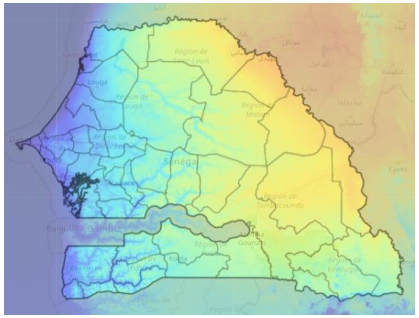
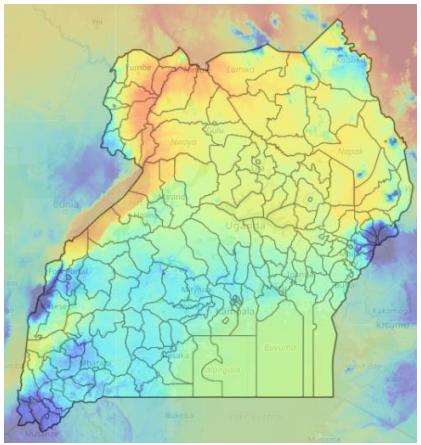
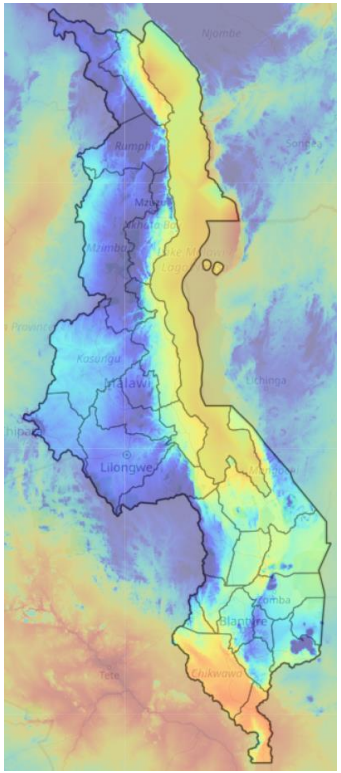
CLIMTAG APPLICATION







CLIMTAG CASES: LONG-TERM OUTLOOKS FOR:

- GROUNDNUTS (SENEGAL)
- MAIZE (UGANDA AND MALAWI)
- ARABICA COFFEE (UGANDA)

CLIMTAG CASES - OBJECTIVE

- CLIMTAG contains a lot of data and information for the rest of the century
- What can we do with this information?
- Some simple cases as examples of what CLIMTAG can mean for:
  - Assessing likely impact of climate change on agriculture over medium and long term
  - In a context of strategic adaptation planning (preparing for, not reacting to)

WHY STRATEGIC ADAPTATION PLANNING? AND WHAT CAN THE ROLE OF CLIMTAG BE?

- Climate adaptation plans often focus on a (local) reaction to recent (catastrophic) events, that may or may not give a correct image of the medium or long-term future (**reactive** vs **proactive** adaptation)
- Sound decision making at policy level should also take into account potential evolutions over the longer term, as preparing for them takes time.
- The longer the time horizon considered, the higher the uncertainties (in terms of hazard, capacity to cope, sensitivity, exposure, …)
- Dealing with uncertainties requires exploring the impacts of different scenario's.
- CLIMTAG can be a useful tool for strategic adaptation planning as it allows to explore different climate change scenario's

PRELIMINARY ANALYSIS CLIMTAG DATA – APPROACH

Objective: use Climtag to make <u>preliminary</u> assessment of changes in crop suitability as a result of climate change (medium to long term)

1. Select **climate indicators** relevant for agriculture, e.g. *total rainfall, precipitation deficit, mean temperature, maximum temperature*, main rainy season length, warm spell duration, number of dry days, …
2. Select **climate change scenario** (3) and **timeframe** (4)
   Proposed: *RCP 8.5 for period 2041-2070* -> focus on medium term adaptation planning
3. Relate selected indicators to **crop suitability** (e.g. treshold values for temperature and rainfall), based on literature review (Ecocrop and others)

PRELIMINARY ANALYSIS CLIMTAG DATA – LIMITATIONS

1. Impact assessment is descriptive and based on simple climate parameters and crop characteristics, '***other things being equal':*** soil quality, fertilizer and pesticide use, crop varieties, access to finance and services, existence of markets, ...
2. Does not take into account other direct and indirect climate related impacts:
   - Crop damage due to heavy rainfall (incl. erosion)
   - Pests: increase of 2 °C in temperatures is associated with a 31 percent higher yield loss in maize due to insect pests, compared to the current losses'.
   - Stronger weed growth
3. Not based on crop modelling:
   - Advantage: limited data requirements, quick results
   - Disadvantage: no quantitative prediction of crop yield

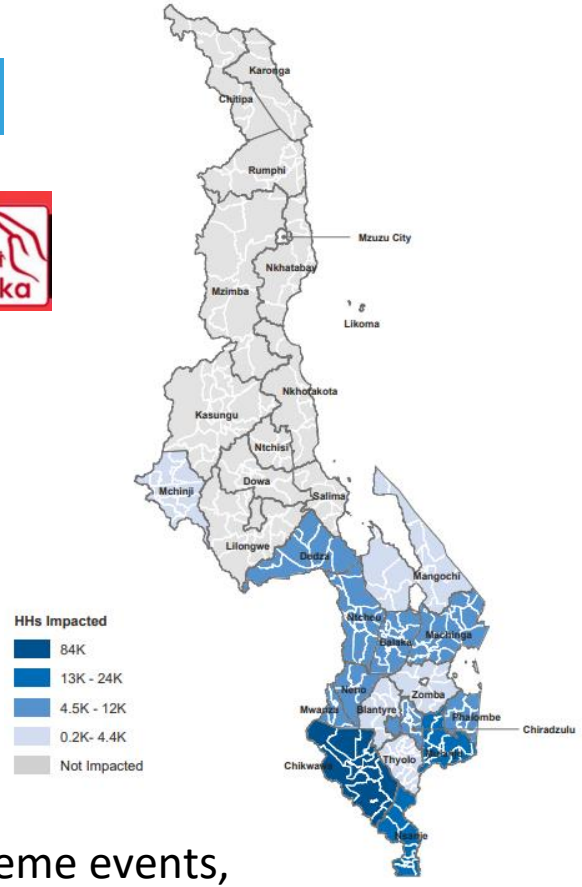
MALAWI FLOODS 2019, 2022, 2023, …

AGRICULTURE

MALAWI FLOOD APPEAL unika

72K Destroyed Hectares

Cyclone Freddy Brings Mudslides and Floods, Leaving Nearly 200 Dead in Malawi



UNITED NATIONS MALAWI

Malawi: Tropical Storm Ana Response
Flash Update No. 3 | 16th February 2022

Average values may hide increased short-term variability and extreme events, which will also become more important over time.

PRELIMINARY ANALYSIS CLIMTAG DATA – LIMITATIONS

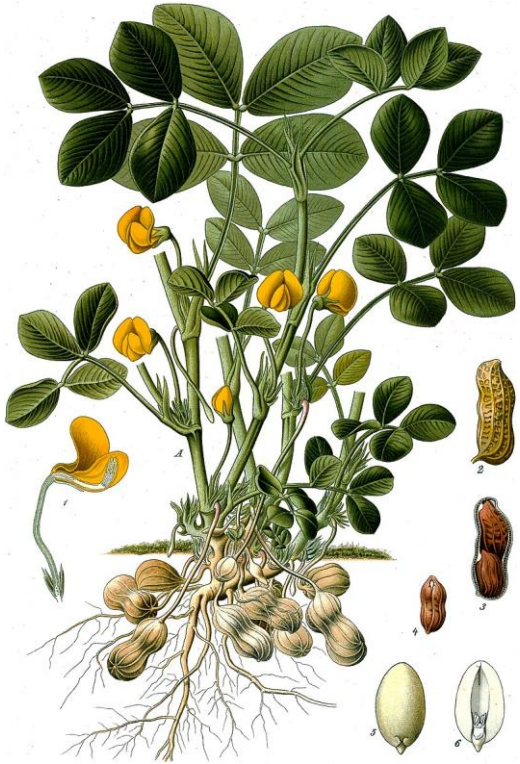
Examples of questions that can (tentatively) be answered:

- Will it still be possible, in 30 years time, to commercialy grow groundnuts in the north of the 'groundnut basin' in Senegal?
- Will Arabica coffee disappear as a crop in Uganda, and if so, by when?
- Will there be an impact on maize yields, and what are the differences between Uganda and Malawi?

-> CLIMTAG can be used as a *scoping tool* for strategic adaptation planning at country level

Example of questions that cannot be (exactly) answered:

- What % yield reduction can we expect for a crop by 2056, on different types of soils?

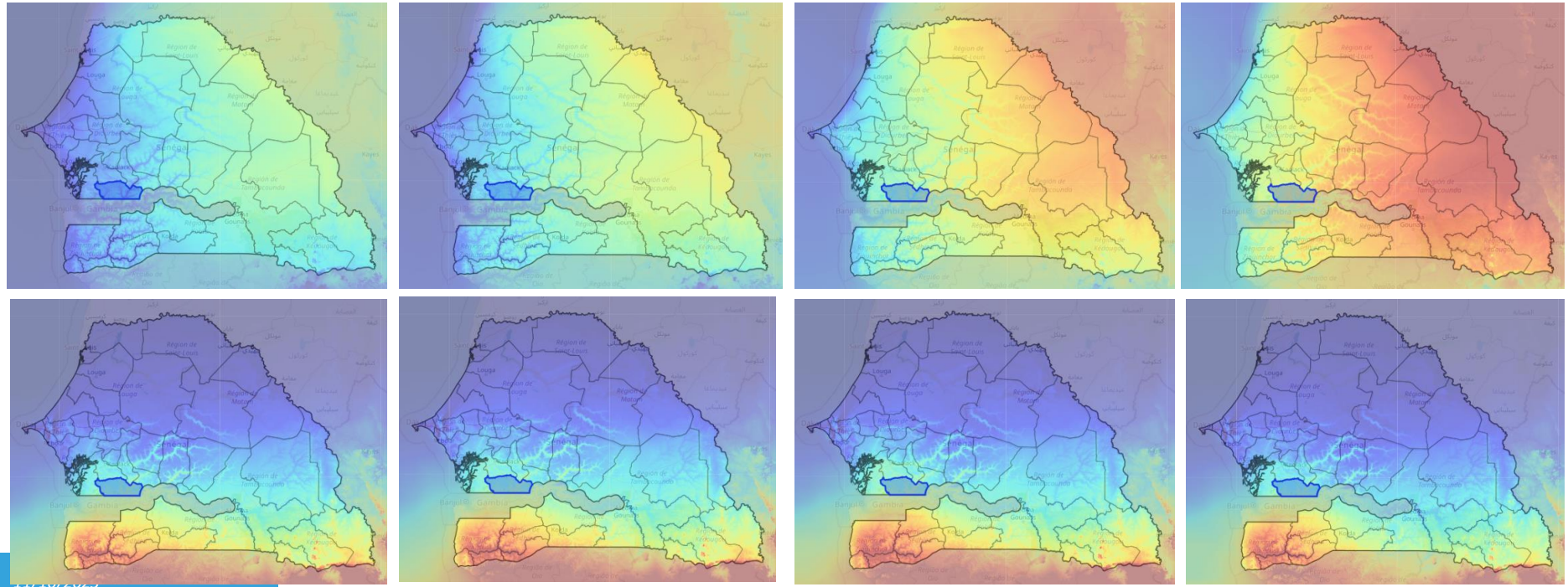


CASE 1: GROUNDNUTS

SENEGAL

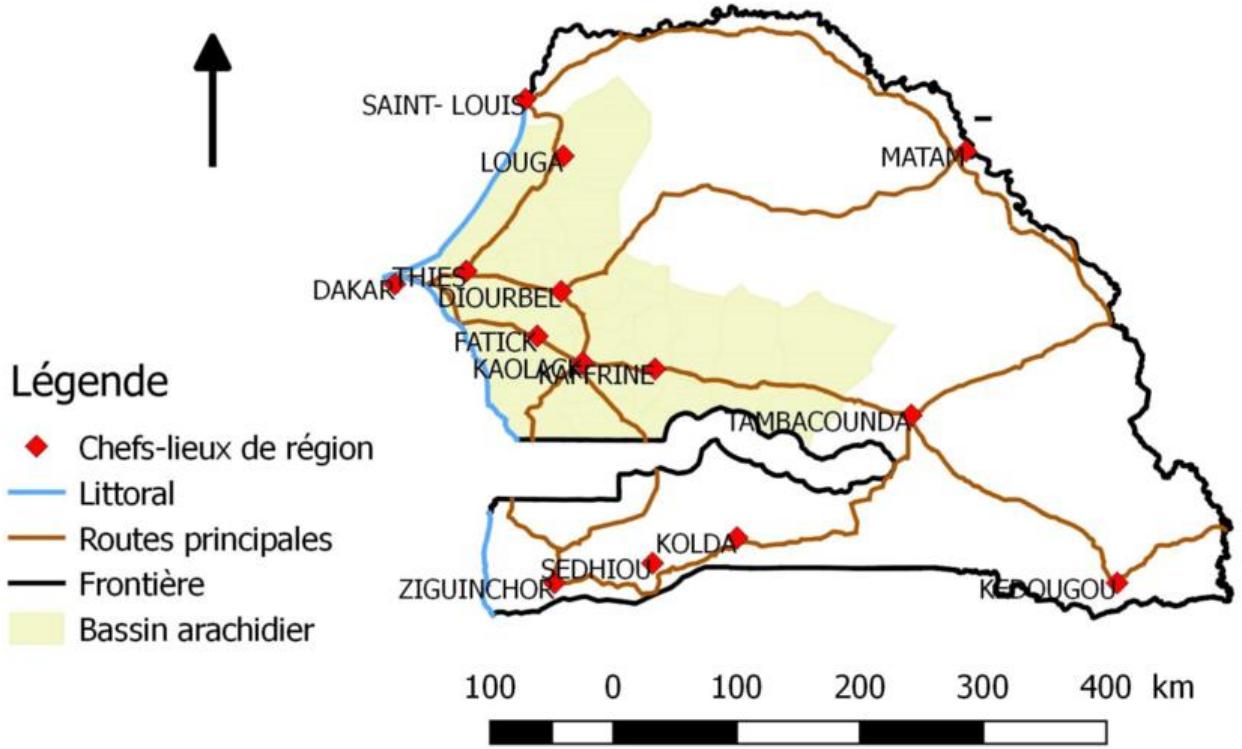
SENEGAL – MEAN TEMPERATURE (TOP) AND TOTAL ANNUAL RAINFALL (BOTTOM)

1981-2010	2011-2040	2041-2070	2071-2100



THE GROUNDNUT BASIN IN SENEGAL

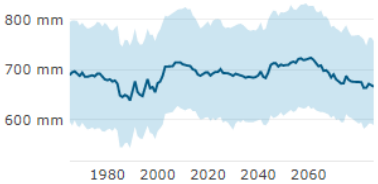
- Main cash crop
- 40% of cultivated land
- About 12,000 km²
  (2021, FAOSTAT)
- Production: 1,678 kTon
  (2021, FAOSTAT)



CLIMATE SENSITIVITY OF GROUNDNUTS -PRECIPITATION

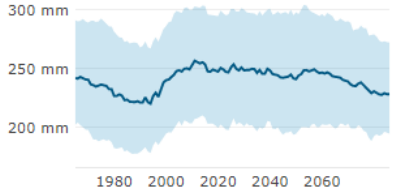
- At least 400 mm precipitation during growing season (Ecocrop) for commercial production – but considerably *less* precipitation in northern parts of *bassin arachidier* (250 à 300 mm).
- No significant decrease in precipitation in *bassin arachidier* expected in the medium term as a result of climate change.

Precipitation



Nioro du Rip - South

Precipitation



Louga - North

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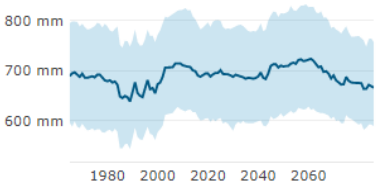
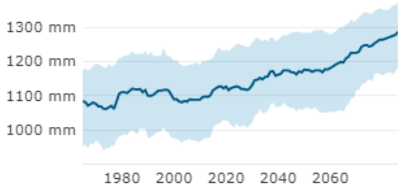
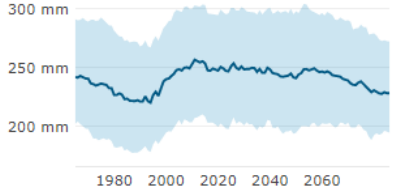


Precipitation deficit

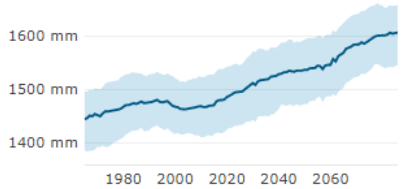


Nioro du Rip - South

Precipitation



Precipitation deficit



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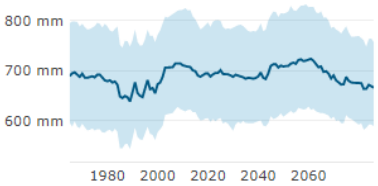
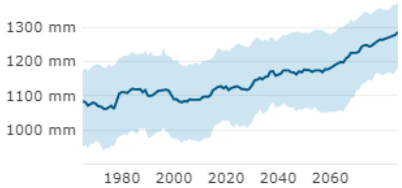
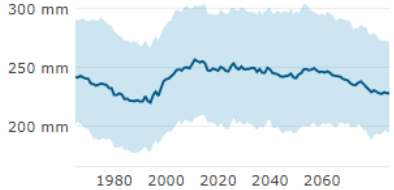


Precipitation deficit

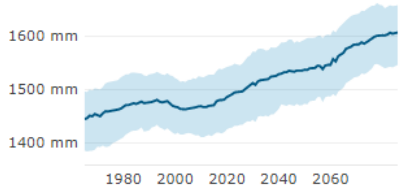


Nioro du Rip - South

Precipitation



Precipitation deficit



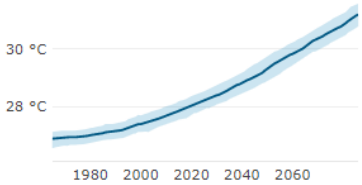
Louga - North

- As result, groundnut production may become marginal or even disappear in northern parts of groundnut growing area in Senegal due to water stress

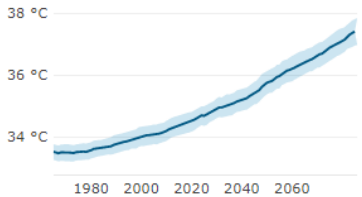
CLIMATE SENSITIVITY OF GROUNDNUTS - TEMPERATURE

- Optimum <u>average</u> temperature around 28°C – which corresponds to average temperatures today in most parts of *bassin arachidier*.
- Optimal <u>max</u>. temperatures < 32°C (already exceeded)
- In eastern parts of the area increases of mean temperature up to 32°C are possible (RCP 8.5, 2041-2070), with maxima > 40°C

Mean annual t°

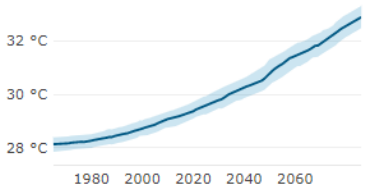


Mean daily maximum t°

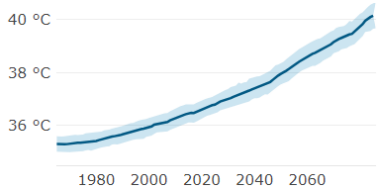


Nioro du Rip - South

Mean annual t°



Mean daily maximum t°



Koupentoum - East

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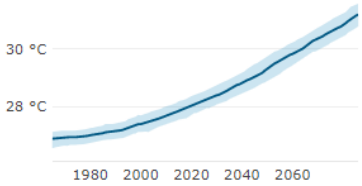
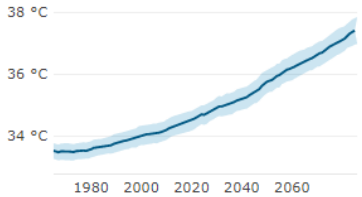
Mean annual t°

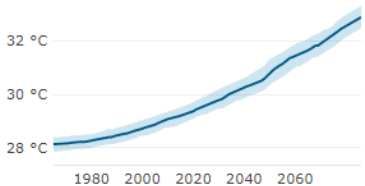


Mean daily maximum t°

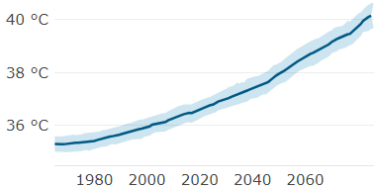


Nioro du Rip - South

Mean annual t°



Mean daily maximum t°



Koupentoum - East

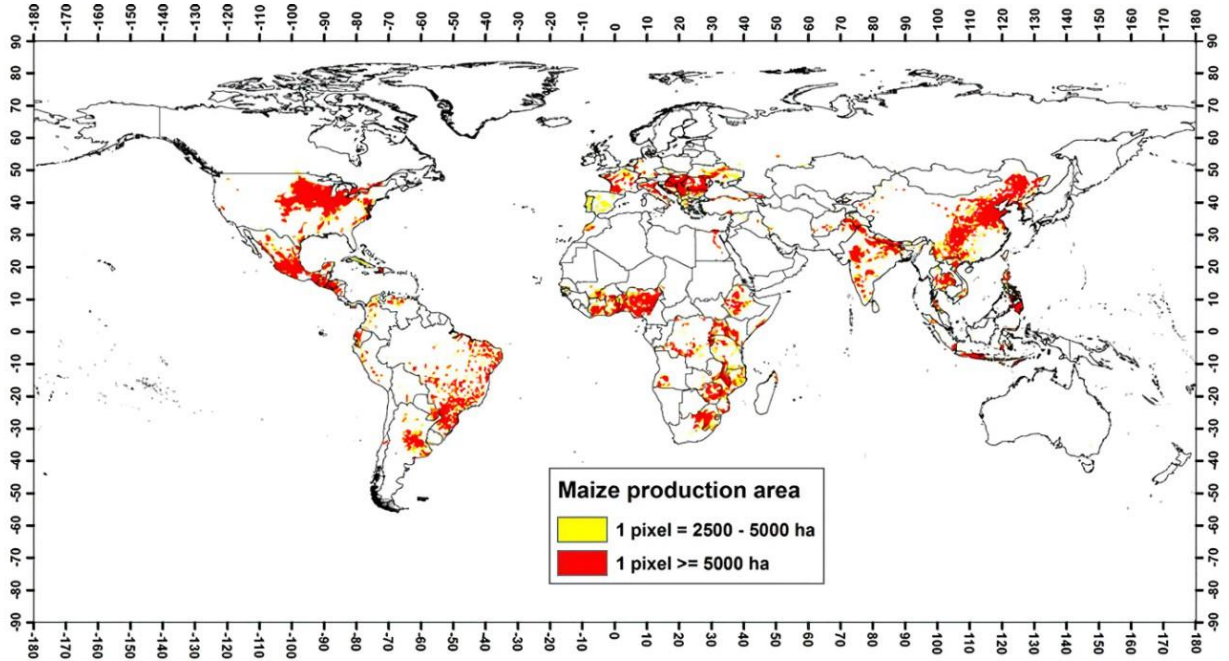
- As a result, some parts of the groundnut growing area in Senegal may become *less suitable for commercial groundnut production due to high temperatures*.

CASE 2: MAIZE

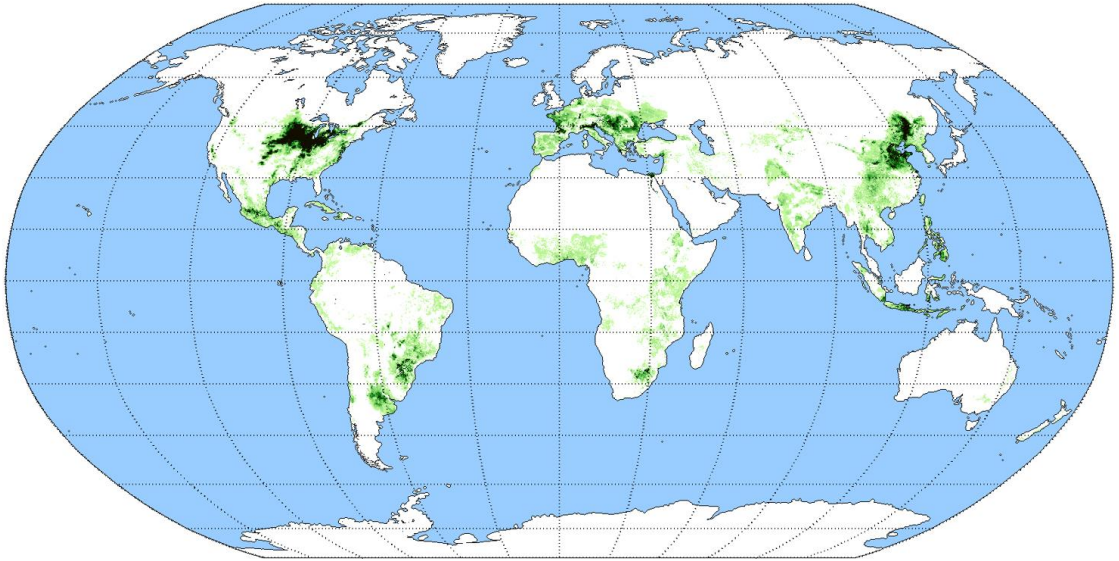
UGANDA AND MALAWI

MAIZE GROWS IN A WIDE RANGE OF ENVIRONMENTS …

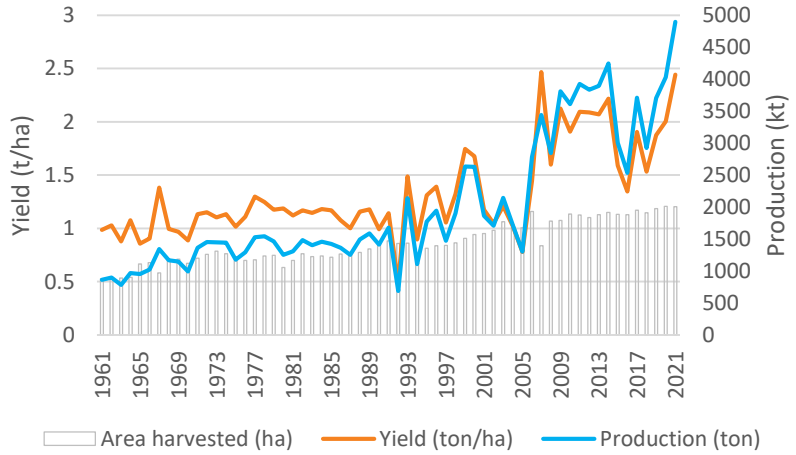
- Most widely distributed cereal
- Grows from sea level to 3800 m altitude, and from 58° N to 40°S

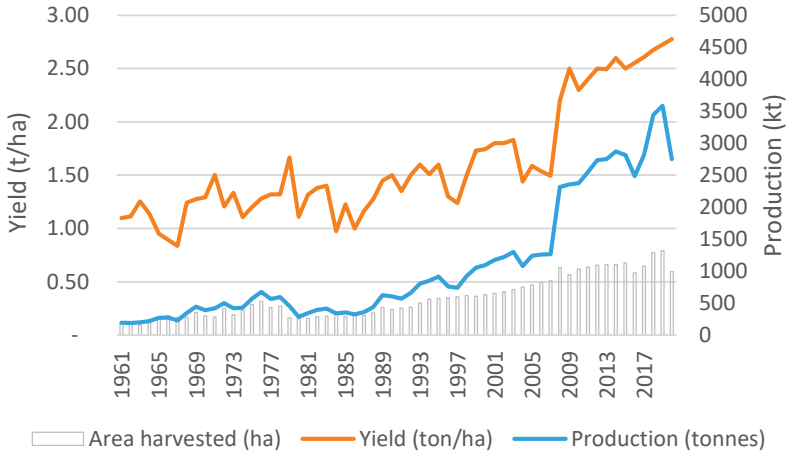


… ALTHOUGH YIELDS ARE UNEVENLY DISTRIBUTED – DUE TO A NUMBER OF REASONS



MAIZE IS AN IMPORTANT FOOD CROP IN BOTH MALAWI AND UGANDA

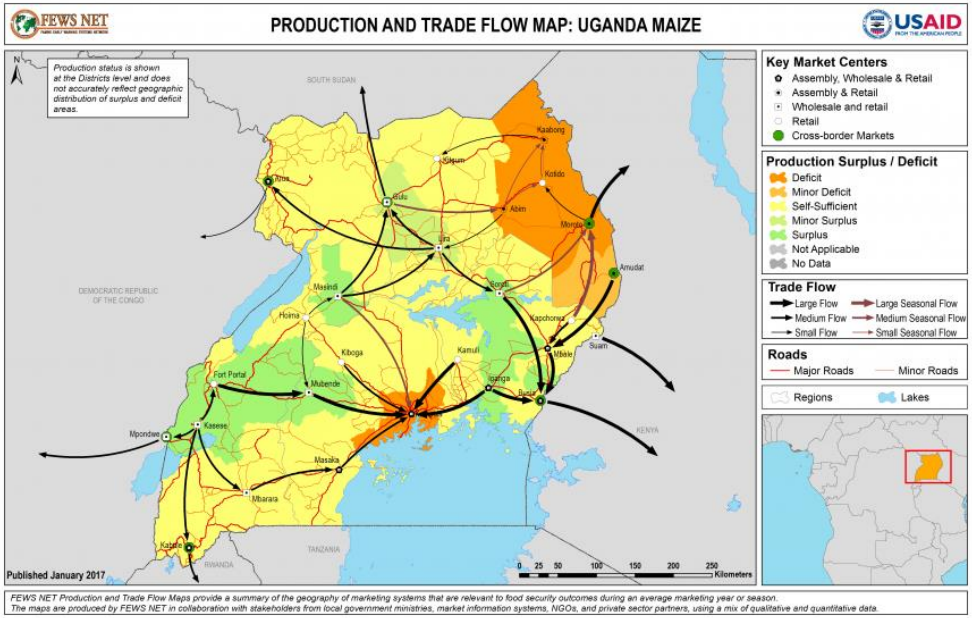




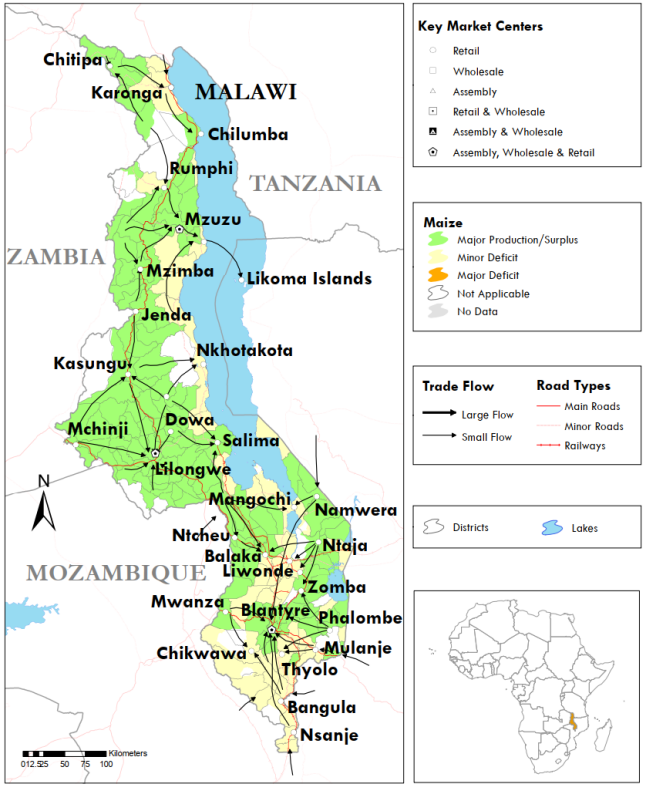
Malawi:
60% of crop area is maize; 90% of grain crop production

Uganda:
Most cultivated crop (in % of households); 3rd crop by production volume

PRODUCTION AND TRADE FLOW



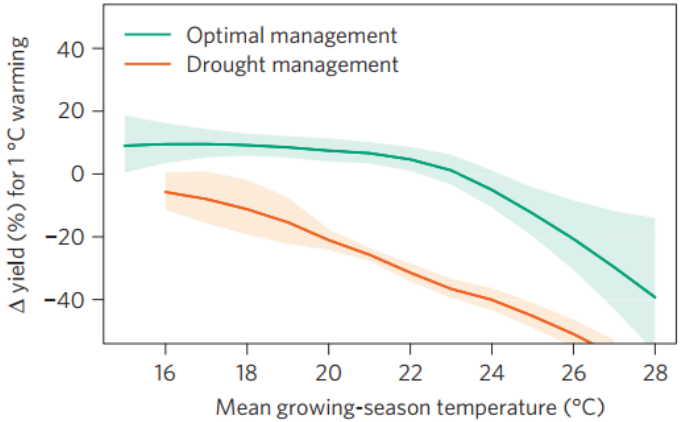
Large export flows to Kenia (from Iganga district and others).
Zones with deficit = Kampala region (high demand) and north-east (very dry).



Major production and surplusses in central region
Only about 7% of production is traded among districts.
International trade less than 5%

CLIMATE SENSITIVITY OF MAIZE

- Optimum mean temperature over growing season: 20-22°C
- Optimum daytime temperature 25 à 30°C; supports 40 à 45°C if sufficient water.
- Decreased yields for daytime mean temperatures > 30°C, even under optimal rainfall
- Yield shows a non-linear relation with mean temperature: Yield increase per degree increase in mean growing temperature up to about 22°C; at higher mean temperatures faster yield decrease per extra degree.

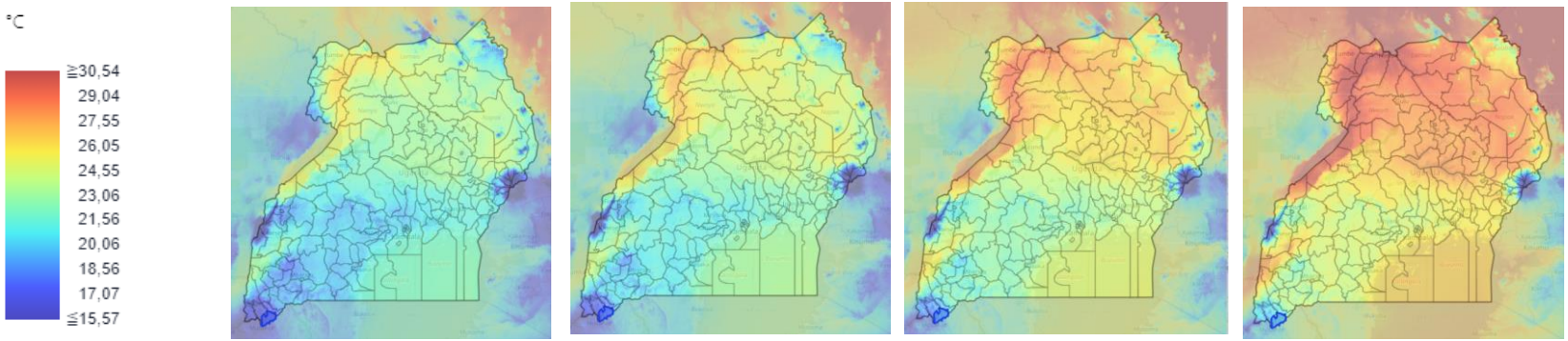


- Temperature effect stronger than drought effect: “a 2°C increase in temperature will result in a greater reduction in maize yields than a 20 % decrease in precipitation”
- But: Strong combined effect of drought and heat stress

- *500 – 900 mm of rain required during growing season; can be as low as 200 mm*

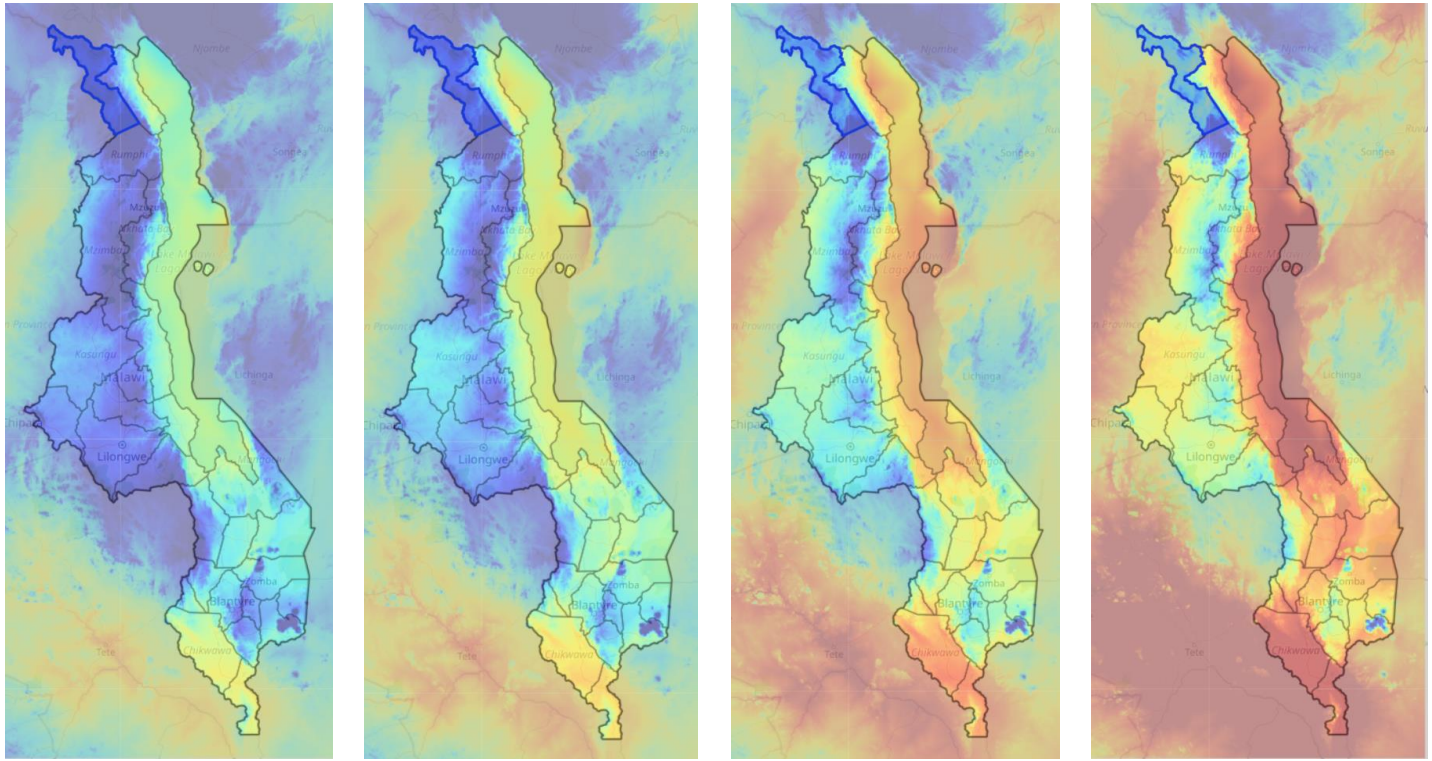
UGANDA – MEAN TEMPERATURE (RCP 8.5)

1981-2010	2011-2040	2041-2070	2071-2100

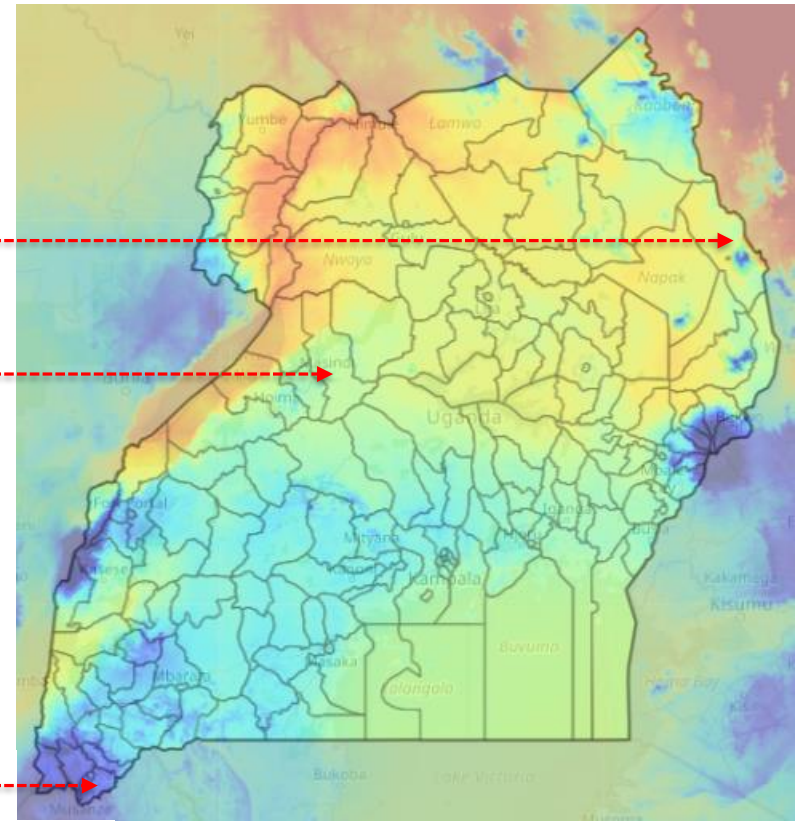


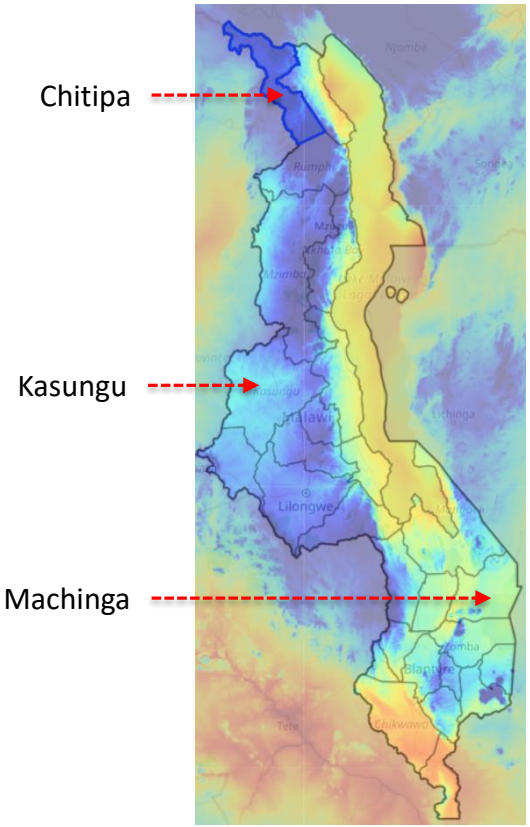
MALAWI – MEAN TEMPERATURE (RCP 8.5)

1981-2010	2011-2040	2041-2070	2071-2100



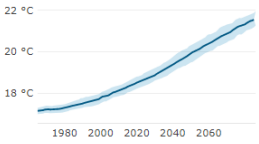
REPRESENTATIVE RANGE OF GROWING CONDITIONS

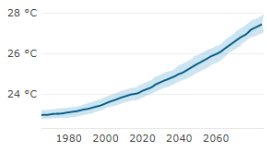


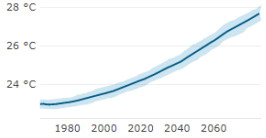


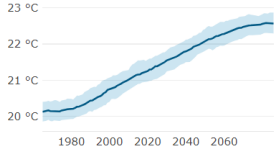
IMPACT OF CLIMATE CHANGE ON MAIZE YIELDS - TEMPERATURE

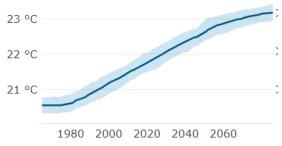
	Kabale	Masindi	Matheniko	Kasungu	Chitipa	Machinga
$Tavg_{2022}$	18,6 °C	23,9 °C	24,2 °C	21,0 °C	25,6 °C	25,6 °C
$Tavg_{2056}$	19,8 °C	25,3 °C	25,6 °C	22,9 °C	27,2 °C	26,4 °C
$Tmax_{2022}$	23,1 °C	29,5 °C	30,1 °C	25,8 °C	31,2 °C	31,1 °C
$Tmax_{2056}$	24,7 °C	30,8 °C	**31,3 °C**	27,3 °C	32,9 °C	32,2 °C
$Tmax_{2085}$	25,9 °C	**32,3 °C**	**32,7 °C**	29,3 °C	**34,4 °C**	**32,4 °C**

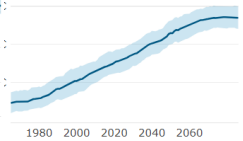








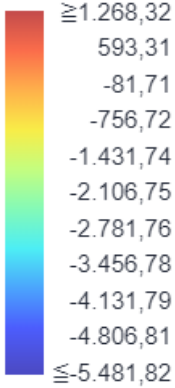




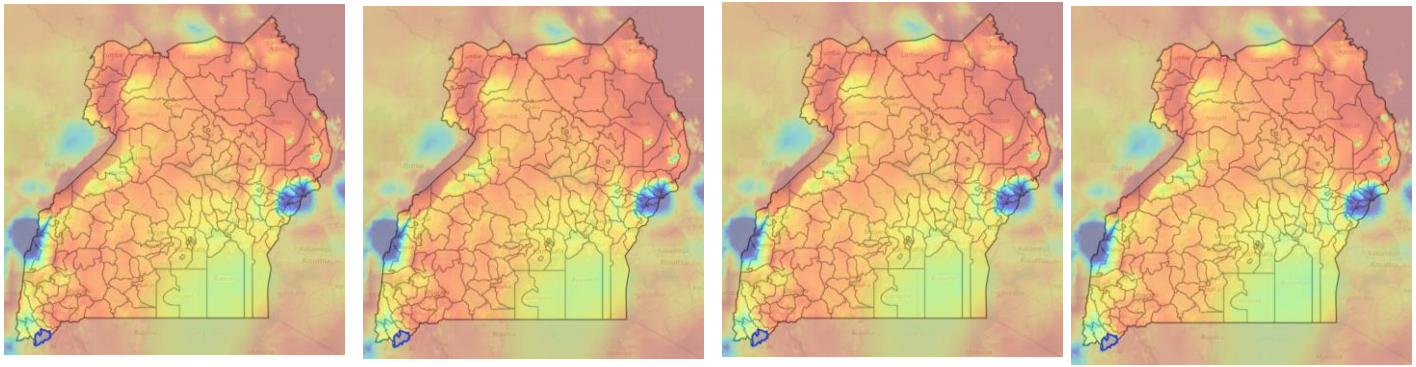
TEMPERATURE RELATED IMPACTS OF CLIMATE CHANGE ON MAIZE - SUMMARY

- Average mean t° today slightly above optimum, except for Kabale (U) and Kasungu (M).
- In Kabale, increase in mean t° by period 2041-2070 may result in yield *increase* (+ 5 à 10%)
- In other districts, increase in mean t° beyond optimum and corresponding increase in number of days > 30°C will result in yield *losses* (especially in Malawi).
- Impacts increase with time; by 2100 losses of about 40% can be expected in some regions.
- Impacts will be higher in regions that already are hot today and/or in regions with moisture deficit

UGANDA – ANNUAL PRECIPITATION DEFICIT (RCP 8.5)

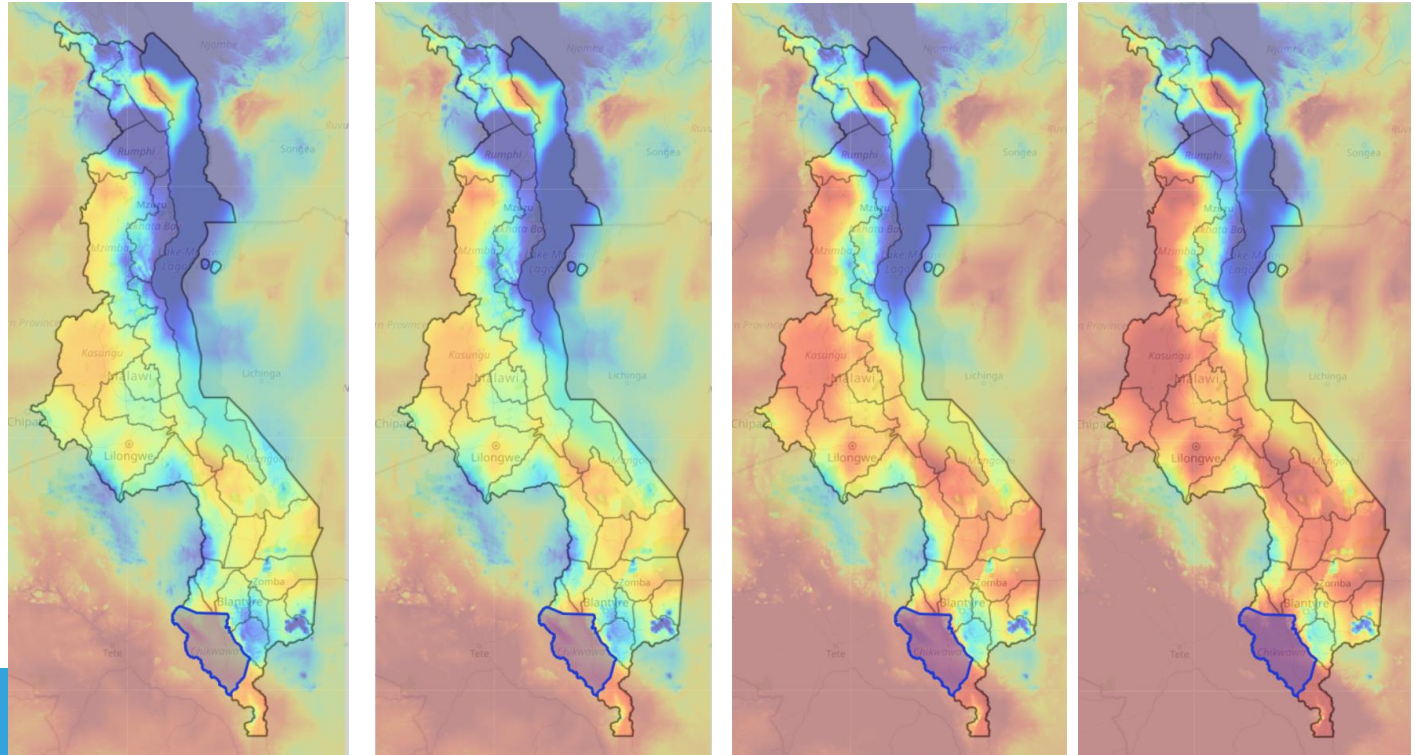


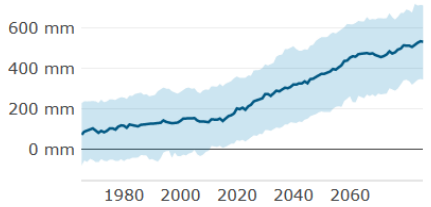
1981-2010	2011-2040	2041-2070	2071-2100

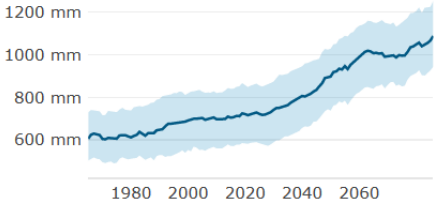


MALAWI – MEAN ANNUAL PRECIPITATION DEFICIT (RCP 8.5)

1981-2010	2011-2040	2041-2070	2071-2100



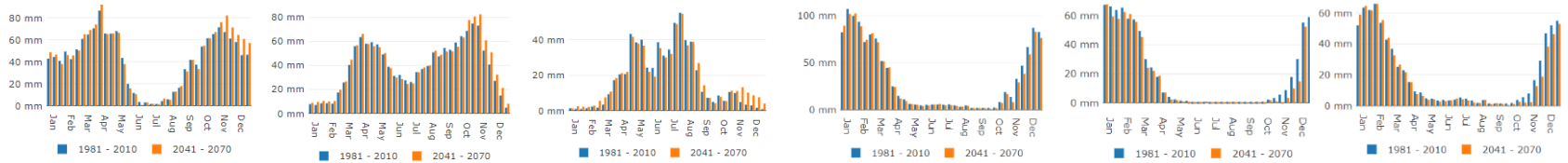




IMPACT OF CLIMATE CHANGE ON MAIZE YIELDS - RAINFALL

	Kabale	Masindi	Matheniko	Kasungu	Chitipa	Machinga
$Ptot_{2022}$	1749mm	1647 mm	888 mm	1283 mm	803 mm	883 mm
$Ptot_{2056}$	1856 mm	1688 mm	919 mm	1301 mm	788 mm	827 mm
$Pdef_{2022}$						
$Pdef_{2056}$						

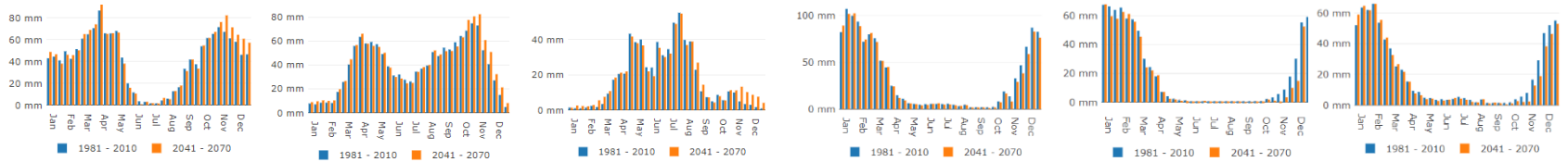
Rainfall



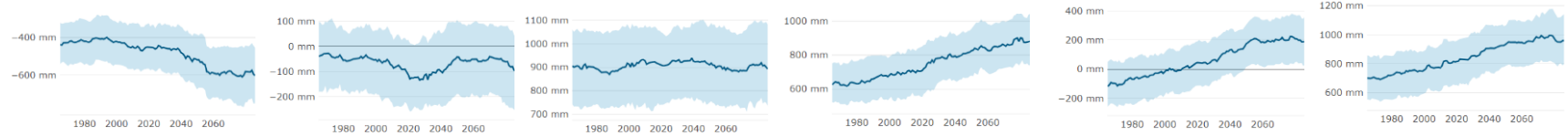
IMPACT OF CLIMATE CHANGE ON MAIZE YIELDS - RAINFALL

	Kabale	Masindi	Matheniko	Kasungu	Chitipa	Machinga
$Ptot_{2022}$	1749mm	1647 mm	888 mm	1283 mm	803 mm	883 mm
$Ptot_{2056}$	1856 mm	1688 mm	919 mm	1301 mm	788 mm	827 mm
$Pdef_{2022}$	-453 mm	-124,5 mm	906 mm	30 mm	720 mm	832 mm
$Pdef_{2056}$	-583 mm	-58,6 mm	906 mm	245 mm	932 mm	949 mm

Rainfall



Deficit



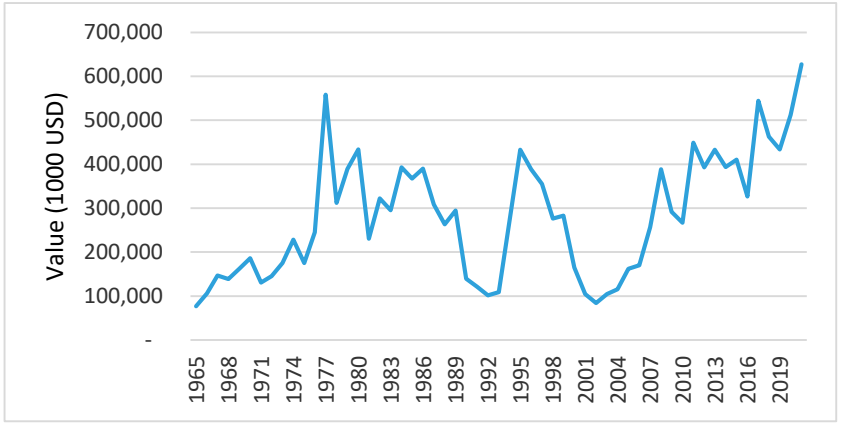
PRECIPITATION-RELATED IMPACTS OF CLIMATE CHANGE ON MAIZE - SUMMARY

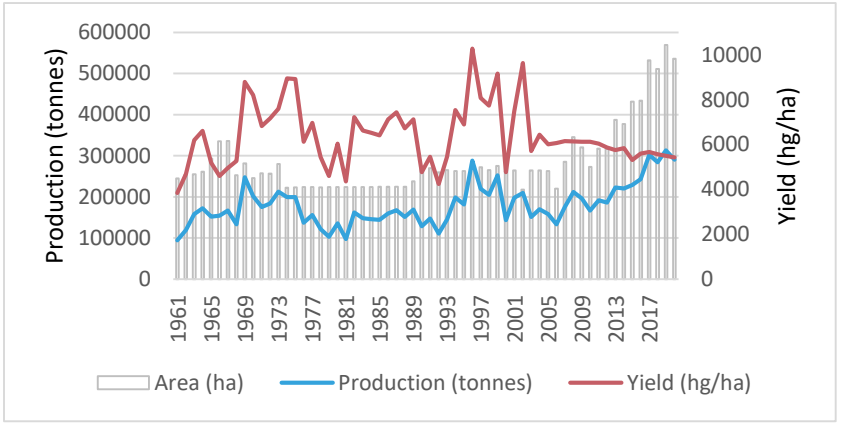
- **Uganda**:
  - Rainfall ranges from 3200 to 900 mm/year - suitable
  - Negative rainfall deficits (= surplusses) in most districts
  - Slight increase in rainfall by 2041-2070
  - Slight increase in rainfall surplusses and decrease in rainfall deficits in all areas by 2041-2070
  - In dry regions increase will not be sufficient to change suitability for maize.
  - Overall: changes in rainfall do not change suitability for maize cultivation on average
- **Malawi**:
  - Rainfall 900 – 1300 mm/year -> suitable
  - Deficits in most disctricts
  - Rainfall status quo in most areas
  - Deficits increase in most areas
  - Rainfall deficit aggravating factor for impact of temperature increase
  - Overall: yield reductions for maize will occur

CASE 3: COFFEE

UGANDA

COFFEE EXPORTS REPRESENT ABOUT 1/5 OF THE EXPORT VALUE OF UGANDA

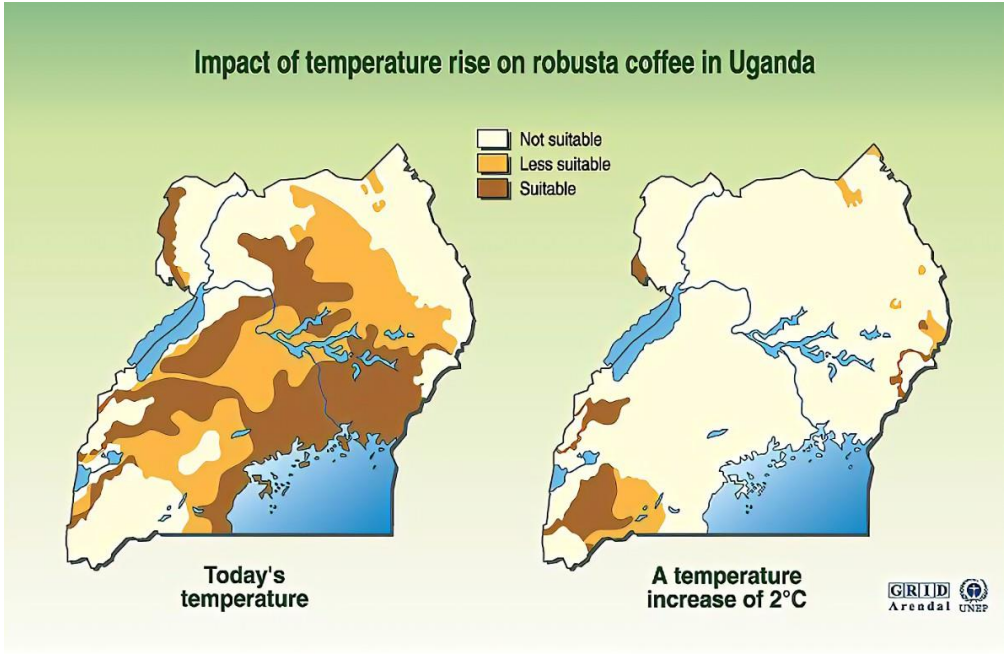




ECOLOGY OF COFFEE –IS EXTINCTION NEAR?

- **Quotes**:
  - "Nearly 100 percent of the world's Arabica coffee growing regions could become unsuitable for the plant by 2080"
  - "It is predicted that a two degree rise will reduce Uganda's coffee production by 80 per cent".
  - "By the end of this century, climate change could wipe out nearly all the world's coffee"

Is this true?

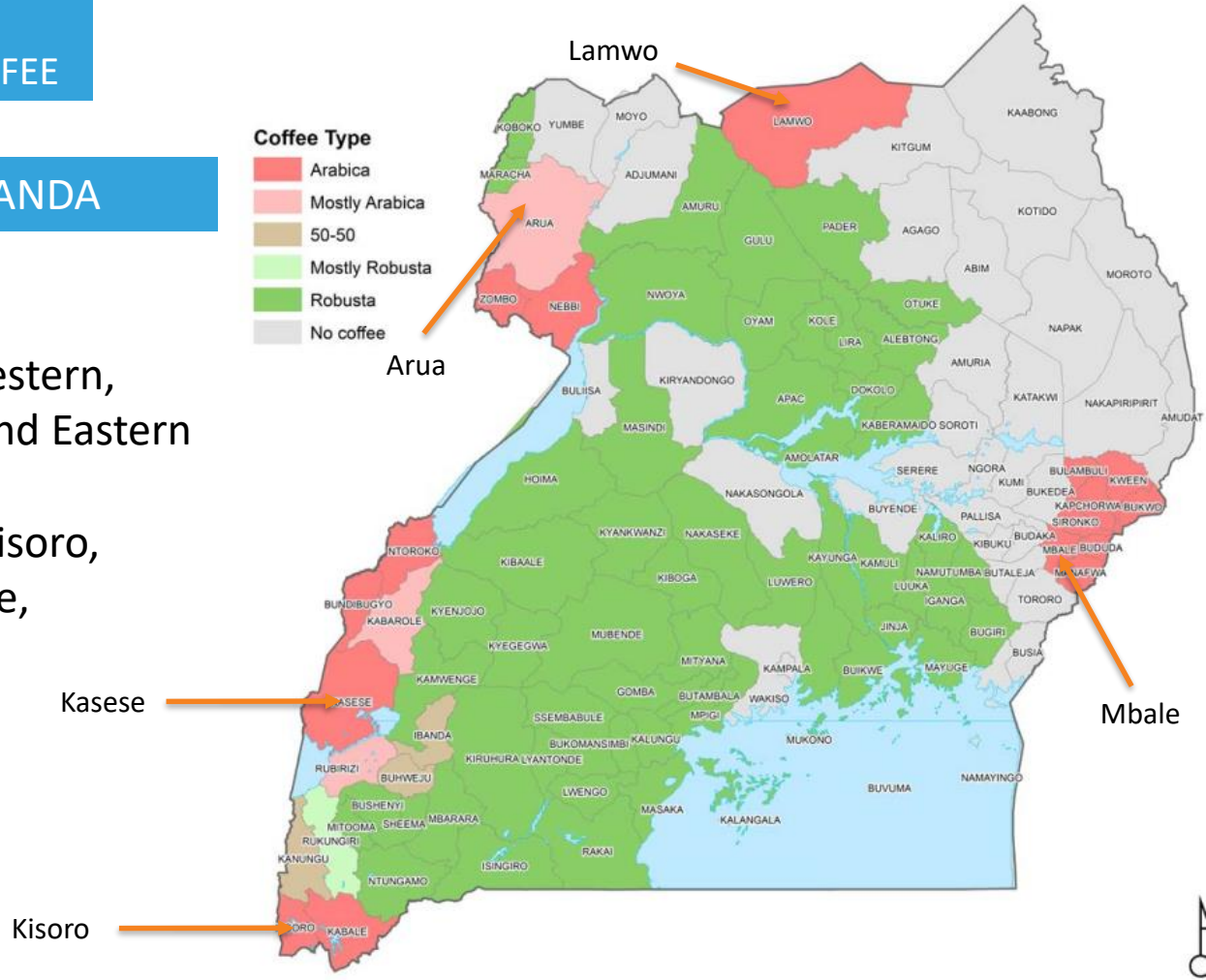


Source: Otto Simonett, Potential impacts of global warming, GRID-Geneva, case studies on climatic change. Geneva, 1989.

CLIMTAG CASE
UGANDA - COFFEE

COFFEE PRODUCTION IN UGANDA

- 80% Robusta, 20% Arabica
- Coffee grown in Central, Western, South-Western, Northern and Eastern regions.
- Selected for Arabica case: Kisoro, Kasese, Arua, Lamwo, Mbale,



ECOLOGY OF COFFEE

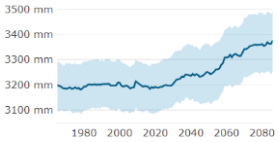
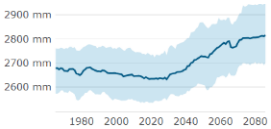
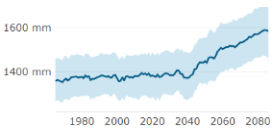
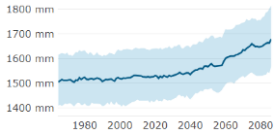
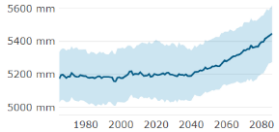
- **Arabica**:
  - Above 1200 to 1500 m; ‘ideal range’ 1500 – 1800 m
  - Average mean temperature range 18 - 21 °C; max. temperature 34 °C (Ecocrop)
  - 1400 – 2300 mm of annual rainfall; ‘optimum’ about 1500 mm; max. = 4200 mm (Ecocrop)

- **Robusta**
  - Less specific requirements
  - 250 -1500 m; optimum 300 m à 800 m
  - Optimum mean temperature range 22-26°C
  - 1200 to 2500 mm of annual rainfall

IMPACT OF CLIMATE CHANGE ON ARABICA COFFEE - PRECIPITATION

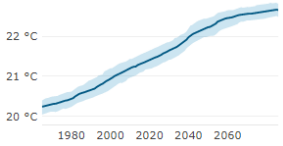
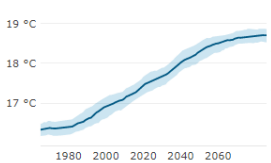
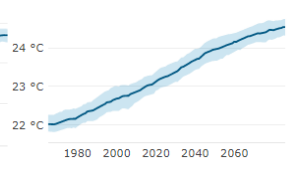
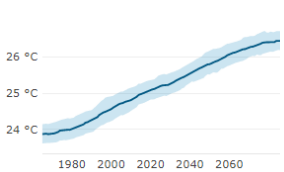
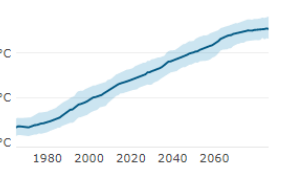
	Kasese	Kisoro	Arua	Lamwo	Mbale
$Ptot_{2022}$	3189 mm	2634 mm	1376 mm	1520 mm	5196 mm
$Ptot_{2056}$	3265 mm	2748 mm	1471 mm	1571 mm	5248 mm

IMPACT OF CLIMATE CHANGE ON ARABICA COFFEE - PRECIPITATION

Kasese	Kisoro	Arua	Lamwo	Mbale
				

$Ptot_{2022}$	3189 mm	2634 mm	1376 mm	1520 mm	5196 mm
$Ptot_{2056}$	3265 mm	2748 mm	1471 mm	1571 mm	5248 mm
$Pdef_{2022}$	-1915 mm	-1373 mm	219 mm	195 mm	-4351 mm
$Pdef_{2056}$	-2022 mm	-1494 mm	204 mm	211 mm	-4399 mm

IMPACT OF CLIMATE CHANGE ON ARABICA COFFEE -TEMPERATURE

Kasese	Kisoro	Arua	Lamwo	Mbale
				

$Tavg_{2022}$	21,7 °C	17,4 °C	23,4 °C	24,9 °C	22,4 °C
$Tavg_{2056}$	23,1 °C	18,9 °C	24,7 °C	**27,0 °C**	24,0 °C
$Tavg_{2085}$	24,6 °C	20,7°C	**26,7 °C**	**28,9 °C**	**25,6 °C**
$Tmax_{2022}$	26,3 °C	22,3 °C	29,0 °C	31,6 °C	26,5 °C
$Tmax_{2056}$	27,8 °C	23,8 °C	30,3 °C	32,3 °C	27,6 °C
$Tmax_{2085}$	29,2 °C	25,1 °C	32,0 °C	33,9 °C	28,9 °C

IMPACTS OF CLIMATE CHANGE ON ARABICA COFFEE - SUMMARY

- Climate change does have a negative influence on Arabica coffee production in many regions, mainly because of higher temperatures
- Some areas may even become unsuitable for Arabica cultivation
- Uphill movement of growing areas can be part of a solution, but has its limits.

- Coffee extinction is not on the horizon, but Arabica may become a rarer commodity.

THANKS FOR YOUR ATTENTION!

Questions?