The not-so-royal tour: impacts of farming on the quality of groundwater and surface water in Tanzania

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Abstract

A recent film, ***"Tanzania: The Royal Tour"***, portrayed Tanzania as the cradle of humanity. The film, starred by Tanzania's President, H.E. Samia Suluhu Hassan and recorded during the COVID-19 pandemic, indicates how vastly rich the country is in terms of natural resources. What is not shown, however, is that having riches of resources is one thing but the quality of such resources is a different phenomenon altogether. Natural resources such as groundwater and surface water are vulnerable to anthropogenic activities that take place in order to feed the world. Some of the recent assessment we conducted in different places Tanzania in the past 3 – 4 years indicated that farming and other were having an additive impact on the country's water resources. For this conference, we chose to showcase five assessments conducted in the Mara ecosystem, Manyara area, Zanzibar, and Kilimanjaro. In all cases, pollution was evident, calling for measures to combat unsustainable farming and water abstraction.

Introduction

Tanzania is known for its tourist attractions. The country boasts of the Serengeti, Kilimanjaro, Ngorongoro, and Zanzibar. Tanzania is also well known for its mineral resources in terms of gold, diamonds, copper, tanzanite, phosphate rocks, and even deposits of uranium. This vibrant natural resource industry requires another important natural resource whose sustainaibility is constrantly threatened by climatic changes and anthropogenic activities. This vulnerable resource is water – both in its surface and underground forms [2]. In the past two years we have conducted studies in Ngorongoro, the projections for future climatic changes indicated that the groundwater is expected to contain unsuitable amoounts of chloride and phosphate by the year 2036 [6]; we also conducted a study on the smallholder paddy irrigation at the slopes of Kilimanjaro with the results indicating that the irrigation water was causing a 'slight to moderate' infiltration problem due to high EC values [4]. In a small town of Babati, northern Tanzania our investigation indicated nitrate levels above 10 mg/L in groundwater samples collected close to agricultural fields and livestock keeping areas [3]. In the Mara River an ecosystem close to the Serengeti, a significant enrichment with respect to Cd and As was found in the river sediments [1]. In the same Mara ecosystem our earlier study had found that anthropogenic activities such as agriculture, livestock keeping, and mining were increasing the risk and vulnerability of both surface and groundwater system [2]. The situation on the islands of Zanzibar was even more alarming; high levels of contaminants in the groundwater driven by high rates of abstraction and changing climatic conditions in terms of rainfall and temperature [5]. Therefore, it is important to take immediate measures to reverse the impacts of human and natural activities on water resources of Tanzania and other places of Africa where similar conditions prevail.

Methods

The studies we are covering in this poster session were conducted from the following areas: the Mara River that originates in Kenya, passes through Tanzania and drains into Lake Victoria [1,2]; Manyara region of northern Tanzania [2]; the irrigated paddy plots on the slopes of Kilimanaro [4]; different groundwater boreholes on Zanzibar Island [5]; the Ngorongoro Crater [6]. In these six studies, surface and groundwater samples were collected using standard methods as stipulated in the American Public Health Association, American Water Works Association, Water Pollution Control Federation, and Water Environment Federation. Soil and sediment sample collection and analysis also followed standardized methods. For climate analyses, accuracy assessments were conducted accordingly followed through ground truth comparisons. Landsat satellite images were used to establish past, recent, compared to current land use and land cover changes. Standard environmental models were applied to establish the risk indices.

Results, discussion & conclusions

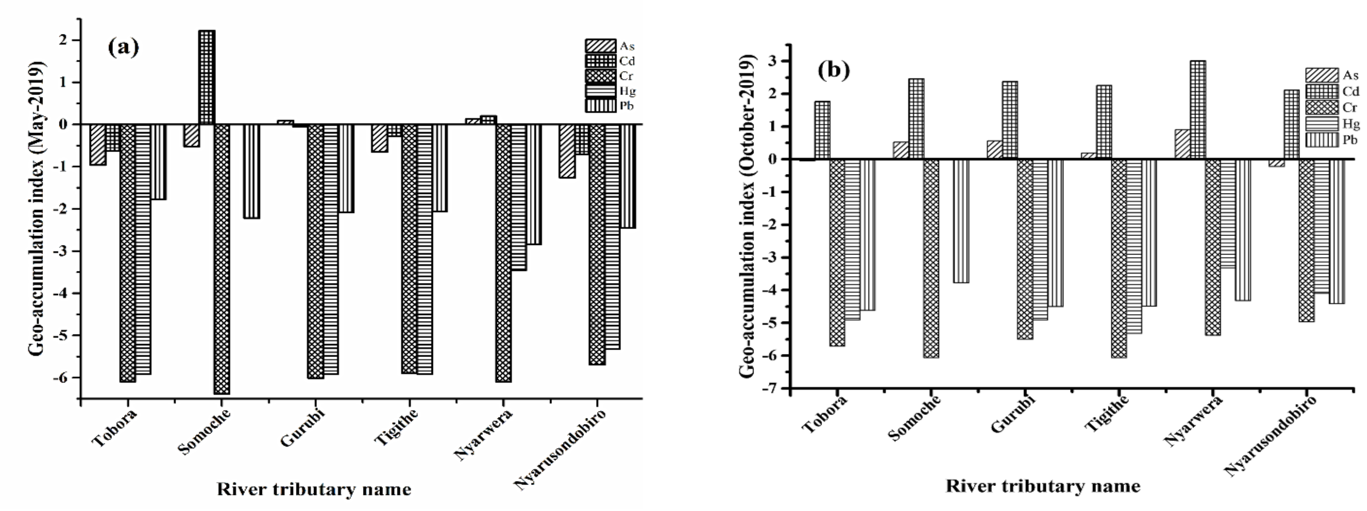

Fig. 1. Indication of the influence of rain (a) and drought (b) on the levels of selected heavy metals in the sediments collected from the tributaries of Mara River [1].

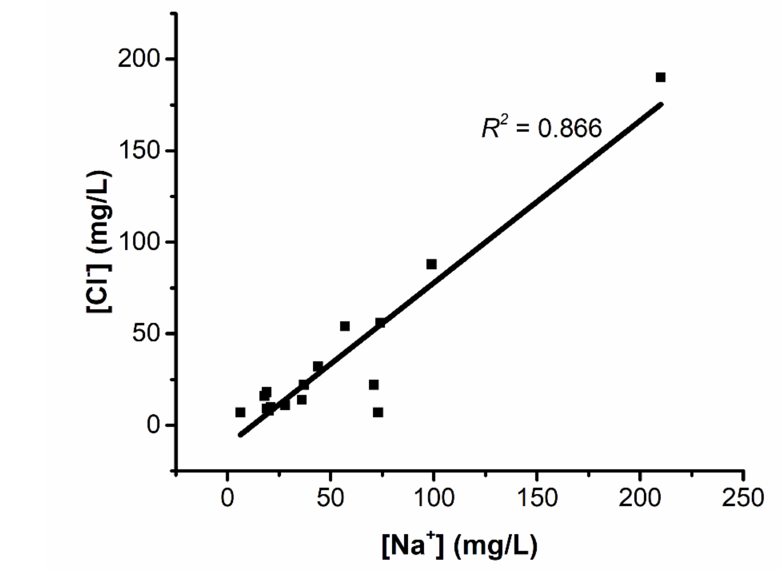

Fig. 2. Highly correlated chloride and sodium ions in water samples collected in the Mara area dominated by farming and mining activities [2].

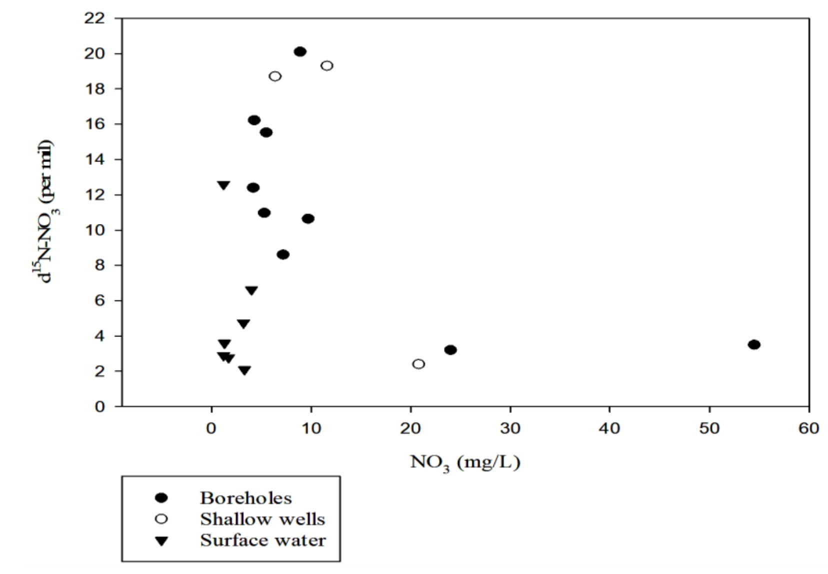

Fig. 3. Enrichment of nitrate-N isotope in ground and surface water in northern Tanzania, indicative of agricultural influence [3].

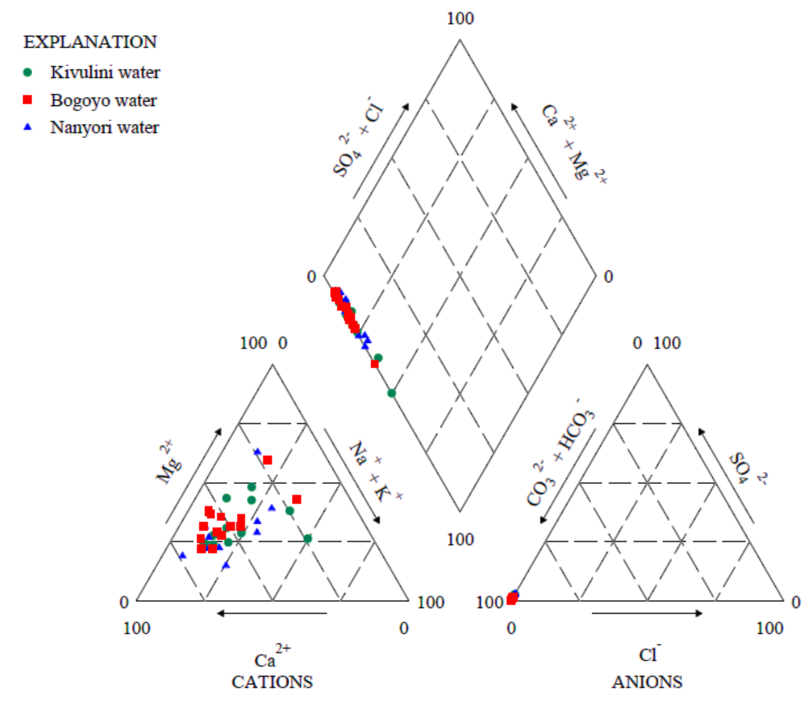

Fig. 4. Chemical classification of paddy irrigation water from three sections of farms at the slopes of Mt. Kilimanjaro in Tanzania [4].

Sampling station	Pumping rates (m^3/y)					
	Year					
	2012	2013	2014	2015	2016	2017
Mbweni	14280	68340	91120	97920	99280	92480
Kwarara	96600	122700	176400	173400	124500	149000
KaburiKikombe	225060	159660	171600	321000	288100	209300
Welezo	188888	178200	337200	331200	321600	285600
Kianga	246000	258000	360000	332400	344400	289200
MwembeMchomeke	416230	658880	854400	832000	353840	685040
Chunga	429000	632040	1036800	969200	952000	947200
Mean value	1616058	2077820	3027520	3057120	2483720	2657820
± SD	153068	245075	366904	331490	283030	315459

Fig. 5. A snippet indicating the values of groundwater abstracted in selected boreholes of Zanzibar for different uses including farming [5].

References

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Conclusions: Can agroecological farming feed the world? The answer is Yes. However, the supporting sectors e.g., the water sector that supports irrigation, and for the farmers safety, needs to be critically studied. Unsustainable anthropogenic practices including over-abstruction, excessive use of fertilizers, unchecked levels of pollutants and nutrients, intensive use of pesticides, etc. are causing serious harm to the surface and groundwater systems in Africa as exemplified by the different studies done in Tanzania that we have cited. The ecosystem upon which agroecological farming is dependent is constantly being degraded. It is high time that the global scientific and research community looks into the aquatic ecosystems of sub-Saharan Africa and how they are being physically and chemically degraded. A holistic approach that integrates farm- and ecosystem-level research is needed to rescue the situation and restore ecosystem stability. Climate change models and prediction for future surface and groundwater quality is necessary, especially in sub-Saharan Africa where management measures have not been undertaken by the authorities.

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