On behalf of

Potsdam Institute for Climate Impact Research
P I K

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Federal Ministry for Economic Cooperation and Development

Policy Brief: Climate risk analysis for adaptation planning in Cameroon's agricultural sector

Overview

Climate change will increasingly affect the productivity of **Cameroon's agricultural sector**, with droughts and precipitation variability challenging livelihoods as well as the economic prospects of agricultural production. Both the **NDC and NAPCC** point out that agriculture is the sector most vulnerable to climate change, as rain-fed agriculture predominates making it highly sensitive to variations in rainfall and drought. Understanding these climate risks and impacts is therefore crucial for effective adaptation planning. New research conducted by the Potsdam Institute for Climate Impact Research (PIK) in cooperation with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ) provides a comprehensive climate risk analysis for the agricultural sector in Cameroon.

Especially the NAPCC promotes several strategies and recommendations to help reduce the sector's vulnerability to the negative effects of climate change, among other improved varieties and farming diversification through agroforestry. Furthermore, the NAPCC underlines that farming systems shall be improved through agronomic research, dissemination of research finding and the promotion of good practices with adaptation potential. Based on the climate risk analysis, this policy brief provides thus information on the projected impact of climate change on selected crops (maize, cocoa, cassava) as well as on the grassland productivity to contribute to availability of robust data on the vulnerability of the agricultural and livestock sector, for instance on forage availability (grassland) in pastoral areas as mentioned in the PNACC. Furthermore, the study assesses the risk mitigation potential and further indicators such as the cost-benefit (see Figure 1) for specific adaptations strategies such as **improved seeds (heat tolerant maize variety), soil management techniques (ISFM for cassava production) and agroforestry (agroforestry in cocoa production). These strategies** that are highlighted in the NAPCC and other national strategies as well as selected by the stakeholders during the Kick-off workshop in Yaoundé. **Furthermore,** the study analyses also the forest cover loss in two departments in the Central region of Cameroon to provide information on land cover changes to support a resilient land use planning, as the extension of agricultural land has led to deforestation.

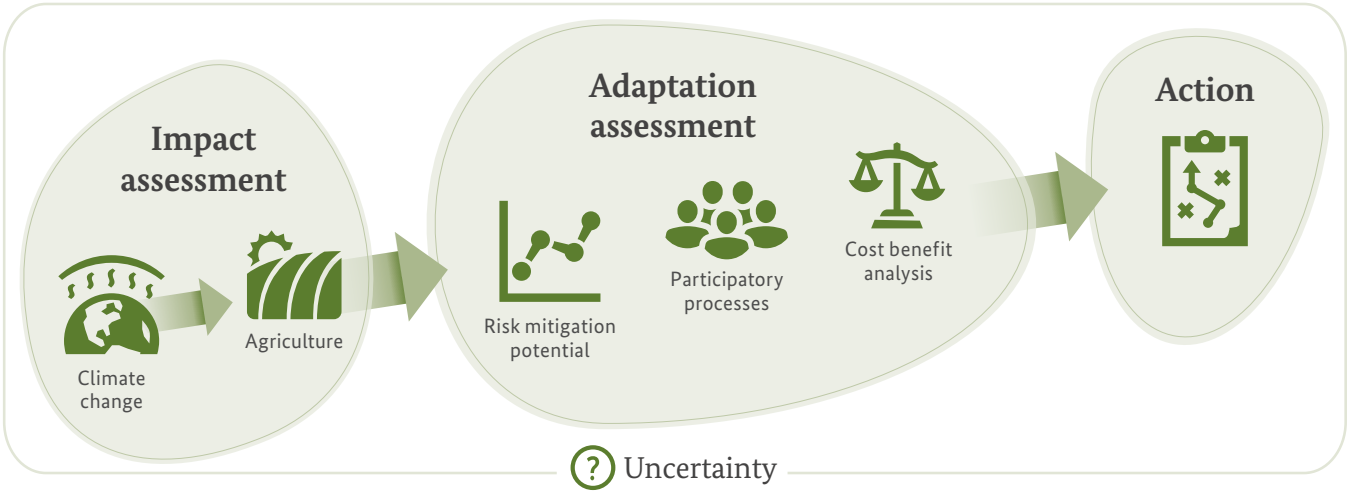


Figure 1: Impact action chain for the climate risk analysis.

Methods

Climate modelling (GHG scenarios)

- Using climate data (EWEMBI, CHIRPS, CRU, local data) and climate analyses (ISIMIP), the study provides a detailed assessment of projected climate parameters and related impacts on agriculture and livestock under different climate change scenarios (called Representative Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs)).
- SSP1-RCP2.6 represents a low emissions scenario that aims to keep global warming likely below 2 °C above pre-industrial temperatures; SSP3-RCP7.0 represents the high emissions scenario built upon the assumption of continuously high future GHG emissions.

Suitability/process-based modelling

- Ecocrop suitability modelling approach, process-based crop models (APSIM) and lobal vegetation model (LPJmL) were applied to determine the suitability of selected crops and yield forecasting as well as assessment of grazing potential.
- For further evaluation of adaptation strategies, economic appraisal methods such as cost-benefit analyses (including input prices, labour inputs, output prices; agroforestry, improved seeds vs. non-adaptation strategies) were used.

Stakeholder Engagement

- The study is endorsed by the Cameroonian **Ministry of Environment** (**MINEPDED**) and conducted in collaboration with the **Observatoire National sur les Changements Climatiques** (**ONACC**), the hffa Reseach GmbH, the University of Yaoundé I and University of Kassel.
- Throughout the project, special emphasis is given to engaging local stakeholders and effectively disseminating findings. This was done through regular stakeholder workshops (with participants from government, research, civil society, international community), semi-structured interviews and consultations with local farmers, as well as a joint selection of adaptation strategies and study focus (during stakeholder workshop).

Projected Climatic Changes

By 2050, mean annual **temperature** is projected to **increase between 1.1°C to 1.5°C** depending on the emissions scenario (Figure 2). Temperatures will stabilize under low future emissions after 2050 and will further rise until the end of this century under high future emissions. The number of **hot days per year (>35°C) is projected to steadily increase** in whole Cameroon except for the highlands. Increases are especially strong under the high emissions scenario.

There is much less confidence in projected **precipitation** changes than in temperature changes. The majority of models projects future **increases of annual precipitation sums** over Cameroon until mid of this century (Figure 3). **Heavy precipitation intensity is projected to increase** under both emissions scenarios with high increases projected for the north.

The **rainy season** shortens in the Extreme North the North and Littoral Region and becomes longer in the West, South and parts of the Central and East Region, though climate models tend to project a **large year-to-year variability in rainy season characteristics** for the future and projections of rainy season onset, cessation and length are uncertain.

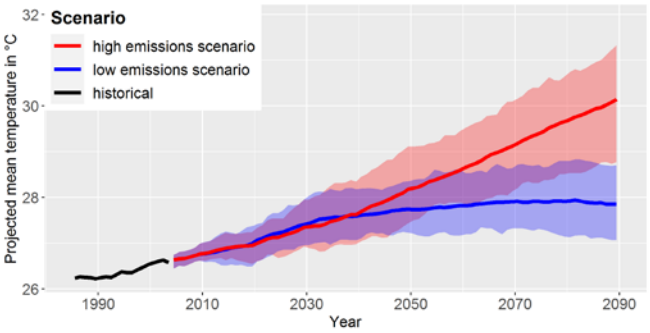


Figure 2: The 10-year moving average of historical and projected annual mean temperature in °C in Cameroon.

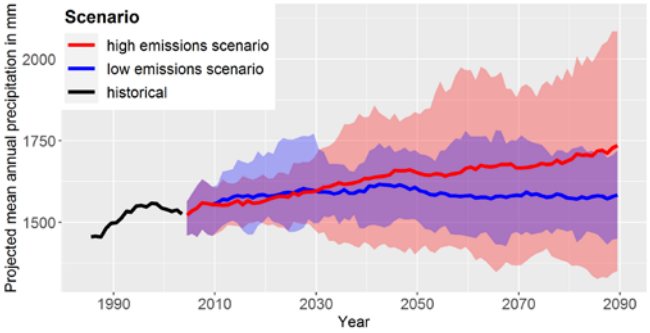


Figure 3: The 10-year moving average of historical and projected annual rainfall in mm in Cameroon.

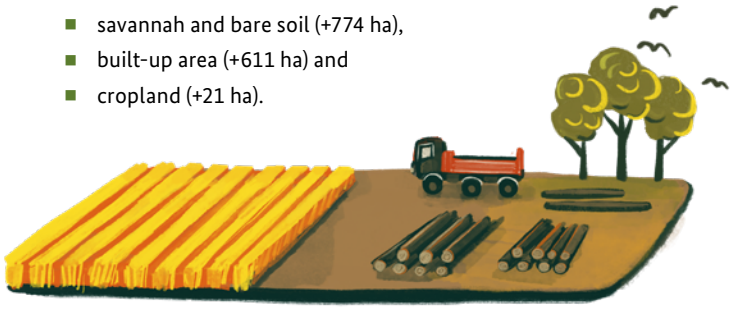
	Climate impacts	Past trend	Future trend	Certainty
	Mean annual temperature	Increasing	Increasing	Very high
	Number of hot days & nights	Increasing	Increasing	Very high
	Mean annual rainfall sums	No significant trend	Increasing	High emissions: Medium
			No significant trend	Low emissions: Low
	Heavy rainfall intensity	Increasing	Increasing	High emissions: Very high
			No significant trend	High emissions: Very high

Summary of climate impacts in Cameroon.

Forest cover changes

Deforestation in Cameroon is ongoing, especially in the Centre and East provinces, where 52 % of the total tree cover loss occurred between 2001 and 2021. According to a case study for Mbam et Kim district in Centre province, heavy losses of primary forest (–1600 ha) were detected in the short period between 2019 and 2022 alone. In turn, increases were recorded in all other land cover classes such as

- savannah and bare soil (+774 ha),
- built-up area (+611 ha) and
- cropland (+21 ha).



This is accompanied by **large losses in CO_2 storage**. In 2021 alone, Cameroon lost 167 kha of natural forest, which corresponds to 105 million tonnes of CO_2 emissions.

The analysis showed that deforestation is continuing, especially in the Central region of Cameroon. This has many negative consequences for the ecosystem and the capability of forests as carbon reservoirs. Efforts to **reduce deforestation, promote reforestation and afforestation, and ensure sustainable forest management** can significantly **contribute to carbon sequestration, biodiversity conservation, and the overall well-being of the planet**.

Assessing these land cover changes at the local, but also on national or global level is, therefore, important for resilient adaptation and mitigation purposes.

Climate impacts and adaptation strategies for the agricultural sector

The following analysis is based on the division of Cameroon into five different agroecological zones (AEZ) stretching from a semi-arid climate in the Sudano-Sahelian Zone in the north (AEZ I), the(Guinean) High Savannah Zone (AEZ II), the High Plateau (Western Highlands) Zone (AEZ III) to the humid equatorial climate with monomodal (Monomodal (Rain)forest Zone (AEZ IV)) or bimodal rainy season (Bimodal (Rain)forest Zone (AEZ V)) in the southern part of the country. In the following the assessed climate risks and the evaluation of an adaptation strategy for the three selected crops maize (I), cassava (II) and cocoa (III) as well as the impacts on grassland productivity (IV) will be presented.

I. Maize

Maize is the most widely grown crop in Cameroon. It is grown both for direct household consumption, as well as for storage as dry flour, which can be used or sold and thus serve as a form of social protection in times of crisis. It is the predominant crop in the North, North West, Adamawa and West regions and the most consumed cereal nationwide.

Climate impacts on Maize cultivation in Cameroon

Under current climate conditions, **more than 77 % of Cameroon's territory is highly suitable for maize** production except in the agroecological zones (AEZs) Sudano-Sahelian Zone (I) and Monomodal (Rain)forest Zone (IV), though the suitable area is expected to be **highly impacted by climate change**. Losses are restricted to the northern part of the country under the low emissions scenario but spread to the majority of suitable areas under the high emissions scenario **by 2090, with a 70 % decrease in suitability** (Figure 4).

Yield impacts of climate change on maize are significant and negative with the highest losses experienced in the North of Cameroon, while the High Guinea Savannah AEZ (II) is least affected. Under the low emissions scenario mean maize yields stabilise after 2050 but continuously decrease under the high emissions scenario with national average yield declines of –79 % by 2090.

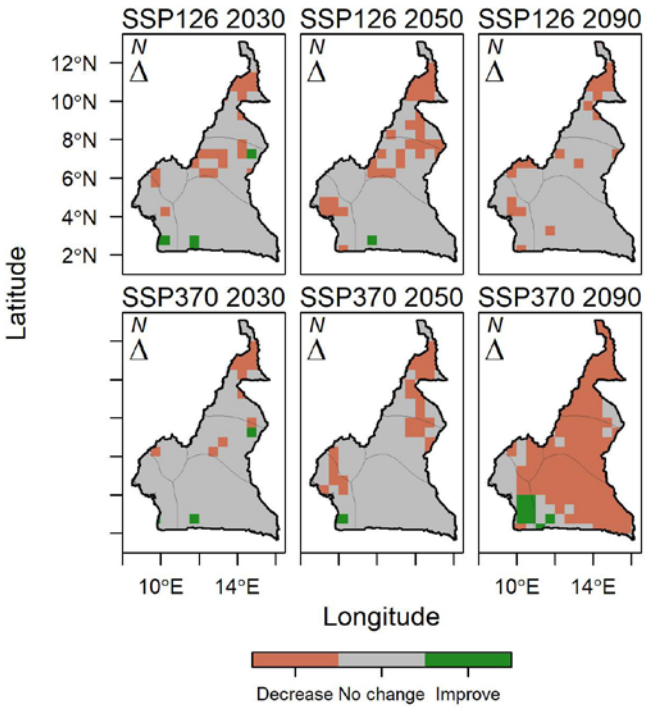
Improved maize varieties: Increasing productivity and climate resilience

As one possible adaptation strategy, **improved maize varieties** have the potential to buffer yield losses projected for local varieties. It presents a **high risk-mitigation potential** and **high cost-effectiveness**. Improved varieties related to heat tolerance could be particularly effective in maize cultivation, especially as maize is the main source of income for more than 3 million smallholder farmers in Cameroon.

Improved varieties with heat-tolerance adaptation shows high impact mitigation potential under the low emissions scenario reducing the high losses to an average loss of 6 % by 2090 and under the high emissions scenario to an average loss of 62 % (17 % less loss than without adaptation).

Policy recommendations for a climate-resilient maize cultivation

- **Institutional support** is needed for targeted breeding towards heat tolerance and to increase availability and access to quality seeds, as well as knowledge on their use to increase adoption by smallholder farmers, especially in rural areas.
- In addition, it should be ensured that **access and knowledge is also targeted to women**, as women are more likely to rely on local and more informal farmer-to-farmer networks, which may make it more difficult for them to adopt improved seeds. Following this, improved seeds have a **high potential to improve livelihoods**.
- However, equitable access to **improved seeds of e.g. maize**, **required inputs and knowledge** should be ensured to the (smallholder) farmers with a particular emphasis on their socio-economic differences.



Projected changes in climatic suitability for maize in Cameroon for the 2030s (left), 2050s (middle) and 2090s (right) under the SSP1-RCP2.6 (upper row) and SSP3-RCP7.0 scenarios.

II. Cassava

Cassava is a starchy tuber and a key staple crop in Cameroon's more humid regions, as it requires a lot of water over a long growing season. It is the most consumed root and tuber crop in the country and its leaves are widely consumed as a nutrient-rich vegetable as well. Despite its versatility and industrial processing potential, cassava has long remained a subsistence crop due to its cultivation in areas with limited infrastructural development and inadequate storage capacities leading to rapid spoilage and major post-harvest losses.

Climate impacts on cassava cultivation in Cameroon

Cameroon possesses high suitability for cassava production in the High Guinea Savannah (II), High Plateau (III) and Bimodal (Rain)forest (V) Zones, which will remain largely unchanged under climate change, with only **marginal variation** for the high emissions scenario.

Climate impacts on cassava **yields show spatial and temporal disparities** with general trends showing that they worsen with time from 2030 to 2090 and with scenario from SSP1-RCP2.6 to SSP3-RCP7.0. At national scale we project a yield loss up to 15 % under SSP1-RCP2.6 by 2090 and up to 28 % under SSP3-RCP7.0 by 2090. The highest cassava losses under most periods and scenarios are projected for AEZ I, where by 2090 yields will decrease by 6 % and 30 % for SSP1-RCP2.6 and SSP3-RCP7.0, respectively.

ISFM practices: Increasing yields and mitigation potential

Integrated Soil Fertility Management (ISFM) includes various traditional practices that hold great potential for adaptation for cassava production in Cameroon under all future climate change scenarios and could bring different co-benefits to all regions of the country. These include, for example, managing soil fertility to be able to cope with climate stress.

The future projections show that **adaptation using ISFM practices increase yield in all AEZs**, with the highest impact mitigation potential of up to 40 % in the Mono- (IV) and Bimodal (Rain)forest Zones (V). Adaptation benefits are stable under the low emissions scenario but decrease over time under the high emissions scenario.

Policy recommendations for a climate-resilient cassava cultivation

- In general, **ISFM can be highly recommended for smallholder farmers in Cameroon**, resulting in very positive effects for societies and environment.
- To promote the uptake of ISFM in the country, **policies towards sustainable land use intensification** as well as the **rehabilitation of degraded soils** and the necessary mechanisms to implement and evaluate these, are recommended.
- Limitations to the implementation of ISFM, such as high labour requirements on a temporal or physical level, which particularly exclude women from adopting the adaptation measure, need to be considered.
- Improved soil and water management should be mainstreamed into all adaptation activities to ensure a sustainable use of resources and leverage climate change mitigation co-benefits.
- **Awareness raising and training on the advantages and implementation of ISFM** as a promising adaptation strategy under all future climate change scenarios for cassava production in Cameroon can help to transmit the information to farmers.

III. Cocoa

Cameroon is part of the so-called “West African cocoa belt” that is stretching from Sierra Leone to southern Cameroon. The cocoa belt produces 70 % of the world’s cocoa, employing an estimated two million farmers. Cocoa is mainly produced as a cash crop for export in Cameroon’s Centre, South and South West regions with an average farm size of 5.7 ha.

Climate impacts on cocoa cultivation in Cameroon

Cocoa production is currently suitable in Cameroon’s humid regions, i.e. AEZs High Plateau Zone (III), Mono- (IV) and Bimodal (Rain)forest Zone (V) and parts of High Guinea Savannah (II), covering 68 % of the country’s area in total. A slight

northward extension of suitable areas is expected under climate change for both scenarios, however traditional production areas in the south are negatively impacted under the high emissions scenario, leading to **overall net losses of 42 % in suitable areas**.

Cocoa in Agroforestry cultivation: Offering alternative income streams and climate resilience

In the context of cocoa production in Cameroon, **agroforestry** offers multiple benefits, such as shading trees from extreme temperature, improving soil health, increasing biodiversity, combating deforestation and thereby improving the quality of cocoa. Integrating fruit trees in cocoa plantation is also worthwhile for their provision of food and potential for generating additional income. Benefits generated through agroforestry systems are more than 7 times higher than its costs. The future projections point out **that both safou and mango are suitable for long-term adaptation and thus offer high potential in agroforestry implementation.**

Policy recommendations for a climate-resilient cocoa production

- The **type of tree species** as companions for cocoa **should be carefully selected, based on** local **current and future suitability**, preferences and opportunities for additional income.
- **The optimal level of shading is an important factor** in the setup of agroforestry systems and requires continuous maintaining such as pruning.
- **Access to land and greater decision-making power** in the design and management of agroforestry systems **for women** need to be improved in order to foster the adoption of agroforestry by women.
- Furthermore, **farmers need support with initial investments** until the adaptation strategy becomes profitable (e.g. in implementation of agroforestry or improved seeds).

IV. Livestock

In 2020, Cameroonian pastoralists held a total of 6.1 million cattle, 5.5 million goats, 3.6 million sheep and 2 million pigs (FAOSTAT, 2020). In terms of the geographical distribution of livelihood systems, the north of Cameroon is dominated by pastoral livelihoods, while the south is dominated by farming livelihoods, due to progressively higher amounts of rainfall in southern Cameroon (Lange, 2019). In particular the mountainous North West region, the Adamawa plateau and the northern regions of Cameroon are the main livestock producing areas (Kelly et al., 2016).

Climate impacts on grazing potential for livestock in Cameroon

Currently, **grazing potentials for livestock** in Cameroon follow a north-south gradient according to precipitation amount, with the highest potentials in the southern zones and the lowest in the Sudano-Sahelian Zone (AEZ I). **Grazing potentials decrease under climate change, though losses are minor.** The general trend points to larger losses under the low emissions scenario, with declines ranging between 3 % in 2030 and 11 % in 2090. In contrast, the losses under the high emissions scenario decrease from 4 % in 2030 to 9 % in 2090. The Sudano-Sahelian Zone (AEZ I) however is projected to experience gains in grazing potential under both emissions scenarios.

Policy recommendations for maintaining grazing potential

- → **Adaptation strategies such as mowing or a pastoral calendar** could be promising option to provide and manage fodder reserves in order to maintain grazing potentials for livestock, but need to be researched.
- → Understanding **transhumance infrastructure** is key to elevating much of the underlying intercommunal tensions.

Climate change and gender

Male and female farmers in Cameroon experience climate change differently and their capacity to cope and adapt varies. There are several factors of **gender-specific vulnerability** to climate change and adaptive capacity, such as traditional gender roles and gendered division of labour (e.g. maize is among the most climate-sensitive crops cultivated in Cameroon which is processed mainly by women), limited access to finance, customary law and land rights, and institutional and structural barriers that often hinder female farmers to adapt their farming practices to changing climatic conditions (e.g. constraints on the use of resources, little or no use of agricultural inputs like drought-adapted seeds or fertilizers, limited access to climate services). Provided that women and other marginalised social groups are moved to the centre of the transformation of these factors – both as a target group and leaders of action – **agricultural systems can be transformed towards greater gender equity, inclusion and climate resilience**.

Conclusion

Generally, there is no single adaptation strategy that is suitable for the whole country, since their effectiveness and co-benefits ultimately depend on the projected climate impacts, as well as on the concrete design tailored to the local context and farmers' needs. The actual impact of the projected climatic changes is not only shaped by the actual hazard, but also by the vulnerability and exposure of the affected farming communities. Differing social characteristics like gender, age, education and health can substantially shape farmers' vulnerability and therefore their exposure to climate change. Taking these characteristics into consideration is an important prerequisite to build resilience across farming communities.

Furthermore, having access to actionable climate information can help farmers to make informed decisions for appropriate adaptation strategies and reduce the impact of climate risks. Moreover, differing social characteristics like gender, age, education and health can, for example, substantially shape farmers' vulnerability and therefore their exposure to climate change. Taking these characteristics into consideration is an important prerequisite to build resilient agricultural production systems.

In addition to the policy recommendations relating to the adaptation measures examined, the following fundamental recommendations are made for Cameroon.

- Planning for adaptation should be **regionally specific**, as different areas in Cameroon will be impacted by climate change differently. For instance, the Northern region (AEZ I) will be particularly hard hit and should therefore require special attention.
- Carefully assessed **combinations of multiple adaptation strategies** are a good option to tap into the merits of more than one strategy.
- Climate change adaptation needs to be **mainstreamed across sectoral policies**. Results from this climate risk analysis can thus feed into further development and implementation of climate adaptation policies and agricultural development planning.
- **Planning for adaptation should always be inclusive, participatory and location-specific**, as different areas and farmer groups in Cameroon will be impacted by climate change differently. It is recommended to collaborate with stakeholders to collect gender-disaggregated data and design adaptation strategies.
- **Seize the rich and diverse indigenous and traditional knowledge** in Cameroon's regions and re-activate formerly practiced indigenous adaptation strategies for successful adaptation.
- Policymakers should pay special attention to **conflict dynamics and the needs of marginalized communities** in agriculture.
- Regular **investments into national research institutes should be upscaled.** Adaptation research should be mainstreamed into extension services and university curricula.
- **Smart adaptation incentives** built around land tenure systems, credit accessibility and market access are key to induce the uptake of suitable adaptation strategies.
- **Trainings and extension services** should be provided to farmers to support them with the implementation of the adaptation strategies.
- The implementation of the adaptation strategies should be supported financially by for instance the Global Environment Facility, the Green Climate Fund, NGOs, technical and financial partners.

The study was designed in alignment with important policy documents and processes in Cameroon, in particular the Climate Change Policy, the Climate Change Act and the Nationally Determined Contribution (NDC) and the National Adaptation Plan for the Agriculture Sector (NAP). Results from this climate risk analysis can thus feed into further development and implementation of **climate adaptation policies and agricultural development planning**.

A report prepared by the Potsdam Institute for Climate Impact Research (PIK) together with 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 **Ministry of Environment (MINEPDED)** and the **Observatoire National sur les Changements Climatiques (ONACC)**, the HFFA Research GmbH, University of Yaoundé I, University of Kassel and stakeholders from local and national governmental institutions, civil society, academia, the private sector, practitioners and development partners. The analyses have been conducted as part of the as part of the project AGRICA - Climate risk analyses for adaptation planning in sub-Saharan Africa. **For more information, please see www.agrica.de**

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