Supplementary Materials

Article

Paleo-geohydrology of Lake Chilwa, Malawi is the source of localised groundwater salinity and rural water supply challenges

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a) Lake Chilwa Basin – Water Resource Area 2 b) Phalombe District c) Water Resource Unit 2A

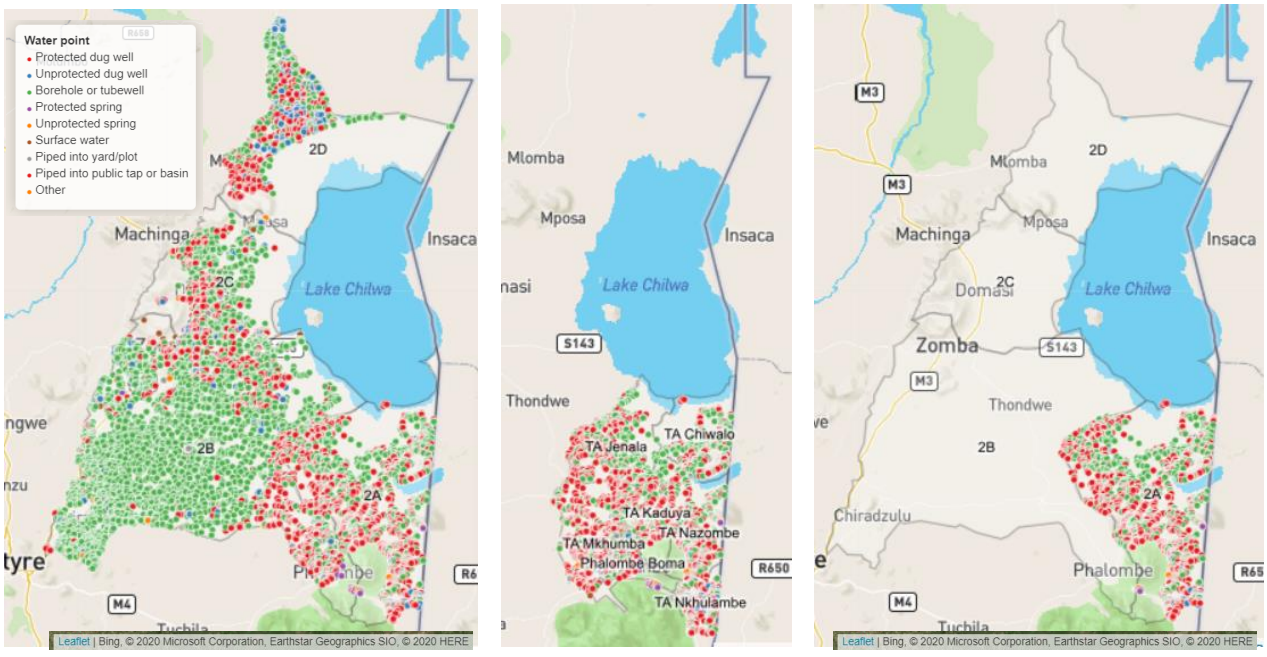


Figure S1. Study area location showing the current (2019) development of mapped water points for a) Lake Chilwa Basin – Water Resource Area 2 (WRA 2), b) Phalombe District, and c) Water Resource Unit 2A (WRU 2A) (based on mWater data retrieval May, 2020).

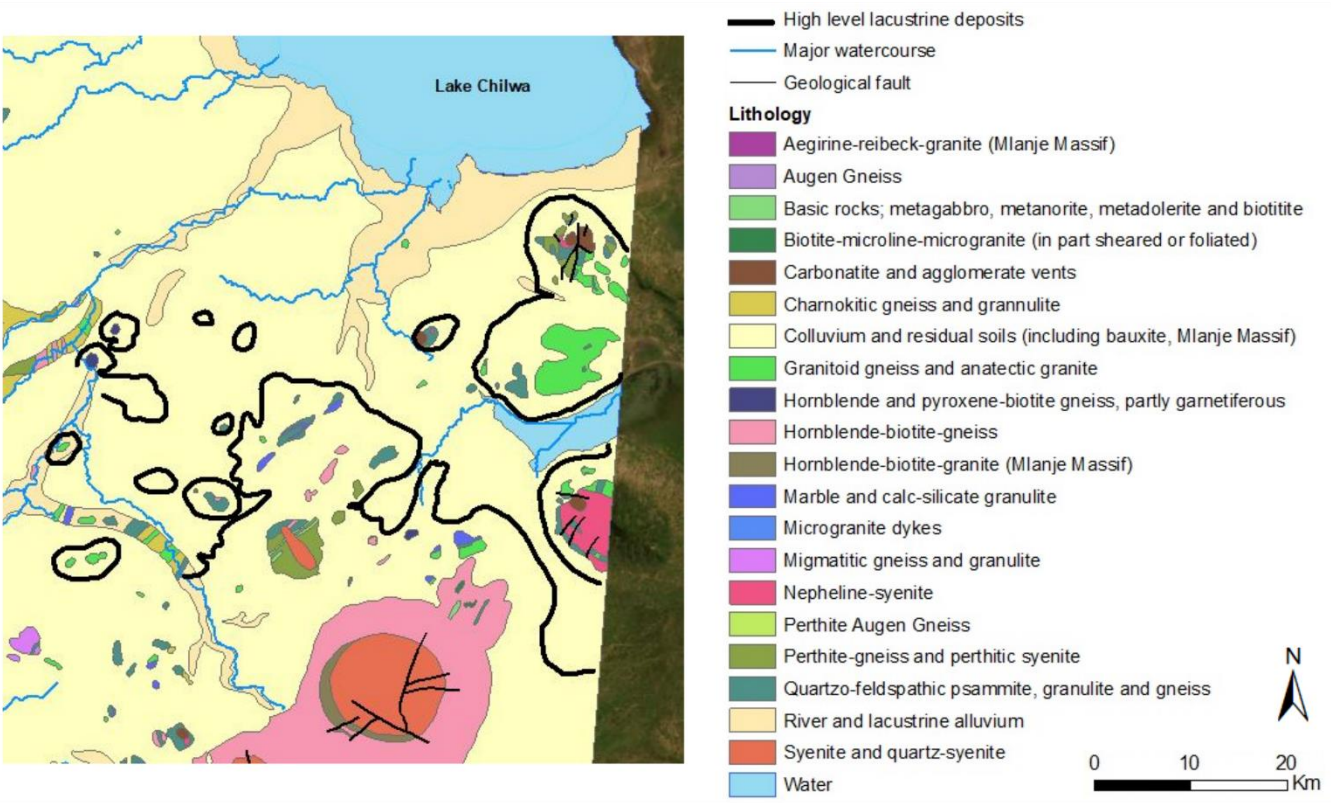


Figure S2. Phalombe District study area solid and superficial deposit geology of the (based on 1:250,000 geological map (1970) published by the Geological Survey of Malawi (after Garson and Walshaw (1969).

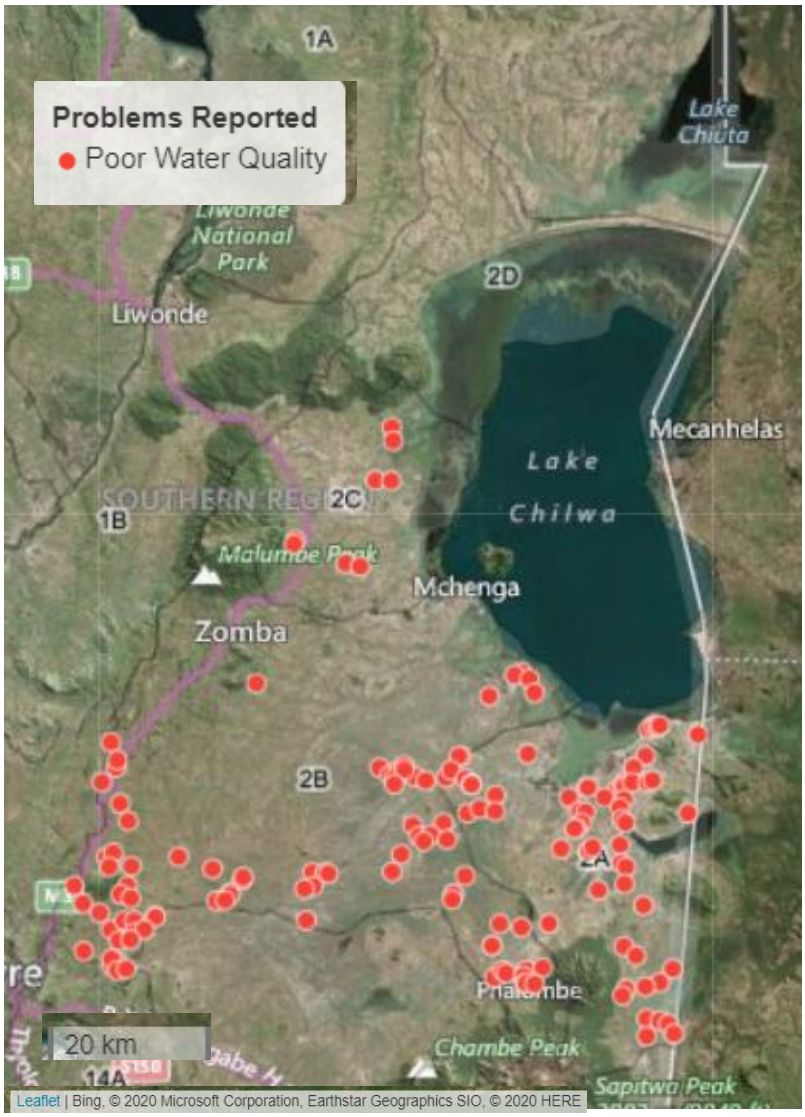


Figure S3. Distribution of Lake Chilwa Basin (WRA 2) groundwater-source water points where local communities have reported 'water quality problems' (based on mWater data retrieval May, 2020).

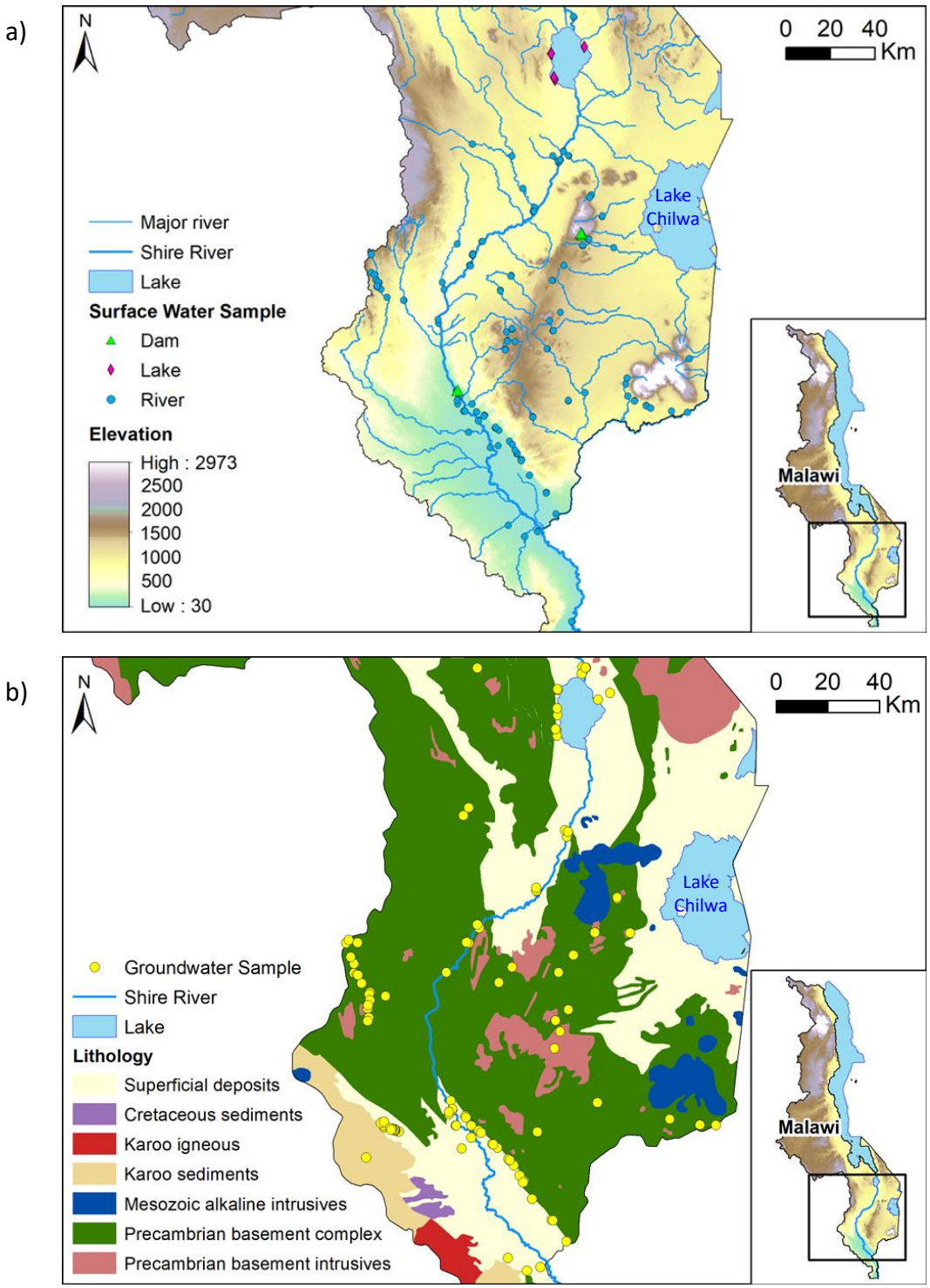
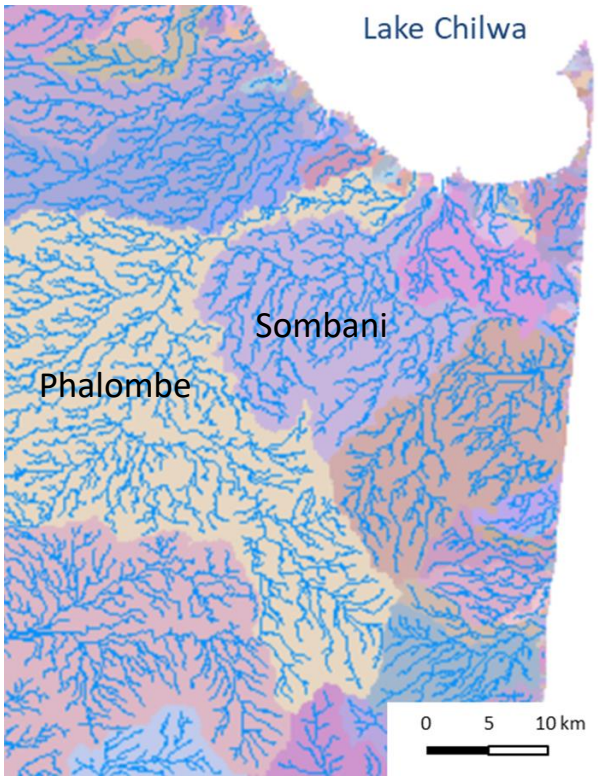
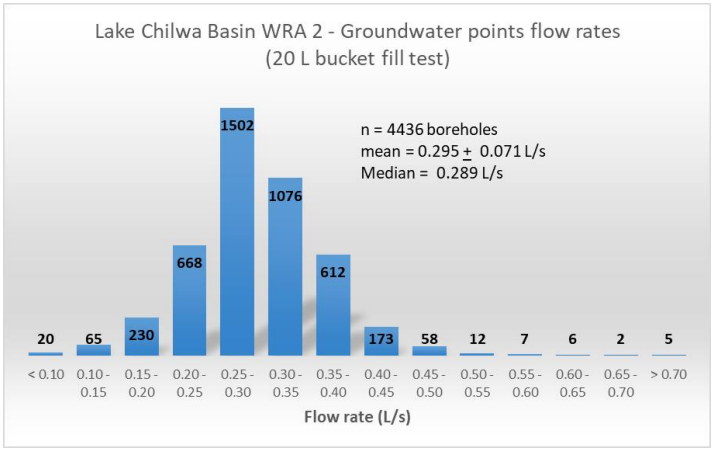


Figure S4. Distribution of stable isotope sampling sites national sampling sites in Southern Malawi including Lake Chilwa Basin (WRA 2) sampling sites for a) surface water and b) groundwater.

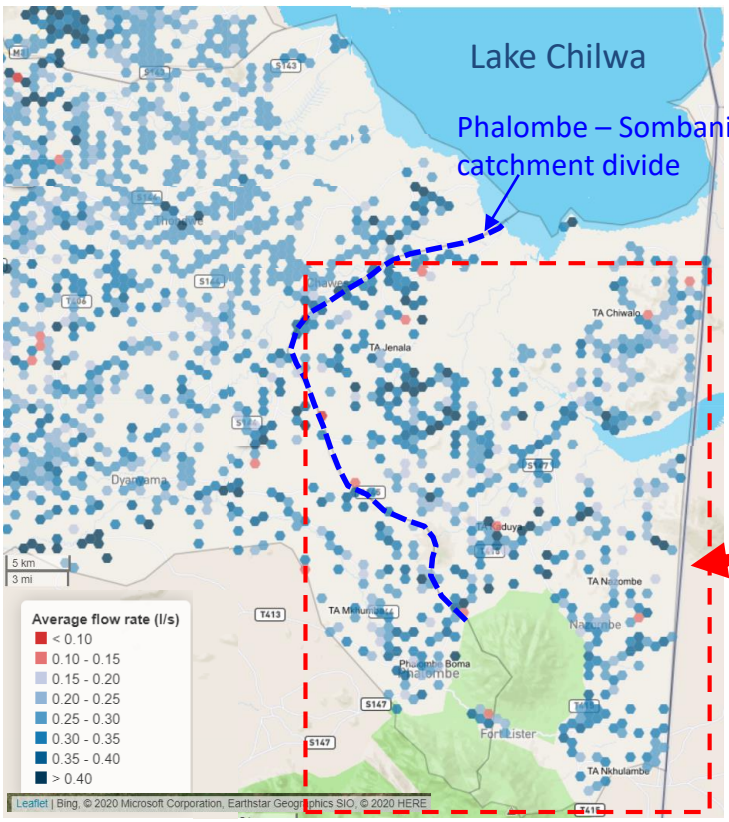
a) Surface water drainage



b) Lake Chilwa Basin borehole flow rate via bucket test



c) Borehole flow rates



d) Groundwater potentiometric surface - Phalombe District

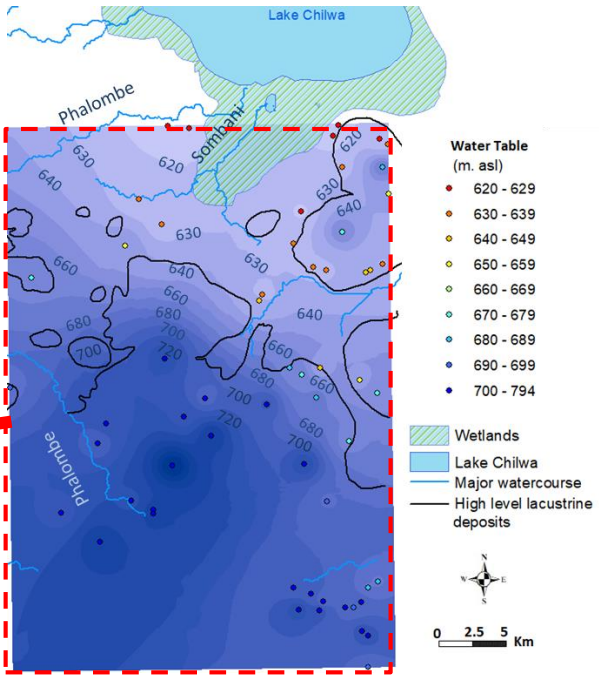


Figure S5. a) Phalombe District detailed surface-water drainage; Borehole flowrate data from mWater download (May 2020) showing b) histogram of occurrence in Lake Chilwa Basin WRA 2 and c) spatial distribution;, compared to d) Groundwater potentiomentric surface in Phalombe District .

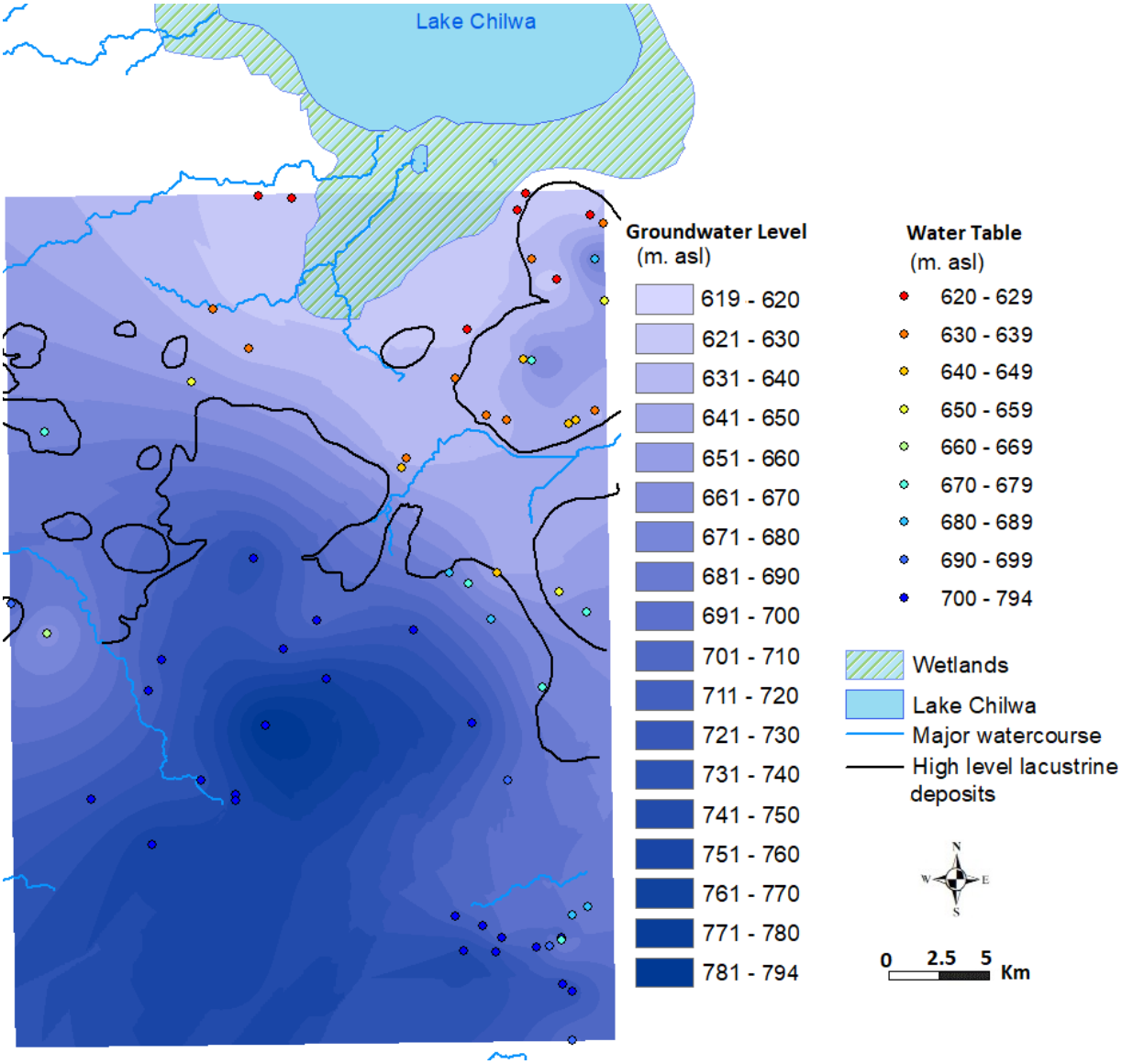


Figure S6. Contoured potentiometric surface (water table) for the Phalombe District based on archive water level data, mostly from 2017 contouring all data (incl. four outliers) to compare with plot omitting outliers in the main manuscript Figure 6.

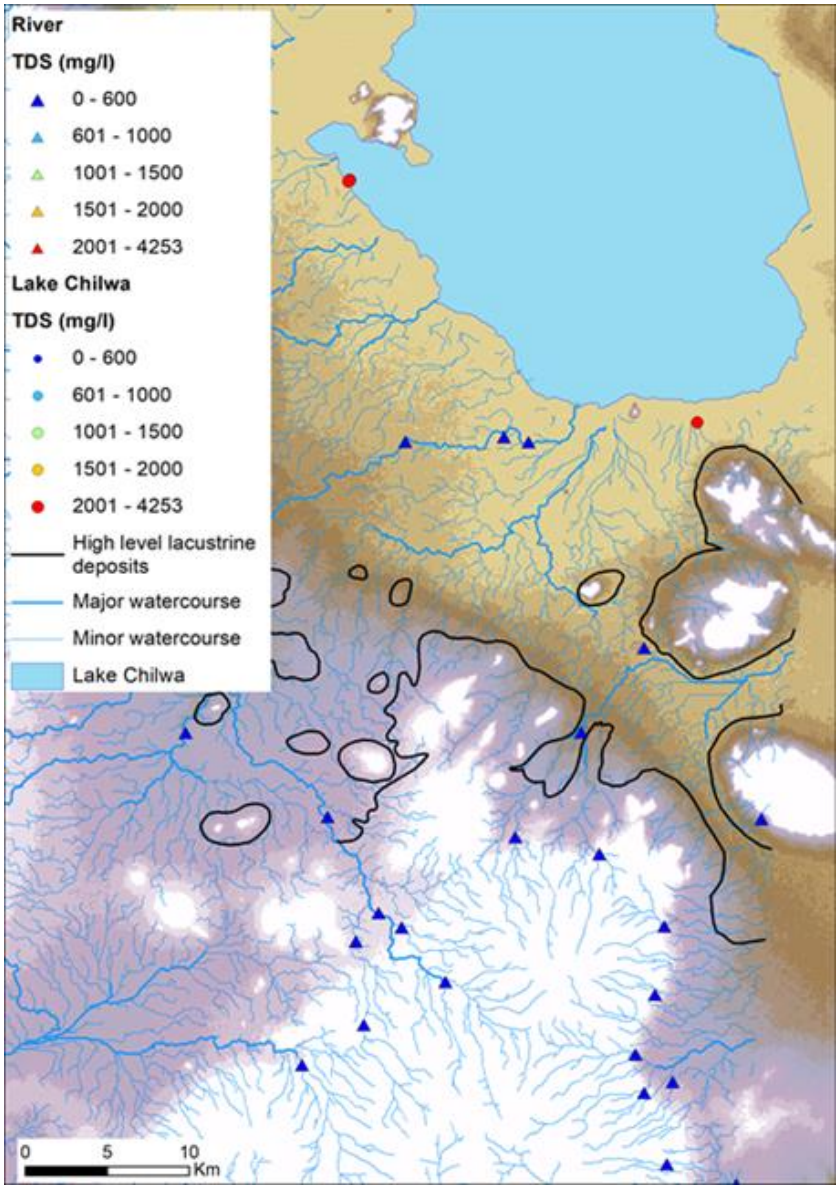


Figure S7. Observed surface-water Total Dissolved Solids (TDS) Phalombe District data shown relative to a backdrop of superficial deposits.

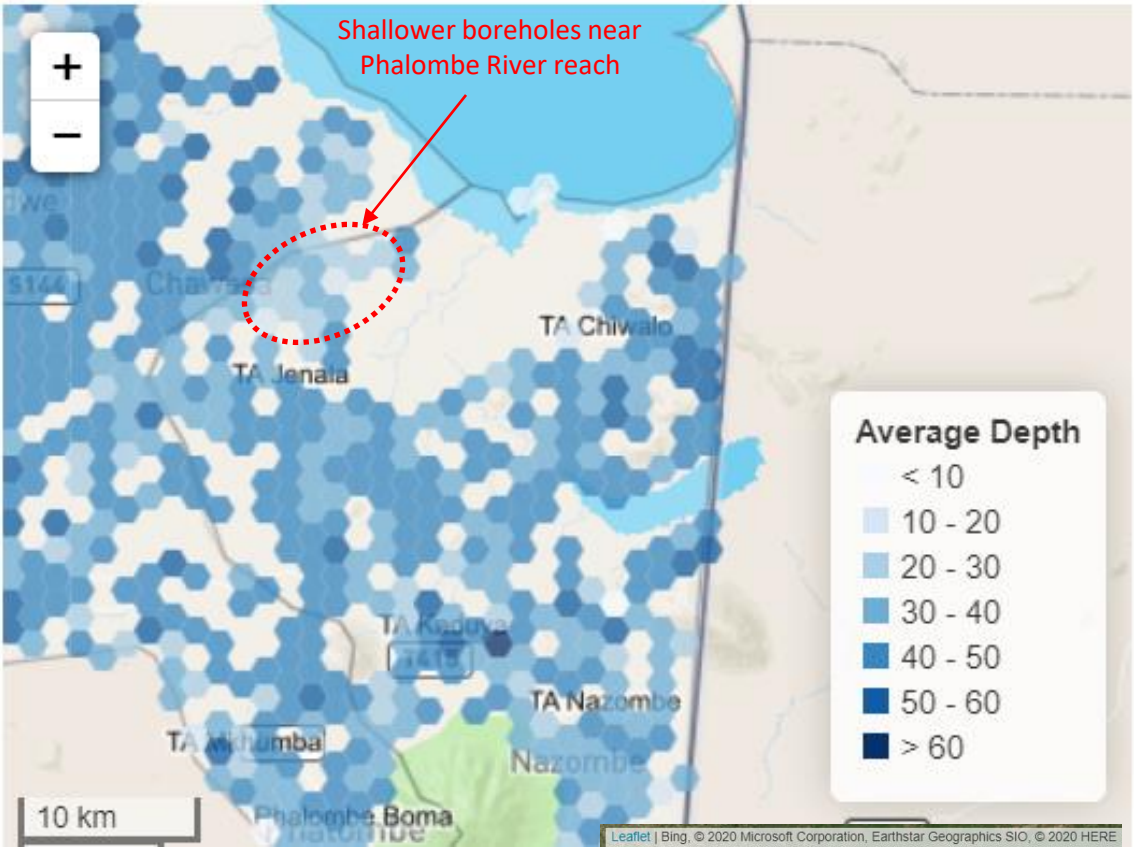


Figure S8. Borehole average depths for pixel area shown in the Phalombe District – southern Lake Chilwa Basin (data from mWater download May 2020).

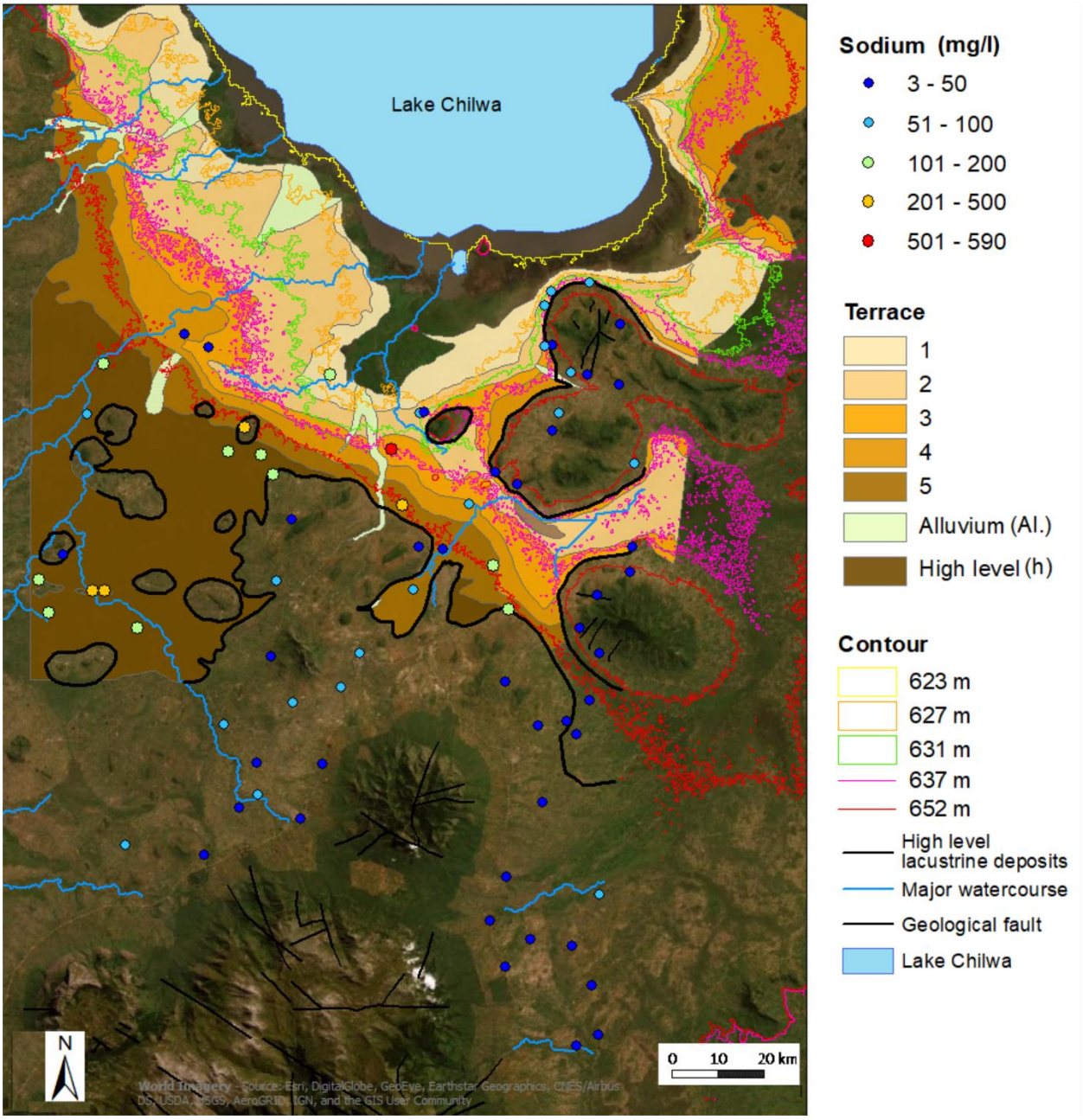


Figure S9. Phalombe District observed groundwater sodium (Na^+) shown relative to a backdrop of superficial deposits and satellite ground image.

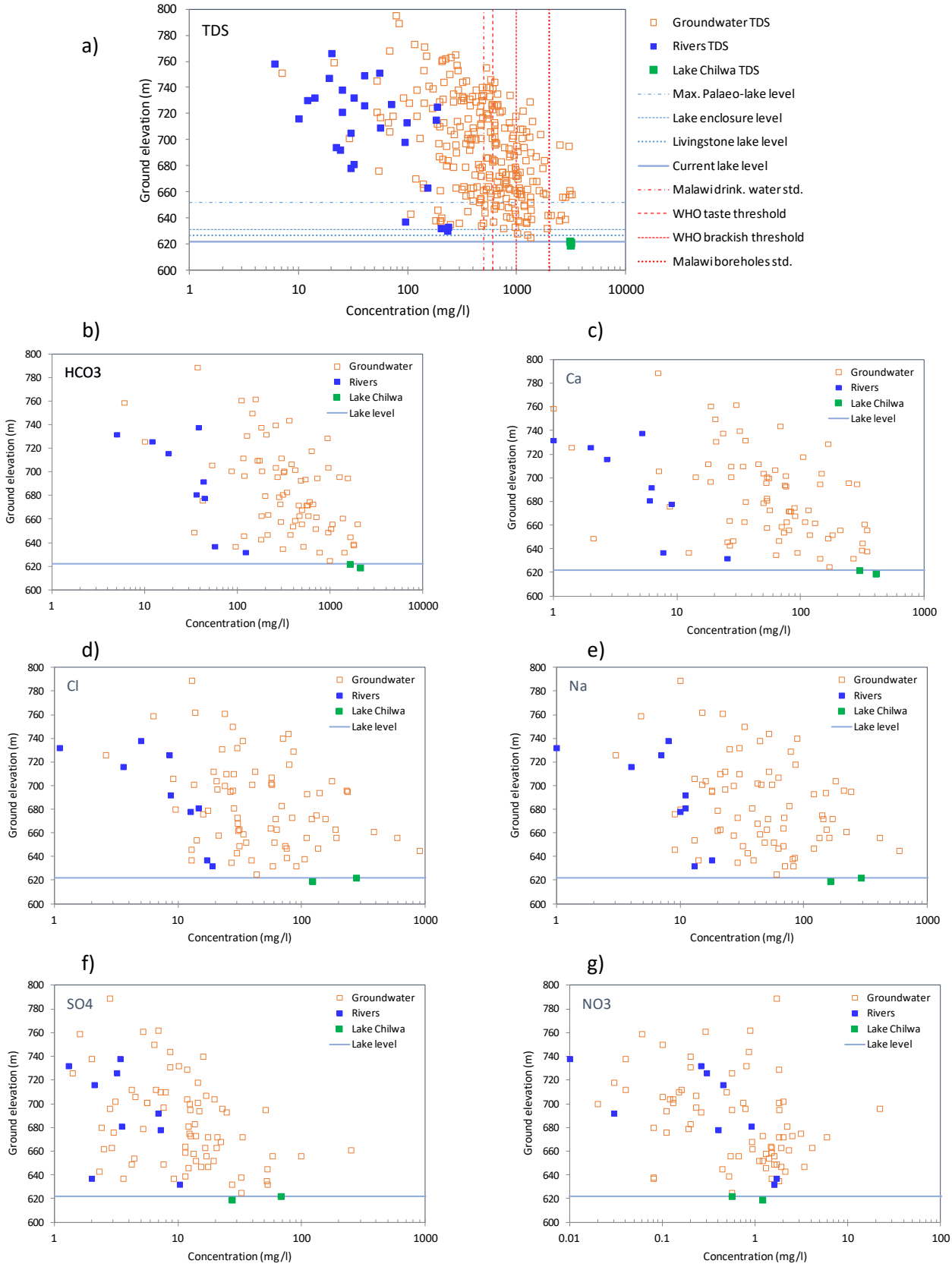


Figure S10. Plot of Basin ground elevation versus Phalombe District observed major ions water quality for groundwater, surface-water and Lake Chilwa samples.

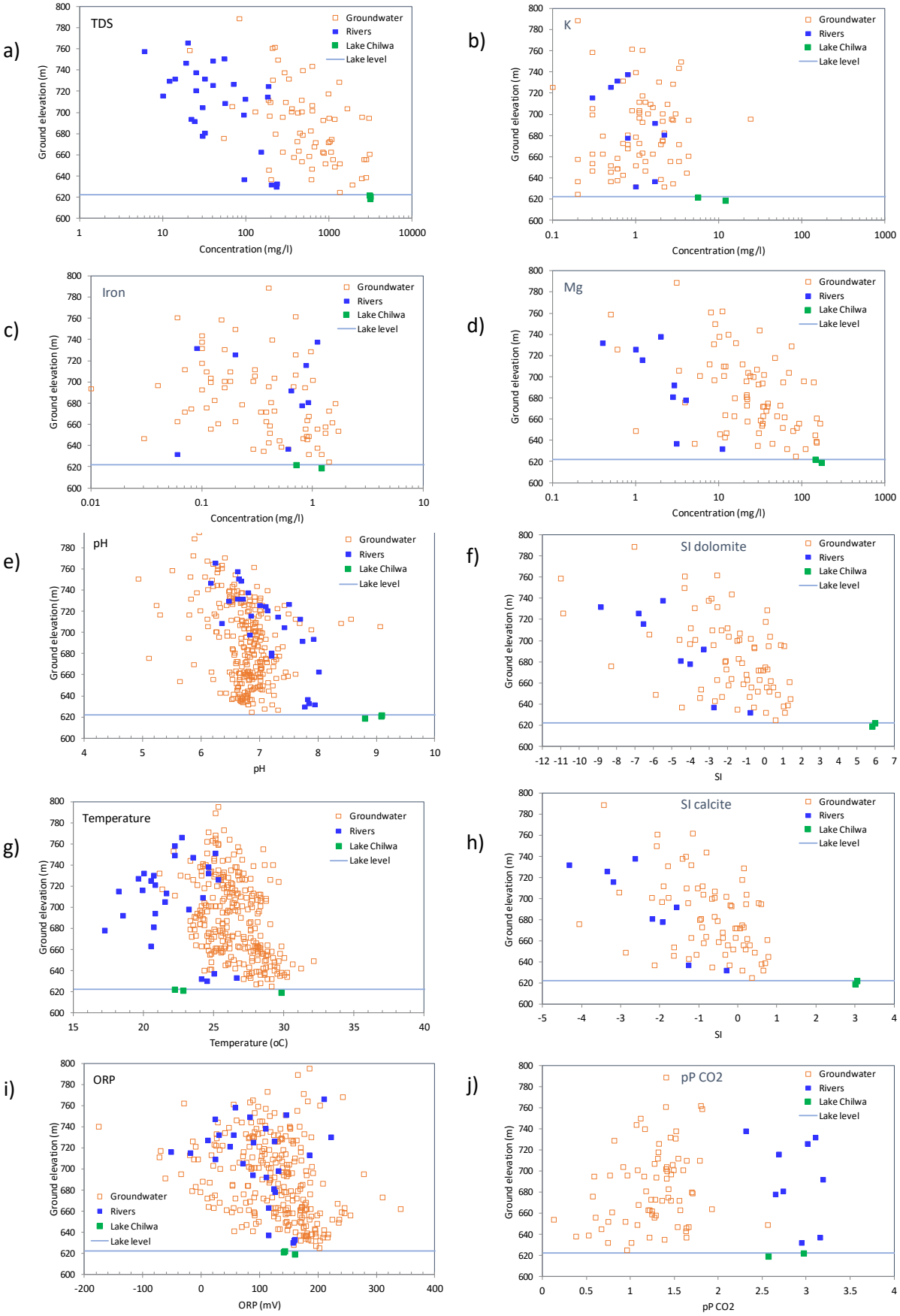


Figure S11. Plot of Basin ground elevation versus Phalombe District observed major ions water quality, field parameter Saturation Indices (SI) for groundwater, surface-water and Lake Chilwa samples.

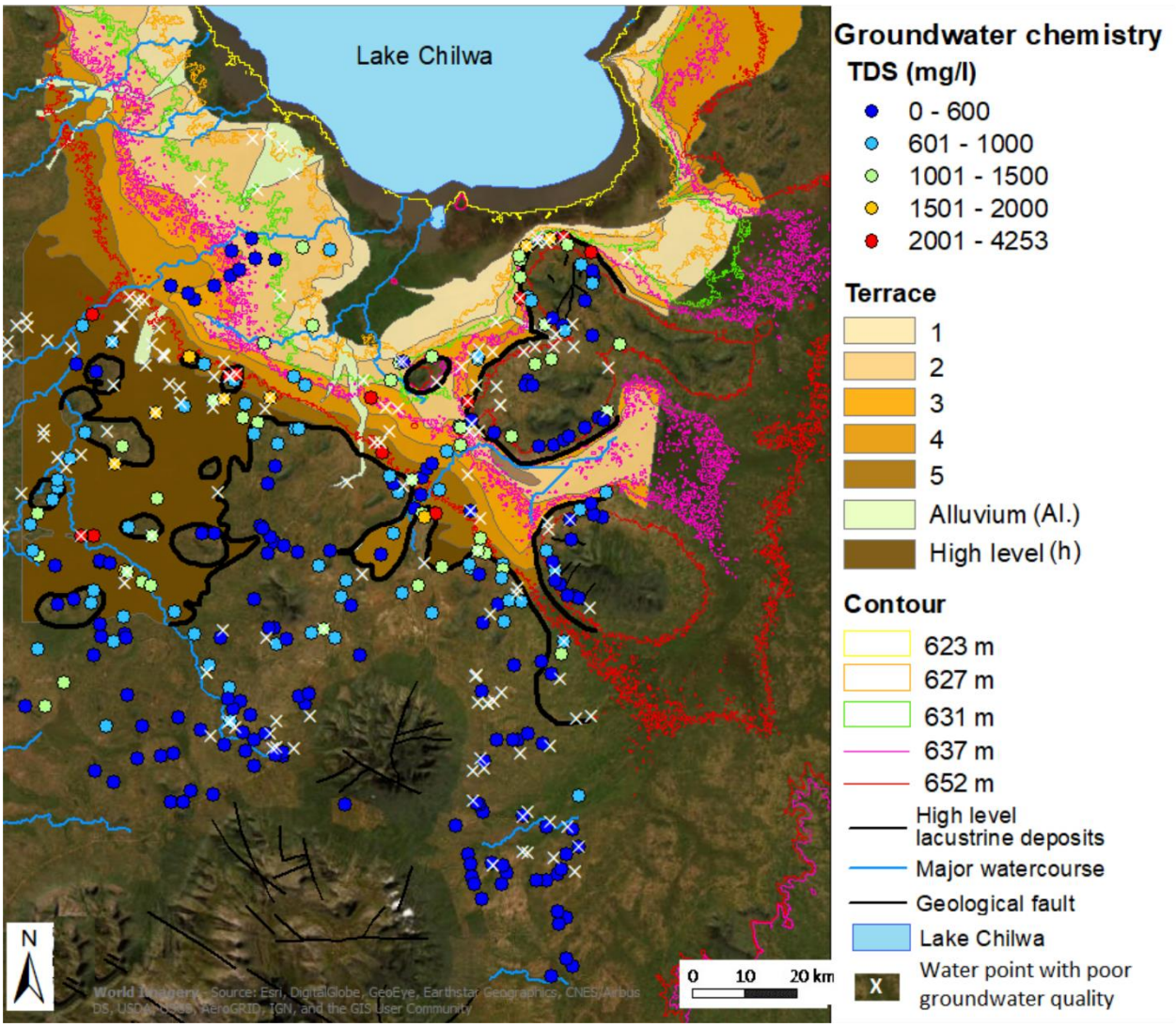


Figure S12. Phalombe District observed groundwater TDS shown relative to a backdrop of superficial deposits and satellite ground image with (additional to manuscript Figure 9) water points registered as 'poor groundwater quality' by communities indicated (per community response data from mWater download May 2020).

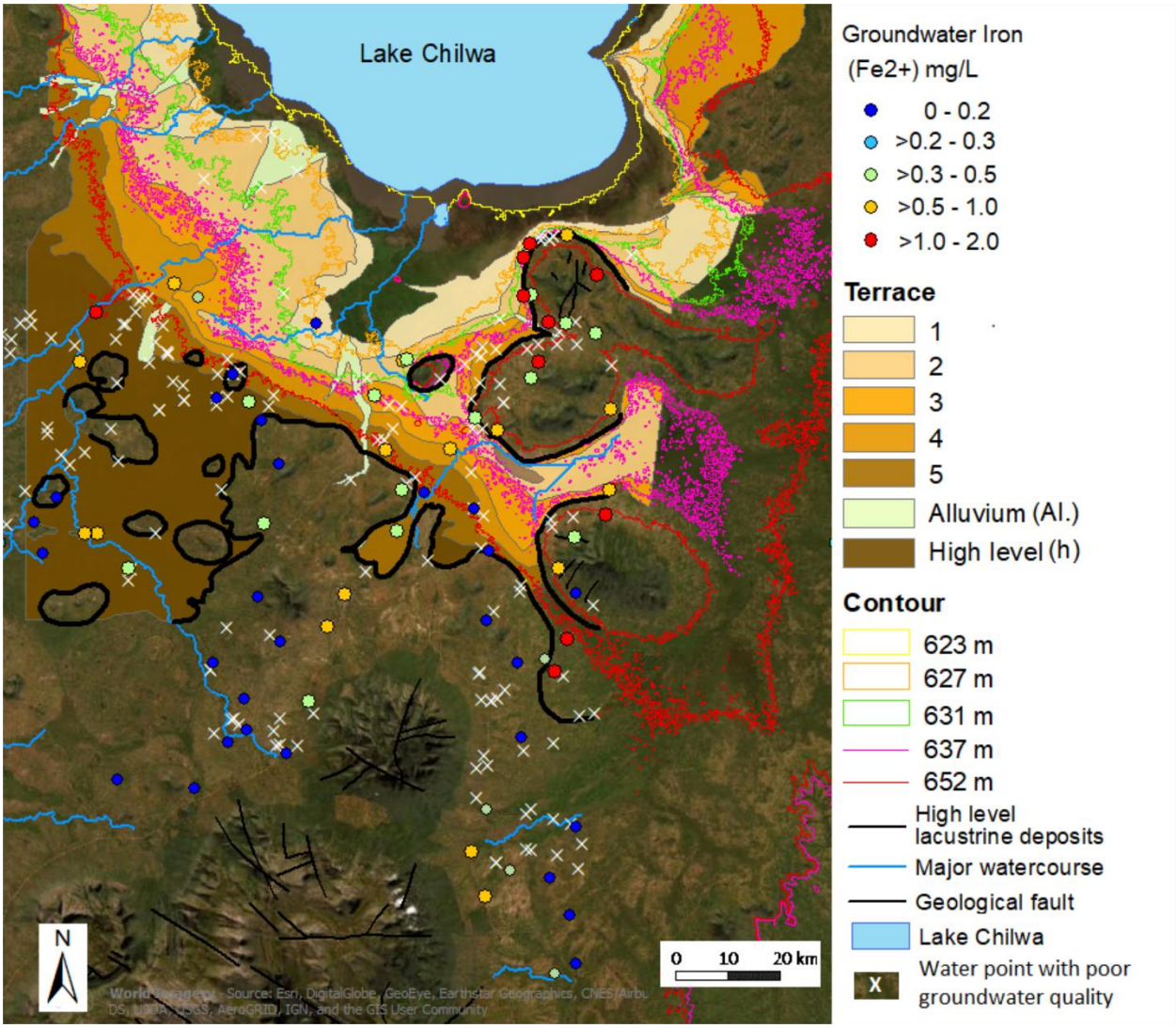


Figure S13. Phalombe District observed groundwater dissolved iron concentrations shown relative to a backdrop of superficial deposits and satellite ground image with water points registered as 'poor groundwater quality' by communities indicated (community response data from mWater download May 2020).

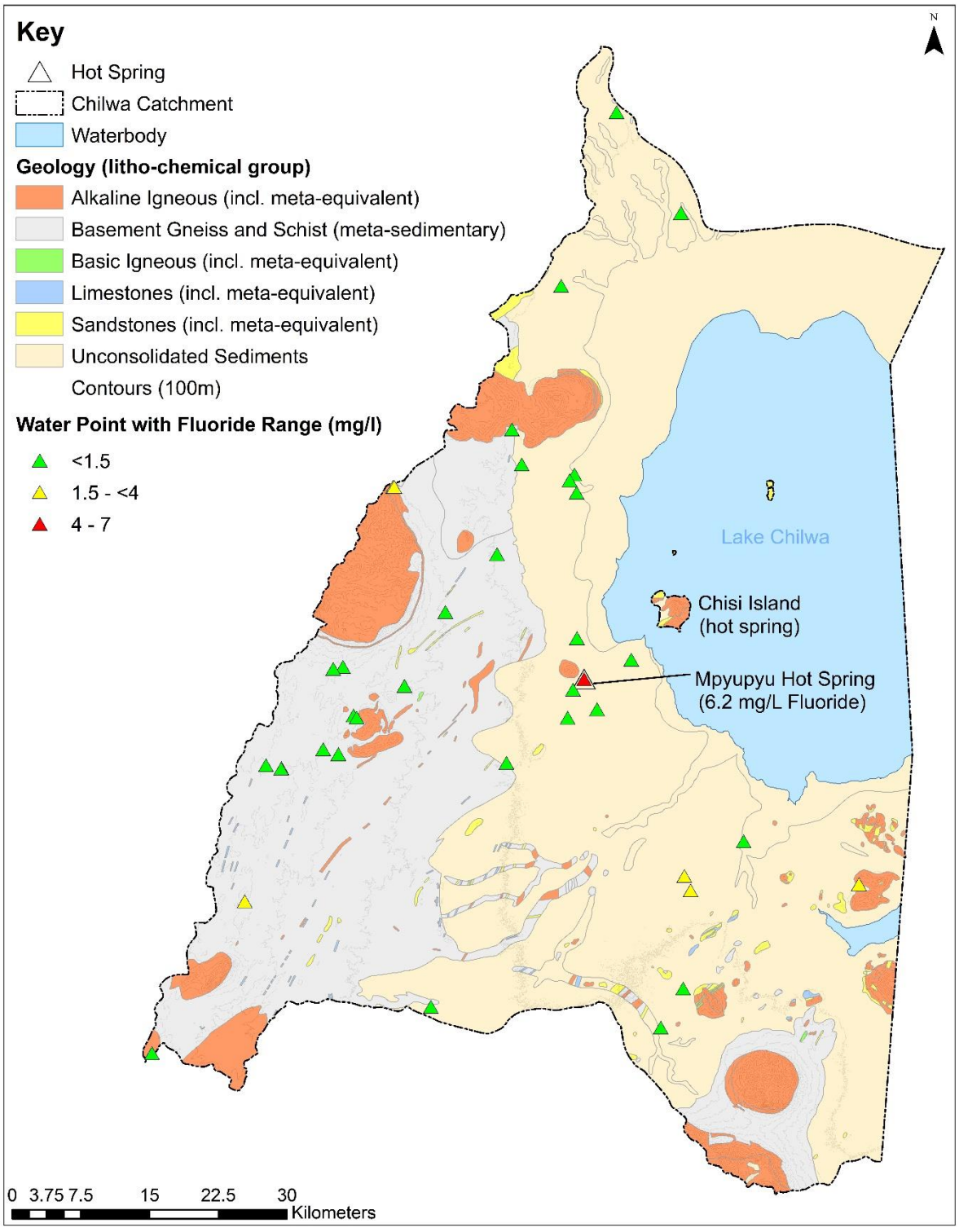
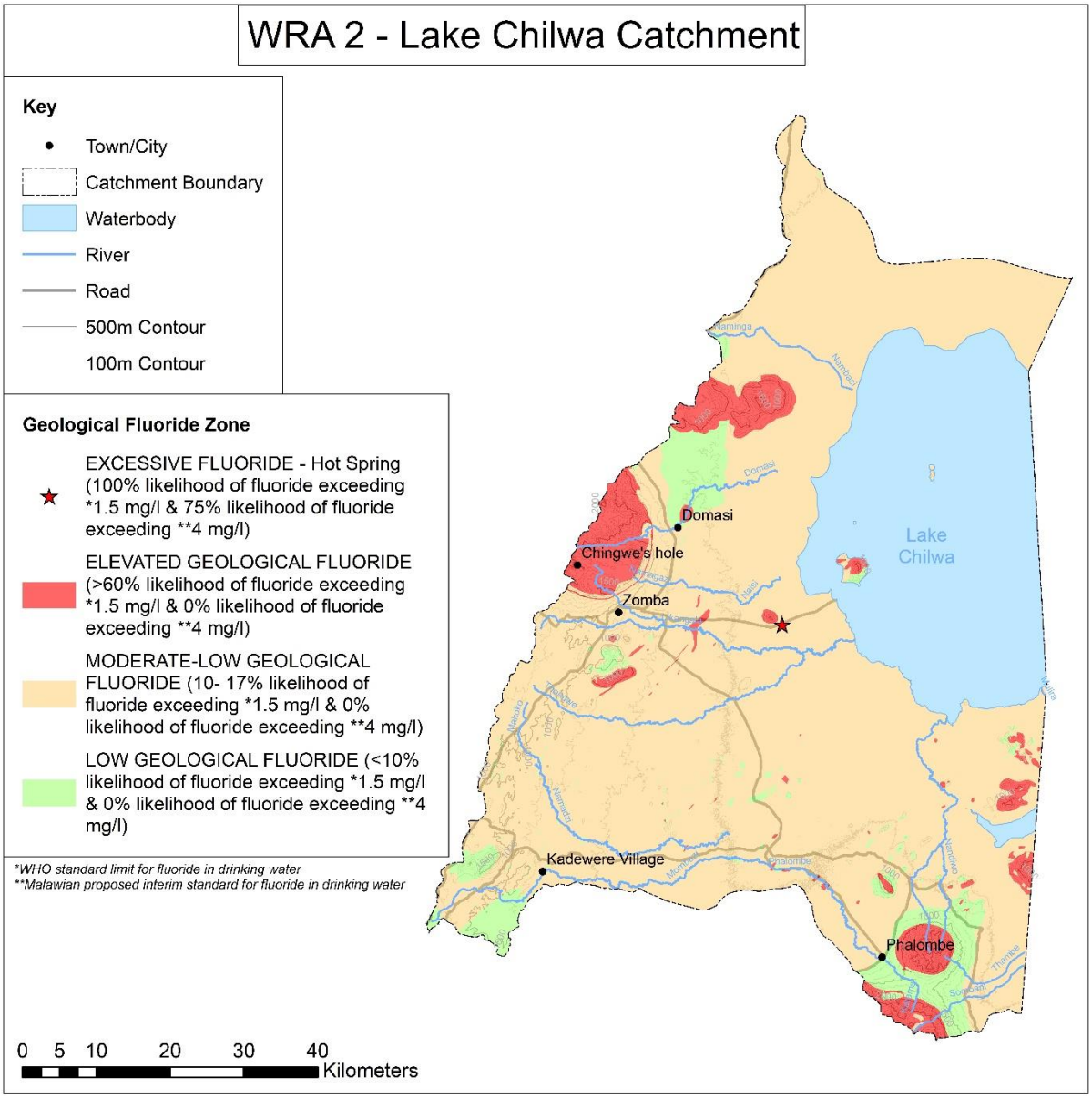


Figure S14. Observed groundwater fluoride in the Lake Chilwa Basin drawn from a national dataset compiled by Addison et al. (2020)* shown over a geological map simplified into litho-chemical group.

* Addison, M.J., Rivett, M.O., Robinson, H., Fraser, A., Miller, A.M., Phiri, P., Mleta, P., Kalin, R.M., 2020. **Fluoride occurrence in the lower East African Rift System, Southern Malawi.** Science of the Total Environment, 2020, 712, 136260 https://doi.org/10.1016/j.scitotenv.2019.136260



Summary Statistics

Geological Fluoride Zone	No. of Water Points		No. of Users
	n	*%*	
*Hot Springs	1	*0.03*	263
*Elevated Fluoride	36	*0.9*	11,602
Moderate-high Fluoride	0	*0*	0
Moderate-low Fluoride	3,569	*90.9*	1,168,556
Low Fluoride	322	*8.2*	80,618

ALL water points are direct groundwater sources and are either functional or partly functional.
No. of users calculation is based on the number of users per each individual water point.
No. of users for hot springs based on average number of users per water point for district.

Figure S15. Map of predicted geological fluoride risk zones in the Lake Chilwa basin (WRA 2) based on the on-going work of Addison et al. (in prep.)

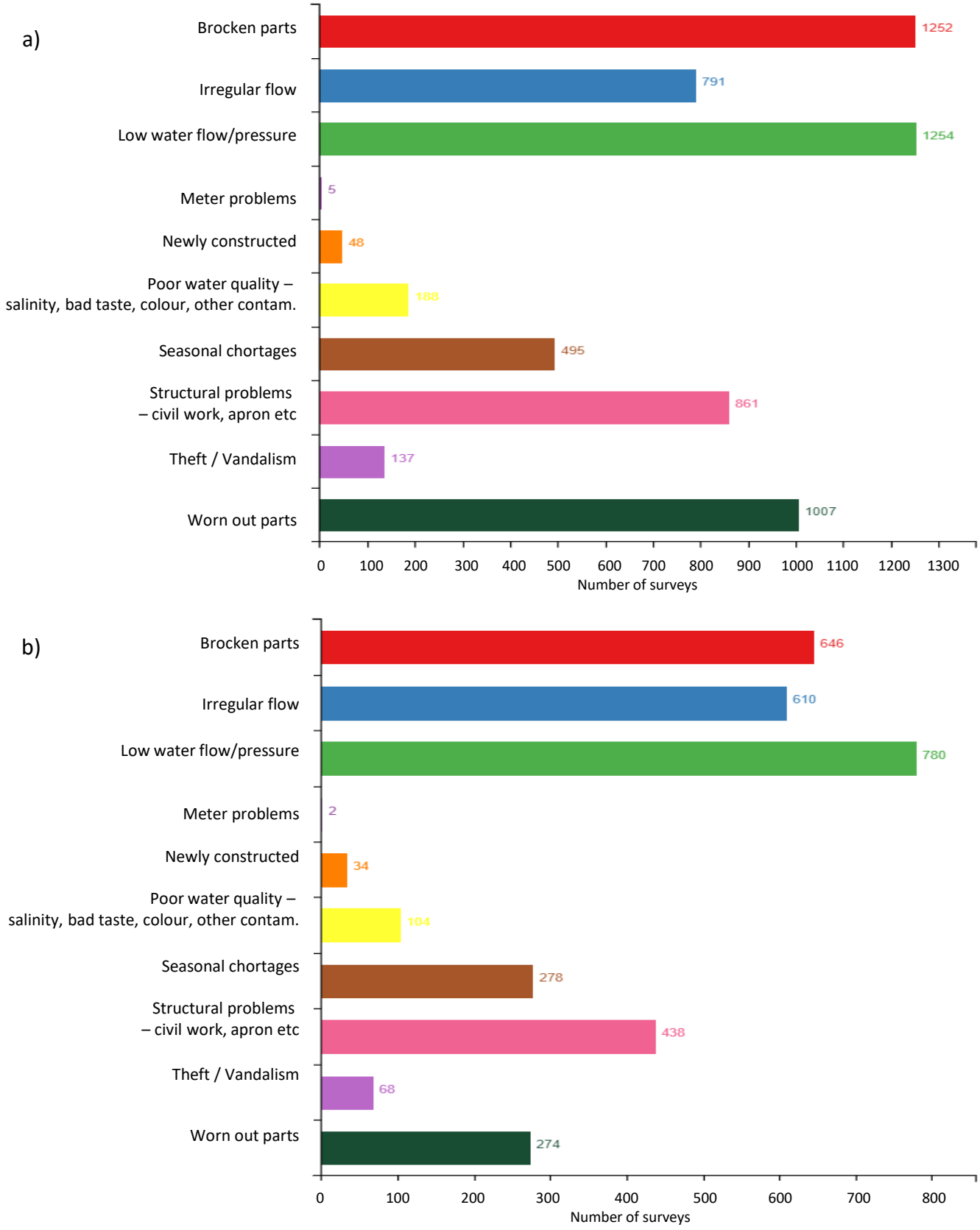
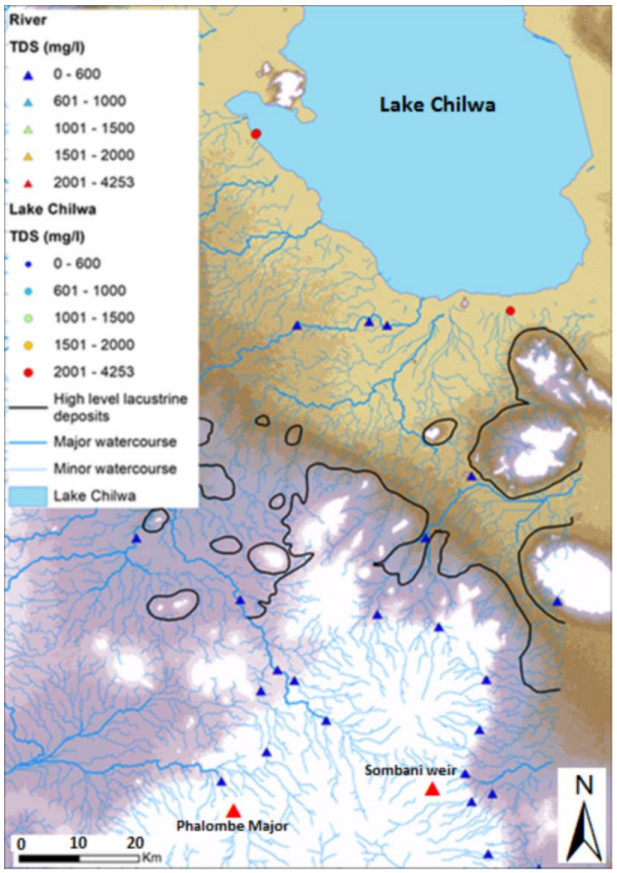


Figure S16. mWater Survey response to 'What is the current problem?' question posed to water points (all types) that are not functional or partially functional for a) Lake Chilwa Basin – WRA 2, and b) Phalombe District (data from mWater download May 2020).

a)



b)

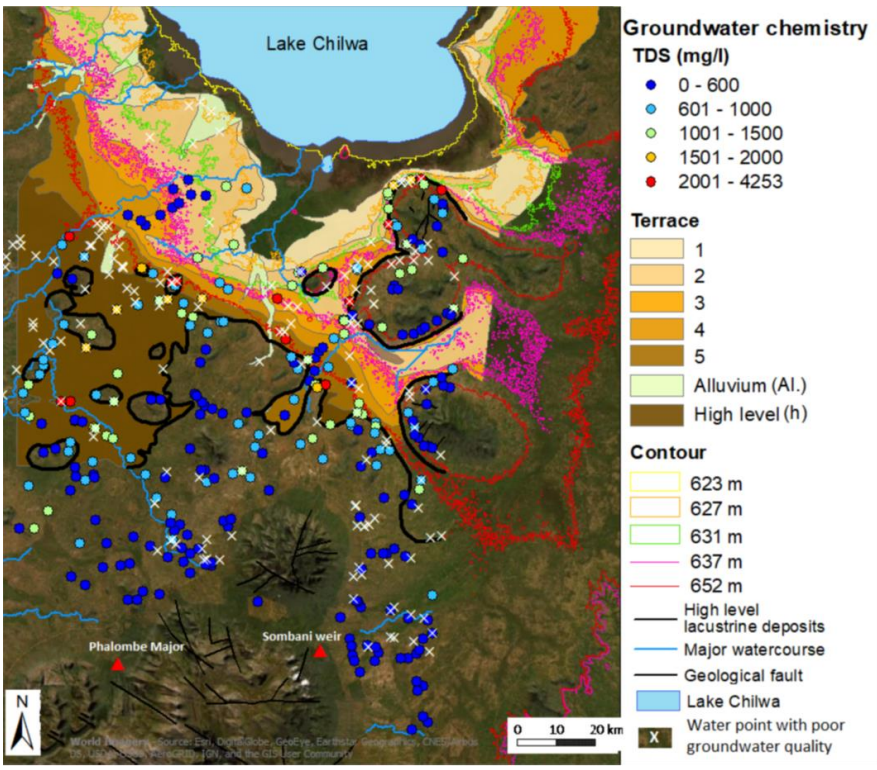


Figure S17. Location of two recently rehabilitating large gravity-fed water supply schemes, Phalombe Major and Sombani Weir located on (a) previous Figure S7 and (b) and previous Figure S12.