Resilience Bond / Insurance Concept
mangrove case study

The Nature Conservancy / Munich Re
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Mangrove science:
General background

- **Mangrove risk reduction science** indicates 10 – 30% flood risk reduction (surge-driven flooding) and 5 – 15% wind risk reduction.

- The level of risk reduction depends on the type of storm and the mangrove characteristics.

- For wind-waves, wave height can be reduced by 50-100 % over 500 meters of mangrove forest.

- Mangrove species with dense vegetation are most effective at reducing wave height.

- With respect to storm surges, water level measurements and numerical models show that mangroves can reduce storm surge peak water levels by 5-50 cm/km of mangrove forest.
Mangrove science: Risk reduction benefits

Global averted flooding to people

Mangrove science: Indonesia

Avoided annual built capital losses ($ millions /100km)

Mangrove science: Indonesia
Annual averted flooding (population per 100km)

Mangrove science: Philippines
High-resolution flood mapping example

1 in 50 year flooding case study

Historical – 1950

Current

No Mangroves

Mangrove science

*Implementation aspects and comparison*

<table>
<thead>
<tr>
<th>Restoration Techniques</th>
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<tr>
<td>Mangroves</td>
<td>Coral Reefs</td>
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<tr>
<td>▪ Successful restoration (for risk reduction) – tens of thousands of hectares</td>
<td>▪ Biological restoration – e.g., coral planting</td>
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<td>▪ Native species and location matter (non-native species in novel places fail)</td>
<td>▪ Structural restoration – e.g., reef blocks</td>
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<td>▪ May need to reduce seaward erosion first</td>
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<th>Costs and Timeline</th>
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<td>▪ <em>Planting costs:</em> $5 - $10k per hectare, implying $100 - $200k costs per km of coastline protected</td>
<td>▪ <em>Restoration costs:</em> $1 – 3 mill. per km of structural reef restoration</td>
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<td>▪ <em>Benefits delivery:</em> 2-10 year growth window with risk reduction growing rapidly</td>
<td>▪ <em>Benefits delivery:</em> Immediate upon structural reef restoration (also influence on sediment and coastal stability)</td>
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<th>Risk Reduction Impact</th>
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<tr>
<td>▪ 10 – 30% flood risk reduction (surge-driven flooding)</td>
<td>▪ 10 – 50% flood risk reduction (wave driven flooding)</td>
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<tr>
<td>▪ 5 – 15% wind risk reduction (after fully grown) (Das and Crepin, 2013)</td>
<td>▪ Potential benefits on shoreline accretion &amp; stability (not quantified)</td>
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Mangrove restoration is less expensive than coral reef restoration. The risk reduction effects will materialize faster than coral reef biological restoration but slower than coral reef structural restoration.
Appendix: The trade-off between risk transfer and resilience-building measures (I/II)

- Upfront investment is amortized via future reduction in risk
- But risk reduction benefits are rarely quantified and not accounted for tangibly

- Future pay-out provides a substantial contribution to post-event relief / recovery
- But premiums may be viewed as “money in insurer’s pockets” if an event does not occur
A resilience insurance solution aims to overcome the trade-off between risk reduction and risk transfer, linking the risk reduction effect with an insurable risk within a combined solution:

- A resilient investment at the beginning of the period reduces the underlying risk
- The risk mitigating impact is monetized via reduced premiums
- An incentive is created both for risk-reducing infrastructure as well as for risk transfer resulting in increased community resilience
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