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Potsdam Institute for Climate Impact Research
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Climate risk analysis for identifying and weighing adaptation strategies in Ghana's agricultural sector

Executive Summary

This summary is based on a study prepared by the Potsdam Institute for Climate Impact Research (PIK) for the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), in cooperation with the Ghanaian Ministry of Food and Agriculture (MoFA). The report aims to contribute to Ghana's NDC implementation and its adaptation content is aligned to the objectives of the NDC Partnership.

Study objective: Oftentimes, information on climate risks - upon which climate change adaptation decisions are based - is limited. This briefing paper summarizes key facts of a study conducted to provide a comprehensive climate risk analysis for Ghana focusing on the evolving trends for temperature and precipitation, future water availability, crop yield changes and the suitability of land for crop production. Based on this information, adaptation strategies are selected and analysed with regard to their feasibility, cost effectiveness and aptitude for local conditions. The study results provide decision-makers in Ghana with information on suitable adaptation strategies, based on state-of-the-art climate risk modelling. The findings can feed/ already fed into the Ghanaian National Adaptation Planning (NAP) process, Ghana's NDC update, National Communications to UNFCCC and other relevant climate change policies. The climate risk study can primarily be useful for decision-makers working on adaptation in Ghana at national or sub-national level, but it can also provide information and evidence at other planning and implementation levels. Based on the study findings the Ghanaian Ministry of Food and Agriculture (MoFA) and GIZ are for instance jointly preparing a policy brief for the subnational agricultural departments in Ghana.

Study approach: The study models the impact chain from a changing climate, to uncertain water availability, to the resulting impacts in the agricultural sector. The results then inform the analysis of adaptation strategies, where different adaptation strategies are assessed with regard to their risk reduction potential, their economic effectiveness and other socio-economic evaluation criteria. The uncertainty attached to the results is critically discussed and an outlook with recommendations is given. Throughout the study design and implementation, the authors took care to consult local stakeholders in Ghana, in order to ensure that the study considers their interests and context-specific expertise. This was done through consultation workshops with the Ghanaian government and other key stakeholders, such as from academia, civil society and the private sector as well as qualitative interviews conducted with experts and key informants. Other data used for the study includes observed weather and climate data, hydrological data from a variety of sources, crop yield data provided by the Ghanaian Ministry of Food and Agriculture and simulated past and future climate data from ISI-MIP2b data (Inter-Sectoral Impact Model Intercomparison Project). The ISI-MIP was created to offer a framework for the comparison of climate impact projections in different sectors, combining the power of a suite of impact models. It thus provides sound aggregate results on projected climate impacts (see Frieler et al. 2017 for further information)[1].

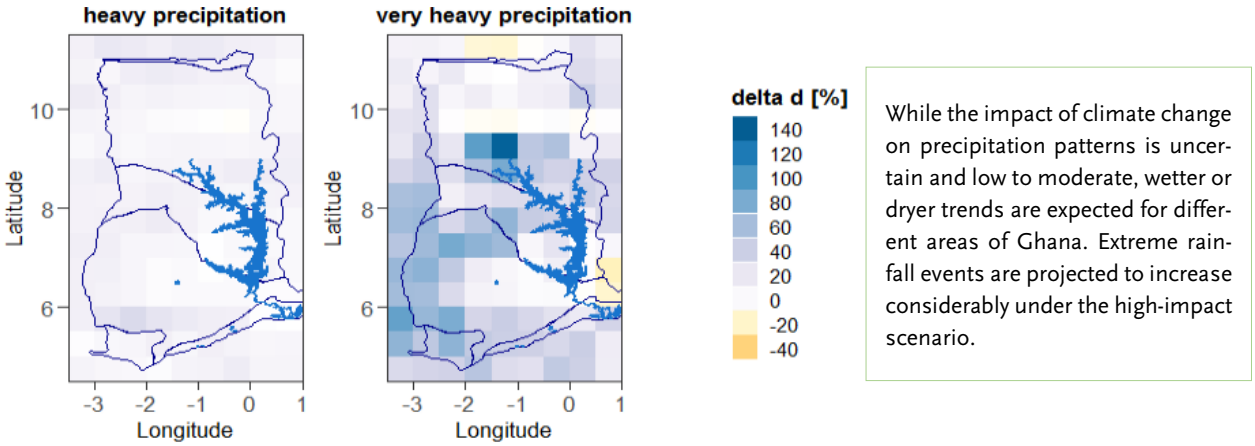
[1] Frieler, K., Lange, S., Piontek et al. (2017). Assessing the impacts of 1.5 °C global warming – simulation protocol of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP2b), Geosci. Model Dev., 10, 4321–4345, https://doi.org/10.5194/gmd-10-4321-2017 .

Key findings:

Impact dimension	
Climate	• **Mean annual temperature** is projected to **increase by 1.3°C (2030), 2.5°C (2050)** and **5.5°C (2090)** compared to today under the **high-emission scenario (RCP8.5)**. Following a **low-emission scenario (RCP2.6)** could stabilise warming at **around 0.8°C**. • **Mean annual precipitation** is more likely to **increase in the North** and **decrease in the South** of Ghana until 2050. However, precipitation projections come with high uncertainties and show **high regional differences**. • **Future dry and wet periods** are likely to **become more extreme** under the high emission scenario. • In line with rising annual mean temperatures, the **annual number of very hot days** (days with daily maximum temperature greater than 35°C) is projected to **rise substantially** in particular over **northern Ghana**. Under **RCP8.5**, by **2090 more than 300 very hot days per year** are projected to occur in most regions in Ghana.
Water	• The **average annual river discharge projections** from four hydrological models suggest an **increase under both climate scenarios by mid-century**. At the end of the 21st century, the two scenarios differ: Where discharge is projected to increase under RCP2.6, a decrease is projected under RCP8.5. • Individual model results show **potentially more extreme impacts** (e.g. flash floods or dry spells), depending on climate model and scenario.
Agriculture	• **A key impact** of climate change will be **shifts in crop suitability**: By 2050, northern areas will either become or remain suitable for growing sorghum and groundnuts. **Maize production** could be focused in the **south-western parts of the country** where suitability will increase in response to changes in weather patterns, especially precipitation quantities and trends. **Cassava** could be grown **in all parts of Ghana**, except for the lower and middle Northern Region, as well as southern parts of the Central Region. • **Adaptation strategies** should be **focused on areas** where crop yields are **projected to become marginal**. The impact of adaptation strategies as assessed by the suitability models depends on the district and the scenario.
Action dimension	
Adaptation	• The qualitative analysis of the adaptation context and implementation barriers to adaptation in Ghana revealed a number of useful design elements for effective adaptation: **Combination of adaptation strategies, use of local and indigenous knowledge, participatory consultations, and upscaling of strategies.** • Many adaptation strategies are useful for adapting agriculture in Ghana to the particular challenges posed by climate change. Specific adaptation strategies, **particularly valuable** for the context of Ghana's agriculture, include **post-harvest management measures, crop insurance and rainwater harvesting for small-scale irrigation systems**, as they can effectively reduce climatic pressures (such as through extreme events and rising temperatures) on agriculture or, in the case of insurance, transfer the remaining climate risk.
Cost-benefit	• **Post-harvest management**: Post-harvest technologies can **effectively offset the economic losses** due to climate change (**between $25 million and $51 million for maize, sorghum and groundnuts combined** in the **whole of Ghana**) in most scenarios. **Purdue Improved Crop Storage (PICS) bags** are a **particularly interesting strategy** for small-scale post-harvest management. • **Crop insurance**: On an individual level, crop insurance can have **positive effects** on the **coverage of losses** due to weather extremes, **stabilising income** and **incentivising investment** into agricultural livelihoods. The current premium rates for crop insurance from pilot schemes in Ghana may be not affordable for smallholder farmers and thus, **subsidized premiums** can help to **increase the insurance uptake**. • **Irrigation**: Mostly not cost-effective, but **as a non-monetary benefit, investment in irrigation** helps to **increase the diversity** (e.g. cereals, pulses and vegetables) and **frequency** (more than once a year) of production, which can **generate additional income**.

Projected precipitation extremes:

The analysis of changing climatic conditions and extreme events among others revealed that average annual precipitation will more likely increase in the North and decrease in the South of Ghana until 2050. Under the high emission scenario, precipitation might decrease also in the North of Ghana at the end of this century. In addition, future dry and wet periods are likely to become more extreme under the high emission scenario.



While the impact of climate change on precipitation patterns is uncertain and low to moderate, wetter or dryer trends are expected for different areas of Ghana. Extreme rainfall events are projected to increase considerably under the high-impact scenario.

Figure 1: Projected changes (in percent) of precipitation extreme events (exceeding the 95th percentile) under RCP8.5 (high emission, "without-climate-policy" scenario) by 2050.

Climate impacts on crop production:

As regards the agricultural analysis of climate impacts on crop yields, crop suitability models highlight that climate change impacts are site- and crop-specific: Figure 2 shows that under the without-climate-policy climate change scenario, **maize areas** in particular will see decreasing suitability in the northern and central parts of Ghana. Maize is the dominant staple crop being cultivated in Ghana, with high cultural and economic value. Groundnut, cassava and sorghum represent important crops as well, but at national level each of the three crops exhibits a smaller area cultivated as compared to maize. For **groundnut**, while the North will become more suitable for production, a central belt will see decreases in suitability. **Cassava production** will remain largely unaffected by the changing climatic conditions, except for a few areas. **Sorghum** is a more tolerant crop under marginal conditions in Ghana, as compared to the other crops: While the South of Ghana is largely unsuitable for sorghum cultivation, it can currently be grown mainly in the northern parts of Ghana, which will remain this way under climate change in the medium term (2050s). It has thus high potential for further cultivation in the vulnerable North of Ghana, even under climate change. Adaptation strategies such as irrigation or improved crop varieties should focus on areas that are predicted to become marginal, as the changes in suitability are indicators of climate impacts.

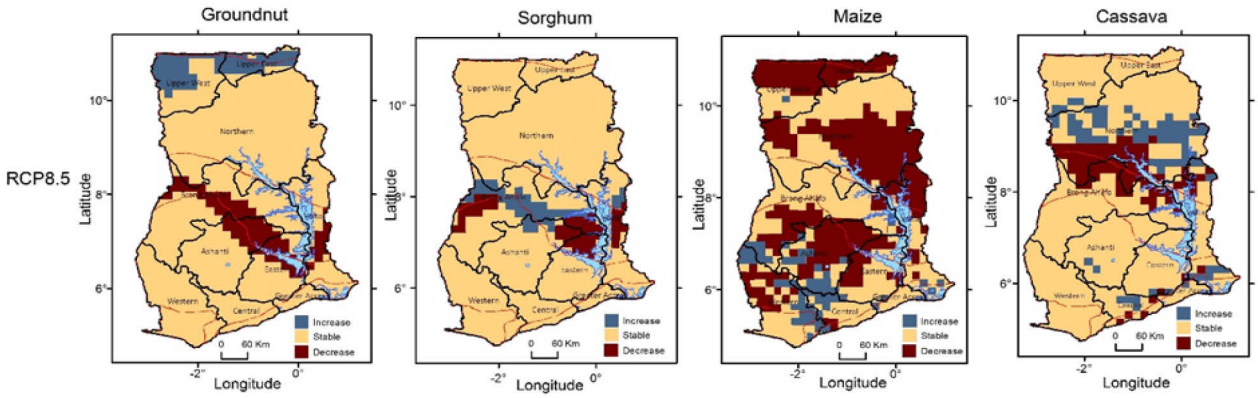


Figure 2: Projected change in crop suitability for different crops under RCP8.5 (without-climate-policy) by 2050, as compared to current suitability. Legend: blue = increase, yellow = stable, red = decrease.

Specific adaptation strategies:

Based on the impact analysis, specific adaptation strategies were analysed with regard to their suitability and effectiveness for the Ghanaian context. The results give general indications and are mainly based on national-level data; the local context thus needs to be considered when using this information. Key results for the five strategies are as follows:

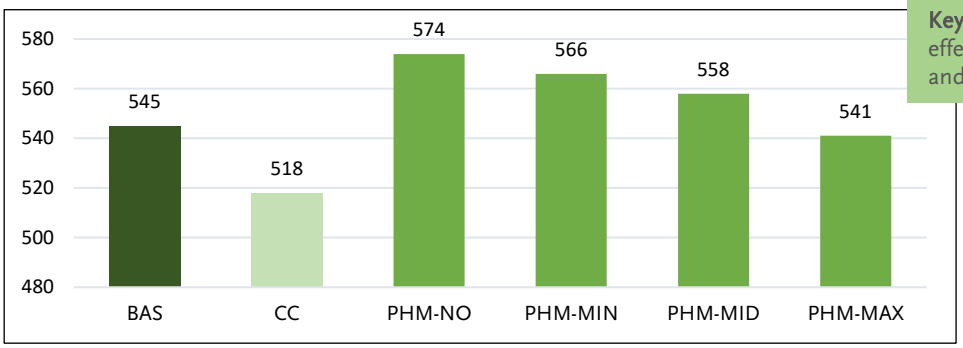
- **Post-harvest management:** "low hanging fruit", recommended for wider implementation across Ghana
- **Crop insurance:** needed to transfer risk, design smart system and start roll-out in preparation for increasing extreme events
- **Rainwater harvesting and small-scale irrigation:** promote and support across the country for vegetable production and income diversification
- **Improved crop varieties:** transformative power, expansion of local breeding capacities and uptake of improved crop varieties needed
- **Irrigation:** mostly sufficient precipitation levels across Ghana, consider for cash crops and in high impact areas

Economic analysis of adaptation strategies:

An important component of the adaptation assessment is the economic potential and cost-effectiveness of adaptation strategies, which indicates investment opportunities and shows the business case for adaptation. For this purpose, a cost-benefit approach was used to calculate the cost effectiveness of three adaptation strategies under climate change. The analysis was conducted at different levels: for Ghana as a whole, the Northern Region and for Savelugu-Nanton as a sample district.

Irrigation:	Not all scenarios are cost-effective
Post-harvest management:	All scenarios are cost-effective
Crop insurance:	Current premiums (rate at 6%) are too low to cover increasing damages

Example analysis – post-harvest management (PHM)



Key message: PHM is cost-effective under all scenarios and mostly a no-regret option.

Figure 3: Net value of maize production in Ghana under climate change and post-harvest management as an adaptation strategy (in million USD), with different cost scenarios (BAS = baseline, CC = climate change without adaptation, PHM-NO = no cost PHM, PHM-MIN = minimum costs, PHM-MID = medium costs, PHM-MAX = maximum costs).

Multi-criteria assessment of selected adaptation strategies:

The economic and biophysical adaptation analysis was complemented by a multi-criteria assessment of the five adaptation strategies. The table below gives an indicative assessment of the five adaptation strategies according to eight criteria (e.g. institutional, economic, biophysical and socio-economic indicators). Assessments placed in brackets indicate high uncertainty attached to the analysis. The colours can be read as follows: green = positive performance, yellow = medium performance, red = negative performance, blue = neutral/ no judgement implied. The category "risk-specific" refers to the fact that some adaptation strategies mitigate specific risks and thus can only be cost-effective if impacts actually occur. In case of no impact, the investment (or a part of it) will be lost. The table also highlights the different performance of adaptation strategies across criteria, meaning that the individual assessment of a strategy can differ according to stakeholder priorities. For more detailed information and the full assessment, please refer to the climate risk study.

Criteria:	Crop insurance	Post-harvest management	Irrigation	RWH	Improved varieties
Adaptation type	Risk transfer	Risk reduction	Risk reduction	Risk reduction	Risk reduction
Implementation level *	Institution-led	All levels	All levels	All levels	Institution-led
Risk gradient	Risk-specific	No-regret	(Risk-specific)	(Risk-specific)	(Risk-specific)
Risk mitigation potential	No risk mitigation	High	(Medium)	(Medium)	High
Cost effectiveness **	High costs	Cost-effective	High costs	(Low costs)	High costs
Upscaling potential	High	High	Medium	(Medium)	(Medium)
Development co-benefits	Medium	High	(Low-medium)	High	Medium
Stakeholder interest	High	High	High	High	High

* Institution-led vs. autonomous, ** Cost effectiveness and average costs

Conclusion

While some uncertainty surrounds our results, risks to Ghana's agricultural sector from climate change appear high. Considerable impacts are projected especially on water availability but also on plant growth and crop suitability. In addition, the results show large spatial variability. Based on these impact findings and in consideration of the local context, suitable adaptation strategies can be selected. The five adaptation strategies analysed in this study show high potential as outlined above and contribute, in most of the cases, to other development goals independent from the change of the climatic conditions. Many other adaptation strategies can also be suitable and effective, with a combination of strategies appearing as most promising for a climate resilient transformation of Ghana's agricultural sector.

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In contribution to:

NDC PARTNERSHIP
ACCELERATING CLIMATE AND DEVELOPMENT ACTION