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Environmental mechanisms of malaria transmission around water-resource reservoirs

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Background and Study Site

- Malaria is transmitted by female *Anopheles* mosquitoes, whose breeding sits are water bodies such as rain-fed pools and reservoirs.
- Dam construction is associated with adverse health impact such as malaria; however, seasonality in malaria transmission suggest that environmental factors, other than the existence of the reservoir, exist in dictating malaria transmission.

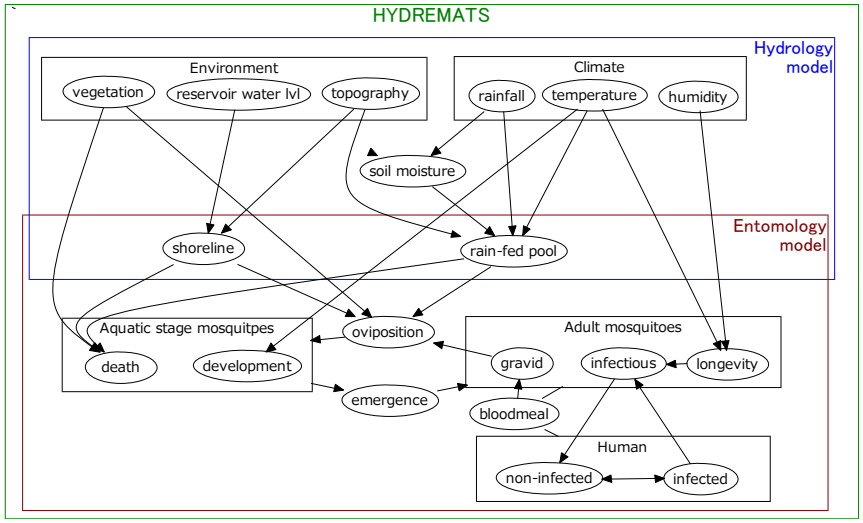
Research Question

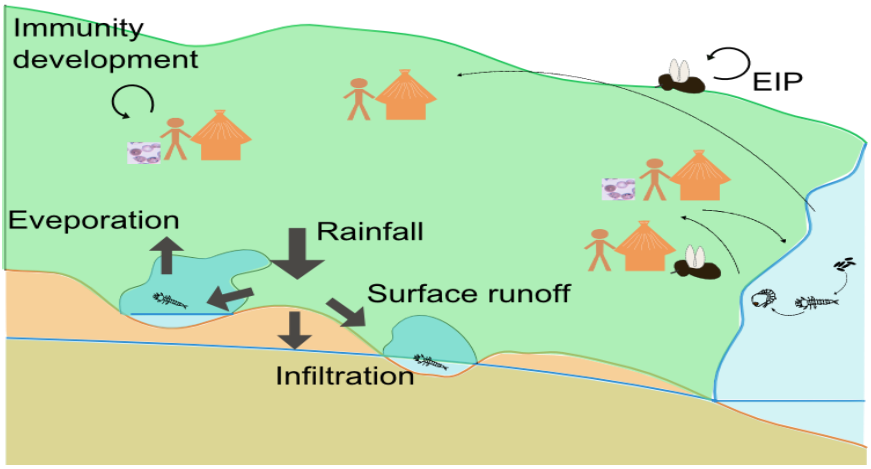
- What are the environmental mechanisms of malaria transmission around reservoirs?
- How can we prevent malaria, manipulating environmental factors?

Mechanistic Modeling Approach

The HYDRology, Entomology and MALaria Transmission Simulator, HYDREMATS (Bomblies *et al., 2008*) was modified to represent hydrology influenced by an adjacent reservoir system.

Its hydrology model is a distributed model, with spatially and temporally explicit representation of rain-fed pools, groundwater pools and reservoir shoreline breeding sites. Using them as inputs, as well as meteorological data, its entomology model simulates the dynamics of *Anopheles* mosquito population and malaria transmission. The entomology model is an agent-based model, simulating the behaviors of individual mosquito, such as aquatic stage development, host-seeking flight, taking bloodmeals, oviposition, and EIP. It also simulates human immunity development. HYDREMATS has been tested successfully over West Africa.

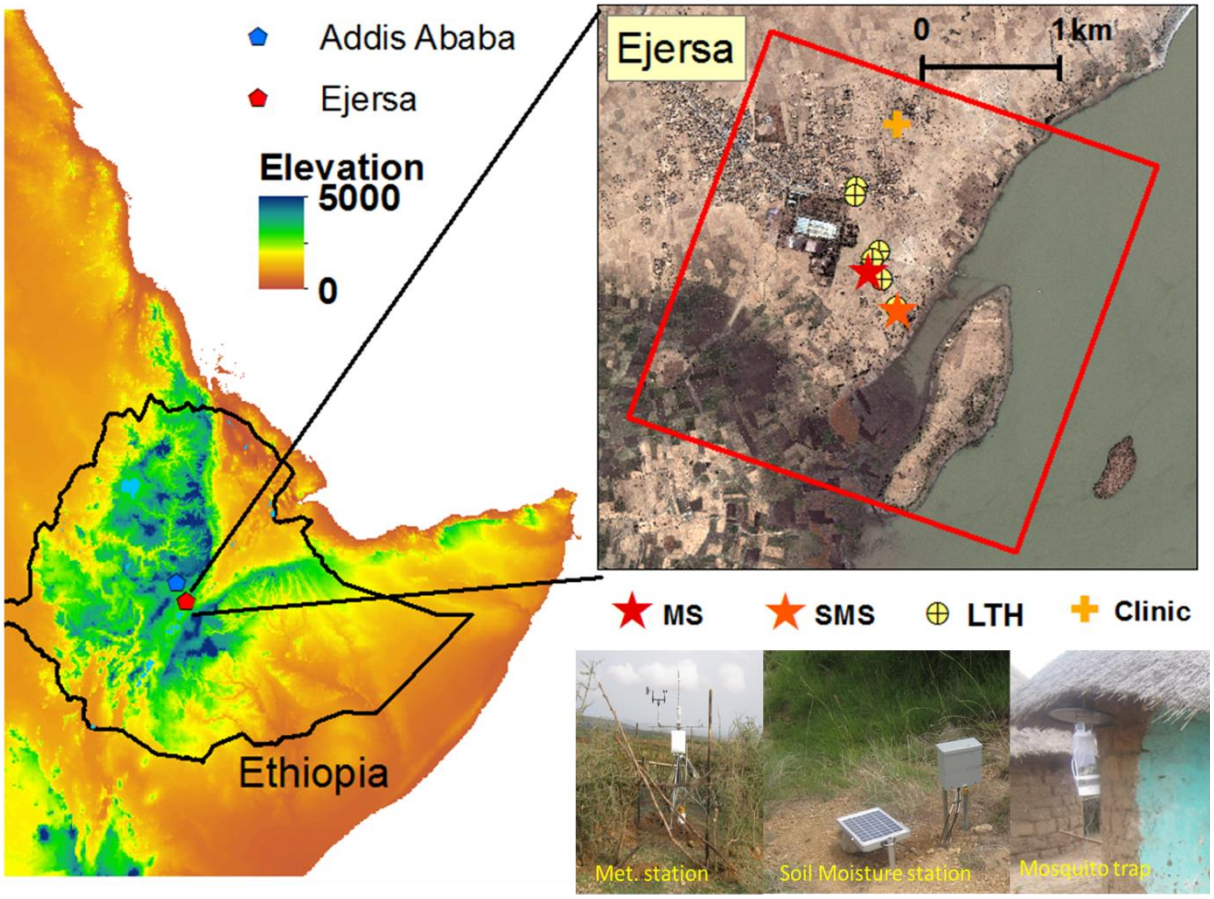




Field Surveys

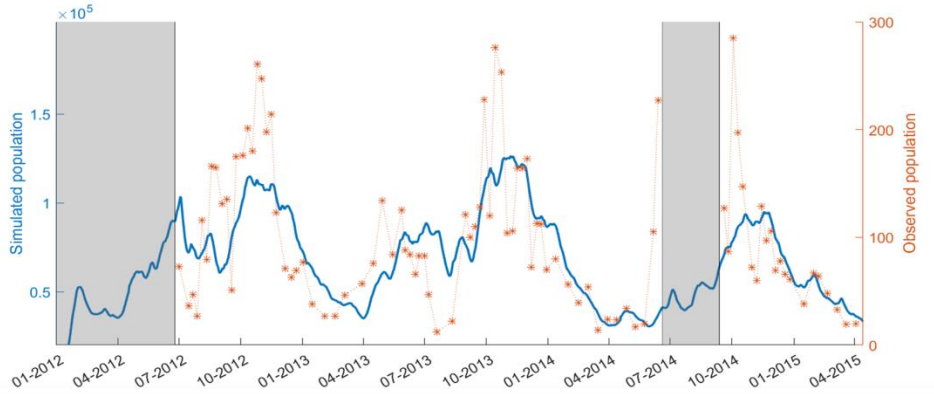
Field monitoring campaign at villages around the Koka Reservoir, Ethiopia.

- Mosquito population
- Larvae breeding sites and population
- Clinical data
- Meteorology
- Soil moisture
- Reservoir water levels and shorelines

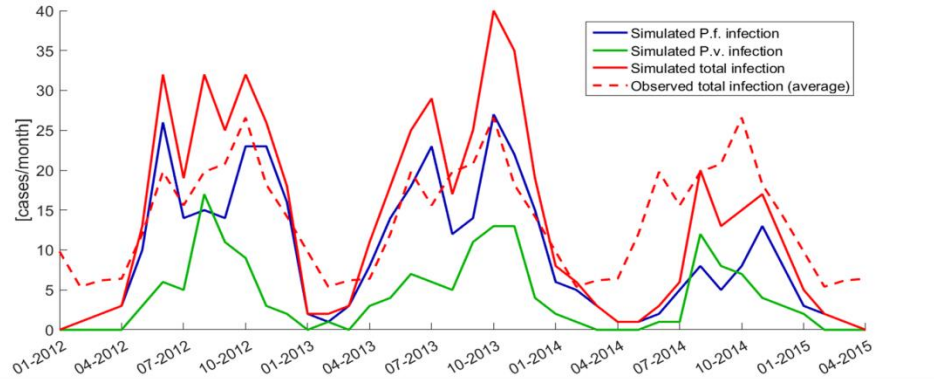


Observations and Simulations

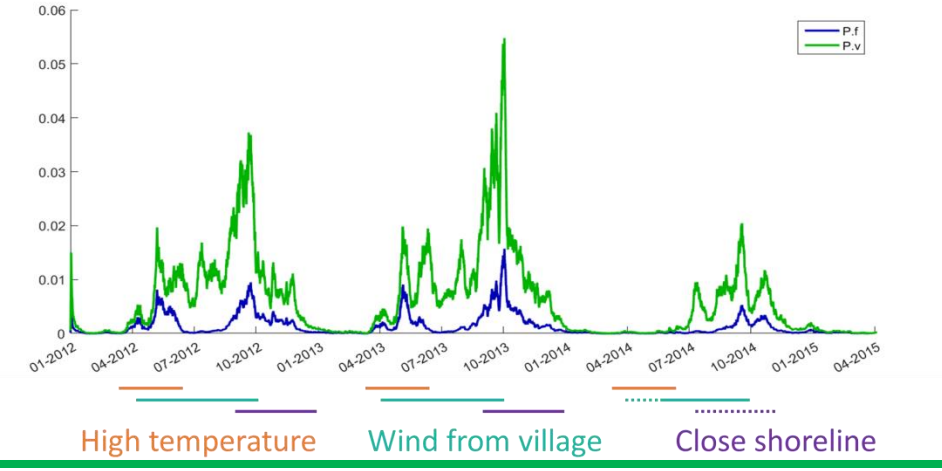
Anopheles population



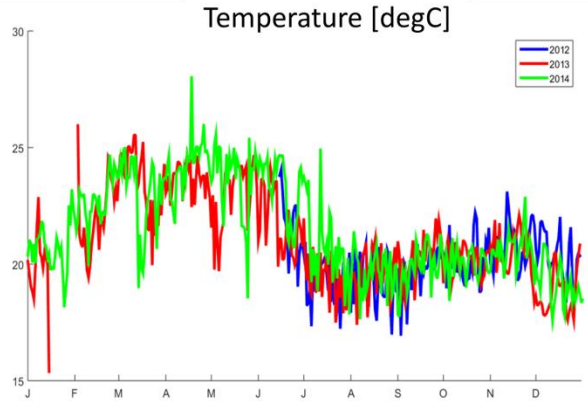
Malaria infections



Vectorial Capacity

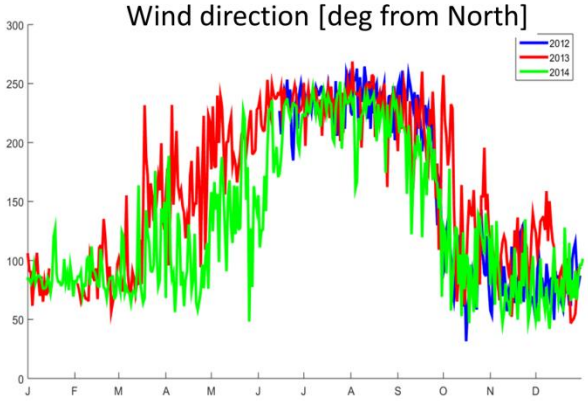


Observations and Simulations



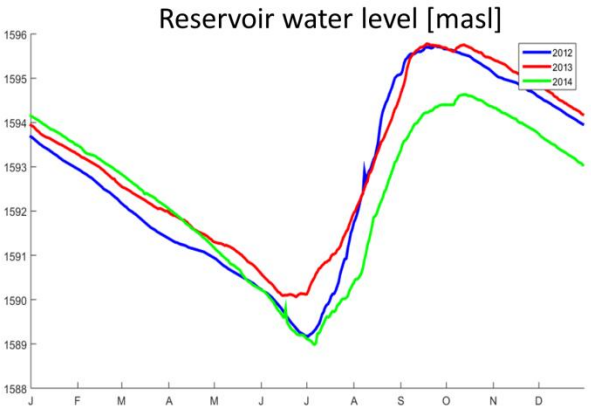
High temperature

Higher temperature from May through June increases malaria transmission through reduction in parasite development time.



Wind from village

Mosquitoes are likely to sense the location of the village more effectively when wind comes from the village. Small mosquito population in Apr. – June 2014 may be explained by the wind direction.



Close shoreline

Reservoir shoreline (=mosquito breeding site) nears the village as reservoir water levels rise, which makes malaria transmission more efficient.

Conclusions

- Based on extensive field surveys in Ethiopia, a mechanistic malaria transmission model, HYDREMATS, was developed to simulate malaria transmission around reservoirs.
- Around reservoirs, where water is not limiting, malaria transmission is influenced by the following three environmental mechanisms: high temperature, wind from village, and close shoreline.
- Malaria around reservoirs can be prevented if these environmental factors are incorporated into the planning of village locations.

Acknowledgement

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