From large scale climate change to socio-economic losses: the case of hurricanes in the U.S.

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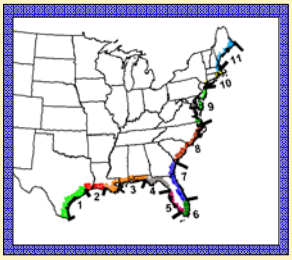


Introduction

Assessing climate change economic damages requires a multi-step approach: (1) large-scale climate change prediction; (2) downscaling to a spatial scale pertinent for impact assessment; (3) assessment of changes in physical hazard or impact; (4) assessment of changes in direct losses; (5) assessment of total losses, including economic feedbacks; (6) investigation of anticipated and reactive adaptation options.

As an illustration, this poster investigates the consequence of a global 10% increase in potential intensity. Downscaling is carried out using the Emanuel's hurricane model that produces 3000 synthetic tracks in the Present Climate and 3000 tracks in the Modified Climate. From these sets of tracks, this poster presents the steps (3), (4) and (5) of a full impact assessment.

(1) Assessment of changes in annual landfall probabilities

Present climate

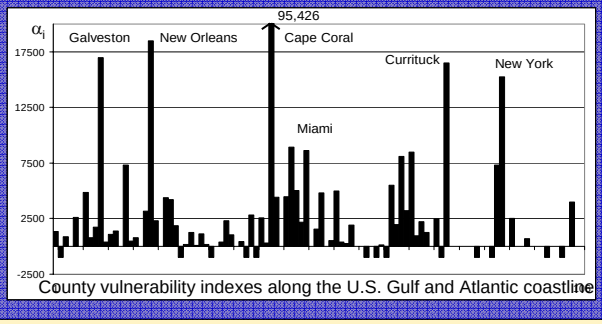
Category / Region	1	2	3	4	5
1	8.9%	2.6%	1.0%	2.9%	0.0%
2	17.0%	3.3%	2.6%	3.3%	0.7%
3 (New Orleans)	**11.6%**	**4.9%**	**3.6%**	**2.3%**	**0.3%**
4	14.2%	5.5%	3.6%	1.0%	1.3%
5	22.1%	6.5%	7.4%	5.2%	3.6%
6	4.2%	2.0%	1.7%	0.3%	0.0%
7	6.1%	4.9%	3.9%	1.3%	0.7%
8	5.8%	1.3%	2.9%	2.3%	0.3%
9	7.1%	2.6%	0.7%	0.0%	0.0%
10	2.3%	0.7%	0.0%	0.0%	0.0%
11	1.3%	1.0%	0.3%	0.0%	0.0%

Modified climate

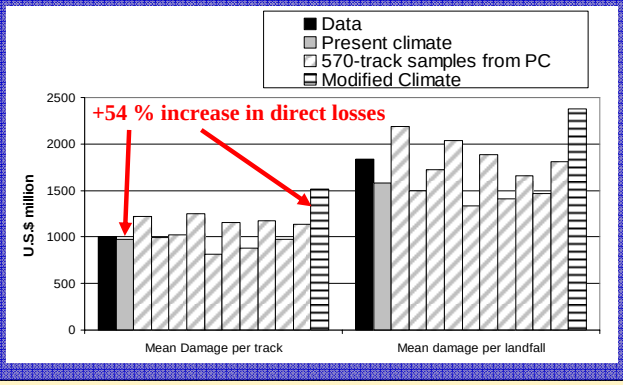
Category / Region	1	2	3	4	5
1	13.9%	2.9%	2.9%	3.9%	2.0%
2	22.9%	7.4%	5.8%	3.3%	3.6%
3	15.6%	5.8%	6.8%	2.9%	2.9%
4	20.6%	7.1%	6.8%	3.3%	2.3%
5	26.9%	9.8%	10.4%	6.5%	9.5%
6	6.5%	3.6%	1.7%	1.0%	0.00%
7	7.1%	3.9%	2.9%	5.5%	2.3%
8	6.8%	3.3%	3.6%	4.2%	0.3%
9	9.8%	5.2%	1.3%	0.3%	0.0%
10	2.9%	0.3%	0.00%	0.3%	0.0%
11	2.9%	0.7%	0.3%	0.3%	0.0%

(2) Assessment of changes in direct costs

Vulnerability indexes (α_i) can be estimated in each county from past hurricane losses (L) and wind (W), assuming the relationship: $L = \alpha_i \cdot W^3$



County vulnerability indexes along the U.S. Gulf and Atlantic coastline



(3) Assessment of changes in total (direct + indirect costs)

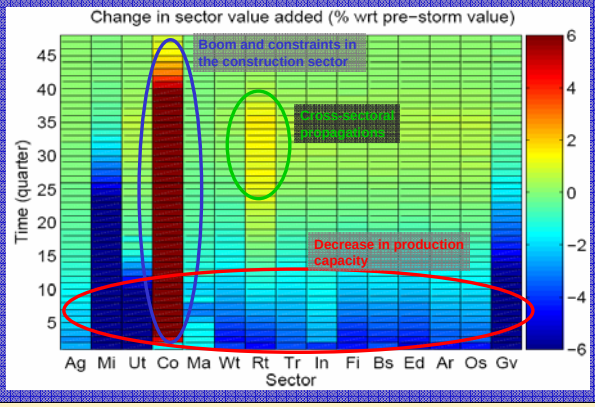
Direct losses:
- Casualties and injuries
- Direct economic losses

Indirect losses:
- Emergency costs (Katrina: $8 billion)
- Business interruption, supply-chain disruption
- Lost production during the (long) reconstruction period
- Demand surge (larger repair costs)
- Macro-economic feedbacks
- Long-term adverse consequences on economic growth

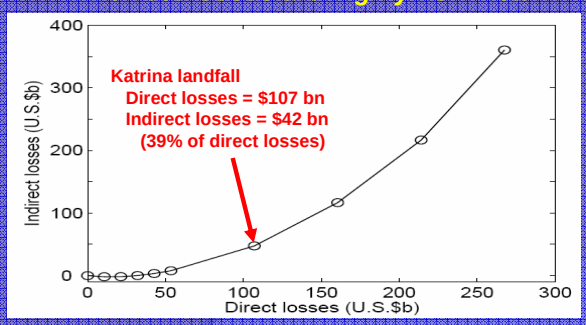
Other costs:
- Political destabilization (developing countries)
- Psychological trauma and social network disruption

Modeling of indirect losses using the ARIO model, based on Input-Output table, simple adaptation rules (e.g., regarding substitution with imports), and limited sector production capacities.

Including indirect losses, total losses in the Modified Climate are 62% larger than in the Present Climate



Indirect losses are highly nonlinear



In the Modified Climate, there is a doubling of the likelihood of a hurricane with losses > $50bn

Conclusions

Different stakeholders need different information to cope with and adapt to climate change. Here, we assume a global 10% increase in potential intensity and we provide: the change in hurricane landfall probability over the U.S. coastline (useful for risk management); the change in direct losses (useful for the insurance industry); and the change in total losses (useful for policymakers and cost-benefit analyses).

The increase in average hurricane risks is found manageable. The risk from the most intense or destructive hurricanes (cat-5 hurricanes or losses > $50bn) is the most worrisome point.

Socio-economic drivers will dominate the future evolution of hurricane risks. Adaptation options can reduce them in a significant way.

The Emanuel's model is particularly pessimistic, but the fact that hurricane risks may increase as much as projected here must be taken into account in many today's decisions (e.g., urbanism, building norms, infrastructure design, etc.)

Parts of these results are published in Journal of Applied Meteorology and Climatology.
Others are submitted to Risk Analysis and to the book "Climate change and Hurricanes", edited by J. Elsner and T. Jagger.