Technical Note

Somalia: Groundwater Quality

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Cover photograph: Puntland water testing training, 2017. *(Photo courtesy: Terre Solidali)*
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Somalia: Groundwater Quality

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An accompanying report (of a suite of six reports) with

Economics of Water: Digging for Data—Towards Understanding Water as a Limiting or Enabling Factor for Socioeconomic Growth in Somalia

Contents

Abbreviations and Acronyms

EC	Electrical Conductivity
m	Meter
km	Kilometer
microS/cm	Micro Siemens Per Centimeter
NGO	Nongovernmental Organization
WB	World Bank
WBG	World Bank Group
WDA	(Somali) Water Development Agency
WHO	World Health Organization

Introduction

The main groundwater quality issues in Somalia are salinity, fluoride, and bacteriological contamination. Salinity affects both the use of water for drinking as well as for agriculture (Said 2021). Bacteriological contamination primarily affects the safe use of water for human consumption.

Drinking water standards in Somalia are set by the Somali Water Development Agency (WDA), which are higher for some parameters (including salinity) than the World Health Organization's guidelines.

This technical note presents a short overview of salinity and bacteriological contamination in groundwater, in Somalia, based on available literature and water quality data sets (SWALIM 2020; Petrucci 2021).[1]

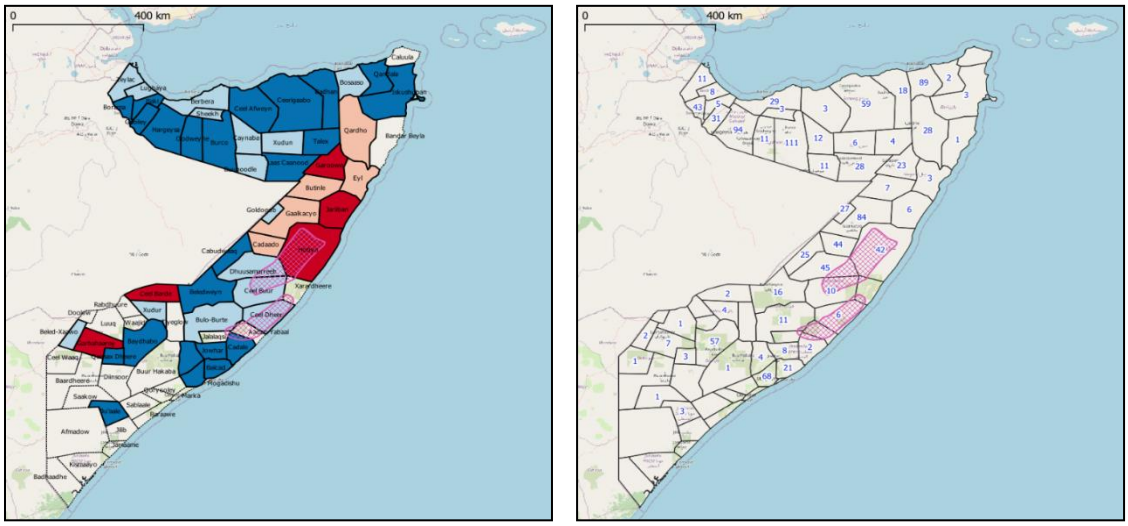
[1] This technical note is one of a suite of six supporting documents along with the 'Economics of Water: Digging for Data—Towards Understanding Water as a Limiting or Enabling Factor for Socioeconomic Growth in Somalia' report. The other five supporting documents comprise: (a) four technical reports (Somalia: An Institutional Analysis Report; Somalia: Groundwater Assessment Technical Report; Somalia: Surface Water and Riverine Assessment; and Water+ in Somalia: A Sectoral Analysis), and (b) a Summary Report. All the reports can be accessed at: the Ministry of Energy and Water Resources' website (https://moewr.gov.so) [the reports will be available in 2022 as the site is currently under development]; the World Bank's Water Global Practice website (https://www.worldbank.org/en/topic/water); as well as the World Bank's Somalia website (https://www.worldbank.org/en/country/somalia).

1 Salinity

The salinity of groundwater in dug wells, boreholes, and springs is relatively high in Somalia. It can be inferred from the SWALIM database that about 70 percent of these water points have salinity levels above the World Health Organization's (WHO) limit of 1,500 microS/cm,[2] while 30 percent are above the Somali Water Development Agency (WDA) limit of 3,500 microS/cm. The origin of the salinity is from different sources (see Appendix).

The high degree of mineralization in most wells results from the dissolution of salts from evaporitic rocks. These groundwaters typically have high concentrations of sulphate. The WDA sulphate limit is 600 mg/l (Berger 1985), while that of the WHO is 250 mg/l. Wells along the coast with high salinities may be affected by seawater intrusion. In these wells, salinity is caused mainly by high chloride contents (the WDA limit is 800 mg/l; the WHO guideline is 250 mg/l).

Figure 1. Groundwater Salinity in Boreholes



Left: Districts with percentage of boreholes with salinities (in electrical conductivity, or EC) higher than 3,500 microS/cm. **Right:** Number of boreholes with EC measurements.
In the map at left, only percentages are displayed for districts with more than one measurement. The low number of measurements in the south is probably not because there are fewer boreholes, but because of the security situation complicating water point surveys. The purple shaded area in Middle Somalia is an area with high salinities, according to a SWALIM map (concentrations are unknown).

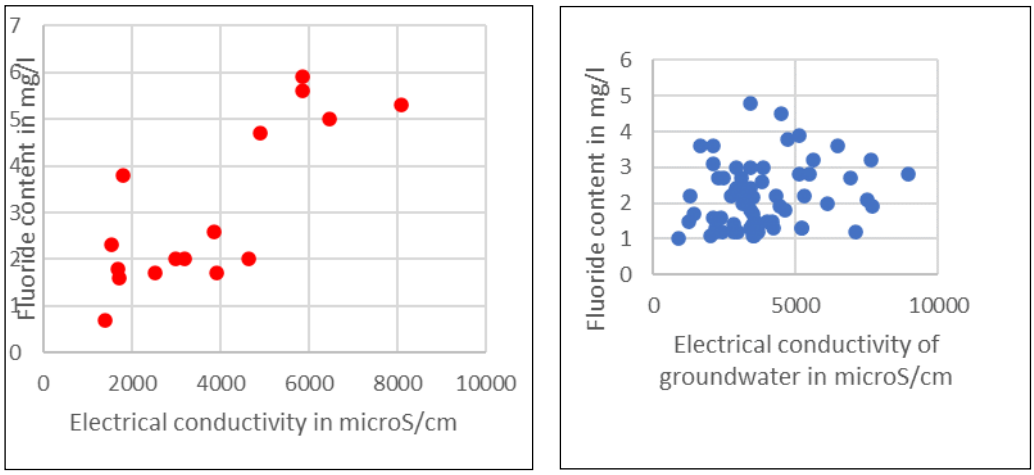
High chloride and sulphate levels are not preferred because of bad taste. In addition, in their study of Middle Somalia, Berger (1985) states that high salinities in combination with high calcium and magnesium contents may cause kidney problems, which is a common ailment in that area. EarthWater (1998) also reports high salinity as the cause of kidney problems in its study for the water supply of Garowe.

Nasreldin et al. (2016) also studied water quality (50 samples) in Middle Somalia. They showed that wells with high salinities (56 percent are above 3,500 microS/cm) also had high fluoride contents

[2] Salinity is often expressed as EC (electric conductivity), which is a physical parameter to measure the amount of electrical current a water sample can carry. Conductivity is an intrinsic property of a material.

exceeding the WHO guideline of 1.5 mg/l. Drinking water with these high fluor contents poses more serious health risks (fluorosis) than just salinity. Faillace (1998) studied water analyses (81 samples) throughout the country and considered fluoride as one of the major problems in drinking water: 51 percent of the sampled wells had salinities above 3,500 microS/cm. In all wells, fluoride contents exceeded 1 mg/l, while in 65 percent fluoride contents were higher than 1.5 mg/l. Within this batch of samples, Faillace (1998) did not find a correlation between salinity and fluoride in contrast to Nasreldin et al. (2016).

Figure 2. Relation between Fluoride and Salinity (in Electrical Conductivity)



Left: In Middle Somalia (Nasreldin et al. 2016). **Right:** In all of Somalia (Faillace 1998). Goracci et al. (1980, 1983) in Faillace (1998) reported many cases of dental fluorosis in Somalia and attributed this to the drinking of fluoride-rich water (WHO guideline is 1.5 mg/l).

Sources of data on salinity are the 513 electrical conductivity (EC) values acquired in 23 years of surveys by the Italian nongovernmental organizations (NGOs) COOPI, Africa '70, and Terre Solidali (Petrucci 2021). A large amount of reliable data are reported in the Faillace Water Quality Book of Somalia (1984)—these data, however, may not be representative today because of increased exploitation and the destruction of many boreholes during the civil war.

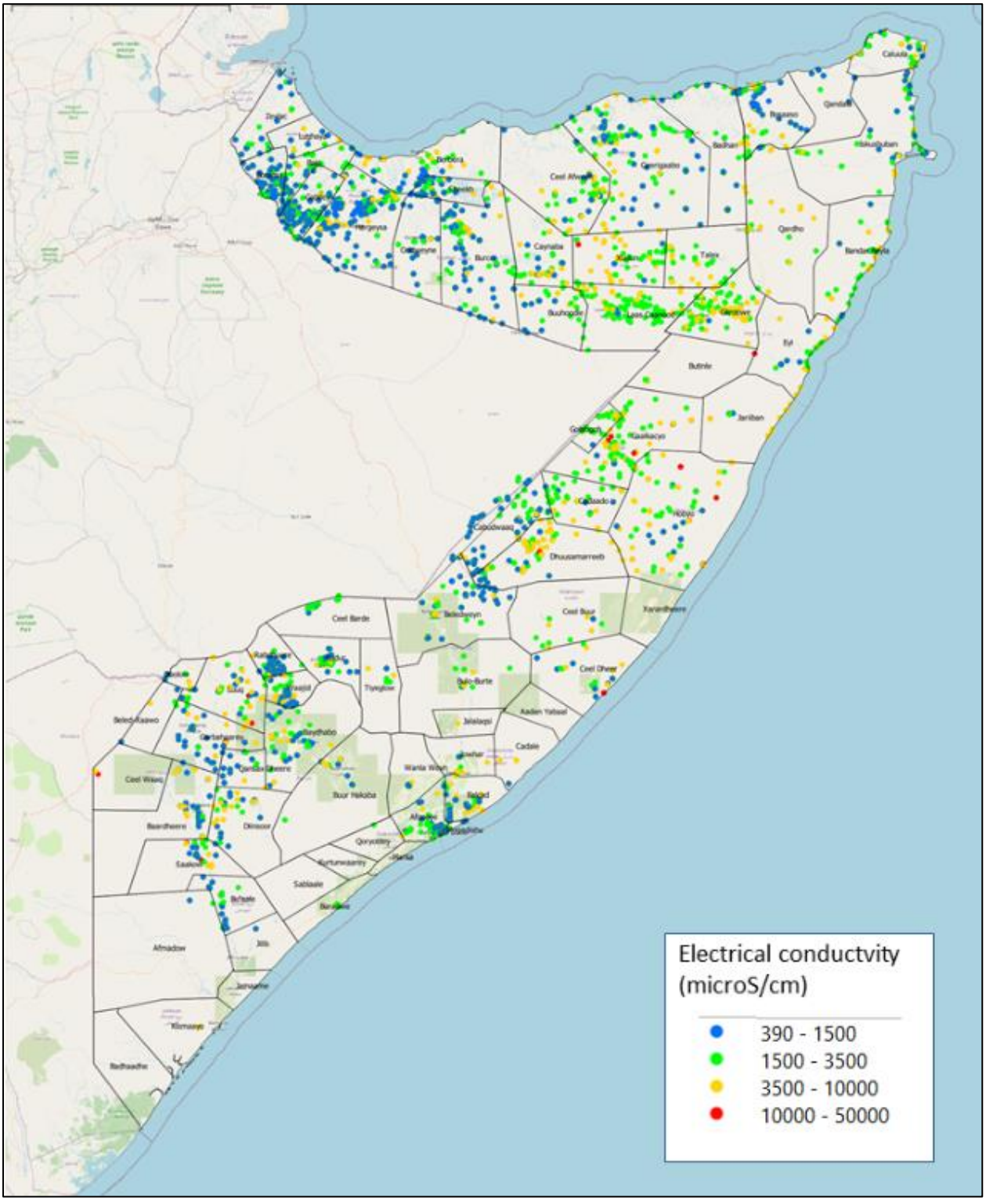
A more recent dataset is available from the SWALIM database which contains almost 4,000 EC values of mostly dug wells and boreholes (SWALIM 2020). The SWALIM data are shown in Figure 3 together with the data (Petrucci 2021).[3]

The areas without data in Figure 3 coincide with the areas controlled by Al-Shabaab. The largest densities of data are found in Somaliland, the border with Ethiopia, and the corridors controlled by AMISOM (the African Union Mission to Somalia).

Interpreting this map is beset with some limitations because of the variations in lithology, depth of the wells or boreholes, and the season of sampling.

[3] Both datasets are available with the authors.

Figure 3. Salinity as Electrical Conductivity of Groundwater as Observed in Dug Wells, Boreholes, and Springs



Source: Based on SWALIM (2020) and Petrucci (2021).

2 Bacteriological Contamination

There are many studies reporting the problem of bacteriological contamination of dug wells, berkads and hafirs (Berger 1985; EarthWater 1998; Muthusi et al. 2007; Van Haren et al. 2017; WASH cluster Somalia, 2017), though not many systematic surveys are available.

An (oral) reference to a pilot study by the NGO COOPI in Somaliland reports the testing of a group of shallow wells, a number of hafirs, and on samples of the same water in houses in pots or jerrycans. The results confirmed that water from the hafirs was seriously contaminated compared with the bacteria content of the hand dug wells. The bacteriological quality of the same water in home pots and jerrycans, however, was worse and even more contaminated than the water from the hafirs.

Though groundwater, especially from deep aquifers, is normally free of pathogenic bacteria, Berger (1985) reports human and animal fecal contamination in old WDA boreholes and high nitrate levels, another indication of man-made influence. Such well contamination probably results from leakage along badly sealed boreholes—which are accessible for large numbers of people and livestock—without sanitary provisions. On a related note, WASH Cluster Somalia (2020) stresses the need for the proper designing of wells to prevent pollution of shallow aquifers.

The above cases and references illustrate the need for a more systematic survey of the bacteriological pollution of shallow and deep groundwater at source, in the respective wells as well as during the abstraction, transport, and storage of the water.

Appendix. Main Causes of High Salinity[4]

Evaporitic Formations

Evaporitic formations are present in the north and in the south of the country. In the north the unit is widely outcropping, mostly in the northeast (Somaliland and Puntland regions), is the Taleex (or Taleh) formation (Fm), which is mostly made by gypsum and anhydrite which contain calcium sulphate ($CaSO_4$) which easily dissolves in, and contaminates, ground and shallow water. As an example, in Rabaable, near Garowe, water pools formed after a flow showed EC values ranging from 2,500 to 3,000 only two days after the flow. The reason is the Taleex Fm outcropping in the wadi bed. In the south, Ferfer Gypsum and Main Gypsiferous Fm have similar characteristics.

Clay Content in Continental Units

The Yesomma Sandstones is a Cretaceous formation characterized by huge thicknesses of sandy deposits, up to more than 300 m. Unfortunately, in many areas, it also has a high content of clayey deposits, often jointly with gypsum crystals. When these conditions are found, as in most of the Haud plateau, groundwater may reach EC values of up to more than 10,000 µS/cm.

Clayey Deposits of Lagoonar Environment

These deposits form in the proximity of the sea coast at each latitude, but mostly are found in the northwest (Zeila to Lugaya coastal strip) and in the south in the lower plain of the Webi Shabelle river, where the sea and river water have alternated for many thousands of years. This environment extends for some 400 km behind the dune strip from Mogadishu to Kismayo. In this case, the clay mostly contains sodium chlorine (NaCl) that dissolves even more easily than calcium sulphate in the water.

Basalt Lava Flows

In Somaliland, north of Hargeisa, powerful lava flows occurred in the Pleistocene, originating from deep and long extensional faults. The reason for the presence of salt in the groundwater near and below the lava flows it is not clear; it does not always occur. The flows, very likely, caused rapid evaporation of the water of the streams or, even worse, dammed streams and formed small lakes or swamps, heating the water and causing, again, strong evaporation with probable NaCl formation.

Sea Water Intrusion

For the most part, the salt in the groundwater of the coastal strip is found in the clayey coastal deposits. However, in the Djibouti volcanic district, the presence of salt is caused by sea water intrusion, jointly caused by the strong overexploitation of the aquifer and the high permeability of lava flows and pyroclastic deposits, which facilitate the underground flow from sea.

[4] Petrucci, B. 2021. Geological causes of the salinity distribution on Somalia. Unpublished note for the 'Economics of Water: Digging for Data—Towards Understanding Water as a Limiting or Enabling Factor for Socioeconomic Growth in Somalia' report.

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