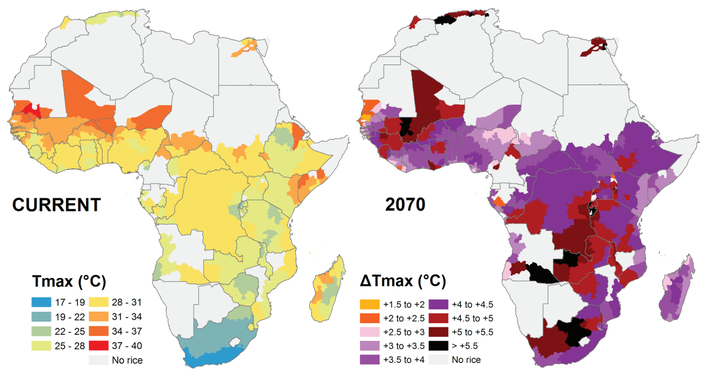
The potential impacts of climate change on rice yields in Africa and options for adaptation

Rice and food security in Africa

- In Africa rice is the fastest growing staple crop in terms of consumption as well as production in Africa.
- Changing diets of urban population in combination with urbanization and fast population growth lead to strong increase in demand.
- The African countries together are the largest importer globally of Asian rice and depend heavily on international markets.
- Approximately 70% of the total rice production in Africa is under rainfed conditions in upland and lowland rice environments.
- Irrigated rice is cultivated under extreme temperature conditions, especially in the Sahel zone in West-Africa.
- Rice cultivation is vulnerable to the impacts of climate change due to reduced availability of surface and rain water and increases in minimum (night) temperature and maximum temperature.
- Rice is cultivated principally by smallholder farmers cultivating less than 1 hectare.



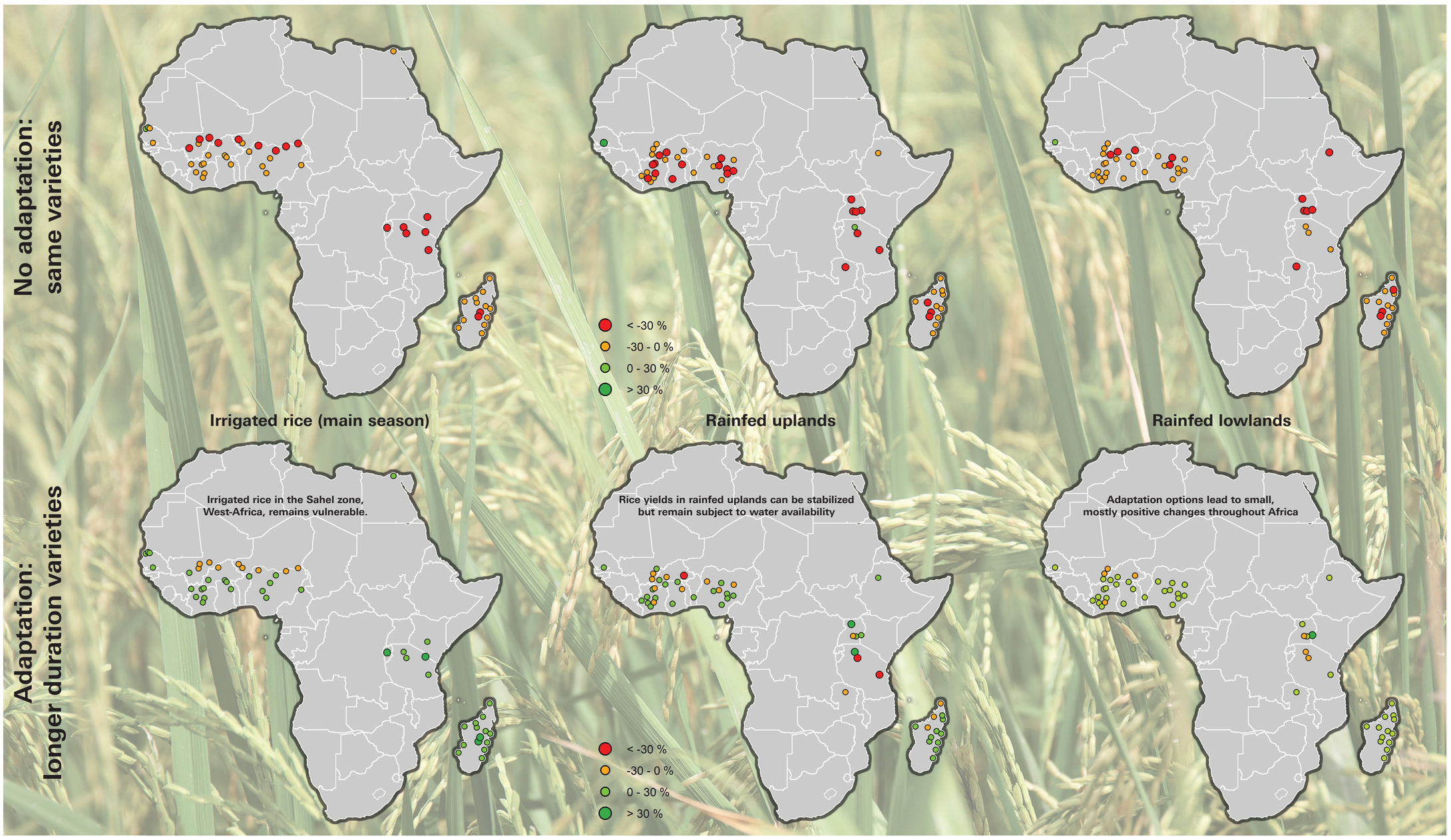
Projected change in maximum temperature during the main rice growing season RCP8.5 – 2070s

Methodology

- Changes in rice yields across Africa were simulated using a combination of spatial analysis and crop modelling.
- Climate change induced alteration in minimum and maximum temperature and atmospheric CO2 were considered.
- Spatial analysis was performed for 4 climate change scenarios (RCP 2.5, 4.0, 6.5 & 8.5) and 3 time slice (2030s, 50s & 70s).
- Downscaled monthly outputs of climate changes scenarios of all available GCMs were averaged.
- Monthly average Tmin and Tmax were crossed with location-specific rice calendars to obtain average changes during the rice cultivation seasons.
- Rice yields were simulated with the ORYZA2000 model for over 60 representative locations across Africa.
- Baseline conditions for the 2000s were simulated and seasonal average Tmin and Tmax for each location were used to develop the climate change scenarios.
- Projected changes in rice yields were then modelled for irrigated rice, rainfed lowland and rainfed uplands.
- Choice of improved rice varieties with longer duration was simulated as adaptation option to the projected changes.

Major findings

- Without adaptation, shortening of the growing period due to higher temperatures results in a yields decline of -24% in RCP 8.5 in 2070 compared to the baseline year 2000.
- With adaptation option rainfed rice yields would increase slightly (+8%) but they remain subject to water availability constraints.
- Irrigated rice yields in East Africa would increase (+25%) due to more favourable temperatures and due to CO2 fertilisation.
- Wet season irrigated rice yields in West Africa were projected to change by -21% with no adaptation or +7% with adaptation.
- Largest decreases of -45% were simulated for dry season rice cultivation in the Sahel zone.
- The main cause of this decline was reduced photosynthesis at extremely high temperatures and not due to heat sterility in rice grains
- Climate change and adaptation options provide new opportunities in East Africa due to less cold stress.



Project yield changes by 2070s in irrigated (left), rainfed upland (middle) and rainfed lowland (right) rice growing environments during the main rice growing season for without adaptation (first row) and with adaptation (second row)

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Global Change Biology

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Impacts of Climate change on Rice production in Africa and causes of simulated yield changes
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