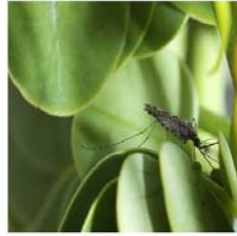


# Predicting and mapping African malaria vectors emergence and geographical distribution under climate change scenarios

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## Introduction

There is growing evidence that climate change has an impact on vector-borne diseases, including malaria. Working knowledge of where malaria vector (*Anopheles*) specially occur and will potentially occur in the future under climate change scenarios is very essential for the malaria control programme managers and policies makers.



## Objectives

This study aims to make use of records to increase our understanding and produce potential future distributional maps for *A. gambiae* and *A. arabiensis* under different climate change scenarios.

## Methods

### Climate changes scenarios

- Scenario 1: A rise of 2°C Africa wide temperature, 10% increase of summer rainfall and 10% decrease in winter rainfall.
- Scenario 2: A 0.1°C rise in summer and winter maximum and minimum temperatures per degree of latitude, 10% increase in summer rainfall and 10% decrease in winter rainfall.
- Scenario 3: A rise of 4°C Africa wide temperature, 20% increase of summer rainfall and 20% decrease in winter rainfall.

### Model

The platform applied is called CLIMEX. The model assumes a species at a given location experience two seasons during a year, one with population growth and the other with population decline. These are referred to as growth and survival or stress seasons, respectively. The overall climatic suitability of a nominated location for a given organism is provided by an Ecoclimatic Index (EI), which combines the annual potential for population growth ( $GI_A$ ), with the annual stresses that limit survival during the unfavorable season (SI) and with the limiting interacting factor between stresses (SX). These indices are calculated as follows:

$$GI_A = \sum_{i=1}^{52} \frac{TI_w * MI_w}{52} \quad SI = (1 - \frac{CS}{100})(1 - \frac{DS}{100})(1 - \frac{HS}{100})(1 - \frac{WS}{100}) \quad SX = (1 - \frac{CDX}{100})(1 - \frac{CWX}{100})(1 - \frac{HDX}{100})(1 - \frac{HWX}{100}) \quad EI = GI_A * SI * SX$$

$TI_w$  and  $MI_w$  weekly temperature and moisture, 52 number of week in a year. CS, DS, HS and WS annual cold, dry, heat and wet stress indices. CDX, CWX, HDX and HWX; annual cold-dry, cold-wet, hot-dry and hot-wet stress interactions indices. Locations with positive values for EI are suitable for a species, and larger the value of EI, the more suitable the location.

## Results

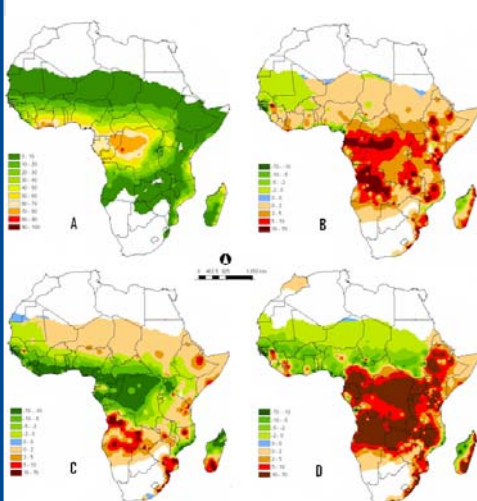


Fig. 1: (A) Distribution of *A. gambiae* under current climate. (B, C, D) Distribution of *A. gambiae* illustrating species ranges shifts under climate change scenario 1, scenario 2 and scenario 3 respectively.

Parameters designation	<i>A. gambiae</i>	<i>A. arabiensis</i>
<b>Moisture parameters</b>		
Lower threshold soil moisture	0.35	0.15
Lower limit optimal range soil moisture	0.70	0.40
Upper limit optimal range soil moisture	1.50	0.60
Upper threshold soil moisture	2.50	0.80
<b>Temperature parameters (°C)</b>		
Lower threshold temperature population growth	15	18
Lower optimal temperature population growth	28	30
Upper optimal temperature population growth	35	38
Upper threshold temperature population growth	40	44
<b>Dry stress indices</b>		
Soil moisture dry stress	0.260	0.300
Rate of accumulation of dry stress	-0.006	-0.001
<b>Wet stress indices</b>		
Soil moisture wet stress	2.50	0.900
Rate of accumulation of wet stress	0.20	0.003
<b>Heat stress indices</b>		
Threshold of heat stress	40.000	44.0000
Rate of accumulation of heat stress	0.001	0.0002
<b>Cold stress indices</b>		
Temperature threshold of cold stress	2.000	2.000
Rate of accumulation of cold stress	-1.000	-1.000
Degree-days threshold of cold stress	25.000	15.000
Rate of accumulation cold stress degree-days	-0.002	-0.001
<b>Cold-wet stress indices</b>		
Degree-days threshold of cold-wet stress	30.000	-
Moisture threshold of cold-wet stress	0.100	-
Rate of accumulation of cold-wet stress	0.001	-

Table 1: CLIMEX parameters values for African malaria vectors

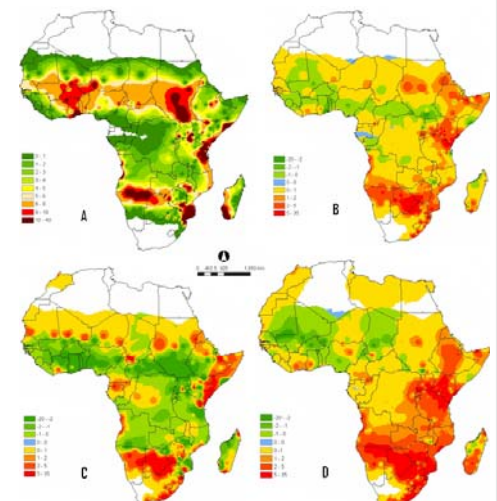


Fig. 2: (A) Distribution of *A. arabiensis* under current climate. (B, C, D) Distribution of *A. arabiensis* illustrating species ranges shifts under climate change scenario 1, scenario 2 and scenario 3 respectively.

## Impact

Shifts in *A. gambiae* and *A. arabiensis* species boundaries towards southward and eastward of Africa is likely to occur rather than jumps into quiet different climatic zone within the continent.

## Conclusion

These outputs will be helpful at control level of decision making, for example in setting up an early warning and sustainable strategies for climate change and climate adaptation for malaria vectors control programme in Africa.

## Acknowledgements

This research was carried out under the African Climate Change Fellowship Program (ACCFP). The ACCFP is supported by a grant from the Climate Change Adaptation in Africa (CCAA), funded jointly by the International Development Research Centre (IDRC) of Canada and the UK's Department of International Development (DFID). START Secretariat is the implementing agency in collaboration with the Institute of Resource Assessment (IRA) of the University of Dar Es Salaam and the African Academic of Sciences (AAS).