The **CLIMSAVE** Project

Climate Change Integrated Assessment Methodology for Cross-Sectoral Adaptation and Vulnerability in Europe

# Summary of the report describing the European driving force database

**Martin Dubrovsky, Karl-Heinz Simon, Benjamin Stuch, Kasper Kok and Paula Harrison**

**Contact for climate scenario database: ma.du@seznam.cz**
**Contact for socio-economic scenario database: stuch@uni-kassel.de**

***Drivers***

There are two types of underlying driving forces considered in the CLIMSAVE project: those reflecting climate change as a trigger for adaptation measures and those representing socio-economic change processes.

***Climate scenario database***

The user interface to the European Integrated Assment Platform allows the user to select a SRES emissions scenario (A1b, A2, B1 or B2), the climate sensitivity (low, medium or high, with medium being the default) and the global climate model (GCM) in order to explore the effects of climate change uncertainties on cross-sectoral impacts and vulnerabilities. In order to make the number of combinations manageable for the user, it was decided to include five GCMs within the IA Platform out of the 16 available from the IPCC-AR4 database (http://www.mad.zmaw.de/IPCC_DDC/html/SRES_AR4/index.html). Thus, a methodology was developed to objectively select a representative subset of GCMs incorporating the "best" GCM (through an assessment of GCM quality, based on the fit between model and observed annual cycles of precipitation and temperature), the most "central" GCM (the GCM whose climate change scenario is the closest to the mean scenario over all 16 GCMs), and three other GCMs that preserve as much uncertainty as possible due to between-GCM differences (based on the Euclidean distance in an 8-dimensional space consisting of seasonal changes of precipitation and temperature). The final set of GCMs selected to include in the IA Platform were: MPEH5 ("best"), CSMK3 ("central"), and HADGEM, GFCM21 and IPCM4 (the triplet of most diverse GCMs for Europe).

The climate change scenarios were constructed using the *pattern scaling method*. In this approach, the scenario for a specific future, emissions scenario and climate sensitivity is determined as a product of the change in global mean temperature and the standardised scenario. The change in global mean temperature (for a selected emissions scenario and climate sensitivity) is determined using the MAGICC model. The standardised scenarios were determined from outputs of the five GCM simulations. The scenario database consists of changes in precipitation, temperature and solar radiation for each month and each 10’ x 10’ gridbox in the European Integrated Assessment Platform (23871 gridboxes for the whole of Europe).

The pattern of temperature and precipitation changes is different according to the GCM. In winter, most GCMs have a north-south or north-east to south-west pattern in temperature changes with the most severe changes occurring in the north/north-east of Europe. The CSMK2 model shows the most severe increases in these areas. In summer, the pattern of temperature change is reversed with the most severe increases in temperature occurring in southern Europe in all GCMs except IPCM4. GFCM21 exhibits the most severe changes and a strong north-south gradient whereas HadGEM shows a more even distribution. For precipitation in winter, all GCMs show a north to south gradient with increases in precipitation in the north and decreases in the south. HadGEM is relatively drier than the other GCMs in northern and central Europe whilst GFCM21 is driest in southern Europe. In summer, the GCMs also show a north to south pattern in precipitation changes although this is less clear in the IPCM4 model. GFCM21 stands out as being particularly dry in large parts of southern and continental Europe, whilst IPCM4 is the least extreme. European area-average changes in winter and summer mean temperature and precipitation for the 2050s time slice are shown in Table 1.

*Table 1: European area-average changes in winter (DJF) and summer (JJA) mean temperature and precipitation for the 2050s time slice, the five GCMs and three combinations of emissions scenario and climate sensitivity.*

| **Emissions** | **Climate sensitivity** | **CSMK3** | | **IPCM4** | | **HadGEM** | | **GFCM21** | | **MPEH5** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **DJF** | **JJA** | **DJF** | **JJA** | **DJF** | **JJA** | **DJF** | **JJA** | **DJF** | **JJA** |
| *2055 Area average temperature change ($^oC$)* | | | | | | | | | | | |
| B1 | 1.5 | 1.72 | 1.10 | 1.27 | 1.29 | 1.07 | 1.25 | 1.19 | 1.06 | 1.17 | 0.98 |
| B2 | 3.0 | 3.27 | 2.09 | 2.42 | 2.45 | 2.04 | 2.38 | 2.27 | 2.02 | 2.22 | 1.87 |
| A1b | 4.5 | 4.86 | 3.10 | 3.60 | 3.64 | 3.04 | 3.54 | 3.38 | 3.00 | 3.30 | 2.78 |
| *2055 Area average precipitation change (%)* | | | | | | | | | | | |
| B1 | 1.5 | 4.23 | -2.00 | 2.48 | -4.15 | 1.08 | -9.59 | 3.59 | -13.56 | 3.56 | -7.82 |
| B2 | 3.0 | 8.27 | -3.42 | 4.88 | -7.37 | 2.13 | -16.79 | 7.23 | -22.55 | 6.99 | -13.62 |
| A1b | 4.5 | 12.45 | -4.58 | 7.38 | -10.27 | 3.25 | -23.03 | 11.12 | -29.49 | 10.56 | -18.59 |

### ***Socio-economic scenario database***

In CLIMSAVE, a set of qualitative scenarios have been developed in a series of three participatory scenario workshops. The European scenarios are organised along two dimensions: “Economic Development” and “Solutions by Innovation”. The scenarios cover a range of aspects including social, economic, cultural, institutional and political developments in a set of integrated future outlooks. The four resulting scenarios for Europe are described in the Reports of the 1st and 2nd European stakeholder workshops.

Within the workshops, stakeholders were asked to quantify a number of (model) parameters, using the fuzzy set method. This method involves two steps. In step 1, stakeholders are asked to reach a consensus on the rate of change in the parameters, expressed in *words*. This will yield results like "the population in Europe in the period 2010-2025 will have a moderate increase". In step 2, stakeholders are asked to individually quantify this statement. Every stakeholder will provide for every parameter their expert judgement on what is e.g. a moderate increase. The overall result is a collective fuzzy numerical view of the stakeholders on the set of model parameters.

Stakeholders were asked to quantify six[1] model variables which were selected as a representative set that could be used to inform the quantification of other socio-economic variables within the models: GDP, population, food import ratio, arable land used for biofuels, oil price and household size. The data derived from the fuzzy sets exercise was analysed to produce translation keys that enable the quantitative values required by the IAP to be determined (Table 2). These values are represented as the default slider positions in the IAP. Different scenarios select different entries for describing the conditions for different time slices (2025 and 2055).

*Table 2: Translation key obtained from the fuzzy sets approach.*

| | GDP | Population | Food imports | Arable land for biofuels | Oil price | Household size |
|---|---|---|---|---|---|---|
| **Very Low** | -1.47 | -1.53 | 6.67 | 1.75 | 72.50 | 1.13 |
| **Low** | 0.00 | -0.47 | 14.00 | 6.67 | 98.33 | 1.97 |
| **Medium** | 1.45 | 0.33 | 26.67 | 10.67 | 138.33 | 3.12 |
| **High** | 2.85 | 0.53 | 40.00 | 15.00 | 162.50 | 3.88 |
| **Very High** | 4.38 | 1.05 | 58.33 | 26.00 | 210.00 | 4.40 |

The sliders in the IAP have a colour coding of green representing the credible range, i.e. that which is considered to be consistent with the socio-economic scenario, and a yellow range representing more extreme uncertainty. Table 3 shows the IAP slider default settings and the credible and absolute minimum and maximum values which define the green and yellow slider ranges. User-defined slider settings beyond the credible ranges are not considered to be consistent with the scenario/storyline assumptions. Nevertheless, they allow users to test the implications of extreme driver values on the IAP performance in a kind of extended sensitivity analysis.

The *absolute minimum* and the *absolute maximum* values are defined as the lowest and the highest estimate per qualitative class, respectively. In contrast, the *default values* for each parameter represent average values over all estimates per qualitative class. The *credible* slider positions are defined as those values that are common among most stakeholder estimates.

[1] In the first workshop a seventh driver "Extent of Protected Area" was also included, but this was dropped in the second workshop where it was considered to be an adaptation option.

*Table 3: IAP slider ranges for the fuzzy sets category "medium".*

| Driver | Absolute minimum | Credible minimum | Default | Credible maximum | Absolute maximum |
|---|---|---|---|---|---|
| GDP growth per year [%] | 0.00 | 0.87 | 1.45 | 1.67 | 3.00 |
| Population growth per year [%] | 0.00 | 0.23 | 0.33 | 0.38 | 0.70 |
| Food imports [% of consumed food] | 10.00 | 19.17 | 26.67 | 31.67 | 50.00 |
| Arable land for biofuels [%] | 2.00 | 7.83 | 10.67 | 11.83 | 20.00 |
| Oil price [$/barrel] | 30.00 | 100.00 | 138.33 | 153.33 | 300.00 |
| Household size [heads] | 2.00 | 2.33 | 3.12 | 3.27 | 4.80 |