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Water borne disease control via dam operation: balancing hydropower production and malaria control on the Kariba lake

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Malaria is a major cause of morbidity and mortality in Sub-Saharan Africa, affecting the lives of at least 200 millions of people each year in the region. While a set of measures already exist to contrast malaria, these measures have failed to fully control the disease. New efforts, focusing on the effect of water bodies on malaria diffusion revealed that the disease burden is higher in the proximity of artificial water reservoirs, where the presence of still water creates larger breeding sites for Anopheles mosquitoes transmitting Plasmodium falciparum. For this reason, a current effort is exploring how alteration to water levels via dam operation may provide a complementary solution to malaria control in the proximity of artificial lakes. In this work, we identify the impact of malaria around Kariba lake, shared between Zambia and Zimbabwe, and seek to develop an operational model of malaria control via dam operation for the lake itself. At present, Kariba dam is primarily operated to produce hydropower energy and goes through a single draw-down fill-in cycle following the dry-wet season yearly alternation. We explored the correlation between malaria incidence and proximity to the reservoir shoreline in eight transects around the reservoir. We also determined relationships between average water levels, several hydro-climatic variables, including temperature and precipitation, and average malaria transmission levels in communities around the reservoir. Based on the highest correlations found, we built a model of malaria diffusion mapping lake level, temperature and precipitations into interannual changes of malaria rate. A Multi-objective Evolutionary Direct Policy Search approach is adopted to design the dam operation balancing the two targets of hydropower production and malaria control. Results allow to explore tradeoffs between malaria diffusion and hydropower production and assess the marginal value of malaria reduction. The model may help to support decision-making around operations of the dam, which may prove increasingly relevant as more hydropower comes online in the basin enabling greater operational flexibility in the management of particular dams such as Kariba.