United States Department of Agriculture

The AfCFTA and Climate Change

GTAP Conference

June 9, 2022

Jayson Beckman[1], Jeffrey R. Bloem[1], Fengxia Dong[1], Maros Ivanic[1], Jeremy Jelliffe[1], Michael E. Johnson[1], Gregory Kiker[2], Savannah Morgan[2], and Kate Vaiknoras[1]

[1] United States Department of Agriculture (USDA), Economic Research Service (ERS).
[2] Department of Agricultural and Bioeconomic Engineering, University of Florida.

Note: Names listed in alphabetic order.

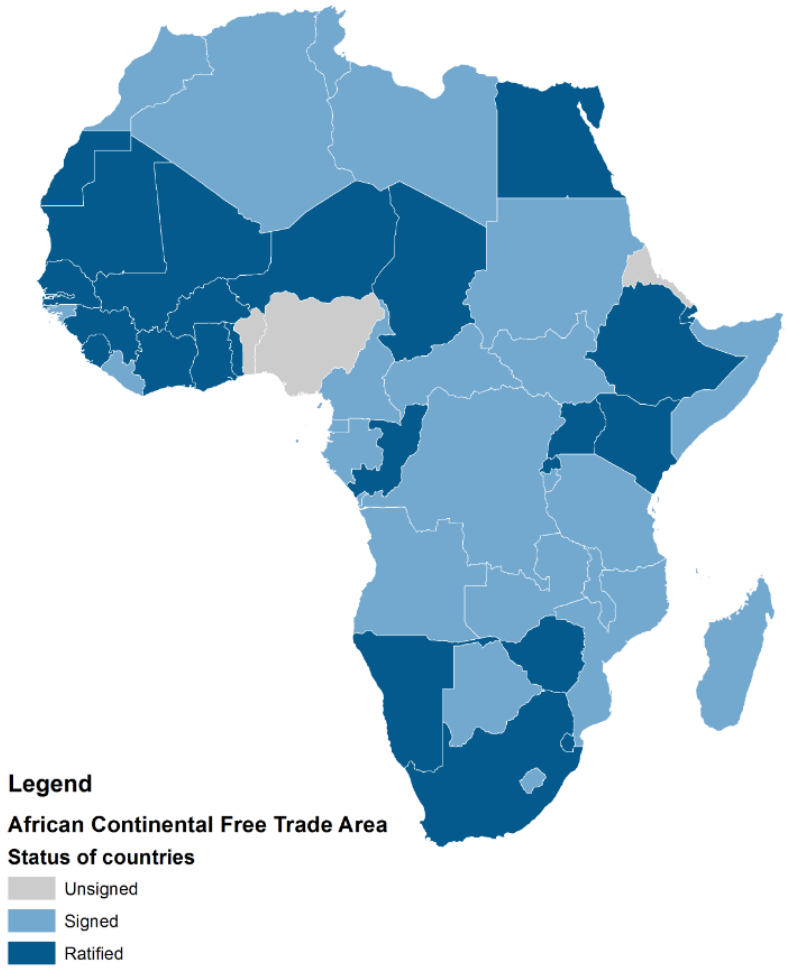
Disclaimer: The findings and conclusions in this presentation are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy or those of the University of Florida. This research was supported in part by the U.S. Department of Agriculture, Economic Research Service.

Outline

- The AfCFTA and what it promises
- Threat of climate change and study objective
- Livestock in Africa
- Climate change impacts on livestock
  - G-Range Model
  - Simulation results
- Linking to GTAP simulations
- Results
- Conclusions – “showing just how much climate change may reduce some of the expected gains from the AfCFTA”

The AfCFTA and what it Promises

- Among one of the largest free trade areas in the World (1.3 billion people across 55 countries)
- A major opportunity for Africa to attract investments and trade, diversify exports, and accelerate income growth (esp. as high urban growth continues to drive demand).
- The scope of AfCFTA is large… especially from reducing non-trade barriers on a most-favored-nation basis… with implications for growth in intra-regional investments and trade.



Source: The Brookings Institution, data as of May 29, 2019.

The Threat of Climate Change and Study Objective

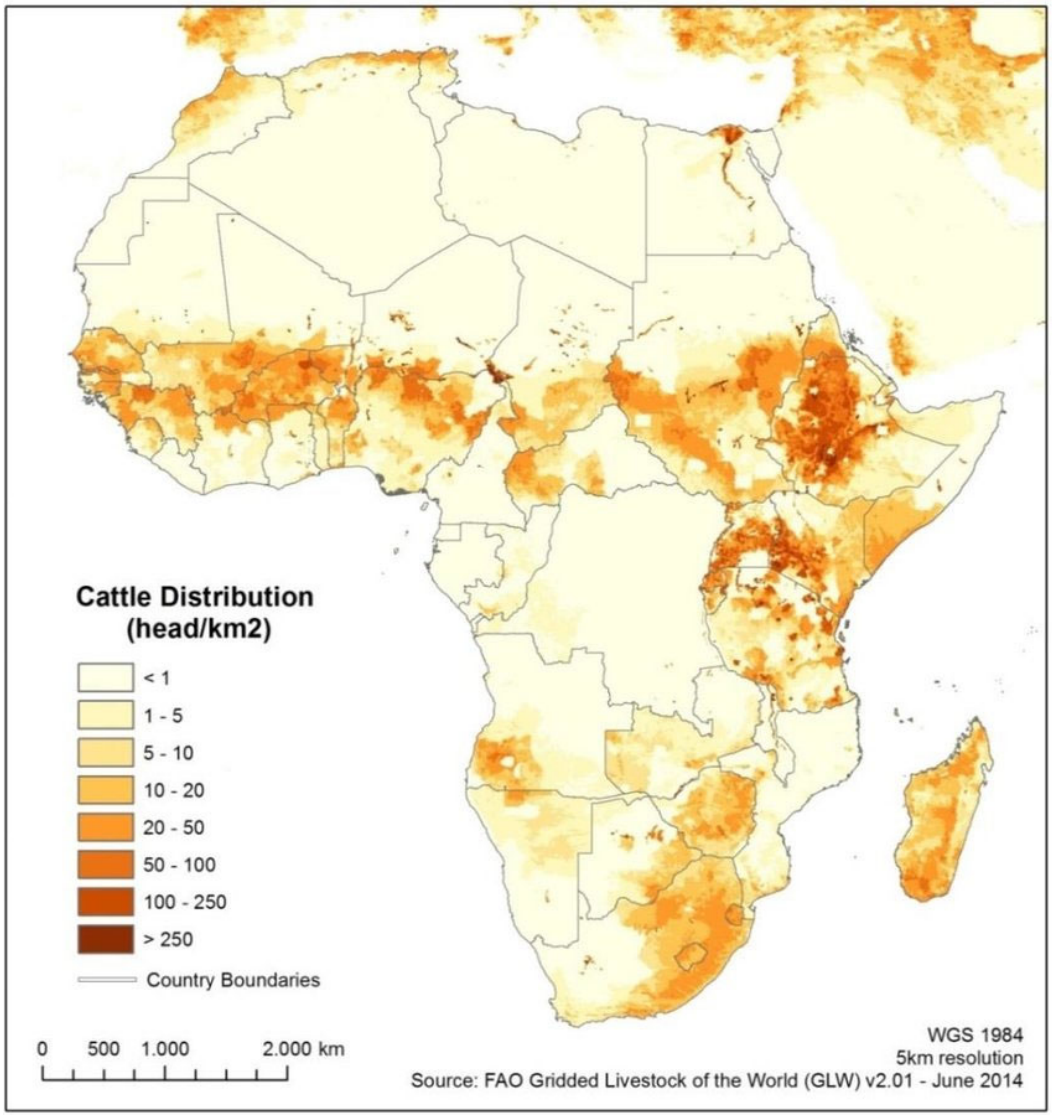
- A consensus among scientists – "**Africa will be hardest hit, both livestock and crops**" (IPCC, 2022).

- Although trade liberalization can partially offset climate change's effects…
  - it remains an empirical question how much Africa stands to lose (or gain) under the AfCFTA and climate change.

- Goal – to estimate the extent to which climate change may adversely affect the potential gains from greater trade integration in Africa – applying biophysical simulation models and GTAP.

Livestock in Africa and Climate Change (CC)

- Top 3 sources, 2020 (FAOSTAT, 2022): *Cattle* (Ethiopia, Chad and Sudan) | *Goats* (Nigeria, Ethiopia and Chad) | *Poultry* (Morocco, S. Africa, Egypt)
- Demand projected to increase due to population, income, and urban growth (Balehegn, M. et al., 2021).
- African pastoral livestock systems particularly vulnerable (80% of livestock supply)



The G-Range Model

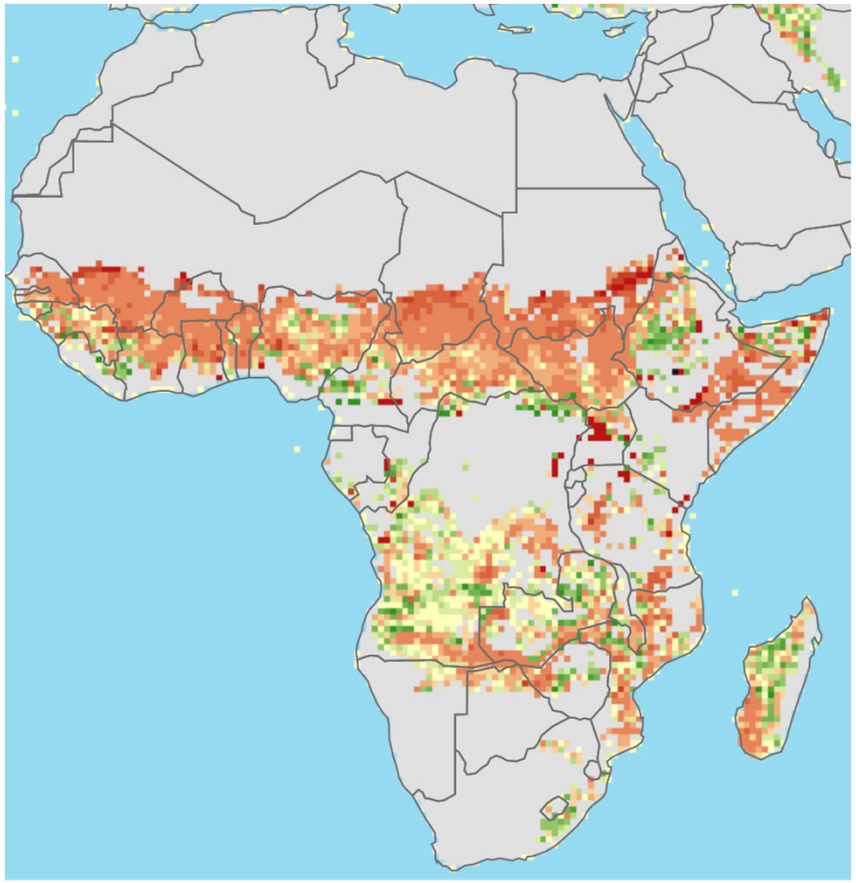
- Simulates changes to forage availability
  - The model uses spatial surfaces describing soil properties and cover for *herbaceous plants (grassland)*, *shrubs*, and *trees.*
  - Includes parameters describing nutrient cycling, plant growth, establishment and plant death, grazing, fire, and fertilization.
  - Projects total biomass changes across all three (grassland, shrubs, trees)

- Various levels of customization
  - Tracks water and nutrient dynamics through four soil layers and up to five plant parts.
  - 0.5-degree resolution (approx. 55km grid)

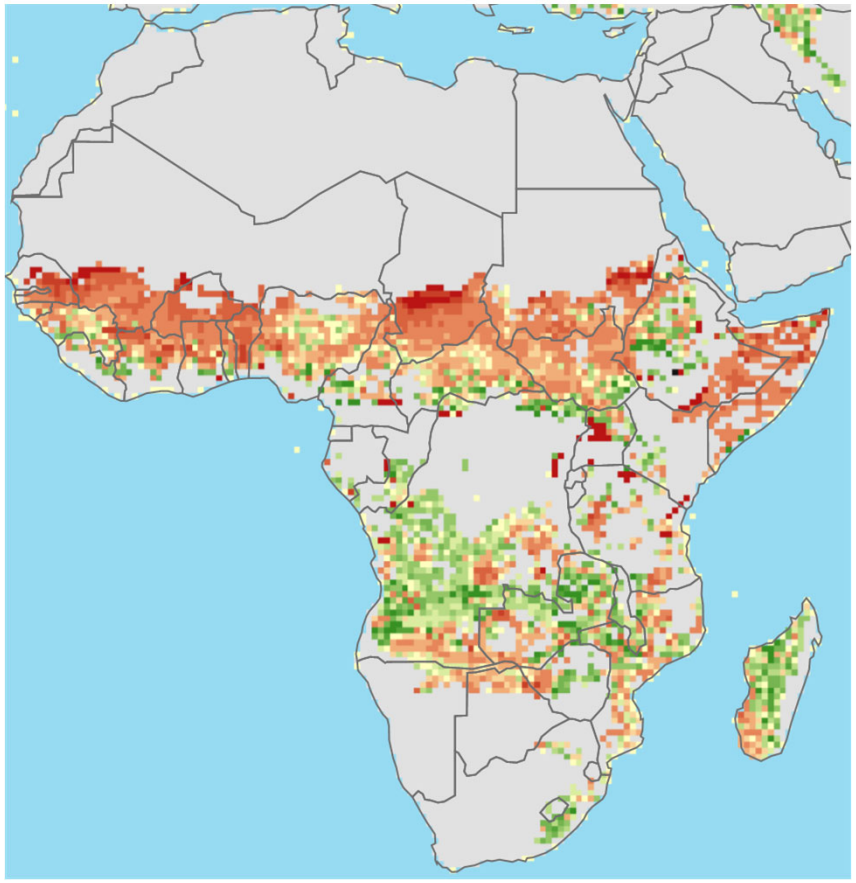
Results: Percent change of total biomass by 2040

- Much of the decline in the intensification of total biomass (in red) occurs across the Sahel (western Africa) and Horn of Africa (eastern Africa), as well as in the semi arid regions in southern Africa.

Results at RCP 4.5



Results at RCP 8.5



% Difference from 2017

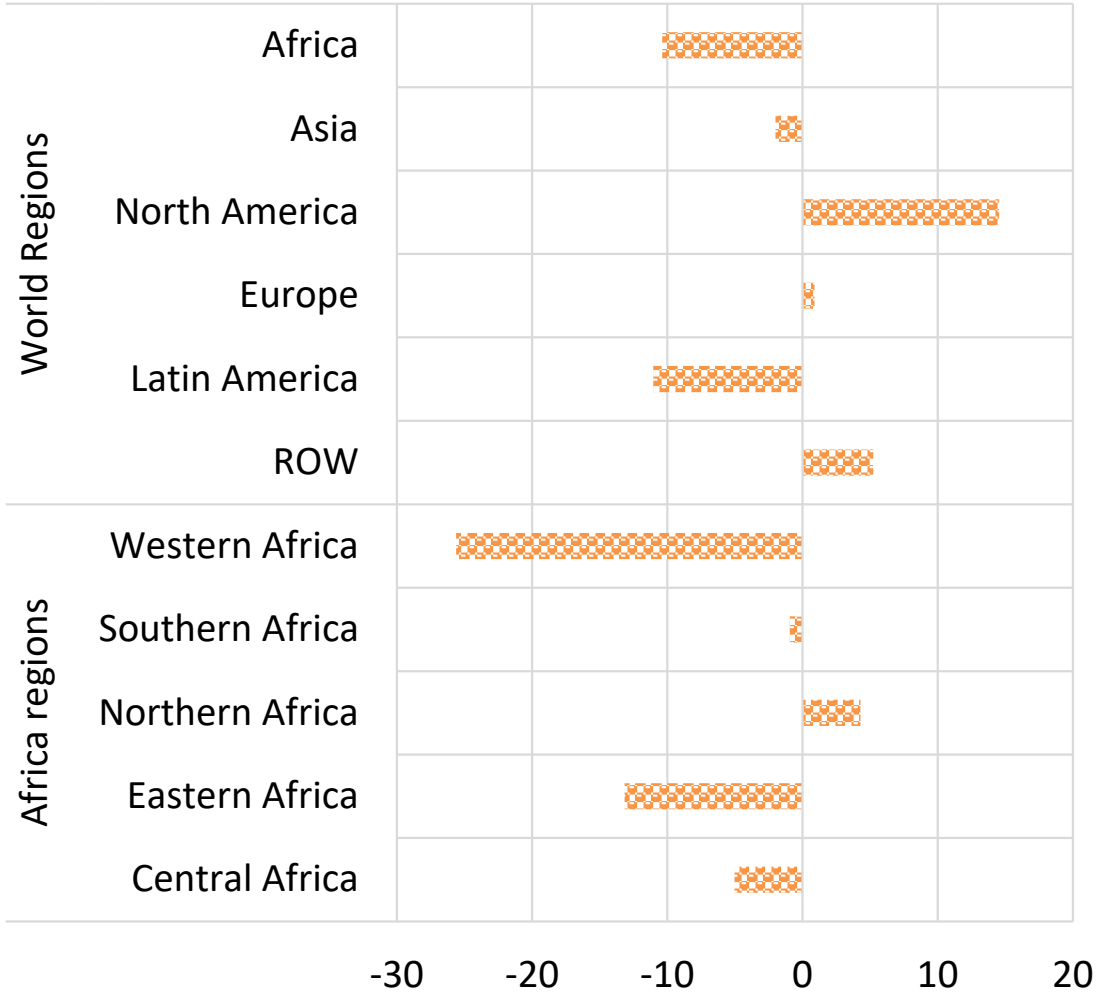
- -100% - -80%
- -80% - -60%
- -60% - -40%
- -40% - -20%
- -20% - -10%
- -10% - -5%
- -5% - 0%
- 0% - 5%
- 5% - 10%
- 10% - 20%
- 20% - 40%
- 40% - 60%
- 60% - 80%

GTAP simulations

- Use shared socio-economic pathway (SSPs)—scenarios of projected global changes to 2040 – specifically SSP5
- SSP Projections are from CEPII
  - Use population for demand growth and TFP for supply
- To capture a full operational AfCFTA - initially remove tariffs and reduce NTMs by 25% to validate with others in the literature.
- We then consider the impacts of climate with AfCFTA in place: SSP5, with and without climate impacts
- Climate shocks in GTAP are measured in terms of changes in land availability for crops and livestock

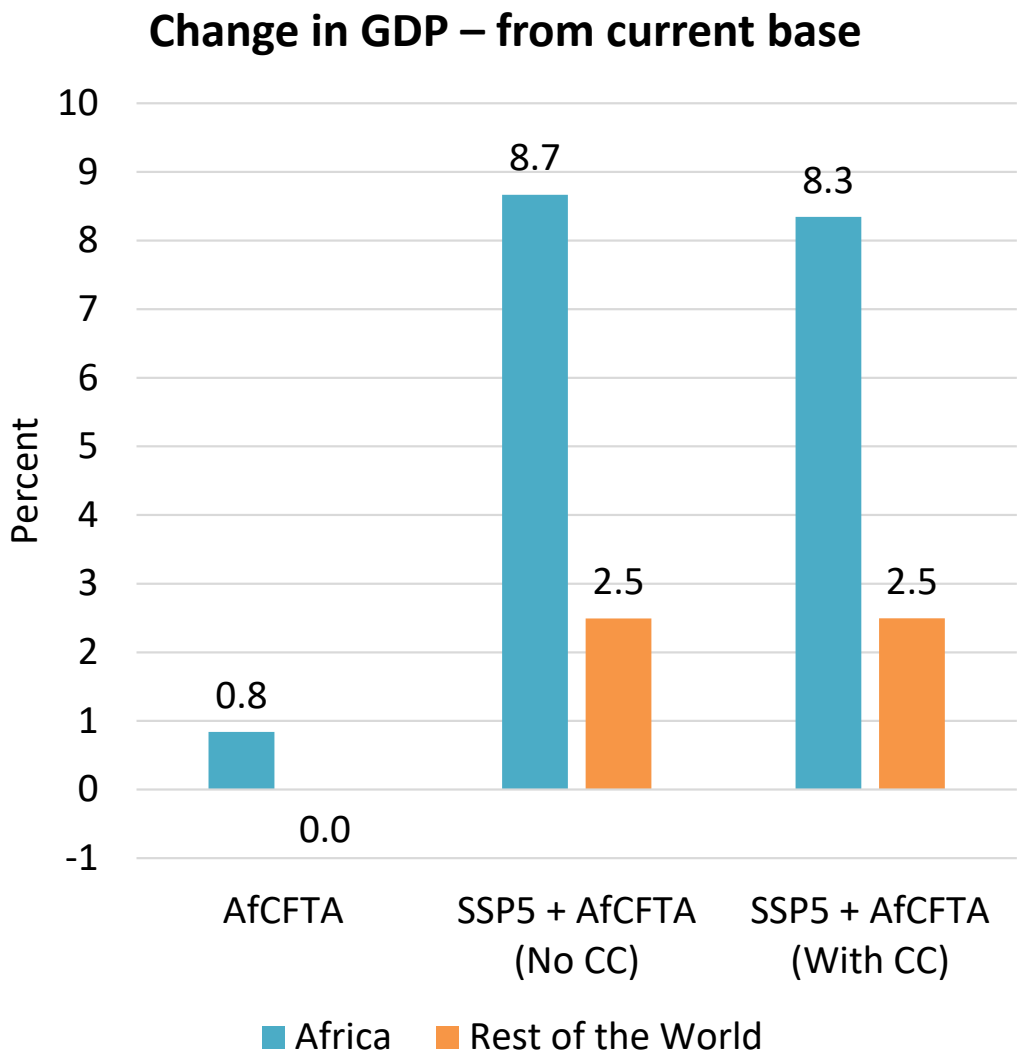
Aggregated G-Range Results for GTAP (total biomass changes, averaged by region)

- Across major regions, **Africa** and **Latin America** face the largest declines in total biomass due to climate change
- Within Africa, **Western Africa**, followed by **Eastern Africa** fare worse
- We use these climate change effects on total biomass to represent changes in land availability for agricultural production (affects both crops and livestock)



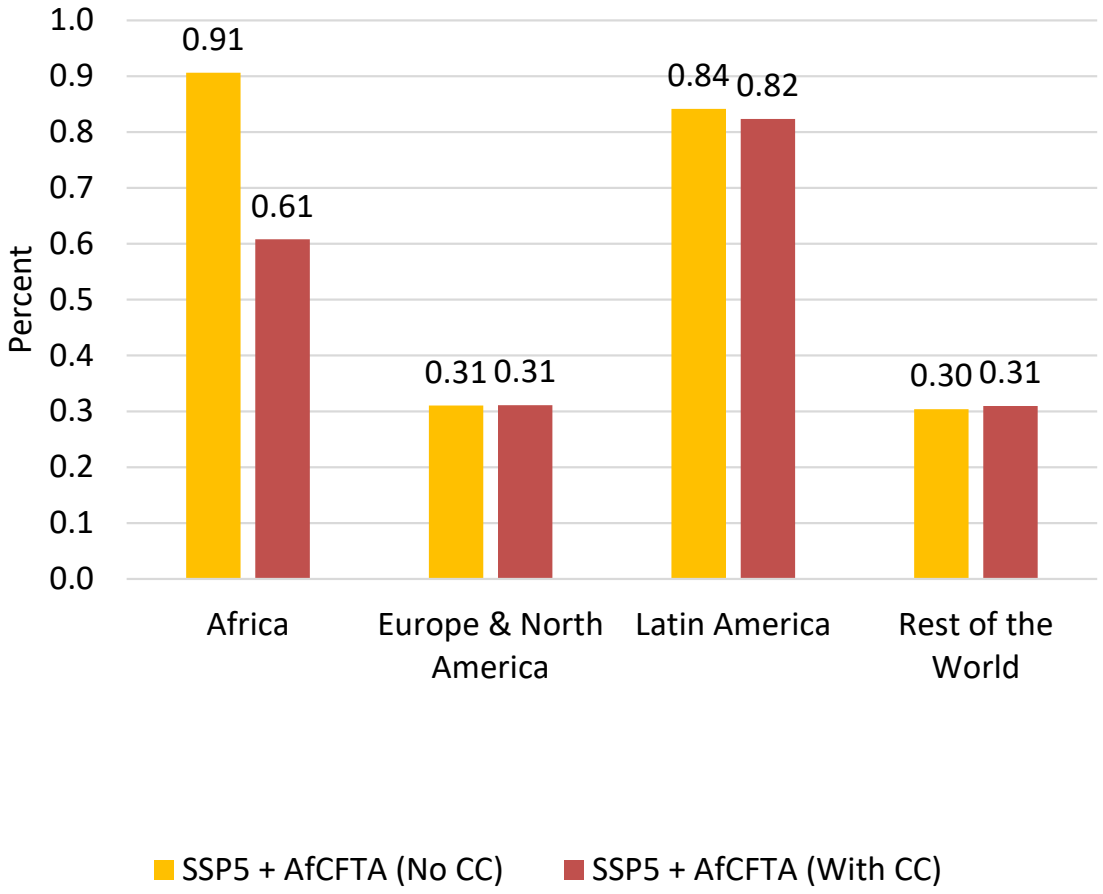
Simulations results – effects on GDP

- Gains from tariff elimination and reducing NTMs under the AfCFTA are similar with others ~ 1% change in GDP plus positive welfare gains
- Adding on a growth-oriented development trajectory (SSP5) with AfCFTA to 2040 results in even greater gains (a change in GDP of 8.7 percent for Africa).
- However, climate change effects by 2040 threaten to reduce some of these gains



Climate change (CC) effects across world regions

- Even with a fully operational AfCFTA and a growth-oriented development agenda (SSP5) in place, effects of climate change on welfare and incomes is significant for Africa
  - Income gains (GDP), decline from 0.9 to 0.6 percent)
  - Rest of the world is less affected (aside from small losses in Latin America).

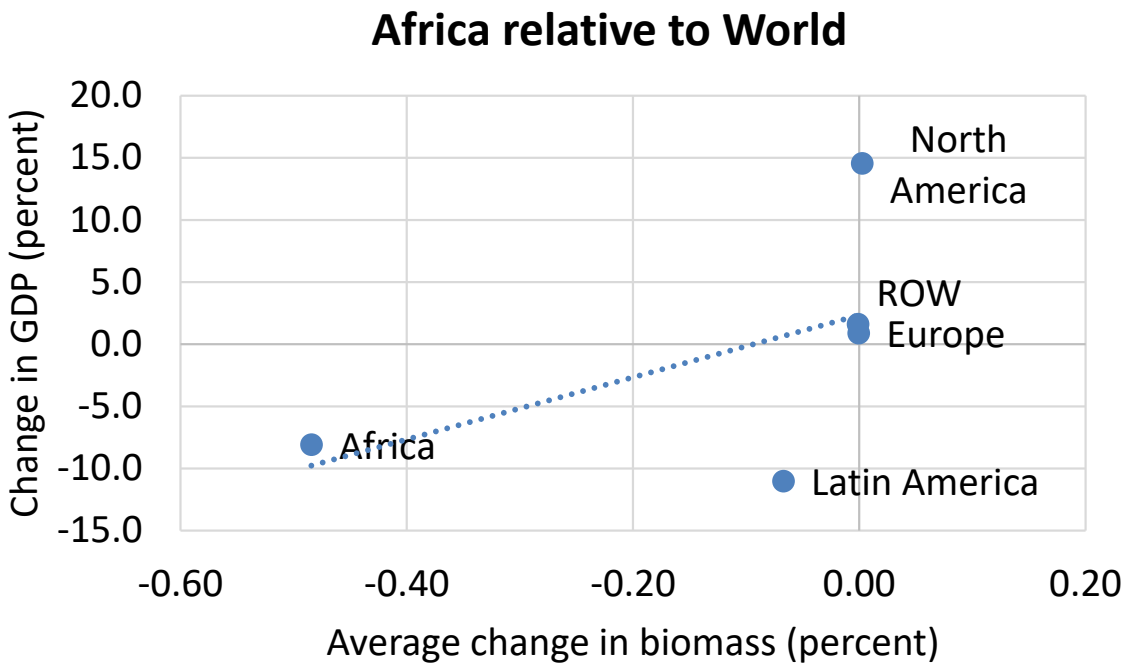


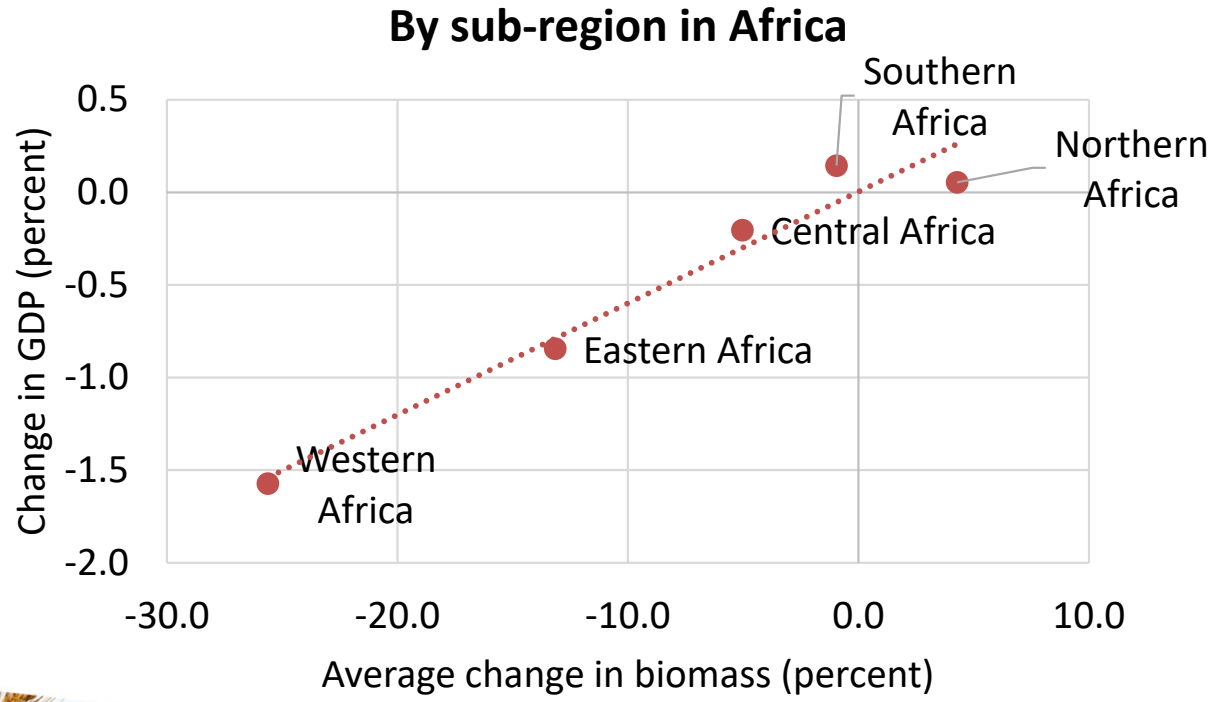
Effect on incomes vary by region

- Simple correlates between changes in total biomass and GDP are strong
  - This is measuring changes in GDP between "SSP5 + AfCFTA (no CC)" and "SSP5 + AfCFTA (with CC)" scenarios.

- With declining biomass and land availability for crop and livestock systems – Africa stands to lose more.

- Not surprisingly, Western and Eastern Africa regions appear most affected..
  - Worst affected countries (Senegal, Benin and Burkina Faso, Uganda and Sudan)

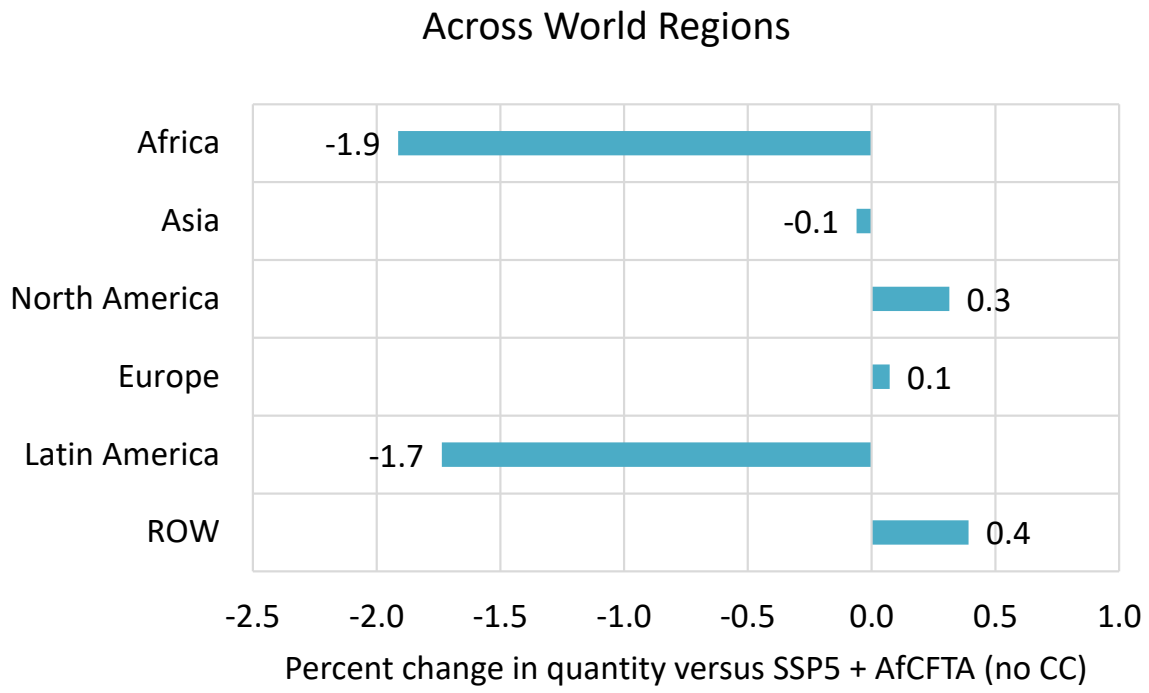


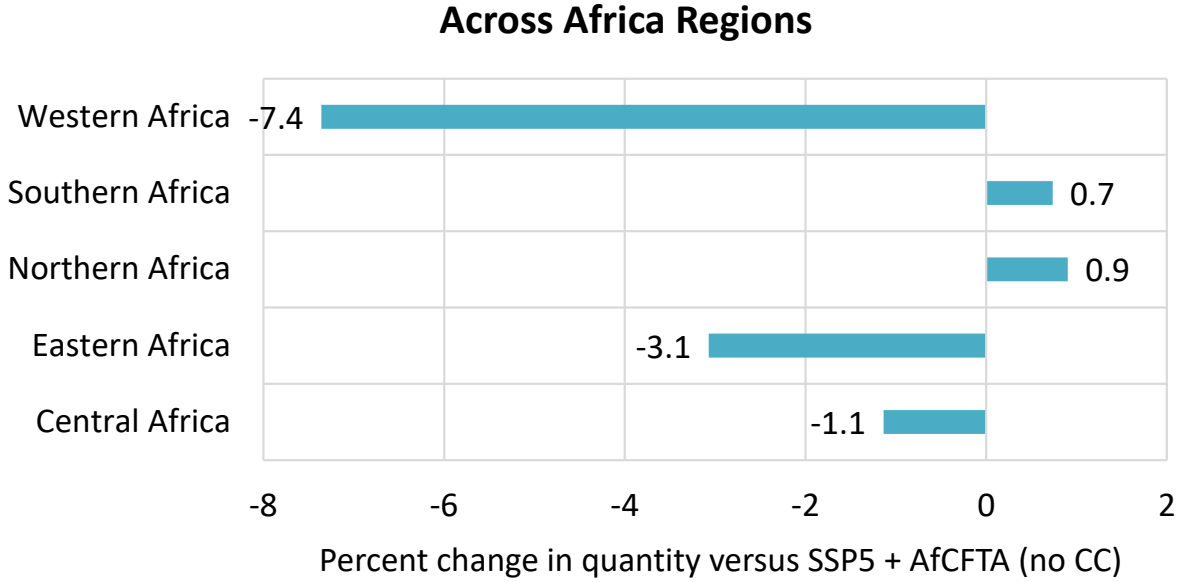


Effect on livestock production

- At global level..
  - Again, Africa experiences the largest declines in production (-1.9%) - but so does Latin America (-1.7%). Both experienced higher losses of plant biomass (> 10% by 2040)

- Within Africa..
  - Aside from Northern and Southern Africa, all other regions experience reductions in livestock production (**up to 7.4 percent for Western Africa**) – but varies by country.





Summary Conclusion

- Systematic decrease of total biomass by 2040 threatens to reduce total land available to support livestock systems in Africa (> 10% by 2040) – despite growing demand for livestock products.
  - Production could decline by almost 2 percent

- The effects vary by sub-region and countries within Africa
  - Production in **Western Africa** is hardest hit (-7.4 percent) followed by **Eastern Africa** (-3.1 percent) | Greatest effects are felt in Sudan, Botswana, and Ethiopia
  - Crops are also hit hard (a majority of countries), potentially leading to more livestock dependency (not captured in the model)

- Overall, positive welfare and income gains as economies rapidly grow under SSP5 and the AfCFTA, climate change is likely to reduce these gains more than the rest of the World.

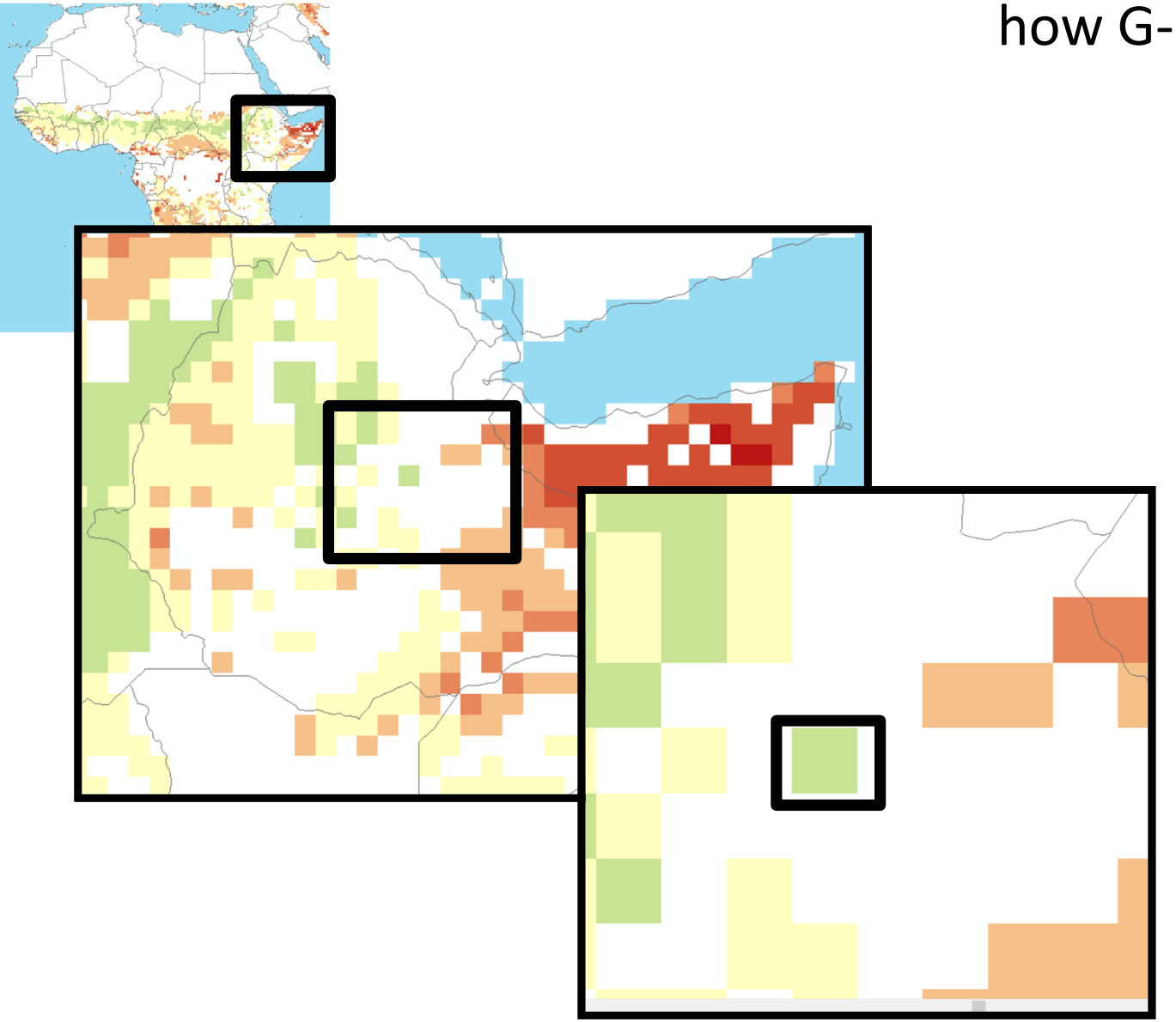
- As part of ongoing research, further improvements planned:
  - Using recent GTAP AEZ database to further disaggregate changes in types of biomass to better capture and link to livestock production
  - Adding a scenario that assessed whether the AfCFTA may help mitigate effects of CC.
  - Projecting out further to 2070, for example.

Thank You

References

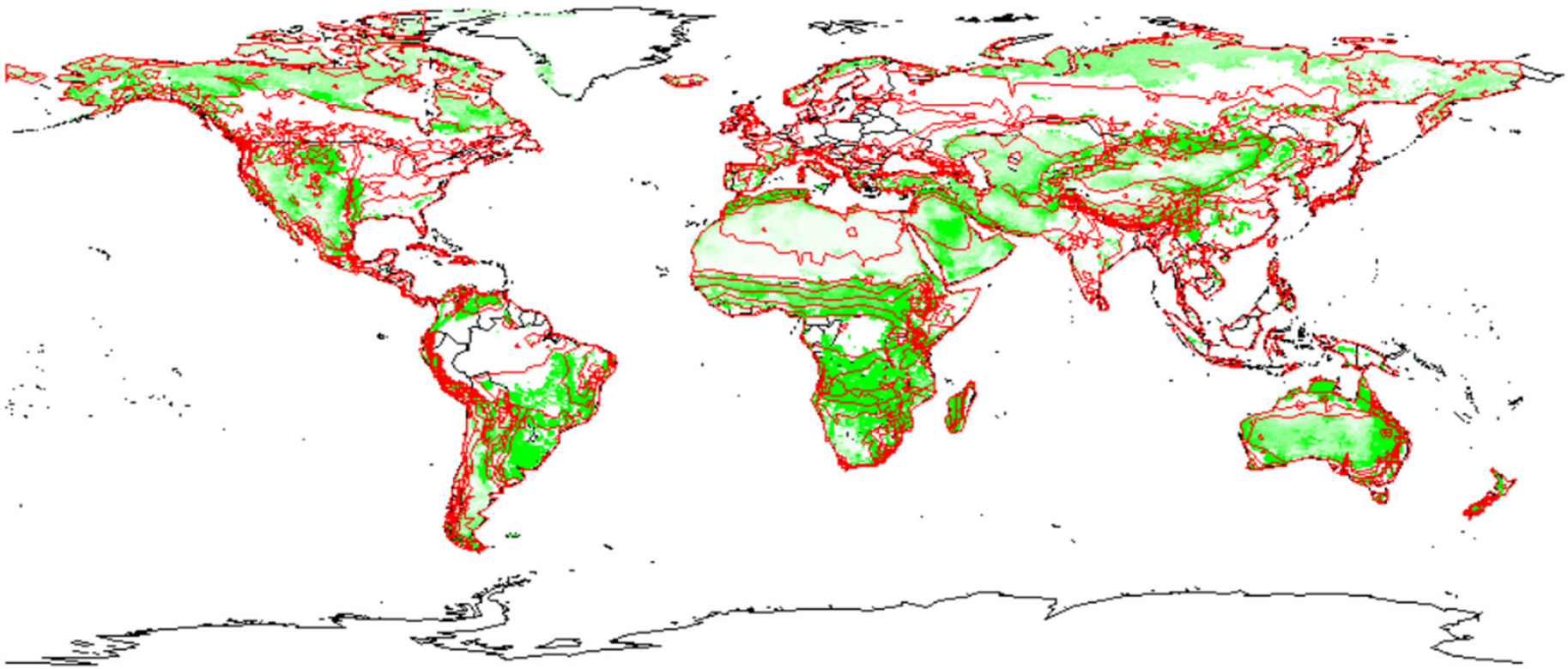
- Balehegn, M., et al. 2021. “Livestock sustainability research in Africa with a focus on the environment.” Animal Frontiers, 11:47-56
- Boone, R. et al., 2017. “Climate change impacts on selected global rangeland ecosystem services.” Global Change Biology
- FAOSTAT, 2022
- IPCC. (2022). Africa. In IPCC WGII Sixth Assessment Report. The Intergovernmental Panel on Climate Change (IPCC) of the United Nations.
- Jones, P.G., and P.K. Thornton, 2009. “Croppers to livestock keepers: livelihood transitions to 2050 in Africa due to climate change.” Environmental Science & Policy, 12(4): 427-437

Things to Remember about how G-Range simulates a grid…

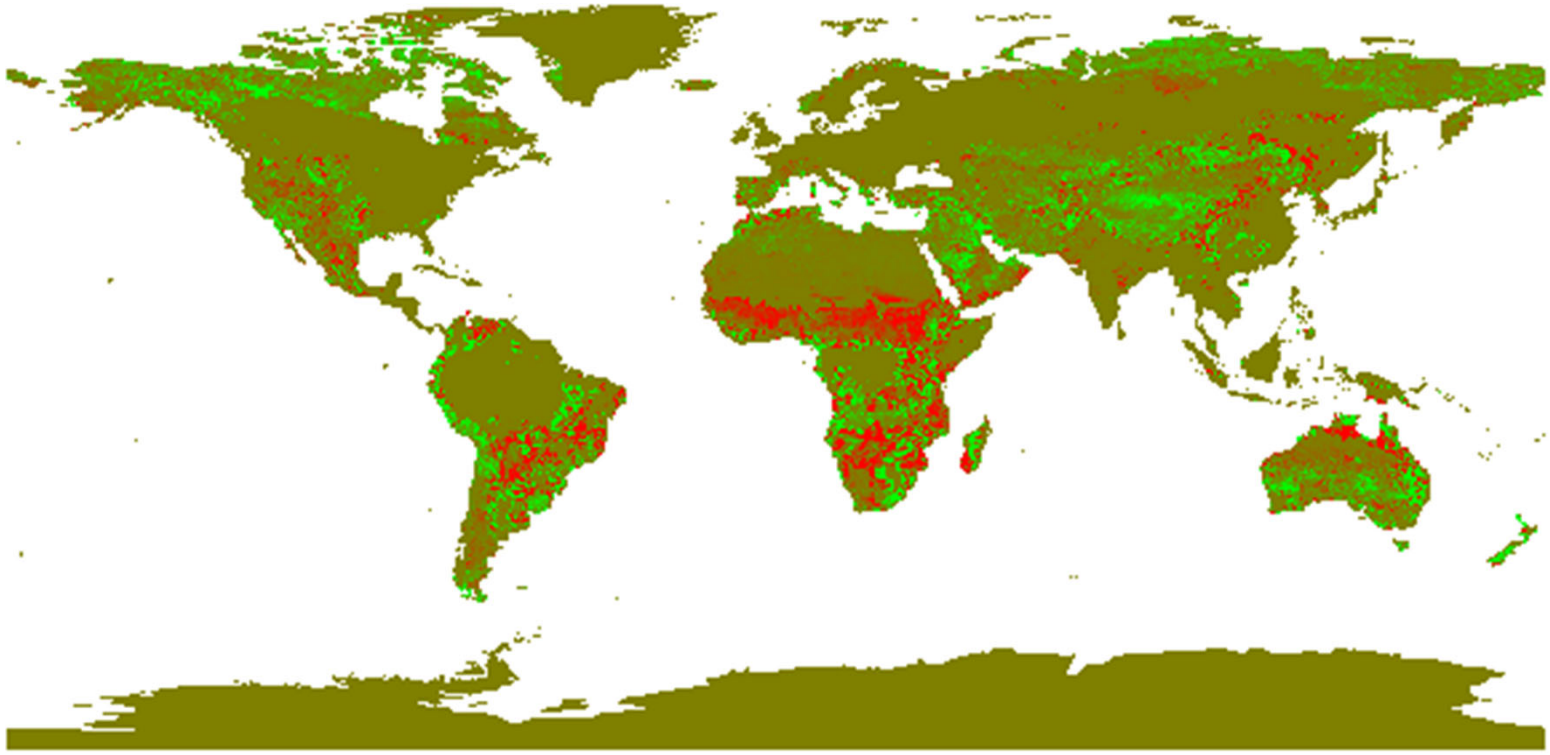


- Every simulated grid (approx. 55 km) has **3 facets** INSIDE it… each simulated as a fraction….
  - Grass – dominated areas
  - Shrub – dominated areas
  - Tree – dominated areas
- These facets are simulated separately so they can change against each other… Grass areas may decrease while shrubby areas increase… while tree areas remain the same…
- They also have separate Carbon, Nitrogen, and other dynamics…

2017 Base data on total biomass (green) by GTAP AEZ regions (red lines)

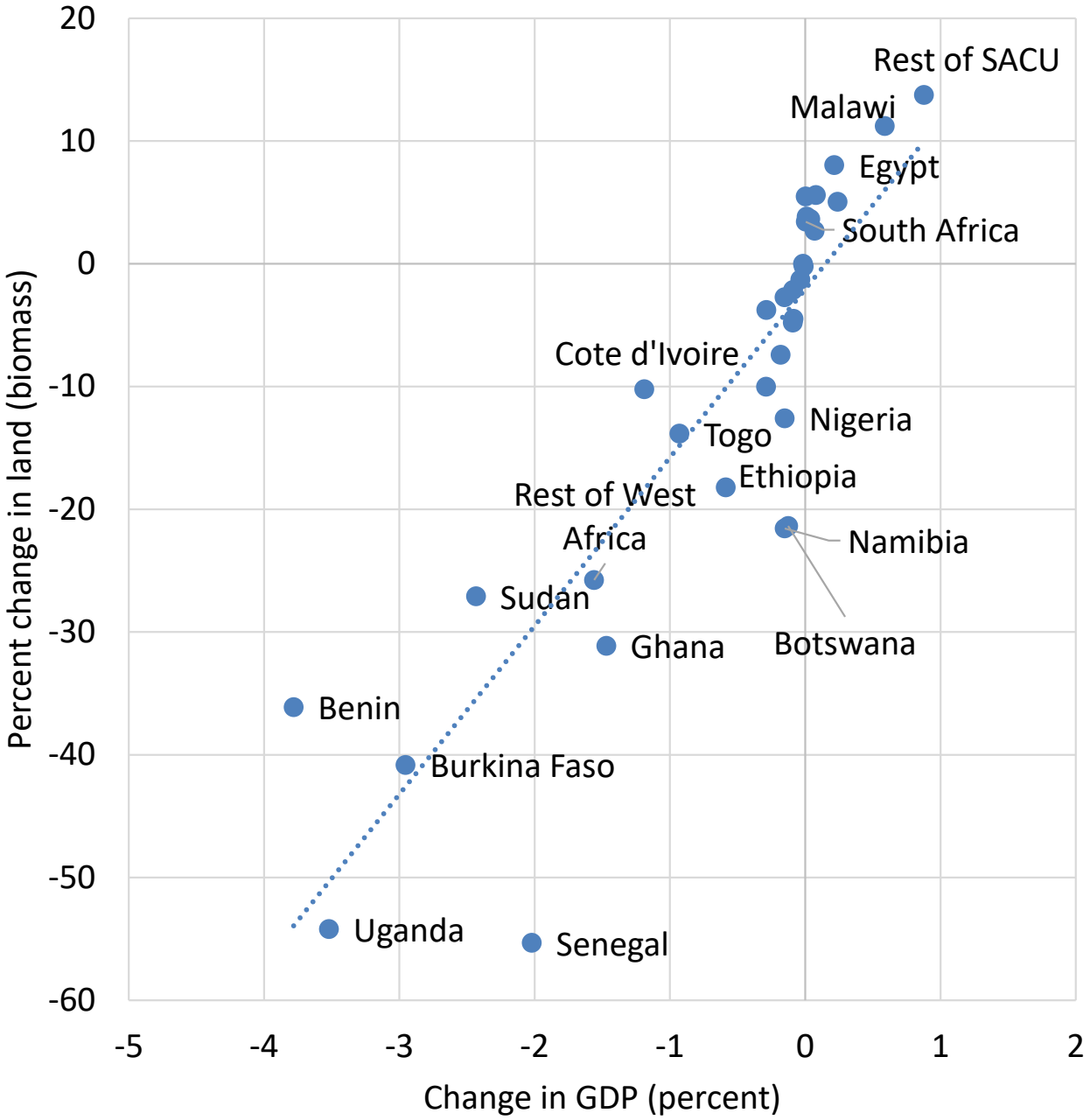


Results: Negative percent change of total biomass by 2040 at global level (in red)



Some African countries affected more than others

- Not surprisingly, a majority that stand to lose more are in West Africa
- In East Africa, it is mostly Uganda and Ethiopia
- Southern Africa includes Namibia and Botswana



Example: Simulating rangeland productivity and effects on livestock herds (Boone et al. 2017)

- Project climate change impacts on rangelands through 2050 compared to 1951-2006 baseline (RCP 8.5 with carbon fertilization) at half-degree spatial resolution

- Given global changes in herbaceous production and information of feed quality within biomes, calculated numbers of megajoules in forage gained or lost → how many animals (in livestock units) can this landscape support?
  - Some regions, including western Africa are projected to lose herbaceous net primary production(-46% in sub-Saharan western Africa)

- Global livestock will decline by 28.7 to 37.1 million livestock units, a decline of 7.5 to 9% (based on declines in herbaceous production)
  - Declines are worse in savannas south of the Sahara