An overview of African SRM research

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SIXTH ASSESSMENT REPORT
Working Group II – Impacts, Adaptation and Vulnerability

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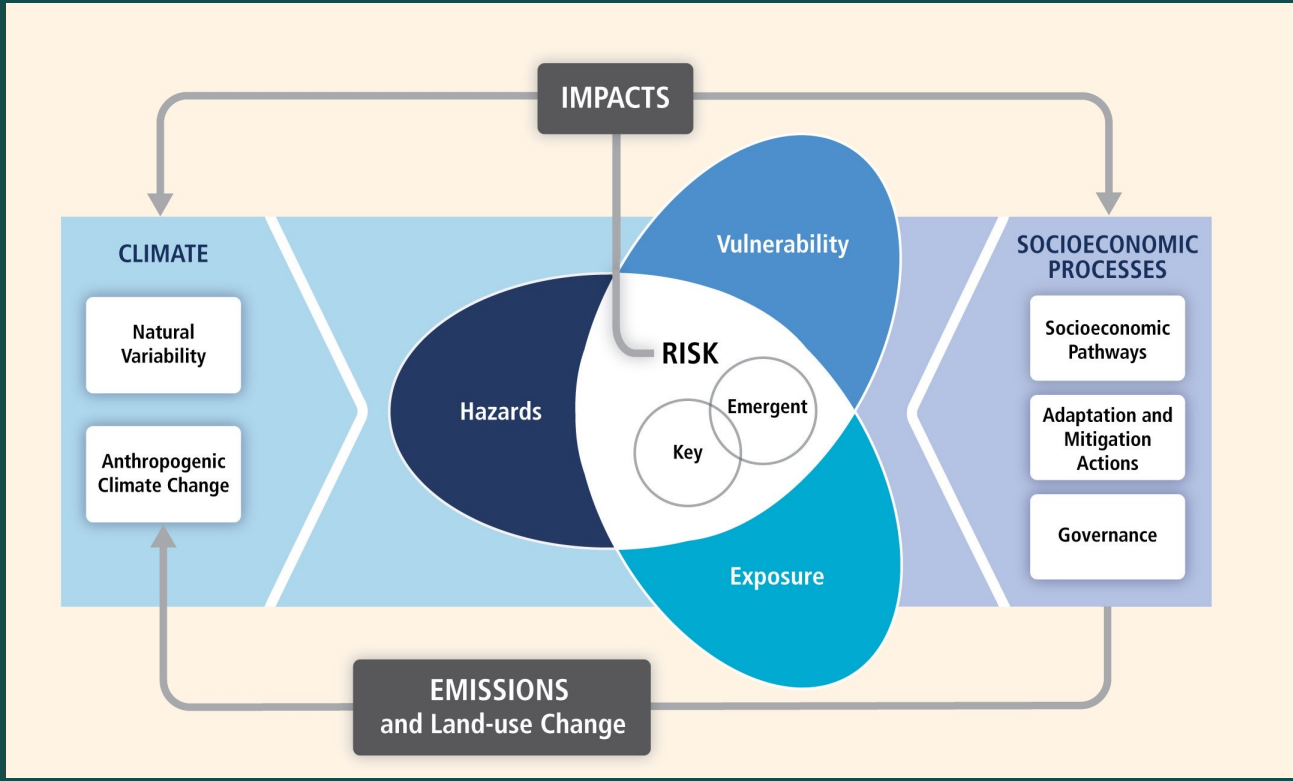
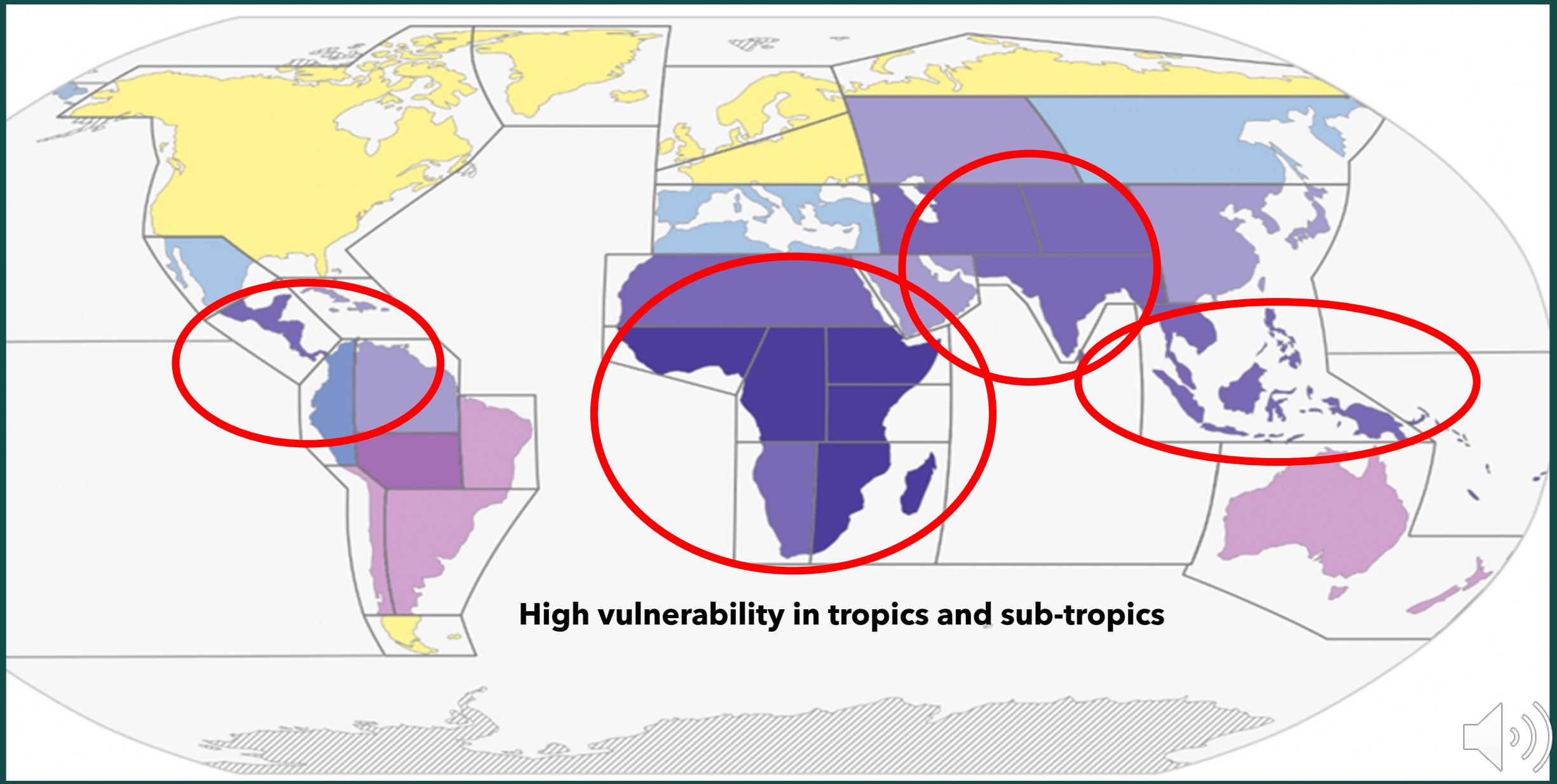
African highlights of the IPCC WG2 Report

Dr Christopher Lennard, Lead Author, Chapter 9 (Africa)

Impact is a function of risk



Impacts are a function of vulnerability



Observed climate change in Africa

At 1.1°C of global warming.....

- Average and extreme temperatures are rising
- Attributable to human-induced climate change
- Marine heatwaves: 2x more likely
- Multi-year drought more frequent in West Africa
- Cape Town drought: 3x more likely

Observed impacts, losses and damages

Africa has already experienced widespread losses and damages that can be attributed to human-caused climate change.

These include

- reduced food production

- reduced economic output

- loss of biodiversity

- increased human morbidity and mortality.

Photos: 1. Giulio Castelli 2. Denis Onyodi

Food security impacts

↓ Growth in agricultural productivity by 34% since 1961 due to climate variability & change

In sub-Saharan Africa:

Maize yields ↓5.8% 1974–2008

Wheat yields ↓2.3% 1974–2008

2/3 of Africans perceive climate conditions for agricultural production worsened over past 10 years

Photos: 1. Alexander Schimmeck 2. Vzosk

Economic impacts

Climate Change has reduced economic growth across Africa

This has increased income inequality between African countries and countries in more temperate, Northern Hemisphere climates

Losses to agriculture, tourism, manufacturing, infrastructure

GDP per capita on average ↓13.6% (1991–2010 vs no climate change)

Reduced productivity leads to lower macroeconomic performance

e.g. In a rural town in South Africa 80% of businesses lost >50% of employees and revenue due to agricultural drought

Photo: Duangphorn Wiriya

Ecosystem impacts

Losses of marine biodiversity

Reduced lake productivity

Changing geographic ranges of animal and plant species

Mass coral bleaching events

Woody plant expansion reducing grazing lands and water supplies

Photos: 1. The Ocean Agency 2. Katsuma Tanaka

Water security impacts

More variable rainfall and river discharge

In southern Africa as a whole, river flows mostly decreased from 1970–2010.

Negative and cascading impacts on multiple sectors, including hydropower generation.

Photos: 1. Giulio Castelli 2. Denis Onyodi

Health impacts

Photo: Axel Fassio

Infectious diseases

Expansion of Anopheles mosquito to higher altitudes (East Africa)

Increasing incidence of malaria (East Africa)

Cholera outbreaks, especially following tropical cyclones (East Africa, Southern Africa)

Heat

44% of heat-related mortality from 1991–2018 is attributable to climate change (South Africa)

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Projected impacts

"What is still to come?"

Future Risks

Above 1.5°C is high risk:

- Large regional crop losses
- Increasing poverty and inequality
- Increasing disease exposure
- Increasing drought
- Increasing heat mortality

Above 1.5°C is very high risk:

- Widespread crop yield loss
- Widespread heat-related mortality risk
- 7 to 18% African species at risk of extinction
- Over 30% decline in fisheries catch potential
- Severe risks of malnutrition

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Adaptation: options, effectiveness, limits

"What is being done about it and does it work?"

Barriers to adaptation in Africa

Economics

Social/Cultural

Information, Awareness, Technology

Human capacity

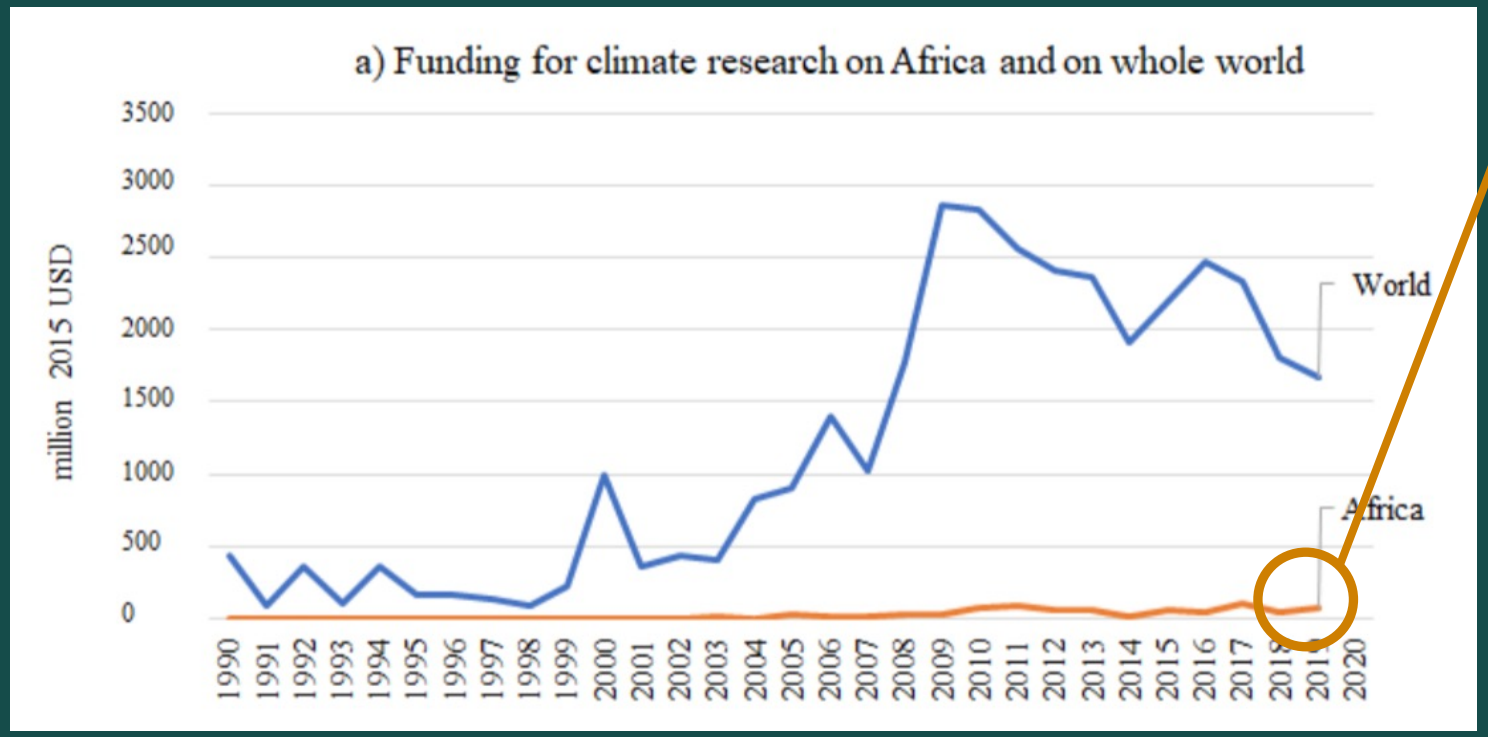
Finance

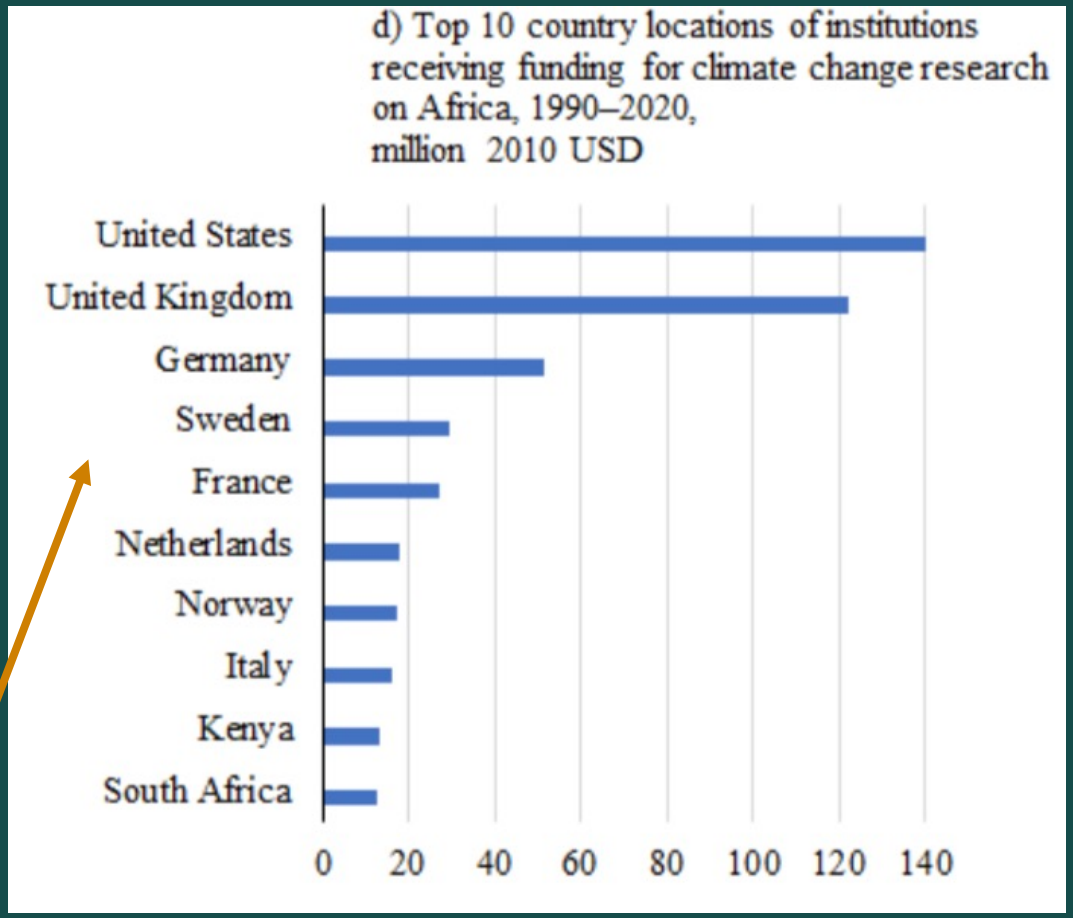
Governance, Institutional & Policy

Information barriers to adaptation in Africa

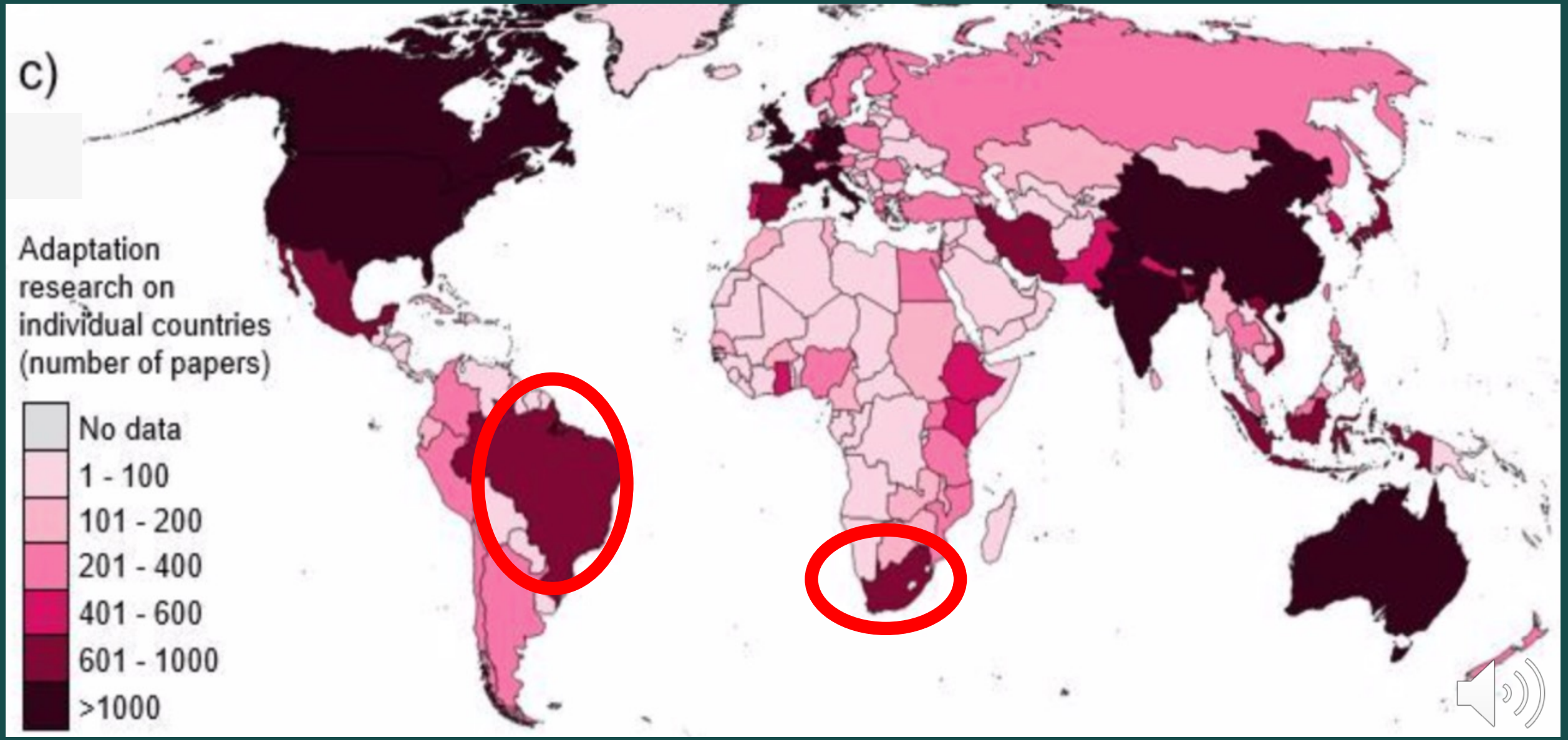
Very little finance for research on climate change in Africa: **Only 3.8% of global climate change research funding was spent on Africa since 1990.**

Most funding for climate research on Africa goes to EU & US institutions (<1% to African Institutions)





Most African countries have low levels of adaptation research



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PUTTING DEVELOPING COUNTRIES AT THE CENTRE OF THE SRM CONVERSATION

Benin

Effects of SRM on climate change in the northern Gulf of Guinea

Project summary

Prof. Ezinvi Baloïtcha and his team are researching how SRM may affect the impacts of climate change on West Africa's regional climate, in particular precipitation regimes and river discharge in the coastal countries located along the northern Gulf of Guinea where the climate is strongly modulated by oceanic conditions. In Benin and West Africa in general, global warming is expected to cause an increase in temperatures, more severe floods, sea level rise, an acceleration of coastal erosion, changes to monsoon precipitation, and disruptions to the overall regional hydrology. These effects could have dramatic socio-economic consequences due to their impact on agriculture, fisheries, water resources and human health. The team's research has the potential to help local governments in each of these countries better identify and manage their climate risks. The project is hosted at the UNESCO International Chair in Mathematical Physics and Applications (ICMPA) at the University of Abomey-Calavi in Cotonou.

Wide-swath Advanced

South Africa

Agricultural production under SRM in Southern Africa

Project summary

The South African DECIMALS team, led by Dr Chris Lennard, is researching the potential impact of SRM on agricultural production in Southern Africa through an analysis of the large-scale prognostic drivers of extreme weather events. This work builds on their previous project (2018-2021) which assessed the impact of SRM on rainfall and temperature extremes in the region—Southern Africa being highly vulnerable to climate extremes such as droughts and heat stress. The team will now seek to evaluate the ability of climate models to reproduce the drivers of such extreme weather events, to quantify the projected changes in these circulations under low and high emission scenarios with and without SRM, and to explore the impact of SRM on two important crops in the region: maize and wheat. The project is hosted at the University of Cape Town.

Photo-like image of South Africa captured in April 2010 by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite. Photo: NASA (Jeff Schmaltz, MODIS Rapid Response Team)

Kenya

Impacts of SRM on extreme rainfall and urban floods in East Africa

Project summary

In Kenya, the team led by Dr Franklin J. Opijah aims to find out what SRM could mean for climate extremes and urban floods in East Africa, with a focus on the urban areas of Dar es Salaam, Kampala, Nairobi and Addis Ababa. More specifically, the team will use a combination of climate simulations and observed as well as remotely-sensed data to determine how rainfall extremes would be projected to change under global warming—with and without SRM—and what this would mean for flash floods in urban areas. Indeed, climate extremes impact urban
they are home to a major portion of the global population, with projections indicating that cities could be home to 60%
tion by 2030. Changes in extreme climate events witnessed globally are already impacting East Africa, and extreme
ojected to intensify with climate change which could be catastrophic for vulnerable populations. The project is hosted
airobi with members at the IGAD Climate Prediction and Applications Centre (ICPAC), Kenya's Water Resources
ty, and the UN Office for Disaster Risk Reduction (Regional Office for Africa).

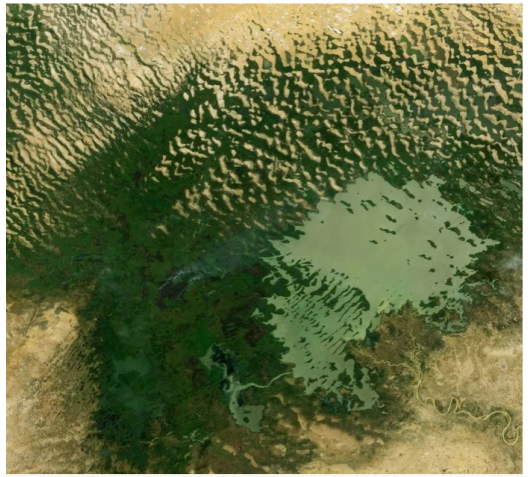
obi, Kenya. Contains modified Copernicus Sentinel data (2019), processed by ESA, CC BY-SA 3.0 IGO

Ivory Coast

GeoMIP-Africa: impact of SAI on temperature and precipitation extremes over West and Central Africa and implications for water resources

Project summary

Over the past few decades, Sub-Saharan Africa has experienced the adverse impacts of increasingly frequent climate extremes. The urgent need to limit the impacts of climate change have led to consideration of geoengineering schemes using SRM technologies, such as stratospheric aerosol injection (SAI). However, the potential impacts of SAI on a local and regional scale (e.g. agriculture, energy, health) in
olored. Using GEOMIP models, Dr Vami Hermann N'Guessan Bi and his team
ipitation extremes over West and Central Africa induced by SAI and using the WEAP
ources in the main basins of the region. The project was hosted by the University of



howing Lake Chad in West Africa's Sahel region. Photo: USGS/ESA

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Geophysical Research Letters

2020

Research Letter | Open Access

Africa's Climate Response to Solar Radiation Management With Stratospheric Aerosol

Izidine Pinto, Christopher Jack, Christopher Lennard, Simone Tilmes, Romaric C. Odoulami

First published: 15 January 2020 | https://doi.org/10.1029/2019GL086047 | Citations: 9

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ENVIRONMENTAL RESEARCH
LETTERS

2020

LETTER • OPEN ACCESS

Stratospheric Aerosol Geoengineering could lower future risk of 'Day Zero' level droughts in Cape Town

Romaric C Odoulami[1], Mark New[1], Piotr Wolski[2], Gregory Guillemet[3], Izidine Pinto[2], Christopher Lennard[2], Helene Muri[4] and Simone Tilmes[5]

Published 18 November 2020 • © 2020 The Author(s). Published by IOP Publishing Ltd

Environmental Research Letters, Volume 15, Number 12

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Article PDF Article ePub

Figures References

+ Article information

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Earth's Future

2020

Research Article | Open Access

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Open Access | Published: 15 December 2021

Potential impacts of stratospheric aerosol injection on drought risk managements over major river basins in Africa

Babatunde J. Abiodun, Romaric C. Odoulami, Windmanagda Sawadogo, Olumuyiwa A. Oloniyo, Abayomi A. Abatan, Mark New, Christopher Lennard, Pinto Izidine, Temitope S. Egbebiyi & Douglas G. MacMartin

Climatic Change **169**, Article number: 31 (2021) | Cite this article

2021

Abstract

Most socio-economic activities in Africa depend on the continent's river basins, but effectively managing drought risks over the basins in response to climate change remains a big challenge. While studies have shown that the stratospheric aerosol injection (SAI) intervention could mitigate temperature-related climate change impacts over Africa, there is a dearth of information on how the SAI intervention could influence drought characteristics and drought risk managements over the river basins. The present study thus examines the potential impacts of climate change and the SAI intervention on droughts and drought management over the major river basins in Africa. Multi-ensemble climate simulation datasets from the Stratospheric Aerosol Geoengineering Large Ensemble (GLENS) Project were analysed for the study. The

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Original Paper | Open Access | Published: 17 January 2022

Response of the Equatorial Atlantic Cold Tongue to Stratospheric Aerosol Geoengineering

Y. W. Pomalegni, C. Y. Da-Allada, Z. Sohou, E. Baloïtcha, E. A. Alamou, F. M. Awo, F. Bonou, I. Biao, E. Obada, J. E. Zandagba, S. Tilmes & P. J. Irvine

Aerosol Science and Engineering **6**, 99–110 (2022) | Cite this article

2022

Abstract

By increasing Earth-atmosphere system albedo, Stratospheric Aerosol Geoengineering (SAG) using sulfur dioxide is an artificial potential means, with the goal to mitigate the global warming effects. In this study, we used the simulations from Geoengineering Large Ensemble project realized under the climate change scenario of Representative Concentration Pathway 8.5 (RCP8.5), to investigate the potential impact of SAG on the Sea Surface Temperature (SST) in Equatorial Atlantic Cold Tongue (EACT) and the physical processes driving these changes. Results reveal that in the EACT region, under RCP8.5, SST warms significantly (compared to present−day climate) with a maximum of 1.7 °C in July, and this increase in SST is mainly due to the local processes related to the weakening of vertical mixing at the base of the mixed layer. This reduction of the vertical mixing is associated to the diminution of the vertical shear from July to April and to the increase of ocean stratification from May to June. However, under SAG,

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2022

Impact of Stratospheric Aerosol Geoengineering on Meteorological Droughts in West Africa

by Adéchina Eric Alamou [1,2,*], Ezéchiel Obada [1,2], Eliézer Iboukoun Biao [1,2], Esdras Babadjidé Josué Zandagba [1,2], Casimir Y. Da-Allada [1,3], Frederic K. Bonou [3], Ezinvi Baloïtcha [3], Simone Tilmes [4] and Peter J. Irvine [5]

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Academic Editors: Baojie He, Ayyoob Sharifi, Chi Feng and Jun Yang

Atmosphere **2022**, *13*(2), 234; https://doi.org/10.3390/atmos13020234

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472 Accesses | 2 Altmetric | Metrics

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How can we increase developing country engagement in the solar climate engineering discussion?

1. Why do you think developing nations have not been involved in the discussion about climate intervention in the past?

2. Why are the perspectives of developing nation researchers important in the general discussion around CI?

3. What factors do you think are the barriers hindering the development and entrainment of developing nation scientists in CI research?

4. What do you think can be done to overcome these barriers (practical suggestions would be great)?

Lack of awareness

Many do not know about the theme of climate engineering

Policy makers are not aware

there is a general lack of awareness on this new field of research

communication around geoengineering is not very accessible

Geoengineering programs are not still in the mainstream

Global north dominance

Dominance of Global North

CE not legitimized, particularly as many strategies are proposed in developing countries by Global North

Cultural deference to authority (largely the global North)

Controversial

there is a general reluctance to be involved in this "controversial" science

cultural influences (against "playing God") are strong in many developing countries (at least in many countries in Africa)

many policy makers (who influence local funding to scientific research) consider that this is an outlandish idea (at most not something of a priority)

Lack of understanding the relavence, Mainly Technical know how. -Research Funding still far below.

Implicit belief that CE is fundamentally a technical problem

Funding

Funding/ limited resources

Geoengineering at university is under-represented? (funding, researchers, communication)

researchers in the fields of climate science, Physics, chemistry, etc are not getting the funding for such research

there is a general lack of funding for scientific research, and geoengineering research is part of that general problem

More pressing Needs/worries

Policy focused on other pressing issues

Uncertainty of impacts in regions already under stress

- **What are the factors hindering developing nation researchers from engaging in Climate Engineering research?**
- **What do you think can be done to overcome these barriers? (Practical suggestions would be great!)**

Create/raise awareness

Increate communication and collaborative research in Universities. Circulation of funding and collaboration opportunities.

Normalization of CE as a valid research topic

Increase awareness in geoenegineering

Raise awareness about CE in public and private sectors

Build awareness among funders that CE is fundamentally a global cooperation issue

include geoengineering in the mainstream curricula

...and shape the discourse

pointing out/emphasizing the importance of research from developing countries and their chance to shape the discourse at an early stage (before other countries dominate it)

Funding, funding, funding...

Establish national CE research programs w/ focus on international engagement

Create ownership of scientific research within developing nation scientists

Develop plans to elucidate research needed in these countries

Targeted funding for international engagement

develop targeted funding programs (such as DECIMALS)

Capacity development for scientific research: training, career paths,

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