as filtering and boiling of drinking water to reduce waterborne diseases. The majority of women reported using these techniques during the dry season and when temperatures were very high.

During the FGDs, women reported that water uses were categorized according to their importance. Drinking was the first priority, cooking was second, and then other uses followed. They further added that they did not use piped water for cooking, bathing and washing dishes. They used piped water for drinking due to the costs of this water (200 Tanzanian shillings per 20 litres). Saltwater was used for washing dishes, clothes and bathing, whilst water from local dams was used for watering plants, bathing, washing clothes and construction activities. Furthermore, women reported that they performed some household activities themselves to reduce frequencies and costs of fetching water. They did not let other household members do them because as women, they knew how to manage water more effectively. The strategy was highly used during dry seasons when water availability from various sources was scarce and required careful management.

Moreover, women reported that since they were assigned most of indoor responsibilities, like cooking, washing clothes, caring for children, maintaining household hygiene and washing dishes, they knew that significant quantities of water were needed per day.

Table 2. Responses to water insecurity (n=97)

Responses	Men	%	Women	%	Total	%
Regular checking of water	0	0	10	10.3	10	10.3
Prioritizing water uses	1	1	12	12.4	13	13.4
Increasing frequencies of fetching water	1	1	5	5.2	6	6.2
Mixing ice with saltwater to reduce salt	0	0	8	8.2	8	8.2
Filtering and boiling water	1	1	2	2.1	3	3.1
Increasing water storage	0	0	12	12.4	12	12.4
Fetching water from far sources	7	7.2	9	9.3	16	16.5
Ordering water from local vendors	22	22.7	1	1	23	23.7
Digging local reservoirs (dam and ponds)	2	2.1	0	0	2	2.1
Drilling wells	4	4.1	0	0	4	4.1
Total	38	39.1	59	60.9	97	100

Source: Field survey, 2016

Discussion

The trend of water insecurity in the study area

Water insecurity has been increasing in the study area compared to 30 years ago. The findings from this study support the assertion that climate variability and change is contributing to this problem. Increasing saltwater is the major

issue that has decreased the quality of water in the study area. This is mainly due to intrusion of saltwater into groundwater aquifers, together with salinization of some springs as well as traditional wells along the shoreline. Salinization of the groundwater aquifer is highly associated with decreases in rainfall and prolonged drought events. This concurs with Linzey (2011) as well as Nadari and colleagues (2013) who indicated that decreases in local precipitation, excessive pumping and increases in drought events in coastal areas is decreasing groundwater recharge and resulting in the landward flow of saltwater from the sea.

Rainfall volume has also decreased over the past 30 years and its timing has become unpredictable. This is associated with early drying of water sources, including local dams and the River Kasiki. Both the long rains (*Masika*) and short rains (*Vuli*) have decreased in terms of the volume and became less frequent during 1999-2015. This does not differ much from the trends indicated by Funk and co-workers (2008) who revealed that rainfall in East Africa has been decreasing between March, May and June over the last three decades. This change in rainfall a pattern will eventually reduce water availability for economic and social activities.

Water is considered accessible if water sources are within 1,000 metres from the home and the time spent per round trip does not exceed 30 minutes (WHO, 2003; United Nations, 2010; Water Aid, 2012). In the study area, water is easily accessible to the majority of households. Despite water being very near, people use saltwater from drilled wells because piped water is very expensive and sometimes it flows for only a short time due to water rationing. In the past 30 years, people travelled long distances but they did not collect saltwater. Access to water was free compared to the present where people have to buy water.

In some cases, people walk long distances and spend many hours to find freshwater from hand dug wells, including from nearby village water sources. This is mostly done when public piped water is unpredictable or people have no money for purchasing water. Kudat and co-workers (1993) indicated that people are more likely to demand for certain attributes of water. However, even though water quantity is very important, sometimes it may not be useful for some purposes such as cooking and drinking. Moreover, water quantity used per day by most households is not enough for all activities. Gleick (1998) estimated that 50 litres of water are needed every day for each individual within the household; 25 litres are needed for personal consumption as well as sanitation; and another 25 litres are required for food preparation and bathing. Access to significant

water quantity is constrained by the costs of purchasing water, which are higher than household incomes in the study area. Nkonya (2010) showed that the household is water secure if it does not spend more than 3 percent of its income on buying water. In the study area, many households reported to spend more than 3 percent of their incomes for buying water

Responses undertaken by men and women pertaining to water insecurity in the study area

Men and women within the household employ different response strategies to water insecurity. Women respond by prioritizing water uses, checking water regularly, increasing household water storage, mixing ice with saltwater as well as increasing the frequency of fetching water. Men respond by digging local reservoirs, drilling wells as well as ordering water from local vendors. These results are similar to those identified in Dube (2014) which showed that women's response to climate change is different from that of men. Other strategies used by women include placing water in aerated cool places to reduce higher temperatures in drinking water, buying more water storage facilities, filtering and boiling of drinking water to reduce waterborne diseases as well as using wooden boxes to save some money to be used to purchase water during difficult times. Since women in the study area have the responsibility to ensure that their households have enough water for all indoor purposes (cooking, drinking, bathing and washing dishes), they are more affected by climate change and the resultant changes in water quality and quantity. They are therefore more adversely impacted by water insecurity than men, thus increasing their vulnerability. Studies such as that of WEDO (2003) and Brody (2008), showed that water insecurity will increase women's workloads as they will have to devote more time to collect more water for indoor purposes. Such time could be spent in earning an income, school or participating in public life. Walking long distances to fetch water can expose girls and women to harassment or sexual assault. Likewise, Hammond, n.d and Denton (2002) revealed that with increasing climate change extremes like drought, time taken to fetch water may entail young female household members to replace other household duties and hence missing schools.

Conclusion

This study provides empirical case study of gender and water insecurity in a coastal region; while most gendered analyses like those of Nelson and Stathers (2009) and Okuliet. *al.*, (2012) have focused more on semi- arid regions. Findings from this study support the assertion that water insecurity has been increasing in the study area in the past 30 years, like many parts of Tanzania.

Short rains and long rains are decreasing and have become less frequent. Compared to semi- arid regions, in coastal areas, saltwater is increasing due to saltwater intrusion into groundwater aquifers, coastal springs and traditional wells constructed along the coastline, thereby reducing quality water for human use. Water availability is also decreasing due to decrease in groundwater recharge, early drying of local dams, river as well as traditional wells the situation which is similar to that of semi-arid regions of Tanzania. People are spending more time and walking longer distances to find drinking waters than was the case before (thirty years or more).

Response strategies pursued by women to respond to water insecurity such as prioritizing water uses, mixing ice with saltwater, performing some of household activities themselves, placing water in aerated cool places to reduce temperatures in drinking water as well as saving money in wooden boxes for purchasing water seems to be different from response strategies used by women in semi arid-regions. Response strategies such as checking water regularly, increasing household water storage, fetching water from distant sources as well as increasing the frequency of fetching water are similar with those pursued by women in semi-arid regions. Men respond by digging local reservoirs, fetching water from distant sources using motorcycles or bicycles, drilling wells, as well as ordering water from local vendors.

Based on these findings, the study recommends that climate change adaptation measures, plans and policies should take into account the differences in the roles and responsibilities of men and women for water security at a household level and differing adaptation strategies between men and women's responses to water insecurity. Furthermore, climate change adaptation interventions to water insecurity should address gender vulnerabilities at the household level. The central government, non-government organizations, Local Government Authorities and other stakeholders should integrate gender issues into adaptation plans and strategies. Moreover, the study calls for appropriate stakeholders including Local Government Authorities, the central government, non-government organizations and other development practitioners to build on opportunities available in the area so as to develop adaptation strategies to water insecurity. These should include improving and expanding existing local dams, improving rainwater harvesting technologies, instituting desalinization technologies and drilling additional wells.

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References

- Babbie, E. (1983) *The practice of social Research*, Belmont: Wadsworth publishing company.
- Bagamoyo District Council. (2006). *The Bagamoyo District Profile*, Bagamoyo District: Tanzania.
- Bates, B. C., Kundzewicz, Z. W., Wu, S. and Palutikof, J. P. (2008) *Climate change and water, Technical paper of the Intergovernmental Panel on Climate change*, Geneva: IPCC secretariat.
- Bonte, M. and Zwolsman, J. J. (2010) *Climate change induced salinization of artificial lakes in the Netherlands and consequences for drinking water production*, *Water research*, 44(15), 4411-4424.
- Brody, A. (2008) 'Gender and climate change'. *Mapping the linkages as scoping study on knowledge and gaps*, Cambridge: Cambridge university press.
- Cutter, S. L. (1995) *The forgotten casualties: women, children and environmental change*, *Global Environment*, (5), 181-194.
- Denton, F. (2002) *Climate Change Vulnerability, Impacts and Adaptation: Why does gender matter? Gender and Development*, 10 (2), 10-20.
- Dube, S. (2014). 'Support women to build their adaptive capacity and resilience, Conflict sensitive Adaptation', *Use Human Right to build social and Environmental Resilience*, Brief 9, Indigenous peoples of Africa Coordinating Committee and Commission on Environmental, Economic and social Policy. Retrieved from http://cmsdata.iucn.org/downloads/tecs_csa_9_support_women_build_their_adaptative_capacity_and_resilience_dube_.pdf (accessed 12 July 2016).
- Food Agricultural Organization (FAO) (2007) '*People- centered climate change adaptation, integrating gender issues*, available: <ftp://ftp.fao.org/docrep/fao/010/a1395e/a1395e00.pdf> (accessed 8 June 2016).
- Fayer, R., Trout, J., Lewis, E., Xiao, E., Jenkins, M. and Graczyk, T. (2002). *Temporal variability of Cyptosporidium in the Chesapeake Bay*, *Parasitol*, (88), 998-1003.

- Funk, C., Dettinger, M. D., Michaelsen, J. C., Verdin, J. P., Brown, M. E., Barlow, M. and Hoell, A. (2008). *Warming of the Indian Ocean threatens eastern and southern African food security but could be mitigated by agricultural development*, Proceedings of the National Academy of Sciences of the United States of America, V.105, (32), 11081-11086.
- Gleick, P. H. (1998) *The World's Water 1998-1999*. Washington, DC: Island Press.
- Global Water Partnership. (2000). *Towards Water Security: A Framework for Action*. Stockholm: GWP.
- Goh, A. H. (2012) *A literature review of the Gender- Differentiated Impacts of climate change on Women's and Men's assets and wellbeing in Developing countries*, CAPRI working paper No.106, Washington, D.C: International food policy Research Institute.
- Grey, D. and Sadoff, W. (2007) *'Sink or swim? Water security for growth and development*. New Delhi: IUCN.
- Guy Howard and Jamie Bartram. (2004) *Domestic Water Quantity, Service Level and Health*, World Health Organisation, p. 22.
- Hagen, H., Middlel, A. & Pijawka, D. (2016) *Global climate change Risks and Mitigation Perceptions: A comparison of Nine countries*, Journal of sustainable Development, 9 (5), 214-228. <http://dx.doi.org/10.5539/jsd.v9n5p214> (accessed 17/6/018).
- Hammond, V. (n.d). *Gender, Climate Change and the United Nations: a gender analysis of climate change and recent United Nations Framework Convention on Climate Change agreements, with particular reference to their implications in Sub-Saharan Africa*, University of Oxford.
- Hay, J. E. and Mimura, N. (2005) *Sea level rise: Implications for water resources management, Mitigation and Strategies for Global change*, (10), 717.
- Intergovernmental Panel on Climate Change (2014a). *Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, United Kingdom: Cambridge University Press.
- Intergovernmental Panel on Climate Change. (2014b) *Climate Change 2014 Synthesis report, Approved summary for Policy makers*, United Kingdom: Cambridge University Press.
- Intergovernmental Panel on Climate Change. (2007). *Impacts, Adaptation and vulnerability*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge: Cambridge University Press.

- Intergovernmental Panel on Climate Change (2001) *Climate change 2001: Impacts, Adaptation and Vulnerability*, summary for policy makers, Cambridge: Cambridge university press.
- James, G.L., Ngana, J.O., Liwenga, E. & Faustin, M.(2013) *Climate change, impacts and adaptations in the coastal communities in Bagamoyo District*, Journal of Environmental Economics, 4(1), 63-71
- Kates, R. (2000).“Cautionary Tales: Adaptation and the Global Poor.” Climatic Change, (45), 5-17.
- Kundzewicz, Z. W., Mata, L. J., Arnell, N. W., Doll, P., Kabat, P., Jimenez, B., Miller, K. A., Oki, T., Sen, Z. and Shiklomanov, I. A. (2007) Impacts, Adaptation and Vulnerability: *Freshwater resources and their management*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, Cambridge University Press, pp. (173-210).
- Linzey, D. (ed.). (2011) *Salt water intrusion and climate change: A primer for local and provincial decision makers*
[http://atlanticadaptation.ca/sites/discoveryspace.ucei.ca.acasa/files/Salt water%20Intrusion%20and%20Climate%20Change%20in%20Atlantic%20Canada.pdf](http://atlanticadaptation.ca/sites/discoveryspace.ucei.ca.acasa/files/Salt%20water%20Intrusion%20and%20Climate%20Change%20in%20Atlantic%20Canada.pdf) (accessed 15 March 2016).
- Mahongo, S. B. (2009) *The changing Global Climate and its Implication on Sea Level Trends in Tanzania and the Western Indian Ocean Region*, *Western Indian Journal of Marine Science*, 8(2), 147-159.
- Mboera, L., Mayala, B., Kweka, E. and Mazigo, H. (2011) *Impacts of Climate Change on human health and health systems in Tanzania: a review*, *Tanzania journey of health research*, 13(1), 1-21. doi: <http://dx.doi.org/10.4314/thrb.v13i1.10>.
- Mkama, W., Msuya, S., Mahenge, J., Mposo, A, Jason, A. N., Amanzi, A., Chausiku, A. and Kundengukila, F. (2013) *Bagamoyo District Coastal Climate Change Rapid Vulnerability and Adaptive Capacity Assessment*, Bagamoyo District, Tanzania. Coastal Resources center, University of Rhode Island, Narragansett, RI, 26 pp. 17-33.
- Nadari, M., Kermani, M.R., and Burani, G. (2013) *Seawater intrusion and groundwater resources management in coastal aquifers*. European Journal of Experimental Biology, 3(3), 80-94. Retrieved from <http://www.imedpub.com/articles/seawater-intrusion-and-groundwater-resources-management-in-coastal-aquifers.pdf>. (accessed 25 May 2016)
- Neelormi, S. and Ahmed, A. (2011). *Contribution on Gender and Adaptation Status in Bangladesh*: Contribution to Second National Communication, Center for Global change.

- Nelson, V. and Stathers, T. (2009). *Resilience, power, culture and climate; a case study from semi-arid Tanzania and new research direction*, Gender & development, 17 (1), 81-94. doi: 10.1080/13552070802696946 (accessed on 21/6/2018).
- Nicola, J. and Rebecca, H. (2010). *Gender inequality, risk and vulnerability in the rural economy: Refocusing the public works agenda to take account of economic and social risks*, Background report for SOFA 2010. Retrieved from <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/6070.pdf> (accessed 15 February 2016).
- Nkonya, L., K. (2010) *Realizing the Human Right to Water in Tanzania*; Human Rights Brief, 17, (3), 25-30.
- Pauline, N. P. (2015) *Living with Climate Change and Variability: Lessons from Tanzania*. PhD Thesis Submitted at the University of the Witwatersrand, Johannesburg.
- Okuli, W., Mbwambo, J. and Magayane, F. (2012) *Gender and Adaptation Practices to the Effects of Climate change in Bahi and Kondoa Districts Dodoma Regions*, Dodoma: University of Dodoma.
- Olmos, S.(2001).*Vulnerability and Adaptation to climate change: Concepts, issues, Assessment Methods*.
<http://lib.riskreductionafrica.org/bitstream/handle/123456789/454/vulnerability%20and%20adaptation%20to%20climate%20change.%20concepts,%20issues,%20assessment%20methods.%20Santiago%20olmos.pdf?sequence=1> (accessed 8/7/2018)
- Roehr, U. (2007) *Gender, climate change and adaptation: introduction to Gender dimensions*, Berlin, Available: http://www.unep.org/roa/amcen/Projects_Programme/climate_change/PreCop15/Proceedings/Gender-and-climate-change/Roehr (accessed 13 December 2015).
- Shemsanga, C., Omambia, A and Gu, Y. (2010) *The Cost of Climate change in Tanzania: Impacts and Adaptations*, Journey of American Science, School of Environmental studies, 6(3), Wuhan: China University of Geosciences.
- Stockholm Environment Institute. (2013). *Using climate information to support adaptation planning and policy making: A practical case in Bagamoyo District, Coastal Tanzania*. Stockholm: Climate System analysis Group.
- Tobey, J., Mkama, W. and Robadue, D. (2012) *Village Vulnerability Assessment and Adaptation Planning, Mlingotini, Bagamoyo District*, Coastal Resources center, University of Rhode Island, Narragansett, RI, pp. 23.

- Tobey, J., Robadue, D., Shaghude, Y.W., Muhando, C., Kalangahe, B., Mahenge, J and Daffa, J. (2013). *State of Mbegani Bay: The Ecosystem, Livelihoods, and Future Status*, Tanzania, Coastal Resources Center, Graduate School of Oceanography: University of Rhode Island.
- United Nations Fund for Population (UNFPA) (2009) State of world population report. Facing a changing world: Women, Population and Climate. The United Nations Environment Programme. Worldwatch Institute (p. 94).
- United Nations Environmental Programme (2007) *Assessment of Transboundary Freshwater vulnerability in Africa to climate change*. http://www.unep.org/dewa/Portals/67/pdf/Assessment_of_Transboundary_Freshwater_Vulnerability_revised.pdf (accessed 11 June 2016).
- United nation, High Commissioner for Human rights. (2010) *Climate change and the Human Rights to water and Sanitation Position paper*, Available: http://www.ohchr.org/Documents/Issues/Water/Climate_Change_Right_Water_Sanitation.pdf (accessed 15 December 2016).
- United Nations Development Programme. (2009) Resource guide on gender and climate change, United Nations Development Programme, Printing: A. K. Office Supplies, Ltd (p.133).
- University of Oslo. (2013). *Proceedings of Transformation in a Changing Climate*, 19-21 June 2013, Oslo: University of Oslo.
- Urama, K. and Ozor, N. (2010) *Impacts of climate change on water resources in Africa: The Role of Adaptation*, African Technology policy studies Network, Available: http://www.ourplanet.com/climate-adaptation/Urama_Ozorv.pdf (accessed 10 March 2016).
- Wandiga, S.O., Kathuri, J., Opondo, M., Olago, D., Apindi, E., Olaka, L., Githeko, A., Githui, F., Opere, A., Ogallo, L., Marshall, M., Downs, T., Yanda, P.Z., Kangalawe, R., Sigalla, R., Kabumbuli, R., Kiramura, E., Mugambi, P., Nanyunja, R., Baguma, T., Achola, P. (2006) *Climate Change Induced Vulnerability to Malaria and Cholera in the Lake Victoria Region: Final Report for Project No. AF 91*, Washington, DC, Available: http://www.start.org/Projects/AIACC_Project/Final%20Reports/Final%20Reports/FinalRept_AIACC_AF91.pdf.
- WaterAid. (2012) *Water security framework*, London: Water Aid.
- Webb, P. (nd). *Food Insecurity in Developing Countries: Major Challenges for the 21st Century*, Food and Applied Nutrition Program Discussion Paper No.29. World Health Organization. (2003) *The Right to water*, Geneva

http://www2.ohchr.org/english/issues/water/docs/Right_to_Water.pdf
(Accessed 12 July 2016).

WEDO. (2003). *Common Ground, Women's Access to Natural Resources and the United Nations Millennium Development Goals*, New York: WEDO
http://www.wedo.org/files/common_ground.pdf (accessed on 16 September 2017)