

# Flood risk insurance: the Blockchain approach to a Bayesian adaptive design of the contract.

Joint research by CISA and Riga Technical University

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# Flood risk insurance: the Blockchain approach ...

## Research group

Actuarial expertise (CISA): Augusto Bellieri dei Belliera, Marcello Galeotti, Giovanni Rabitti, Emanuele Vannucci

Legal expertise (RTU): Andrea Jonathan Pagano

Engineering expertise (RTU): Francesco Romagnoli

... we miss informatics expertise: any guess?

Key point: multidisciplinary.



# Flood risk insurance: the Blockchain approach ...

## Agenda

- 1) Flood risk: assessment and mitigative infrastructures (act. + eng.)
- 2) Adaptive design of the contract: bayesian approach (act.)
- 3) Automatic updating: smart contracts (blockchain + legal environment)\*
- 4) New information by more sources (big data)
- 5) Mitigative infrastructure financing: resilience bonds (act.)

\* The second part of this presentation (by A.J. Pagano) is dedicated to this issue.

# Flood risk insurance: the Blockchain approach ...

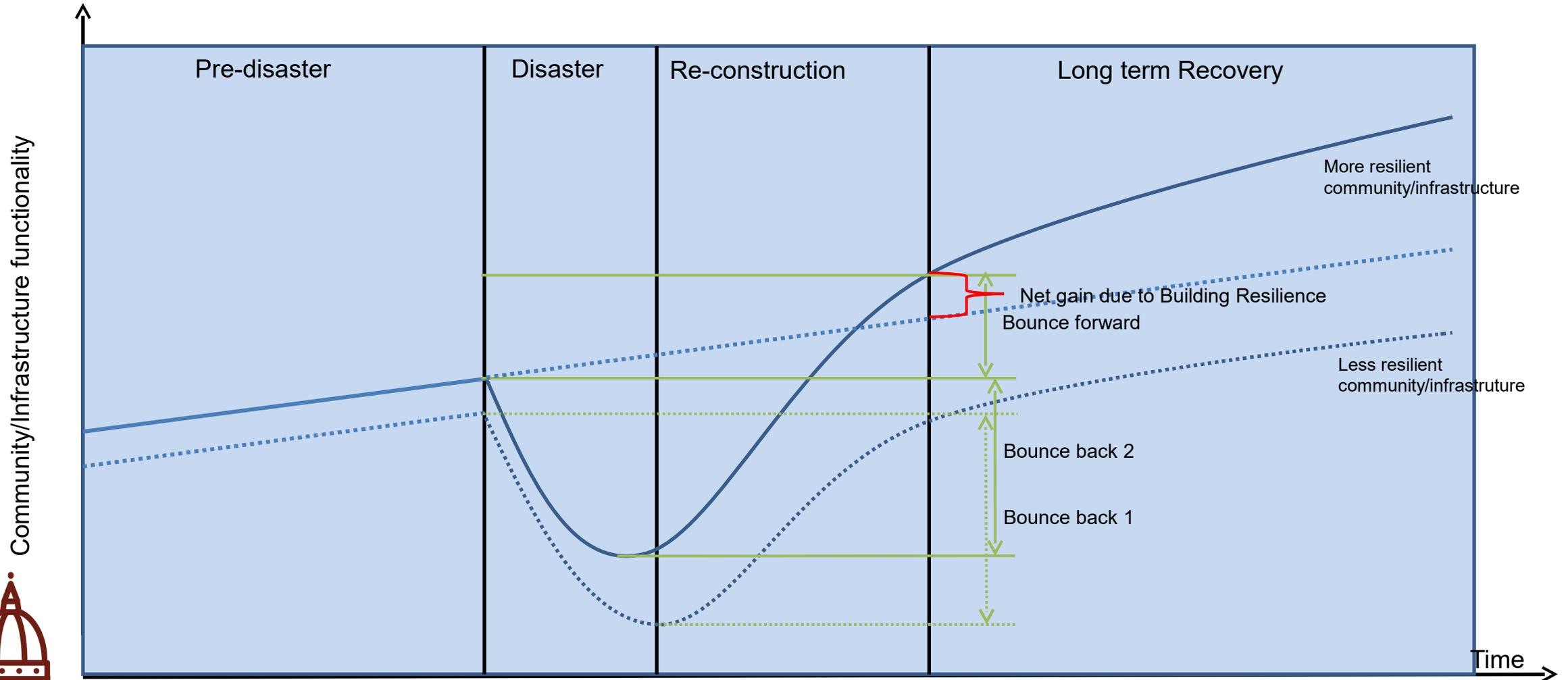
## 1) Flood risk: assessment and mitigative infrastructures

- Define the area under risk and the scale for risk unit (a building, a district, ... )
- Assess the potential loss levels: by historical series and/or by engineering expertise, necessary in case of no previous claims
- Mitigative infrastructures projects: cost and completion time

## Sources of risk

- Climatic phenomena (rain, storm?, ...): big data, statistical inference, ...
- Consequences: water levels of rivers (regression models with climatic phenomena)

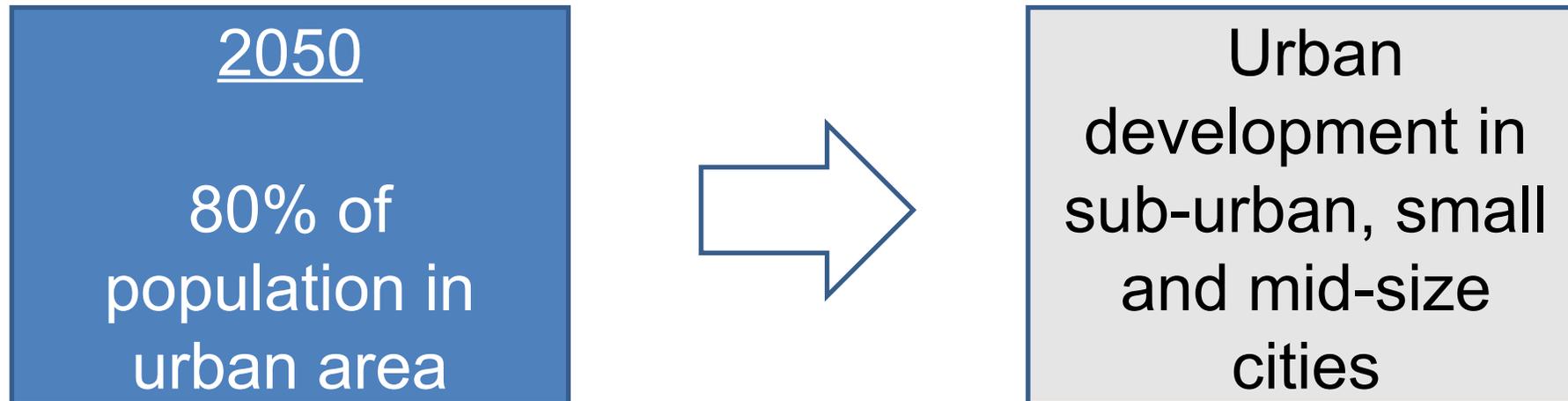
# Resilience and disruption profile



Source: Perera, 2015. presentation within the Baltic Societal Resilience Symposium, Riga 27/02/2015

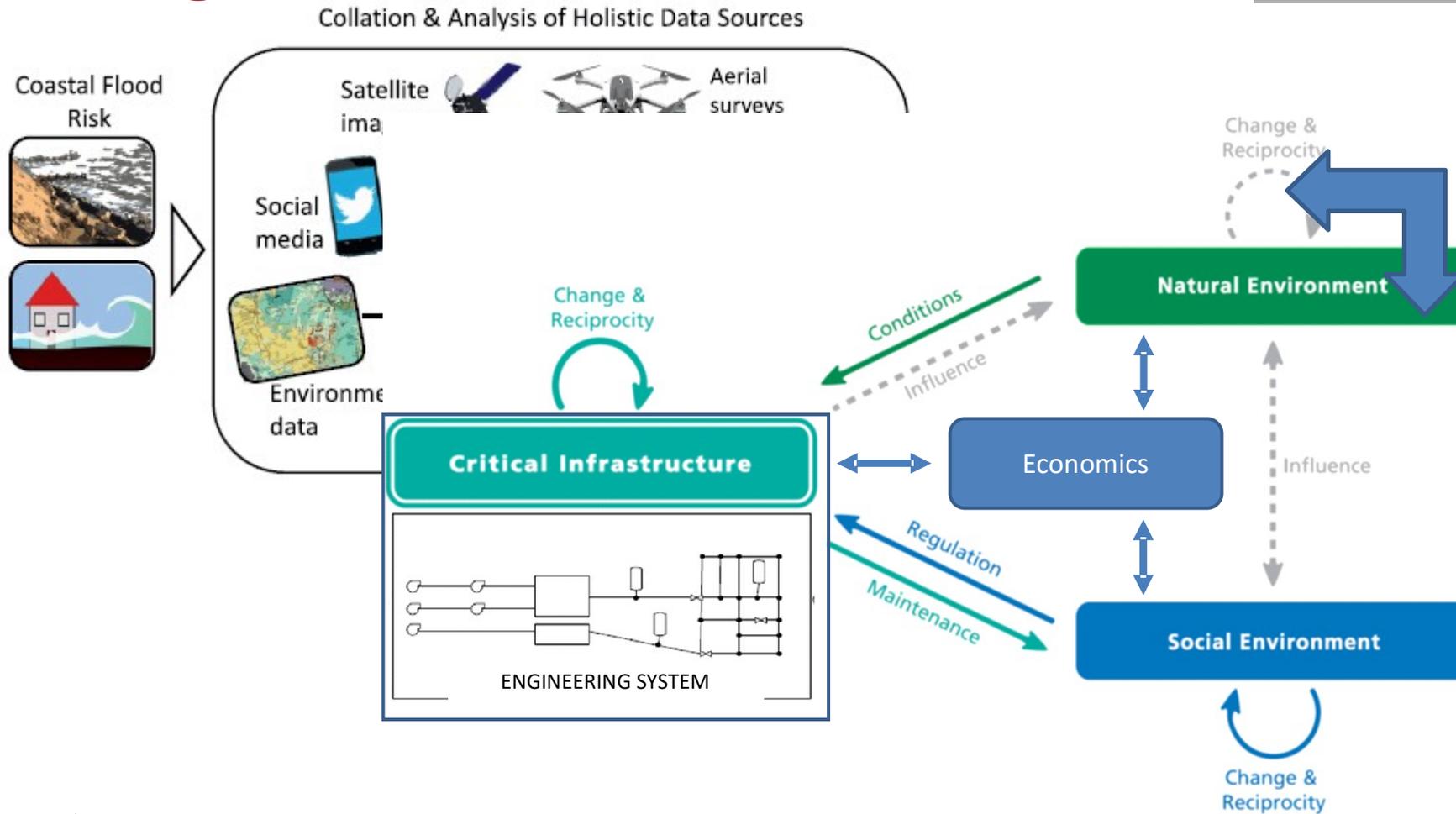
# Focus on cities and urban environment

- In the future decades growth of people and assets will be the major driver of the increasing damages and losses from disasters especially in urban areas (IPCC 2012)



KEY QUESTIONS ON RISK REDUCTION

# Linking critical infrastructure with natural and social environment



Source: Alexander G. Rumson, 2019

Readapted from : Cutter, S. and Corendea, from Social Vulnerability to Resilience: measuring progress toward Disaster Risk Reduction, 2013, p. 33

# Flood risk insurance: the Blockchain approach ...

## 2) Adaptive design of the contract: bayesian approach

Classic actuarial scheme:

new information (from climatic phenomena, claims occurrences, mitigative infrastructures) can leads to variations of risk exposure assessment.

# Flood risk insurance: the Blockchain approach ...

## 3) Automatic updating: smart contracts (blockchain + legal environment)

Detailed analysis is postponed in the 2<sup>nd</sup> part of this presentation

Blockchain could be a platform in which all the new information is collected.

Its use could allow for automating some contractual conditions (risk premium, contingent payment due to cat event occurrence, ...),

that leads to the idea of the so-called smart contracts,

which allow contractual changes without a new agreement between the counterparties (e.g. floating rate loans): which is the key point for a legal aspects analysis.

# Flood risk insurance: the Blockchain approach ...

## 4) New information by more sources (big data)

A new opportunity for risk assessment in recent years are the so called big data.

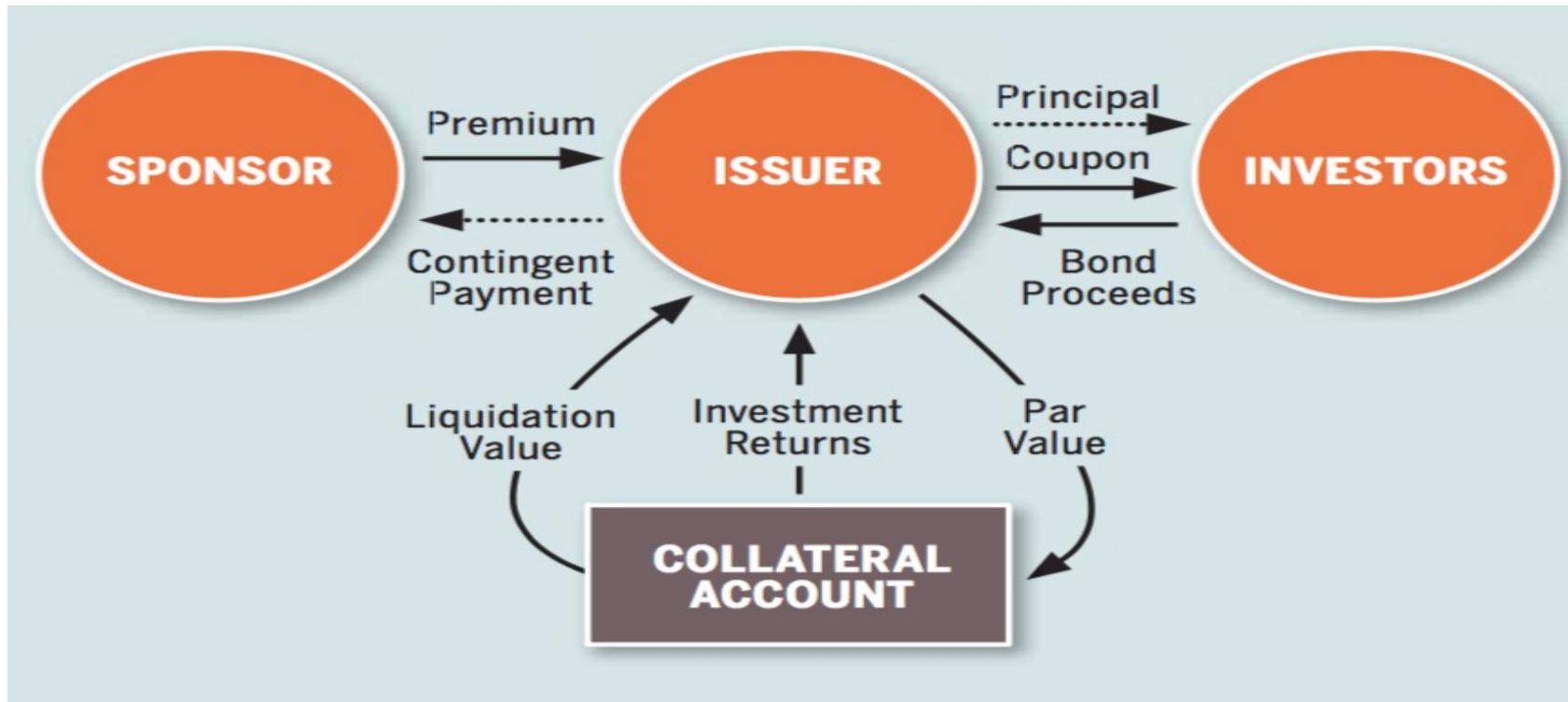
For this research such big data could consist mainly in ones relative to climatic phenomena.

Big data could allow for application of machine learning schemes in addition or in the place of traditional statistical inference models.

# Flood risk insurance: the Blockchain approach ...

## 5) Mitigative infrastructure financing: resilience bonds

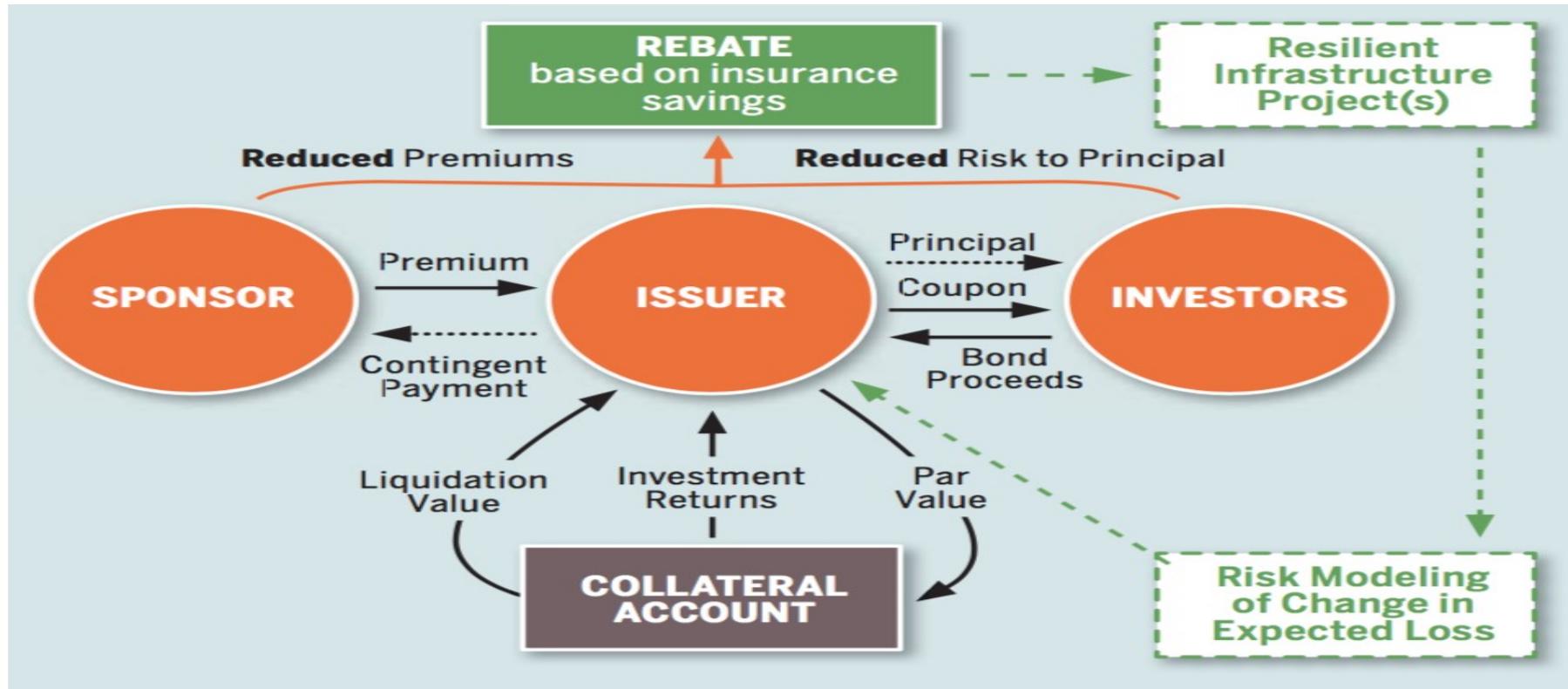
Respect to the well known flowchart of a cat bond ...



# Flood risk insurance: the Blockchain approach ...

## 5) Mitigative infrastructure financing: resilience bonds

... one of a resilience bond adds the investment for the mitigative infrastructure!



# Flood risk insurance: the Blockchain approach ...

## 5) Mitigative infrastructure financing: resilience bonds

Just a quick elementary numerical example on a resilience bond flowchart.

Given that in last e.g. 10 years a certain area have registered 100 monetary units of damages for flood risk: 10 each year in average (but we can have registered a particularly inhomogeneous distribution),

We can expect roughly the same, with potential financial crisis in case of big claims and no insurance (public taxation could be not sufficient!), if no mitigative infrastructures have been realized yet.

How public administrations can use this amount of money? Paying for actual damages? Or buying insurance? Or even for increasing resilience?

# Flood risk insurance: the Blockchain approach ...

## 5) Mitigative infrastructure financing: resilience bonds

Let assume a null free risk rate, such that comparison of various scenarios results depends only on sums.

Let assume that a mitigative infrastructure which costs 40, allows to reduce, in average, the risk exposure by 8 units each year after it has finished and the expected time for finishing it is 5 years.

The break event point for the insured (public administration) is 10 years

$10 * 10 = 100$  classic insurance

$10 * 5 + 2 * 5 + 40 = 100$  insurance and mitigation

# Flood risk insurance: the Blockchain approach ...

## 5) Mitigative infrastructure financing: resilience bonds

### 1) Case of no insurance

- Public administration pays in average 100 and after 10 years still has a risk exposure of 10 each year.
- Insurance doesn't act.
- Investors don't act.

# Flood risk insurance: the Blockchain approach ...

## 5) Mitigative infrastructure financing: resilience bonds

### II) Case of classic insurance

- Public administration pays a fixed amount (insurance premiums for 10 years)

$$10 * 10 = 100$$

and after 10 years still has a risk exposure of 10 each year.

Same (in average) of no insurance case!

- Insurance has a null gain (loss) expectation.
- Investors don't act.

# Flood risk insurance: the Blockchain approach ...

## 5) Mitigative infrastructure financing: resilience bonds

### III) Case of resilience bond

- Public administration pays a fixed amount

(insurance premiums = coupons for 10 years)  $10 * 10 = 100$

After 5 years:

has a reduced risk exposure of 2 each year!

the “resilience” has increased of 40!

Obs. Public administration still has an “advantage” even if pays a charge  $c$  to the insurance company for issuing services, with  $c * 10 < 40$ .

# Flood risk insurance: the Blockchain approach ...

## 5) Mitigative infrastructure financing: resilience bonds

### III) Case of resilience bond

- After 5 years insurance reduces its risk exposure from 10 to 2,  
so  $8 * 5 = 40$  saved.

So insurance can fix the coupon at level 4, total payment  $4 * 10 = 40$

Its “advantage” is charge  $c * 10$ .

- Investors receive the coupons  $4 * 10 = 40$

and they will lose in average the same amount in a risk neutral environment.

# Flood risk insurance: the Blockchain approach ...

## 3) Automatic updating: smart contracts (blockchain + legal environment)

A smart contract is a piece of code which is stored on a Blockchain, triggered by Blockchain transactions, and which reads and writes data in that Blockchain's database".

(G. Greenspan, "Beware of the Impossible Smart Contract," <http://www.theblockchain.com/2016/04/12/beware-of-theimpossible-smart-contract> 2016)

# Flood risk insurance:the Blockchain approach ...

Some regulatory «pills» around the World

USA

Increasing number of laws dedicated to the regulation of Blockchain technology.

Arizona: House of Bills 2602 12/04/2018, to prohibit the introduction of local regulations regarding Blockchain, aimed at preventing and / or limiting to individuals the management of transactions using Blockchain technology, of exclusive state regulation.

# Flood risk insurance:the Blockchain approach ...

California: Bill 838 28/09/2018, it authorizes joint-stock companies to include in their deed of incorporation specific provisions that allow the registration of issue, transfer and storage operations carried out by their shareholders using Blockchain technology.

New Jersey: Bill 3613 12/03/2018, it prescribes the creation of the New Jersey Blockchain Initiative Task Force, with the task of identifying the advantages deriving from the use of Blockchain technology in the record keeping and service delivery operations, through the development of distributed databases protected by cryptographic algorithms.

# Flood risk insurance:the Blockchain approach ...

## EU

The European Parliament with the Resolution of 3 October "on distributed register and blockchain technologies: creating trust through disintermediation", recognized the relevance of Blockchain technology as a tool "that can democratize data and strengthen trust and transparency", in how "strengthens the autonomy of citizens" and improves "the efficiency of transaction costs by eliminating intermediaries and intermediation costs, as well as increasing the transparency of transactions".

# Flood risk insurance: the Blockchain approach ...

## ITALY

DL semplificazioni 12/02/2019, Italy is at the forefront of blockchain and distributed register technologies with legislation that has a certain revolutionary value for IT documents.

Among the others, it expressly acknowledges the value of contracts and IT documents to software codes. Smart contracts can be used in all cases where the law requires the mandatory written form.

# Flood risk insurance:the Blockchain approach ...

## Smart insurance contracts

### Some examples

- InsureETH – airline field
- AIG – multinational insurance coverage
- AXA insurance – airline field

# Flood risk insurance:the Blockchain approach ...

## Closer look to AXA insurance: FIZZY

- Flight delay or cancellation
- Exclusion of any kind of negligence
- Exclusion of any kind of subjective/objective liability
- Automatic compensation when the event (delay/cancellation) occurs
-

# Flood risk insurance: the Blockchain approach ...

State of the art of Smart Insurance contracts 1/3

All the implemented contract so far are one/dimensional. One shot contracts.

Ex. AXA

Option 1. No delay/cancellation. Premium – no event – no compensation – termination of agreement.

Option 2. Delay/cancellation. Premium – event – compensation – termination of agreement.

# Flood risk insurance:the Blockchain approach ...

State of the art of Smart Insurance contracts 2/2

The blockchain technology is used as the automation of the mechanism of compensation.

- 1) validation of the insured event, such as the hours of flight delay
- 2) the payment of the sum of money (compensation)

Blockchain technology acts exclusively as a verifying agent of the insured event.

# Flood risk insurance:the Blockchain approach ...

Possible implementation of Smart Insurance Contracts

Look forward to developing a multiperiod contract

What would «multiperiod» mean?

Combination of using blockchain data storage technology and modification of the contractual structure

# Flood risk insurance: the Blockchain approach ...

Comparison **traditional**/multiperiod insurance contract 1/3

- **Fixed premium**
- Variable premium in order to the variation of the risk (section on Variable rate Mortgage)
- **Assessment of the risk before signing the contract**
- Assessment of the risk before signing the contract and time by time at the end of any established periods

# Flood risk insurance:the Blockchain approach ...

Comparison **traditional**/multiperiod insurance contract 2/3

- **No need of periodic check of assets/risk/natural hazard**
- **Mandatory periodic check.**
- **No data storage.**
- **IT data storage from Municipalities. Mix Historical data series and data flow in real time. Ex. Flood, rain occurrence, damages etc etc**

# Flood risk insurance: the Blockchain approach ...

Comparison **traditional**/multiperiod insurance contract 3/3

- Instant effect and consequent termination of agreement (One shot)
- Adaptation of the contract in order to the data flow. Continuation of agreement at any period scan without any parties' declaration
- Limited contract time cannot be sufficient for any risk mitigative buildings implementation.
- Multiperiod implementation might be able to create a synergy between municipality and insurance creating risk mitigative buildings

# Flood risk insurance: the Blockchain approach ...

Variable premium? Is really possible to modify the weak party conditions *in peius*?

Legal dissemination on Variable interests rate mortgage/multi-period smart contract

A variable rate mortgage is a type of mortgage whose interest rates vary based on the performance of certain parameters indicated in the contract

Its structure and contractual framework do not seem to coincide with the insurance dynamics.

# Flood risk insurance:the Blockchain approach ...

According to the binding Italian regulations, and in most EU countries, it seems premium insurance shall be established at the beginning of the agreement.

How can we create another *plus* of the contract since the premium shall remain stable?

Engineering area implementation. Planning of risk mitigation structures. Determination of the quantum (surplus) exceeding the right premium according to the risk data scanning.

# Flood risk insurance: the Blockchain approach ...

## Final comments

- In the urban context of cities, resilience translates into a new pathway for urbanization plan (i.e. provides practical rules that can guide stakeholders' to invest on management of disasters and climate risks).
- Urban resilience goes beyond risk mitigation; it increases not just preparedness but also capacity to respond to a disaster and swiftly recover from it.
- Strong agreement among policy makers, practitioners and academic researchers that the concept of resilience must play a major role in assessing the extent to which various entities — critical infrastructure, networks, communities, regions, and the Nation — are prepared to deal with the full range of threats they face.

# Flood risk insurance:the Blockchain approach ...

## Final comments

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- Strong agreement among policy makers, practitioners and academic researchers that the concept of resilience must play a major role in assessing the extent to which various entities — critical infrastructure, networks , communities, regions, and the Nation — are prepared to deal with the full range of threats they face
- For investment in urban resilience insurance play a key role with the need of constant and updated data flow to avoid lack in insurance coverage in-fact guaranteeing an integrated risk assessment
- Promotion of a multidisciplinary block-chain approach

Integration of resilience/insurance concept towards the transition from SEAP to SECAP