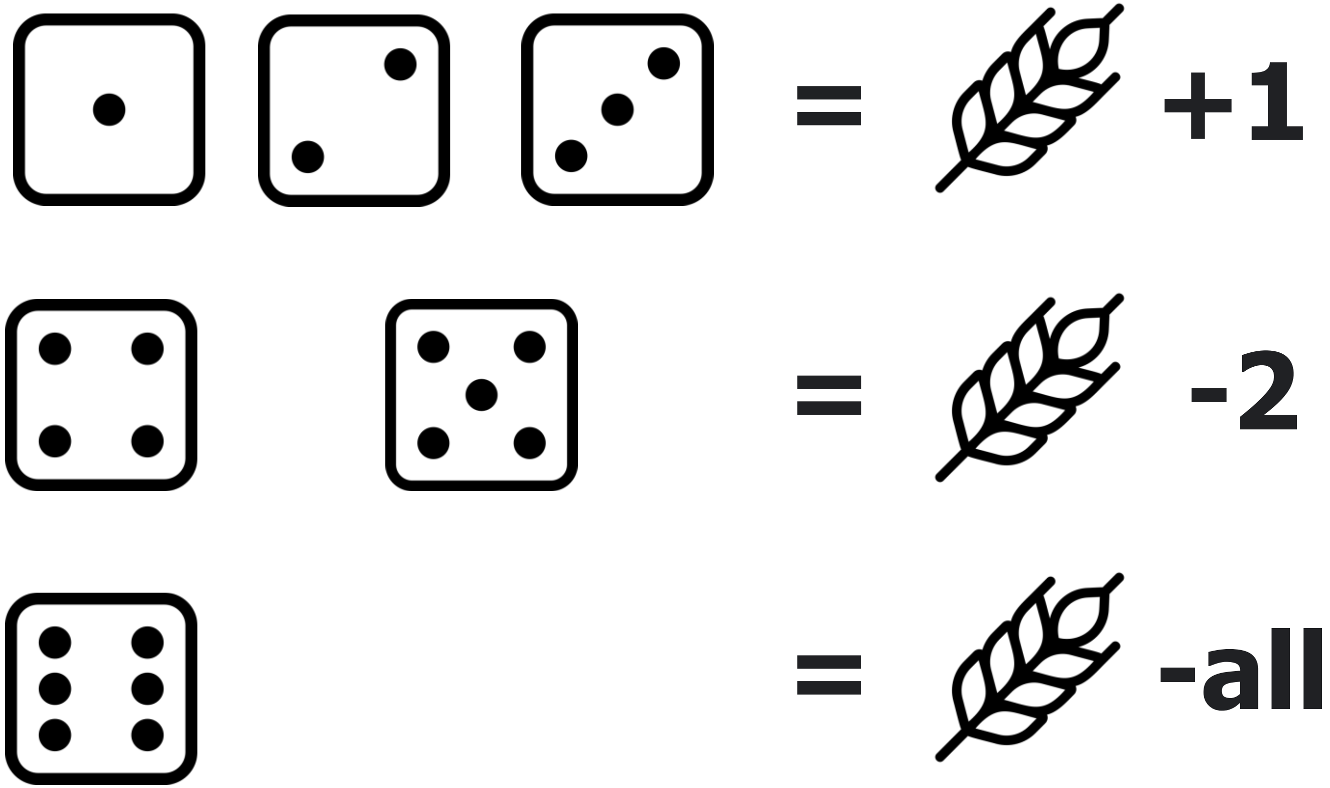
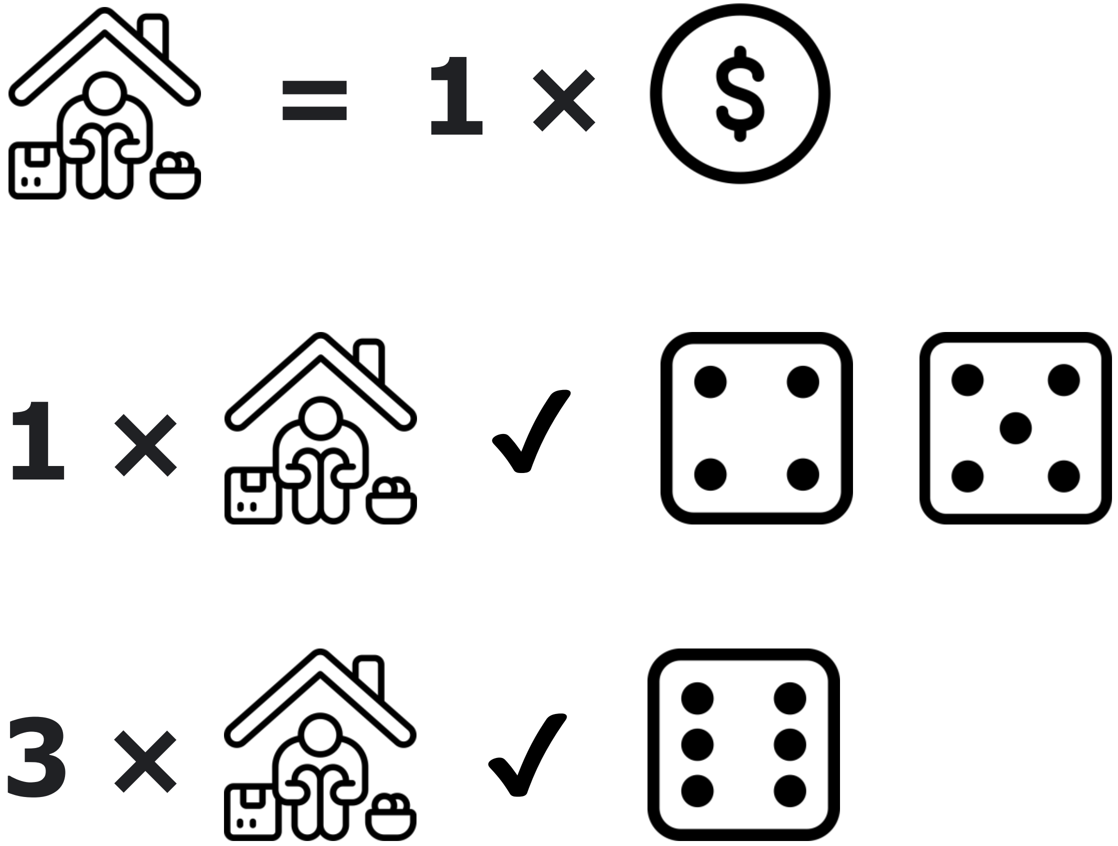
Welcome to the Climate Casino!

A Climate Casino



A Climate Casino



Game starts

Round 1:  × 9  × 1

Dice : 

Token:  × 10

Game starts

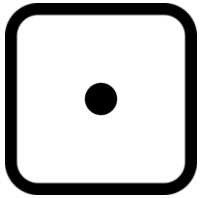
Round 2:  × 9  × 1

Dice : 

Token:  × 10

Game starts

Round 3:  × 9  × 1

Dice : 

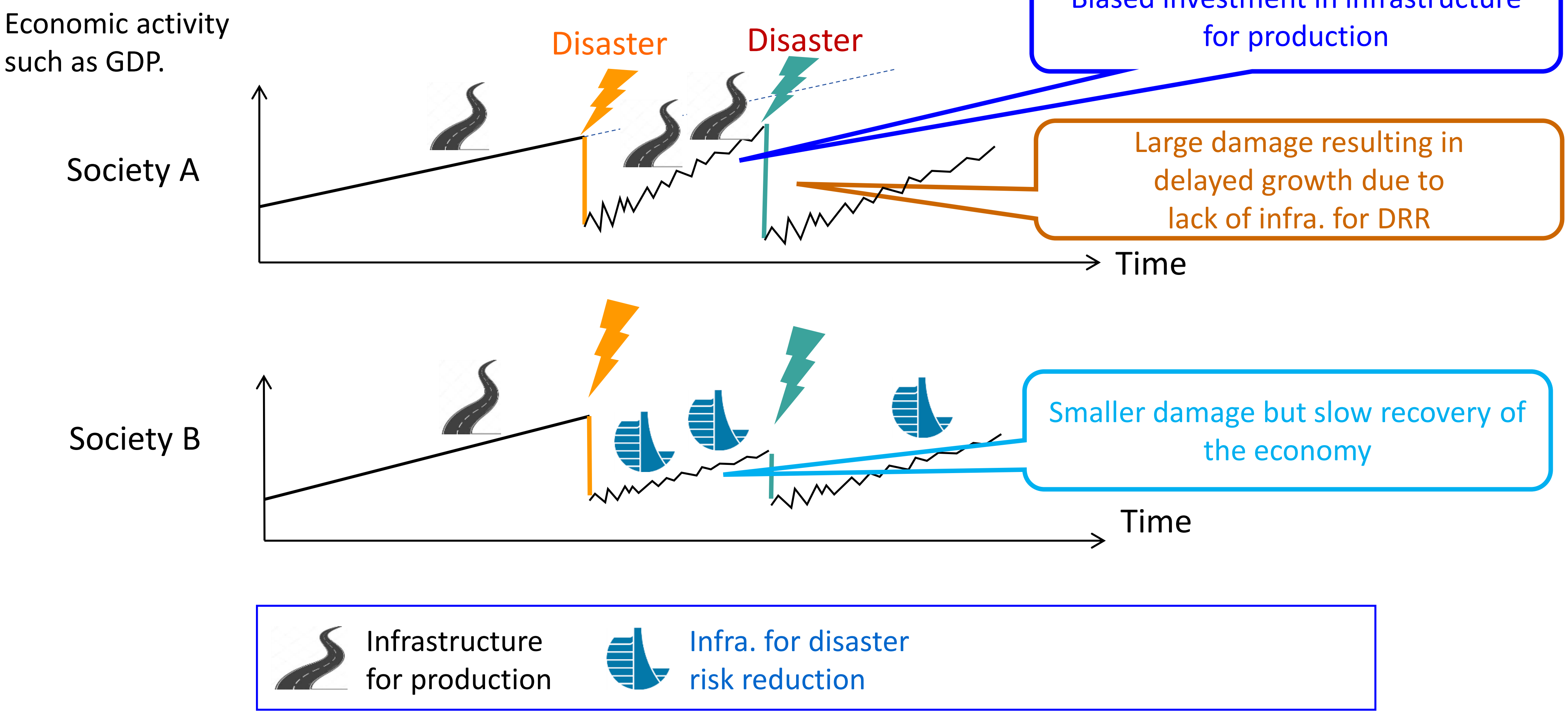
Token:  × 10

What if?

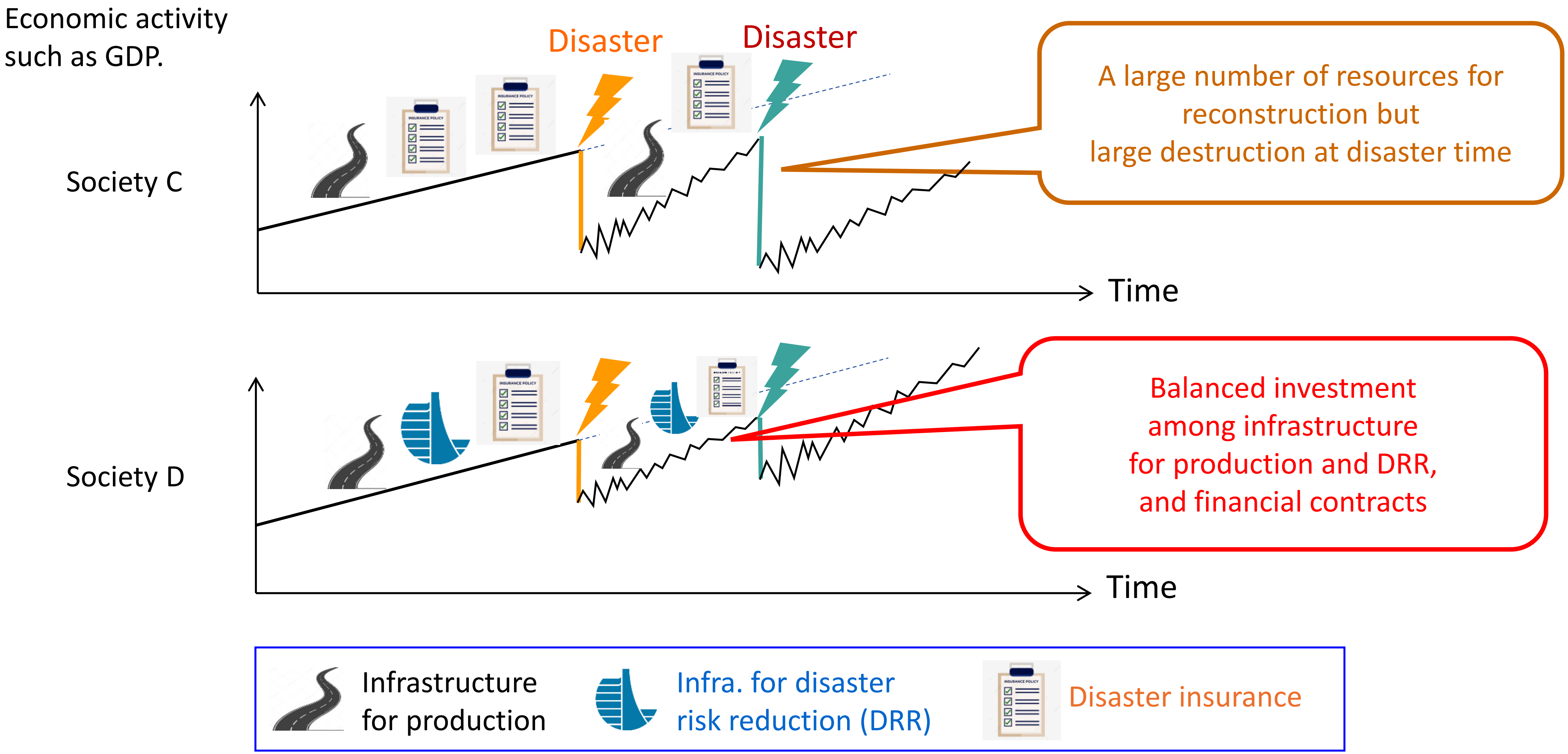
 × 3

 =  -all

Effects of climate disaster reduction measures



Integrating risk reduction and risk finance



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Smart-Support for Governments in Developing Countries for Addressing Physical and Fiscal Risks of Climate Change

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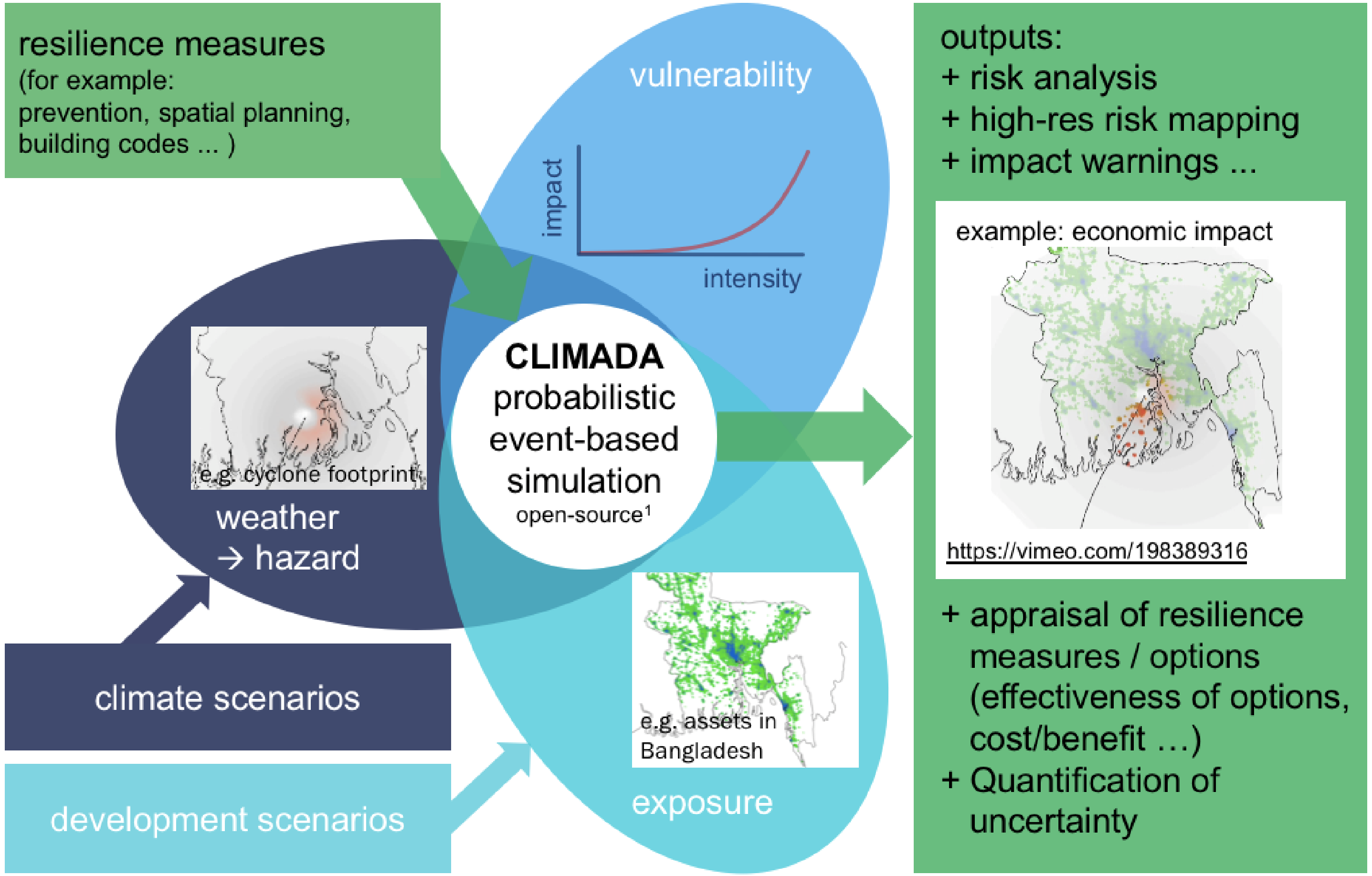
Reinhard Mechler

International Institute of Applied Systems Analysis

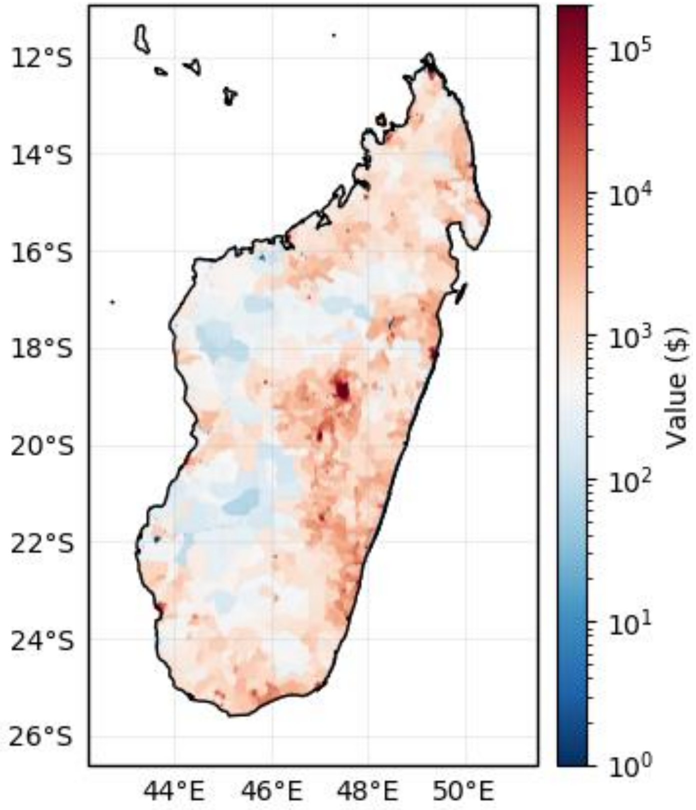
Analyse multi-hazard risks under different scenarios

- Model: CLIMADA
- Case study: Madagascar
- Covered hazards: tropical cyclones, riverine flood, coastal flood

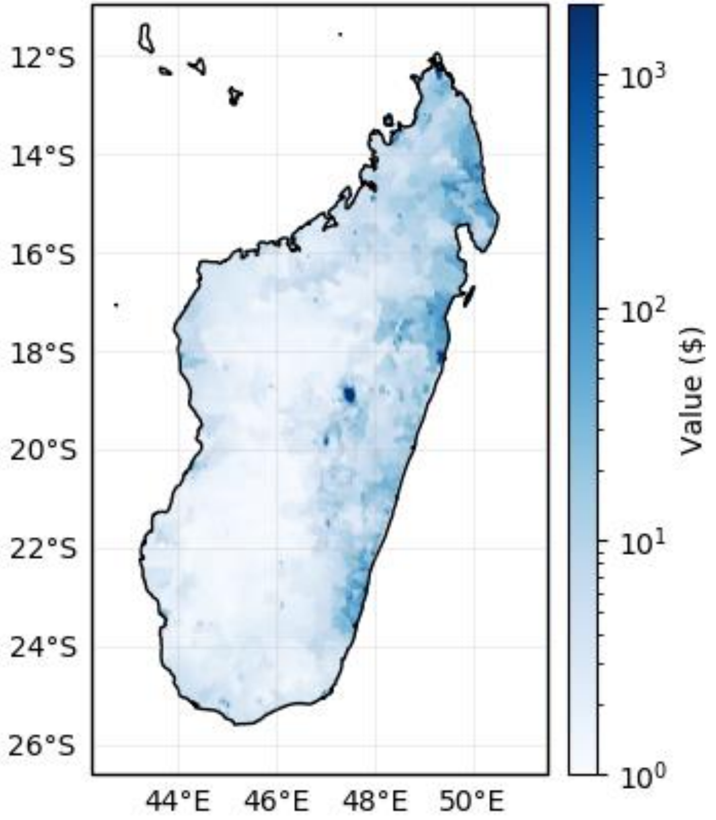


Physical risks in Madagascar

- Average Annual Losses considering cyclones and flood:
    - General assets: 30 million $
    - Public assets: 16.8 million $
    - Agriculture : 4.6 million $
- 50-year compound event: 521 million $ (2.7% of total assets, 3.8% of GDP)



Asset exposure: dollar per km2



Overall average annual damage: dollar per km2

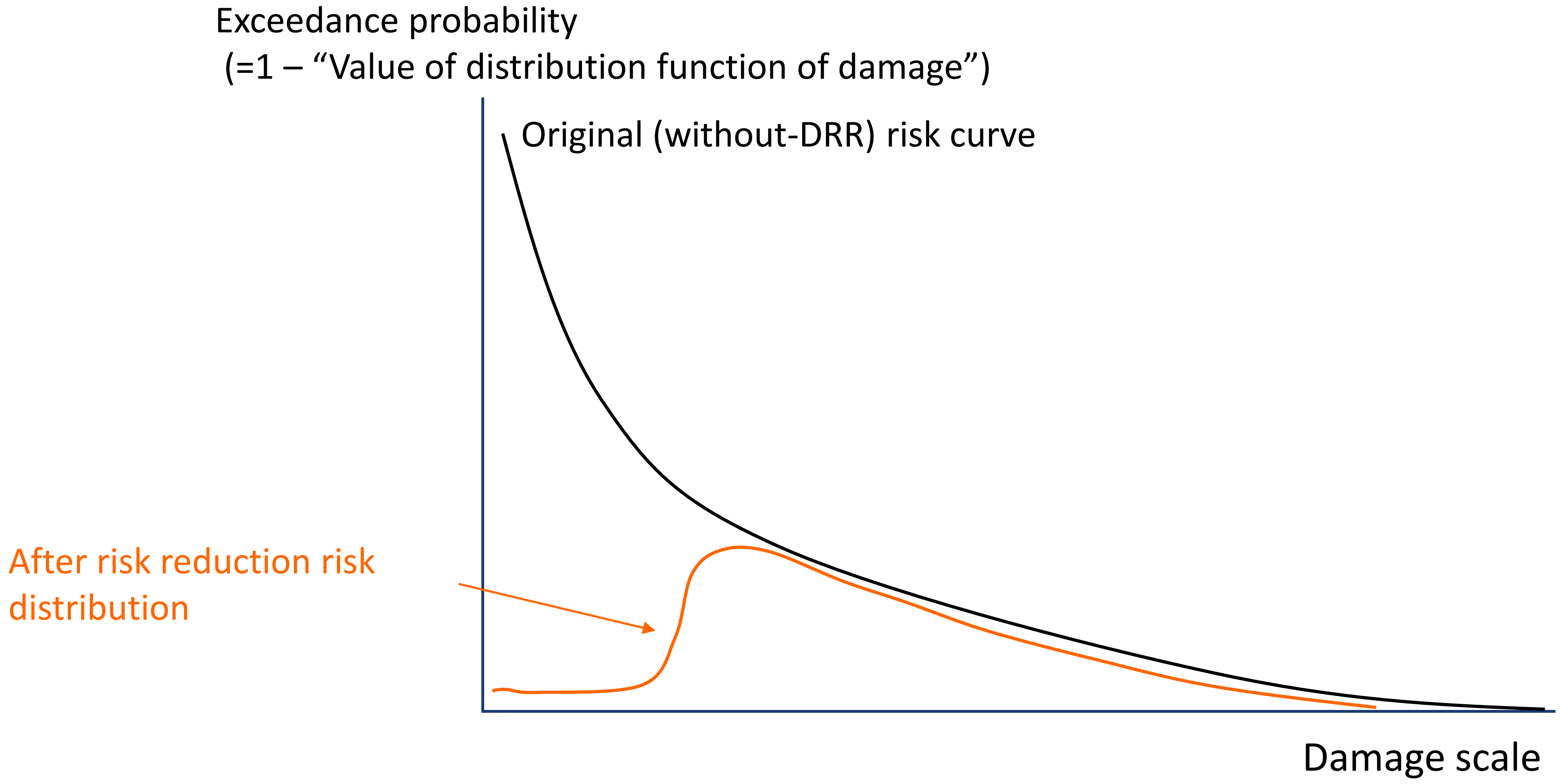
Risk Reduction

- Physical: Storm-reinforced Housing (wood and unreinforced masonry housings make up 78% of all residential land area (Madagascar evidence)
- Natural: Bamboo T-fence (global evidence)

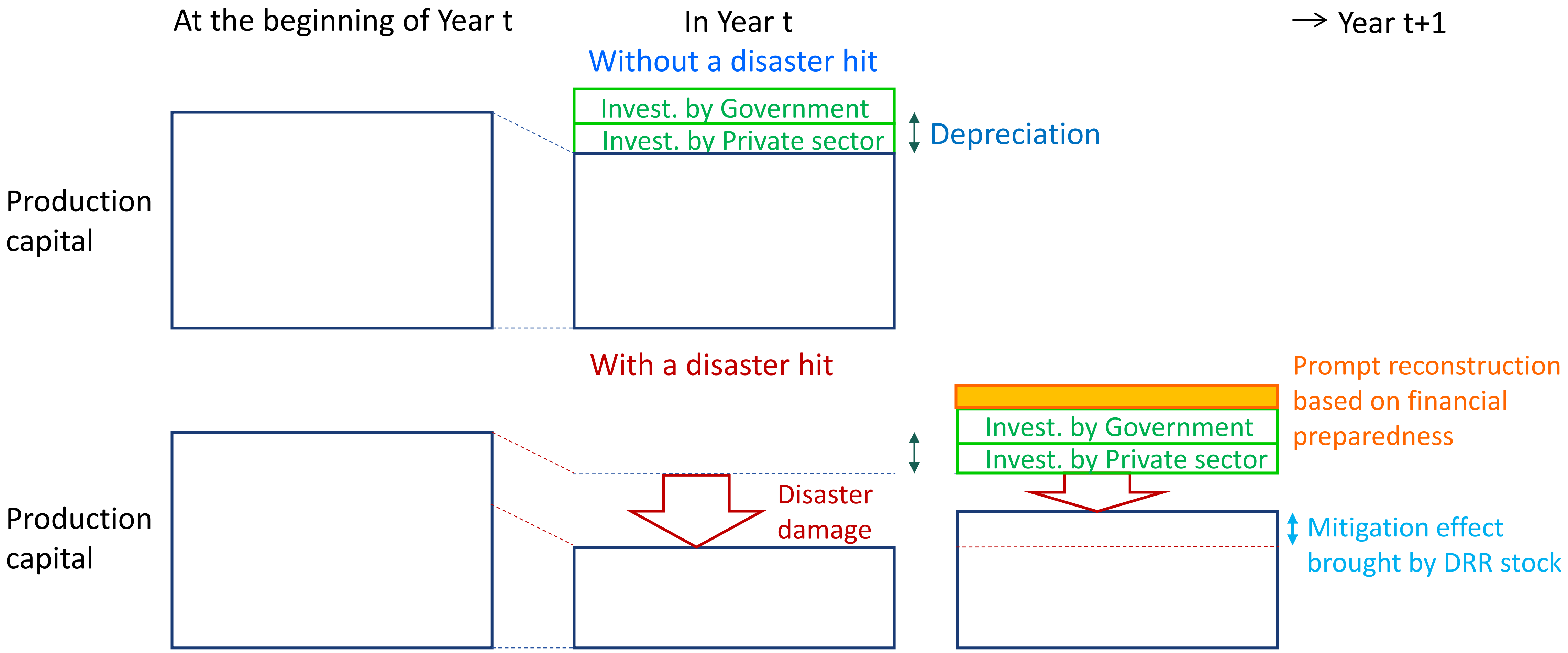
Option for retrofitting	AAL after retrofitting (AAL2)	Benefit of retrofitting (AAL1-AAL2)
Wood only	48.5	8.9
Unreinforced Masonry (UM) only	42.0	15.5
Both wood and UM	33.0	24.4

Estimated benefits of enforcing higher building code, unit: million $

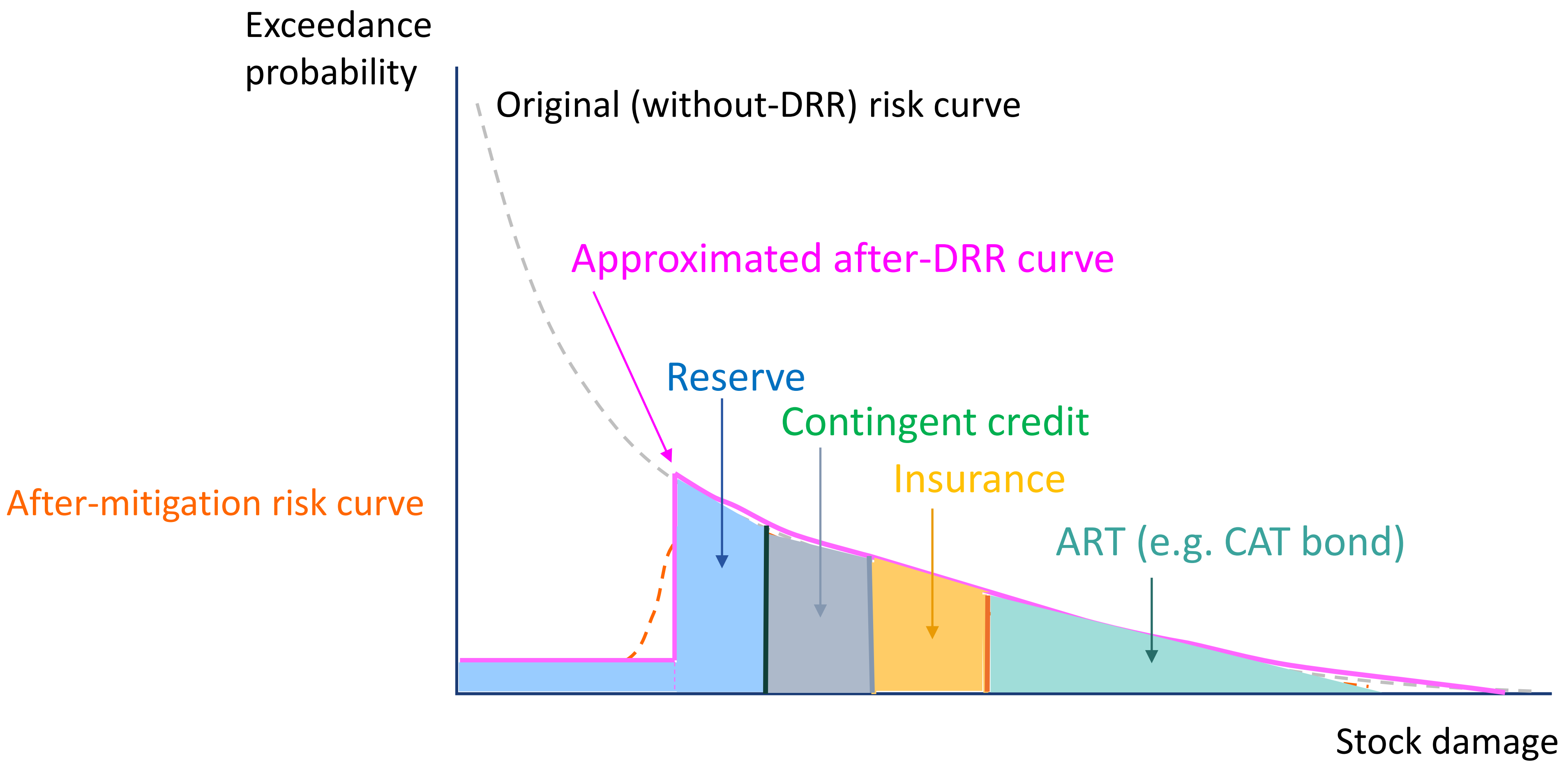
Effects of disaster risk reduction measures:



Stock formation process: Production capital and DRR stock



Layered strategy: combining risk reduction and risk finance



CatSim: Fiscal-centered macroeconomic modelling

	Independent of disaster occurrence	At disaster time
Revenue	Tax, Grant from donor countries, Other revenues (including dividends from state companies), Seigniorage (i.e., income from printing money, technically by the central bank)	Income from Disaster finance contracts: 1) Withdrawal from Reserve fund 2) Contingent credit 3) Insurance claim 4) Income of ART
Expenditure	Gov. consumption, Investment in Prod. capital and DRR stocks, Interest payment of debt, Annual expenditure for Disaster finance: 1) Transfer to Dis. Reserve stock, 2) Fee for credit line contract, 3) Insurance premium, 4) payments for alternative risk transfer (ART)	Prompt reconstruction of Prod. capital and DRR stocks, Relief good supply

Debt sustainability and default

- Process of government's financial position: in terms of sovereign debt

Debt (Year t+1) = Debt (Year t) + Expenditure (t) - Revenue (t)

- Index that serves as the criterion

Debt-GDP ratio

$$x_D(t) := \frac{\mathrm{Debt}(t)}{\mathrm{Nominal\ GDP}(t)}$$

Assumption: national government is subjected to

$$x_D(t) < \bar{x}_D.$$

$\bar{x}_D$: Constant value of the limitation of the debt-GDP ratio

Index focused for policy evaluation

- GDP growth rate

γ_{YAT} : The average annual real-GDP growth rate over the planning period (T years)

Example)

- Expected growth rate and its variance

In the numerical simulation, run the model many times with many disaster scenarios over the planning period (i.e., “Monte-Carlo simulation”), and obtain

[Expected level of γ_{YAT}] : the mean over the tested disaster scenarios,

[Variance of γ_{YAT}]: the size of distribution, which reflects uncertainty of growth.

Policy evaluation

- Evaluation function

F (Policy) = [Expected level of γ_{YAT}] − [Weight] × [Variance of γ_{YAT}]

- ✓ γ_{YAT} : The average annual real-GDP growth rate over the planning period (T years)
- ✓ Each set of Policy is input to be evaluated by the function.
- ✓ Degree of risk aversion is represented by the value of [Weight].
- ✓ NOTE: In stead of focusing on the growth rate, the objective function could also be

$$\max_{\text{Policy}} F_{\text{GDP}}(\text{Policy}) = E[\text{GDP}(t)] - \nu_{\text{GDP}} \cdot \text{Var}[\text{GDP}(t)].$$

- Problem formulation

Maximize F (Policy) with respect to Policy,

Subject to

“Net external debts (at the national level) must be smaller than the certain level.”

Sample of the results

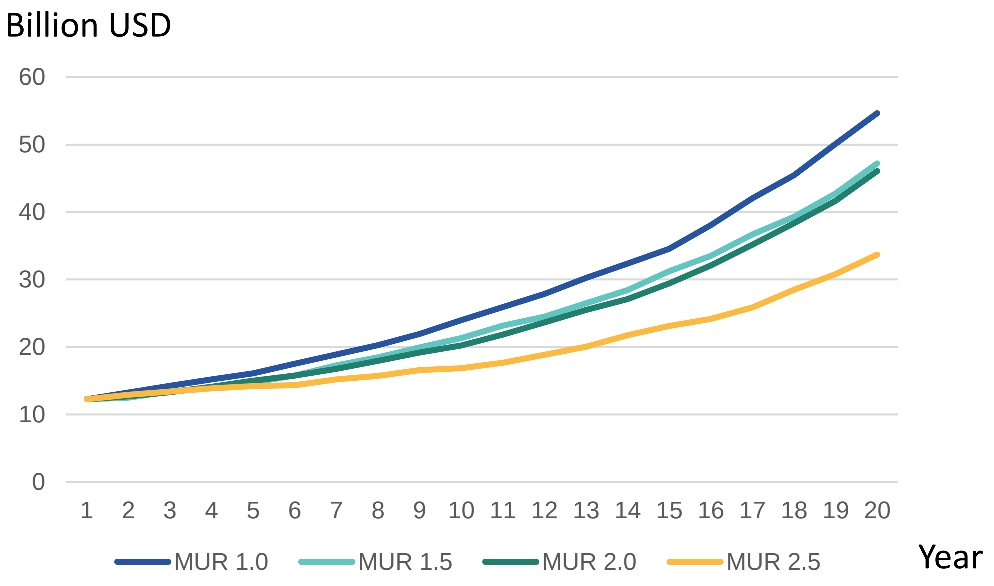
- ➢ Data collection is ongoing in Madagascar
- ➢ Policy variables
- ✓ θ_S : Investment rate in DRR (disaster mitigation) infrastructure; in terms of the GDP share
- ✓ ξ_{KS}: The ratio of Government's prompt investment for reconstruction to the total destroyed physical capital within the disaster year
- ✓ ω_I: The insurance-coverage rate against the total prompt needs of resources (= the total stock damage and the relief supply)

Sample of the results (Cont'd)

- Environment

Mark-up rate of the insurance: MUR=1.0,1.5,2.0,2.5

MUR	1	1.5	2	2.5
Optimal set of policies				
Inv. rate in DRR	0.0371	0.0457	0.0457	0.0371
Gov. recovery rate	1	0.6	0.6	0.4
Insurance cov. rate	0.8	0.4	0.2	0.2
Results				
Value of Eva. function	0.0786	0.0468	0.0448	0.0382
Expected average growth rate	0.0898	0.0715	0.0701	0.0534
Variance of growth rate	0.000112	0.000247	0.000253	0.000152



Mean path of real GDP

Policy variables

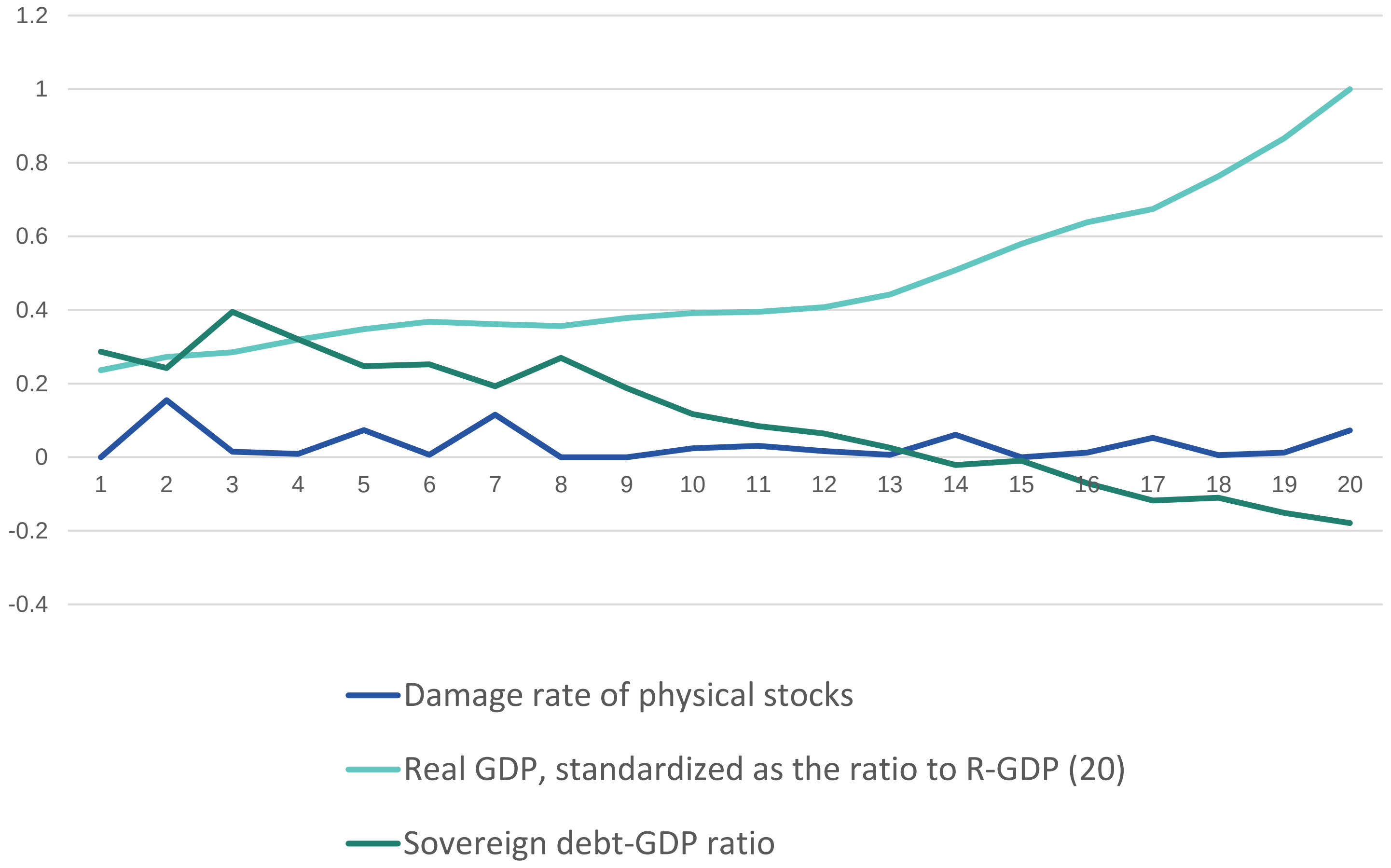
✓θ_S : Investment rate in DRR (disaster mitigation) infrastructure; in terms of the GDP share

✓ξ_{KS}: The ratio of Government's prompt investment for reconstruction to the total destroyed physical capital within the disaster year

✓ω_I: The insurance-coverage rate against the total prompt needs of resources (= the total stock damage and the relief supply)

Sample of the results (Cont'd)

- Sample path (under one process of random arrivals of disasters) of the case MUR=2.0 and the optimal policy set



Sample of the results (Cont'd)

- Sensitivity analyses

Basic case

MUR	1	1.5	2	2.5
Optimal set of policies				
Inv. rate in DRR	0.0371	0.0457	0.0457	0.0371
Gov. recovery rate	1	0.6	0.6	0.4
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Variance of growth rate	0.000112	0.000247	0.000253	0.000152

1. More strict default threshold: 0.8->0.5

MUR	1	1.5	2	2.5
Optimal set of policies				
Inv. rate in DRR	0.0500	0.0414	0.0329	0.0371
Gov. recovery rate	0.8	0.2	0.2	0.2
Insurance cov. rate	0.8	0.6	0	0.2
Results				
Value of Eva. function	0.0490	0.0252	0.0268	0.0160
Expected average growth rate	0.0778	0.0507	0.0527	0.0447
Variance of growth rate	0.000288	0.000255	0.00026	0.000287

Less expenditure for recovery investment

2. Increasing damage rate due to climate change

MUR	1	1.5	2	2.5
Optimal set of policies				
Inv. rate in DRR	0.0329	0.0500	0.0500	0.0457
Gov. recovery rate	1	0.8	0.6	0
Insurance cov. rate	1	0.2	0.2	0.2
Results				
Value of Eva. function	0.0596	0.0423	0.0469	0.0218
Expected average growth rate	0.0802	0.0713	0.0729	0.0435
Variance of growth rate	0.000206	0.000290	0.000260	0.000217

Larger preparedness

Most critical component:
Estimation of the interest rate function

- Interest rate function

$$i\left(x_D(t), \{\Omega_{hI}(t) | \text{for all } h\}, P(t)Y(t)\right) := \begin{cases} r(t) & \text{if } x_D(t) \leq \bar{x}_r \\ r(t) \cdot \{1 + a_{i1}\tilde{x}_D(t) + a_{i2}\tilde{x}_D(t)^2 + a_{i3}\varepsilon_i(t)\} & \text{if } x_D(t) > \bar{x}_r \end{cases}$$

where

$$\tilde{x}_D(t) \coloneqq x_D(t) - a_{i0}\frac{\sum_h \Omega_{hI}(t)}{P(t)Y(t)} = \frac{D(t) - a_{i0}\sum_h \Omega_{hI}(t)}{P(t)Y(t)}$$

$r(t)$: risk free interest rate in market, $x_D(t)$: the sovereign debt-GDP ratio, $\bar{x}_r$: threshold value

$\sum_h \Omega_{hI}(t)$: sum of insurance claims, representing the total scale of insurance contract

$\varepsilon_i(t)$: truncated standard normal random variable: $0 \leq \varepsilon_i(t) \leq 1$

$\bar{x}_r, a_{i0}, a_{i1}, a_{i2}, a_{i3}$: parameters to be estimated by data.

In the numerical examples, it was found that giving a small positive value to a_{i2} results in explosion of the interest rate and the sovereign debt-GDP ratio.

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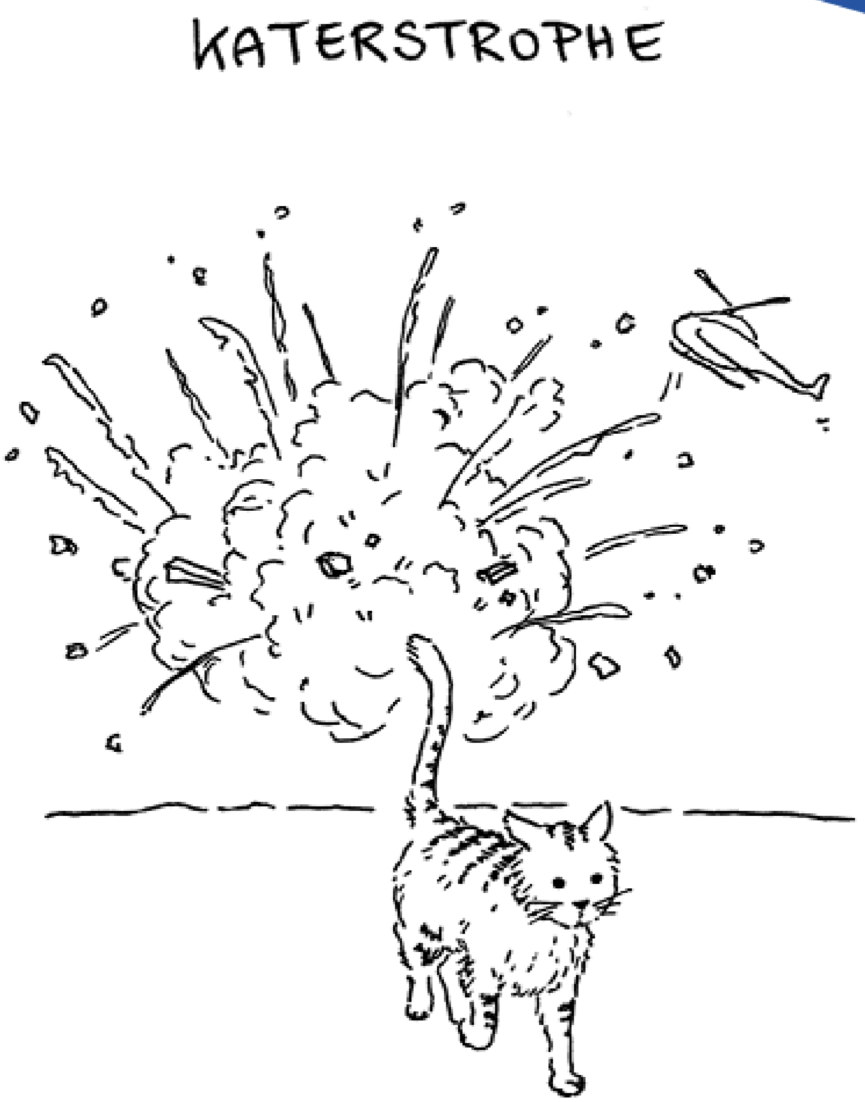
Milefa ny fossa, tojo ny kary?

To escape from the fossa but meet a wild cat



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Thank You!

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