“Climate change increases the risk of malaria transmission in South Africa”

Monique Shanahan (UP ISMC)
Co-authors: Richard Hassall (UK Centre for Ecology & Hydrology), Nada Abdelatif (SAMRC), Gbenga Abayomi Afuye (University of Fort Hare), Bernard W.T. Coetzee (University of Pretoria)

UP ISMC
UNIVERSITY OF PRETORIA
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Introduction

- Malaria is responsible for ~247 million infections globally
  - Increased by 15 million since 2019
  - ~619 000 deaths annually
- Climate and land use change will intensify global rates of malaria transmission and vector distributions
  - Prolonged seasonal transmission
  - Geographical expansion
- Larger scale analysis often under- or overestimate local relationships between climate change and malaria
- Including a wider range of species increases our understanding on malaria transmission and vector ecology patterns

https://climateclock.world/

Aim

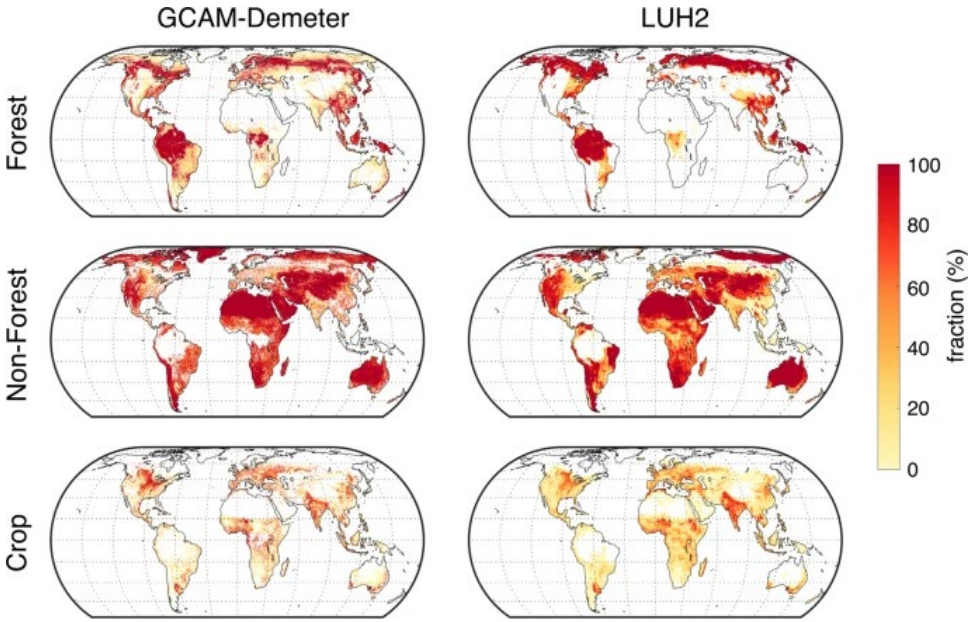
- To improve the current understanding of how climate change and land use will influence vector habitat suitability
    - Multiple malaria vectors across the north-east of South Africa.
- Identify the overlap of vector habitat suitability with areas predicted to be suitable for malaria transmission.
    - Seasonal transmission
    - Future population density

Methods

- Vector species presence 1990-2020
  - PubMed=64, Google Scholar=239, ScienceDirect=949
  - 161 898 *Anopheles* records
- 11 Abiotic variables
  - Worldclim, Copernicus, Chen *et al.* 2020, Domisch *et al.* 2015
  - Temperature, precipitation, vegetation, waterbodies, land use *etc*.
- Ensemble Model BIOMOD2
  - Pseudo-absence selection techniques
  - GLM, GAM, MARS, GBM, RF, ANN
  - cAUC, TSS, Boyce Index

Global land use for 2015–2100 at 0.05° resolution under diverse socioeconomic and climate scenarios

Min Chen[1]✉, Chris R. Vernon[2], Neal T. Graham[1], Mohamad Hejazi[1], Maoyi Huang[2,3], Yanyan Cheng[2] & Katherine Calvin[1]



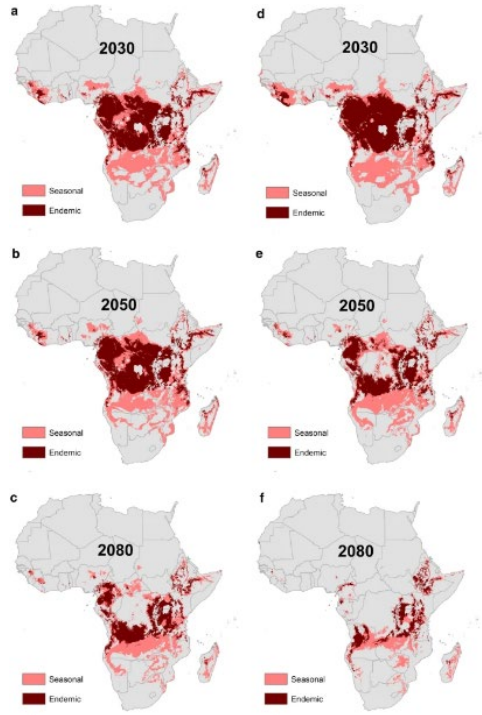
Methods

- Shared Socioeconomic Pathways
  - SSP2 (medium population growth, medium land use)
  - SSP3 (high population growth, high land use)
- Malaria transmission suitability
  - Ryan *et al*. 2020
  - Staked vector habitat suitability
  - Seasonal transmission
  - SSP2 vs SSP3

RESEARCH Open Access

Shifting transmission risk for malaria in Africa with climate change: a framework for planning and intervention

Sadie J. Ryan[1,2,3*], Catherine A. Lippi[1,2] and Fernanda Zermoglio[4]



Results

- Important variables influencing vector habitat suitability in Africa
  - Mean annual precipitation
  - Mean annual temperature
  - Physiological and/or behavioural variations
  - Sinka *et al*. 2010

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The dominant *Anopheles* vectors of human malaria in Africa, Europe and the Middle East: occurrence data, distribution maps and bionomic précis

Marianne E Sinka[1*], Michael J Bangs[2], Sylvie Manguin[3], Maureen Coetzee[4,5], Charles M Mbogo[6], Janet Hemingway[7], Anand P Patil[1], Will H Temperley[1], Peter W Gething[1], Caroline W Kabaria[8], Robi M Okara[8], Thomas Van Boeckel[1,9], H Charles J Godfray[1], Ralph E Harbach[10], Simon I Hay[1,8*]

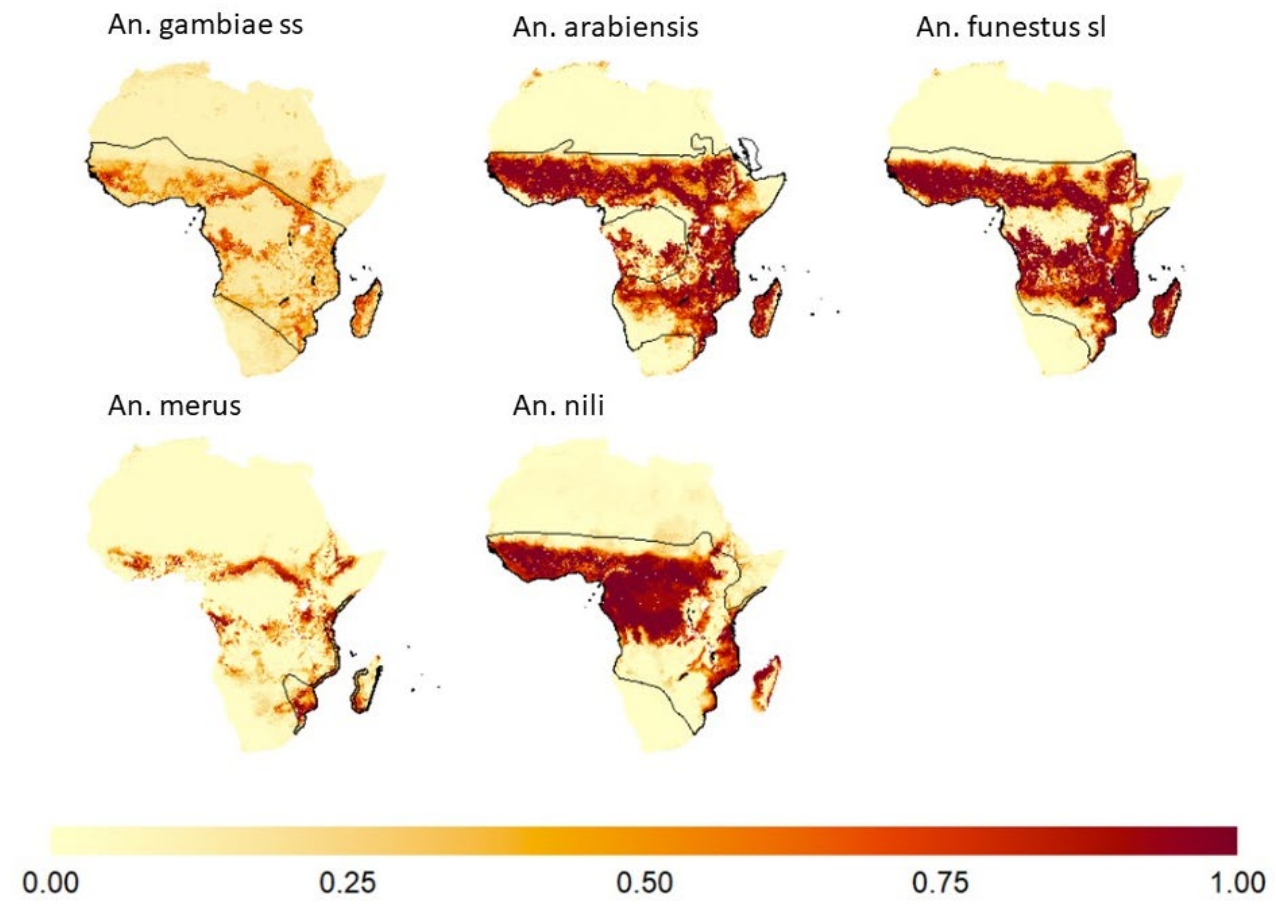

Figure 1: Final suitability estimates for all 5 vector species across Africa. 0 indicates low suitability and 1 indicates high suitability for a species. Polygons show ranges put forward by Sinka *et al*. (2010)

Results

- Increasing vector habitat suitability in South Africa
  - Kwazulu-Natal
  - Limpopo
  - Mpumalanga
  - Eastern Cape
  - Free State
  - Gauteng
  - North West

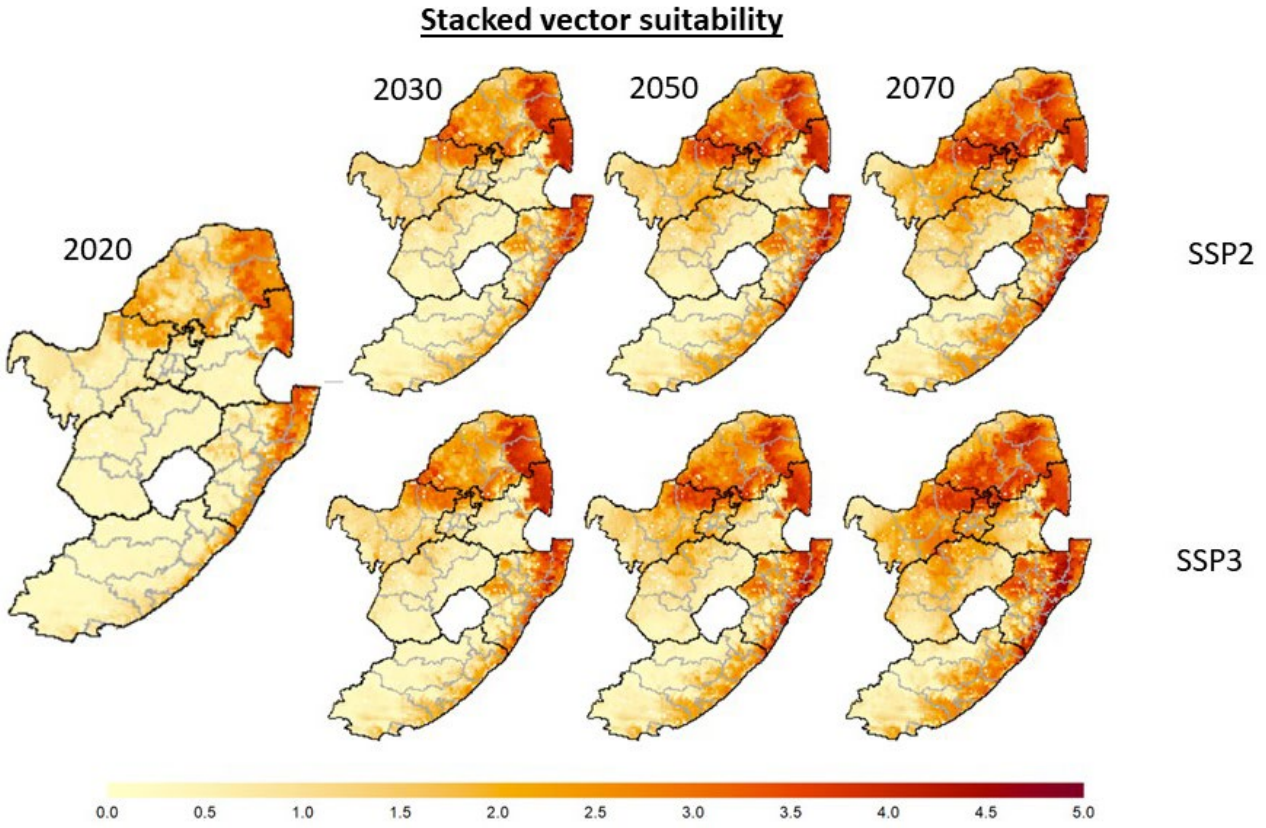

Figure 2: Stacked suitability layers for five focal vectors with 5 representing very high suitability for all vector species and 0 indicating very low suitability for all vectors. Map covers Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga and North West provinces.

Results

- Moderate malaria transmission
  - KwaZulu-Natal, Limpopo, Mpumalanga, Eastern Cape, Free State, Gauteng and North West Provinces
- Seasonal malaria transmission
  - KwaZulu-Natal, Limpopo, Mpumalanga, Gauteng and North West Provinces
- Endemic malaria transmission
  - None

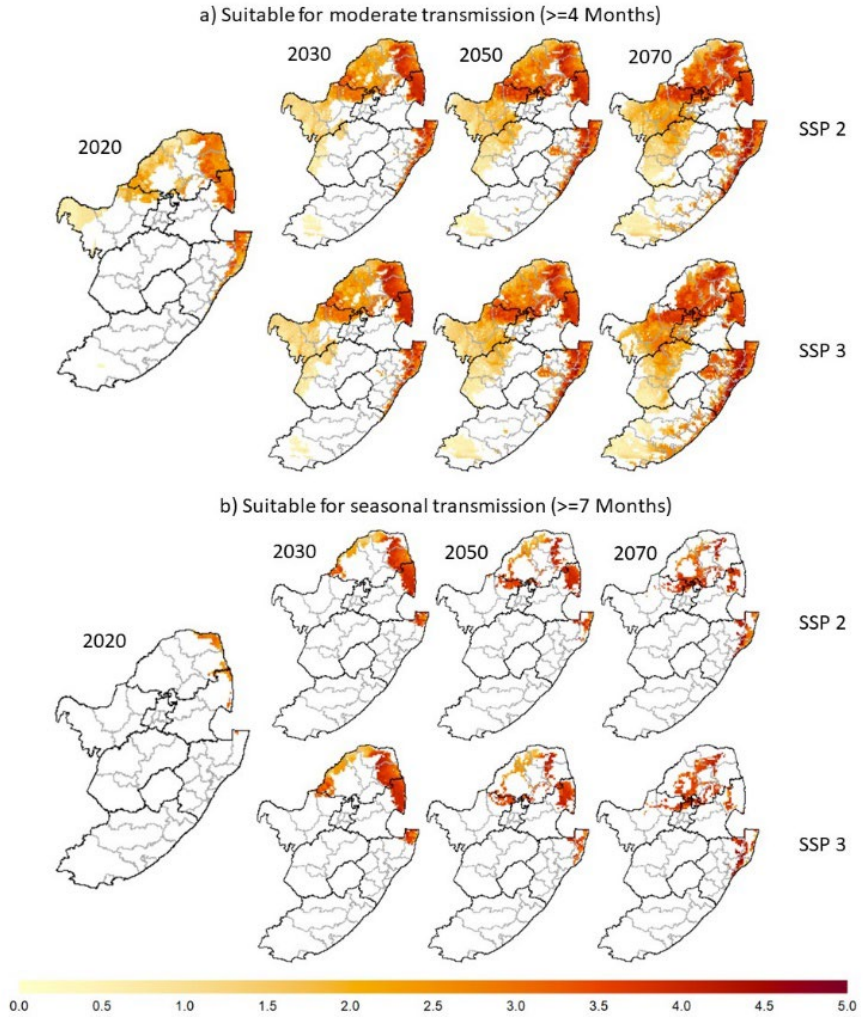

Figure 3: Stacked suitability layers for all 5 vectors only showing areas with temperatures suitable for a) moderate and b) seasonal malaria transmission.

Results

- Population at risk
- Moderate malaria transmission
  - 5.36 - 32.1 million
- Seasonal malaria transmission
  - 0.25 - 7.9 million

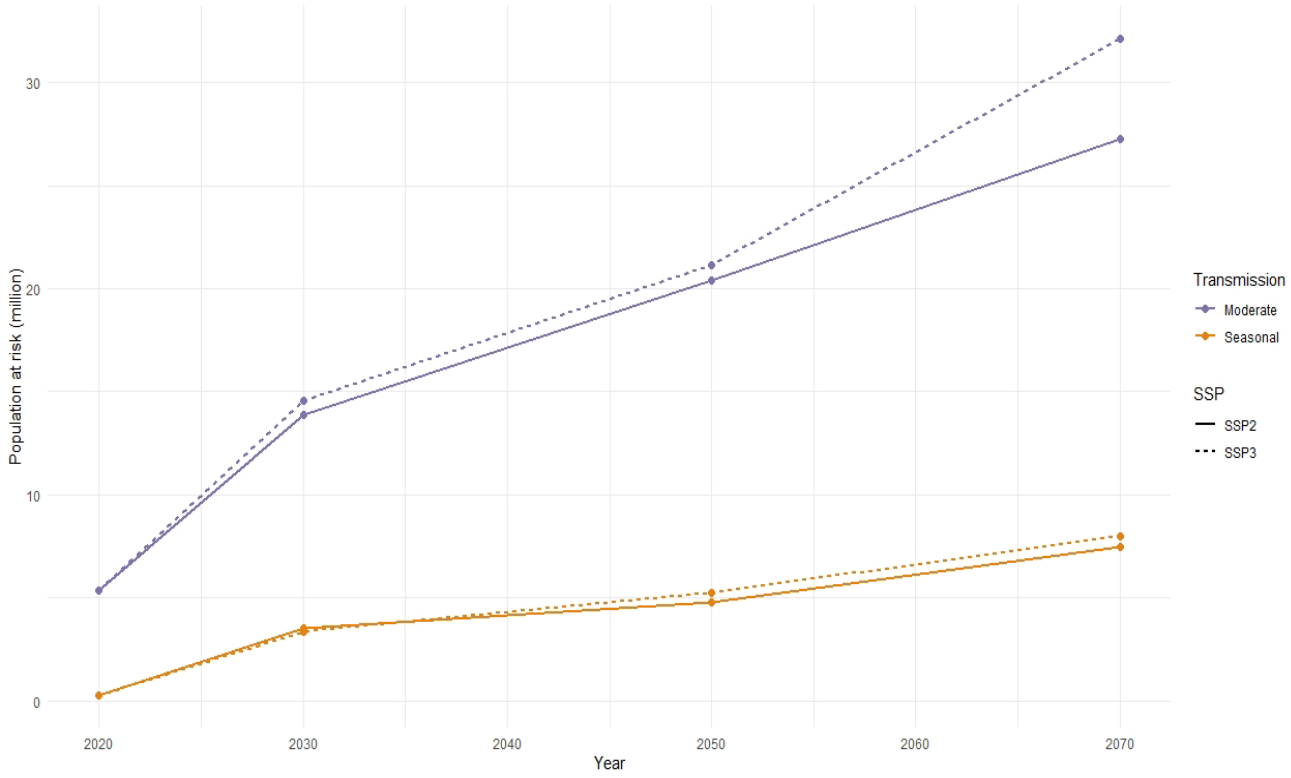

Figure 4: Plot showing population living in areas predicted to have a vector suitability of greater than 2.5 and temperatures suitable for moderate or seasonal malaria transmission. Results area shown for both SSP2 and SSP3 scenarios.

Conclusion

- Vector species suitable habitat projections
  - Temperature and precipitation driven
  - Physiological and/or behavioural variations
- Projections for suitable malaria transmission under current climate change models will be more prominent in the south and eastern regions of Africa
- Findings correlate with Ryan *et al*. (2015 and 2020)
  - Temperature is a driving factor for malaria transmission
- Aiding public health programmes to anticipate and adapt current malaria control programmes in key risk areas that require more intensive surveillance and resource allocation

Research Support

Research Links Climate Challenge Workshop sponsored by the British Council:

C2MA - Climate Change Malaria Action

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