CLIMTAG

Crop Suitability Indicators

Francisco Pereira

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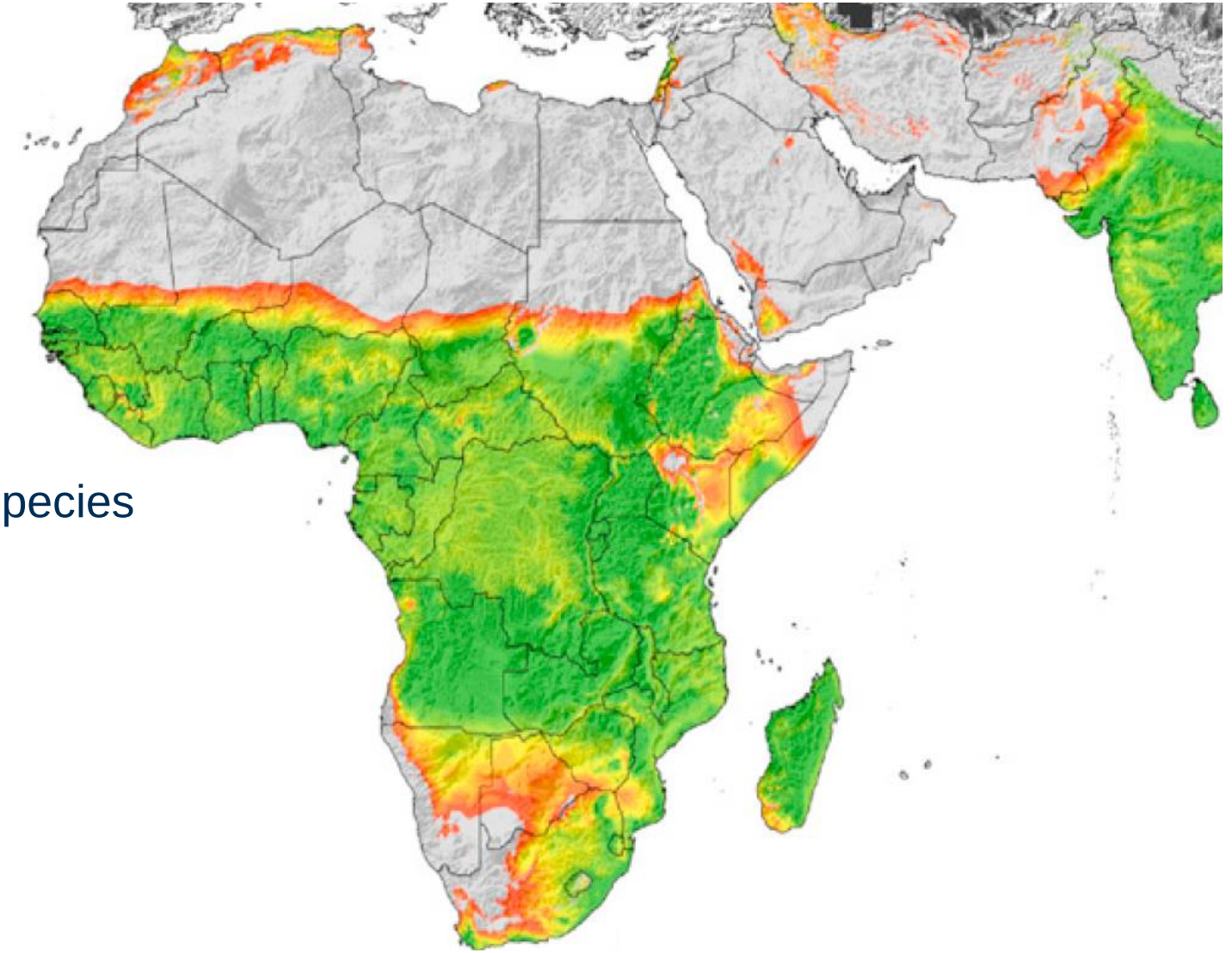
Crop Suitability indicators

Why in CLIMTAG ?

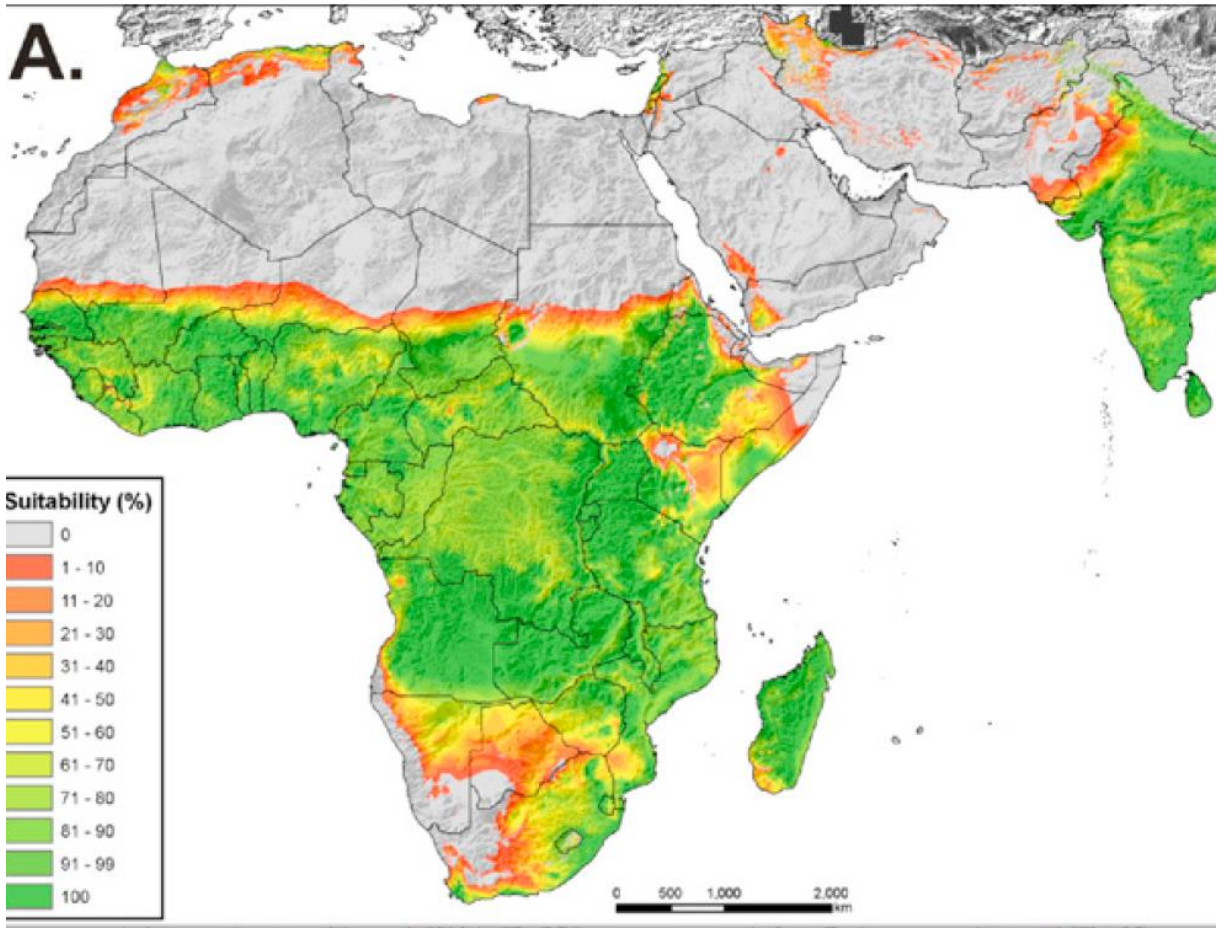
- Simple and spatially explicit assessments
- Great range of crops and plant species
- Agricultural vulnerabilities & opportunities for planning



Assessing impacts of climate change on agriculture: EcoCrop model and case study with grain sorghum

Sorghum: Crop suitability maps for + harvest area data

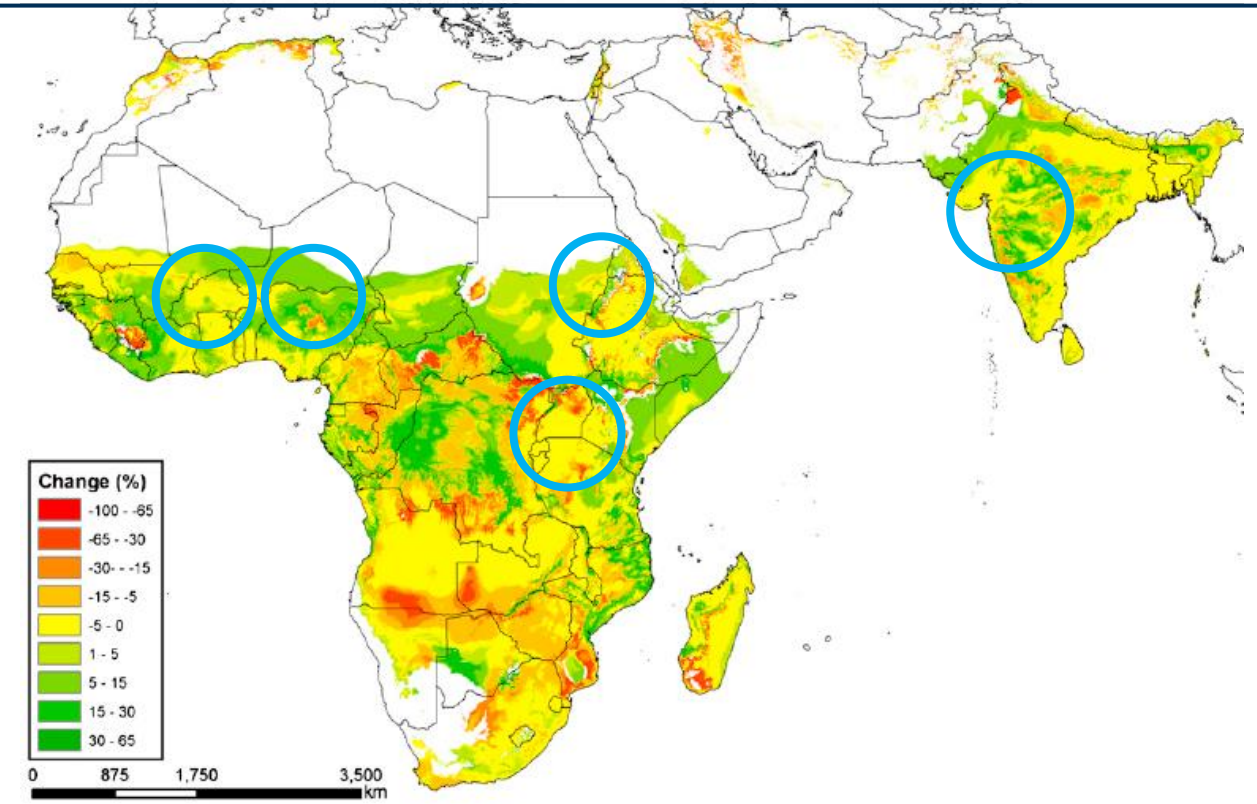
Present-day suitability of sorghum (Ramirez-Villegas et al., 2013)



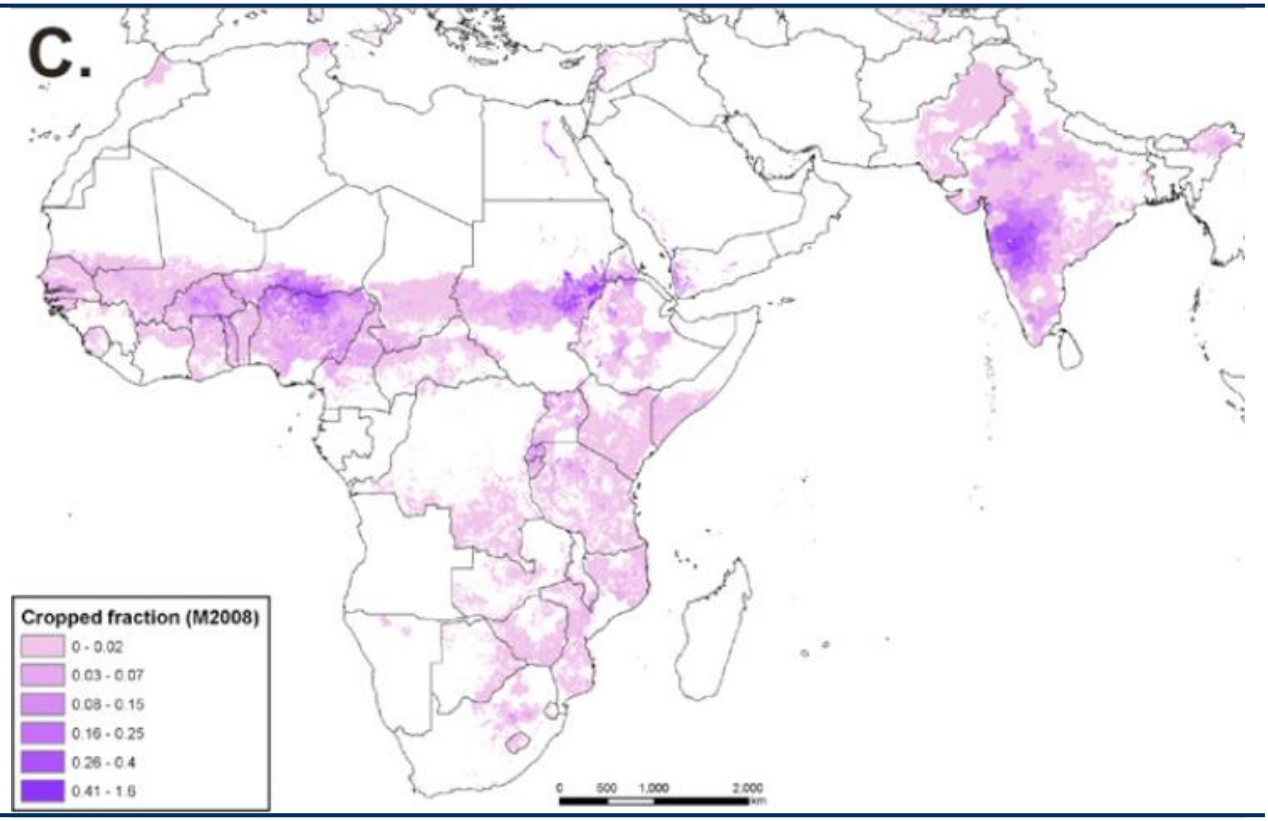
Assessing impacts of climate change on agriculture: EcoCrop model and case study with grain sorghum

Sorghum: Crop suitability maps for + harvest area data

Predicted changes in suitability across the region as an average of 24 GCMs (2049)



Sorghum distribution as reported in Monfreda et al. (2008)



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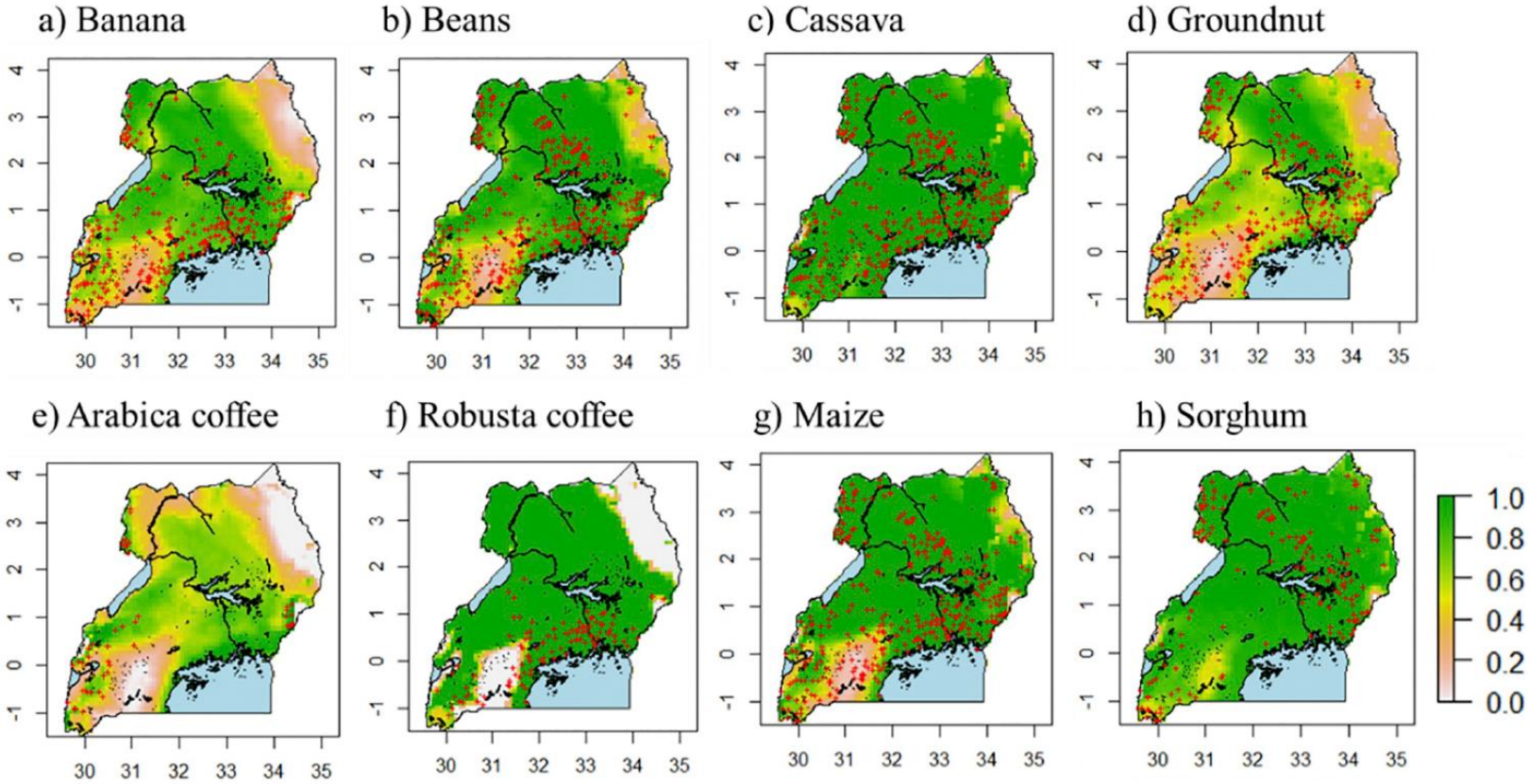
Vulnerability and adaptation options to climate change for rural livelihoods – Uganda

crop suitability maps + household food availability data

(Wichern et al., 2019)



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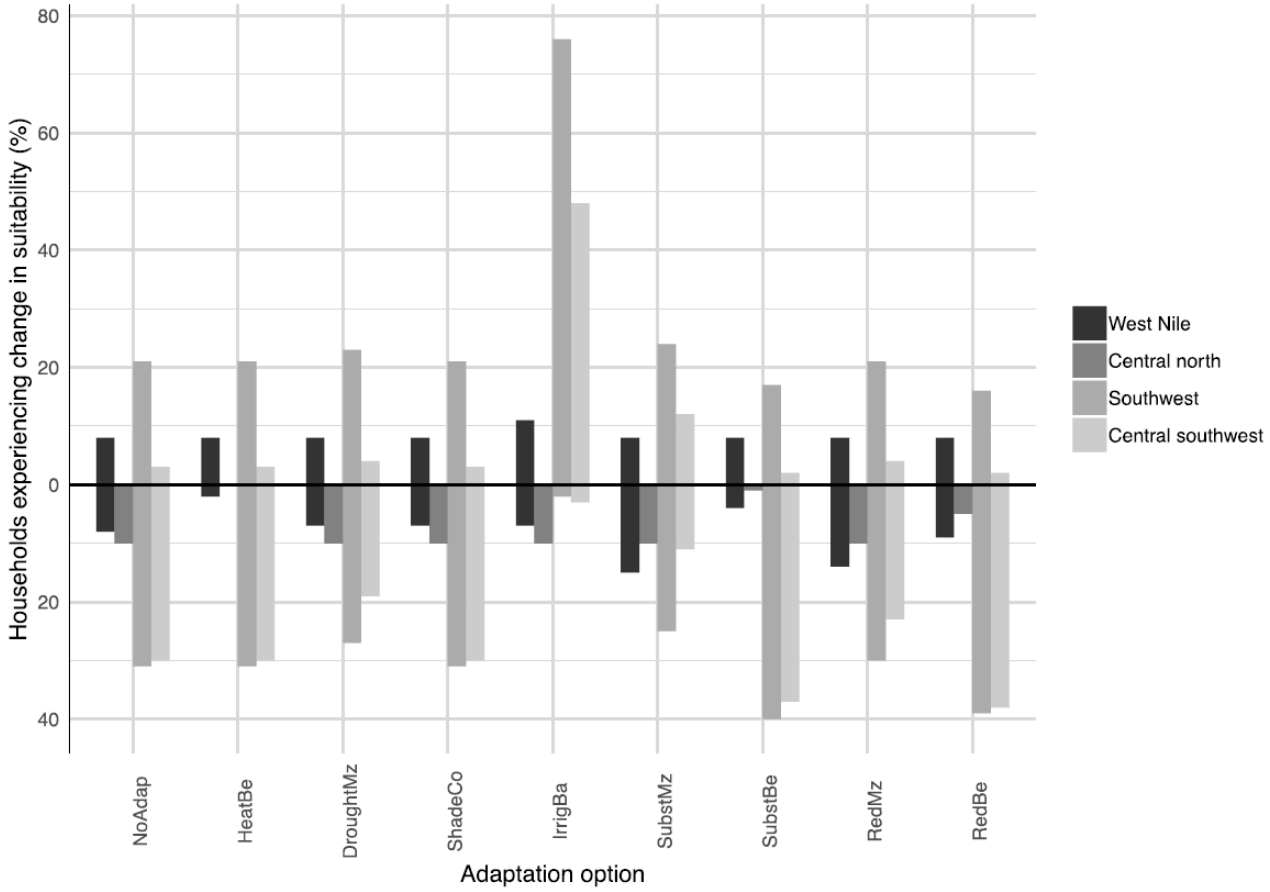

IrrigBa: Irrigation of banana systems (Rsuit = 1)

SubstMz: Substitute maize for cassava

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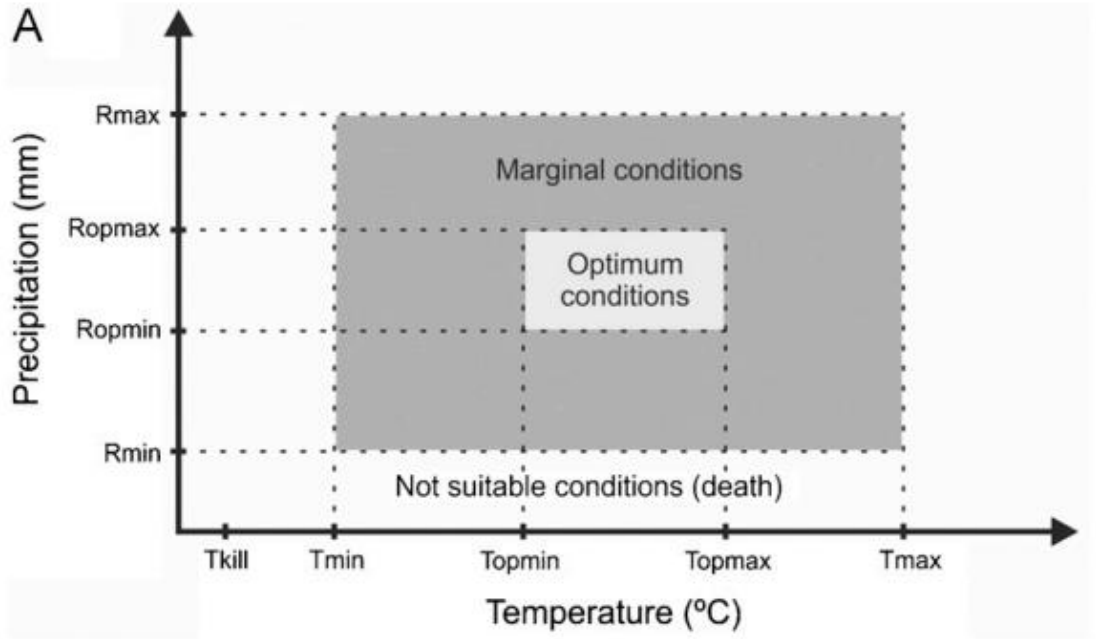
Methodology

- **EcoCrop Model:** basic mechanistic model that uses environmental ranges to determine the main climatic niche of a crop, producing a suitability index (0-1).
- The model takes these fixed ranges from the FAO-EcoCrop database (more than 2000 plant and crop species).
- Two variables (temperature and rainfall) and two ecological ranges (an absolute and optimum range)
- SUIT = highest scores of 12 potential growing seasons



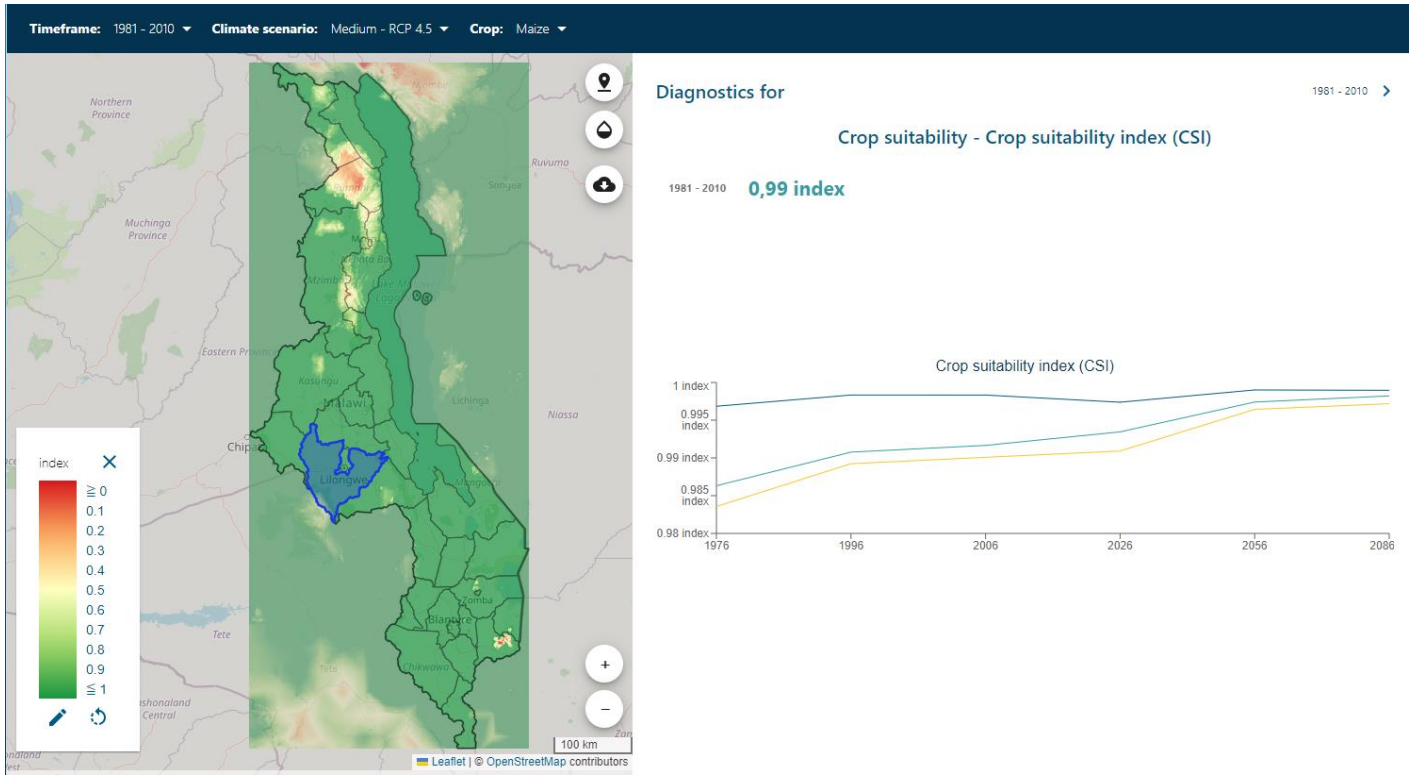
$$SUIT = R_{SUIT} * T_{SUIT}$$

Early implementation in CLIMTAG

Crop Suitability Index (CSI)

- **Malawi and Ghana**
- **Maize, Groundnut, Soybean and Tobacco**

CLIMTAG Test



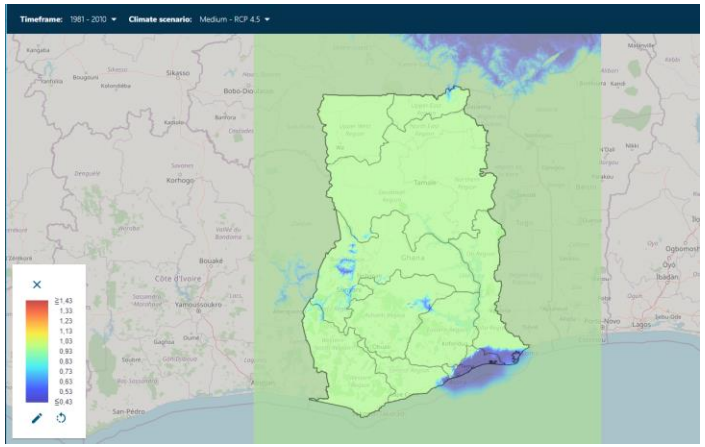
Crop Suitability Index in CLIMTAG

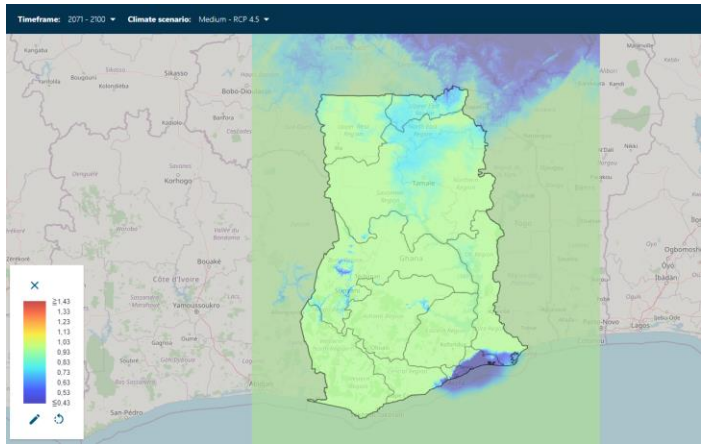
Example: Maize suitability in Ghana

1981 - 2010

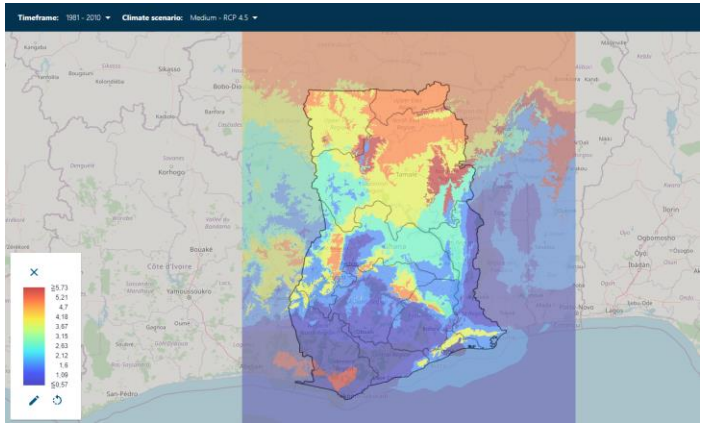
2071 - 2100

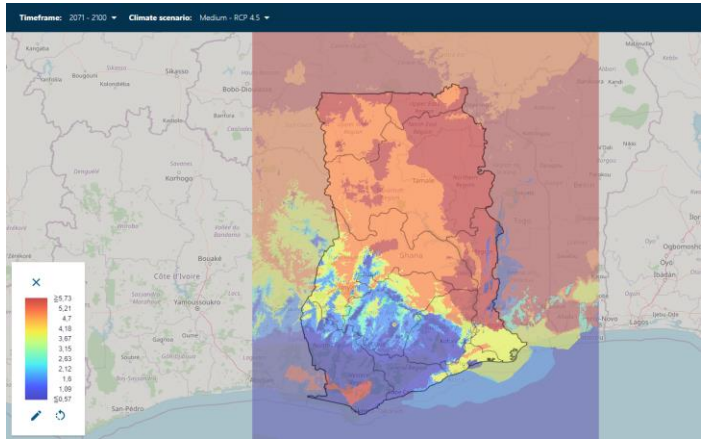
Crop Suitability index





Best starting month of cropping season





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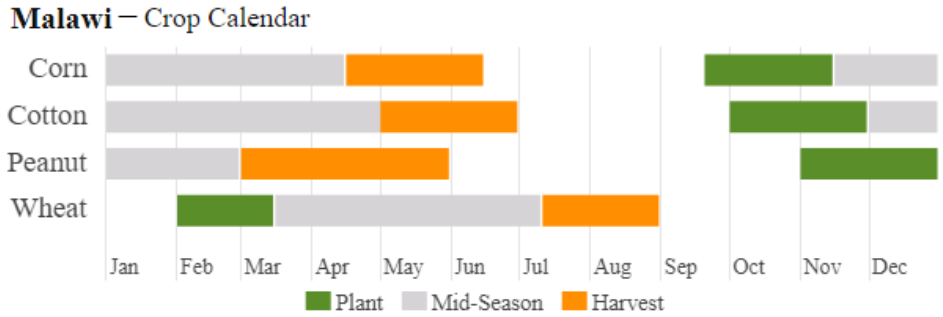
Exercise

1. Download excel file sent to you
2. Follow instructions in the file
3. Search and insert crop-specific parameters from Ecocrop Database

Example: Maize – Lilongwe province

- Considered crop cycle of 8 months
- No irrigation was considered, but it can be.
- Temperature suitability at 100%, precipitation is driving changes.

	SUIT		
Month	**1996**	**2026**	**2056**
Jan	57%	64%	53%
Feb	0%	0%	0%
Mar	0%	0%	0%
Apr	0%	0%	0%
May	0%	0%	0%
Jun	16%	10%	0%
Jul	96%	94%	78%
Aug	100%	100%	100%
Sep	100%	100%	100%
Oct	100%	100%	100%
Nov	100%	100%	100%
Dec	100%	100%	100%



USDA Foreign Agricultural Service – IPAD

Possible next developments

- Expand to all countries
- Direct link with the ECOCROP database
- Take soil and topography into account
- Temperature-rainfall interactions on suitability
- Seasonal changes in crop climatic requirements (e.g. flowering)
- Risks of extreme weather events

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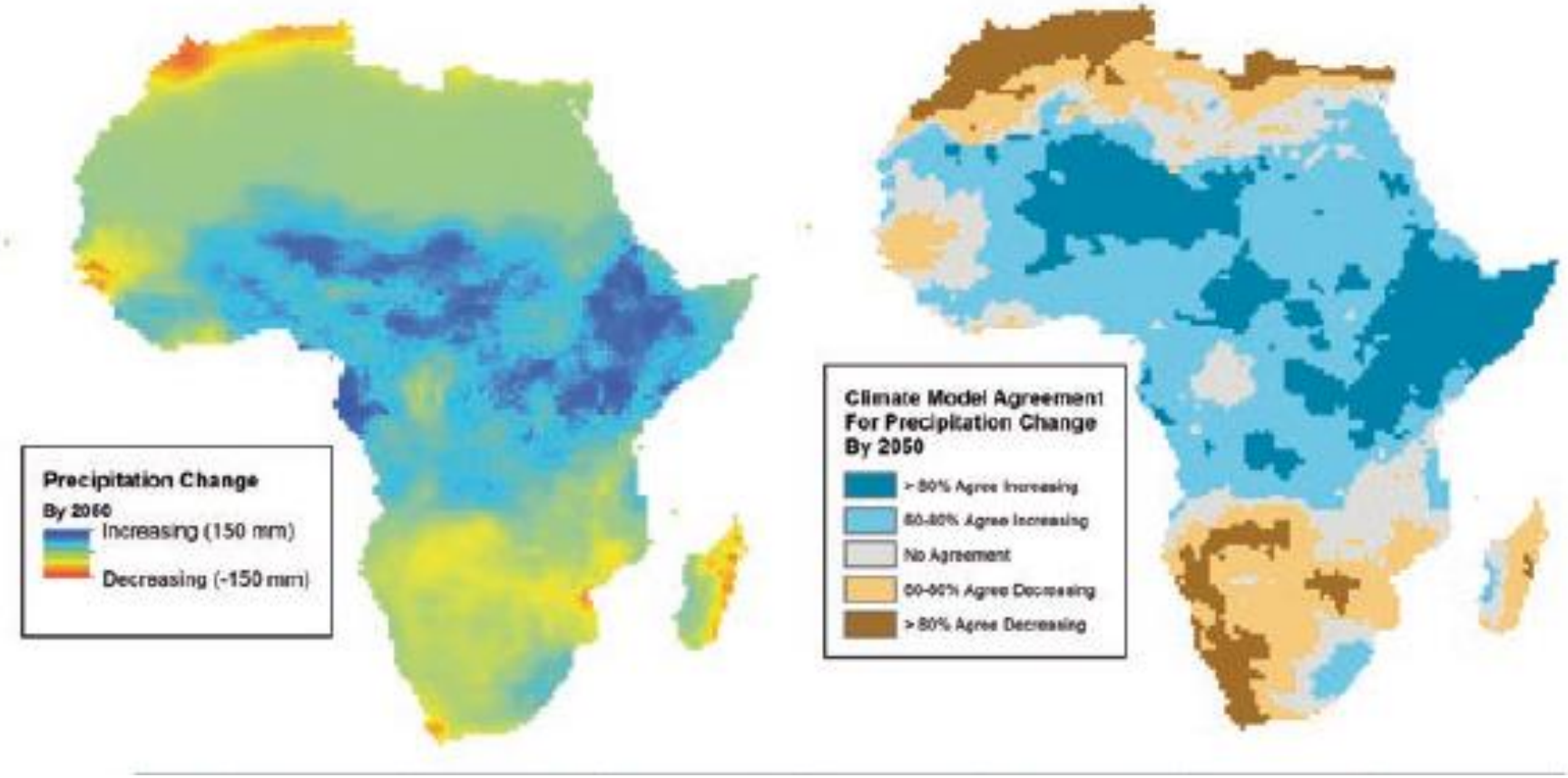
Vulnerability and adaptation options to climate change for rural livelihoods – Uganda

Table 2

Adaptation scenario name		Adjusted parameter	
HeatBe	heat-tolerant bean variety[a]	$T_{OPMAX\text{-}M\ beans} + 4\ ^{\circ}C$	
DroughtMz	drought-tolerant maize variety	$R_{OPMIN\text{-}M\ maize} - 100\ mm\ month^{-1}$	
ShadeCo	shade-tree systems for coffee[b]	$T_{MEAN\text{-}D} - 2\ ^{\circ}C$	
IrrigBa	irrigation of banana systems	$R_{SUIT\ banana} = 1$	
SubstMz	substitute maize by cassava	$CropContr_{cas,\ new} = CropContr_{cas,\ old} + CropContr_{ma,\ old}$ $CropContr_{ma,\ new} = 0$	
SubstBe	substitute beans by groundnut	$CropContr_{gn,\ new} = CropContr_{gn,\ old} + CropContr_{be,\ old}$ $CropContr_{be,\ new} = 0$	
RedMz	reduce maize, increase cassava contribution	$CropContr_{ma,\ new} =$	if $CropContr_{ma,\ old} \leq 0.2$: $CropContr_{ma,\ old}$ if $CropContr_{ma,\ old} > 0.2$: 0.2
		$CropContr_{cas,\ new} =$	if $CropContr_{ma,\ old} \leq 0.2$: $CropContr_{cas,\ old}$ if $CropContr_{ma,\ old} > 0.2$: $CropContr_{cas,\ old} + CropContr_{ma,\ new}$
RedBe	reduce beans, increase groundnut contribution	$CropContr_{be,\ new} =$	if $CropContr_{be,\ old} \leq 0.15$: $CropContr_{be,\ old}$ if $CropContr_{be,\ old} > 0.15$: 0.15
		$CropContr_{gn,\ new} =$	if $CropContr_{be,\ old} \leq 0.15$: $CropContr_{gn,\ old}$ if $CropContr_{be,\ old} > 0.15$: $CropContr_{gn,\ old} + CropContr_{be,\ new}$



Girvetz, E., Ramirez-Villegas, J., Claessens, L., Lamanna, C., Navarro-Racines, C., Nowak, A., ... & Rosenstock, T. S. (2019). Future climate projections in Africa: where are we headed?. The climate-smart agriculture papers: Investigating the business of a productive, resilient and low emission future, 15-27.

Methodology

$$T_{SUITi} = \begin{cases} 0 & T_{MIN-Pi} < T_{KILL-M} \\ 0 & T_{MEAN-Pi} < T_{MIN-C} \\ a_{T1} + m_{T1} * T_{MEAN-Pi} & T_{MIN-C} \leq T_{MEAN-Pi} < T_{OPMIN-C} \\ 100 & T_{OPMIN-C} \leq T_{MEAN-Pi} < T_{OPMAX-C} \\ a_{T2} + m_{T2} * T_{MEAN-Pi} & T_{OPMAX-C} \leq T_{MEAN-Pi} < T_{MAX-C} \\ 0 & T_{MEAN-Pi} \geq T_{MAX-C} \end{cases}$$

$$R_{SUIT} = \begin{cases} 0 & R_{TOTAL-P} < R_{MIN-C} \\ a_{R1} + m_{R1} * R_{TOTAL-P} & R_{MIN-C} \leq R_{TOTAL-P} < R_{OPMIN-C} \\ 100 & R_{OPMIN-C} \leq R_{TOTAL-P} < R_{OPMAX-C} \\ a_{R2} + m_{R2} * R_{TOTAL-P} & R_{OPMAX-C} \leq R_{TOTAL-P} < R_{MAX-C} \\ 0 & R_{TOTAL-P} \geq R_{MAX-C} \end{cases}$$

Malawi CC Adaptation

USAID Study on Climate Change Adaptation in Malawi
Main Vulnerabilites:
- Malawi's agriculture are vulnerable to increase uncertainty in precipitation patterns and frequency of extreme weather events such as floods and droughts
- Maize (staple crop) is particularly vulnerable to drought and changes in the seasonality of rainfall
- Export crops also impacted by droughts, estimated to reduce GDP by 1,7% each year.

National Adaptation Programme Department (NAPA) Strategies:
- 1. Improving community resilience through development of sustainable rural livelihoods
- 2. Restoring forests in the Upper, Middle and Lower Shire valleys (high deforestation rates)
- 3. Improving agricultural production under erratic rains and changing climatic conditions
- 4. Improving Malawi's preparedness to cope with droughts and floods
- 5. Improving climate monitoring to enhance Malawi's early warning capacity and decision-making
- 6. Improving sustainable utilization of Lake Malawi and its lakeshore

Government Priorities:
- Developing improved crop varieties, improving farmer choice, and increasing access to those varieties
- Strengthening extension services to improve information flow to farmers
- Enhancing community storage systems for seed and food reserves
- Promoting low-cost nutritional supplements
- Diversifying crops and livestock to improve nutrition and food security
- Improving access to water, including water treatment works
- Enhancing water management to withstand erratic rains through water harvesting, water conservation, and small-scale irrigation