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Cross-border climate impacts and systemic risks in Europe and beyond
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"Differential Fiscal Performances of Plausible Disaster Events
A storyline approach for the Central American and Caribbean
Governments under CCRIF"

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ReCeipt

Introduction

- The **government** is usually seen as one **key risk bearer**, both for public and private losses, and is expected to be responsible to assist and support a **fast recovery of the economy**.

- Therefore, **fiscal resilience** is an important dimension as urgent liquidity is vital for humanitarian aid and the recovery process **as without swift access to available funds** for disaster relief, damages to human and the economy would be further exacerbated because of lacking necessary logistics and slow.

- To **enhance fiscal resilience** various options are available to governments, including setting up reserve funds, contingent credits, emergency loans or insurance

- Recognizing the potential benefits of a climate storyline **approach we developed and applied a corresponding framework to the Caribbean and Central Amer**ica (CCA) region to analyze the **fiscal performance** of local governments due to **cyclone risk and potential benefits of insurance**.

- The area was chosen as it is one of the most vulnerable regions to tropical cyclones and saw the establishment of the first **multi-country risk pool in the world, namely the Caribbean Catastrophe Risk Insurance Facility** (CCRIF).

CCRIF: Caribbean Catastrophe Risk Insurance Facility
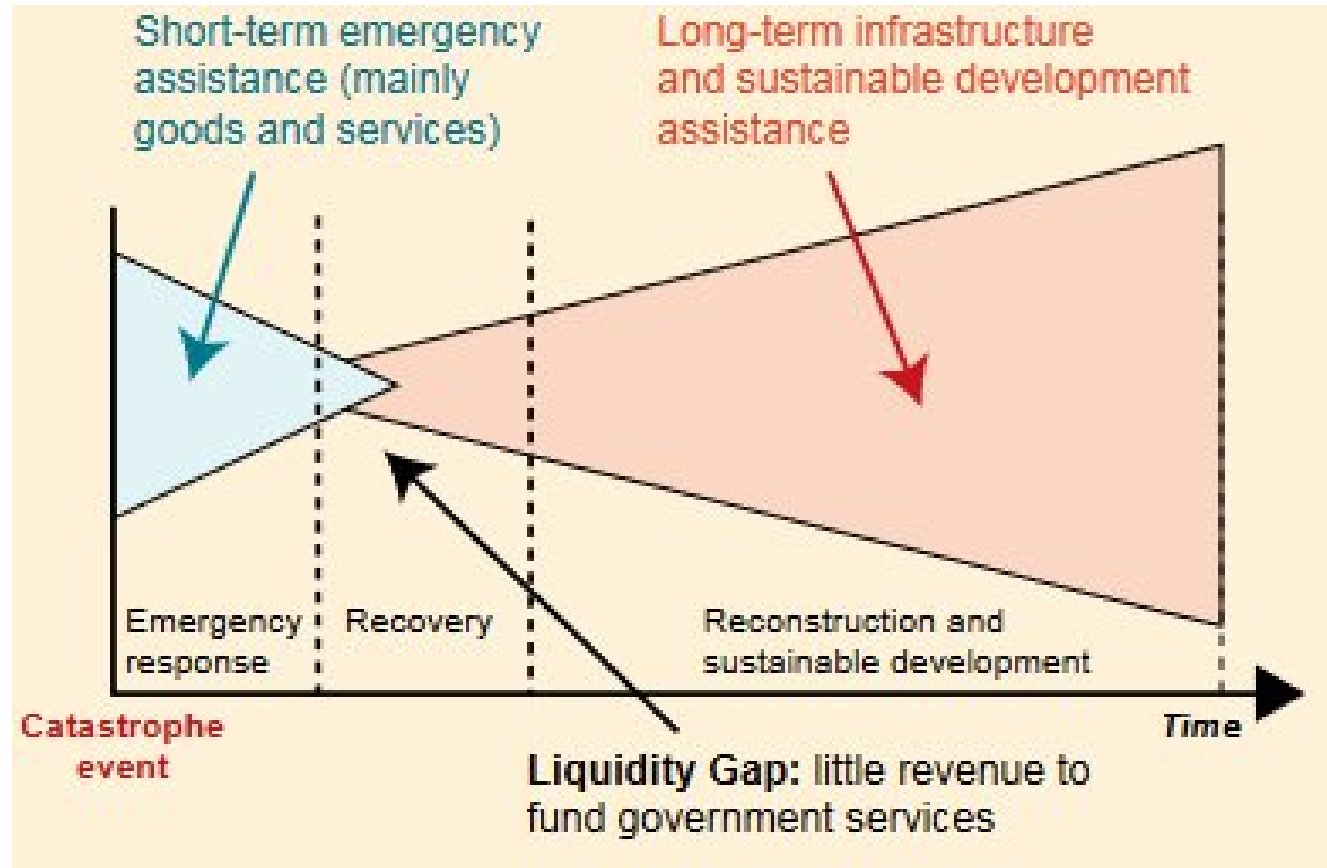
The liquidity gap and the different phases of recovery (CDKN 2012).

Fiscal Performance

- We specifically focus on possible **liquidity gaps of governments within the Caribbean region**, i.e. not having enough resources to address all emergency related losses,

- Their **consequences on fiscal performance** over time and the effect of CCRIF on these fiscal effects.
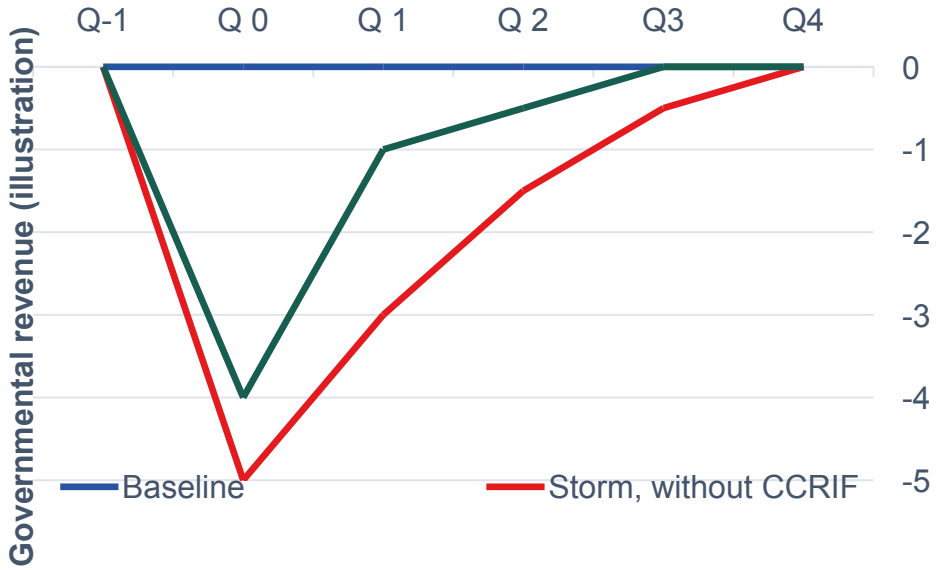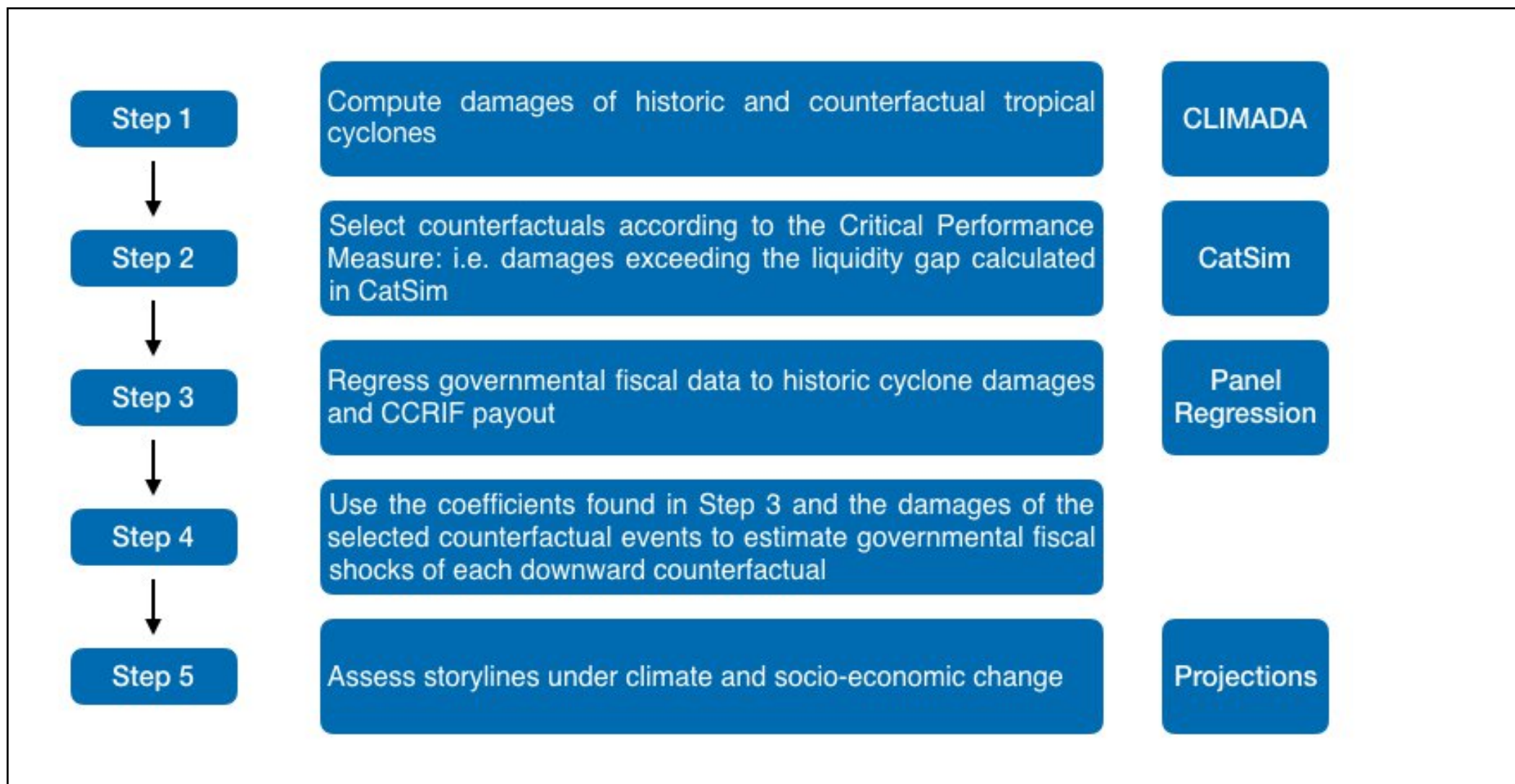

Illustration of hypothetical volatility of governmental revenue; seasonal and annual trend removed; storm hits in Quarter 0; red curve represents a virtual non-CCRIF countries; green curve a CCRIF member.

Can we find empirical evidence that this fast-financing source counteract fiscal shocks and connect it with a storyline approach?

- Caribbean governments affected from **short-term fiscal stress after storms**, e.g. damaged tax bases and corresponding decrease in **revenue**, increase in **expenditure** due to disaster relief and increase in **debt**.

Methodology

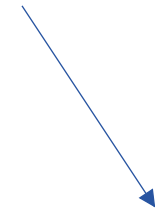| Step 1 | Compute damages of historic and counterfactual tropical cyclones | CLIMADA |
Step 2	Select counterfactuals according to the Critical Performance Measure: i.e. damages exceeding the liquidity gap calculated in CatSim	CatSim
Step 3	Regress governmental fiscal data to historic cyclone damages and CCRIF payout	Panel Regression
Step 4	Use the coefficients found in Step 3 and the damages of the selected counterfactual events to estimate governmental fiscal shocks of each downward counterfactual	
Step 5	Assess storylines under climate and socio-economic change	Projections

Climate Storylines

- Combinations of counterfactuals may represent what Shepherd et al. (2018) define as storylines:
  - *a physically self-consistent **unfolding of past events**, or of **plausible future events** or pathways.*
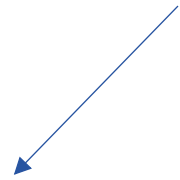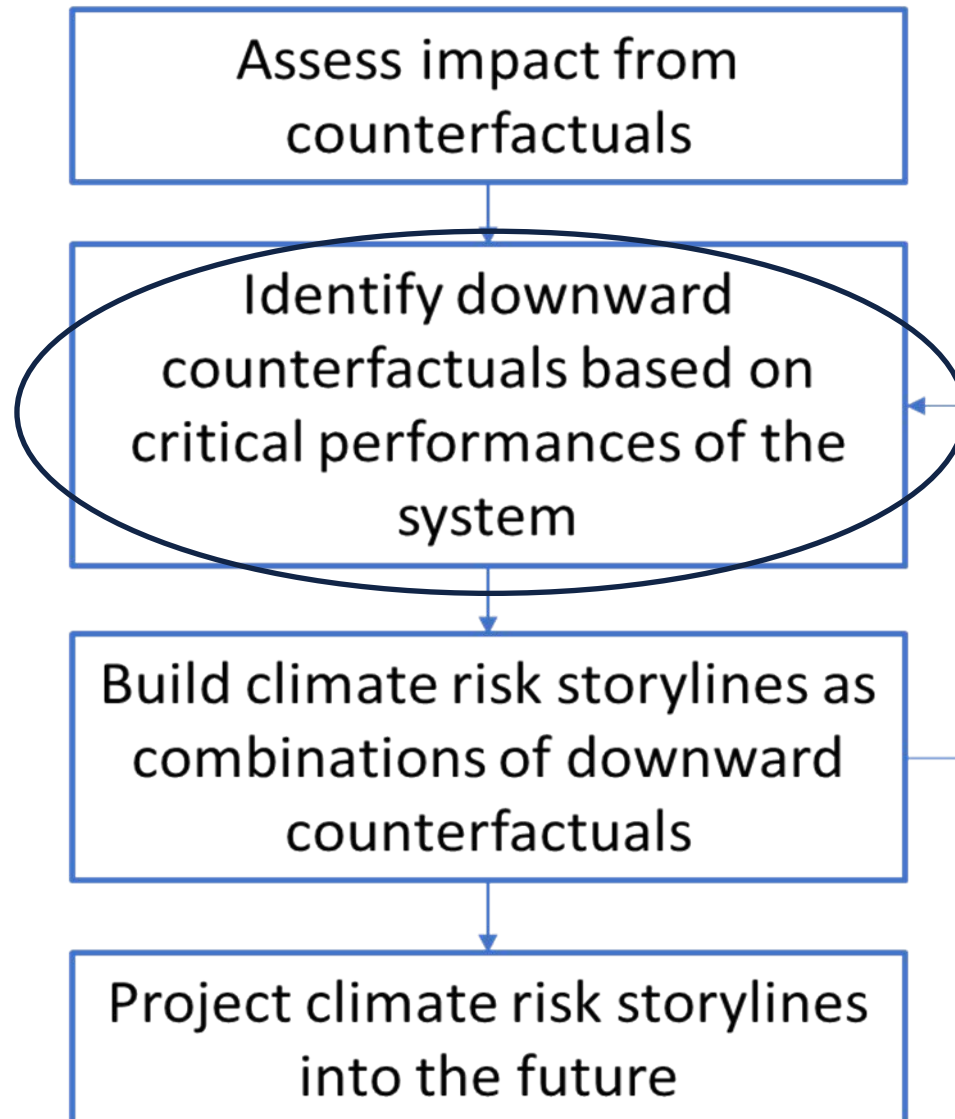
Counterfactuals

Scenarios

Counterfactuals refer to alternative pasts, i.e., events that may have occurred but did not. **Downward** counterfactuals refer to events which **may have turned worse** than actually did (Roese 1999).

How to Select Climate Storylines

Assess impact from counterfactuals

Identify downward counterfactuals based on critical performances of the system

Build climate risk storylines as combinations of downward counterfactuals

Project climate risk storylines into the future

- Counterfactuals are given by forecasts; by definition, plausible alternative realizations of past weather events

- Iterative: it fosters participation and engagement
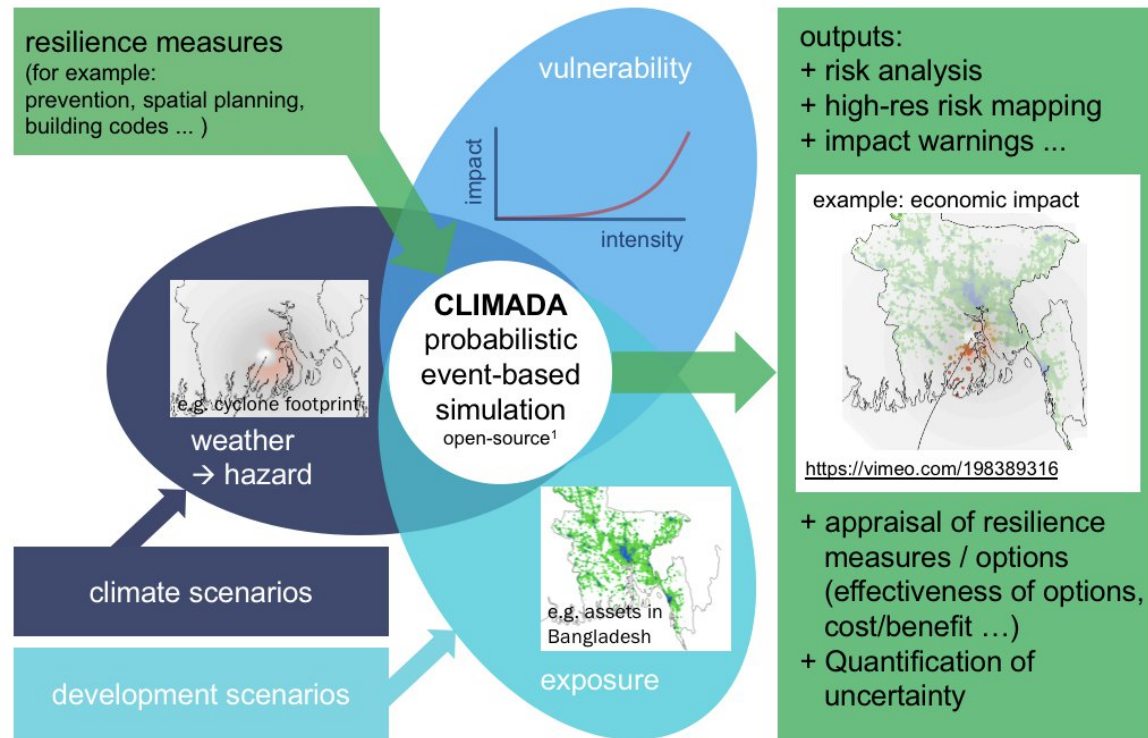
- It focuses on impacts and plausibility

- **Step 2:** Critical performance if resources of governments are not enough to cope with all losses it is responsible for. CatSim approach.

Introduction: How to include Climate and Global Change
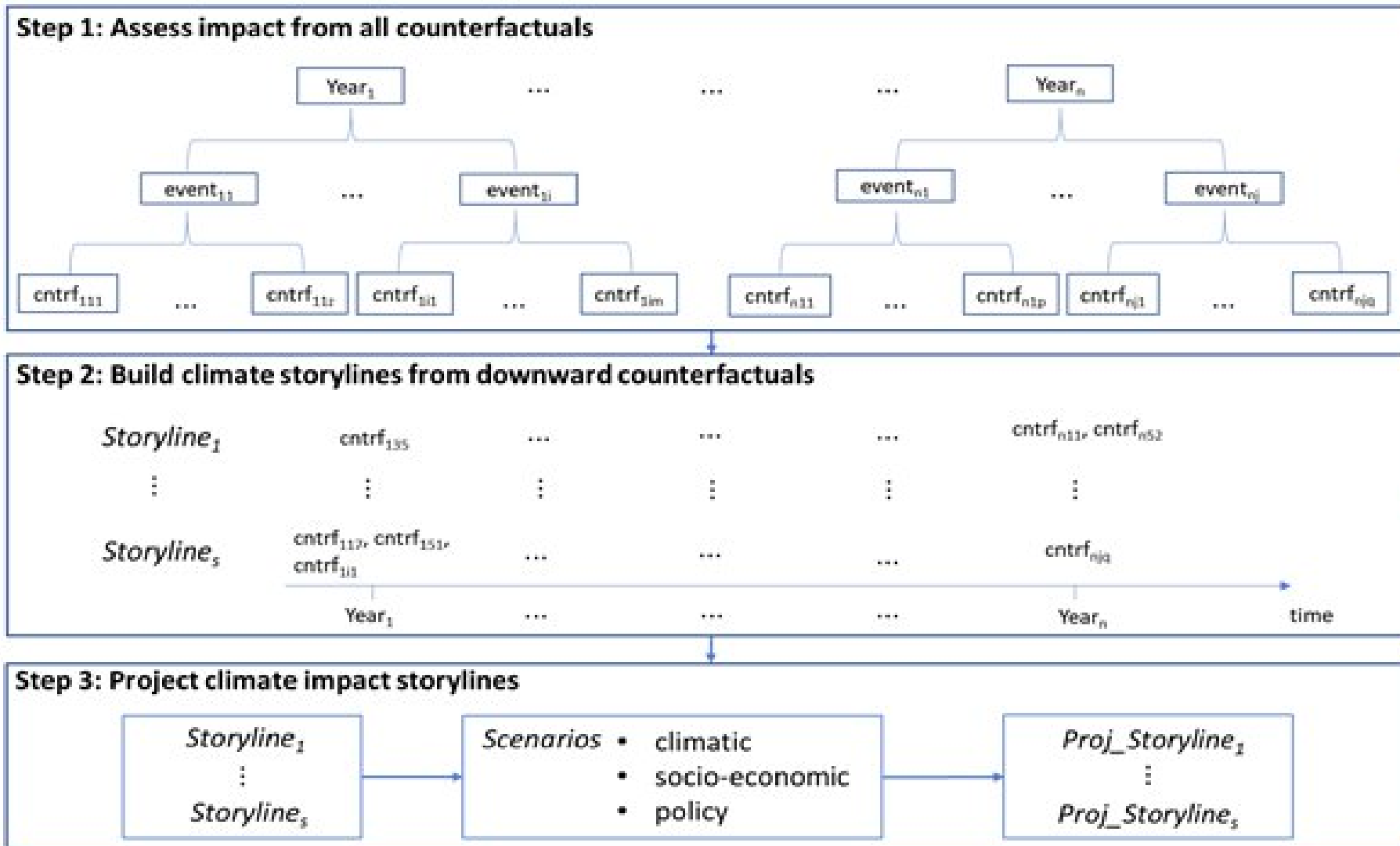
Cat-Model and Empirical Analysis

Step 1: Storm damage model applied in CLIMADA

$$damage = f(hazard, exposure, vulnerability) = exposure \times f\_imp\,(hazard)$$

Step 2: Panel Regression model

$$\frac{fiscal\_var_{i,t}}{GDP_{i,t}}$$
$$= \rho \cdot \frac{fiscal\_var_{i,t-1}}{GDP_{i,t-1}} + \alpha_i + \sum_{l=0-4} \beta_1^l \cdot Damage_{i,t-l} + \sum_{l=0-4} \beta_{i,2} \cdot CCRIF_{i,t-l} + \gamma Q_i$$
$$+ \lambda Q_{i,t} + \theta Yt + \varepsilon_{i,t}$$

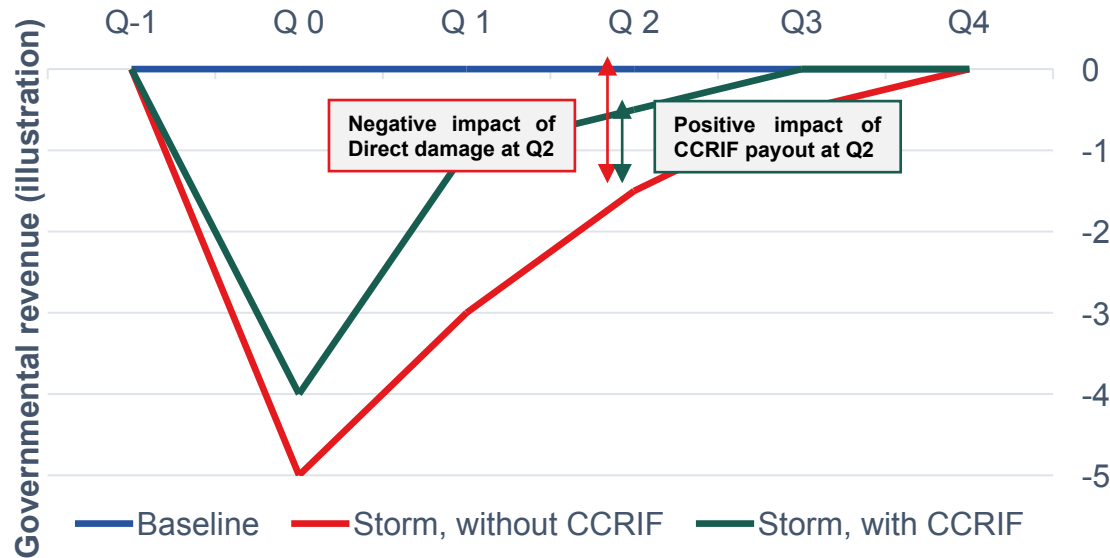Q: country-specific quarter dummies to account for the seasonality
λQ: a country-specific linear deterministic time trend
θY: year fixed effects that capture unobservable global trends
ε: the error term.

Country specific data on a quarterly basis from 2007 till 2021 used.

Impact of every $ hurricane damages and CCRIF payout on governmental revenue, newly raised debt and expenditure each quarter (compared to baseline level of that quarter) after the storm

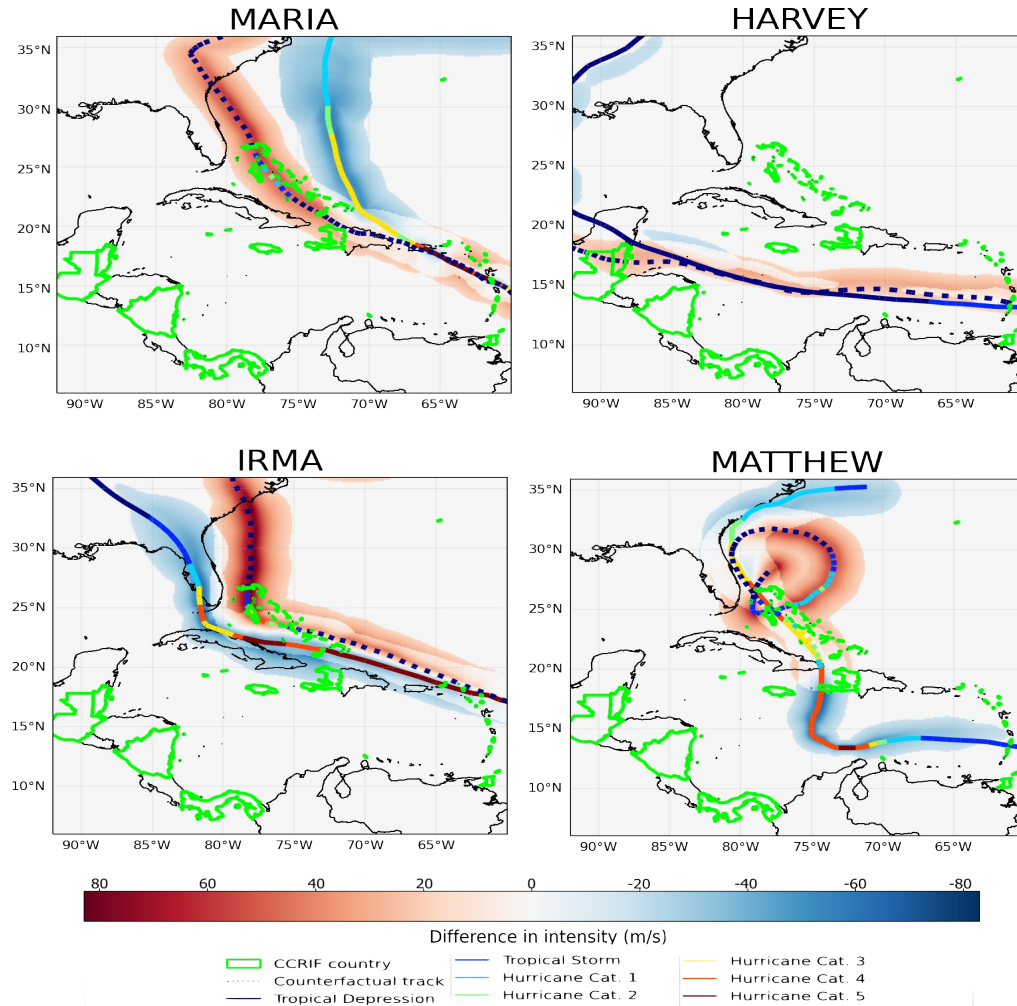| VARIABLES	Impact at different time (the quarter of the storm is Q0)	Current revenues	Newly raised debt via external grant	Current expenditure
Direct damage	Q0	-0.0151*	0.0144***	-0.0181***
	Q1	-0.0116	0.0401**	0.0131***
	Q2	-0.0102**	0.0277***	-0.0250***
	Q3	0.00339	0.0297***	-0.0119***
	Q4	0.00923	0.0206***	-0.0061
	Sum of impact over a year (include only values with *)	-0.0102	0.1325	-0.0419
CCRIF payout	Q0	0.317	-0.641***	0.491***
	Q1	-0.00845	-1.502***	-0.152
	Q2	0.353**	-1.055***	0.787***
	Q3	1.986***	-1.143***	0.945***
	Q4	-0.935**	-0.848***	-0.0785
	Sum of impact over a year (include only values with *)	1.404	-5.189	2.223

CCRIF payout functioned more than an extra funding

- o **lowered** the loss of revenue

- o **brought down** the reliance on external grant after storms

- o accelerated **economic recovery**

Storyline name	Counterfactuals developed from	Historical storm happened in
Extreme Quarter (EQ)	Maria	3rd quarter of 2017
	Irma	3rd quarter of 2017
	Harvey	3rd quarter of 2017
Consecutive Quarters (CQ)	Gascon	3rd quarter of 2016
	Karl	3rd quarter of 2016
	Matthew	4th quarter of 2016

The first storyline, named "Extreme Quarter" (EQ), involves downward counterfactuals of Storm Maria, Harvey and Irma in 2017. the counterfactuals not only hit more countries, but also became stronger. This results in higher damages.

The second storyline features Consecutive Quarters. construction of a counterfactual storm season with two storms in the third quarter (Gaston and Karl), and one in the fourth quarter (Matthew)

Historical (solid line) and counterfactual storms (dashed line) in the Caribbean region, the color shows the difference of wind speed between the counterfactual and the historical storm.

Results: Damages, CCRIF and CC Impacts

Historical or Storyline	Time	Damage (billion $)
	3rd Quarter 2017	12.87
Historical	3rd Quarter 2016	0
	4th Quarter 2016	31.88
EQ (current climate conditions)	Based on 3rd Quarter of 2017	60.04
CQ (current climate conditions)	Based on 3rd Quarter 2016	6.66
	Based on 4th Quarter 2016	64.24
EQ (10% intensity increase)	Based on 3rd Quarter 2017	89.51
CQ (10% intensity increase)	Based on 3rd Quarter 2016	10.58
	Based on 4th Quarter 2016	82.69

Damages of the two selected storylines under current climate and RCP8.5

Change of wind speed and asset value in each future climate change scenario. Data extracted from the Shared Socio-economic Pathways (SSPs) and Representative Concentration Pathways (RCPs)

Climate change scenarios	Change of cyclone intensity of selected counterfactuals	Change of asset value of all CCRIF countries
Failed Paris	+10% (RCP8.5)	+450% (SSP5)
Conservative Paris	+5% (RCP4.5)	+320% (SSP2)
Ambitious Paris	0% (RCP2.6)	+260% (SSP1)

Damage, payouts and fiscal impacts of the "Extreme Quarter" storyline (in bn. USD). CCRIF payout in the EQ storyline is calculated so that the total debt change over a year equals the historical level.

	Storyline type	Damage	Payout/ Payout needed	Revenue change over a year	Debt change over a year
3rd Quarter of 2017 (Maria, Irma, Harvey)		12.9	0.035	-0.3	1.5
Extreme Quarter Storyline	Current climate without CCRIF	60.0	0	-1.5	4.2
	Current climate	60.0	1.2	0.2	1.5
	Ambitious Paris	216.1	5.2	1.9	1.5
	Conservative Paris	310.3	7.63	2.9	1.5
	Failed Paris	491.4	12.3	4.8	1.5

EQ damages lead to a total $ 4.2 billion increase of debt under the Extreme Quarter storyline compared to history over a year since the event. In order to counteract this amount of additional increase in debt and balance the debt to historical level a payout of around $ 1.2 billion is needed from CCRIF,

Summary

- Storylines used to **show benefits of CCRIF in case of counterfactuals**

- **CCRIF will not be enough in the future** to cope with disasters as loses increase drastically

- Fiscal risks can be **reduced through CCRIF** like instruments

- Increase in **climate resilience through risk reduction and risk financing**

- Storyline important to show counterfactuals which are **interesting for decision makers**.

- However, for financial instruments such as insurance **a probabilistic assessment is necessary**, e.g. to set up premiums.

- One way forward would be through **stochastic sampling of loss distributions and creating a corresponding fiscal risk distribution**.

End of Presentation Discussion

Further Details

	Direct impact	Calculated change of debt in each period					CCRIF payout	Total change of fiscal variables over a year since the disaster	
		Quarter of event	1st quarter after event	2nd quarter after event	3rd quarter after event	4th quarter after event		Debt	Revenue
History	12.9	0.2	0.5	0.3	0.3	0.2	0.035	1.5	-0.3
Cf without CCRIF	60.0	0.9	2.4	1.7	1.8	1.2	0.0	4.2	-1.5
EQ	60.0	0.1	0.5	0.4	0.4	0.2	1.2	1.5	0.2

Application: Remote Events affecting Europe
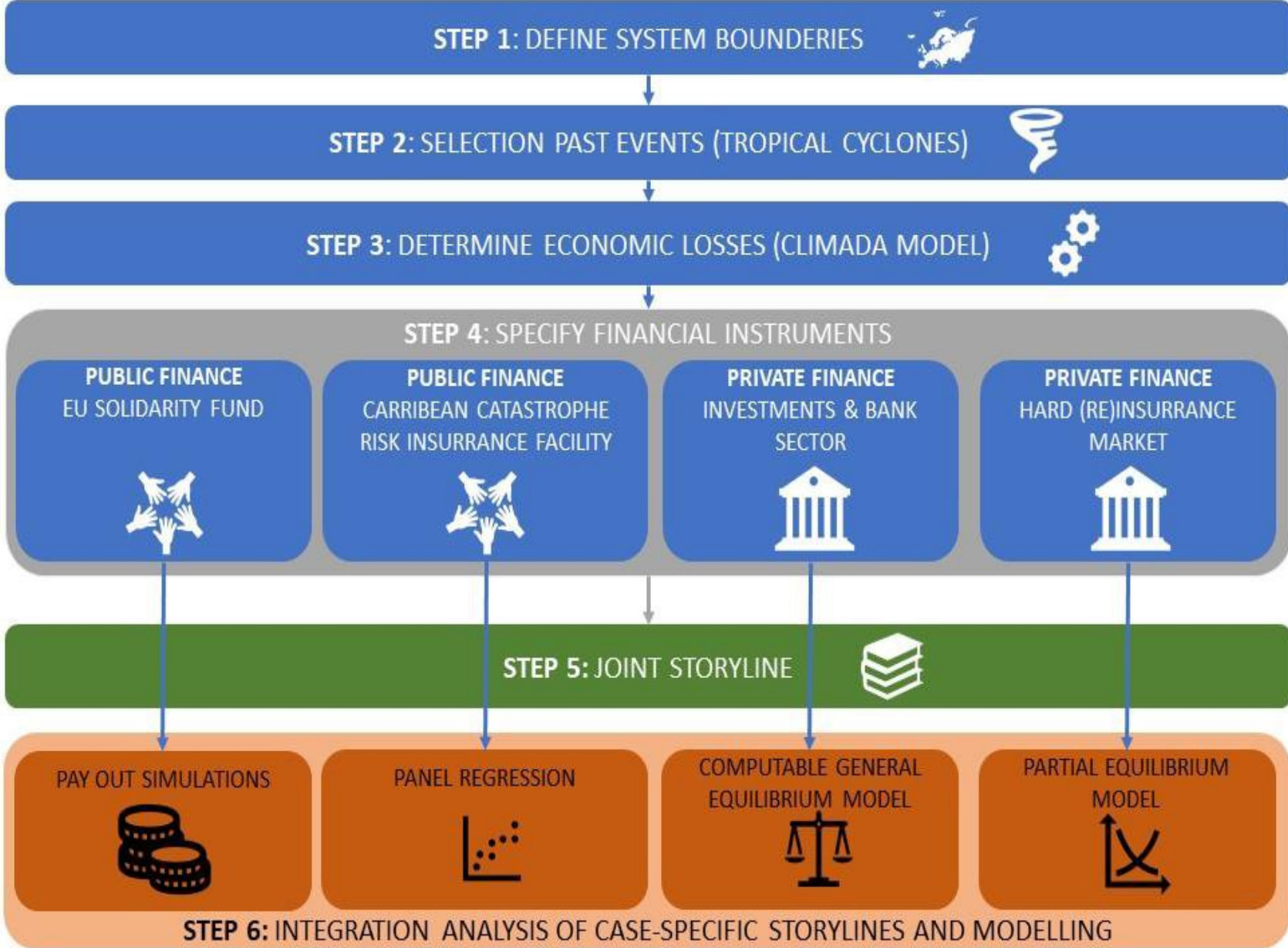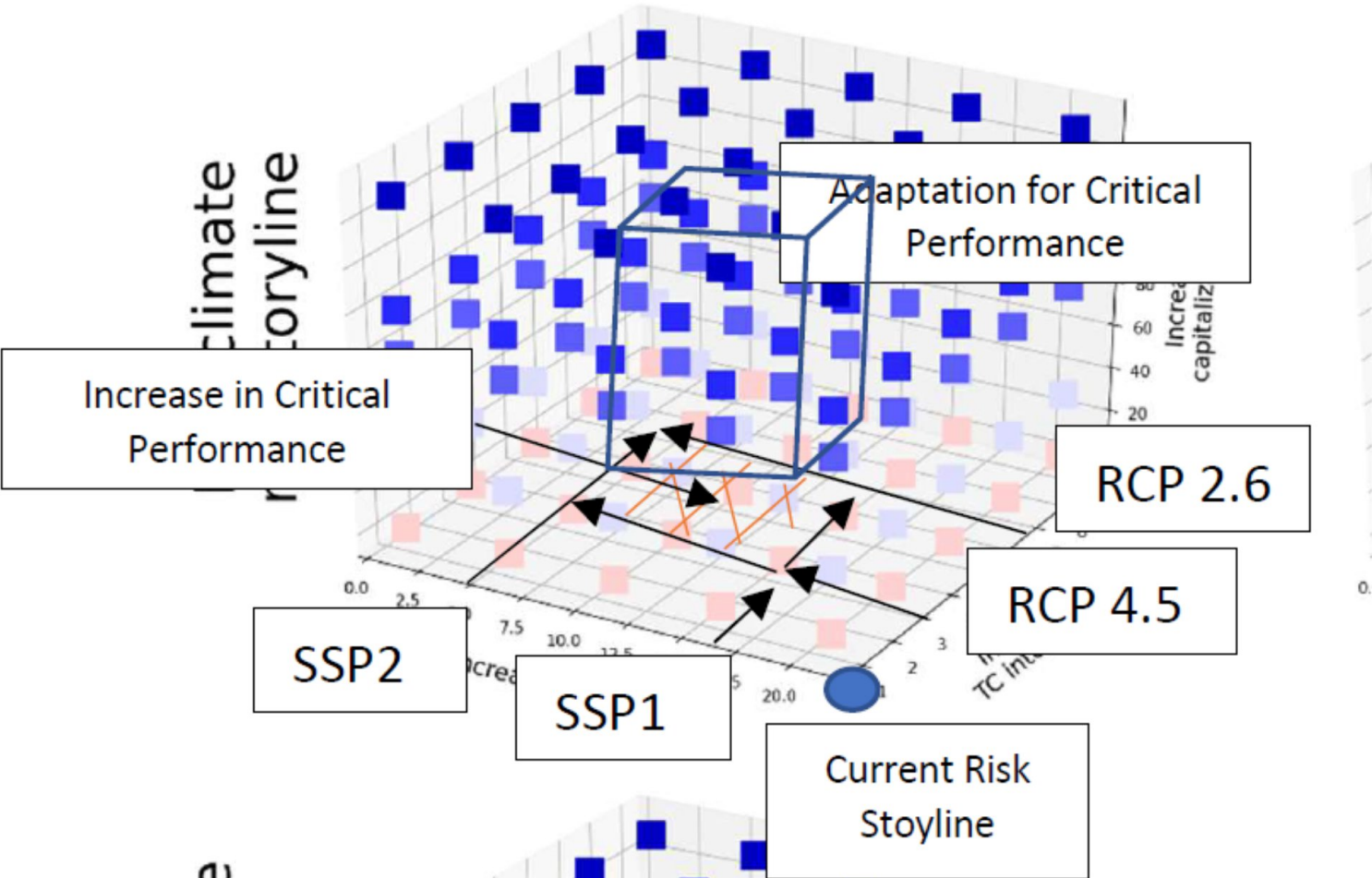
Combinations of Counterfactuals
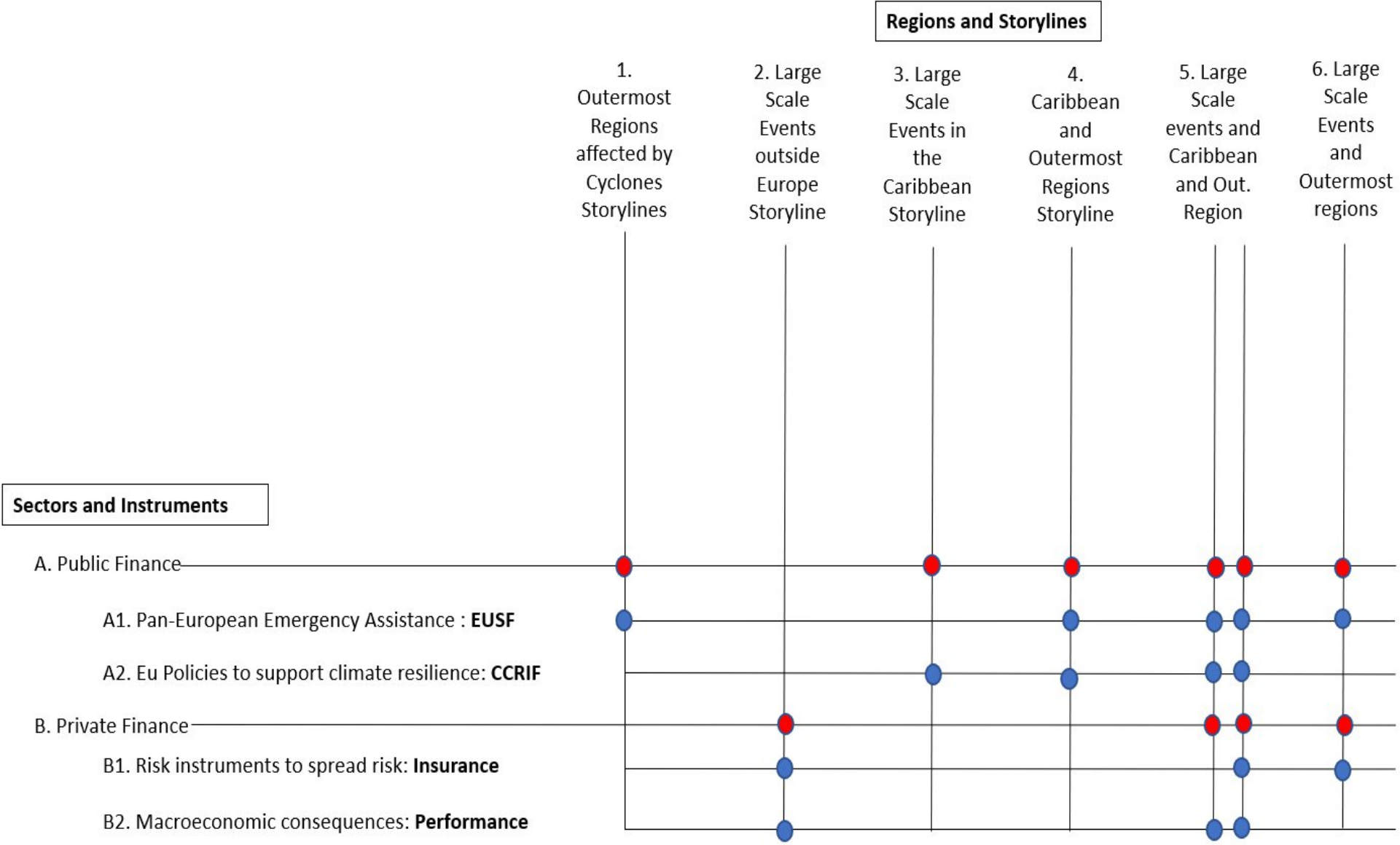
Example: European Solidarity Fund

EUSF assist Outermost Countries Affected by Disasters.

Counterfactuals events can critically effect the EUSF Fund (e.g. probability of ruin).

Climate and Global Change can exacerbate the risk.

Adaptation potential can be Identified based on these counterfactuals and future changes.

Summary of Different Policy Options for Instruments

Storyline	Methodology / Model	Problem set-up	Future risks	Resilience options
Public finance - EU Solidarity Fund (EUSF)	Pay-out Simulations	EU Solidarity Fund Capitalization Levels decrease due to risk in outermost regions	Increase in future cyclone events, multi-risks such as pandemics and conflicts	Increase in capitalization levels of EUSF
Public finance - Caribbean Catastrophe Risk Insurance Facility (CCRIF)	Panel regressions	Insurance for indirect fiscal risks in Caribbean countries that decrease outside assistance needs	Unsustainable increase in risk due to exposure and intensity increase of hazards	Insurance as viable option for decreasing contingent moral obligations
Private finance - Macroeconomic consequences	Computable general equilibrium Model	The impact of remote climatic catastrophes is transmitted to the EU's financial sector via global trade and financial flows.	Increased frequency and intensity of tropical cyclones can increase EU vulnerability to remote events	Improved investment circumstances in the EU. Safeguard access to financial resources. Identify vulnerability in terms of sectoral composition of the affected countries.
Private finance - Hard insurance market	Partial equilibrium model	A hard insurance market arises due to a large remote climatic catastrophe. Higher reinsurance costs trigger higher EU insurance premiums and reduce coverage.	A wide range of natural hazards occurring remotely.	Reducing insured risk in the EU by DRR. Governmental provision of reinsurance coverage for NatCat insurance

Summary of Different Policy Options for Instruments

Storyline	Resilience options	Policy option 1	Policy option 2
Public finance - *EU Solidarity Fund (EUSF)*	Increase in capitalization levels of EUSF	Multi-Hazard and Multi-Risk tool as designed in SEAR	Changes in policy processes regarding pay-outs
Public finance - *Caribbean Catastrophe Risk Insurance Facility (CCRIF)*	Insurance as viable option for decreasing contingent moral obligations	Integration of emergency phase with reconstruction phase to decrease indirect risks	Risk reduction for future climate change impacts needed
Private finance - *Macroeconomic consequences*	Improved investment circumstances in the EU. Safeguard access to financial resources. Identify vulnerability in terms of sectoral composition of the affected countries.	Increased responsiveness to provide substitute production capacity and turn the EU into a safe destination for long term investments.	Monitor capital availability and investment levels in the EU to remediate in case of capital shifts to affected regions.
Private finance - *Hard insurance market*	Reducing insured risk in the EU by DRR.\n\nGovernmental provision of reinsurance coverage for NatCat insurance	Combine it with EUSF and SEAR into a public-private partnership	Related insurance and risk reduction through incentives and provide subsidies for most vulnerable