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United Nations
Economic Commission for Africa

Enhancing the Climate Resilience of African Infrastructure

THE ROAD TRANSPORT SECTOR: PROGRESS REPORT
APRIL 2015

Raffaello Cervigni
Lead Environmental Economist
Regional Coordinator, Climate Change
Africa Region, The World Bank

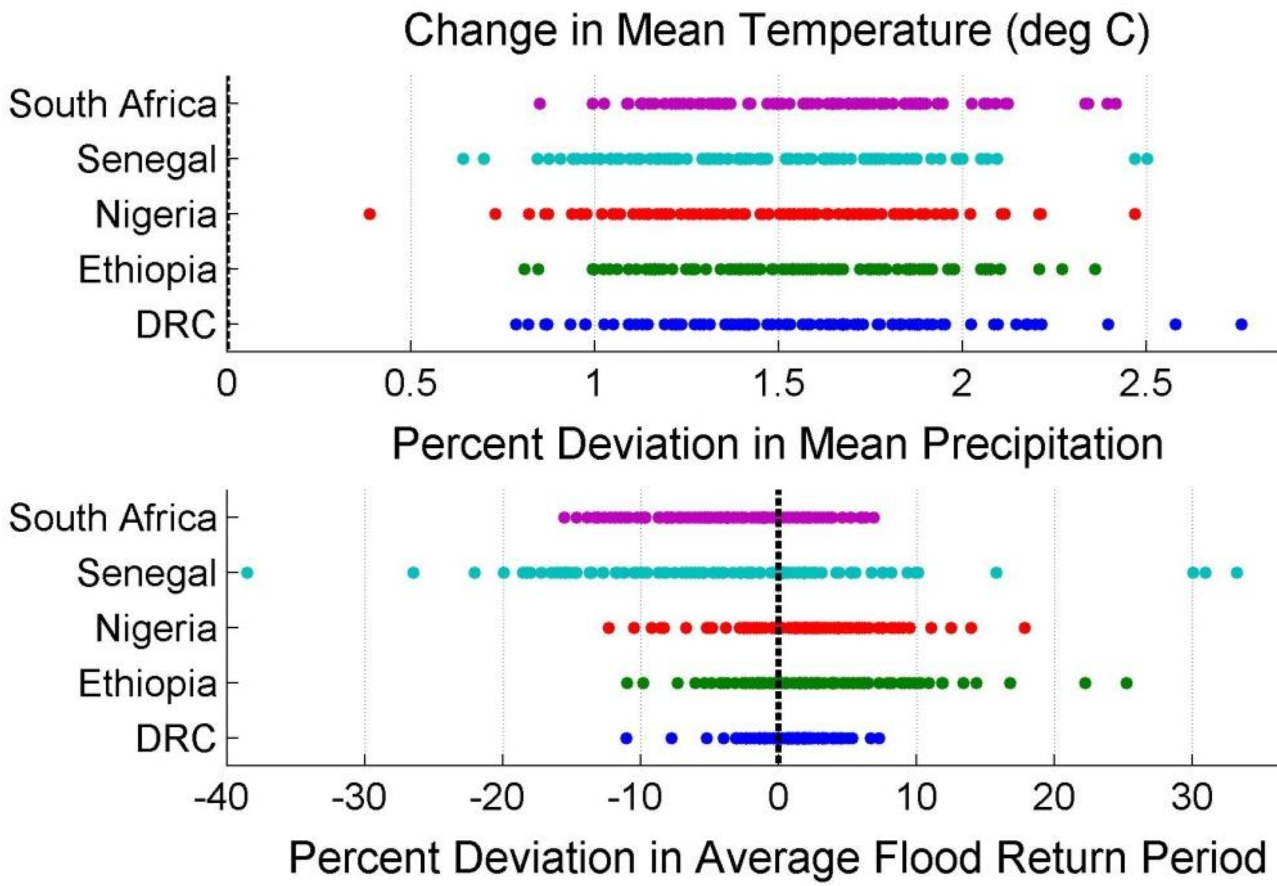
AGENCE FRANÇAISE DE DÉVELOPPEMENT
BANK-NETHERLANDS PARTNERSHIP PROGRAM
Nordic Development Fund
KfW BANKENGRUPPE
UKaid

Context: Upgrading Africa's infrastructure..

PIDA long term targets

Sector	Target by 2040
Modern highways	37,300 km
Hydroelectric power generation	54,150 MW
Interconnecting power lines	16,500 km
New water storage capacity	20,101 hm3

..under an uncertain future climate



Objectives of regional report

<u>Overall</u>: Strengthen the analytical base for investments in Africa's infrastructure under a future uncertain climate; specifically:

1. Estimate the **impacts** of climate change on the performance of PIDA and national road investments over a range of climate scenarios
2. Develop and test a **framework** for the planning and design of infrastructure investment that can be "**robust**" over a wide range of climate outcomes;
3. Enhance the "**investment readiness**" of African countries to use climate finance to increase climate resilience of road infrastructure

The approach in 4 steps

A. **Reference scenario**: by 2050, projected road improvements

B. **Impacts**: how performance will be affected under 91 climate scenarios (no adaptation) – measured in increased road maintenance costs

C. **Perfect foresight adaptation**: assume climate change known in advance, how would modify plans ex-ante

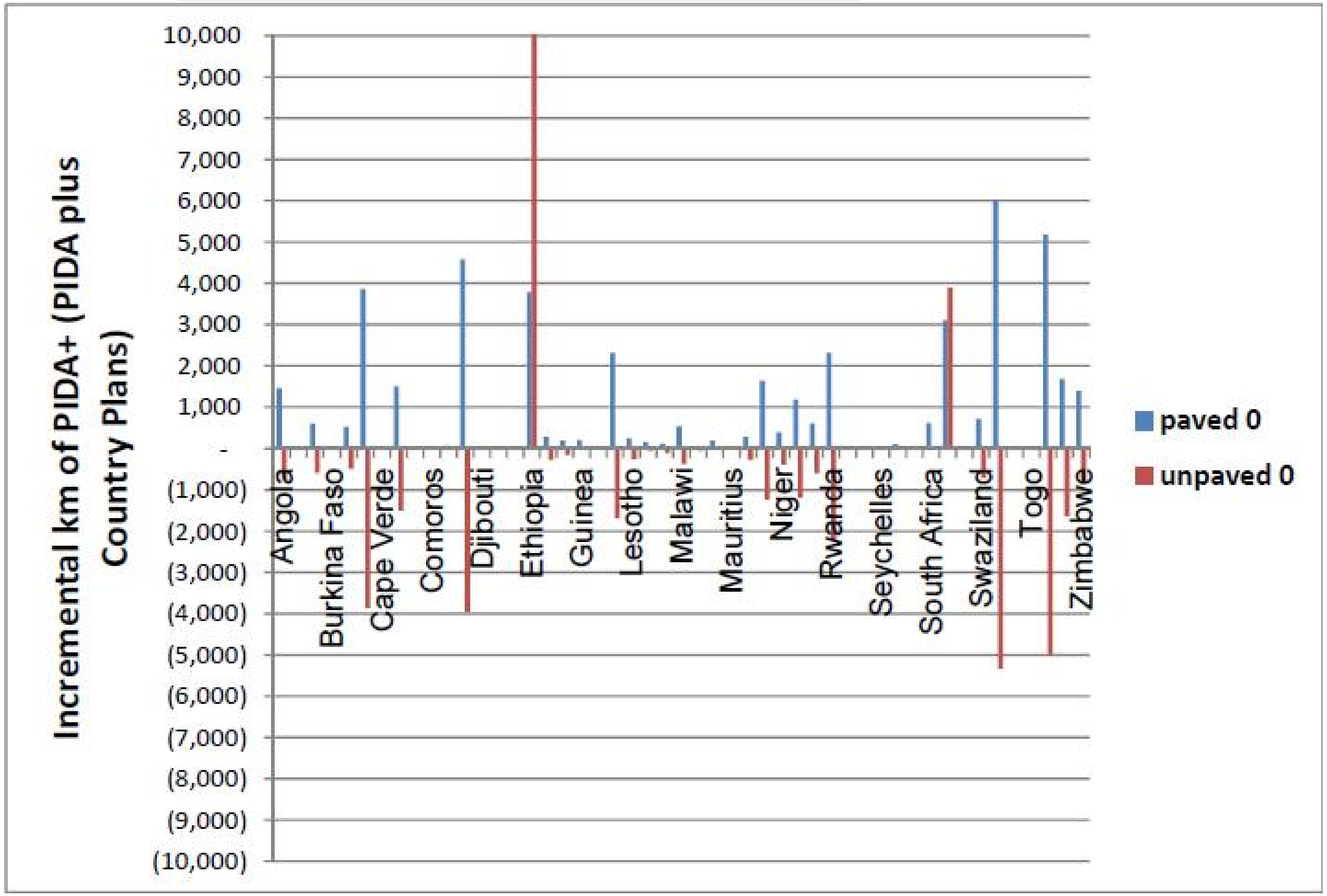
D. **Robust adaptation**: what are the planning choices that deliver performance minimize maximum regret or in as many climate scenarios as possible

Scope of the transportation analysis

PIDA Corridors

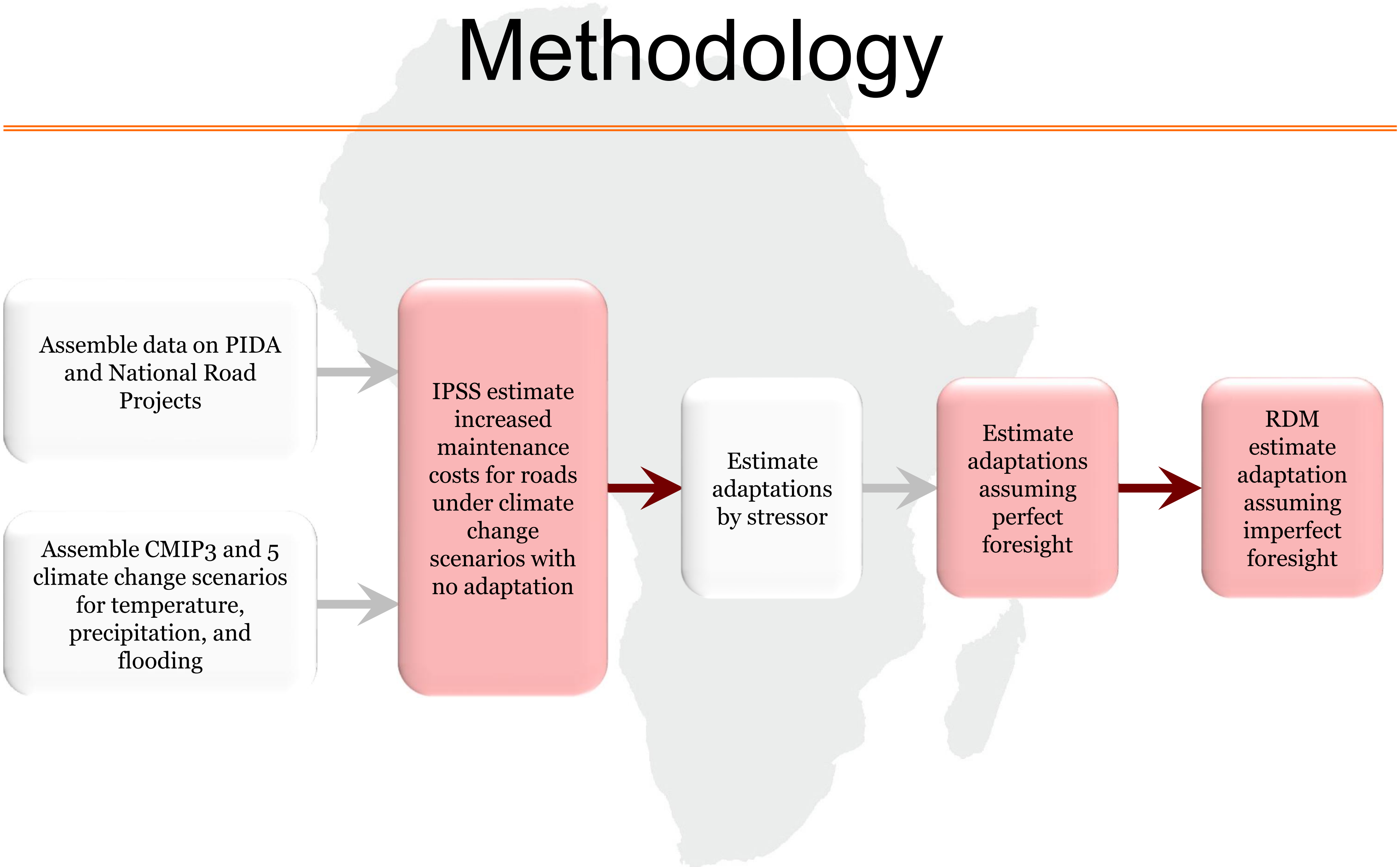
AICD
AFRICA INFRASTRUCTURE COUNTRY DIAGNOSTIC

Additional km of Roads from PIDA+ by 2050



AICD
AFRICA INFRASTRUCTURE COUNTRY DIAGNOSTIC

Methodology



AFRICA INFRASTRUCTURE COUNTRY DIAGNOSTIC

Adaptation

- Temperature
  - Dense seals
  - Bitumen binders with higher softening points
- Precipitation
  - Wider paved shoulders
  - Increased base thickness or quality
- Flooding
  - Increased culvert size

Adaptation Costs (provisional estimates)

Cost of Adapt per km of primary road	
Temperature	$12,880
Precipitation	$74,060
Flooding	$54,740

* this is incremental cost respect baseline

** this cost happens every 30 years as part of end of life rehabilitation operations. then for projects starting before 2020, this cost should be added twice, as our analysis goes from 2015-2050.

*** all costs must be present value set at 2015 discounted at 3%

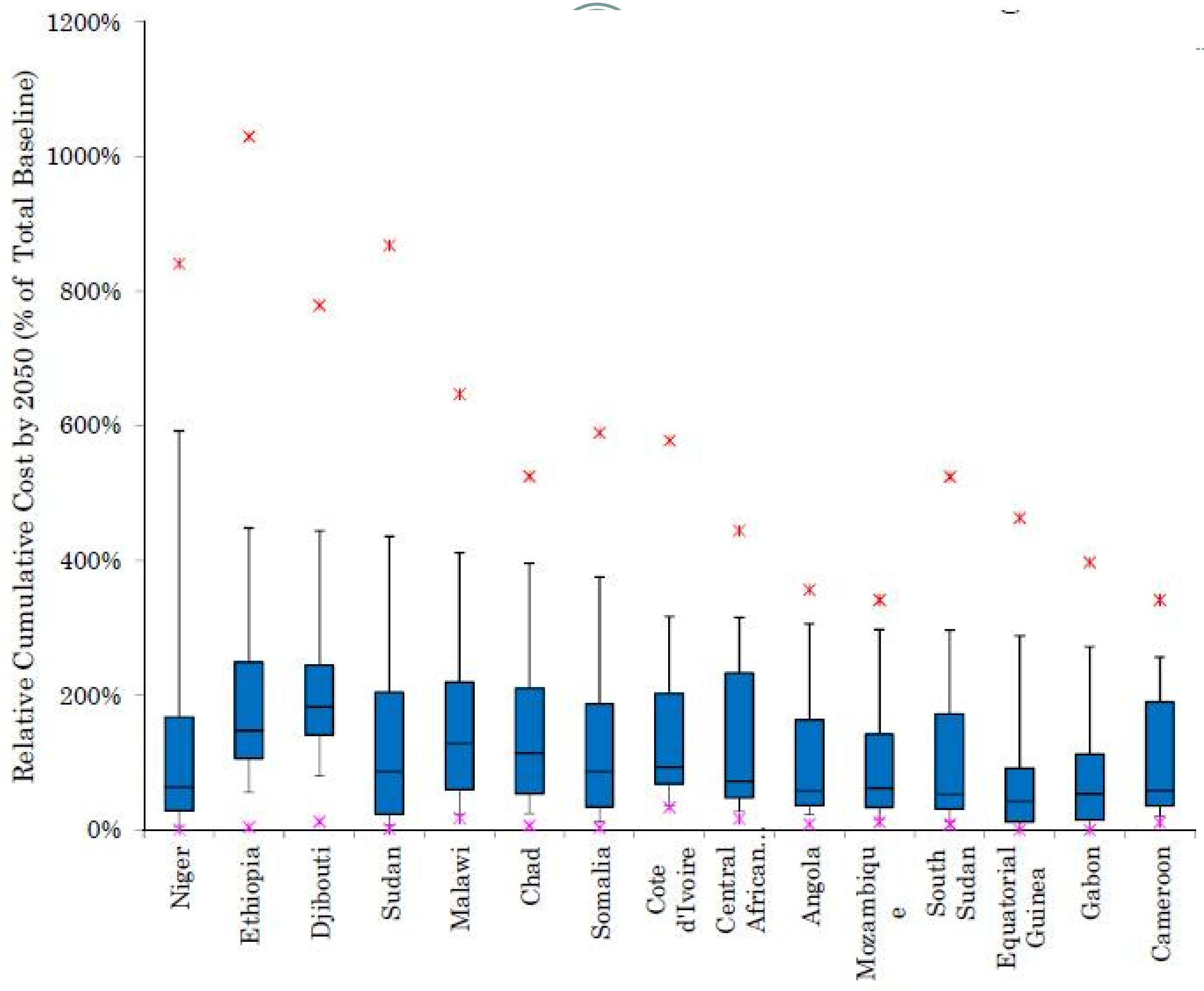
Impacts Methodology

- Only examines change in maintenance costs
- Assume uniform climate thresholds and costs across sub-Saharan Africa
  - Actual conditions and costs will vary
- Costs of traffic disruption are not estimated
- Benefits of adaptation without climate change not monetized
  - Adaptations on temperature and precipitation would allow more traffic on roads
  - Larger culverts reduce current flood risks

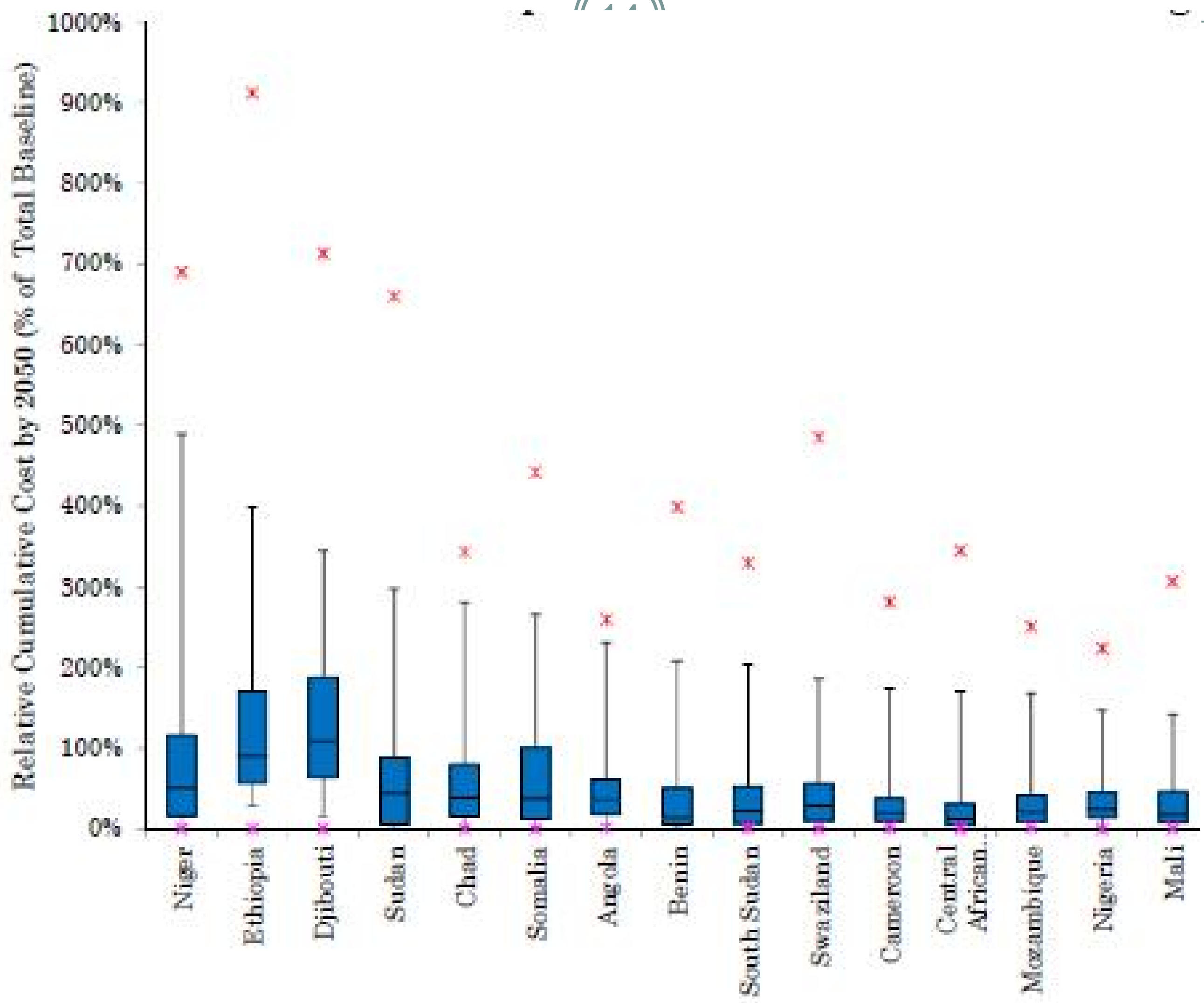
Impacts

EXAMPLES OF COSTS OF REACTIVE ADAPTATION ASSUMING NO PROACTIVE ADAPTATION

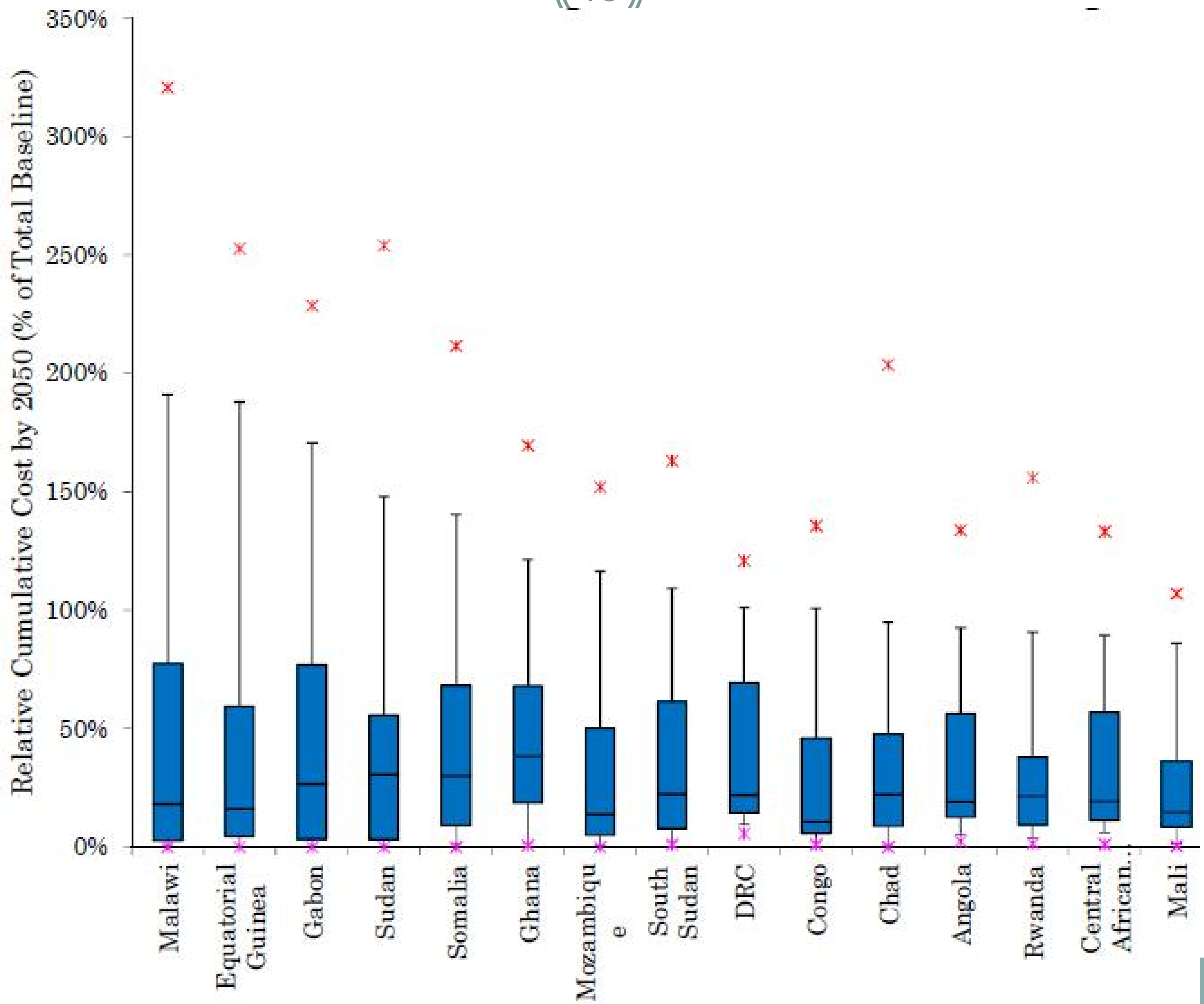
15 Countries with Highest Relative Reactive Adaptation Costs – All 3 Stressors –



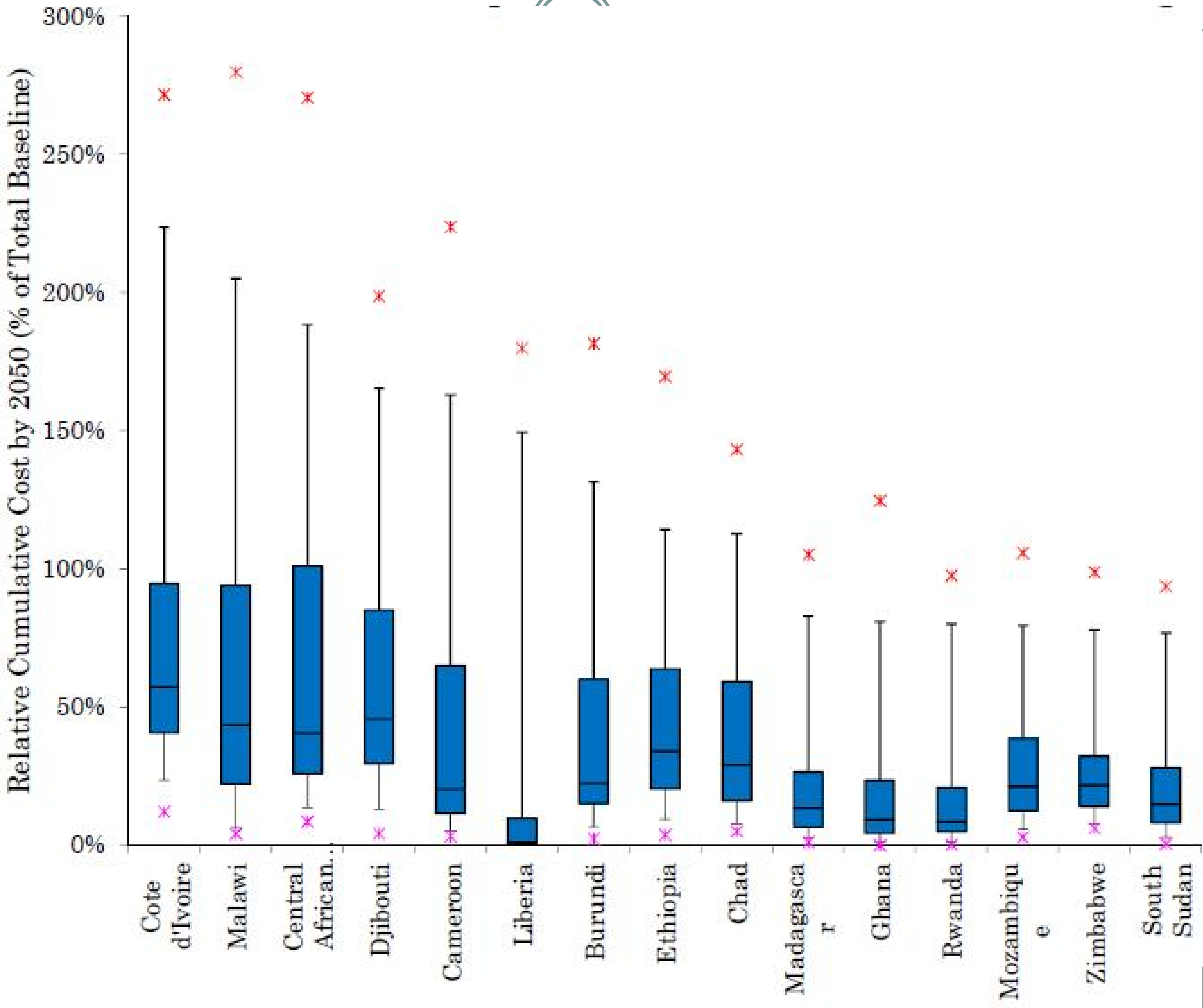
15 Countries with Highest Relative Reactive Adaptation Costs –Precipitation



15 Countries with Highest Relative Reactive Adaptation Costs – Flooding



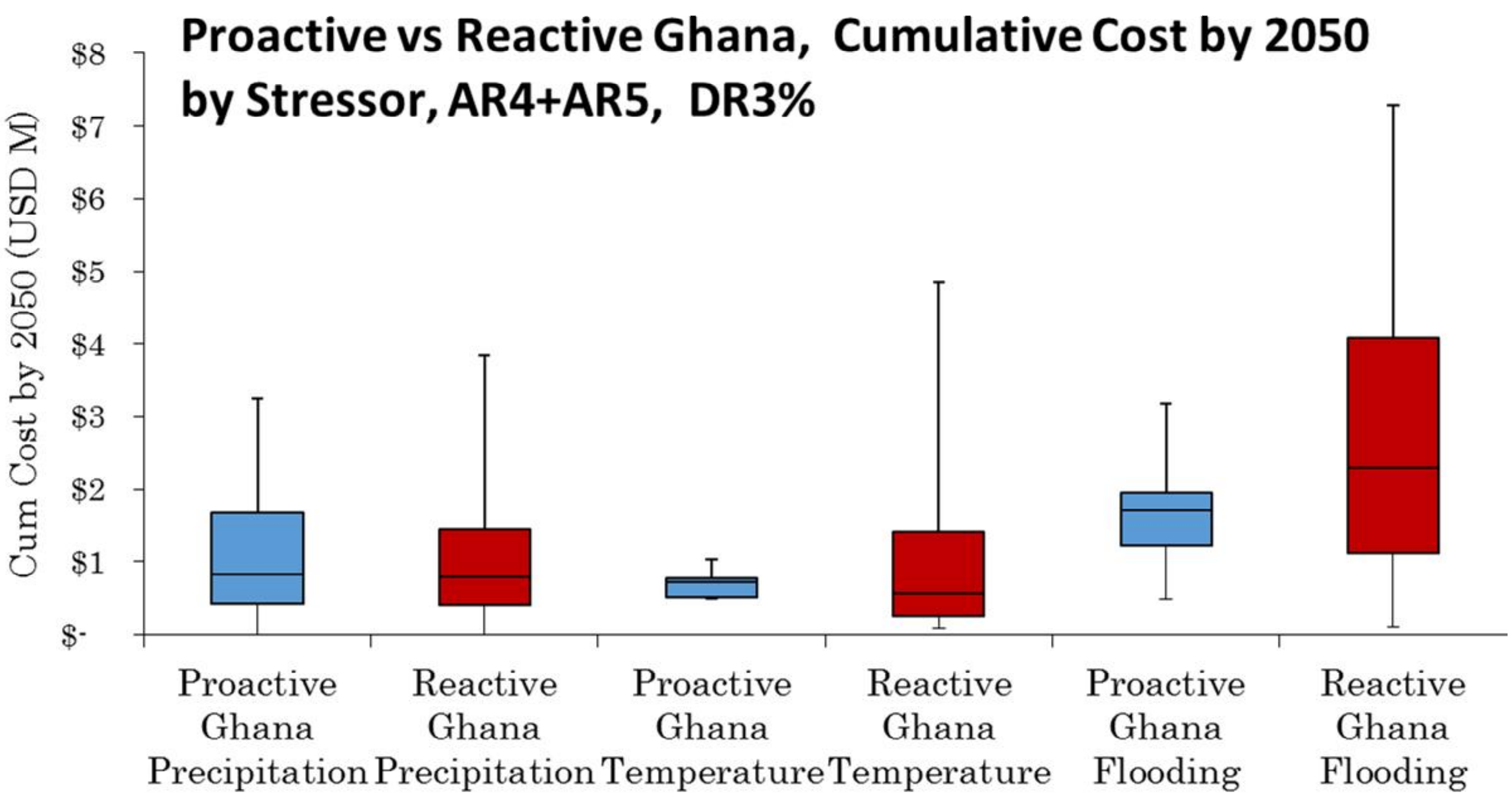
15 Countries with Highest Relative Reactive Adaptation Costs – Temperature



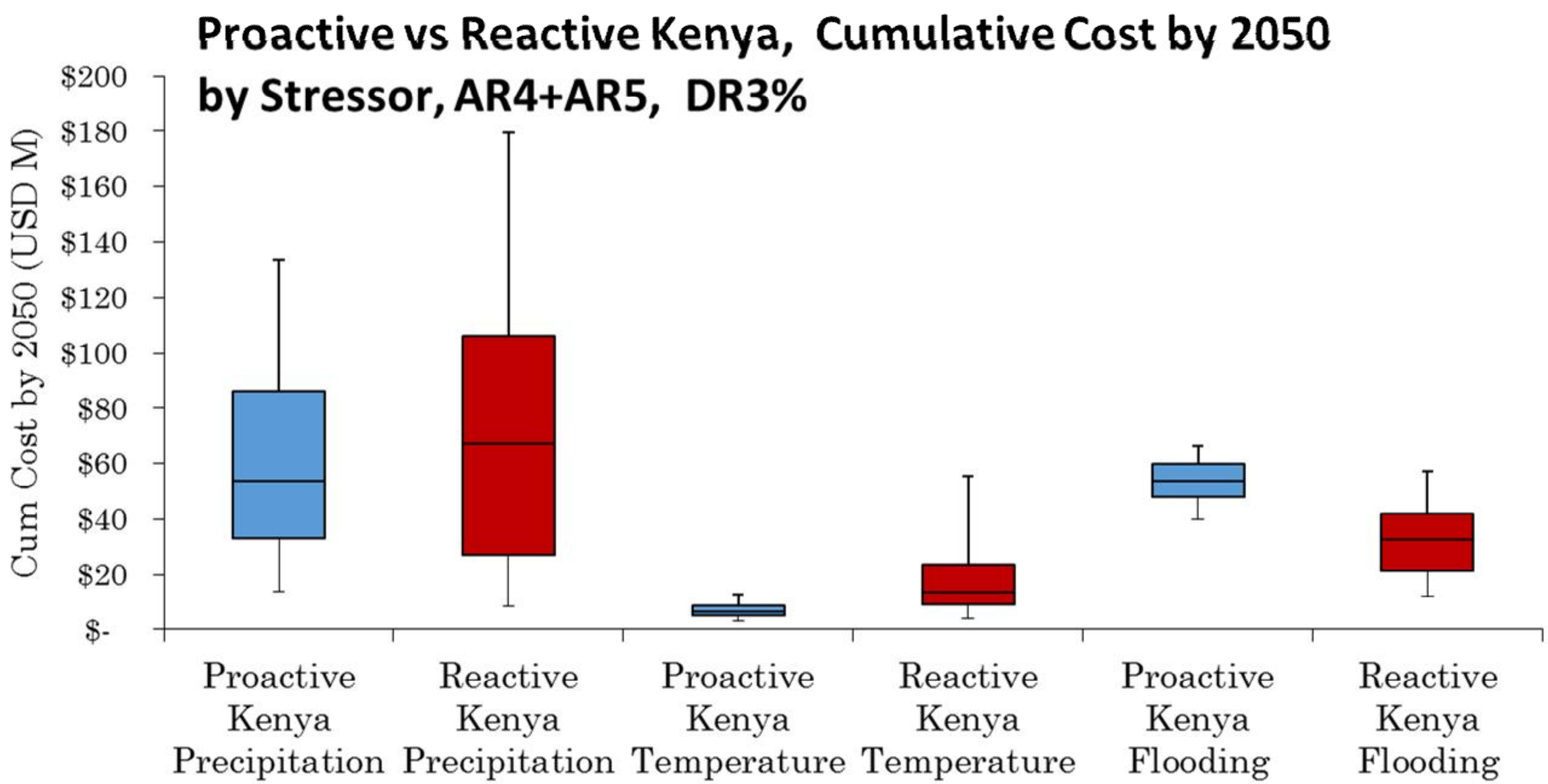
Perfect Foresight

EXAMPLES OF COSTS OF REACTIVE ADAPTATION VS. PERFECT FORESIGHT PROACTIVE ADAPTATION

Ghana


Proactive vs Reactive Ghana, Cumulative Cost by 2050
by Stressor, AR4+AR5, DR3%
Cum Cost by 2050 (USD M)
$8
$7
$6
$5
$4
$3
$2
$1
$-
Proactive Ghana Precipitation
Reactive Ghana Precipitation
Proactive Ghana Temperature
Reactive Ghana Temperature
Proactive Ghana Flooding
Reactive Ghana Flooding

Kenya


Proactive vs Reactive Kenya, Cumulative Cost by 2050 by Stressor, AR4+AR5, DR3%
Cum Cost by 2050 (USD M)
$200
$180
$160
$140
$120
$100
$80
$60
$40
$20
$-
Proactive Kenya Precipitation
Reactive Kenya Precipitation
Proactive Kenya Temperature
Reactive Kenya Temperature
Proactive Kenya Flooding
Reactive Kenya Flooding

RDM

IMPERFECT FORESIGHT ANALYSIS

MINIMIZE MAXIMUM REGRET

"SATISFICING"

Given Imperfect Climate Information, Consider Robust Adaptation

To calculate robust adaptation:

1. Calculate "regret" of proactive and reactive strategies in each of 91 climate futures
   - Regret is how much better you could have done by choosing the best strategy for that future: reactive instead of proactive, or vice-versa
2. Use alternative criteria to suggest robust strategies
   i. Minimize maximum regret – choose strategy that has the smallest maximum regret
   ii. Satisfice over the broadest range of futures – choose strategy with small regret over the largest number of futures

Expected results

- What is the cost of inaction?
- Is adaptation worthwhile?
- In which countries is the case for adaptation stronger?
- What does it take to adapt?

Next steps

- May 2015: finalization of analysis
- June 2015: internal review
- Summer 2015: presentation in Africa

Annex slides

Preliminary Findings

Initial Findings

- Most favorable case for proactive adaptation appears to be for temperature
  - Adaptation costs are relatively low
  - We know temperatures will rise so regrets are relatively low
- Case appears to be more mixed on precipitation and flooding
  - Adaptation costs are higher, particularly for precipitation
  - Whether precipitation and flooding increases or decreases more uncertain
- Have not considered other benefits
  - For example, avoided traffic disruption costs
  - Damages from road disruption can be high, particularly for flooding

.

The study team

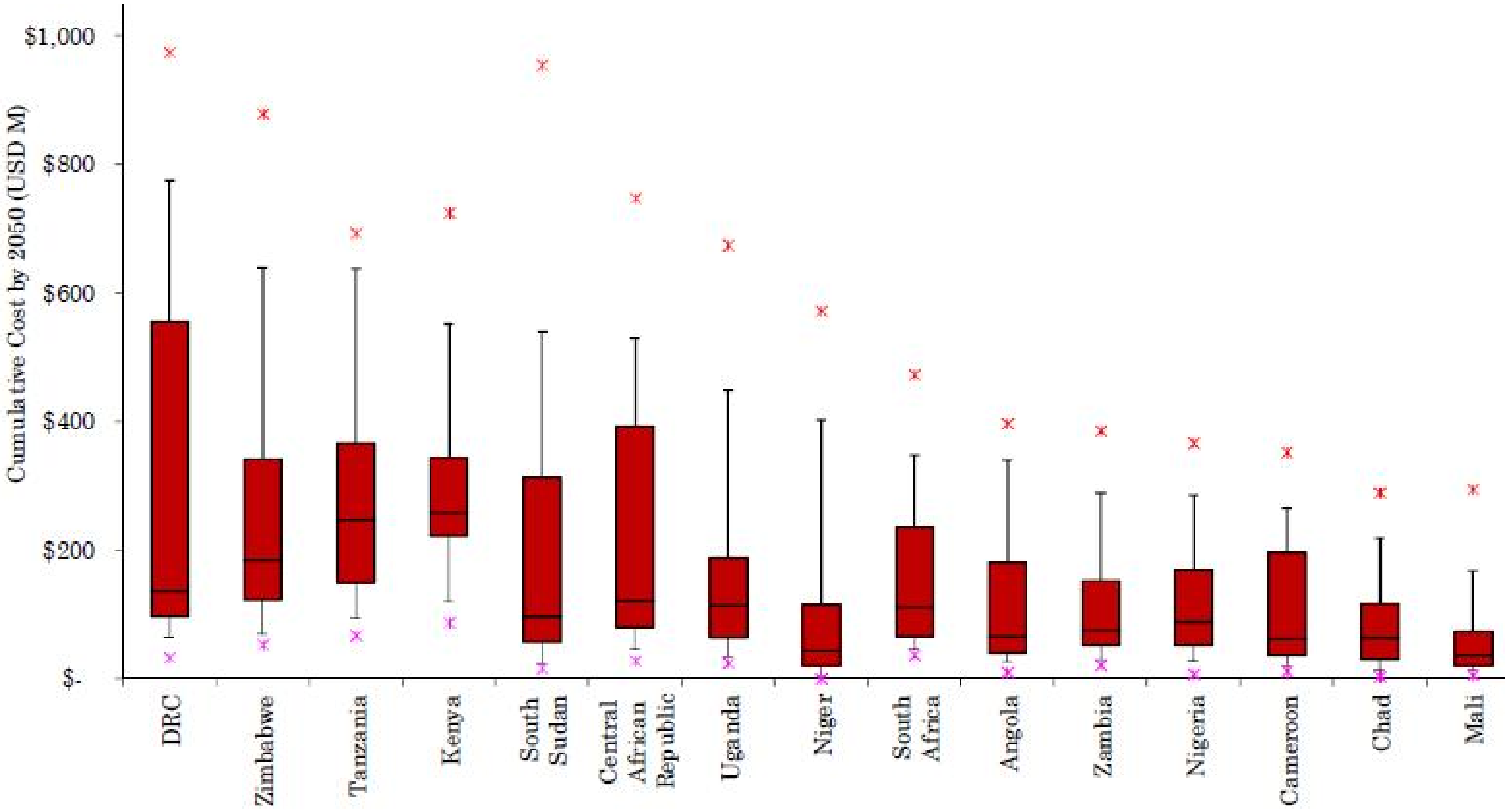
US/ Europe experts	Africa experts
• Stratus Consulting • University of Colorado • RAND • Cambridge Systematics	• Aurecon

Total Potential Costs for Maintenance

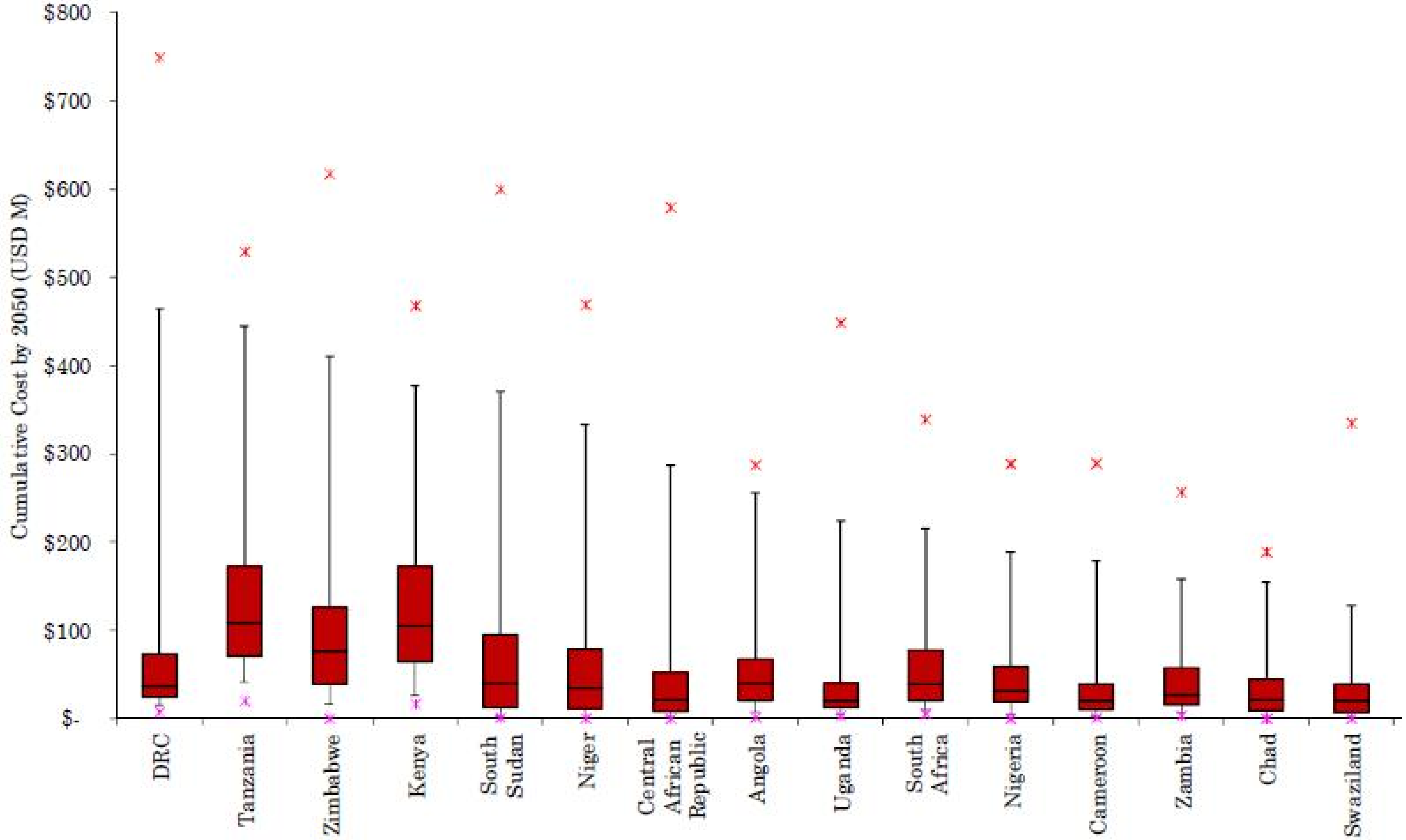
- CMIP 3 models
  - $500 M to $ 1 Billion
    - 45 to 85% increase in maintenance costs

- CMIP 5 models
  - $1.9 to $3.8 Billion
    - 166 to 326% increase in maintenance costs
  - Newer model runs have more severe climate change projections for sub-Saharan Africa

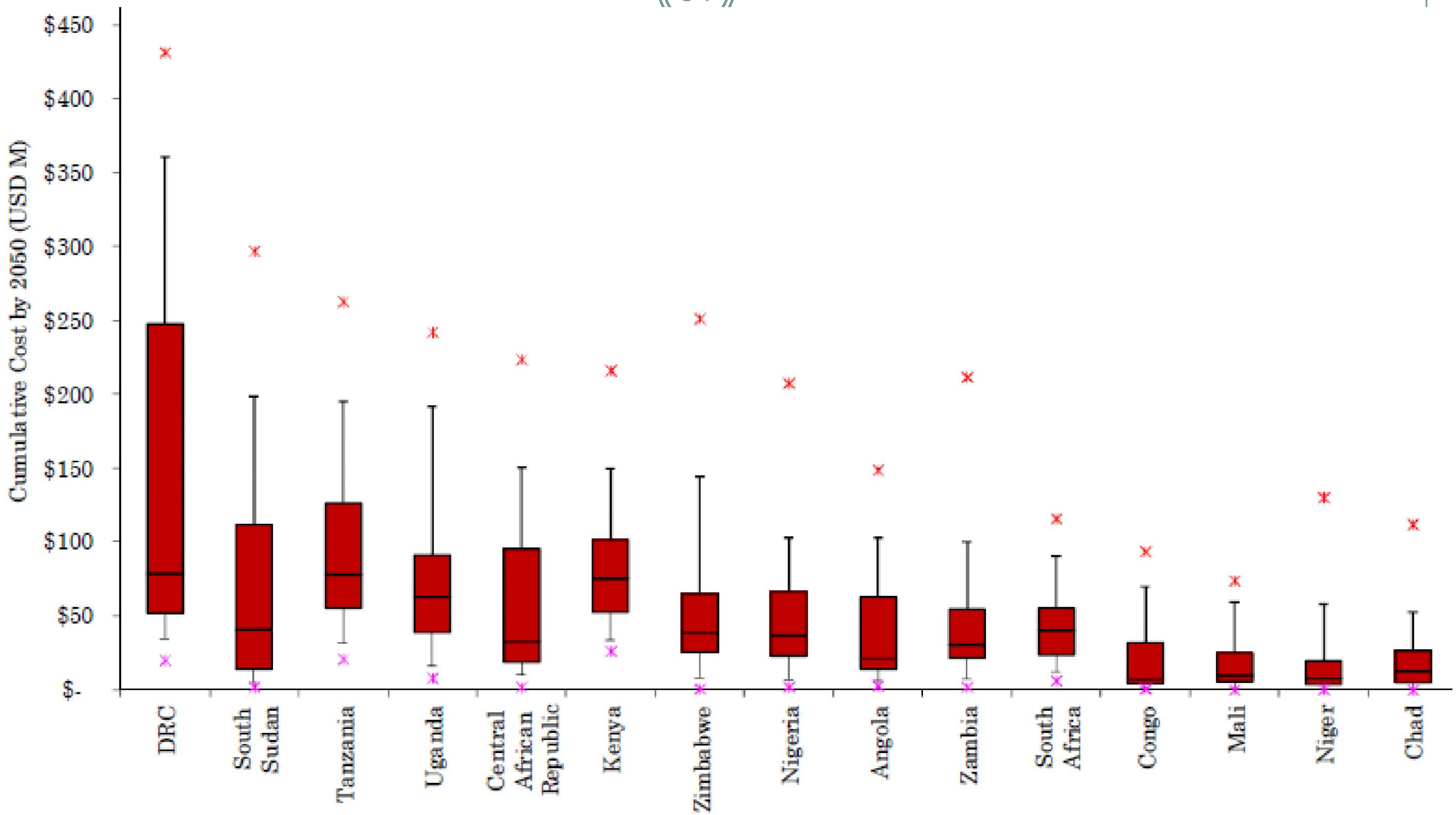
15 Countries with Highest Cumulative Reactive Adaptation Costs – All 3 Stressors 3% discount rate



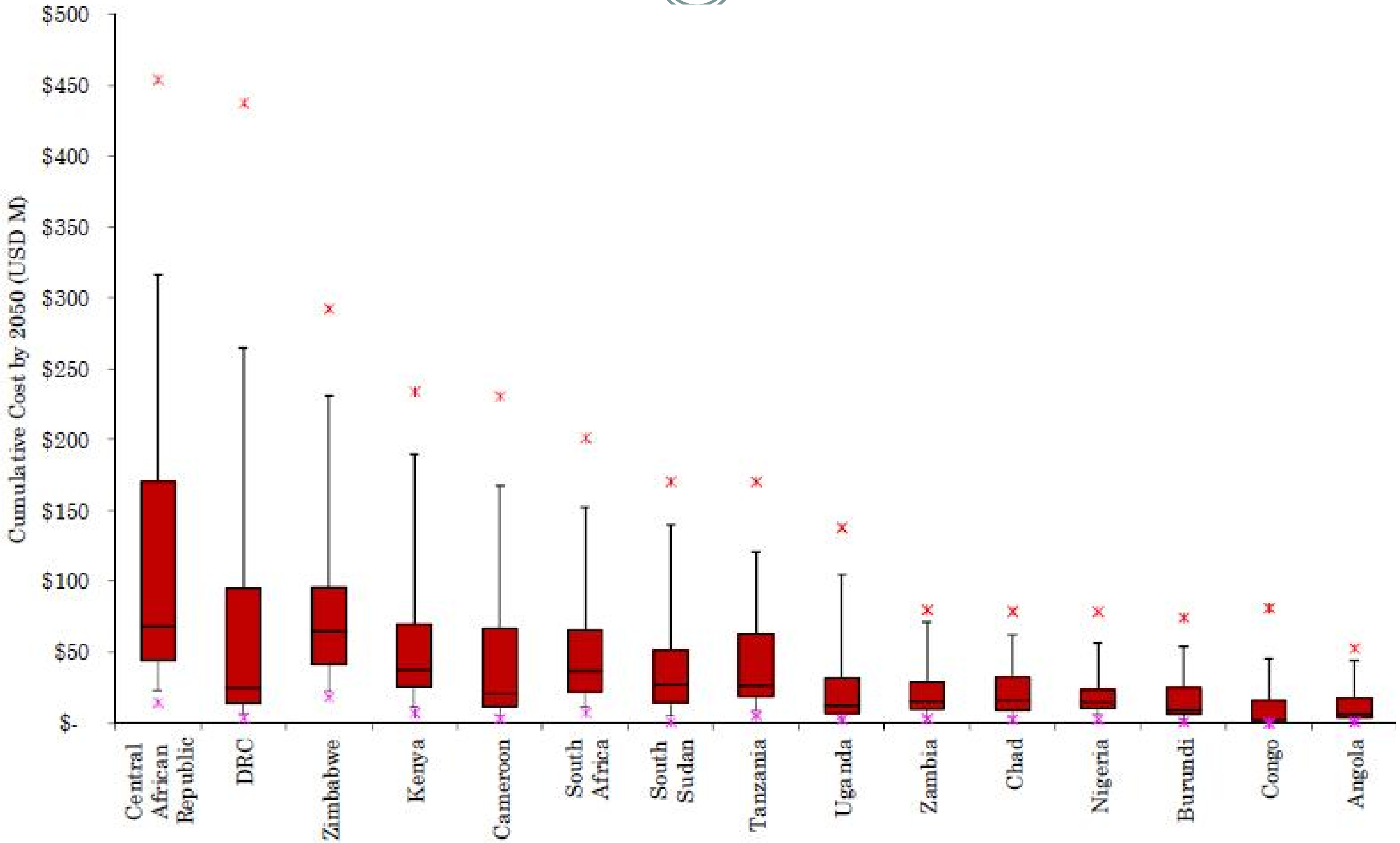
15 Countries with Highest Cumulative Reactive Adaptation Costs –Precipitation 3% discount rate



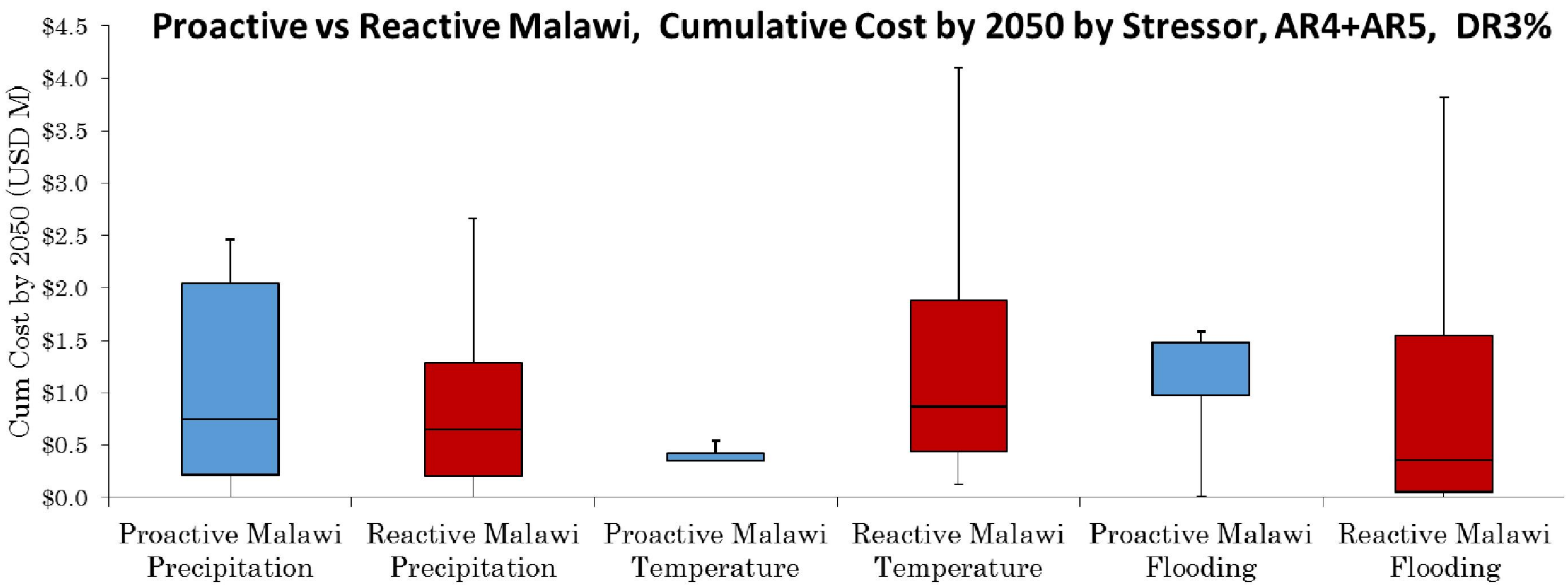
15 Countries with Highest Cumulative Reactive Adaptation Costs – Flooding 3% discount rate



15 Countries with Highest Cumulative Reactive Adaptation Costs – Temperature 3% discount rate



Malawi


Proactive vs Reactive Malawi, Cumulative Cost by 2050 by Stressor, AR4+AR5, DR3%
Cum Cost by 2050 (USD M)
$4.5
$4.0
$3.5
$3.0
$2.5
$2.0
$1.5
$1.0
$0.5
$0.0
Proactive Malawi Precipitation
Reactive Malawi Precipitation
Proactive Malawi Temperature
Reactive Malawi Temperature
Proactive Malawi Flooding
Reactive Malawi Flooding

Perfect Foresight Analysis

- Temperature
  - In some cases proactive adaptation estimated to be less costly than reactive adaptation
  - Are exceptions
- Precipitation
  - Results are mixed
  - Some cases proactive is more cost-effective; in other cases reactive is
- Flooding
  - Reactive adaptation generally appears to be more cost effective

Notional Results for One Country

	Precipitation		Temperature		Flooding	
	Proactive	Reactive	Proactive	Reactive	Proactive	Reactive
Max regret	$30.9	$0.0	$4.9	$45.9	$15.8	$22.7
Number of satisficing futures	0	91	50	41	4	87

Note: satisficing level is 10% of adaptation cost

For Precipitation, *Reactive* strategy has least maximum regret and satisfices over most futures

For Temperature, *Proactive* strategy has least maximum regret and satisfices over most futures

For Flooding, *Proactive* strategy has least maximum regret but Reactive strategy satisfices over most futures