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Reducing drought emergencies in the Horn of Africa

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GRAPHICAL ABSTRACT

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ABSTRACT

Drought-driven humanitarian emergencies are becoming more frequent in the Horn of Africa where millions of people in this arid region face chronic water and food insecurity. Evidence from the region shows increasing reliance on groundwater supplies, infrastructure and institutional systems in response to decreasing rainfall. Drought emergencies can be mitigated by investing in resilience efforts that make safe water reliably available at strategic groundwater abstraction locations during cycles of water stress. A combination of early warning data, policy reform, asset management and improved rural water supplies and maintenance may enable rapid, responsive, and accountable water governance that is more cost effective than emergency relief and better positioned to absorb and adapt to shocks.

1. Drought and emergency

Drought-driven humanitarian emergencies are becoming more frequent in the Horn of Africa where millions of people in this arid region

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face chronic water and food insecurity (Viste et al., 2013; Shiferaw et al., 2014). The region has experienced increasing frequency and severity of drought conditions in recent years as a result of decreased spring rainfall (Lyon, 2014; Masih et al., 2014; Ahmadalipour and Moradkhani, 2018). The recent 2016–2017 drought in Kenya caused food insecurity for over 3 million people (Uhe et al., 2017). Preventable death and malnutrition hits hardest in the pastoral communities which have been politically marginalized since colonial times. UNICEF estimates that there are 19.5 million pastoral people in the Horn of Africa, of whom 40% survive on less than one dollar a day (UNICEF, 2006).

Drought emergencies occur when reduced rainfall, exacerbated in recent years by climate change (Funk et al., 2015), conspires with limited climate-proofed water infrastructure and accompanying community institutional failures to operate and maintain water services infrastructure. These convergences cause dramatic reductions in availability and access to adequate and safe water for people, livestock and agriculture. This lack of safe water may result in use of saline or fecally contaminated water previously considered unfit for human and livestock, crop stress and failures, livestock deaths, a deterioration in public health, economic shocks, herder-farmer conflicts, and displacement of people.

Historically, responses to drought have been *reactive*, involving international emergency assistance to save lives and livelihoods, through short term emergency programmes. Because of the increase in drought frequency, there is no longer enough time for pastoralists to recover their herds and crops in between droughts, thus the destabilizing impact increases with each successive event, leading to drought vulnerability, triggering resource-based conflicts and insecurity in this complex region of Africa. These humanitarian emergencies are preventable.

2. Increasing rainfall variability and groundwater demand

Recent evidence published in the Science of the Total Environment from this region demonstrates the interconnectedness of rainfall variability and reliance on groundwater resources and groundwater delivery infrastructure during drought conditions. In a recent study in northern Kenya and northern Ethiopia, we examined satellite remotely sensed rainfall against in-situ sensor-collected groundwater extraction data from 221 water points serving over 1.3 million people. We observed an overall 23% increase in borehole runtime following weeks with no rainfall compared to weeks preceded by some rainfall. Further, a 1 mm increase in rainfall was associated with a 1% decrease in borehole use the following week (Thomas et al., 2019). In another study also published in this journal, we examined the relationship between rainfall and community groundwater use in rural Kenya. We observed a 34% reduction in groundwater use during the wet season compared to during the dry season over the whole study area. Our observations also revealed substantial short-term changes in use of handpumps immediately following heavy rainfall (Thomson et al., 2019).

The empirical evidence from these studies highlights communities' shifting groundwater use patterns as a function of precipitation, which make effective management of groundwater resources and infrastructure even more critical. While decreased use of groundwater during precipitation may conserve resources, if the shift is to less safe water sources there will be public health implications.

3. The challenge of rural water service functionality

Drought-driven humanitarian emergencies can be reduced if groundwater is reliably made available, and its use facilitated, at strategic locations during cycles of water stress.

In the past decade, countries and international donors have spent millions of dollars to install thousands of groundwater pumping stations in the region in part to increase water security and reduce drought emergencies. Unfortunately these investments are failing to improve the dire situation in the region largely because these boreholes break down quickly, and are unavailable during the periods of greatest need (Hope et al., 2012; Nagel et al., 2015; Foster et al., 2018). New work, by us and others, has been done to enhance monitoring of boreholes toward improved functionality, but evidence shows that local communities and regional governments are not yet able to successfully manage the operations, maintenance and service delivery in this region (Butterworth et al., 2010; Moriarty et al., 2013; Koehler, 2018).

In Kenya, over half of rural water supplies were nonfunctional or dry during the 2016 drought, causing a ten-fold increase in the cost of water (UNICEF, 2017). In Ethiopia, the costs of emergency water trucking attributable to water system failures are estimated at over two thousand dollars per person over ten years (Godfrey and Hailemichael, 2017).

The combination of drought conditions and preventable water system failures increases water stress and the costs of emergency drought response and leads to poorer water quality. Therefore, a new approach to the use of strategic boreholes is needed to cost-effectively end drought emergencies in the Horn of Africa.

4. Government policy response

The Kenyan government's Ending Drought Emergencies — Common Programme Framework" (EDE-CFP), supports the integration of climate resilience, humanitarian relief, and development, acknowledging that, "The 2010–11 crisis in the Horn of Africa proved to be a turning point in drought management. It generated a commitment from governments and their partners not just to improve their future response once drought arises but to address the challenge of growing vulnerability. This emphasis on the structural causes of drought emergencies is the principal point of departure from previous drought management efforts in Kenya."

Under this framework the Kenya National Drought Management Authority, has several key response activities during drought emergencies: a) maintenance of groundwater boreholes, b) installation of temporary "dry-season" boreholes, particularly along migratory routes, and c) water trucking of purified drinking water to affected communities (Government of Kenya, 2015).

In Ethiopia, the government's Climate Resilient Water, Sanitation and Hygiene (CR-WASH) initiative includes a focus on investing in the capital infrastructure of deep boreholes and improved piped water systems with capacity building to sustain water services. The CR-WASH initiative was in part motivated by three consecutive years of drought in Ethiopia, that resulted in as many as 95% of water points running dry in Somali region. The GOE committed $5 billion dollars in 2018, over seven years, with supporting funds from international donors to create climate resilient improved water services (Wilson et al., 2018). As in Kenya, these sector specific investments are complimented by a broader set of investments aimed at reducing vulnerability and better managing drought, including the Government of Ethiopia's Productive Safety Net Programme (PSNP).

5. International policy support

In 2011–12, international donors and partners also collectively recognized that continuing to treat recurrent drought emergencies in the Horn of Africa as though they are anomalies is extremely costly in terms of lost lives and livelihoods, losses to national and regional economies and unsustainable humanitarian spending. In turn, this led to far greater development investment, including in the water, sanitation and hygiene sector, in areas of recurrent crises such as northern Kenya and the chronically vulnerable lowlands and highlands of Ethiopia that had long been treated as a perpetual humanitarian risk. This was embodied in new development investments aligned behind country-led efforts, first in the Horn of Africa in 2011–12 and then in the wake of a drought emergency in Sahelian West Africa in 2013. DFID's Braced program and USAID's Partnership for Resilience and Economic Growth (PREG) in Kenya.

Like USAID, the UK's Department for International Development also recognizes the importance of drought resilience in the Horn of Africa. The framing of DFID's July 2019 announcement of a £250M aid package for Africa as building climate resilience, shows that DFID approaches drought resilience through the broader climate lens, reflecting the increasing importance of climate change and carbon reduction as a political issue in the UK. The stated aim of this programme is to partner governments and institutions across Sub-Saharan Africa, to increase climate resilience and support the transition to lower carbon economies.

As part of this broader, cross-sector effort to build resilience to recurrent crises, USAID is focused on addressing the rural water service functionality challenge, so that communities are in a better position to absorb shocks when in drought periods. Through activities such as the Sustainable WASH Systems Learning Partnership (SWS), USAID is investigating how communities and their institutions can better deliver the necessary operations and maintenance services to keep improved water services running both before and during droughts (Lockwood, 2019).

Complementing these efforts, we are also using satellite connected sensors to monitor the water supplies of over three million people in arid Kenya and Ethiopia, expanding to over five million this year. These data are provided to the Ethiopia Ministry of Water, and Irrigation and Energy and the Kenya National Drought Management Authority and county governments in the hope of facilitating coordination with local governments to improve water services and reduce turn-around time in the event of breakdown during drought. Ongoing evaluations seek to establish the utility of such data. Further, supported by the National Aeronautics and Space Administration (NASA) we are linking this data with satellite-based Earth observation to improve water security forecasting.

6. Looking forward — improving drought resilience with local, national and international partnerships

Drought-driven humanitarian emergencies can be mitigated by investing in resilience efforts that make safe water reliably available at strategic locations during cycles of water stress. Experience shows that the damage caused by most droughts can be mitigated primarily by early warning, coupled with consistent functionality of water services, effective governance, and advanced planning that is informed by and executed in conjunction with pre-emergency data. These actions are likely to be more cost-effective than emergency relief investments. A 2018 study by USAID estimated that, over the long-term, each $1 invested in resilience in areas of recurrent crises would result in nearly $3 savings in averted losses and humanitarian need (USAID, 2018).

This combination of early warning data, policy reform, asset management and improved rural water supplies and maintenance enables rapid, responsive, cost-effective and accountable water governance that is better positioned to absorb and adapt to shocks. Future water management strategies should integrate more robust monitoring of water point functionality with known water quality to deliver water that is fit for purpose. This may require decentralized water treatment or water trucking to provide potable water for human consumption and desalination for saline water to be used in irrigation or animal management.

Our proposed approach to drought mitigation in the Horn of Africa incorporates emerging tenants in water management. A recent policy review in *Science* identified four of these tenants toward sustainable development of water resources 1. Improved measurement of watershed status and water use via remote sensing and local electronic sensors, 2. Valuation of water resources, 3. Improved decision-making, and 4. Improved water governance institutions and incentives (Garrick et al., 2017). Our approach embraces these practices and extends their utility to reducing water-related humanitarian crises.

Unfortunately, these proposed approaches do not presume to solve the underlying causes of drought, including climate change, population growth and increasing agricultural demands. Nor do they address the political economy of dependencies and power imbalances that may affect uptake of such approaches at various levels. Instead, through building institutional capacity, with technical and policy expertise to adapt to this changing and dynamic interplay, drought could instead be a manageable chronic condition which can be sustainably planned for and mitigated by the communities and countries which have the most at stake, while providing for more cost-effective investments when compared to emergency relief efforts.

While we can't end droughts, by ensuring water reserves and infrastructure are coordinated and available when needed, we can prevent droughts from resulting in large-scale, humanitarian emergencies in the Horn of Africa.

Declaration of competing interest

The authors are each individually employed at institutions that are engaged in drought relief efforts in East Africa as either implementers, policy makers, or funders.

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