Exploring the role of risk perception in influencing flood losses over time

Elena Ridolfi, Frederike Albrecht, Giuliano Di Baldassarre

elena.ridolfi@geo.uu.se

Download the paper at https://www.tandfonline.com/doi/full/10.1080/02626667.2019.1677907

Why?

• What implications do societies’ risk perceptions have for flood losses?

• Case studies with knowledge of detail, large N studies with lack of detail – how can we structure and categorize?

• How can social science theories be used to explain and predict human behavior and its consequences?
How can we distinguish between different strategies that societies apply to address flood risk?

- Cultural theory: human views and behavior is clustered, shared among groups (rationality)
- We have identified 4 ideal types of societies that cope and respond to flood risk in different ways
- Myths of nature: Four ideal types of society
  
  Fatalist, hierarchic, individualist, egalitarian societies

- Application on flood risk:
  
  Risk neglecting, controlling, downplaying, monitoring societies
Risk rationalities and predicted action

A) Risk neglecting

"Nature cannot be managed, no plans for future needed."

→ No action taken.

B) Risk controlling

"Risks need to be controlled by experts and governments."

→ Technological solutions (levees), government regulations
Risk rationalities and predicted action

“Our environment is very robust and resilient.”
→ Insufficient action taken.

C) Risk downplaying

“All of us need to act to not to disturb the precarious balance.”
→ Participative action, increase risk awareness, relocation etc.

D) Risk monitoring

Images of animals from the web

Ridolfi et al., HSJ, 2020
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**Sociohydrological model**

\[
\frac{dD}{dt} = \rho_D [1 - D(1 + \alpha_D M)] - \Delta(\psi(t)) \cdot FD_-
\]

\[
\frac{dH}{dt} = \Delta(\psi(t)) \cdot R - \kappa_T H
\]

\[
\frac{dM}{dt} = \Delta(\psi(t)) \cdot FD_+ - \mu_S M.
\]

The reduction of the population due to the relocation of people after a flood event and the contemporaneous building of societal memory

As a response to the flood event, the community may also decide to either protect the floodplain with structural measures (i.e. building or heightening levees; \(H\)), or not

As soon as the community experiences a flood event, it builds memory (\(M\)) of the flooding

The memory, built because of the occurrence of flooding, reduces to half its initial value in a time (half-life, \(\lambda\))

\[
\mu_S = \frac{\ln(2)}{\lambda}
\]

**Flood damage**

\[
F = 1 - \exp\left(-\frac{W + \xi_H H_-}{\alpha_H}\right) \text{ if } W + \xi_H H_- > H_-
\]

**Levee heightening**

\[
R = \begin{cases} 
\varepsilon_T (W - \xi_H H_- - H_-); & \text{technological} \\
0; & \text{green}
\end{cases}
\]
Sociohydrological model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Risk neglecting (fatalistic)</th>
<th>Risk controlling (hierarchical)</th>
<th>Risk downplaying (hierarchical)</th>
<th>Risk monitoring (egalitarian)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$ (Preparedness)</td>
<td>0</td>
<td>Medium (2.5-7.5)</td>
<td>Low (0.5-5.5)</td>
<td>High (7.5-15)</td>
</tr>
<tr>
<td>$\lambda$ (Memory coeff.)</td>
<td>Any value (2-8 yrs)</td>
<td>Medium/High (5-10 yrs)</td>
<td>Low (2-5 yrs)</td>
<td>High (5-15 yrs)</td>
</tr>
<tr>
<td>Levee construction</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>$\rho_v$ (Demographic growth)</td>
<td>Medium/High (0.02-0.08 yrs$^{-1}$)</td>
<td>Medium (0.02-0.04 yrs$^{-1}$)</td>
<td>Medium (0.02-0.04 yrs$^{-1}$)</td>
<td>Very low (0.001-0.01 yrs$^{-1}$)</td>
</tr>
</tbody>
</table>
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Sociohydrological model

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Cumulative flood losses over time

R.Monitoring
R.Controlling
R.Downplaying
R.Neglecting

Sum Flood Losses [-]
Take home message

• Societies that tend to neglect or underestimate risks, are in danger of experiencing high flood losses without the capacity to learn from past flood events and adopt adequate measures

• Societies that attempt to control flood risk through the construction of levees will decrease their total flood losses

• However, a dense population in the floodplain that feels safe due to the presence of a levee may experience catastrophic outcomes of a flood event if the levee system fails

• In contrast, risk monitoring societies stand out in their ability to maintain high flood-risk awareness and a memory of flood events that guides participatory preparedness measures

• Our model does not identify any catastrophic impact of floods on this type of society, not even for water levels that cause catastrophic flood damage in other societies
Want to know more?

Check out the paper at

https://www.tandfonline.com/doi/full/10.1080/02626667.2019.1677907
“For in the end, it is all about memory, its sources and its magnitude, and, of course, its consequences”

Elie Wiesel
Thank you!