Sea level rise: impacts and adaptation options

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Sea Level rise: a signature of global warming

Volume expansion + melting of major stores of land ice + land water storage

SOURCE: IPCC
GMSLR: a signature of global warming

GROUND DATA: 1870-2000
Data source: Coastal tide gauge records.
Credit: CSIRO

1870-2000

1993-

6 cm in 22 years

20 cm in 125 years

SOURCE: NASA
Regional variability (1993-)
Table 5-2 | Projections of global mean sea level rise in meters relative to 1986–2005 are based on ocean thermal expansion calculated from climate models, the contributions from glaciers, Greenland and Antarctica from surface mass balance calculations using climate model temperature projections, the range of the contribution from Greenland and Antarctica due to dynamical processes, and the terrestrial contribution to sea levels, estimated from available studies. For sea levels up to and including 2100, the central values and the 5–95% range are given whereas for projections from 2200 onwards, the range represents the model spread due to the small number of model projections available and the high scenario includes projections based on RCP6.0 and RCP8.5. Source: WG IAR5 Summary for Policymakers and Sections 12.4.1, 13.5.1, and 13.5.4.

<table>
<thead>
<tr>
<th>Emission scenario</th>
<th>Representative Concentration Pathway (RCP)</th>
<th>2100 CO₂ concentration (ppm)</th>
<th>Temperature increase (°C)</th>
<th>Mean sea level rise (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2081–2010</td>
<td>2046–2065</td>
</tr>
<tr>
<td>Low</td>
<td>2.6</td>
<td>421</td>
<td>1.0 [0.3–1.7]</td>
<td>0.24 [0.17–0.32]</td>
</tr>
<tr>
<td>Medium low</td>
<td>4.5</td>
<td>538</td>
<td>1.8 [1.1–2.6]</td>
<td>0.26 [0.19–0.33]</td>
</tr>
<tr>
<td>Medium high</td>
<td>6.0</td>
<td>670</td>
<td>2.2 [1.4–3.1]</td>
<td>0.25 [0.18–0.32]</td>
</tr>
<tr>
<td>High</td>
<td>8.5</td>
<td>936</td>
<td>3.7 [2.6–4.8]</td>
<td>0.29 [0.22–0.38]</td>
</tr>
</tbody>
</table>
# Impacts of SLR

**Table 5-3** | Main impacts of relative sea level rise. Source: Adapted from Nicholls et al. (2010).

<table>
<thead>
<tr>
<th>Biophysical impacts of relative sea level rise</th>
<th>Other climate-related drivers</th>
<th>Other human drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryland loss due to erosion</td>
<td>Sediment supply, wave and storm climate</td>
<td>Activities altering sediment supply (e.g., sand mining)</td>
</tr>
<tr>
<td>Dryland loss due to submergence</td>
<td>Wave and storm climate, morphological change, sediment supply</td>
<td>Sediment supply, flood management, morphological change, land claim</td>
</tr>
<tr>
<td>Wetland loss and change</td>
<td>Sediment supply, CO₂ fertilization</td>
<td>Sediment supply, migration space, direct destruction</td>
</tr>
<tr>
<td>Increased flood damage through extreme sea level events (storm surges, tropical cyclones, etc.)</td>
<td>Wave and storm climate, morphological change, sediment supply</td>
<td>Sediment supply, flood management, morphological change, land claim</td>
</tr>
<tr>
<td>Saltwater intrusion into surface waters (backwater effect)</td>
<td>Runoff</td>
<td>Catchment management and land use (e.g., sand mining and dretching)</td>
</tr>
<tr>
<td>Saltwater intrusion into groundwaters leading to rising water tables and impeded drainage</td>
<td>Precipitation</td>
<td>Land use, aquifer use</td>
</tr>
</tbody>
</table>

SOURCE: IPCC
Flooding components

AT: Astronomical Tide
SSL_PW: Storm surge (Pressure + Wind set-up)
SSL_H: Wave component (run-up/ set-up; a*Hs)
TWL: Total Water Level

0.1<a<0.4
(Subsidence/uplift)

Coastal Flooding

Local Mean Sea Level
Coastal Development

60’s

today

Spanish Mediterranean coast: 1st Km - 40% urbanized!
Implications for coastal protection

Figure 5-2 | The estimated increase in height (m) that flood protection structures would need to be raised in the 2081–2100 period to preserve the same frequency of exceedences that was experienced for the 1986–2005 period, shown for 182 tide gauge locations and assuming regionally varying relative sea level rise projections under an Representative Concentration Pathway 4.5 (RCP4.5) scenario (adapted from Hunter et al., 2013).

SOURCE: IPCC
Impacts on natural systems

a, Seagrass meadows and coral reefs form distinct ecosystems, yet often live in close proximity in linked tropical marine ecosystems. b, Coral reefs block and dissipate wave energy and permit seagrass, which is less wave tolerant, to exist in protected lagoons. c, Deepening water from sea-level rise will allow larger, more energetic waves to traverse the reef into the lagoon, reducing habitat suitability for seagrass.
The need for adaptation

- technological
- policy related
- financial
- institutional
- ecosystem-based
Figure 2 Ecosystems can form an important part of risk reduction, which is typically achieved through a combination of environmental, engineered, social, cultural, and legal approaches as illustrated in the upper figure. Cumulative interventions (lower figure) cannot remove risk, but rather reduce it to an acceptable level of residual risk.
Take home messages

Coastal systems and low-lying areas will increasingly experience adverse impacts due to relative sea level rise

Adaptation is already occurring

Not reaching an immediate stringent reduction of emissions will extend our commitment to SLR for centuries due to delayed response of MSL to warming