

Research Overview:

International research has focused recently on understanding and addressing development issues directly related to climate change. These costs are required to assist in the adaptation to and the mitigation from the effects of climate change. While costs are a concern for all countries, these costs are of particular concern in developing countries, where the additional funds needed to address climate change concerns are limited or non-existent. The limitations on these available funds are challenging developing countries to identify the threats that are posed by climate change, develop adaptation approaches to the predicted changes, incorporate changes into mid-range and long-term development plans, and secure funding for the proposed and necessary adaptations (UNFCCC 2009, UNFCCC 2010). The alternative to this proactive planning is the potential for climate change to significantly impact the social fabric of communities, where individuals may be required to consider change that will impact standards of living to an extent as to require relocation. Earlier work by the UNFCCC, IPCC, World Bank and others, have attempted to quantify the impact of climate change on physical assets that will be affected in the coming decades. iCLiCS research extends these efforts by addressing the effect of climate change on the road infrastructure and examines the extent to which climate change from climate scenarios will divert resources from the further development of road infrastructure to the maintenance and adaptation of the existing infrastructure. Roads are of specific importance for analysis in the developing world because of the smaller existing networks that exist in the countries in comparison to other parts of the world. The iCLiCS research is designed to create a broader understanding of the effect climate change may have on facets of development including social, economic, and transport issues by analyzing quantitatively the impacts on assets including: road infrastructure and buildings.

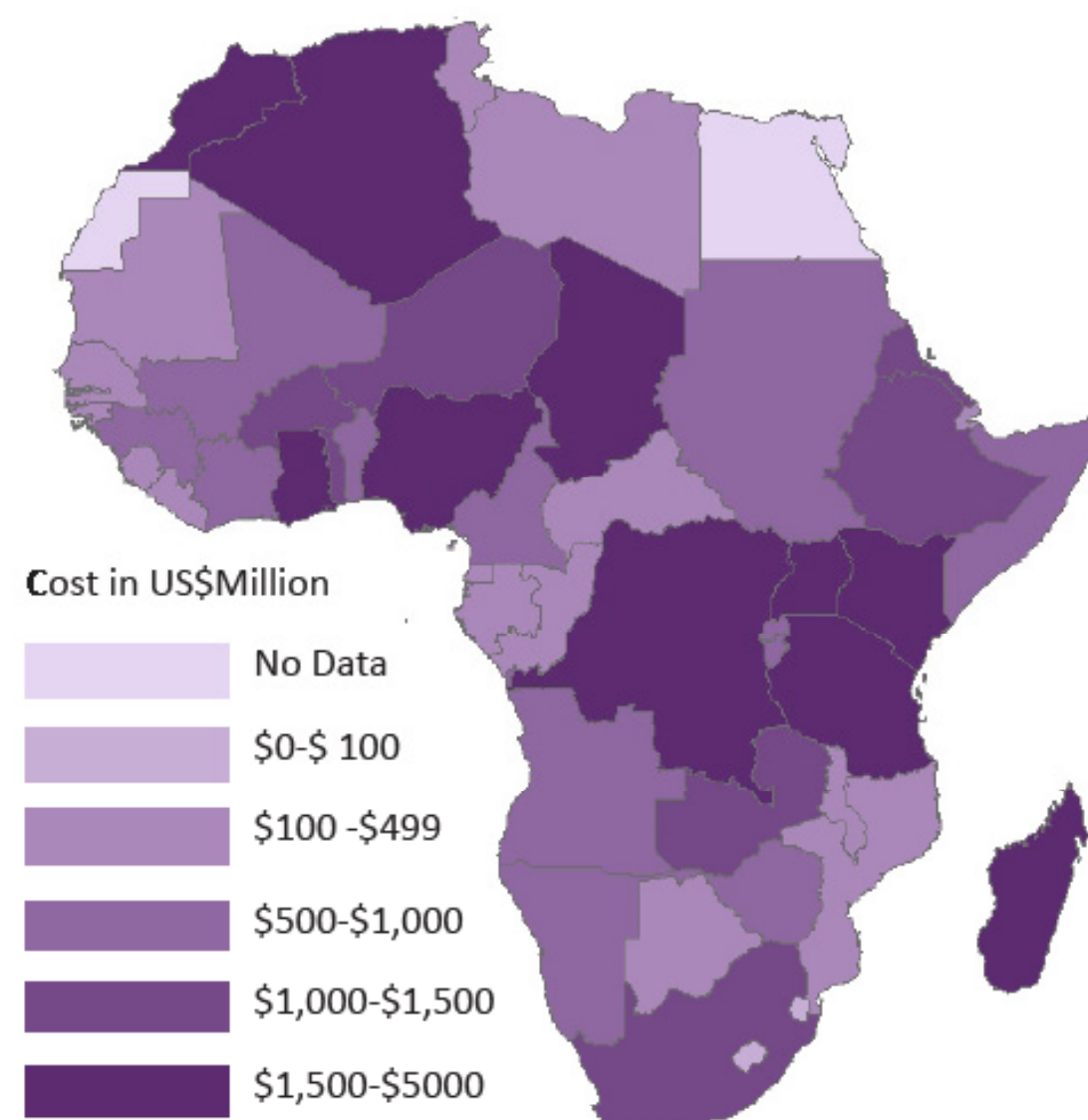
Climate Change Impacts on Road Infrastructure: Africa

The impacts of climate change vary widely depending on several factors, including: existing inventory of paved, gravel and unpaved roads, topography, and the projected climate changes in flooding frequency and severity, precipitation and temperature. Policy choices are evaluated for impact: Pro-active (perfect foresight) "Adapt" policy where designs that are climate resilient are constructed, and "No Adapt" policy where current design standards are continued through 2100 despite changing climatic conditions.

Total Cost

Total Cost is the cumulative annual cost of additional O&M and construction costs attributable to climate change impacts. Assumes existing roadstock and USD\$ costs.

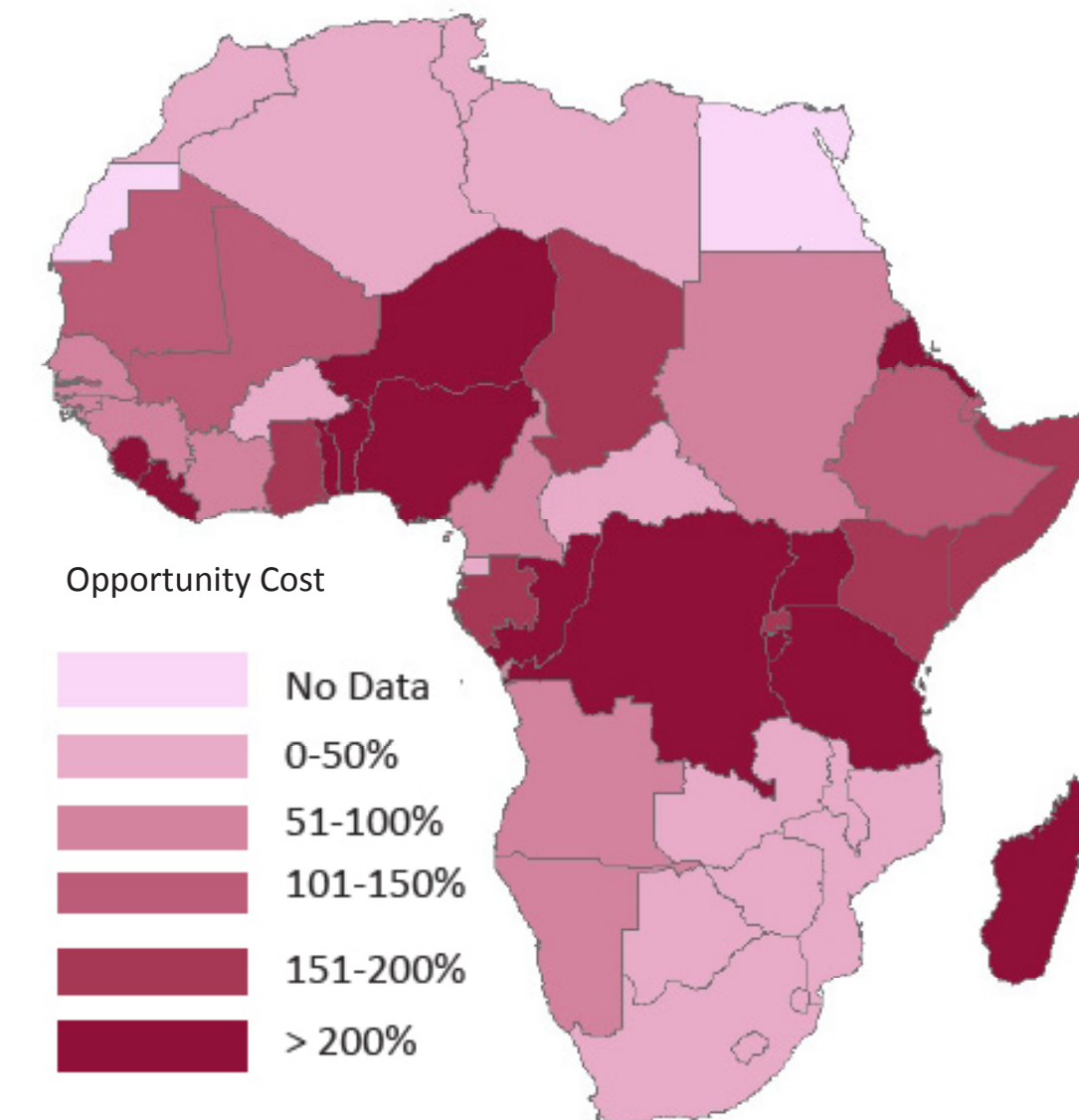
Total Cost: 2020-2100 (Adapt)



Opportunity Cost

Opportunity Cost refers to the percent of new, secondary paved roads that could be built if money was not diverted to climate change costs for O&M of existing roads.

Total Opportunity Cost: 2020-2100 (Adapt)



Calculating Opportunity Cost:

$$OCx = (CCx / SRCx) / PRx$$

Where:

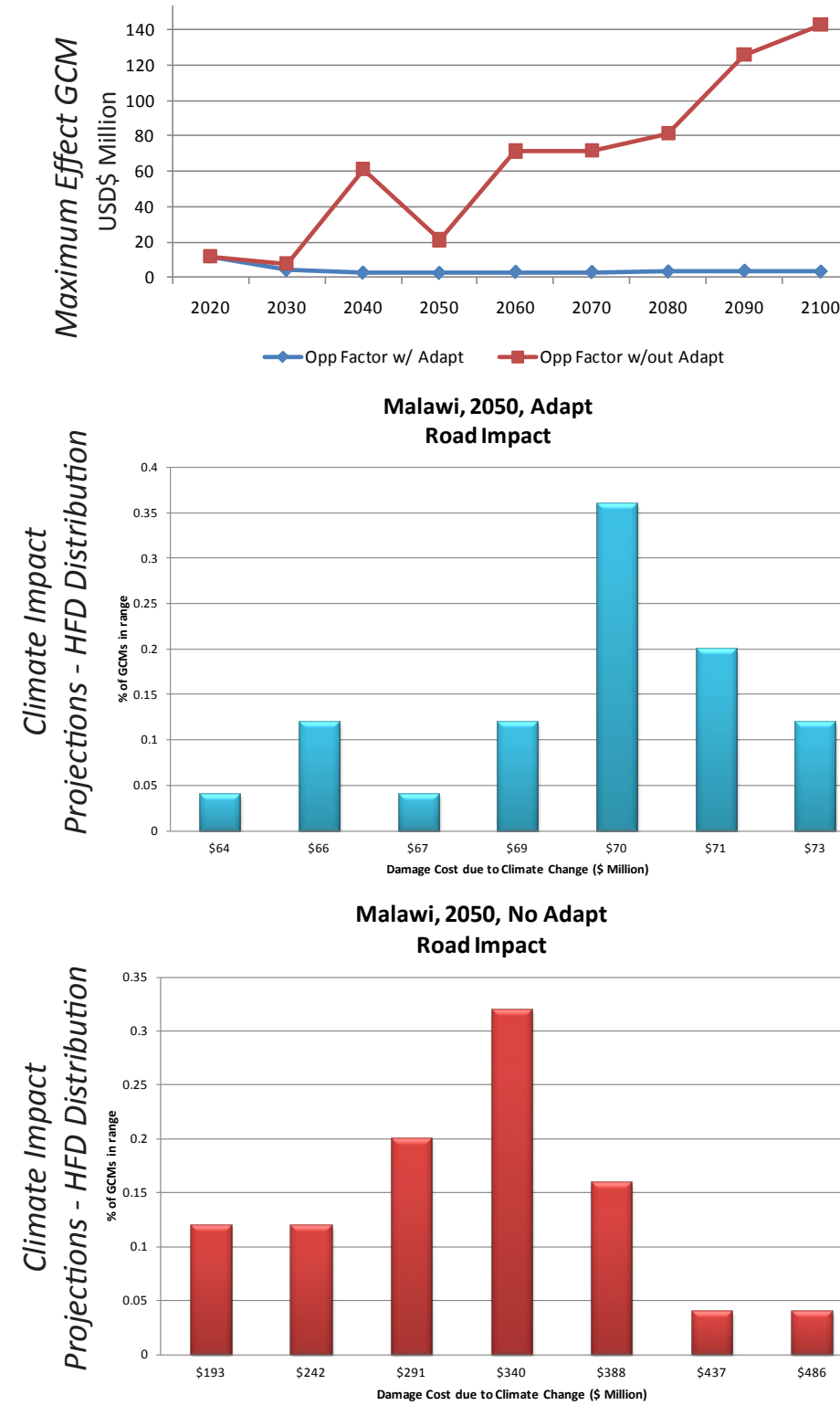
- X: A specific country
- OC: Opportunity cost for a country in percentage
- CC: Total estimated climate change cost for a country including both maintenance and new costs through 2050
- SRC: Cost of constructing a kilometer of new, secondary paved road
- PR: Current paved road inventory within a country in kilometers

Regional Comparison:

Below, the Total Cost under 'Adapt' scenario between Zambia and Mozambique is significant: \$384 million/year. However, the Opportunity Cost in Mozambique is 101%, compared to a OC in Zambia of 60%.

Country	Planning Approach	Total Cost (millions USD)	Opportunity Cost	Kilometres Lost
Malawi	Adapt	156	38%	2,660
	No Adapt	190	71%	4,960
Mozambique	Adapt	355	101%	5,760
	No Adapt	186	83%	4,720
Zambia	Adapt	739	60%	12,100
	No Adapt	547	66%	13,320

Malawi - Policy Comparison



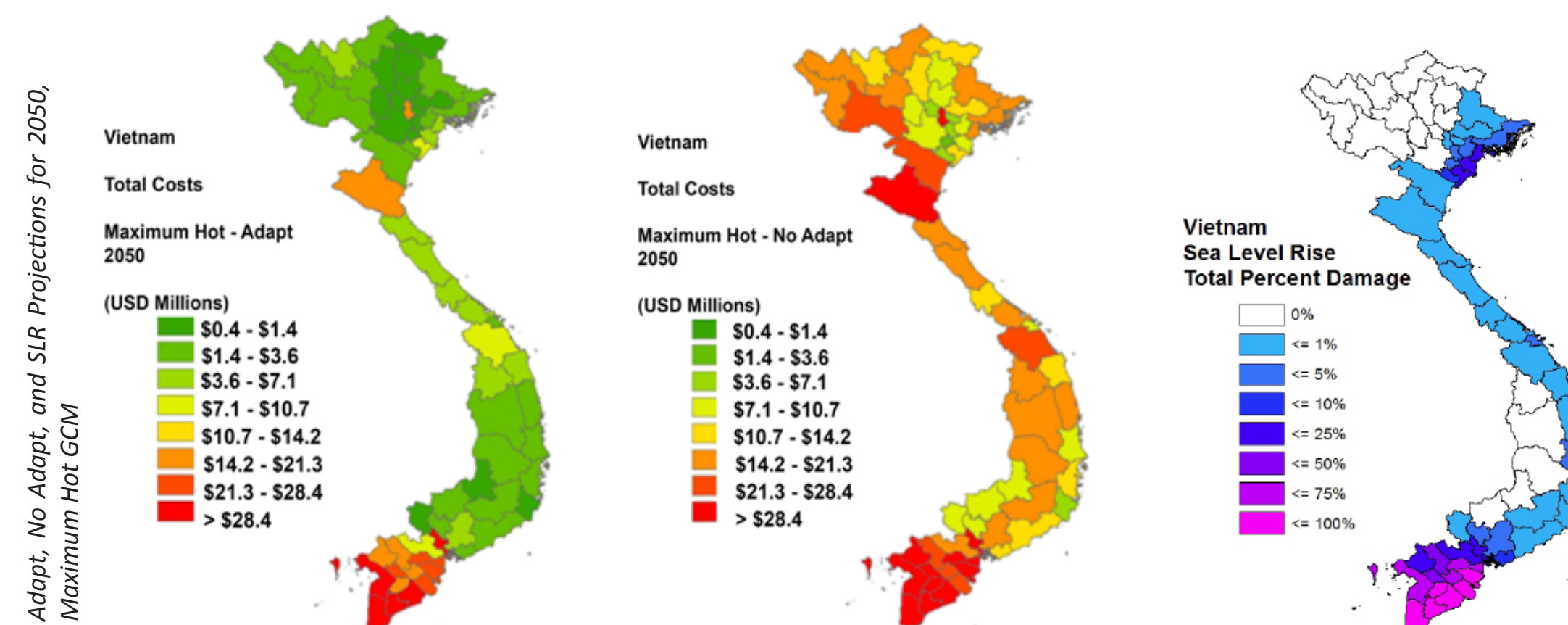
Sea Level Rise & Road Infrastructure: Vietnam

Background:

Projections on the amount of sea level rise that will occur in a specific region are uncertain and vary widely. Some recent studies have predicted a future SLR higher than 1m by 2100 (Nichols and Cazenave, 2010). The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) published in 2007 predicts an average of 60 cm by 2100 (IPCC 2007). However, it is widely believed that the SLR will not be uniform throughout the world and certain areas will be affected at much greater levels than others (Neumann, et al 2007).

Vietnam:

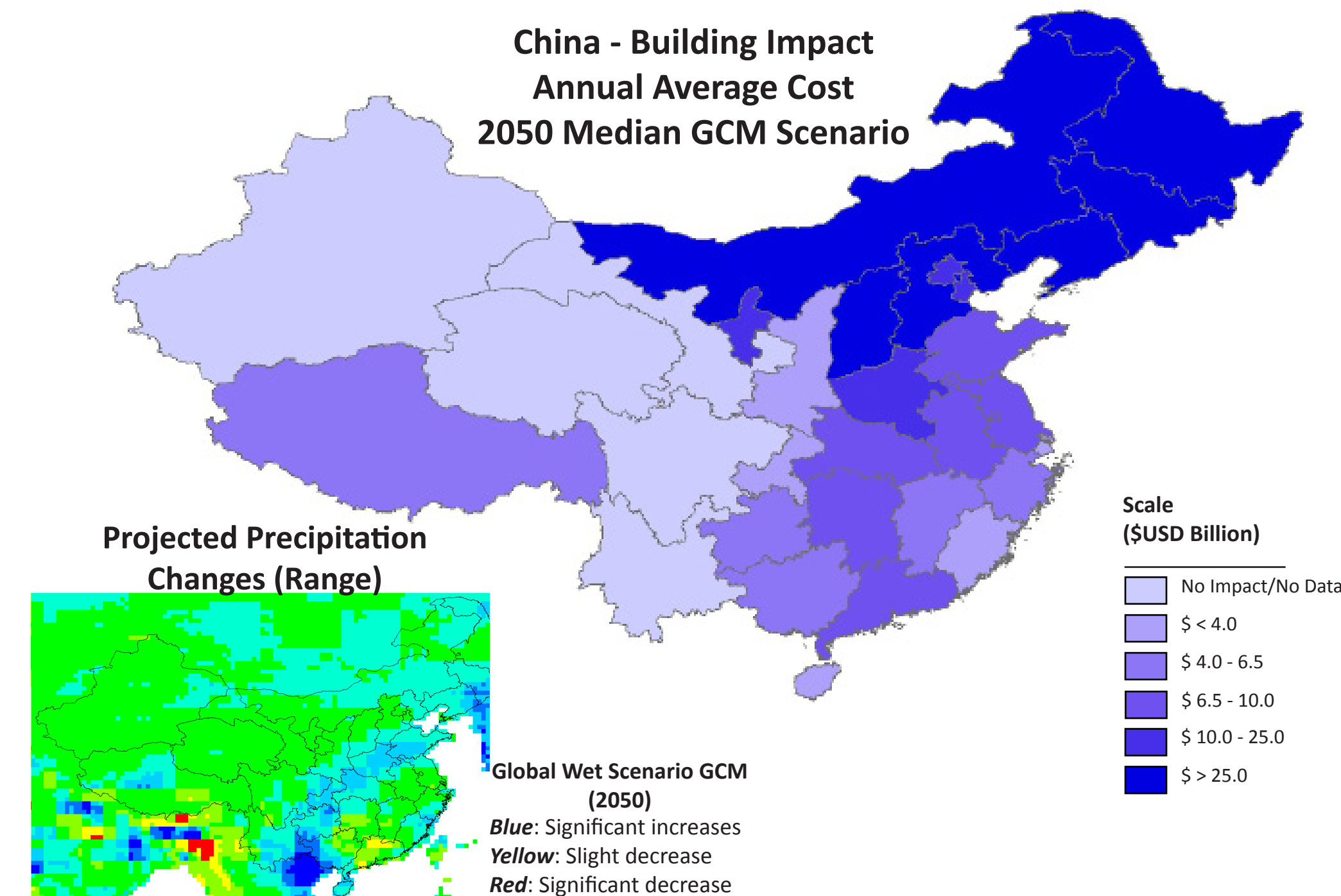
A sea level rise of 1 meter will affect the existing estimated road infrastructure in Vietnam at an extent of 19,000 KM of road infrastructure inundated and destroyed; just under 12% of existing road infrastructure. This is a cost of approximately USD\$297 million in 2050 discounted dollars to replace the inundated infrastructure (Table 6). The projected sea level rise is distributed unevenly, with the majority of damages affecting coastal regions in the Southern part of the country. There are several provinces where a complete inundation is projected, resulting in a loss of at or near 100%. These include Bac Lieu, Hau Giang, Soc Trang, Tra Vinh and Ca Mau.



Buildings & Climate Impact: China

Climate change impacts are projected on the existing building stock to estimate the costs. Buildings are divided into two categories: Wooden and Non-Wooden Structures. Increased precipitation and/or temperature increases the rate of decay for wooden structures, lessening the lifespan. Non-Wooden Structure impacts are seen in the increased precipitation load for roofing and in mandatory upgrading of HVAC systems to ensure interior climate health.

China - Building Impact Annual Average Cost 2050 Median GCM Scenario



About:

Institute of Climate and Civil Systems

The Institute of Climate and Civil Systems (iCLiCS) is a group comprised of interdisciplinary researchers focusing on the effects of climate change on civil systems, including infrastructure components such as roads and buildings. The iCLiCS goal is to develop analysis methods that will allow a more quantitative analysis and understanding of how climate change may impact current and future infrastructure. This will allow more informed decisions to be made regarding the vulnerabilities of infrastructure to climate change.

Publications in:

- IPCC 5th Assessment Report (2012)
- Global Environmental Change
- Climatic Change
- Review of Development Economics
- Engineering Project Organization Journal
- Economics of Adaptation to Climate Change (World Bank Report)