Projecting the risk of mosquito-borne diseases in a warmer and more urbanized world

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Background

- Rising global-mean temperature increase concerns that malaria and dengue **will intensify their transmission** particularly in tropical highlands and urban areas.
- Both diseases are expanding their spatial range, gradually **emerging** in areas previously considered disease-free and **re-emerging** in areas where they had subsided for decades.
- The importance of climate change compared to other drivers such as **population density and urbanisation** remains under debate.
- Estimates across a altitudinal and population density gradients **have not yet been produced.**

Objectives

- We project the risk of malaria and dengue for 4 RCP and 3 SSP scenarios using a **multi climate-model and multi disease-model** approach.
- To build on the previous work by comparing and contrasting historical and future projections of malaria and dengue.
- To assess changing risk profiles **along altitudinal and population density gradients** and investigate changes in the length of the transmission season (LTS) and population at risk (PAR), to aid policy makers.

Methods

Models used

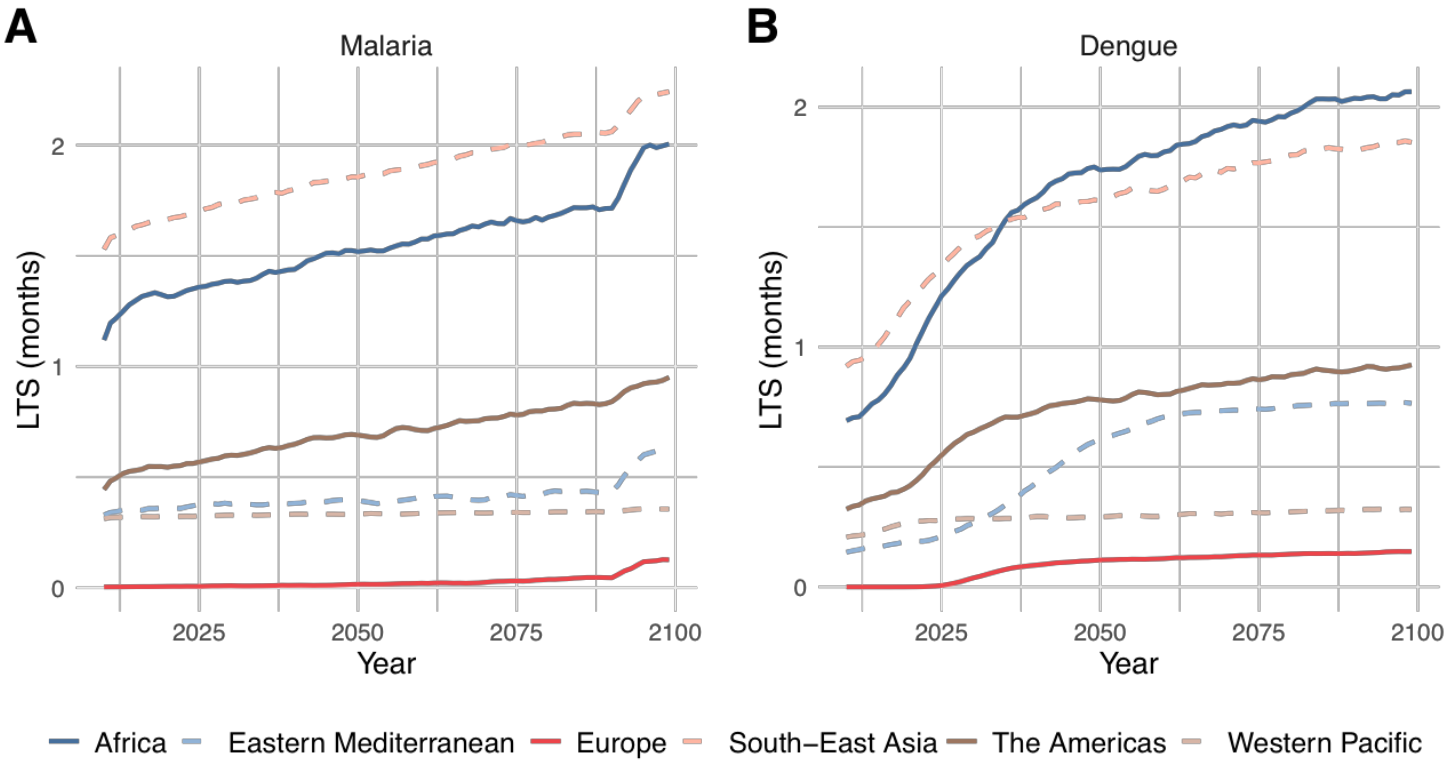
Malaria	Dengue
Liverpool Malaria Model (Mathematical)	Umea *Aedes aegypti* (Mathematical)
VECTRI (Mathematical)	Umea *Aedes albopictus* (Mathematical)
Lancet Countdown (Threshold-based)	DGM (Statistical)

	RCP2.6	RCP4.5	RCP6.0	RCP8.5
SSP1	X			
SSP2	X	X	X	X
SSP5				X

Metric	Definition
Length of the transmission season (LTS)	Number of suitable months/days per year
Population at risk (PAR)	Total population in a grid cell having at least 1 suitable month in a year

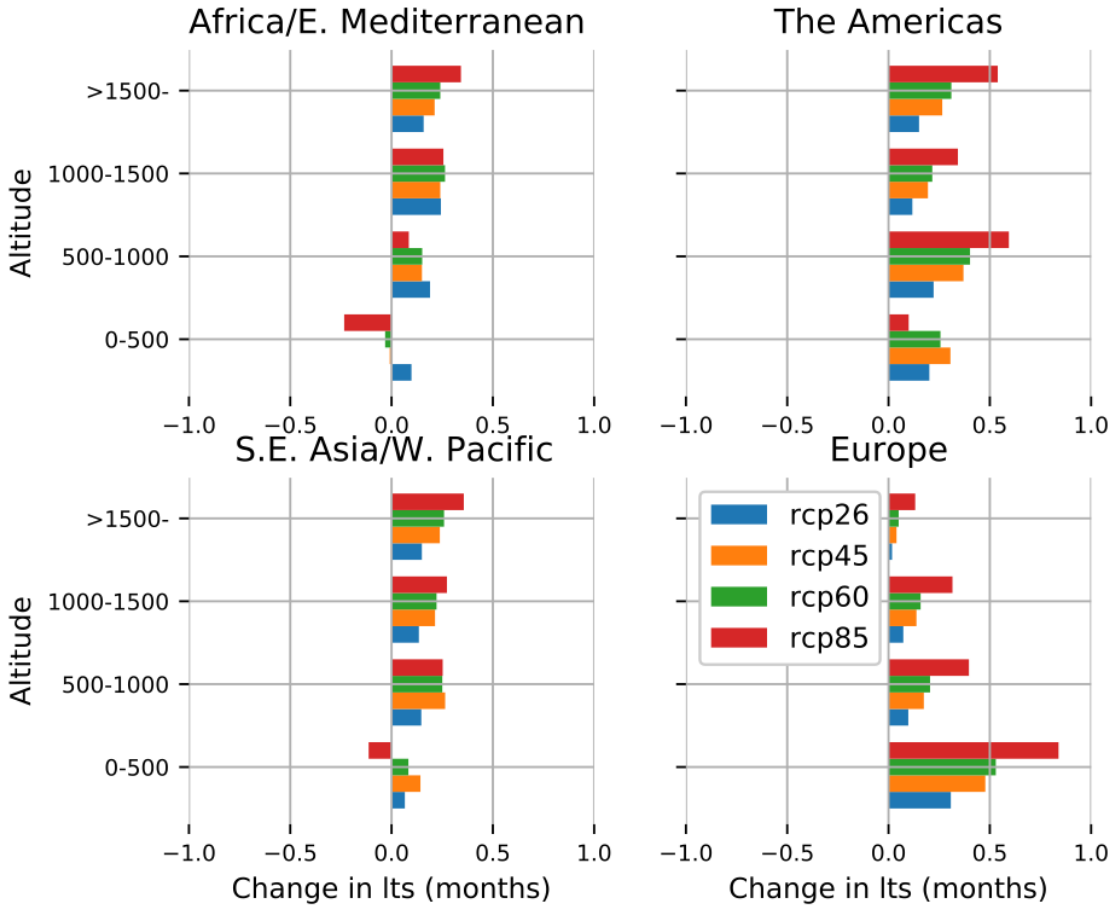
Results – LTS in Highland areas (>1500 m.a.s.l.)

- **Consistent yet small increases** between 0.5-2 additional months in the LTS of malaria over highland areas in Africa, South-East Asia and the Americas albeit with large regional and between-model differences.
- Similar results were obtained for dengue in Africa, south-east Asia, the western Pacific, and the Americas.



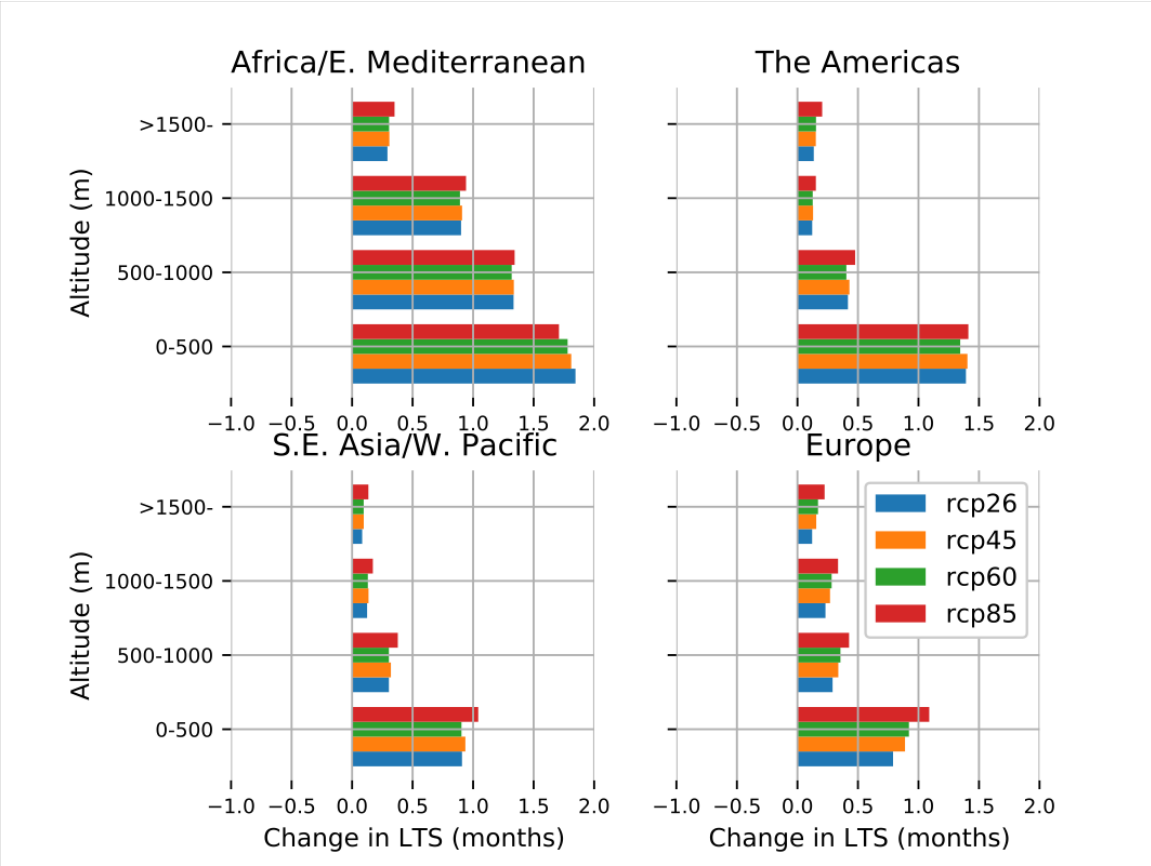
Results – LTS by altitude gradient (malaria)

Relative to the reference period 1970-1999, changes in the LTS of malaria are simulated **to increase with altitude** in Africa, the western Pacific, the Americas, and south-east Asia with the largest changes predicted at altitudes above 500 masl.



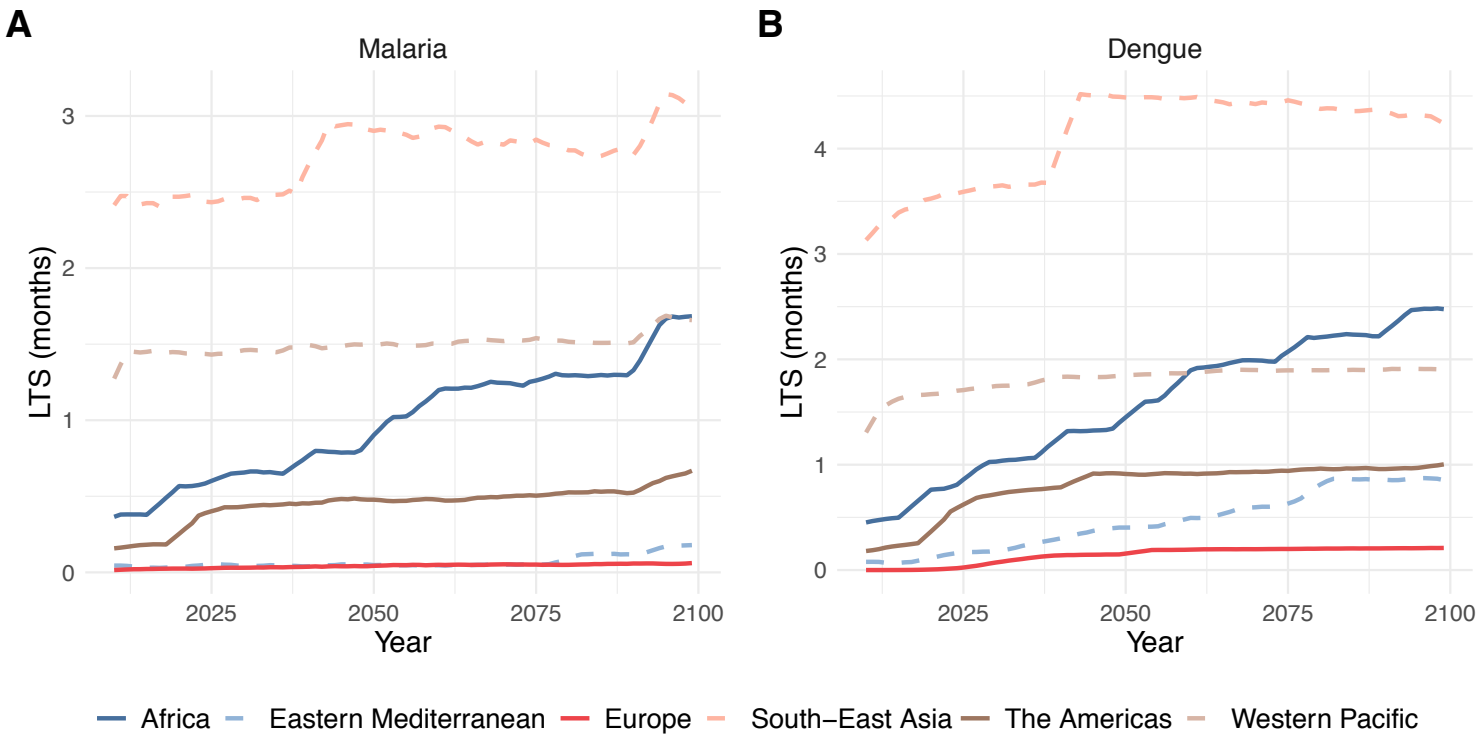
Results - LTS by altitude gradient (dengue)

Conversely, changes in the LTS of dengue are simulated **to decrease with altitude** across all regions with the largest changes predicted at altitudes between 0-500 masl relative to the reference period 1970-1999,



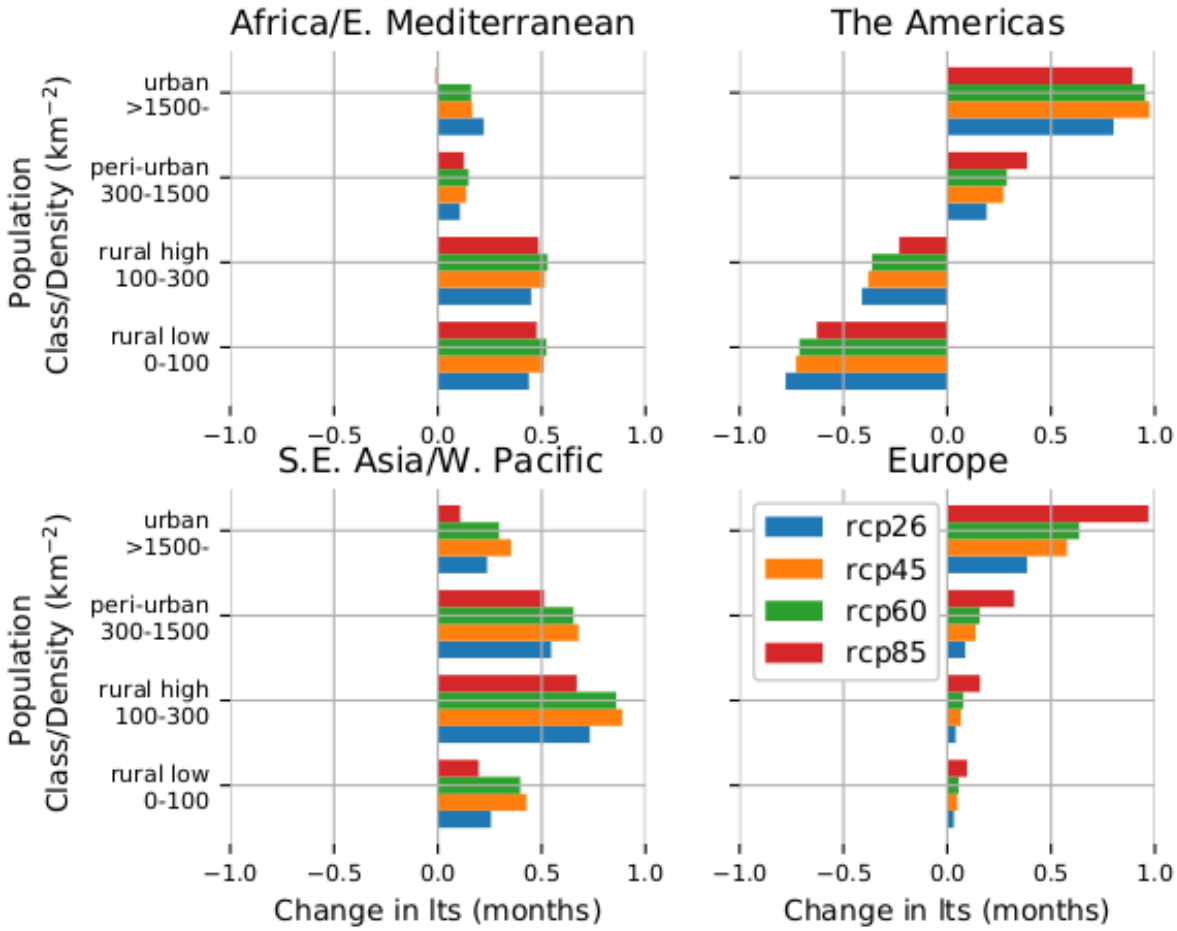
Results – LTS high-density urban areas (>1500 people km²)

- Models predict **increases in malaria LTS** high-density urban in South-East Asia, Africa, and the Americas.
- Increases in the LTS of dengue are predicted in all regions, though they are **more consistent** in Africa and the eastern Mediterranean.



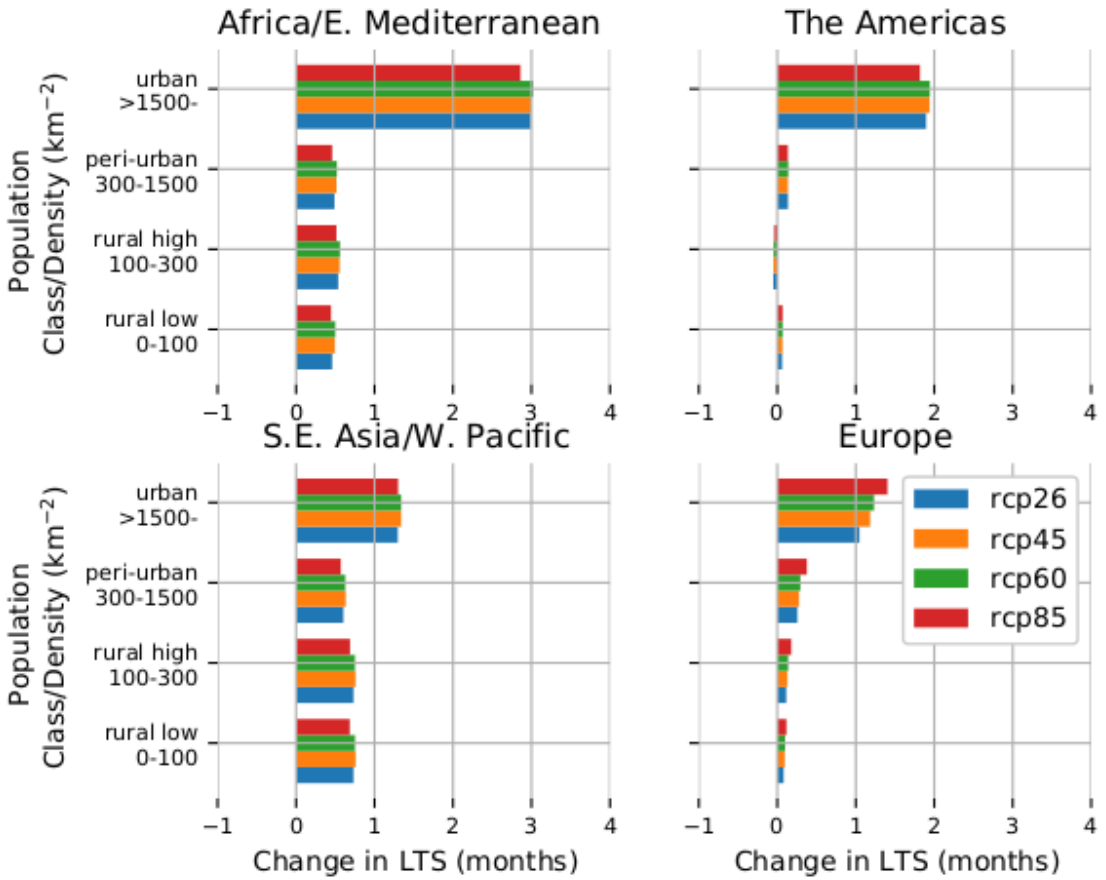
Results – LTS by population gradient (malaria)

- Compared to the reference period, and stratified by population density gradients, the largest **increases in malaria LTS** are simulated in highly populated areas of the Americas and Europe followed by rural areas in SEA and Africa/E. Mediterranean.
- **Decreases** in LTS are simulated in rural areas in the Americas



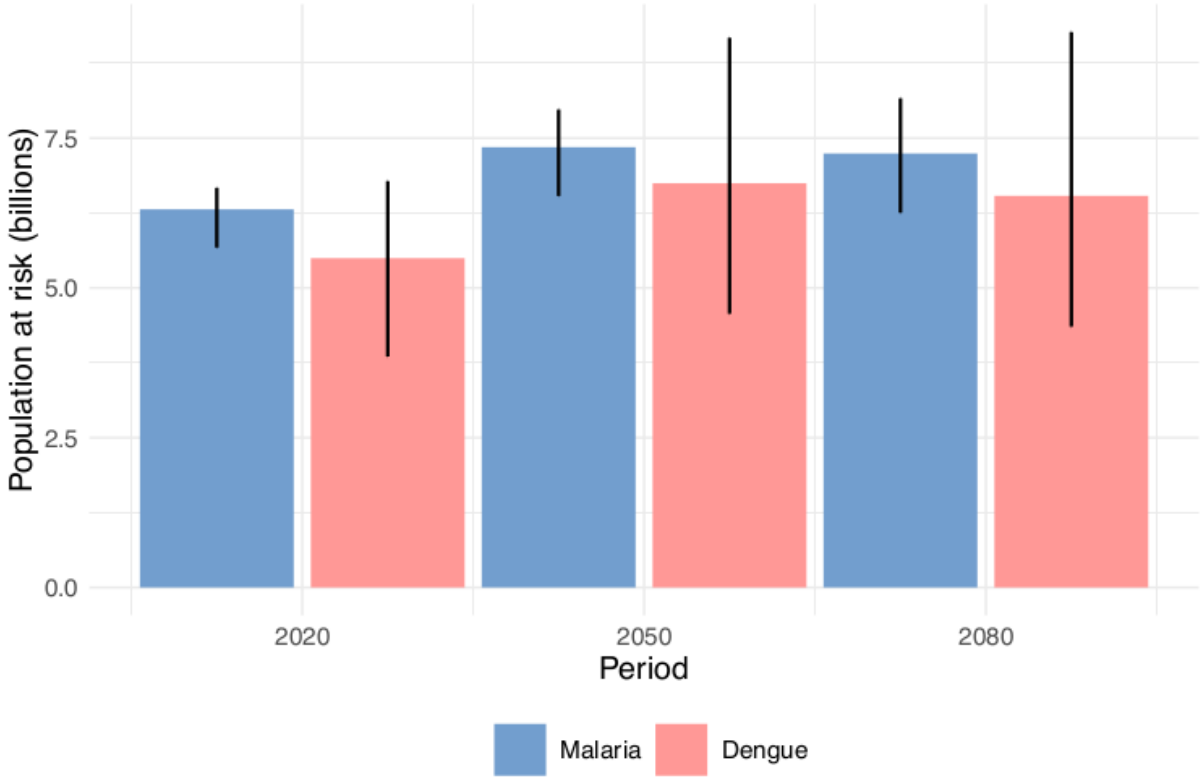
Results – LTS by population gradient (dengue)

- Compared to the reference period, and stratified by population density gradients, the largest **increases in dengue LTS** are simulated in highly populated areas in all regions as expected.



Results - PAR

- Increases in PAR of malaria (blue bars) and dengue (red bars) were simulated over time.
- Similar patterns were observed across RCP and SSP.
- **PAR increases in the 2050s** and slightly decreases towards the end of the century.



Conclusions

- Based on our findings, increased control efforts and surveillance should focus in tropical high-altitude regions in Africa for malaria, and over low elevation semi-temperate and temperate urban regions for dengue, **without neglecting** urban hotspots in tropical climates.

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Thank you for your attention!

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