Enhancing the Climate Resilience of African Infrastructure

THE WATER AND POWER SECTORS: SUMMARY OF FINDINGS
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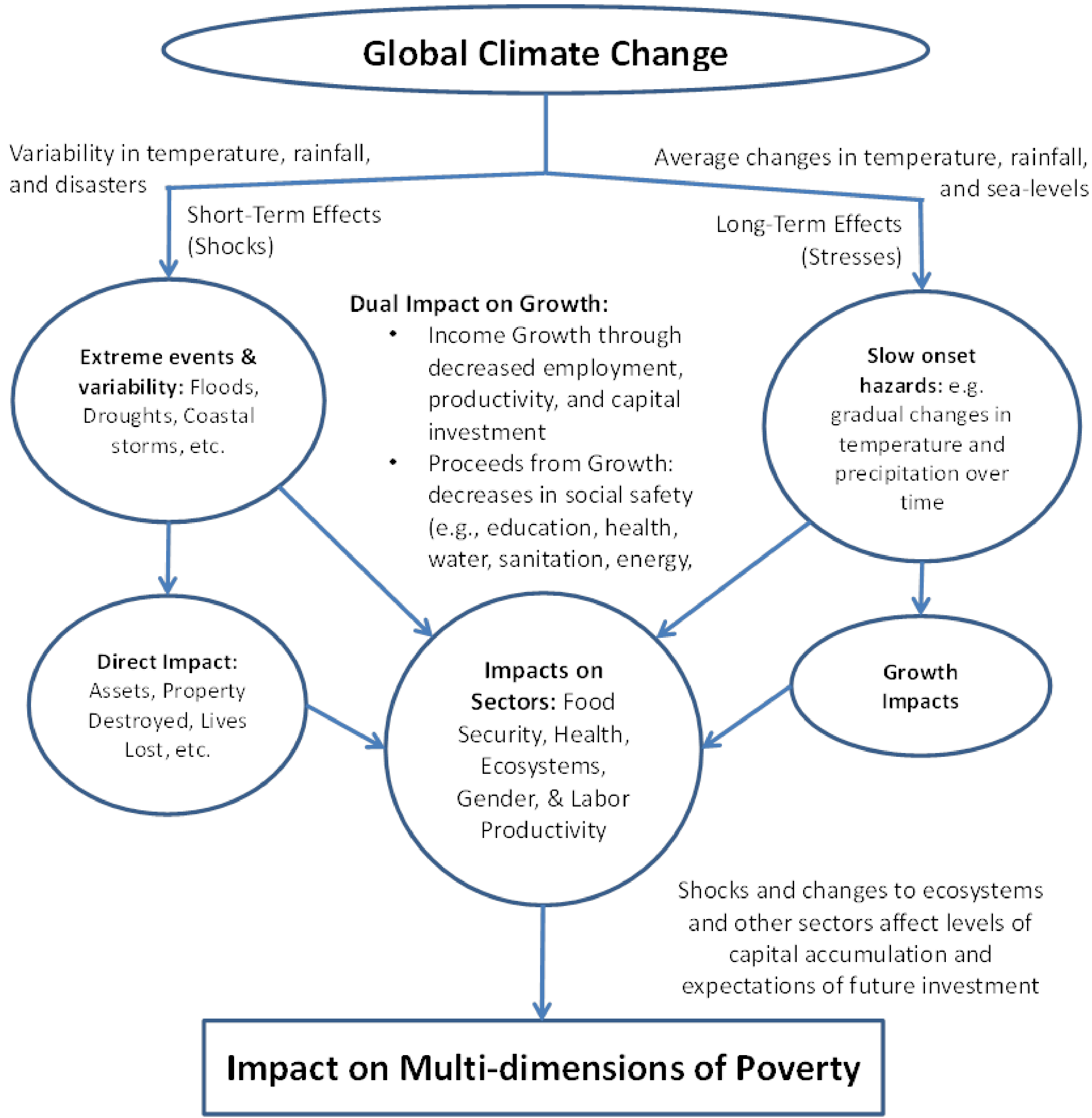
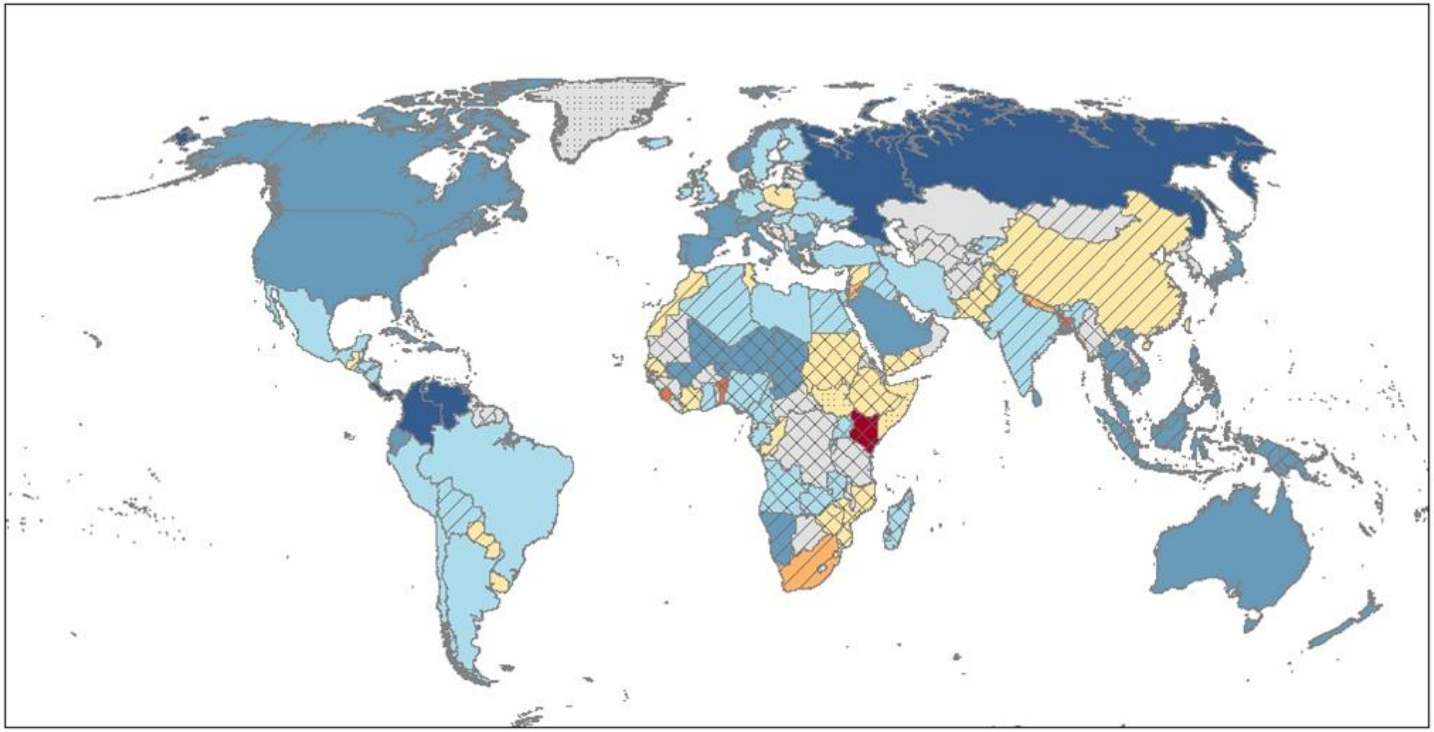
The Climate-Poverty-Development Nexus



Vulnerability to Climate Change by Human Development Index



Vulnerability to Climate Change

1 Little
2
3
4
5
6
7
8
9 Severe
No Data

Human Development Index (HDI)

No Data
Low
Medium
High and Very High

Sources:
1. Socioeconomic Data and Applications Center (SEDAC). Integrated Assessment of Climate Change: Model Visualization and Analysis (MVA). http://sedac.ciesin.columbia.edu/mva/ccv/index.html#maps
2. UNDP. 2011. Human Development Reports. Human Development Statistical Tables. Accessed on February 27, 2012 at: http://hdr.undp.org/en/statistics/data/

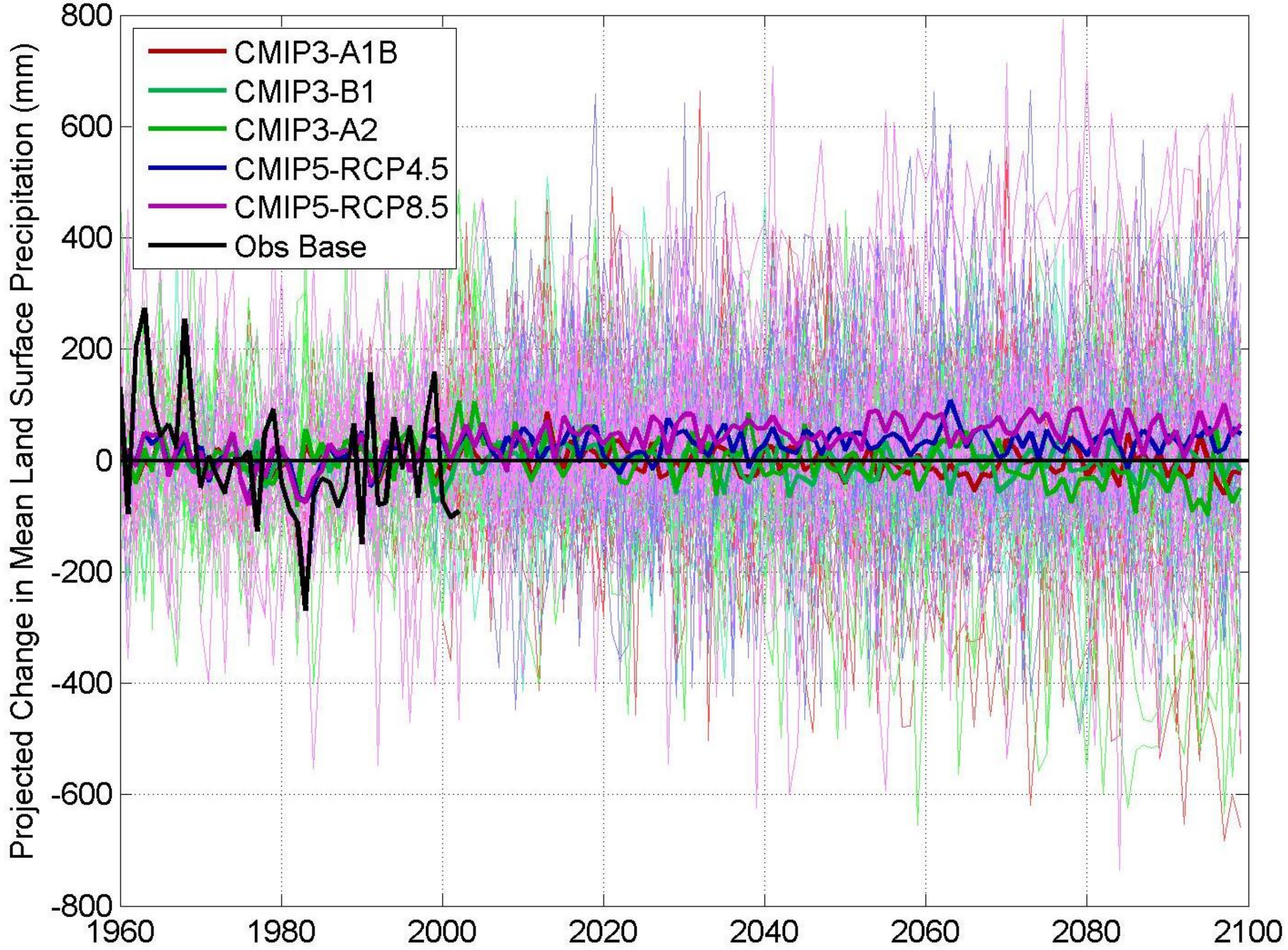
The issue: a long term commitment to infrastructure development..

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

..in the context of a very different climate in the future..

Data refer to the Volta river basin



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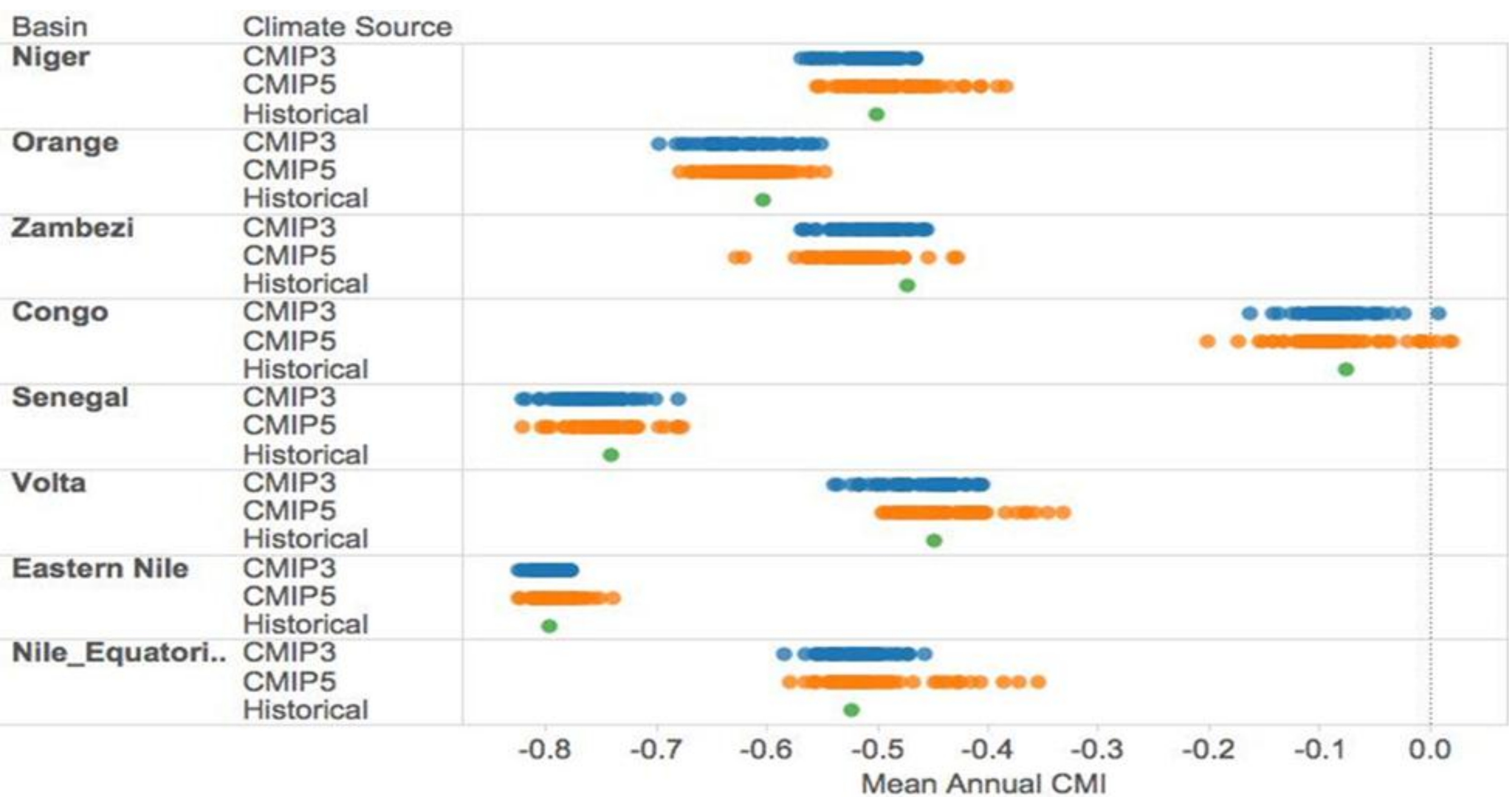
..with increasing uncertainty on direction and magnitude of change



Objectives of regional report

Overall: 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 a subset of infrastructure 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 infrastructure

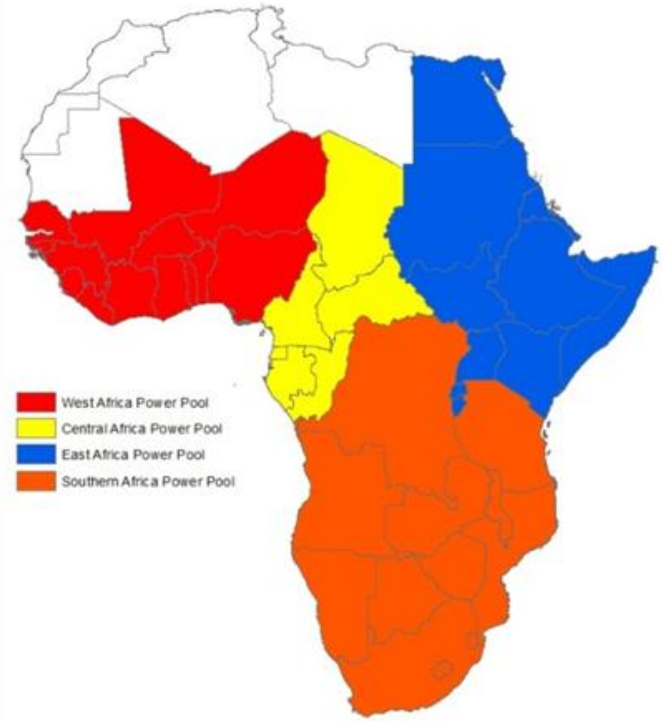
Summary of findings

1. Climate change has large effects on infrastructure performance; ignoring it may lead to significant "regrets"
2. Despite uncertainty, it is possible to plan infrastructure development so as to reduce regrets
3. There will be cost increases and cost savings; the benefits in terms of reduced risk outweigh the cost increase
4. Climate resilience is a new challenge, but is manageable

Scope of the water and energy analysis

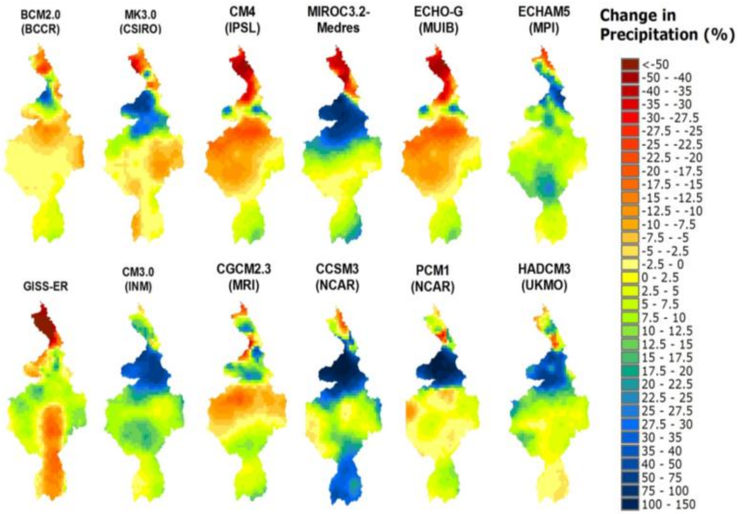
Seven River Basins

Four Power Pools



Two tracks of analysis

- Track 1: coarser scale (basins and power pools)
  - Emphasis on planning, trade-offs among policy objectives
- Track 2: specific investments scale
  - Emphasis on project design options



The study team

US/ Europe experts

- Stockholm Environment Instit./ US
- Rand Corporation
- Royal Institute of Technology – Sweden
- Massachusetts Institute of Technology
- University of Massachusetts
- Industrial Economics, Inc.

Africa experts

- Nile Basin Initiative (Uganda)
- International Institute for Water and the Environment (Burkina Faso)
- Rhodes University (South Africa)
- University of Cape Town (South Africa)

The approach in 4 steps

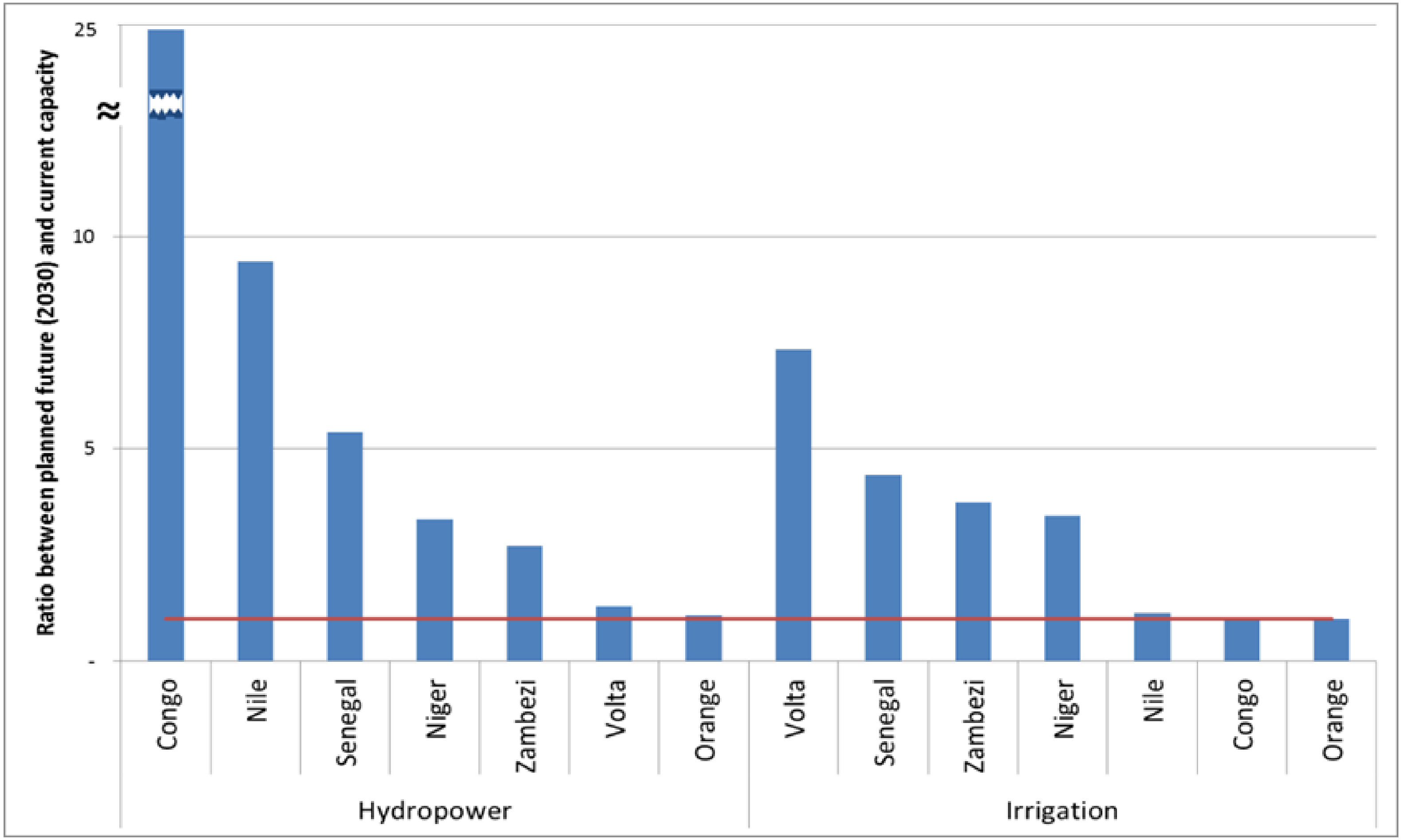
A. **Reference scenario**: by 2030, what infrastructure, where, when, what performance (MW, Hectares, etc.)

B. **Impacts**: how performance will be affected under 100+ climate scenarios (no adaptation)

C. **Perfect foresight adaptation**: assume you knew in advance the climate, how would you modify plans ex-ante

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

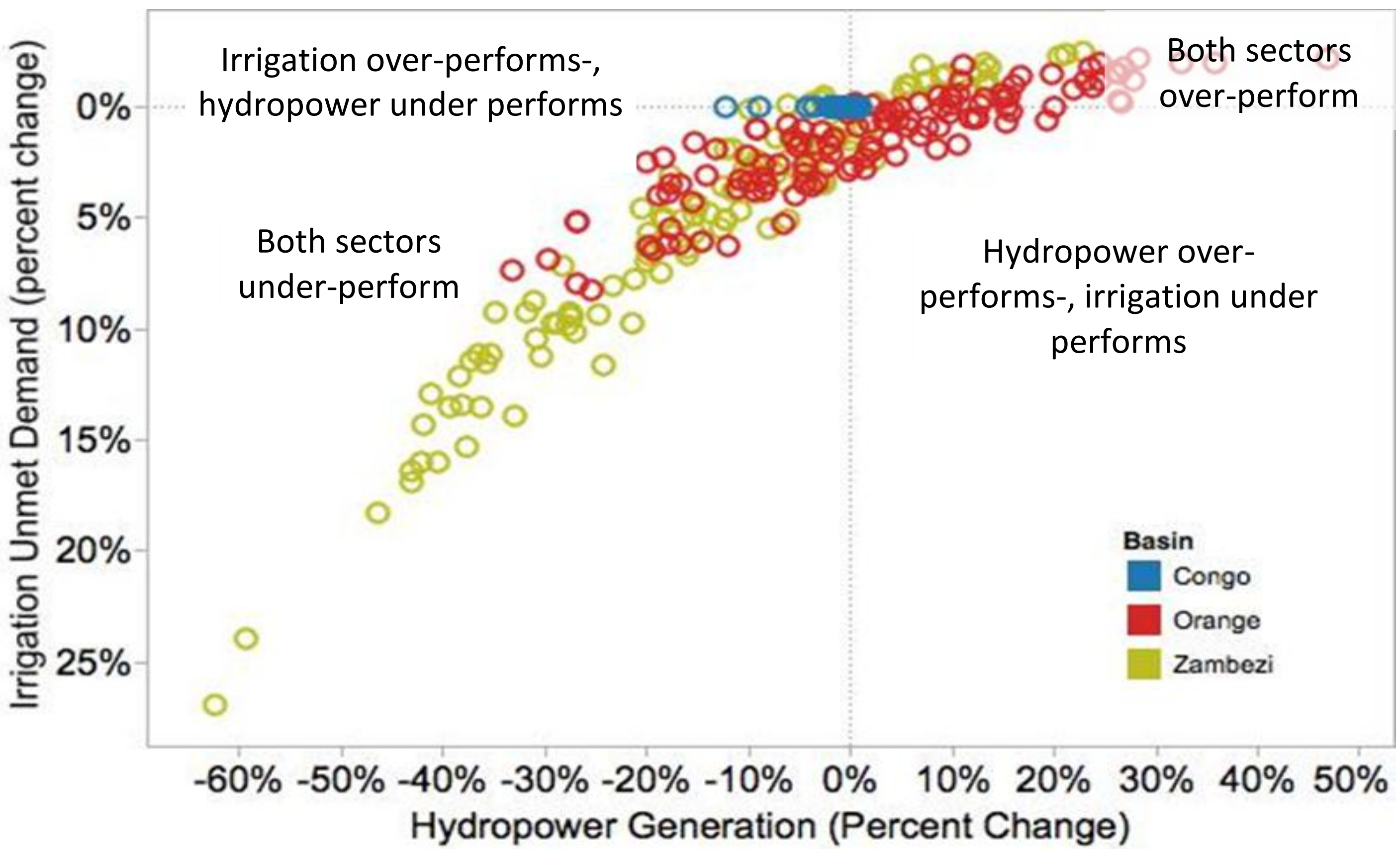
The reference scenario: a program of massive investment



Impacts

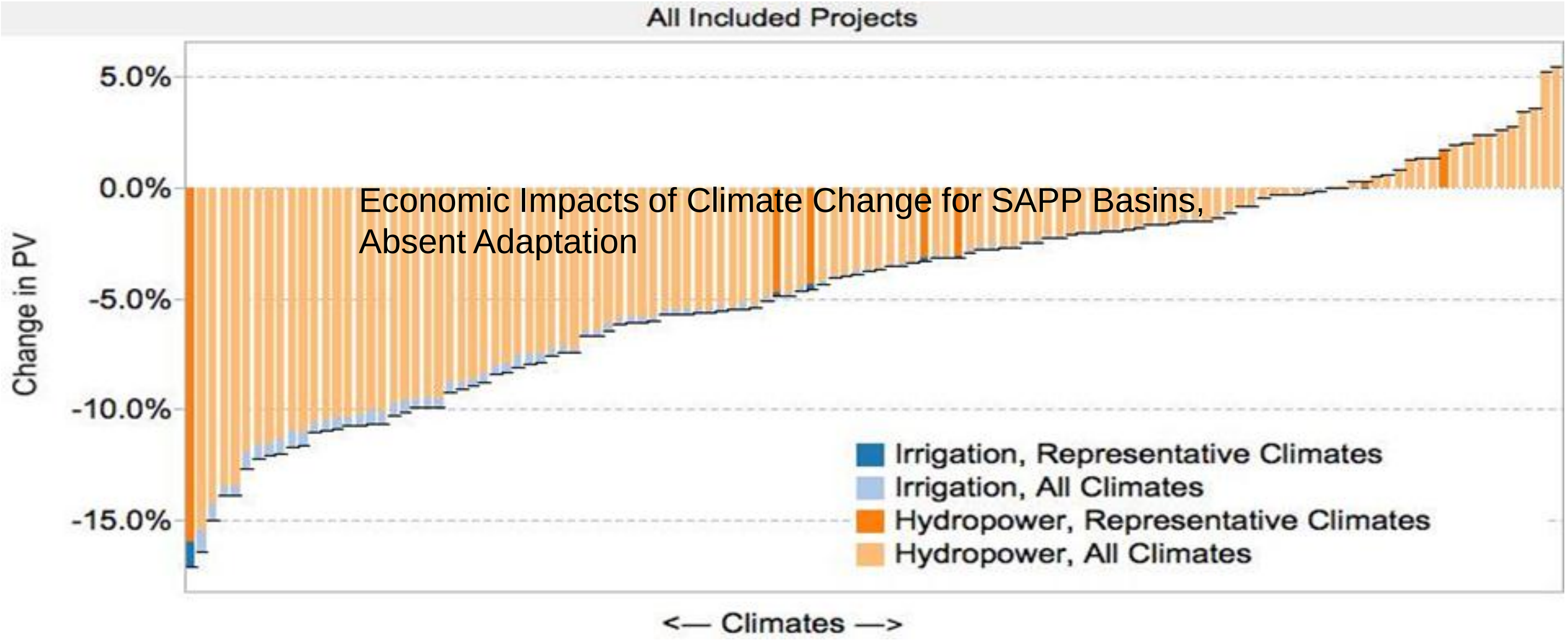
Large impacts on physical performance..

Changes in physical performance of hydropower and irrigation under climate change (2015 to 2050) in the Congo, Orange and Zambezi basins



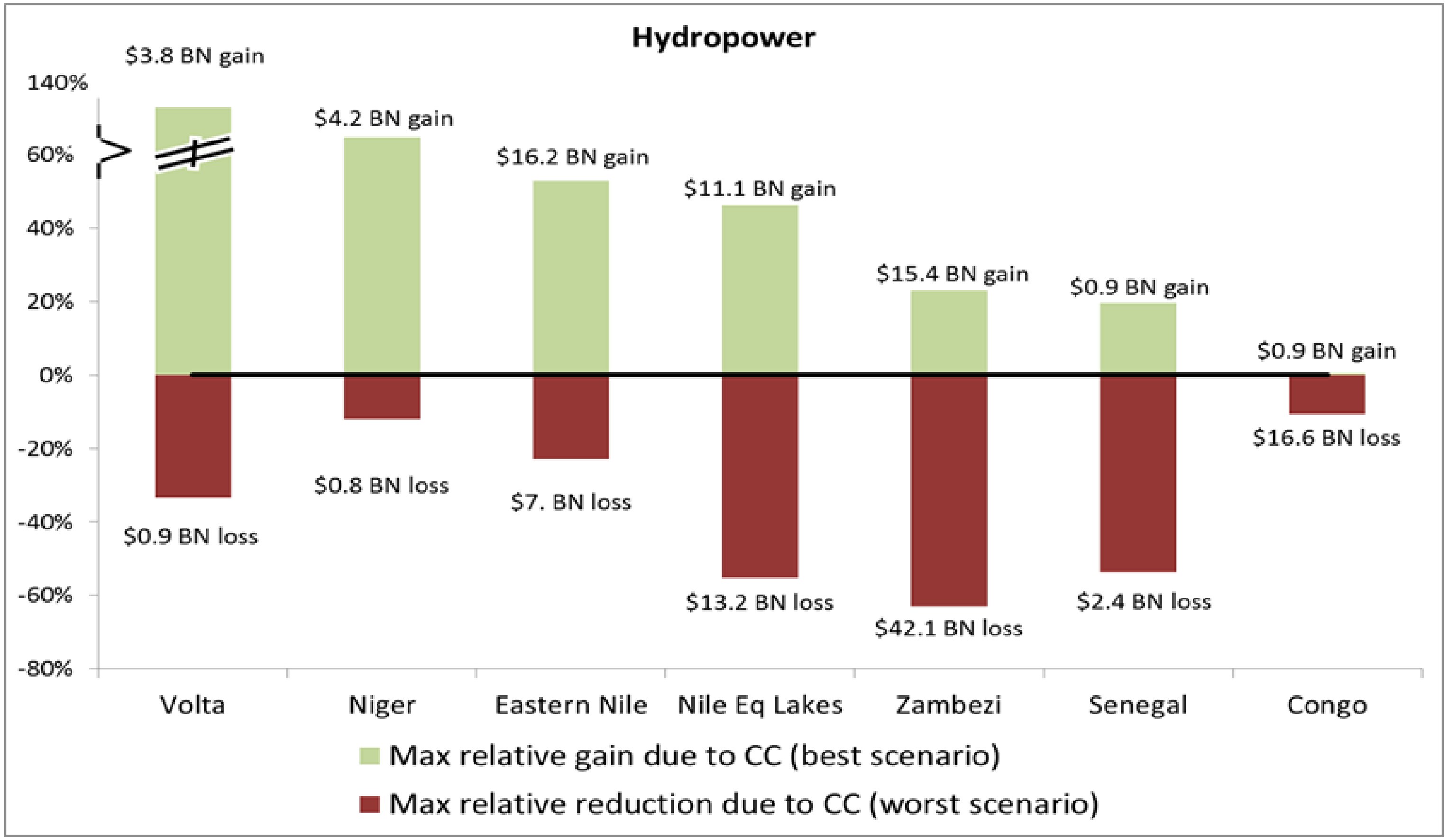
..and thus on economic performance..

Change in present value of revenues from Hydropower and irrigation for SAPP Basins, Absent Adaptation



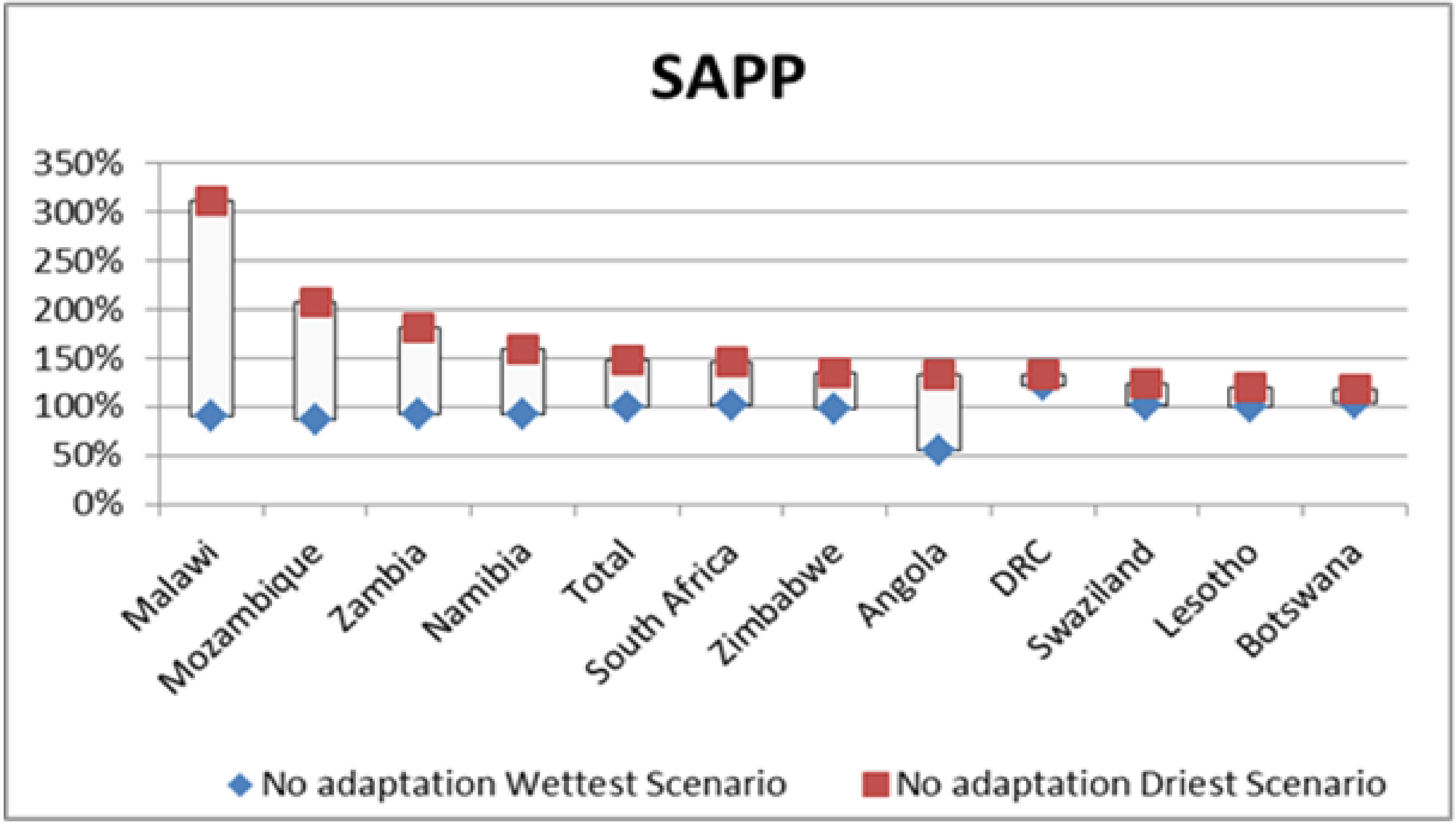
..across almost all basins

Changes in hydropower revenues from climate change (present value 2015 to 2050)



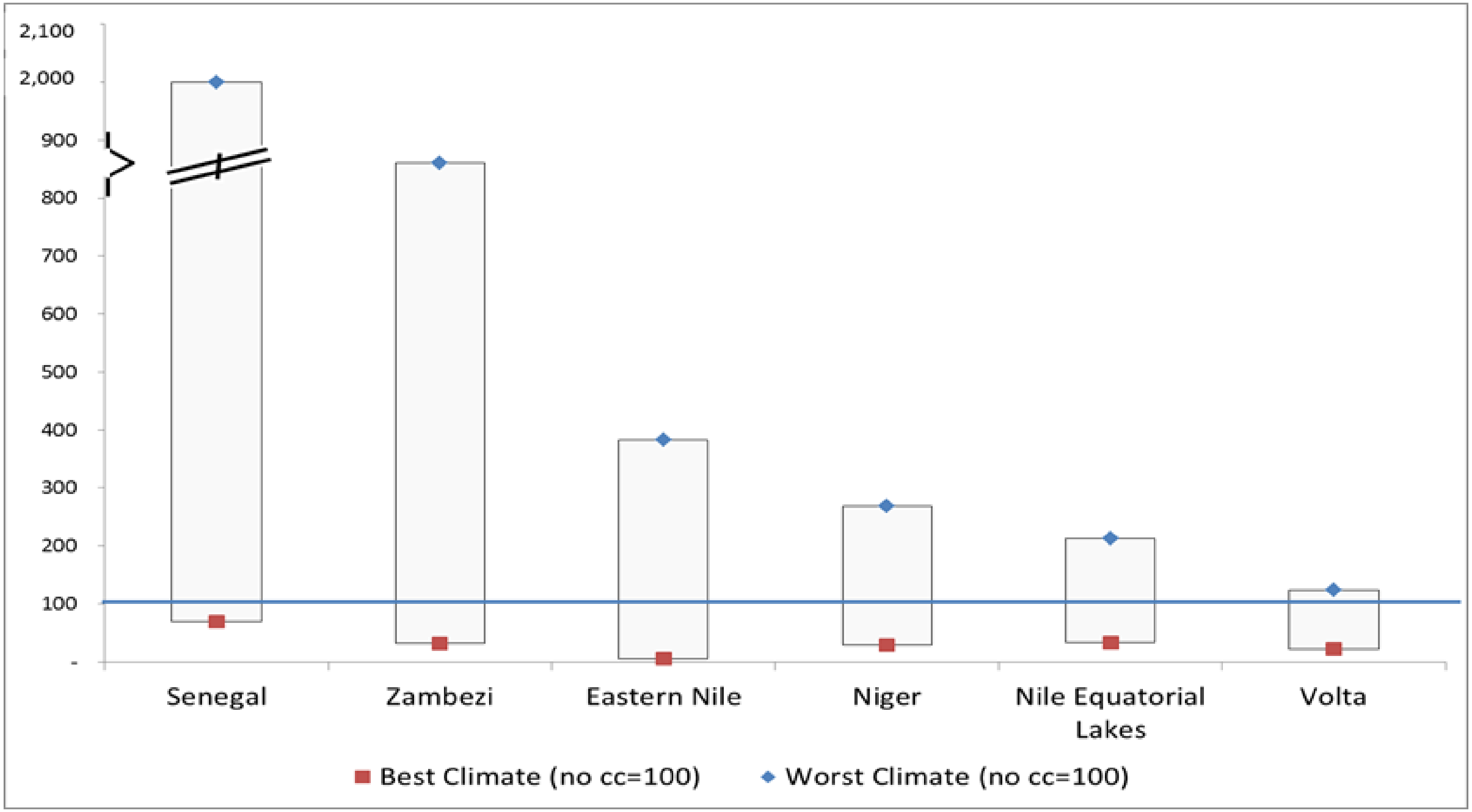
Large impacts on power consumers..

Cumulative consumer expenditure on electricity (no climate change case=100%)



..and on agriculture imports

Cumulative expenditure on agriculture imports (no climate change case=100)



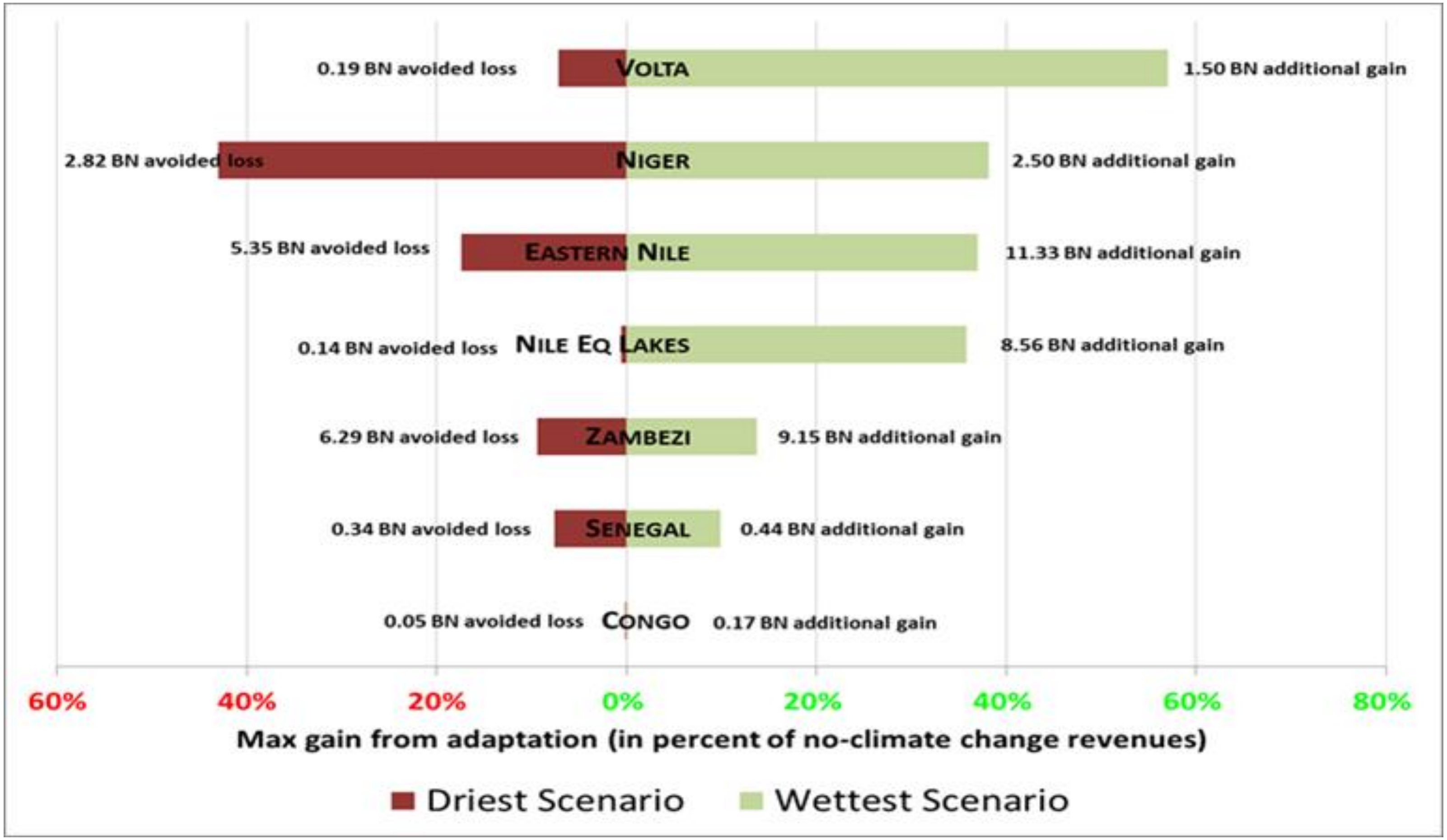
Adaptation

Six adaptation levers

Decision Variable	Range of Lever Modification
Basin Level	
Planned turbine capacity	50%, -25%, 0%, +25%, +50%
Planned reservoir storage	-50% or -25%.
Mean conveyance irrigation efficiency	Improved in increments of 10% from a baseline assumption of 75%, to 85% or 95%.
Farm Level	
Planned irrigated area	adjusted on a continuous basis from -50% to +50%.
Mean deficit irrigation (of water requirements)	deficit irrigation of 30%, 20%, 10%, or 0%.
Mean field-level irrigation efficiency	60% in the Reference case, can be increased to 70% or 80%
Annual crop imports (of total production)	Stop-gap measure

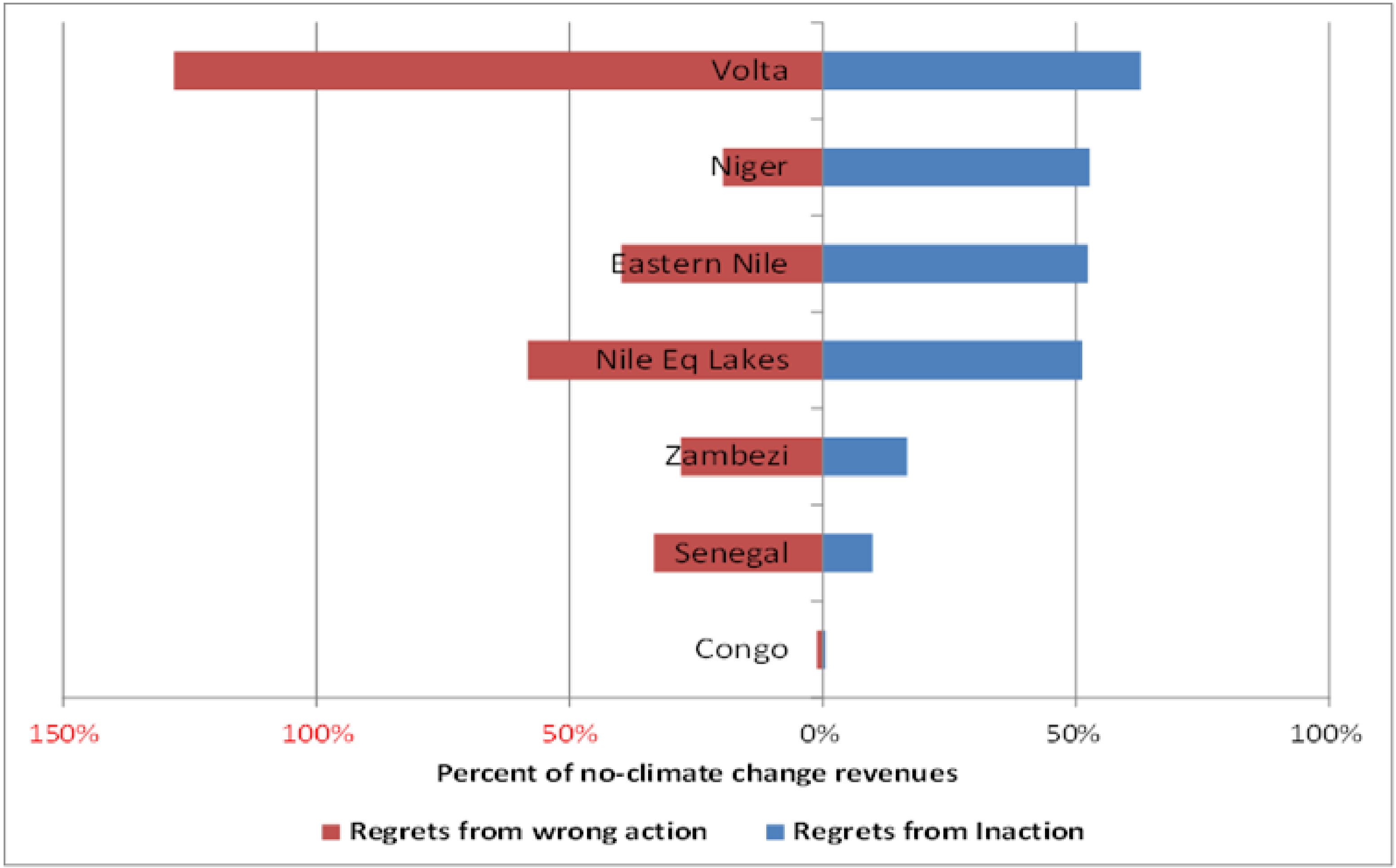
In principle adaptation is attractive…

Gains from perfect foresight adaptation in hydropower



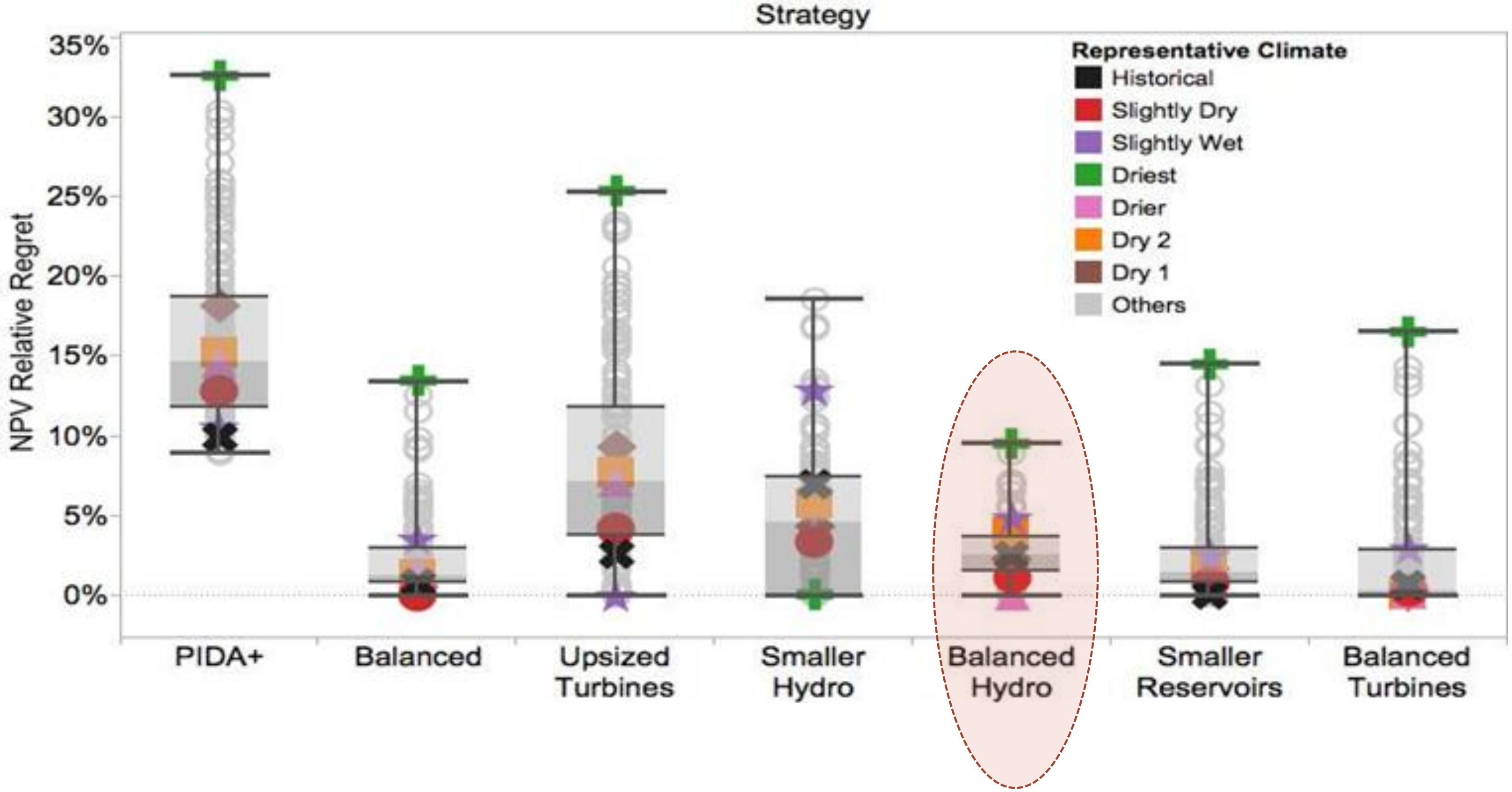
..but it can go wrong if not designed carefully

Damage from not adapting or mis-adapting hydropower expansion plans



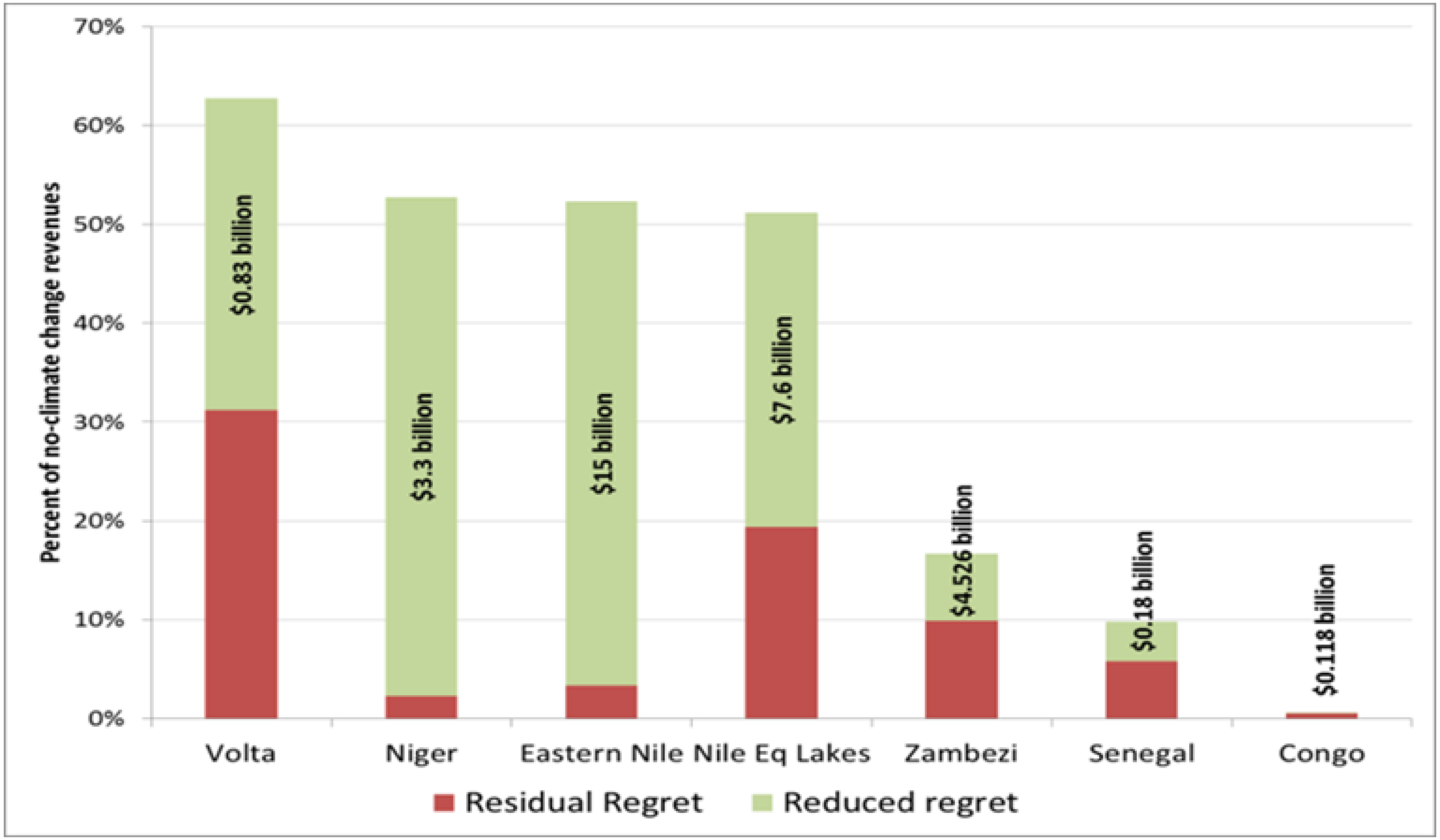
Choosing a mini-max adaptation strategy..

Zambezi basin: Regrets from alternative design options



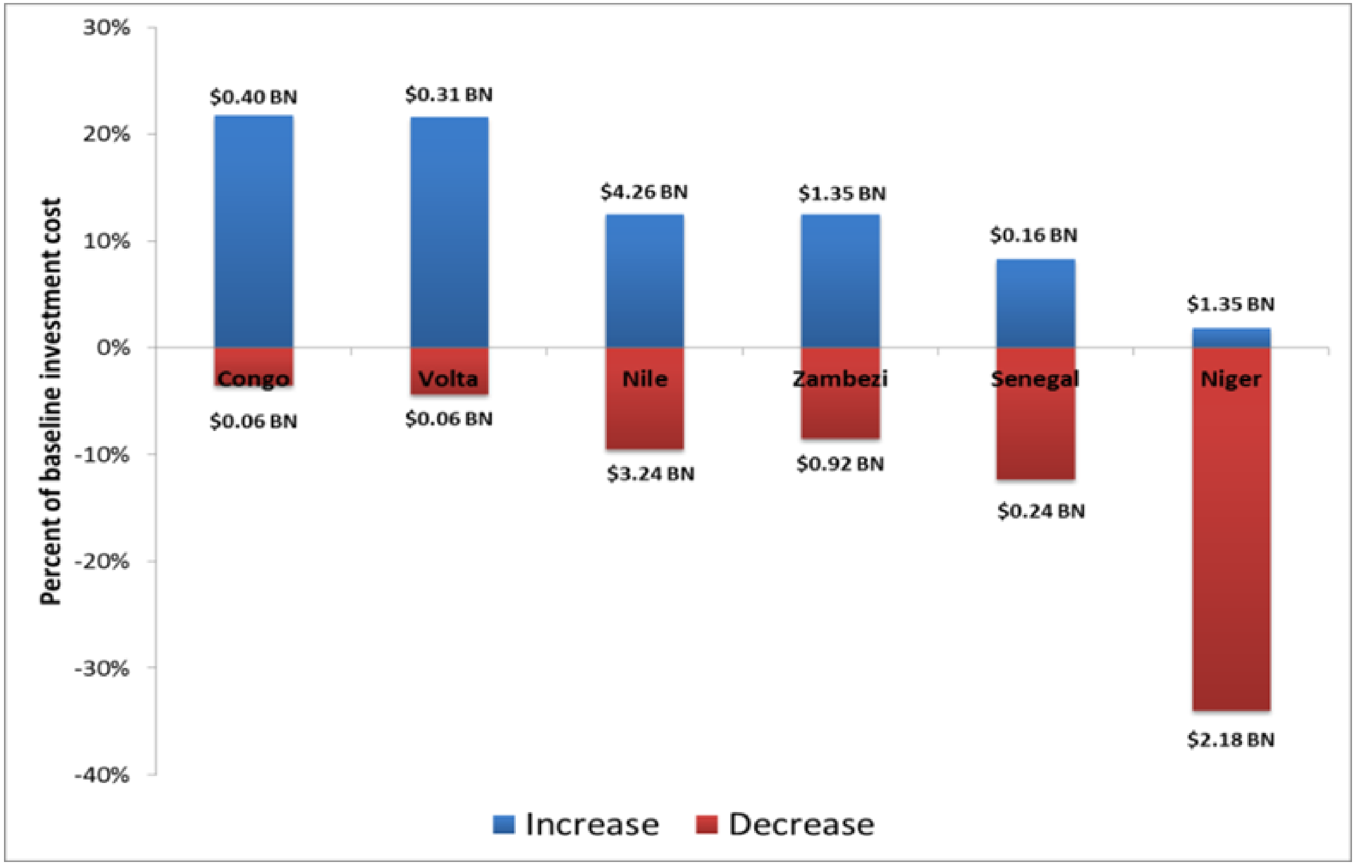
..leads to large reduction in regrets..

Reduced and residual regrets from the mini-max adaptation strategy



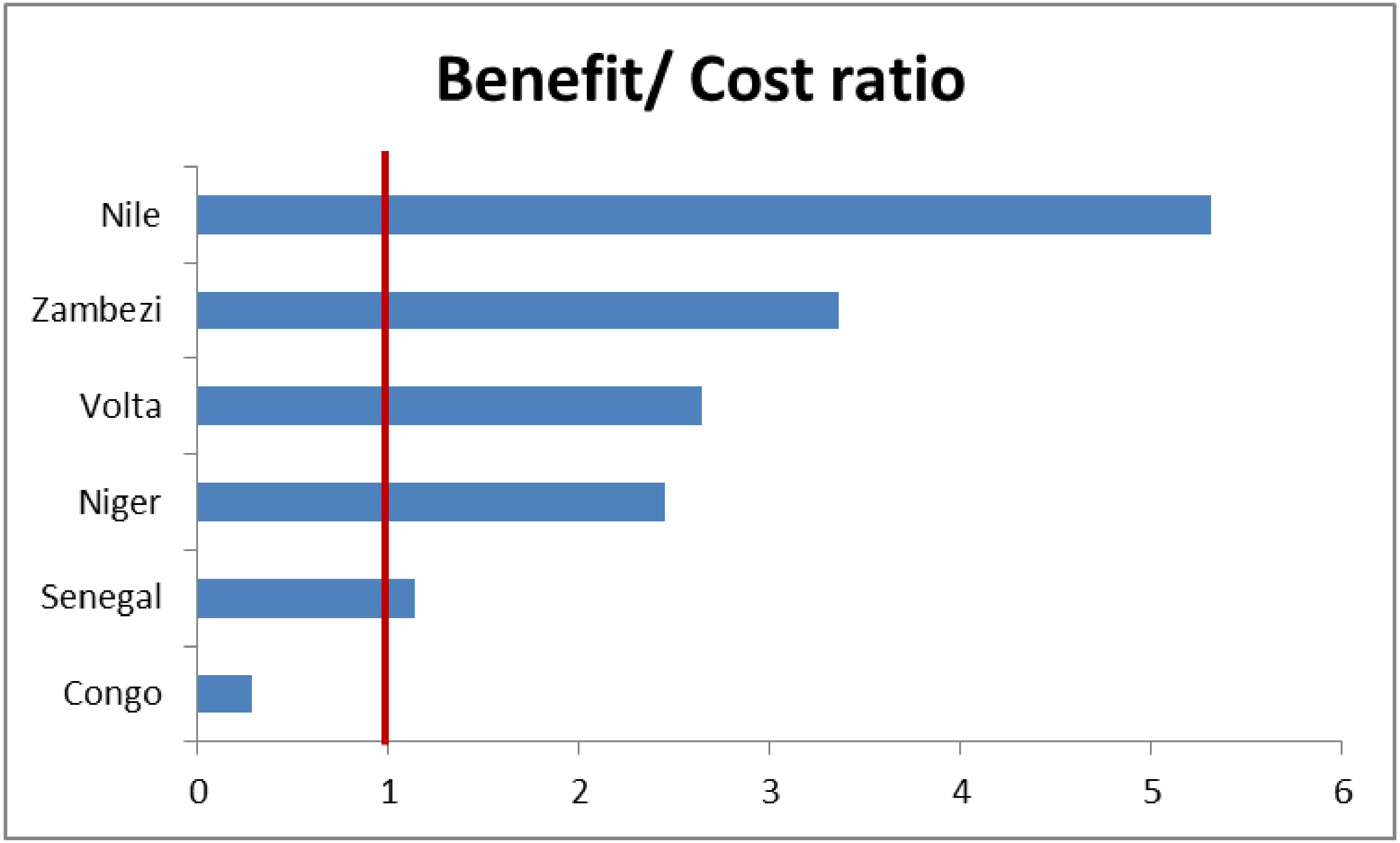
..with both cost increases and savings..

Incremental cost of mini-max adaptation in hydropower



..making adaptation economically worthwhile

Benefit/ cost ratio of mini-max adaptation in hydropower (only considering cost increases)



What does it take to implement the approach?

1. A set of downscaled climate projections
2. A hydrologic model of the relevant region
3. A project design and cost model

Recommendations

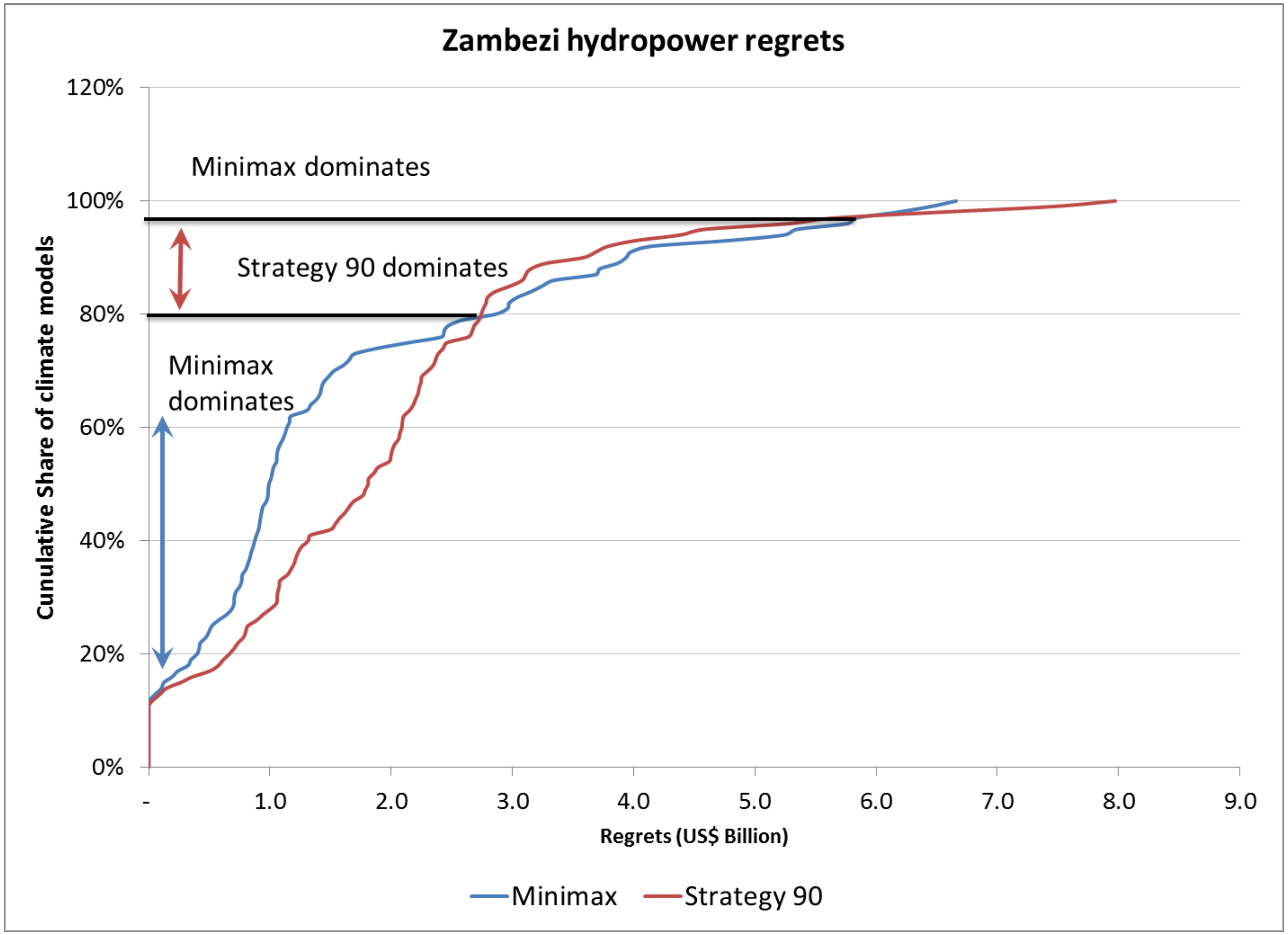
1. Develop technical guidelines on the integration of climate change in the planning and design of infrastructure in climate-sensitive sectors.
2. Promote an open-data knowledge repository for climate resilient infrastructure development
3. Integrate climate resilience into project preparation facilities
4. Launch training programs for climate-resilient infrastructure professionals
5. Set up an observatory on climate resilient infrastructure development in Africa, e.g with ICA

Next steps

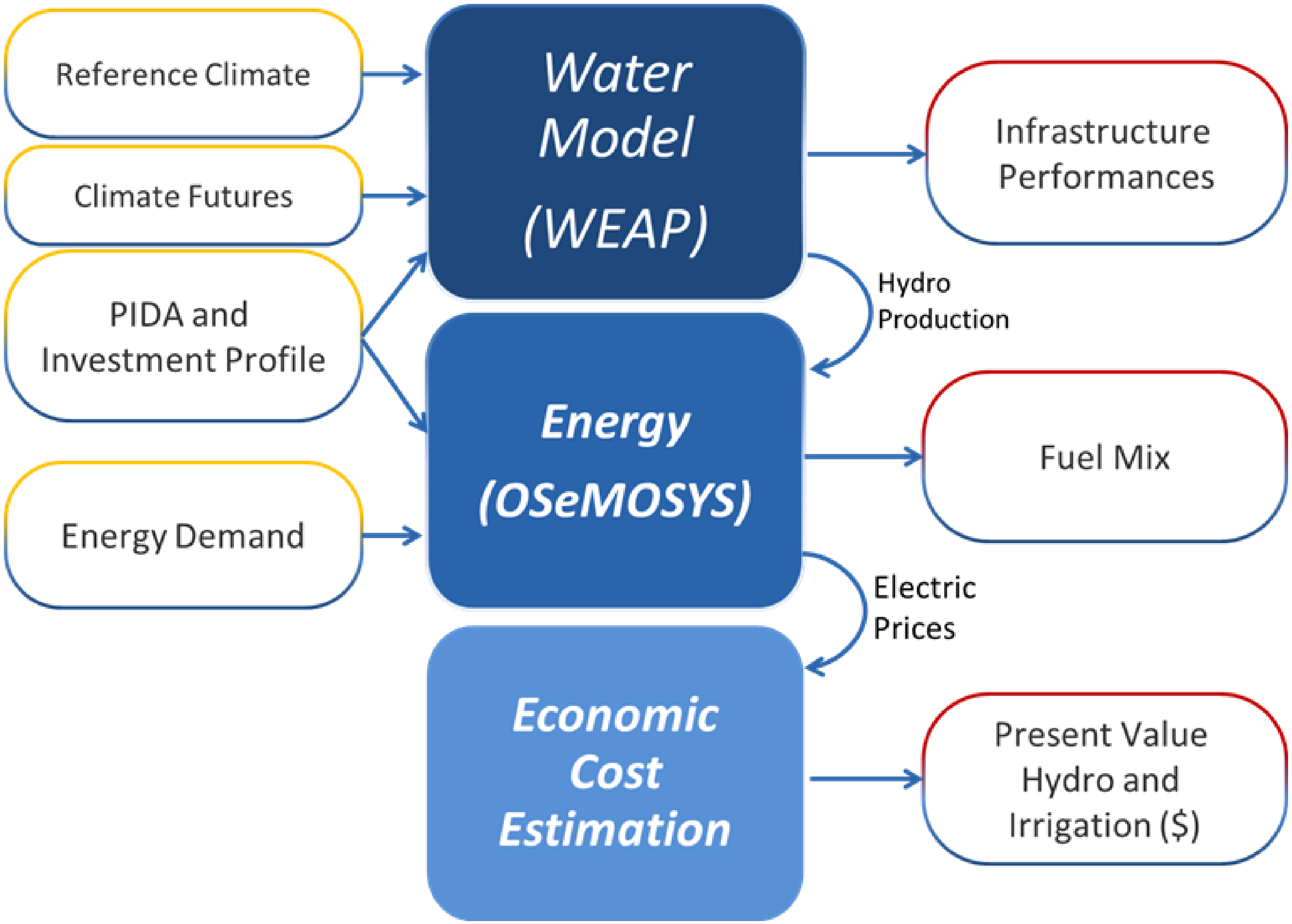
- March/April 2015: expert workshop to be convened with AUC
- April 2015: presentation/ launch, possibly at Africa Climate Resilient Infrastructure Summit (ACRIS)
- May/ June 2015: completion of the road transport component

Annex slides

Method can be used to capture different degrees of risk aversion



Modeling the interaction of climate, hydrology, energy and irrigation systems



Starting points: Africa Infrastructure Country Diagnostic (AICD)…

- Comprehensive overview of current infrastructure status, policy, institutional and financial challenges
- Concludes that Africa needs to spend US$93bn pa to catch-up on infrastructure with rest of developing world
- Estimates made under a "no climate change" presumption