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A socio-hydrological model to explore the role of social inequality on human-flood interactions

HS5.2.1 Advances in Socio-Hydrology

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Inequality and urban flood risk

- Cities are heterogeneous, and do not interact with natural hazards uniformly
- The urban poor are disproportionately affected by climate variability and shocks
- Hence, if socio-hydrology is to contribute to the SDGs (Di Baldassarre *et al*., 2019), it must consider the effect of inequality on human-water interactions
- From a modelling perspective, this will involve encoding societal heterogeneities in our conceptual models
- Here, we adapt the well known flood model of Di Baldassarre *et al*. (2013) and Viglione *et al*. (2014) to consider a stratified society consisting of planned and unplanned settlements

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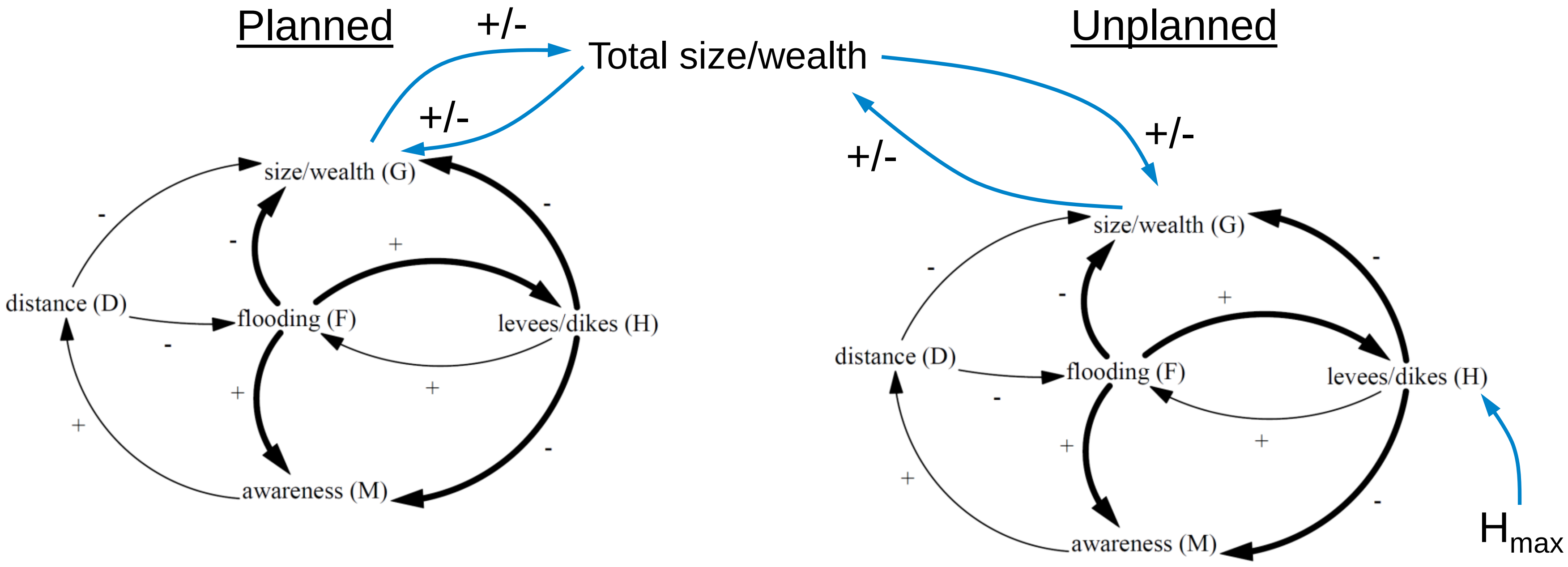
The two neighbourhoods are linked through the redistribution of wealth, which is controlled by a new parameter, τ_P



Inequality also manifests as a lack of empowerment. To account for this, we introduce a parameter, H_{max}, to limit the height of flood protection in the unplanned settlement

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We use three parameters to represent inequality:

	Description	**Domain**	**Planned**	**Unplanned**
τ_P	Proportion of wealth differential which is redistributed	Politics	0 - 1	
H_{max}	Maximum height of flood protection	Politics	∞	0 - ∞
α_H	Slope of floodplain/resilience of human settlement	Hydrology	10	0 - 10

All other parameter values as per Viglione *et al*. (2014)

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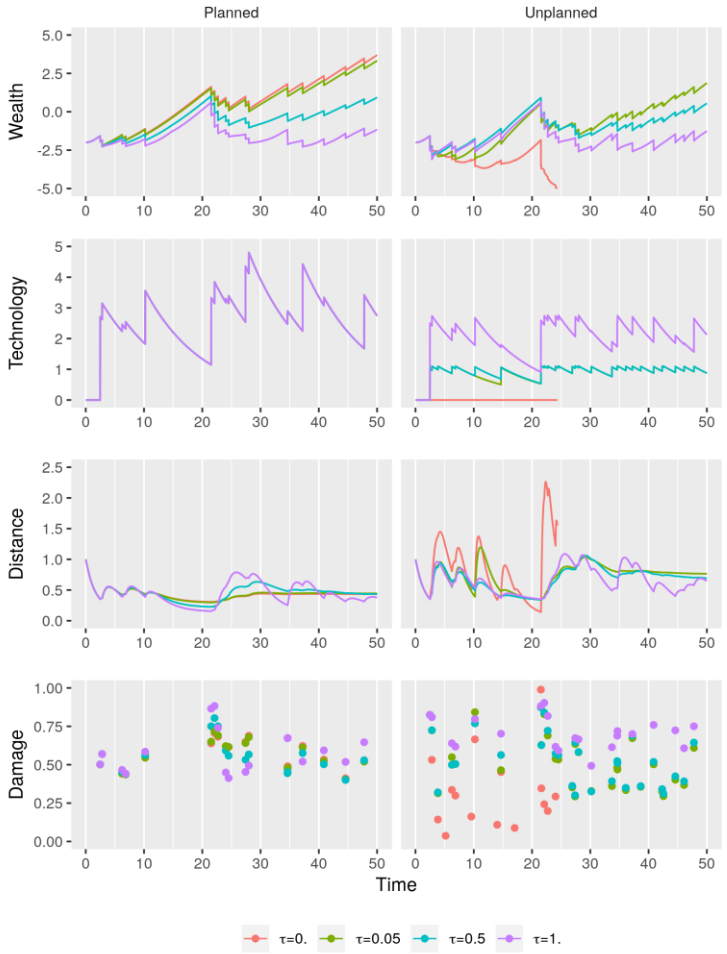
Scenario 1: Cheap protection

	Planned	Unplanned
τ_P	{ 0, 0.05, 0.5, 1 }	
H_{max}	{ (∞, 0), (∞, 1), (∞, 1), (∞, 2.5) }	
γ_E	$5 \cdot 10^{-3}$	
α_H	10	4



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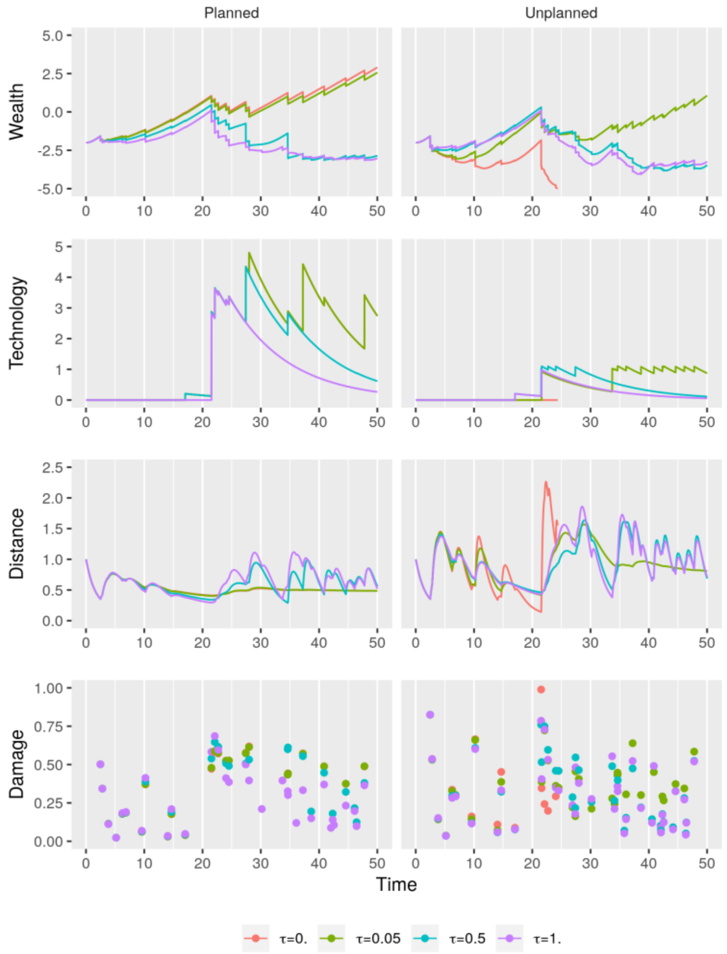
Scenario 2: Expensive protection

	Planned	Unplanned
τ_P	{ 0, 0.05, 0.5, 1 }	
H_{max}	{ (∞, 0), (∞, 1), (∞, 1), (∞, 2.5) }	
γ_E	0.1	
α_H	10	4



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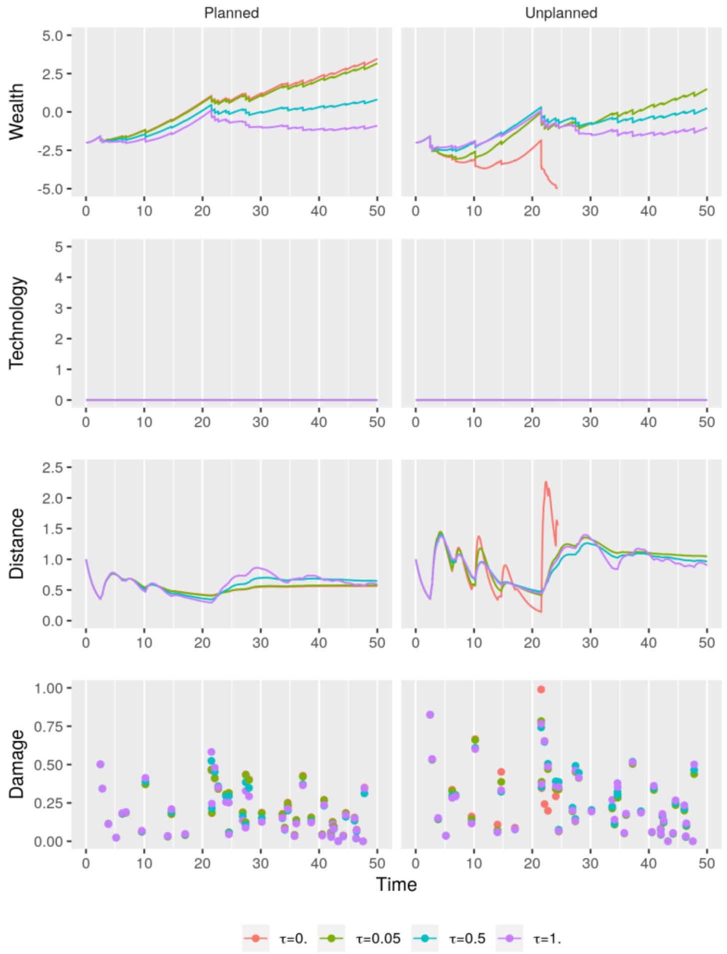
Scenario 3: Prohibitively expensive protection

	Planned	Unplanned
τ_P	{ 0, 0.05, 0.5, 1 }	
H_{max}	{ (∞, 0), (∞, 1), (∞, 1), (∞, 2.5) }	
γ_E	∞	
α_H	10	4



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Conclusion

- Under scenarios of no wealth redistribution, the unplanned settlement fails before the end of the simulation
- The model is sensitive to the redistribution parameter (τ_P), highlighting the challenge of selecting an appropriate level of taxation to raise living standards while encouraging economic growth
- Community-driven, sub-optimal flood protection measures (i.e. installing protection which is lower than the previous flood depth) may produce an effect similar to the adaptation effect
- Policies to reduce flood risk must tackle the structural inequalities which contribute to the exposure and vulnerability of inhabitants

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References

- Di Baldassarre, G., Sivapalan, M., Rusca, M., Cudennec, C., Garcia, M., Kreibich, H., Konar, M., Mondino, E., Mård, J., Pande, S. and Sanderson, M.R. (2019). Sociohydrology: Scientific challenges in addressing the sustainable development goals. *Water Resources Research*, *55*(8), 6327-6355.
- Di Baldassarre, G., Viglione, A., Carr, G., Kuil, L., Salinas, J. L., & Blöschl, G. (2013). Socio-hydrology: conceptualising human-flood interactions. *Hydrology and Earth System Sciences*, *17*(8), 3295.
- Viglione, A., Di Baldassarre, G., Brandimarte, L., Kuil, L., Carr, G., Salinas, J. L., Scolobig, A. & Blöschl, G. (2014). Insights from socio-hydrology modelling on dealing with flood risk–roles of collective memory, risk-taking attitude and trust. *Journal of Hydrology*, *518*, 71-82.