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The historic distribution of schistosomiasis transmitting snails in Mbombela and Nkomazi local municipalities

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Abstract:

Schistosomiasis is a neglected tropical parasitic disease that is transmitted by freshwater host snails and it enters humans through the skin when in contact with the infested water (Adenowo et al., 2015). Climate variability affects the prevalence and geographical distribution of schistosomiasis by influencing climate variables, such as temperature and precipitation (Adekiya et al., 2020). This influences the suitability of freshwater bodies that host the parasite and its snail host population. De Boni et al. (2021) noted that baseline information on the disease prevalence and distribution are important in implementing health programmes to reduce morbidity and prevalence of schistosomiasis. In order to plan successful interventions against the disease, and target communities in high-risk areas, it is important to be able to determine the past spatial and seasonal distribution of schistosomiasis at a reasonably fine scale, including the distribution of parasites and host species (Manyangadze et al., 2016; Aula et al., 2021).

Therefore, the study aims to map the historical distribution of two intermediate host snails, *Biomphalaria pfeifferi* and *Bulinus globosus*, by use of environmental variables. Historical snail data was accessed from the National Freshwater Snail Collection (NFSC) of South Africa for a period of 40 years, from 1955 to 1995.
Climatic and bioclimatic variables were obtained via satellite ERA5-Land as monthly averaged data. To eliminate multicollinearity within the variables a Principal Component Analysis and Pearson correlation was conducted on the bioclimatic and climatic variables. Any variables < 0.6 and > 0.8 were excluded. ArcGIS was used to prepare and align the variables within Mbombela, and Nkomazi local municipalities located in
the Mpumalanga province, South Africa. The data were loaded into MaxEnt to map the historical distribution of schistosomiasis. The jacknife test was used to evaluate the variables in MaxEnt.

The MaxEnt results for the historical distribution of *Biom. pfeifferi* and *Bul. globosus* indicated that the species react to climatic variables differently. The maps showed that *Bul. globosus* was found in the northern areas of Mbombela away from the main rivers such as the Crocodile River and this may be attributed to the snail being able to survive drier conditions compared to *Biom. pfeifferi*. Jacknife test showed that BIO 13 (Precipitation of the Wettest Month) was the most important variable for both snail species. The AUC value for *Biom. pfeifferi* was 0.843 and for *Bul. globosus* was 0.824 suggesting the model predicted the distribution of both snails with moderate accuracy. Suitable conditions for *Bul. globosus* were highly probable in the Mbombela local municipality and towards the northern parts of the municipality such as Nelspruit. The *Biom. pfeifferi* distribution was mostly centered along the Crocodile River and Matsulu. Both species were widely distributed along the border of the two local municipalities. It is important to model and map the historical distribution of species, such as schistosomiasis host snails, using a sound species distribution model to map areas that were and are vulnerable to schistosomiasis infection and transmission. This will aid in predicting areas that may be vulnerable to exposure in the future by using what is already known from historical behavior.

Understanding species historical distribution is one of the fundamental questions to determine risk (Dai et al., 2022). Pedersen et al., (2014) also modelled and mapped the impact of climate change impact on the spatial distribution of schistosomiasis host snails in Zimbabwe and concluded that climate change may cause a decrease in the spatial distribution of suitable habitats of host snails such as *Biom. pfeifferi.* This means that historical distribution patterns within Mbombela and Nkomazi local municipalities may have changed, and will possibly continue to change, due to shifts in the environmental variables. Climate change will more likely shift than expand the geographic ranges of the snail species within Mbombela and Nkomazi, and this is a pattern that has also been noted in other studies (McCreesh & Booth, 2013; Stensgraad et al., 2013; Pederson et al., 2014; Stensgraad et al., 2019).

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