Socio-hydrology modelling and flood risk: roles of collective memory, risk-taking attitude and trust

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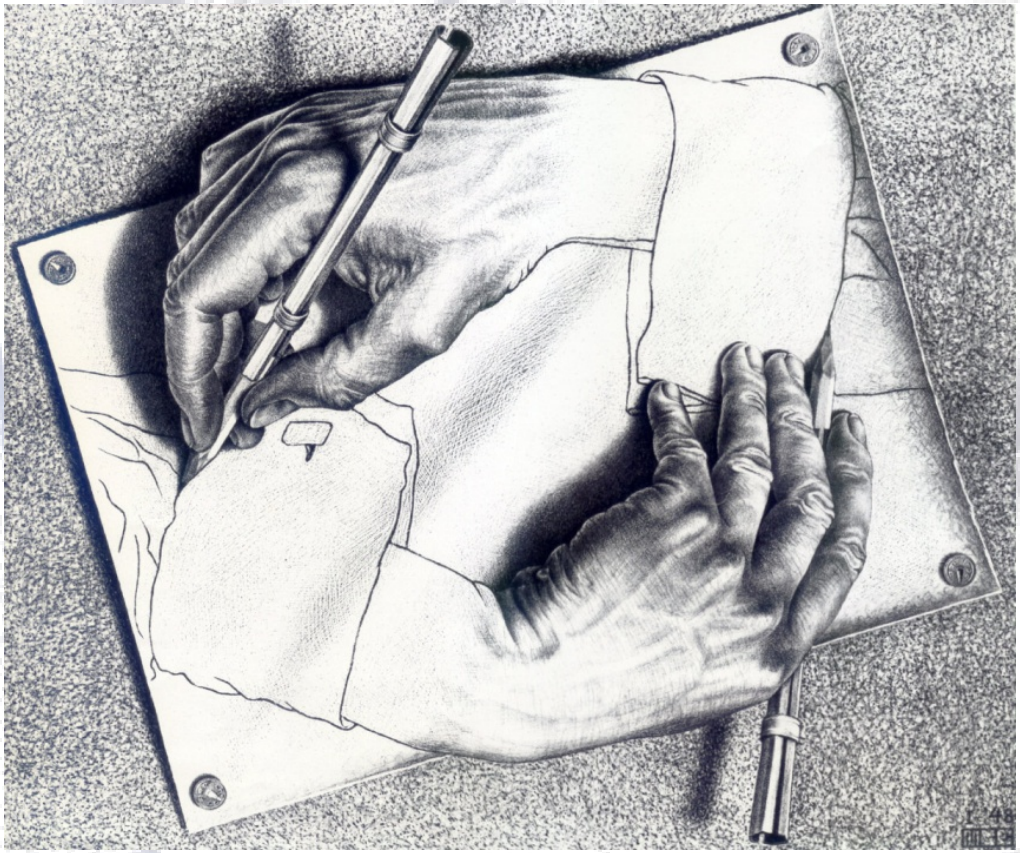
Floods and societies: who shapes who?

Human societies change the hydrology of flooding, while (in turn) the hydrology of flooding shapes societies



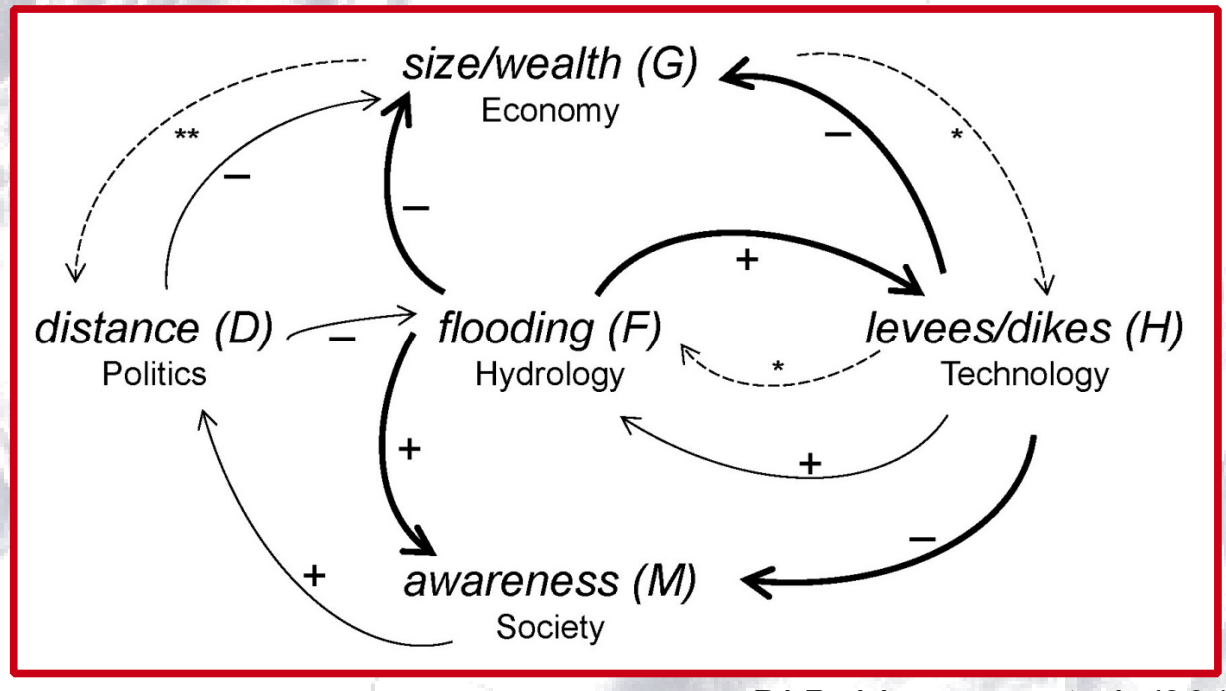
"Drawing hands" by Escher (1948)

Developing theories to explain the **co-evolution of floodplain systems***:*

- *historical studies*
- *comparative studies*
- *modelling studies*

Di Baldassarre et al. (2013a) HESS

Conceptualizing human-flood interactions



Di Baldassarre et al. (2013b) HESS

Focus on **interactions and feedbacks** *between floods and societies*

Hydrological, economical, political, technological, and social processes are simplified (same level of reduced complexity)

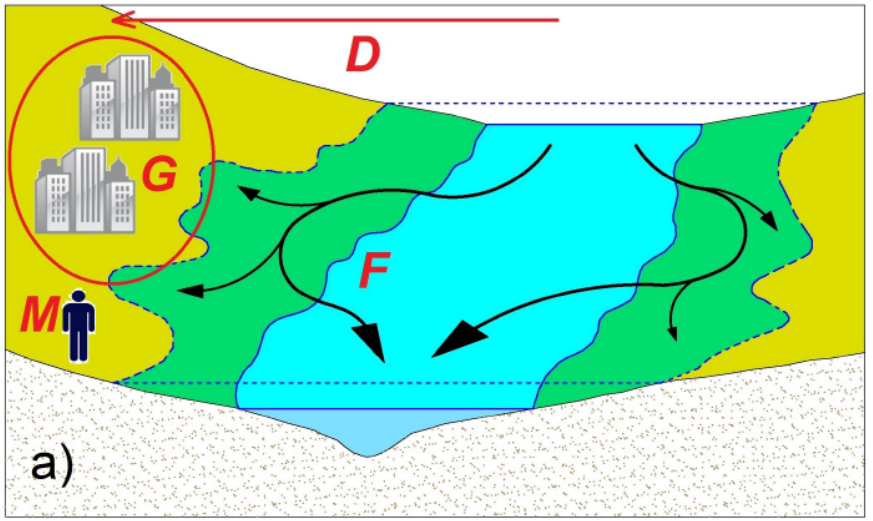
Narrative

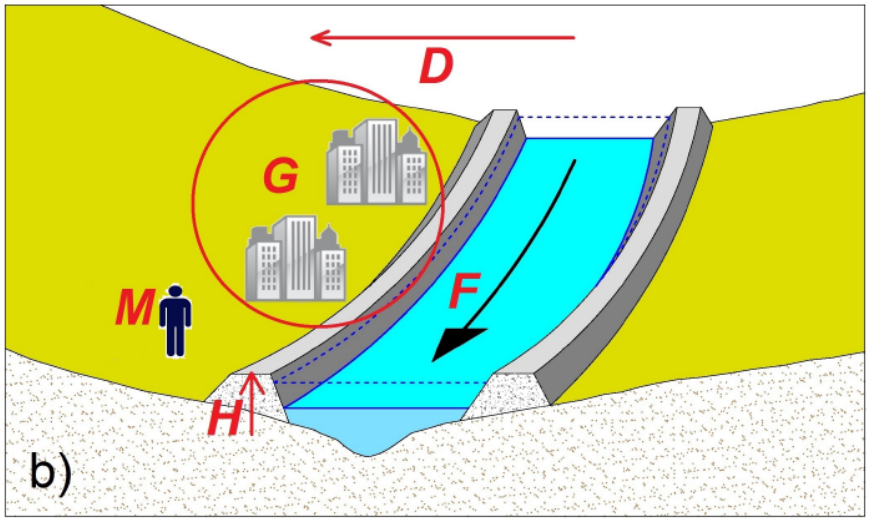
Community starts settling and developing in a floodplain, gaining the associated benefits (e.g. trading)

Occurrence of flooding causes economic damages

Community is shocked and builds flood risk awareness

Community reacts by building away of the river of by building protections





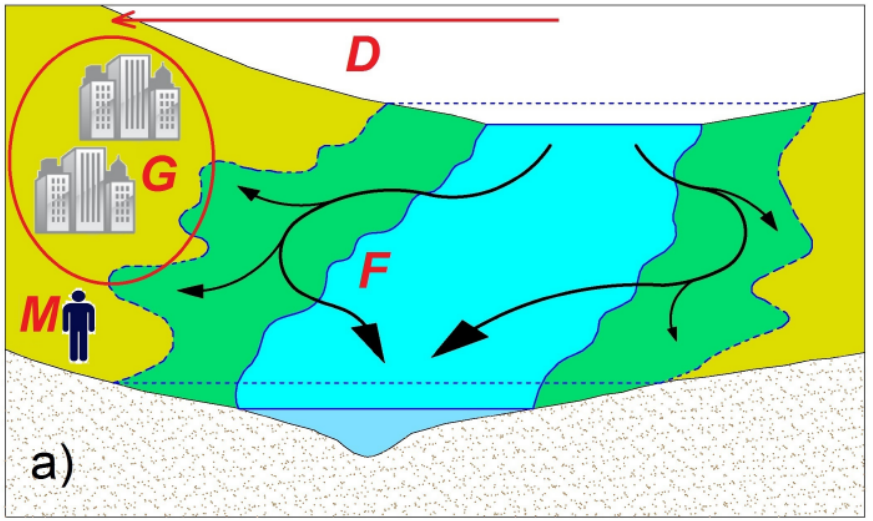
Model

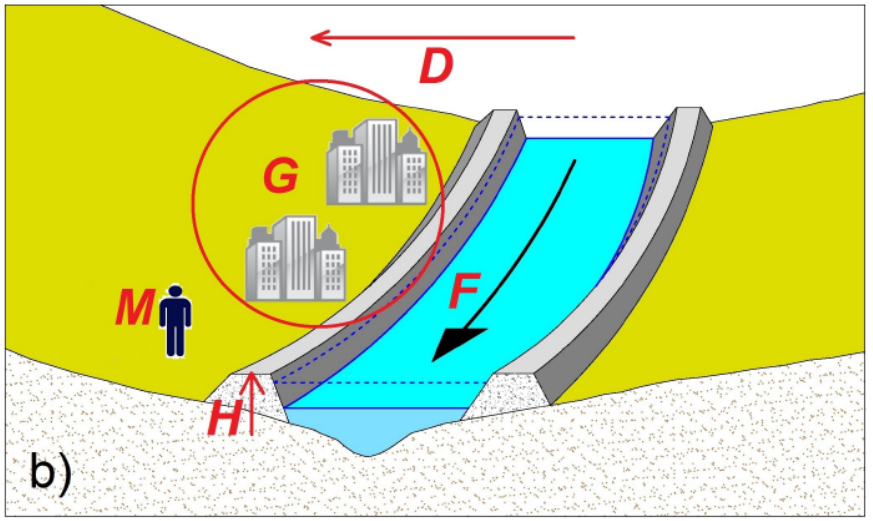
- *Wealth G*
- *Distance from the river D*
- *Protection level H*
- *Flood risk awareness M*
- *Intensity of flooding F*

$$
\begin{cases}
\dfrac{dG}{dt} = \rho_E (1-D) G + & \\
\quad -\Delta(\Upsilon(t)) \cdot \left(FG + \gamma_E R \sqrt{G} \right) & \text{Economy} \\
\dfrac{dD}{dt} = \left(M - \dfrac{D}{\lambda_P} \right) \dfrac{\varphi_P}{\sqrt{G}} & \text{Politics} \\
\dfrac{dH}{dt} = \Delta(\Upsilon(t)) R - \kappa_T H & \text{Technology} \\
\dfrac{dM}{dt} = \Delta(\Upsilon(t)) S - \mu_S M & \text{Society}
\end{cases}
$$

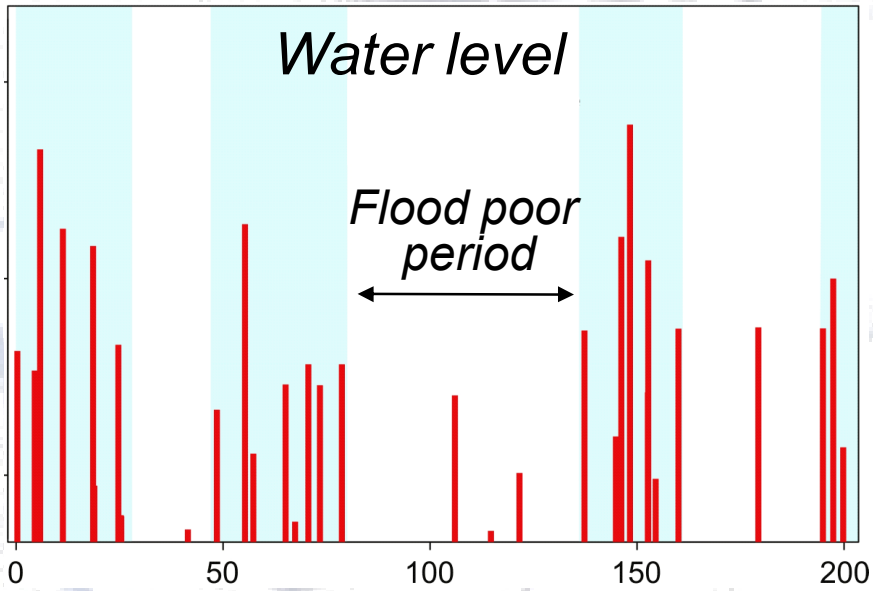
Hydrology:

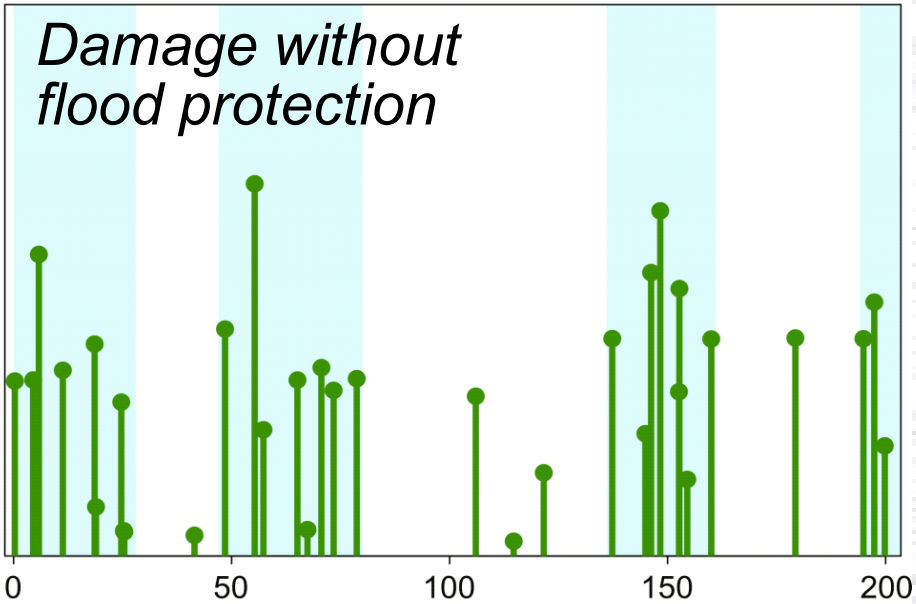
$$
F = \begin{cases}
1 - \exp\left(-\dfrac{W + \xi_H H}{\alpha_H D} \right) & \text{if } W + \xi_H H > H \\
0 & \text{otherwise}
\end{cases}
$$

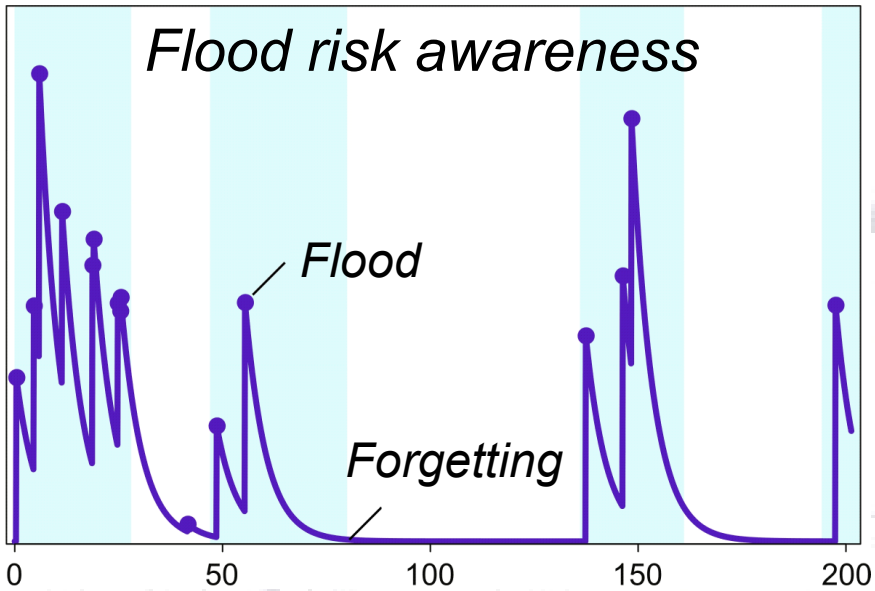


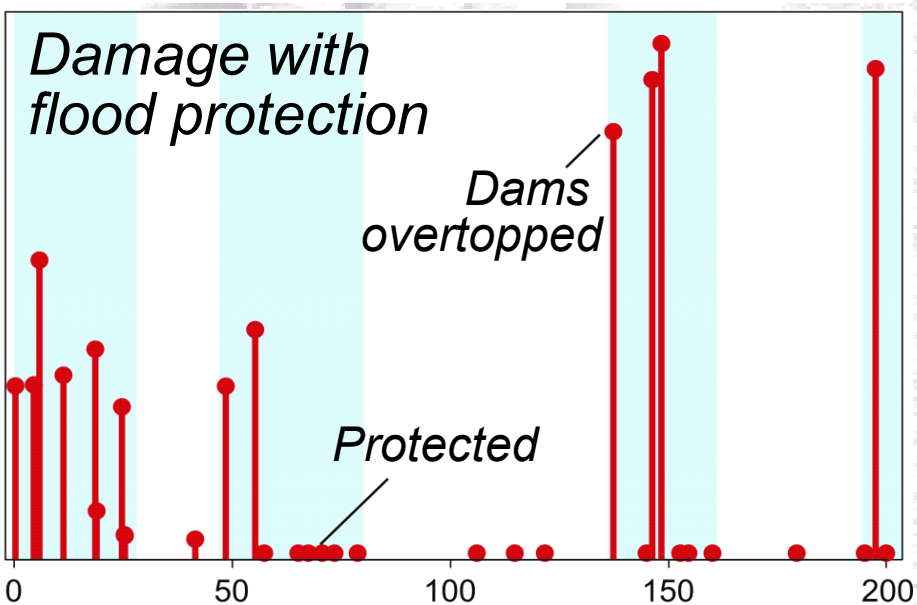


Dynamic model of human-flood interactions





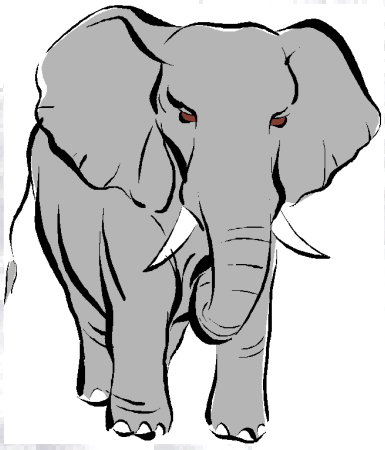


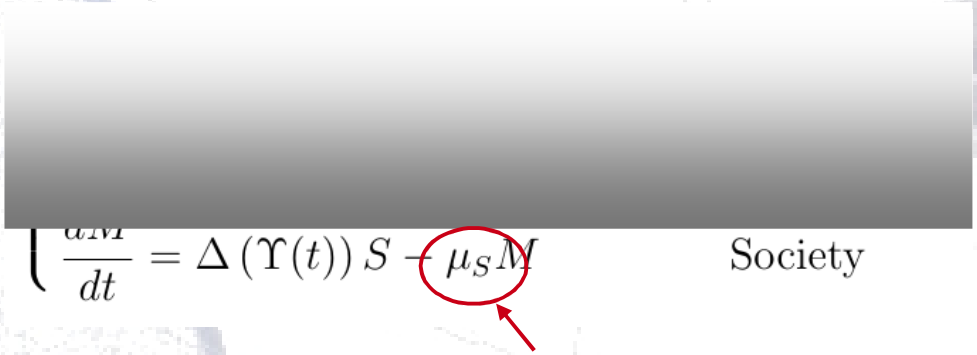


Collective memory

- *Sociologist Maurice Halbwachs (1877-1945): "memory is a matter of how minds work together in society", which fades away if not renewed*

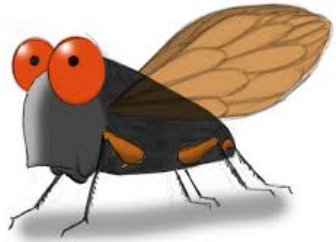
- **Our definition:**
  Capacity of the community to keep the awareness of flooding high





$$\frac{dM}{dt} = \Delta\left(\Upsilon(t)\right) S - \mu_S M \qquad \text{Society}$$

Decade rate of awareness

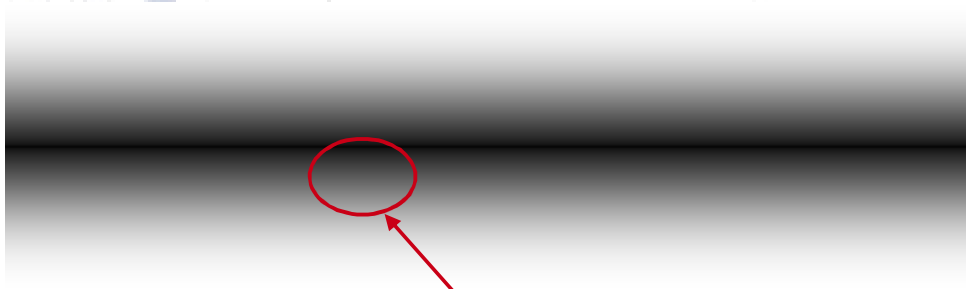


Viglione et al. JoH, under revision

Risk-taking attitude

- *General disposition towards risk (which varies between countries/cultures, male and female, rich and poor)*

- **Our definition:**
  The amount of risk the community is willing to expose itself to



Distance perceived as safe

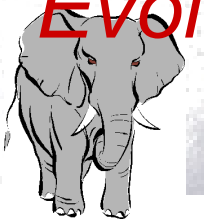
Trust

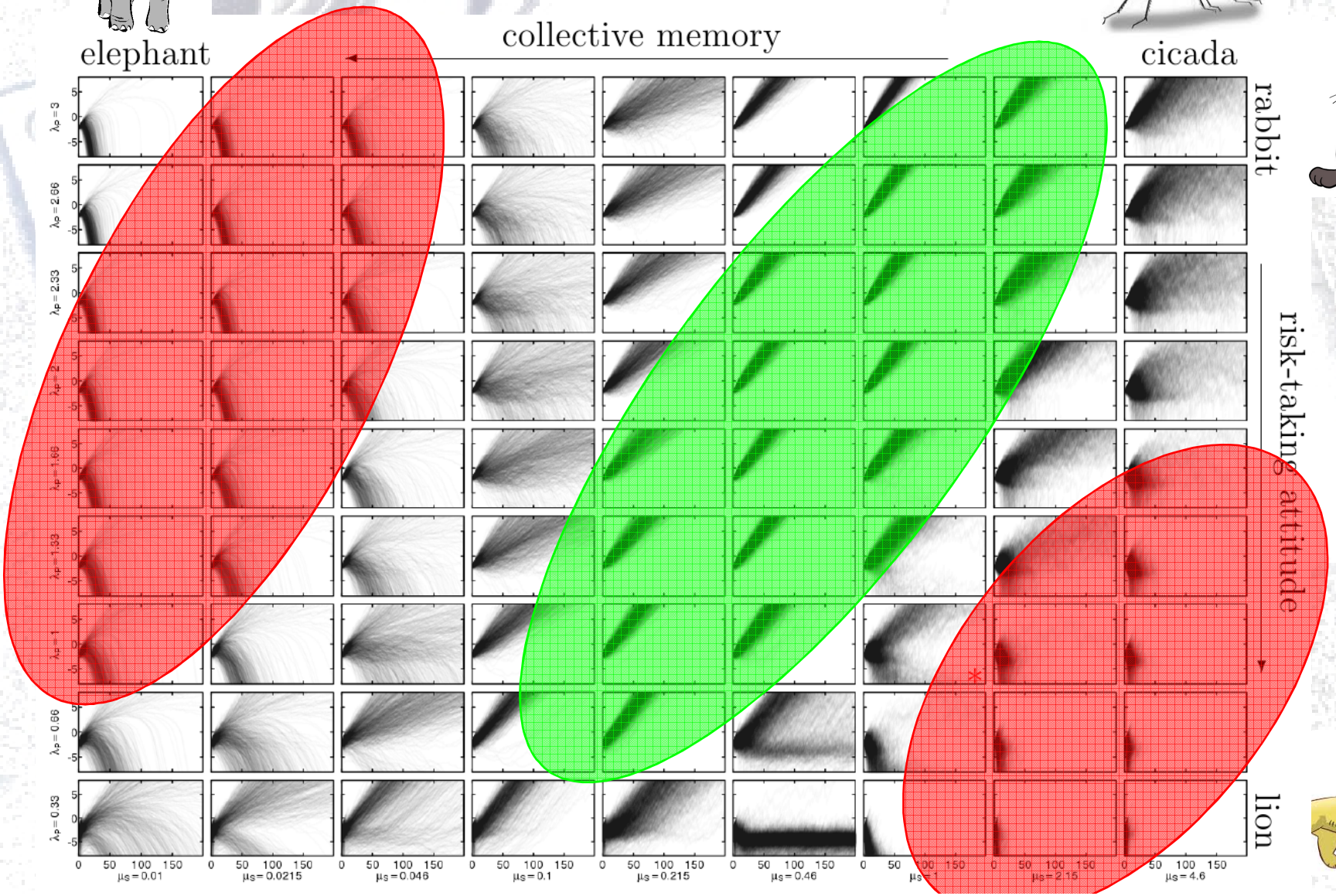
- *Trust in authorities and confidence in protective measures second most important factor for risk perception in natural disasters (Wachinger et al., 2013)*

- **Our definition:**
  Proportion of shock alleviated if levees are raised

$$S = \begin{cases} \alpha_S F & \text{if } (R > 0) \\ F & \text{otherwise} \end{cases}$$

Evolution of the wealth G of the settlement





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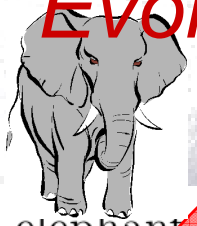

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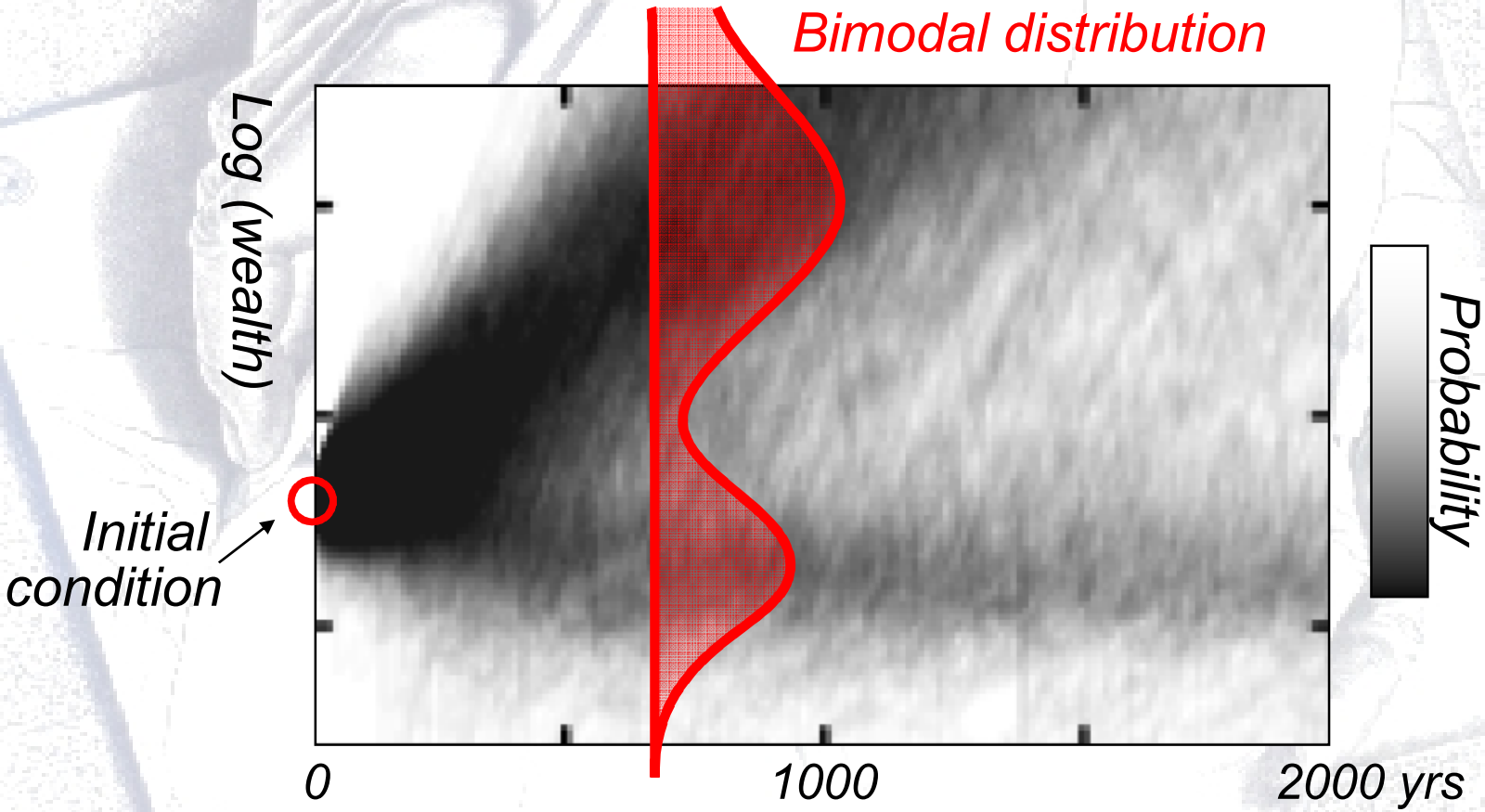

Uncertainty due to differences in **sequence** *of floods only*

Conclusions

- *Complementing historical and comparative studies aiming to developing theories to explain the co-evolution of floodplain systems*

- *Panta Rhei initiative – one of the vehicles to further socio-hydrology research*

Evolution of the wealth G of the settlement