Extractives, climate and health equity

Trends in water resources in east and southern Africa

R Loewenson, Training and Research Support Centre in the Regional Network for Equity in Health in East and Southern Africa (EQUINET)[1]

May 2020

Background

This brief is produced as part of the scoping work in the Regional Network for Equity in Health in east and southern Africa (EQUINET). Co-ordinated by TARSC, SATUCC and SEATINI, it aims to use scenario planning to explore the distributional consequences for current and future wellbeing of projected trends in extraction of water, minerals, biodiversity and genetic materials and of climate change, to promote understanding and dialogue on how different choices made today can influence these different long-term outcomes. This paper focuses on water as a resource and presents

- The current situation and projected trends related to water in east and southern Africa (ESA).
- The implications for the wellbeing of current and future generations of these trends.
- The policy choices and alternatives to respond to these trends and the factors that influence policy design and uptake of choices.

Key messages

Water resources are unevenly distributed in the region, with abundant water in the Congo River basin, physical water scarcity in southern Africa and economic water scarcity elsewhere. Water scarcity is exacerbated by weak rainwater harvesting, limited renewal of groundwater and limited water conservation. Maldistribution and water scarcity and stress are predicted to intensify in coming decades. Southern countries will become significantly drier and east Africa will have higher rainfall. Climate change will amplify existing variability but may be less critical than growing demand for water. A growing, urbanised population, expanded enterprise and agriculture will deplete and can pollute water resources, with lowest income households least served.

Water scarcity contributes to ill health, food insecurity, poverty and increases women's burdens. There is a potential for vicious or virtuous cycles between these impacts and water resources, depending on the policy choices made. Future water scarcity and inequality may stimulate conflict and mass migration, but may also raise demand for co-operation.

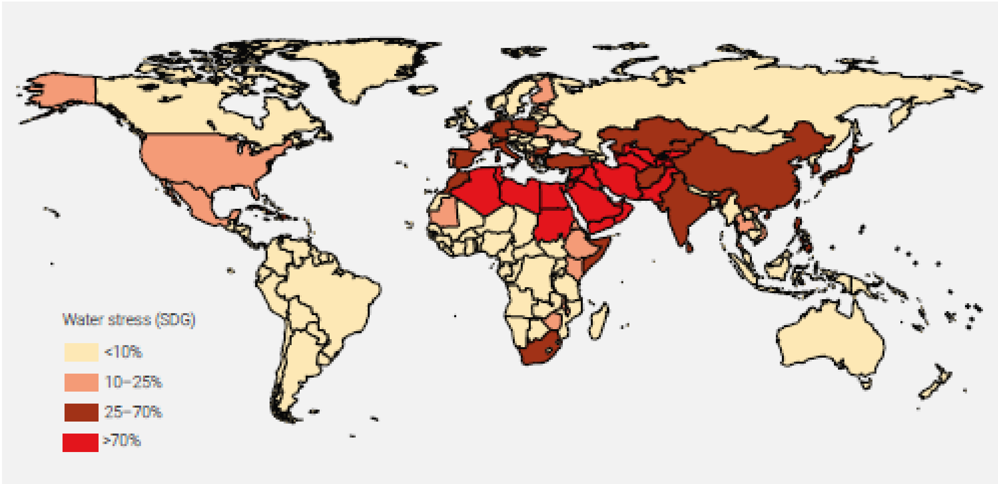
Inequality and stress is not inevitable. There is potentially adequate water to meet the basic needs of all in the region and for sustaining ecosystems if managed through co-operation, paying attention to equity, interdependence and long-term outcomes. It is already recognised that 'business as usual' will lead to potentially disastrous consequences and that policies and programmes need to balance environmental, social and economic objectives. There are options: they involve regional co-operation and inclusive participatory local management; water-basin and holistic approaches and a range of technological innovations (detailed in the paper). Depending on how different cities grow in the region, there are options for reliable, adequate, contamination-free access for drinking while providing water for other uses and ways of preventing water contamination by enterprises and households. These options do demand resources but this is more a political than a technical issue. The dividends from investments in water systems thus need to be made more visible as well as the harms of competitive, short term choices.

Tomorrow isn't built in a day: actions need to be planned, sequenced, implemented, monitored and widely reviewed. Evidence on current and projected water resources should be publicly available to build demand for effective responses, together with information on the alternatives that indicate that something can and should be done.

[1] With acknowledgement of R Machemedze for peer review and Training and Research Support Centre, Open Society Foundation and Medico Int. for support.

The current situation and projected trends in water resources

Figure 3. Levels of water stress by country (%) (2000–2015)



In 2015, UN Water estimated that the average water stress globally was almost 13%, although with wide variations across regions and countries. As the adjacent figure shows, while the ESA region generally had a lower level of water stress than other regions, water stress was higher in the south of the region (UN water, 2018:35).

The terms green water and blue water are sometimes used to identify types of water. *Blue water* refers to the liquid water in streams, rivers, wetlands, lakes and aquifers that can be extracted for human use, such as irrigation and domestic use. *Green water* stands for the rain-fed soil moisture, a water source available to plants. Globally, the water consumed in agriculture is 78% green water and 22% blue. Municipal and industrial consumption is mainly blue water (Mats, 2011:3)

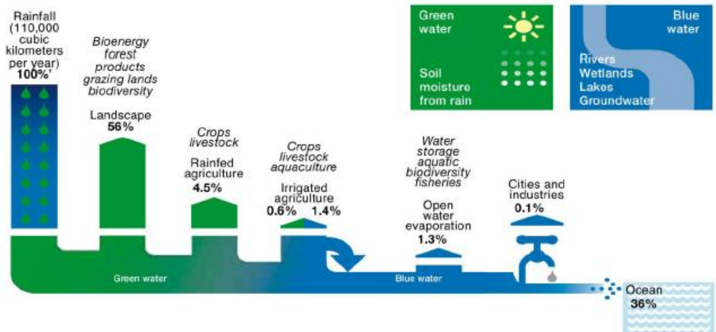


Figure 1 | Global water use by sectors, showing consumptive water use of water-infiltrated rainfall, green water, and of water from surface water bodies and aquifers, blue water.[2]

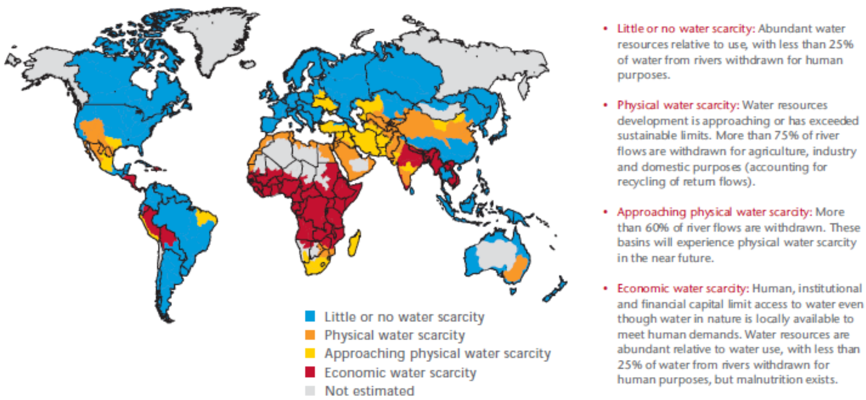
Africa has 17 rivers as blue water sources with catchment areas greater than 100 000 km^2 and more than 160 lakes larger than 27 km^2, most of which are in the equatorial region and in the East African Highlands within the Rift Valley. This generates water interdependency, with significant flows downstream to countries outside the source borders. For example, 94% of river water in Botswana originates outside its borders. This makes co-operation across countries a key feature of regional water systems, discussed later (UN Water Africa, undated).

Water resources are unevenly distributed across the continent. About 50% of total surface water on the continent is contained in the Congo River Basin, in the ESA region. The Zambezi is a second major river basin in the ESA region. In the region, the most annual renewable water is found in the Democratic Republic of Congo (DRC), Madagascar and Mozambique. Yet, as discussed later, countries with most water resources are not the greatest water consumers, with Madagascar and South Africa top consumers (Revenga and Cassar undated).

Groundwater is important in the region. It is estimated that over 40% of Africans use groundwater as their main source of drinking water, particularly in North and Southern African countries. Piped water is the most important source of urban drinking water, yet even here, boreholes are becoming more important. However, groundwater accounts only for less than 20% of the region's total renewable water resources, with only 9% of South Africa's renewable water resources from groundwater. The runoff from rainfall feeding useable and renewable surface water and groundwater resources in the region is very low. In Southern Africa, only 9.25% of total rainfall contributes to renewable water resources, given evaporation from surface water or plants and inadequate rainwater conservation, adding to water stress (UN Water Africa, undated).

Water stress can be understood to imply situations where there is not enough water for all uses, whether due to physical or economic factors. When annual per capita renewable freshwater availability is less than 1,700 cubic meters, countries begin to experience periodic or regular water stress. Below 1,000 cubic meters, water scarcity begins to hamper economic development and human health and well-being. The adjacent figure shows the level and forms of water stress in the region. Millions of people live in areas approaching physical water scarcity, with not enough water to meet all needs. An even greater number live in areas of economic water scarcity, where capacities and funds are likely to be insufficient to provide adequate water resources (Figure: WCBD, 2009: 8) While 10 countries had low levels of water stress (1-10%) viz: Angola, Botswana, Democratic Republic of the Congo, Lesotho, Madagascar, Mozambique, Namibia, Uganda, United Republic of Tanzania and Zambia, three countries - Kenya, Malawi and Zimbabwe - had higher water stress levels of 10-25%, and three others - Eswatini, Mauritius and South Africa - had even higher water stress levels of 25-70% due to physical scarcity. At the same time, most of the region had high levels of economic water scarcity, more so than in South Africa and Mauritius.

Areas of physical and economic water scarcity[15]



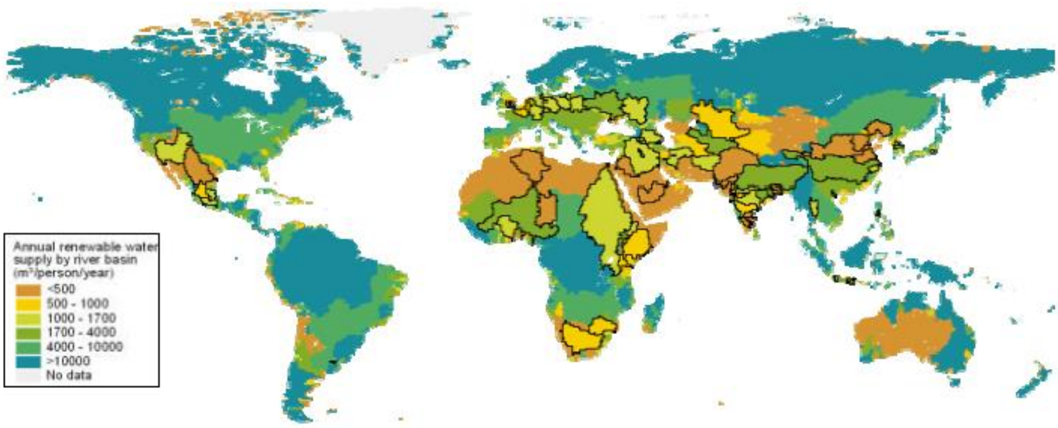
In terms of drinking water, progress has stagnated, with more people in the region without safe drinking water than in 1990. In 2005 only 58% of the population in SSA had access to safe drinking water. In rural areas, about 65% of the population did not access to an adequate supply of safe drinking water (UN Water Africa, undated).

So what will happen to these green and blue water sources in the future?

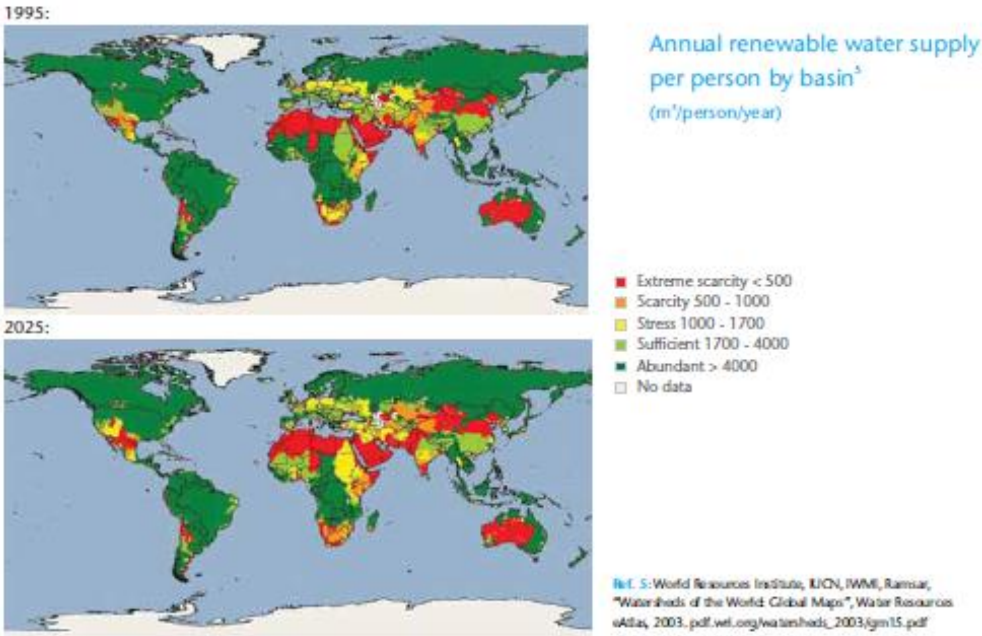
Water scarcity and stress will increase, more for some countries and areas than for others.

The figure below shows water scarcity projections globally, calculated by river basin for 2025. Of the 63 outlined river basins in the world that are projected to have more than 10 million people, 29 are already experiencing water stress and will descend further into scarcity by 2025, including the basin in southern Africa and the basin in East Africa, while the Congo River basin will continue to be well supplied (Revenga and Cassar undated). The maldistribution of water availability within the region is thus likely to intensify.

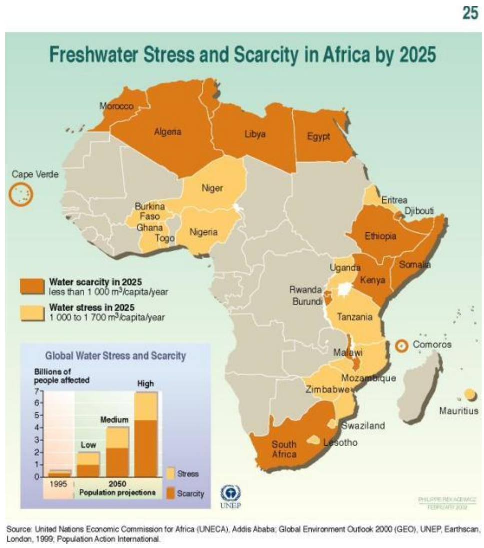
Projected Annual renewable water supply per person by River basin, 2025 In Revenga and Cassar, undated:2



A trend analysis indicates that stress will deepen in currently stressed areas and widens to new areas. (See the Figure adjacent, WBCSD, 2009:2). The projections are that both water scarcity and water stress will increase in the future.



Twenty-five African countries are projected to be water stressed by 2025, compared to 13 in 1995. By 2025, no fewer than 25 of the 48 countries that are expected to be facing water shortages will be African. This means that approximately 230 million Africans (16% of the projected population) will be living in water-scarce areas (with <1,000 cubic metres of water/capita/year), including South Africa, Malawi and Kenya in the ESA region. Another 460 million people (32% of the projected population) will live in water-stressed areas (with 1,000-1,700 cubic metres/capita/year), including in Mozambique, Zimbabwe, Lesotho, Eswatini, Uganda and Tanzania (see adjacent map; (UN Water Africa, undated).



The Africa Water Vision 2025 and UN studies project that the sustainability of water resources in the context of multiple trans-boundary water basins will be challenged by both climatic and natural phenomena and by human factors. The extreme variability of climate and rainfall in the region across areas and time, coupled with climate change, the shrinking of some water bodies and desertification are argued to present growing natural challenges. However, human activity is seen to be having an even more important and growing influence, with growing population and economic demand depleting water resources, including through pollution, environmental degradation and deforestation, discussed later.

Climatic factors will have different effects in different parts of the region

High variations in rainfall between and within countries and over time
In the last 30 years in southern Africa, the Lake Malawi basin, Southern Tanzania, and northern Madagascar have become wetter. In contrast, in the same period Mozambique, southeast Angola and western Zambia have become significantly drier, although with episodes of cyclonic rainfall and flooding in Mozambique. The frequency of drought has been increasing over the past 30 years, with significant socio- economic and environmental costs.

Wide variations in rainfall across and within ESA countries and annual/seasonal variations in rainfall (typically 40% around the mean) make rainfall more unpredictable, affecting surface water resources and limiting the input to low storage aquifers that depend on effective levels of annual rainfall (UN Water Africa, undated). The Intertropical Convergence Zone has a strong influence on climate in the region intensifying the unpredictability of and variation in rainfall, and indicating that this will continue into the future (UN Water Africa, undated).

However, as noted earlier, even where rainfall is adequate, high evaporation losses result in a weaker rainfall contribution to renewable water resources than in other continents, depending on the extent of conservation efforts, discussed later.

Climate change will amplify existing variability and may be less critical than demand side factors
In SSA climate change is predicted to affect availability of water resources through higher temperatures, more rainfall variability and greater frequency of extreme events. Rising temperatures could increase the rate of evaporation from surface waters and reservoirs and lead to the loss of freshwater held in glaciers. Climate change will alter the timing, amount and intensity of rainfall, while changes in temperature, radiation, humidity and wind speed will affect evaporation and thus surface and groundwater availability. Any increases in rainfall might come in the form of storms that lead to flooding and damage, doing more harm than good.

The effects are not simple, however, and will vary across the region. There is caution on making specific projections. In broad terms, however, water availability is expected to decrease in the dry tropics, but to increase in some wet tropical areas. Most of the ESA region except for the southern-most part of South Africa falls within the tropics. This reinforces the need to identify likely hotspots and to manage the variability of impact across the region. For areas experiencing less rainfall, the soil moisture stress is expected to increase, such as in southern Africa, affecting crop yields and food security. In contrast, in eastern Africa higher rainfall might potentially open up irrigation expansion and more water for domestic and industrial uses (Mats, 2011).

Over the next 30 years, reports thus suggest that the effects of climate change will not be uniform across the region. Indeed, climate change will amplify the variability that is already found in the region. Variability over seasons and years presents a challenge for water managers and may need different responses than managing scarcity. It makes it hard to design systems and provide assured and equitable supplies in both dry and wet seasons or years and to design infrastructure that works in both floods and droughts (Mason et al, 2017). However, these same projections also suggest that climate change may have less impact in the region on water resources than the impact of demand-side changes from human activity, discussed next.

A growing and urbanised population will significantly increase demand for water

A rising population will generate rising demand.
In the decade between 1990 and 2000 in Africa, the population increased by 27%, the highest growth globally, particularly in East Africa. This growth is projected to continue, as shown in the adjacent figure, with the urban population increasing three-fold by 2050 and the rural population by a third (Figure: Mats 2011:9). This population growth will increase the urban domestic water demand by as much as 650-1,300% by 2050, raising huge supply challenges in areas already facing the physical and economic water scarcities noted earlier (Mats, 2011). The projected 30% increase in the rural population at the same time will also place a significant demand for water for agricultural activities.

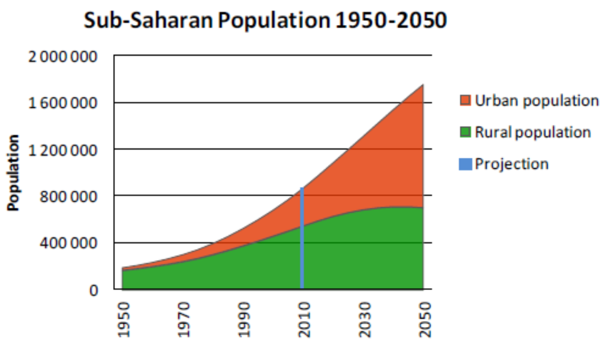


Figure 5| Sub-Saharan urban and rural population projections, medium projection.[11]

Rapid urbanization will accelerate demand. Urbanization requires significant investment in water infrastructure to deliver water to households and to process wastewater from individuals and from business (Mason et al, 2017). Assuming that the average per capita water supply in urban and peri-urban areas in SSA today is about 50 litres per person per day, this amounts to almost 6,000 million cubic meters per year. Reaching the optimal domestic water supply for public health and human needs set at 200 l per person per day with three times the urban population demands an increase of 1 300% in water supply.

Even halving the daily per capita supply to 100 litres calls for a 650% increase in supply over 40 years. Further, for the many ESA cities providing well below the recommended level and averaging only 50 l/person/day, the scale up will need to be even greater.

Increasing affluence in some communities and an expansion of business activities will further intensify this demand. Although family sizes may fall with increasing incomes, improved economic status is associated with higher water consumption, not only for domestic use but for gardens, car washing, or even private swimming pools (Mason et al, 2017). The expansion of industries, services and tourism also requires increased water services.

An aging infrastructure, if managed in current levels, will raise further costs, environmental risks and water wastage. Urbanisation and the deficits described earlier, call for a significant capital investment in water supply infrastructure and water treatment, especially given that easily accessible water sources have already been appropriated (Mats, 2011). For many ESA cities the infrastructure is already ageing, with breaks costing about 50% of water in lost water; seepage of sewer overflows into wastewater collection systems and untreated wastewater discharged into the environment (WCBSD, 2009).This is exacerbated by poor planning of new settlements, inadequate maintenance of installed equipment and infrastructure and limited capital investment, adding to the use of perverse incentives and inefficient technologies. In many African countries, loans for water supply often go towards rehabilitating installed facilities instead of expanding services, as a form of borrowing for maintenance, limiting the expansion of services to unserved populations. Private boreholes, bottled water and bulk water deliveries are more likely to be used by higher income communities, but withdraw the contributions and leverage of these communities from improvements to public systems. While economic growth may generate new resources for water, if the current approaches continue, this will leave significant numbers of households in new and unplanned settlements without adequate water services, even while water loss and pollution continues, further exacerbating inequality and risk (UN Water Africa, undated).

The region will face a continued and increased demand for water for agriculture

Agriculture will continue to be a key economic activity, both for domestic consumption by a growing and more urbanised population and for exports and to meet the current deficits in per capita food supplies for the currently under-nourished population. With improved agricultural output, a few upper middle income SSA countries shift from being deficit to surplus countries and from import to export. ESA countries with too little water for self-sufficient food production will, however, need to import food to address deficits, placing a demand on national incomes. By 2050, studies project that countries in the upper income groups will have the purchasing power to import food to compensate for water deficits, but that lower income countries will have difficulties with this option. By 2050, using a medium population projection, an average per capita food supply of 3,000 kcal / person / day, 20% of which comes from animal products and with baseline water productivity, the water deficit for food production in SSA will be 96% of the global deficits and will be so large that even exports from surplus countries will not be enough to meet the deficit. The food demand from water-deficit countries is projected to be seven times larger than the possible export capacity (Mats, 2011). As discussed in a later section, this can be moderated by practices that improve water productivity and yields, including through expansion and irrigation of croplands, although this may be at the cost of biodiversity losses and also depends on the rainfall patterns outlined earlier (Mats, 2011).

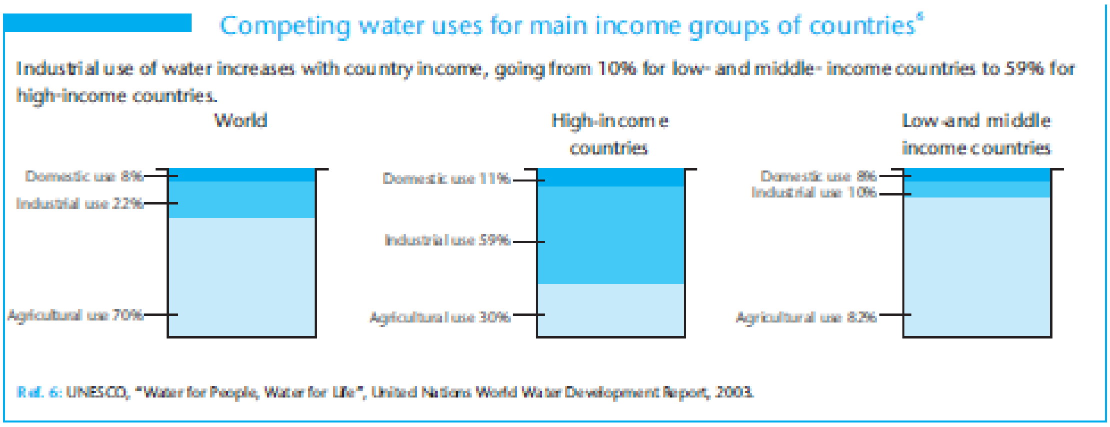
The projections suggest a growth in inequality between higher- and lower- income countries in the region experiencing similar levels of water scarcity, and even greater inequality given the economic drivers of water scarcity alluded to earlier. Equally within countries, in the absence of coherent universal and public strategies to address water for food production, rising costs of imported foods and rising levels of urbanisation may lead to greater food deficits in poorer households, or a reallocation of spending from other social investments to food purchases, acting as a poverty driver. Meat and dairy require more water than grains and vegetables to produce the same number of calories (Mason et al, 2017).

If current pricing and tax policies continue, any growth in household incomes may be associated with an increase in consumption of these higher water-demanding meat and dairy products. This increase in consumption is likely to be greater in higher- than lower-income households, providing a perverse natural resource subsidy to wealthier households. Availability of food and water will be a critical issue in the coming decades and, in the face of the above trends, will be a critical driver of socio-economic inequality.

If current trends continue, human and corporate actions will deplete water resources due to excessive withdrawals and pollution

People and corporates contribute to water stress by excessive withdrawal from surface waters and from underground aquifers. Water is used to make every product we produce. The term "virtual water" is sometimes used to describe the water that is used or embedded in agricultural and manufactured products and processes, including in exported goods, and the 'water footprint' the volume of freshwater used or consumed to produce the goods and services, including in the supply-chain for end chain operational processes (WCBSD, 2009)..

Global estimates see industry, thermal power cooling and domestic demand as key rising pressures on water resources by 2050, potentially raising water demand by 55%, set against finite water resources, even if they are renewable (Mason et al, 2017). In the largely middle and low income ESA countries, however, as noted above and in the graphic below, agriculture will place a much greater demand than in other parts of the world, raising the increase in demand, drawn from rivers, lakes and groundwater. The decisions on how economic activities are organised will affect the level of this withdrawal. For example, while agriculture will be a significant source of demand in ESA countries in the coming decades, water depletion is elevated in commercial export agriculture, where these activities are already resulting in the drying up of water sources (UN Water Africa, undated). The national water footprint assessment tool suggests that ESA countries with higher water scarcity like South Africa and Botswana (with very different populations) have a higher water footprint than better water-resourced east African countries or DRC, suggesting an imbalance between availability and use that will increasingly call for equitable regional approaches to secure the wider regional economy. The same is likely to be the case for high and low income communities and users within ESA countries.



Source: WBCSD, 2009:3

The current bias is towards exploitation of surface water and short-cycle renewable groundwater for economic activities, with less use of slower-to-renew and 'fossil' groundwater reserves, mainly as these are more expensive to exploit. However, there is already evidence of excessive withdrawal depleting aquifers. In the 10-year period 2003-2013, water levels fell in 21 of the world's 37 largest aquifer systems due largely to over-pumping for agriculture. Most of these aquifers underlie important agricultural regions (Mason et al, 2017). Poor irrigation practices, leakages and, inefficient use by industry and excessive consumption by individuals can all contribute to water stress (WCBSD, 2009).

The contribution of human and corporate activity to water shortages through pollution may improve- but also may not! Wastewater disposal in natural freshwater systems through industrial and agricultural activities, salinization due to over-pumping, the drying out of wetlands, the de-oxygenation of lakes due to sewage inflows and the proliferation of invasive aquatic plants all contribute to water shortages. If in small quantities, this pollution can be naturally broken down in rivers and lakes, but if safe limits are exceeded, water quality declines and the downstream water is no longer useable without expensive treatment (WCBSD, 2009).

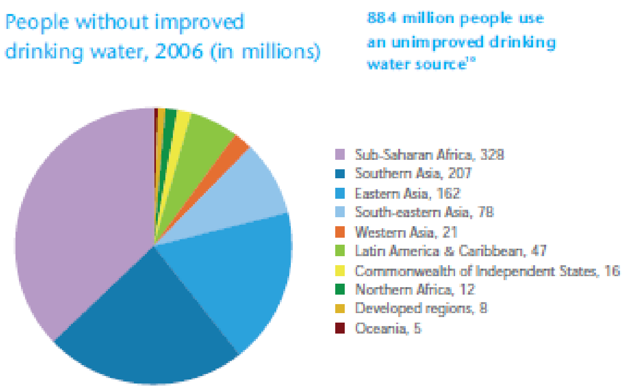
Increased pollution and the continued degradation of riverbank and wetland habitats that help to filter water are already exacerbating water scarcity in many regions globally (Revenga and Cassar undated). While visible pollution captures media attention, many forms of biological, faecal and chemical contamination are hidden or invisible, especially in groundwater supplies. Yet this contamination affects significant volumes of our water resources (Mason et al, 2017). While climate change is affecting water stress and scarcity differently in different parts of the regions, the pressure from degrading quality is widespread across the region, with pollution rendering water unusable for its intended purpose. Contamination may be expected to expand as populations, industrial and agricultural activities expand, unless monitoring and public awareness grows and processes integrate design improvements to reduce pollution. Globally there is likely to be an expansion of green technologies and production systems in future decades that may also expand in the region. There has, however, also been a history of 'dumping' harmful processes, technologies and products in lower income ESA countries and uptake of green technologies will be slow as cost presents a barrier. Here too inequality may grow, with different results in higher- and lower-income countries and communities in the region.

There is a two-way link between trends in water and trends in biodiversity. Loss of habitat due to water scarcity, pollution and water extraction have negatively impacted the conservation status of freshwater species. Over 1 000 vertebrate species that live exclusively in freshwater are threatened with extinction globally, with many of these extremely rare freshwater habitat types in Africa. Some freshwater dependent birds are found only in Madagascar, while freshwater river otters, pygmy hippos, Madagascar big-headed turtle or Namibia's cave catfish are also uniquely located only in these ESA countries, so that water scarcity may risk extinction of the species (Revenga and Cassar undated). A reduction in vegetation reduces the ecosystem's ability to recycle moisture back into the atmosphere, affecting rainfall and lake water for irrigation. These problems are expected to worsen in the coming years as population and economic demands increase (Revenga and Cassar undated).

Health and wellbeing impacts of current and projected trends

Water scarcity contributes to ill health, food insecurity, poverty and women's burdens

Clean water is essential for life, and for domestic and economic activities. Yet as the adjacent figure shows, SSA, which includes ESA countries, has the highest share of people living without improved drinking water globally and millions of people in the region do not have enough water to sustain their livelihoods, contributing to poverty, ill health and insecurity (Figure: WCBSD, 2009:6). Women spend a significant amount of time retrieving daily water needs from distant sources (Mats, 2011). In urban areas, low income communities may be close to water resources but lack the infrastructure or funds to access water.



Limited access to safe water has led to high levels of water-related diseases, including cholera, diarrhoea and bilharzia. These diseases reduce energy and productivity. They lead to nutritional losses, adding to other causes of food insecurity and household poverty. As shown in the adjacent figure, urbanisation and commercial food markets have changed dietary patterns in less than two decades (Figure: Mats 2011:12). Continuing a trend of recent decades, chronic undernutrition and food insecurity co-exists with childhood obesity and adult-onset of diabetes even in poor communities.

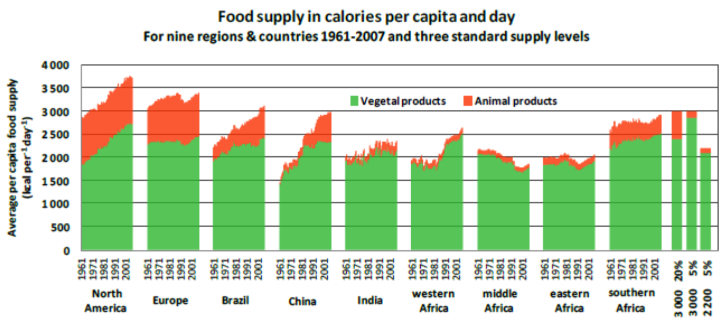
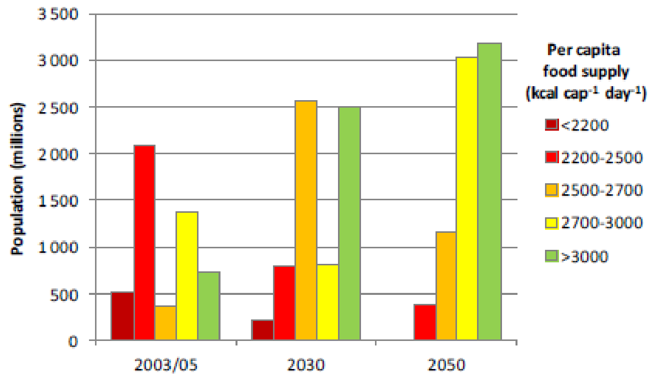


Figure 6| Per capita calorie food supply per day 1961-2007 separated into vegetal and animal calories for nine regions and countries, and three standard food supply levels for comparison.[18]

Urbanisation and dietary changes will raise water demand for food production, with variations in how far this demand is met.



As urbanisation progresses in the coming decades, if the region follows the paths of other regions, these dietary changes may gather speed, with higher calorie levels in the diet, more animal and fast food products and greater dependence on imported foods (Mats, 2011). The adjacent graphic shows the future projection of average per capita food supply for the population living in low and middle income countries, up to 2050 showing this increase (Figure: Mats, 2011: 16). In SSA, the average intake is expected to increase from 2 200 kcal/ person/ day in 2003/05 to 2 700 kcal / person/ day in 2050. While undernutrition is projected to fall from 220 million people in SSA in 2006/08, it is estimated that there would still be 130 million under-nourished by 2050 (Mats, 2011). Fish from rivers, lakes and wetlands are a major nutrient for people, especially poor people.

Under current demand and supply trends, cereal imports are expected to rise three fold in the next 25 years, in part due to the unpredictable rains, drought and water stress noted earlier. These trends imply that more water is mobilised for food production, as shown in the adjacent figure (Figure, Mats, 2011:16). It also implies, however, that food water requirements are reduced – will this be achieved? The trends indicated in the previous section suggest that water scarcity can constrain agricultural developments and food security, while the demand for expanded food supplies may exacerbate water scarcity.

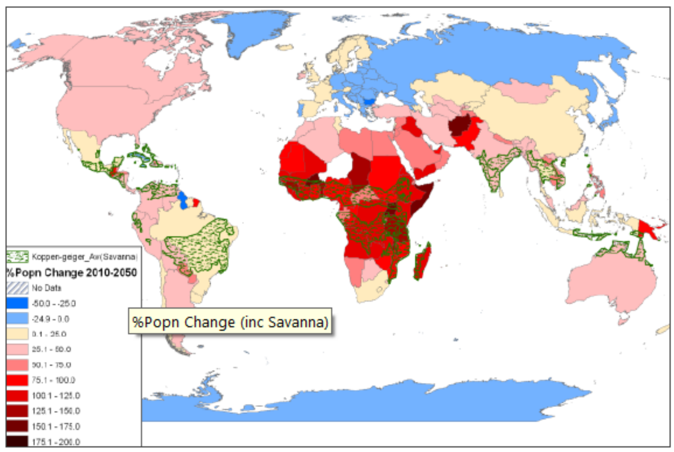


Figure 9| Water importance for future food production. The expected population increase and decrease in percent by 2050, overlaid with the savannah climatic zone.

This link is significant as agriculture is the largest user of water in Africa, accounting for about 85-88% of total water use, even though less than 10% of the region is under cultivation, and only 6% of this cultivated land is irrigated (Mats, 2011). Despite high levels of food insecurity in the region, most countries have substantial underutilized potential for irrigation expansion and there is also scope for expansion of rain fed agriculture. Crop failures, dying livestock, collapsed fisheries, and the continuous draining of lakes are expected to worsen as population and irrigation demands continue to increase.

The habitat degradation, overexploitation, and pollution noted earlier can lead to wild fish stock falling and depleting these resources without enhancements and restocking. Globally, polluted water is estimated to affect the health of more than 1.2 billion people, and to contribute to the death of an average 15 million children every year (Revenga and Cassar, undated). Arsenic and other chemical contaminants and the spill-over of faecal contaminants into shallow wells, boreholes and ground water affect health. Naturally present contaminants are also exacerbated by human activity including from mining, water abstraction and fertiliser use (Mason et al, 2017).

A combination of levels of technology, irrigation / rain fed development and production efficiencies may affect whether population demand, water resources and farming co-exist in a vicious or virtuous cycle in the region (UN Water Africa, undated). While a virtuous cycle has the potential to widen improved food security, a vicious cycle has the potential to widen inequalities in food security and quality and to further deplete the water resources and food intakes needed to improve socio-economic development in the poorest communities.

Rising costs and falling public funding can intensify socio-economic consequences of water scarcity, especially for poorer countries and communities.

Unmanaged water scarcity and risks is projected to pose significant costs to countries, communities and businesses (Mason et al, 2017). US$50 billion of investment is estimated to be needed annually in 2010 to 2030 to meet Africa's water deficiencies and US$ 30 billion annually for the following thirty years. There has been a near ten-fold increase in the estimated cost of water-related infrastructure to support economic growth, food and energy securities and adaptations to climate change and hazard management, and these cost increases are projected to continue (UN Water Africa, undated). Economic activities face rising costs to address scarcities, to mitigate groundwater pollution and to manage floods and droughts (Mason et al, 2017).

The past decades have seen growing fiscal constraints in most ESA countries leading to decreasing budgets for social services and safe water supplies, further undermining water access and intensifying the socio-economic consequences of water scarcity, especially for the poorest countries and communities in the region. Beyond its immediate effect on health, poverty and household and country food security, reports thus estimate that Africa is losing 5% of its gross domestic product (GDP) as a result of poor water and sanitation infrastructure, between 5%-25% to drought and floods, and perhaps a further 5% to the (future) impact of climate change (UN Water Africa, undated).

Water scarcity and conflict have been linked. Future scarcity and inequality may stimulate further conflict or co-operation.

Water insecurity is argued to have sparked violence within countries, particularly where drought has led to rising food prices and scarcities, or where people converge in queues around urban boreholes. The information is anecdotal and it is difficult to make direct links. However, when conflict and political instability undermines institutions, infrastructures and capacities it is reported to be harder to deliver water services and protect people from water-related disasters. People in fragile situations are reported to be more than four times as likely to lack basic drinking water. Displaced people may be cut off from water access and people displaced by conflict often migrate to countries with their own water challenges. For example, Kenya and Uganda are major refugee hosting countries, but face their own water scarcity and stress (Mason et al, 2017).

While these relationships between conflict, migration and water scarcity are not simple, a projection that by 2030 half of the world's poor people will live in fragile contexts, many of which are currently water scarce, suggests that they will become more important. The claim made by some that water scarcity and inequality in access and impacts will trigger new conflict may come to be (Mason et al, 2017). It could, however, also be a reason for countries and groups of people to cooperate. This will depend on the choices made to address the current and projected trends and their impacts. This is discussed in the final section.

Choices, responses and policies

*Among the many things I learnt as a president, was the centrality of water in social, political and economic affairs of the country, the continent and the world. (*Nelson Mandela)

Inequalities and stress are not inevitable

The differentials in the trends and capacities in the region suggest that there is potentially adequate water and means to meet the basic needs of all in the region and for sustaining ecosystems if planned for and managed. High water adequacy in DRC vs scarcity and stress in other ESA countries, higher rainfall in east Africa and reduced rainfall in southern Africa, a potential for greater rain to freshwater conversion and the whole region dependent on agriculture suggests that solidarity and regional co-operation can address these different challenges to the benefit of all (UN Water Africa, undated). At the same time, if the strategies do not promote equity, efficiency, and sustainability, including gender and intergenerational equity, there is a potential that inequalities will intensify within and between ESA countries.

Choices and strategies should be based on principles and attention to equity, interdependence and long-term outcomes.

Solidarity, equity, efficiency and sustainability thus represent key principles for the choice of strategies in the region, in line also with international principles on water management. The 1992 Dublin Principles and later Rio principles, state that:

1. Fresh water is a finite and vulnerable resource, essential to sustain life, development, and the environment. Water is thus not only an economic good but also a social good. As both economic and social good, the role of women in providing, managing and safeguarding water should be recognised, as should the rights of future generations.
2. Water has economic value and as an economic good, water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels.(UN Water Africa, undated).

These principles are reflected in the global Sustainable Development Goal (SDG) commitments. SDG 6 sets out that by 2030, countries will substantially increase water-use efficiency across all sectors; ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity, with participation of local communities. This implies, by 2030, achieving universal and equitable access to safe and affordable drinking water; reducing pollution, dumping and untreated wastewater, increasing recycling and safe reuse and protecting and restoring water-related ecosystems. It means increasing water-use efficiency, ensuring sustainable withdrawals and implementing integrated water resources management at all levels, including through transboundary cooperation. One target of the commitment to international cooperation is for support to developing countries in water--related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies (UN Water, 2018).

These principles and commitments have been adopted in Africa, with adequate water supply identified as a sectoral priority in the African water vision and NEPAD plans. These plans pay specific attention to ensuring enhanced irrigation and rainfed agriculture to improve agricultural production and food security and wetland conservation. The plans recognise that ‘business as usual’ at national and regional levels would lead to negative and potentially disastrous consequences, with a future where available water resources are inadequate to support competing demands over sustaining life, economic development and the environment (Revenga and Cassar, undated).

National, regional and continental sectoral objectives need to be assessed for their synergy with these water-related commitments and longer-term outcomes. For example, NEPAD's Energy objectives to exploit and develop the hydropower potential of river basins of Africa would need to be carefully assessed for the impact on ecosystems and equity in the distribution of benefit (Revenga and Cassar, undated). This is particularly important as activities with high economic returns that have maximized single objectives have been favoured in the past, such as abstracting water for irrigation schemes, draining wetlands, or erecting dams for electricity production. *This suggests a need for a new policy mindset in the region, reflecting a commitment to a balance in environmental, social and economic objectives.*

Improving gender and intergenerational equity also implies addressing patriarchal cultures that pose barriers to gender inclusive water planning and distribution, and that influence policy choices (Olagunju et al, 2019). Increasing the share of women and youth on water committees and promoting culturally appropriate ways to inform and involve both in water management can assist but is not enough. *There is need to explicitly assess, integrate in planning and monitor the different equity implications of policy choices.*

Implementing institutional arrangements that reflect regional co-operation and local inclusion

Implementing an ecosystem approach to water resources management means overcoming compartmentalized institutional approaches, entrenched institutional structures, local administrative boundaries and sovereign protectionism so that ecological units and systems can be managed in their entirety (Mason et al, 2017).

This too calls for change. The current approach to management of water resources is reported to be mostly fragmented and sectoral (Revenga and Cassar, undated). Fragmentation between states in water management systems dilutes traditional water sharing arrangements across boundaries and intensifies disequilibria in water use between upstream and downstream users. For example, building a dam to increase irrigation for cereal production may increase cereal yields in the upstream region, but can cause freshwater quality and quantity declines downstream, with a consequent loss of wetland fisheries, increased frequency of flooding events and other long-term development impacts (Mats, 2011). Fragmented water administration raises barriers to involvement of and access by disadvantaged groups.

As a principle, there is an understanding of the need to improve co-operation and team work across sectors and areas; to integrate transparency, accountability and involvement of all affected in decision-making; and to improve the assessment, monitoring, communication and management of impacts in the interest of common, mutually beneficial goals, including across generations (UN Water Africa, undated). The African Water Vision urges close vertical integration across administrative systems and countries, and close horizontal integration across sectors, with partnership, solidarity and measures to find and ensure mutual interests across sectors. This is particularly important for shared ecosystems and water basins, where the principles imply a shift away from provincial and district water administration to basin and sub-basin management in regional river-basin commissions and authorities. For example, the SADC Protocol on Shared Watercourse Systems proposes such cooperation over shared water resources in the region, while the Okavango River Basin Commission (OKACOM) organises this co-operation between Angola, Namibia and Botswana for the shared Okavango River (UN Water Africa, undated).

With sometimes competing public, market, national and intergenerational interests at play, institutional arrangements also need to ensure transparency, accountability, evidence- and demand-responsive approaches, mainstreaming equity, gender, youth and inter-generational concerns. This implies involving key groups, such as communities, women, youth, business and local authorities in consultation and decision-making in institutional structures, with authorities and resources for key aspects of management decentralised to the lowest appropriate level, including where appropriate to communities in participatory approaches. It also implies specific measures and processes to 'level the playing field' so that all participating countries/ stakeholders are able to negotiate on an equal footing for their shared and mutual benefit (UN Water Africa, undated).

These arrangements for regional co-operation and local inclusion will need to progress over time, managing the political tensions, shortfalls in expertise, resources, intention and public pressure that hinder their implementation. They need increased resources and effective regulation and incentives to change diverse stakeholder behaviours with respect to water.

Holistic approaches to development and management of water resources call for technological innovation, but also for new lenses, dialogue and demand

The water trends highlight that inequities in availability and access in ESA countries is not entirely a result of natural phenomena. It relates also to decisions on technology development, resource allocation and other policy choices on the development of water resources.

As a knee-jerk response to meet urgent water needs, national and sector leaders confronted by accelerating demand and water stress often implement short term measures or commission large infrastructure projects, such as the Lesotho Highland Water Project, planned to cost $8bn and transferring about 2000 million cubic meters of water from Lesotho to South Africa annually. There is evidence that investment in such large projects is resurging, with their visibility of 'concrete', money and prestige. For example, Ethiopia's Grand Ethiopia Renaissance Dam reservoir, funded in part by a bond issued to its citizens at home and abroad, will hold 74 cubic kilometres of water, more than thirty times the flow of the Thames in London. There is debate on whether these projects pay adequate attention to cost escalations, to future variability in supply and demand, or to risks to people and ecosystems (Mason et al., 2017). The Lesotho Highland Water Project has attracted critique of its limited compensation or benefit to local communities and possible link to HIV transmission through migrant construction workers (Reeh, 2012).

As noted earlier, there is a still unused potential for collecting surface run-off and for converting rainfall to renewable water resources. This includes initiatives to widen storage to balance natural and climate-change-related rainfall variability and demand. Small-scale rainwater harvesting offers an option for smallholder farmers, with small run-off collected in storage in dams, ponds and tanks for supplemental irrigation of crops during dry spells, or for continuous garden crops. Another option is to use the soil as storage for infiltrated rainfall, amplified by soil management to increase the infiltration and improve the water-holding capacity of soils (Mats, 2011). Other options exist: Drip irrigation uses plastic pipes to release water directly onto the roots of plants without flooding fields, recapturing any excess water for reuse (WCBSD, 2009).

These ideas emerge when there is dialogue between agricultural, irrigation, environmental, service and other communities, such as in the Dialogue for Food, Water, and Environment. In South Africa, for example, a '*Working for Water programme*' launched in 1995 joined these diverse lenses to find ways to achieve environmental, economic and social objectives. The programme aims to improve water flow in currently dry streams, restore native flora and fauna to rivers and to address socio-economic issues such as poverty alleviation and unemployment. The programme has taken steps to clear invasive species in water bodies that have high water uptake compared to native vegetation and takes a holistic, overall river basin approach to managing water flow. In bottom-up processes, it involves communities in active citizenship, enhances skills, provides job opportunities and in some cases offers childcare. The programme aims to shift 92% of current participants into higher paying permanent jobs in water-related areas such as fire management and ecotourism (Revenga and Cassar, undated).

Such programmes also demonstrate ways to address the long term sustainability of systems as a whole. This implies covering all aspects of water use, addressing irrigated agriculture, supporting fish stocks, freshwater biodiversity and the goods and services that humans derive from freshwater ecosystems, and rehabilitating rivers and lakes where damage has already been done (Revenga and Cassar, undated). The technical options are not only directly related to water. Changing to solar energy, for example, can reduce water consumption for energy production, mitigate climate change and provide affordable energy for domestic water and irrigation technologies, provided financing is made available to spread capital costs and enable poor farmers to access the technologies (Mason et al, 2017).

The options also need to address the link that will increase further in coming decades between water and food. Expanding the land under crops is one option. However, it implies replacing (and endangering) vegetation and ecosystems and requires sufficient rainfall and land that is suitable for cultivation, something that each ESA country has to assess (Mats, 2011).
The three countries with the most irrigation potential have each developed less than 10% of their potential irrigated area, indicating the scope for expanding irrigation to improve crop yields. There

is, however, an even greater scope for expansion of rain-fed agriculture (UN Water Africa, undated), There are also options, including different measures to increase water productivity ("more crop per drop"); to improve the efficiency of conversion of feed and fodder to animal products and in choices of less water intensive feeds (Mats, 2011). Reducing food exports reduces virtual water losses, while consuming less animal products can reduce water demand. *Annual food water requirements can be reduced by almost 70%, by improving water productivity, reducing water losses and reducing consumption of animal food products* (Mats, 2011)

Any country lacking the potential of full expansion of croplands or water resources to meet food demands will be in the most precarious situation, and might have to rely on food imports or food aid. This externalizes the water use for food production to meet food demands. Regional co-operation may help to balance the "virtual water" traded between countries in the region and to meet food needs as a region (Mats, 2011). Regional development plans and international solidarity can also help support countries less able to produce adequate food to develop other economic activities, to enable them to import foods to ensure national food security (Mats, 2011).

The growth in urban populations in the coming decades raises the challenge to meet rising demand and ensure delivery of safe water. Incentives and technological improvements can reduce water waste and improve the efficiency of investments in water- utilities (UN Water Africa, undated). 'Safely managed' services provide a step-change for households to achieve safe water needs, located on premises, available when needed and free from contamination. This implies moving from access to a type of technology, to a service of a certain quality and to address those who are unserved (Mason et al, 2017). Improving access to and quality of urban water supplies will increase domestic water consumption, as population growth and reliable water on-premises will surely lead to higher consumption, even if people use water more conservatively. It will also require more energy for pumping and treatment, and more infrastructure to deal with wastewater in urban areas (Mason et al, 2017).

While the capital demands on large cities to meet this will be significant, small cities may not be as 'locked' into established infrastructure networks, opening a window to find new solutions and to leapfrog conventional infrastructure technologies. Water needs to be moved to consumers, but it can be questioned whether it needs a big network, a big utility company to manage it; centralised treatment and fused waste streams after use treated centrally, whatever its purpose. These systems may fit in large urban areas due to economies of scale, but may not fit as well in the less planned growth in smaller cities or in informal settlements. There are legitimate questions about treating all water to an equal quality, whether it's used for drinking, or washing cars or about the merits of pumping water around 'big, leaky networks'. Investment and ideas for urban water systems that often flow from high-income countries and private sectors respond to investment opportunities of tapping into existing, publicly-funded capital infrastructure. However, depending on how different African cities grow, it is possible to consider other technological and management options for reliable, adequate, contamination-free access for drinking and water for other uses (Mason et al, 2017). "Gray (waste) water" can be brought to drinking quality standards by using new filtration technologies (WCBSD, 2009). Innovations in technology could enable households or neighbourhood blocks to treat water to drinkable quality in-situ, and use higher volumes of lower-grade water for other uses. The measures outlined next for reducing pollution of waste-water can improve the water volumes for reuse or recycling. Delegated management models could allow a single bulk-water provider to supply smaller service providers that have the local knowledge to manage 'last mile' provision, as settlements expand. (Mason et al, 2017).

Industry has an important role in this. Enterprises can measure and monitor water use and better understand the water "footprint" of the business, across the whole supply and production chain, to explore how to reduce water consumption per dollar of output, encouraging and where needed assisting those they deal with to do the same. Enterprises can work towards a goal of zero discharge by recycling and reusing water and reviewing production systems to select and use less toxic products to limit contaminants in all operations involving water. They can use more water-efficient production processes and use and invest in research and development for more efficient technologies for treatment and production, in partnership with government, municipalities, non-state organisations and scientific institutions (WBCSD, 2009).

Remediation of water contamination is more expensive and technically difficult than preventing it. As noted earlier, groundwater pollution can persist for decades, even after the polluting activity has stopped, calling for a precautionary approach. There are technical solutions to prevent or reduce pollution risks. They imply reviewing the use of fertilisers, sediments and pesticides in agriculture and the level of faecal waste seeping into ground and surface water, particularly in cities. This is not simply a technical issue- it often means challenging vested interests and getting political commitment to tackle issues that may be less visible or short term. As a start, groundwater reserves need to be monitored for quality and adequacy, including using remotely controlled hardware and digital systems, and the findings publicly reported to generate public and institutional demand for regulation and action (Mason et al, 2017).

Financing systems will need to make significant resources available to address equity and long-term investment needs, but this is more a political than a technical issue.

According to the African Development Bank, US$ 20 billion will be needed annually in the next 25 years to attain a minimum condition in the desired water future, with the bulk of this being for water supply for basic needs ($5bn), sanitation ($7bn), irrigation and water-productivity improvement ($4bn) and water for industry, energy and transport ($2.1bn). The other elements (flood and drought management; policy and institutional reform and capacity-building; knowledge and information; awareness and education and research and development) are all estimated to demand less than $0.5bn annually each (UN Water Africa, undated). Annual investments of US$ 10 per person living in urban areas in urban water infrastructure (backbone and last mile) appear to be a minimum amount to achieve substantial coverage increases GIZ, 2019). Given that limited financial resources have been a factor in the low level of water resources development in the past, this resource demand may be an increasing barrier to proactively addressing the future challenges raised in this paper, notwithstanding economic growth (UN Water Africa, undated).

Investments in water systems do yield dividends, however, and these need to be made more visible and politically clearer. Avoiding water-losses implies more efficient crop production and greater yields, while meeting water demand reduces household impoverishment and expenditures at all levels on treating water-related diseases. Investing in water systems reduces the costs of repairing preventable damage from floods, creates jobs and stimulates economic activity (Mason et al, 2017). While rarely priced in and poorly monitored, as an investment in long term ecosystems it provides future economic, social and natural resource benefit, whether in relation to human consumption, natural flood controls, nutrient cycling and retention, carbon storage, water filtering and storage, aquifer recharge, erosion control and protection of diverse natural species, food and material products.

Improving financial resources for these investments is not only a matter of more money. The returns on spending can be enhanced by improving the overall efficacy, professionalism, transparency and accountability of financing. The allocation of financing should include incentives for governance, adequate tariff levels and performance improvements, while integrating equity calls for efficient use of scarce grant finance to subsidize expansion of services to low income communities, with investment in appropriate technologies and earmarking of resources for the “last mile” extension of services into underserved areas (GIZ, 2019). While there is general policy agreement that any financing and cost-recovery methods need to be equitable, adequate and sustainable, this is not always delivered on in practice. The imbalance between cost and equitable access in some financing approaches and costs to poor communities and producers used has led to debates about the commercialization and privatisation of water and conflicts between water as an economic asset or a human right (UN Water Africa, undated).

With longer-term consequences of many current decisions on water systems overshadowed by preoccupations to fund immediate, visible issues, it is possible that resources may not be directed to investments that are either equitable or that promote sustainable resource use, shifting the burden and consequences to the next generation. As ESA countries move over time into being middle-income countries and even for low-income countries, progressively channelling taxes and tariff revenues to improve water systems and extend access is thus seen to be less a technical challenge than a political one (Mason et al, 2017).

This is also pertinent at regional and global level. Water rights and ownership of international waters are even less well resolved internationally and national interests can prevail over shared interests. While national and customary laws can help to deal with conflicts within countries, existing international laws are not adequate for fully addressing these conflicts between countries (UN Water Africa, undated). Within the region, competition for resources between countries can drive harmful responses, undermining the co-operation needed to resource and manage the water basin, natural resource and food security strategies to invest in technology development to meet rising demands from urbanisation, agriculture and industrial activity. The higher costs of not developing a regional investment strategy and of competitive and protectionist approaches may still emerge, however, including in large scale population movements downstream, as people turn to migration to manage ecosystem and economic stress (Mason et al, 2017).

Tomorrow isn't built in one day: actions need to be planned, sequenced, implemented, monitored and widely reviewed.

As noted earlier, while planning needs to be evidence-based and inclusive, with an open mind for new approaches and methods, the bigger challenge may be the invisibility of the long-term in the preoccupations of today. Investments have been more easily routed to concrete outputs that are visible within electoral periods than to less visible outputs like institutional processes and capacities or to investments that may prepare for and realise longer-term benefit. This is especially the case when there is inadequate collection, analysis and dissemination of evidence on water resources and ecosystems, and especially on these longer term challenges.

This suggests that more attention may need to be given to the 'when' (sequencing) and 'how' (method) of reform efforts, including how improvements are focused on lower income, underserved communities and less visible issues, even while general improvements and more visible changes keep wealthier communities and political actors engaged. For example, pro-poor reforms for water utilities in a number of African countries were found to start with wider performance improvements, building wider public support and opening the political space for strategies dedicated to poorer areas (Mason et al, 2017). Policies on water systems are a product of socio-political processes, and technology decisions are embedded in these processes. This implies not overly relying on engineering solutions (dams, water pumping facilities, desalination plants) and paying more attention to social strategies, such as the strategic design of reforms or how to widen awareness and enable current and intergenerational rights claims.

Given the time taken to yield benefit, strategies need to identify how to make visible more immediate gains, while longer term outcomes are in process. Reforms in access to piped water initiated in the 1990s in five African countries, for example, took between five and ten years to achieve the first substantial results, given the restructuring of public national water service providers, institutional frameworks and regulatory authorities to address adequacy, quality and equity shortfalls (Mason et al, 2017). Transformative shifts call for a widening of capacities and of actors from early adopters interested in water to others involved in a range of sectors, including agriculture, business, food, climate change mitigation, environments, urban planning, health and social movements, and the right balance of incentives, rewards and regulatory provisions to make voluntary or mandatory shifts in institutional behaviours.

It is possible that in coming decades, debates on economic transformation, natural shocks and rising population expectations will generate demand for attention to water. However, this attention also needs to be fostered. Information systems need to provide a more accurate picture to the public, professionals in diverse sectors and planning systems from local to regional level of the current status of, trends in and projections for water resources, demand and equity, to show performance against policy commitments, entitlements and goals (GIZ, 2019). While evidence is important for planning, it should also fuel public and political concern over water systems. Experience on areas like climate change suggests people can care deeply when they are confronted with evidence of threats to their health and wellbeing and that of their children, even when these threats are invisible or in the future. This is even more the case when visible signs can be linked to longer term harms, and more importantly, when feasible alternatives are shown to indicate that something can and should be done.

References

1. African Studies Centre Leiden (2012) Water in Africa, online resources, University of Leiden, Netherlands
2. GIZ (2019) Access to Water and Sanitation in Sub-Saharan Africa, GIZ, Germany
3. Mason, N., Le Sève, M., Calow, R. (2017) ‘Future flows: global trends to watch on water and sanitation’. ODI Working Paper 520. London: Overseas Development Institute.
4. Mats L (2011) Trends in water availability and accessibility and potential impact on nutrition in Africa, Mimeo, Stockholm
5. Olagunju A, Thondhlana G, Said Chilima J, Sène-Harper A, Compaoré N, Ohiozebau E (2019) Water governance research in Africa: progress, challenges and an agenda for research and action, Water International, 44:4, 382-407,DOI: 10.1080/02508060.2019.1594576
6. Reeh M (2012) Lesotho water project failed to cut poverty, critics say, DW Global ideas, online at https://www.dw.com/en/lesotho-water-project-failed-to-cut-poverty-critics-say/a-16182680
7. Revenga C and Cassar A (undated) Freshwater Trends and Projections: Focus on Africa, WWF International, Geneva
8. UN Water (2018) Progress on Level of Water Stress 2018 Global baseline for SDG indicator 6.4.2 , UN, New York
9. UN Water Africa (undated) Africa Water Vision 2025, ECA, AU and ADB, Addis Ababa
10. World Business Council for Sustainable Development (WBCSD) (2009) Facts and trends: Water, WBCSD, UK
11. Working for Water 2002. Working for Water Web Site Available on-line at : http://wwwdwaf.pwv.gov.za/wfw/
12. WRI (World Resources Institute) in collaboration with United Nations Development Programme, United Nations Environment Programme, and the World Bank. 2000. World Resources 2000-2001: People and Ecosystems: the Fraying Web of Life. Washington DC: World Resources Institute.
13. WRI (World Resources Institute) 2002. EarthTrends Website Statistitical Database available online at www.earthtrends.wri.org.

Klein Pella, Orange River, Northern Cape, South Africa, 2015