

***ESPON Climate***  
Climate Change and Territorial Effects on  
Regions and Local Economies

Applied Research Project 2013/1/4

Final Report

**Annex 9**

**Indicators**



## *Annex: Indicators*

This report presents the final results of an Applied Research Project conducted within the framework of the ESPON 2013 Programme, partly financed by the European Regional Development Fund.

The partnership behind the ESPON Programme consists of the EU Commission and the Member States of the EU27, plus Iceland, Liechtenstein, Norway and Switzerland. Each partner is represented in the ESPON Monitoring Committee.

This report does not necessarily reflect the opinion of the members of the Monitoring Committee.

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## List of indicators

Note on data availability: For some countries or regions no data were available for certain indicators. Usually this only had minor effects, but in some instances it made subsequent assessments impossible. This problem relates primarily to Cyprus, Iceland and Switzerland as well as the French outermost territories. In the case of Iceland and the French outermost territories the CCLM model runs that were used to calculate the exposure indicators do not cover these countries and regions and due to methodological reasons could not be substituted with other model runs. Data on river flooding were derived from the outputs of the LISFLOOD model which in addition to the aforementioned countries also lacks data on Cyprus. The lack of exposure data in turn also meant that no impact and vulnerability indicators could be calculated for these cases. Furthermore, sensitivity indicators that are based on CORINE land-use data do not cover Switzerland as well as the French outermost territories. Sensitivity indicators based on data from the Eurosoil database do not cover Cyprus, Iceland and the French outermost territories. Since the CORINE and Eurosoil based indicators constitute a significant part of the overall sensitivity analysis, no overall sensitivity, no impacts and no vulnerability could be calculated for these cases. For details on each indicator see table below.

Indicator	Source(s)	Missing values (no data cases)
<i>Exposure</i>		
<b>Change in annual mean temperature</b>	CCLM A1B Lautenschlager et al. 2009	<ul style="list-style-type: none"> <li>No CCLM data for: IS, outermost, northern parts of NO 073</li> </ul>
<b>Change in annual mean number of frost days</b>	CCLM A1B Lautenschlager et al. 2009	<ul style="list-style-type: none"> <li>No CCLM data for: IS, outermost, northern parts of NO 073</li> </ul>
<b>Change in annual mean number of summer days</b>	CCLM A1B Lautenschlager et al. 2009	<ul style="list-style-type: none"> <li>No CCLM data for: IS, outermost, northern parts of NO 073</li> </ul>
<b>Relative change in annual mean precipitation in winter months</b>	CCLM A1B Lautenschlager et al. 2009	<ul style="list-style-type: none"> <li>No CCLM data for: IS, outermost, northern parts of NO 073</li> </ul>
<b>Relative change in annual mean precipitation in summer months</b>	CCLM A1B Lautenschlager et al. 2009	<ul style="list-style-type: none"> <li>No CCLM data for: IS, outermost, northern parts of NO 073</li> </ul>
<b>Change in annual mean number of days with heavy rainfall</b>	CCLM A1B Lautenschlager et al. 2009	<ul style="list-style-type: none"> <li>No CCLM data for: IS, outermost, northern parts of NO 073</li> </ul>

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<b>Relative change in annual mean evaporation</b>	CCLM A1B Lautenschlager et al. 2009	<ul style="list-style-type: none"> <li>No CCLM data for: IS, outermost, northern parts of NO 073</li> </ul>
<b>Change in annual mean number of days with snow cover</b>	CCLM A1B Lautenschlager et al. 2009	<ul style="list-style-type: none"> <li>No CCLM data for: IS, outermost, northern parts of NO 073</li> </ul>
<b>Change in river flooding</b>	LISFLOOD A1B CCLM 2010	<ul style="list-style-type: none"> <li>No LISFLOOD-Data available for: CY, IS, outermost</li> </ul>
<b>Change in coastal flooding</b>	DIVA 2004	<ul style="list-style-type: none"> <li>No Diva Data available for: outermost</li> </ul>
<i>Physical sensitivity and impact</i>		
<b>Combined physical sensitivity/impact</b>	CCLM A1B Lautenschlager et al. 2009, DIVA 2004, LISFLOOD A1B CCLM 2010, CORINE Land Cover 2000/2006, IRPUD Transport Networks 2009, GISCO 2009, E-PRTR 2010	<ul style="list-style-type: none"> <li>No LISFLOOD-Data available for: CY, IS, outermost</li> <li>No airport or harbor data available for: NO, CH (reduced dataset for calculation of Norway)</li> <li>No CORINE data available for: CH</li> </ul>
<b>Roads, rails (river flooding)</b>	LISFLOOD A1B CCLM 2010, CORINE Land Cover 2000/2006, IRPUD Transport Networks 2009	<ul style="list-style-type: none"> <li>No LISFLOOD-Data available for: CY, IS, outermost</li> </ul>
<b>Roads, rails (coastal flooding)</b>	DIVA 2004, USGS Hydro1K, IRPUD Transport Networks 2009	<ul style="list-style-type: none"> <li>No Diva Data available for: outermost</li> </ul>
<b>Roads, rails (flash floods)</b>	CCLM A1B Lautenschlager et al. 2009, JRC Eurosoil database	<ul style="list-style-type: none"> <li>No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>No JRC Eurosoil data for: CH</li> </ul>
<b>Airports, harbors (river flooding)</b>	LISFLOOD A1B CCLM 2010, GISCO 2009	<ul style="list-style-type: none"> <li>No LISFLOOD-Data available for: CY, IS, outermost</li> <li>No airport or harbor data available for: NO, CH</li> </ul>

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<b>Airports, harbors (coastal flooding)</b>	DIVA 2004, GISCO 2009	<ul style="list-style-type: none"> <li>• No airport or harbor data available for: NO, CH</li> <li>• No Diva Data available for: outermost</li> </ul>
<b>Settlements (river flooding)</b>	LISFLOOD A1B CCLM 2010, CORINE Land Cover 2000/2006	<ul style="list-style-type: none"> <li>• No LISFLOOD-Data available for: CY, IS, outermost</li> <li>• No CORINE data available for: CH</li> </ul>
<b>Settlements (coastal flooding)</b>	DIVA 2004, CORINE Land Cover 2000/2006	<ul style="list-style-type: none"> <li>• No CORINE data available for: CH</li> <li>• No Diva Data available for: outermost</li> </ul>
<b>Settlements (flash floods)</b>	CCLM A1B Lautenschlager et al. 2009, JRC Eurosoil database, CORINE Land Cover 2000/2006	<ul style="list-style-type: none"> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>• No JRC Eurosoil data for: CH</li> <li>• No CORINE data available for: CH</li> </ul>
<b>Thermal power stations (river flooding)</b>	LISFLOOD A1B CCLM 2010, E-PRTR 2010	<ul style="list-style-type: none"> <li>• No LISFLOOD-Data available for: CY, IS, outermost</li> </ul>
<b>Thermal power stations (coastal flooding)</b>	DIVA 2004, E-PRTR 2010	<ul style="list-style-type: none"> <li>• No Diva Data available for: outermost</li> </ul>
<b>Refineries (river flooding)</b>	LISFLOOD A1B CCLM 2010, E-PRTR 2010, CORINE Land Cover 2000/2006	<ul style="list-style-type: none"> <li>• No LISFLOOD-Data available for: CY, IS, outermost</li> </ul>
<b>Refineries (coastal flooding)</b>	DIVA 2004, E-PRTR 2010, CORINE Land Cover 2000/2006	<ul style="list-style-type: none"> <li>• No CORINE data available for: CH</li> <li>• No Diva Data available for: outermost</li> </ul>
<i>Social sensitivity and impact</i>		
<b>Combined social sensitivity/impact</b>	Gallego et al. 2009/2011, DIVA 2004, Hydro1K, LISFLOOD A1B CCLM 2010, CORINE Land Cover 2000/2006.	<ul style="list-style-type: none"> <li>• No Gallego data available for: CH</li> <li>• No LISFLOOD-Data available for: CY, IS, outermost</li> </ul>

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<b>Population (summer heat)</b>	CCLM A1B Lautenschlager et al. 2009, Gallego et al. 2009/2011, CORINE Land Cover 2000/2006	<ul style="list-style-type: none"> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>• No Gallego data available for: CH</li> </ul>
<b>Population (coastal flooding)</b>	CCLM A1B Lautenschlager et al. 2009, Gallego et al. 2009/2011, USGS Hydro1K, DIVA 2004	<ul style="list-style-type: none"> <li>• No Diva data available for: outermost</li> <li>• No Gallego data available for: CH</li> </ul>
<b>Population (river flooding)</b>	CCLM A1B Lautenschlager et al. 2009, Gallego et al. 2009/2011, LISFLOOD A1B CCLM 2010	<ul style="list-style-type: none"> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>• No LISFLOOD-Data available for: CY, IS, outermost</li> </ul>
<b>Population (flash floods)</b>	CCLM A1B Lautenschlager et al. 2009, USGS Hydro1K, JRC Eurosoil database, Gallego et al. 2009/2011	<ul style="list-style-type: none"> <li>• No Gallego data available for: CH</li> <li>• No CCLM data for: IS, outermost</li> <li>• No EuroSoil data for: CY</li> </ul>
<i>Environmental sensitivity and impact</i>		
<b>Combined environmental sensitivity/impact</b>	JRC EuroSoil, NATURA 2000 database 2010, OEROK 2011, JNCC 2010, World Fire Atlas 2010, CORINE Land Cover 2000/2006	<ul style="list-style-type: none"> <li>• Reduced data for Norway: No Natura 2000 data available for CH, NO</li> <li>• No EuroSoil data available for: CY</li> <li>• No CORINE data available for: CH</li> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>• No LISFLOOD-Data available for: CY, IS, outermost</li> </ul>
<b>Protected areas (Natura 2000)</b>	CCLM A1B Lautenschlager et al. 2009, NATURA 2000 database 2010, JNCC 2010, OEROK 2011, CORINE Land Cover 2000/2006	<ul style="list-style-type: none"> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>• No Natura 2000 data for: CH, NO</li> </ul>

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<b>Forest fires</b>	CCLM A1B Lautenschlager et al. 2009, JRC EuroSoil, World Fire Atlas 2010, CORINE Land Cover 2000/2006	<ul style="list-style-type: none"> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>• No CORINE data available for: CH</li> </ul>
<b>Soil organic carbon</b>	CCLM A1B Lautenschlager et al. 2009, JRC EuroSoil,	<ul style="list-style-type: none"> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>• NO EuroSoil data for: CY</li> </ul>
<b>Soil erosion</b>	CCLM A1B Lautenschlager et al. 2009, JRC EuroSoil, CORINE Land Cover 2000/2006	<ul style="list-style-type: none"> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>• NO EuroSoil data for: CY</li> <li>• No CORINE data available for: CH</li> </ul>
<i>Cultural impact</i>		
<b>Combined cultural sensitivity/impact</b>	World Heritage Commission 2010, national Yellow Pages and equivalents 2011, DIVA 2004, LISFLOOD A1B CCLM 2010	<ul style="list-style-type: none"> <li>• No LISFLOOD-Data available for: CY, IS, outermost</li> <li>• No museums for: outermost</li> </ul>
<b>Museums (river flooding)</b>	LISFLOOD A1B CCLM 2010,	<ul style="list-style-type: none"> <li>• No LISFLOOD-Data available for: CY, IS, outermost</li> <li>• No museums for: outermost</li> </ul>
<b>Museums (coastal flooding)</b>	DIVA 2004	<ul style="list-style-type: none"> <li>• No museums for: outermost</li> <li>• No Diva Data available for: outermost</li> </ul>
<b>World Heritage Sites (river flooding)</b>	LISFLOOD A1B CCLM 2010, World Heritage Commission	<ul style="list-style-type: none"> <li>• No LISFLOOD-Data available for: CY, IS, outermost</li> </ul>
<b>World Heritage Sites (coastal flooding)</b>	DIVA 2004, World Heritage Commission	<ul style="list-style-type: none"> <li>• No Diva Data available for: outermost</li> </ul>

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<i>Economic sensitivity and impact</i>		
<b>Combined economic sensitivity/impact</b>	CCLM A1B Lautenschlager et al. 2009, DIVA 2004, LISFLOOD A1B CCLM 2010, USGS Hydro1K, Eurostat 2010, Gallego et al. 2009/2011, CORINE Land Cover 2000/2006, JRC EuroSoil 2010, E-PRTR 2010	<ul style="list-style-type: none"> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>• No LISFLOOD-Data available for: CY, IS, outermost</li> <li>• No Diva Data available for: outermost</li> <li>• No CORINE data available for: CH (reduced dataset for calculation)</li> </ul>
<b>Energy sector</b>	CCLM A1B Lautenschlager et al. 2009, DIVA 2004, LISFLOOD A1B CCLM 2010, E-PRTR 2010, CORINE Land Cover 2000/2006, Gallego et al. 2009/2011, Eurostat 2010	<ul style="list-style-type: none"> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>• No LISFLOOD-Data available for: CY, IS, outermost</li> <li>• No Diva Data available for: outermost</li> <li>• No CORINE data available for: CH (reduced dataset for calculation)</li> </ul>
<b>Agriculture and forestry</b>	CCLM A1B Lautenschlager et al. 2009, JRC EuroSoil 2010, CORINE Land Cover 2000/2006, Eurostat 2010	<ul style="list-style-type: none"> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>• No CORINE data available for: CH</li> <li>• No EuroSoil data for:</li> <li>• CY</li> </ul>
<b>Tourism</b>	CCLM A1B Lautenschlager et al. 2009, TCI 2010, USGS Hydro1K, Eurostat 2010	<ul style="list-style-type: none"> <li>• No CCLM data for: IS, outermost, northern parts of NO 073</li> </ul>



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<i>Aggregate impact</i>		
<b>Aggregate impact</b>	See information for each (impact) dimension	<ul style="list-style-type: none"> <li>• No airport or harbor data available for: NO, CH (reduced data for calculation on Norway)</li> <li>• Reduced data for Norway: No Natura 2000 data available for CH, NO (reduced data for calculation on Norway)</li> </ul>
<i>Adaptive capacity</i>		
<b>Educational commitment</b>	Eurostat 2010	• -
<b>Computer skills</b>	Eurostat 2010	• No data for CH, LI
<b>Attitude towards climate change</b>	GESIS (Eurobarometer) 2008	• No Eurobarometer data for CH, IS, LI, NO
<b>Resources for technology</b>	Eurostat 2010	• No data for LI
<b>Capacity to undertake research</b>	Eurostat 2010	• No data for LI
<b>Patents</b>	Eurostat 2010, INE 2010 (for ES630 and ES640)	• -
<b>Transport infrastructure</b>	Eurostat 2010, national statistical institute 2010 (for ES630 and ES640)	• -
<b>Water infrastructure and water availability</b>	EEA 2006	• no data for LI
<b>Hospital bed and doctors</b>	Eurostat 2010, national statistical institutes (for Iceland and ES630 and ES640)	• -
<b>Government effectiveness</b>	World Bank 2010	• -
<b>National adaptation strategies</b>	Massey & Bergsma 2009	• -
<b>Democracy</b>	Finnish Social Science Data Archive 2010	• no data for LI
<b>Income per capita (GDP)</b>	ESPON Database 2006, Eurostat 2010	• -
<b>Age dependency ratio</b>	Eurostat 2010, national statistical institutes (for LI and LU)	• -

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<b>Unemployment</b>	Eurostat 2010	<ul style="list-style-type: none"> <li>no data for LI</li> </ul>
<b>Aggregate adaptive capacity</b>	See information for each (impact) dimension	<ul style="list-style-type: none"> <li>CH</li> </ul>
<i>Vulnerability</i>		
<b>Vulnerability</b>	See information for each (impact) dimension	<ul style="list-style-type: none"> <li>No airport or harbor data available for: NO, CH (reduced data for calculation of Norway)</li> <li>Reduced data for Norway: No Natura 2000 data available for CH, NO (reduced data for calculation on Norway)</li> </ul>
<i>Scenarios</i>		
<b>Summer heat on population in 2100</b>	CCLM A1B Lautenschlager et al. 2009, Gallego et al. 2009/2011, DIVA 2004, USGS Hydro1K, JRC Eurosoil database, LISFLOOD A1B CCLM 2010, CORINE Land Cover 2000/2006, ESPON DEMIFER Project	<ul style="list-style-type: none"> <li>No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>No CORINE data available for: CH</li> </ul>
<b>Coastal storm surge on population in 2100</b>	CCLM A1B Lautenschlager et al. 2009, Gallego et al. 2009/2011, DIVA 2004, USGS Hydro1K, CORINE Land Cover 2000/2006, ESPON DEMIFER Project	<ul style="list-style-type: none"> <li>No Diva Data available for: outermost</li> <li>No CORINE data available for: CH (CH not sensitive for coastal storm surges)</li> </ul>
<b>Flash floods on population in 2100</b>	CCLM A1B Lautenschlager et al. 2009, Gallego et al. 2009/2011, JRC Eurosoil database, CORINE Land Cover 2000/2006, ESPON DEMIFER Project.	<ul style="list-style-type: none"> <li>No CCLM data for: IS, outermost, northern parts of NO 073</li> <li>No CORINE data / Gallego data available for: CH</li> <li>NO EuroSoil data for: CY</li> </ul>
<b>River flooding on population in 2100</b>	CCLM A1B Lautenschlager et al. 2009, Gallego et al. 2009/2011, LISFLOOD A1B CCLM 2010, CORINE Land Cover 2000/2006, ESPON DEMIFER Project.	<ul style="list-style-type: none"> <li>No LISFLOOD-Data available for: CY, IS, outermost</li> <li>No CORINE data / Gallego data available for: CH</li> </ul>

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<p><b>Aggregate potential impact of climate change (scenario equal weights)</b></p>	<p>See information for each (impact) dimension</p>	<ul style="list-style-type: none"> <li>• No airport or harbor data available for: NO, CH (reduced data for calculation on Norway)</li> <li>• Reduced data for Norway: No Natura 2000 data available for CH, NO (reduced data for calculation on Norway)</li> </ul>
<p><b>Aggregate adaptive capacity (scenario equal weights)</b></p>	<p>See information for each (impact) dimension</p>	<ul style="list-style-type: none"> <li>• CH</li> </ul>
<p><b>Potential vulnerability to climate change (scenario equal weights)</b></p>	<p>See information for each (impact) dimension</p>	<ul style="list-style-type: none"> <li>• No airport or harbor data available for: NO, CH (reduced data for calculation of Norway)</li> <li>• Reduced data for Norway: No Natura 2000 data available for CH, NO (reduced data for calculation on Norway)</li> </ul>