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Simulation of Hydrology and Dynamics of Anopheles Mosquito Population around the Koka Reservoir, Ethiopia

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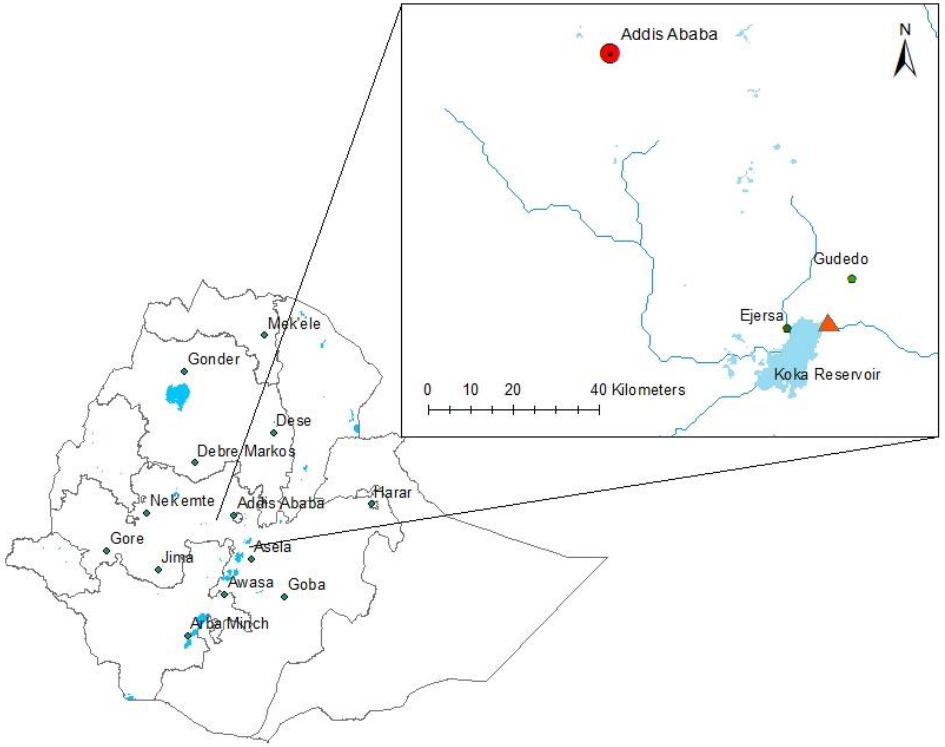
Background and Study Site

- 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.
- Ethiopia has a large hydropower potential. Thus, its future risk of malaria is large. We selected study sites around the Koka Reservoir in Ethiopia; one adjacent to the reservoir, Ejersa, and the other approximately 12 km away from it, Gudedo.

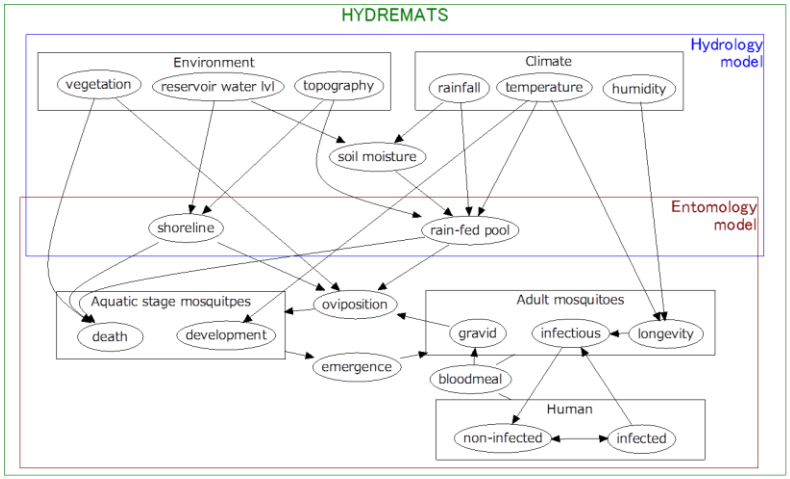
Research Question

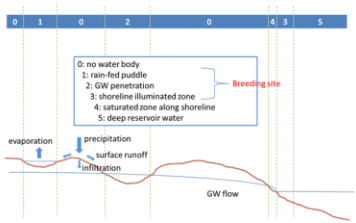
- Can we simulate hydrology around the reservoir?
- Can we simulate the difference in *Anopheles* population dynamics at the two villages?



Mechanistic Modeling Approach

The HYDRology, Entomology and MALaria Transmission Simulator, HYDREMATS (Bomblies *et al., 2008*) was modified to represent how the hydrology in nearby villages is influenced by the reservoir system. Its hydrology model is a distributed model and simulates the formation of rain-fed pools, groundwater pools and reservoir shoreline breeding sites explicitly. Using them as inputs, as well as meteological parameters, its entomology model simulates the dynamics of *Anopheles* mosquito population. The entomology model is an agent-based model, simulating the behavior of individual mosquito such as aquatic stage development, host-seeking flight, taking bloodmeal, oviposition and malaria transmission.



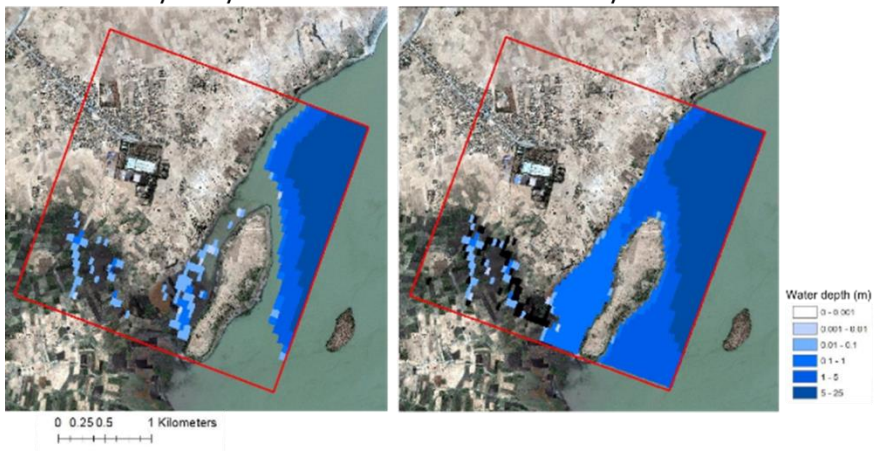


Hydrology model simulates three types of breeding pools: rain-fed pool, groundwater pool and reservoir shoreline water.

Hydrology model output

Secondary rainy season

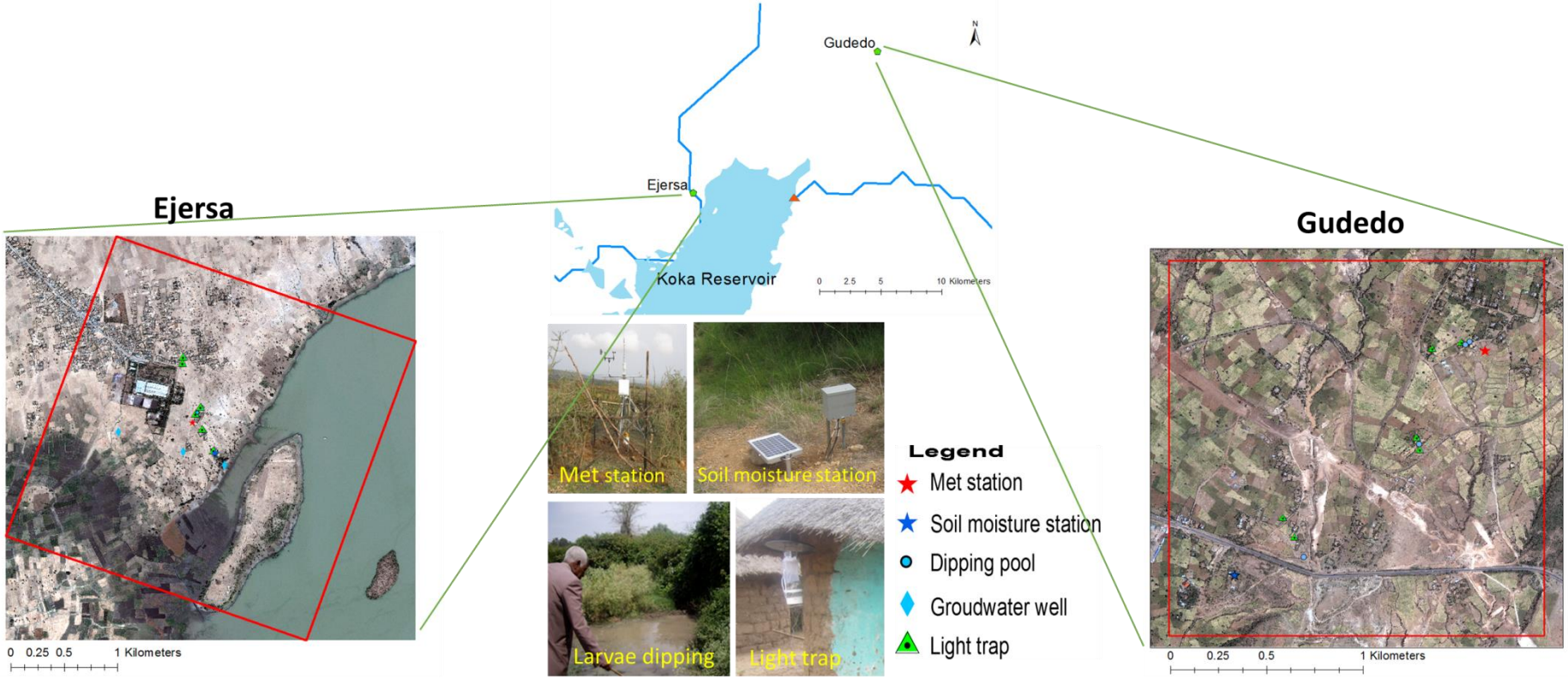
Main rainy season



Snap shots of hydrology model output are shown. Shoreline changed by 600m in a year. Only shallow area at the shoreline is used as mosquito breeding site.

Field Surveys

Two field sites selected around the Koka Reservoir.
-Ejersa: adjacent to the reservoir
-Gudedo: 12km away

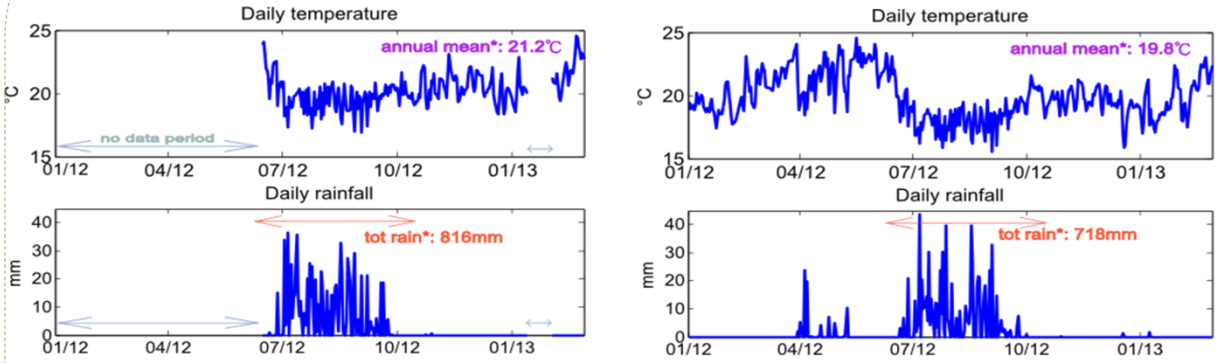


Hydrology and Entomology around the Koka Reservoir

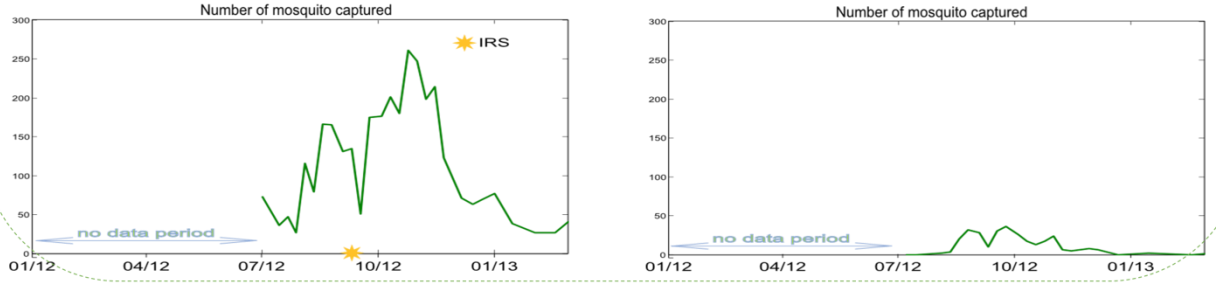
Observations

Ejersa **Gudedo**

Gudedo and Ejersa have similar climatology.

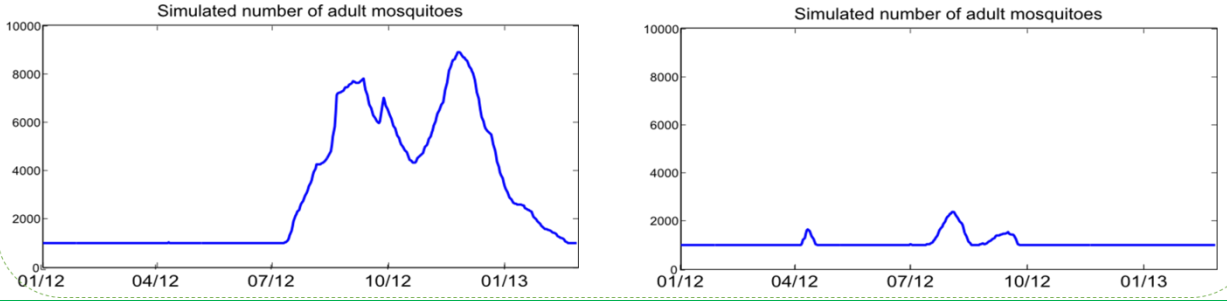


However, entomology is different. Ejersa has enhanced and prolonged mosquito season.



Simulations

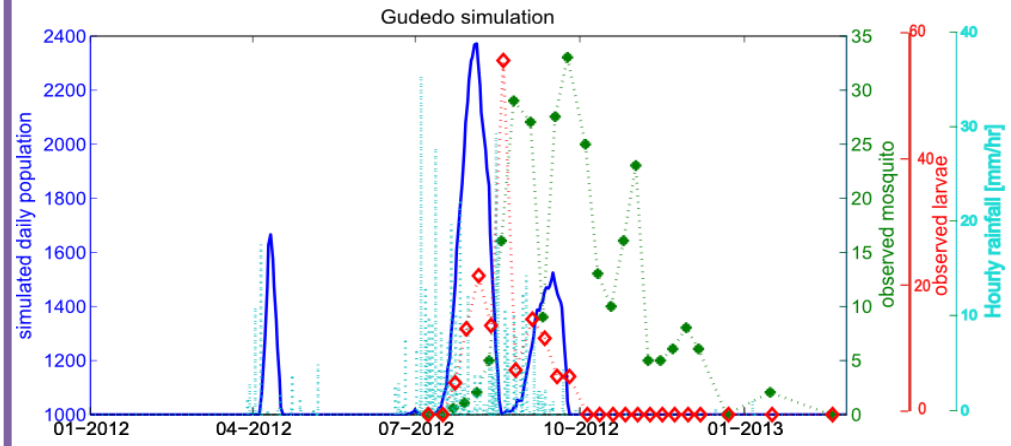
HYDREMATS captures the difference in population dynamics well.



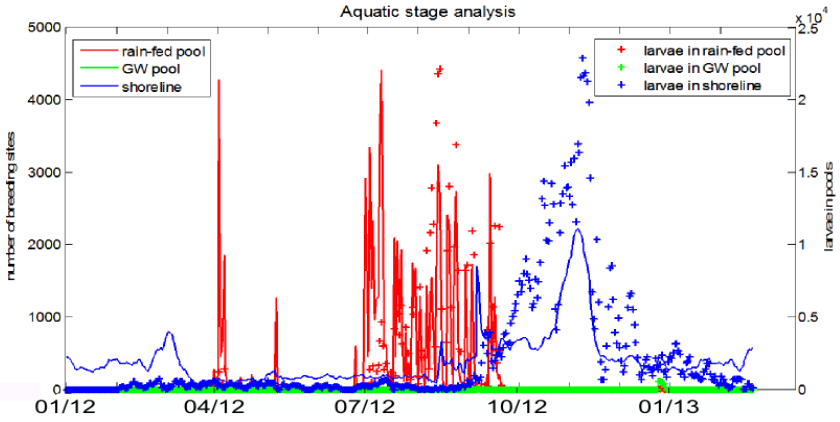
What explains the mosquito population difference?

In Gudedo, *Anopheles* mosquito population dynamics follow rainfall patterns. The simulated mosquito population result matches observed larvae data. Observed adult mosquitoes after the rainy season are likely due to migration from outside the simulation domain.

Larger mosquito population was simulated in Ejersa because more persistent rain-fed pools are created due to its topography, shallow groundwater table, and the existence of the reservoir. Prolonged mosquito season is caused by creation of shoreline pools due to inundation of shallow area at reservoir high levels from Sep.-Nov.



Simulated number of adult mosquito is shown in (blue-). The observed adult mosquitoes and larvae are shown in (green*) and in (red ◊), respectively. Observed precipitation is in (light blue:).



Number of breeding sites (solid lines) and aquatic stage mosquitoes (asterisks) simulated for each type of pool: rain-fed pool (red), groundwater pool (green) and reservoir shoreline (blue).

Conclusions

- Despite similar climatological conditions, only Ejersa experiences enhanced and prolonged mosquito seasons.
- HDYDREMATS was able to simulate the hydrology influenced by the reservoir system and the dynamics of *Anopheles* mosquito population well in both villages. The model will be validated for a longer period in the future.
- Our model has future implications for vector control around reservoirs.

Acknowledgement

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