# 13 Coastal Infrastructure

## 13.1 Scenarios

Climate change affects coastal infrastructure through rising mean and extreme sea levels, causing damages through temporary flooding and losses due to permanent submergence of land. To assess these impacts, climate scenarios have to be complemented by sea-level-rise projections. While the information about thermal expansion and dynamical changes of sea level is provided by the four GCMs considered, contributions from mountain glaciers and ice sheets have to be added from other sources, which introduces a further dimension of uncertainty (see section 5). The uncertainty range introduced is substantial and a least on equal footing with the climate model and scenario uncertainty (e.g. Kopp et al. 2014). To reflect this aspect we include an additional scenario dimension in the scenario design for this sector and sample this by providing projections for the median and $5^{th}$ and $95^{th}$ percentiles of the contributions from ice sheets and mountain glaciers to sea-level rise. One aspect specific to the coastal-infrastructure sector is that impacts are extremely non-linear in and sensitive to adaptation. Impacts without adaptation are 2-3 orders of magnitudes higher than those with adaptation (Hinkel et al. 2014). This leads to the circumstance that the regions with the highest infrastructure damages under the scenarios without adaptation are actually the regions least vulnerable to sea-level rise, because it is highly cost-efficient and standard practise to protect those regions against sea-level rise. Scenarios including adaptation are therefore added to the protocol to provide projections of climate change risks including adaptation potentials.

Those models that do not account for varying societal conditions (population, GDP, protection levels etc.) should keep these fixed at year 2005 levels throughout the simulations (**2005soc** scenario in Group 1 (dashed line in Figure 1 a) + **rcp26soc** or **rcp60soc** scenario in Group 2). They only need to run the first pre-industrial period of Experiment I (1661-1860). Group 3 runs only refer to models that are able to represent future changes in societal conditions.

| **Climate & $CO_2$ scenarios** | |
|---|---|
| **picontrol** | Pre-industrial climate (year specific for the entire period 1661-2299) |
| **historical** | Historical climate and $CO_2$ concentration. |
| **rcp26** | Future climate and $CO_2$ concentration from RCP2.6 |
| **rcp60** | Future climate and $CO_2$ concentration from RCP6.0 |
| **Human influence & land-use scenarios** | |
| **1860soc** | Pre-industrial society and protection |
| **2005soc** | Representation of fixed year 2005 society and protection |
| **ssp2soc** | Varying society and protection according to SSP2 |
| **2100ssp2soc** | Representation of fixed year 2100 society and protection according to SSP2 |

**Table 31** ISIMIP2b scenario specification for the simulations of impacts on coastal infrastructure.

| | Experiment | Input | Pre-industrial 1661-1860 | Historical 1861-2005 | Future 2006-2099 | Extended future 2100-2299 |
|---|---|---|---|---|---|---|
| **I** | no climate change, pre-industrial $CO_2$<br><br>varying society & protection up to 2005, then fixed at 2005 levels thereafter | Climate & $CO_2$ | **picontrol** | **picontrol** | **picontrol** | **picontrol** |
| | | Human & LU | Option 1:**1860soc** | Option 1: **histsoc** | **2005soc** | **2005soc** |
| | | | Option 2*: **2005soc** | Option 2*: **2005soc** | | |
| **II** | RCP2.6 climate & $CO_2$<br><br>varying society & protection up to 2005, then fixed at 2005 levels thereafter | Climate & $CO_2$ | Experiment I | **historical** | **rcp26** | **rcp26** |
| | | Human & LU | | Option 1*: **histsoc** | **2005soc** | **2005soc** |
| | | | | Option 2*: **2005soc** | | |
| **III** | RCP6.0 climate & $CO_2$<br><br>varying society & protection up to 2005, then fixed at 2005 levels thereafter | Climate & $CO_2$ | Experiment I | Experiment II | **rcp60** | not simulated |
| | | Human & LU | | | **2005soc** | |
| **IV** | no climate change, pre-industrial $CO_2$<br><br>varying society & protection up to 2100 (SSP2), then fixed at 2100 levels thereafter | Climate & $CO_2$ | Experiment I | Experiment I | **picontrol** | **picontrol** |
| | | Human & LU | | | **ssp2soc** | **2100ssp2soc** |
| **VI** | RCP2.6 climate & $CO_2$<br><br>varying society & protection up to 2100 (SSP2), then fixed at 2100 levels thereafter | Climate & $CO_2$ | Experiment I | Experiment II | **rcp26** | **rcp26** |
| | | Human & LU | | | **ssp2soc** | **2100ssp2soc** |
| **VII** | RCP6.0 climate & $CO_2$<br><br>varying society & protection (SSP2) | Climate & $CO_2$ | Experiment I | Experiment II | **rcp60** | not simulated |
| | | Human & LU | | | **ssp2soc** | |

## 13.2 Output data

**Table 32** Variables to be reported by coastal infrastructure models.

| Variable | Variable name | Resolution | Unit | Comments |
|---|---|---|---|---|
| Expected number of people flooded annually | **par** | Time resolved grid | thousands/yr (1000 $yr^{-1}$) | Par = People at risk. |
| Expected seaflood costs | **seafloodcost** | | million dollars/yr (mio 2005US$ $yr^{-1}$) | Expected annual damage caused by seafloods |
| Adaptation costs of building and upgrading dikes | **seadikecost** | | million dollars/yr (mio 2005US$ $yr^{-1}$) | Cost for building/upgrading dikes |
| Adaptation costs of maintaining dikes | **seadikemain** | | million dollars/yr (mio 2005US$ $yr^{-1}$) | Cost for maintenance of dikes build since the initial year (2000), but not cost for dikes “build” in the initialization of the model. |