Global Climate Screening Tool – Technical Report

Revision 2
Sitra
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Contents

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Glossary

Adaptation	Actions taken to adapt to a future, changing climate to cope with, for example, rising sea-levels, changes in rainfall amounts or intensity and increases in heatwave duration and severity.
AR5	IPCC Fifth Assessment Report
CMIP5	Coupled Model Intercomparison Project Phase 5
COP21	Conference of the Parties
HDCC	Human Dynamics of Climate Change
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
KNMI	The Royal Netherlands Meteorological Institute/Koninklijk Nederlands Meteologisch Instituut
Mitigation	Actions taken to prevent given levels of climate change occurring. This is usually achieved by decreasing the amount of greenhouse gases present in the atmosphere through reducing emission rates or enhancing processes which remove these gases.
Projections	Climate model experiments run using plausible estimates for future greenhouse gas emissions and other processes that affect the climate to provide best possible information for future conditions. Different scenarios can be created by using different emission models.
RCP8.5	This RCP scenario has continued increases in atmospheric greenhouse gas concentrations throughout the 21st century.
RCPs	Representative Concentration Pathways
UK	United Kingdom
UN FAO	United Nations Food and Agriculture Organization
UNFCCC	United Nations Framework Convention on Climate Change

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Introduction

The United Kingdom (UK) Met Office has been commissioned by Sitra, the Finnish Innovation Fund, to develop a climate screening tool. This report acts as a technical report. The Met Office has produced an additional user guide report to accompany this report and the climate screening tool.

Organisations in Finland and the Nordics are keen to protect themselves from future global hazards affecting their business. Assessments of risks related to resource availability and other megatrends influencing the business environment are thought to be ahead of those from climate change. For this reason Sitra, the Finnish Innovation Fund, commissioned the development of the climate screening tool to enable Finnish organisations to understand and manage potential risks associated with climate change. The tool has been tested and developed in collaboration with Fortum and the Climate Leadership Council in Finland, and it is made available for all Finnish companies and the wider public by Sitra with the aim of encouraging companies to assess and evaluate their climate risks.

Aim

The climate change screening tool (and this report) aims to provide a high level tool to inform business users of the risks of climate change which may influence their operations. It is designed as an initial "entry point" to enable users to start considering future risks and in cases where the tool indicates medium or high risks, users are directed to further information. All the information used is 'broad scale', from global assessments and is suitable for initial screening work only. Any detailed site assessments require more detailed information.

In addition, the climate screening tool can be used to determine whether a risk exists, the high level consquences of the risk and whether further consideration of the risk is required. By highlighting the potential high level risks of climate change on business operations these can be considered in more detail to be included in companies risk registers. Note: The tool does not provide bespoke consultancy nor does it provide adaptation or mitigation advice for the highlighted risks of climate change.

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Climate Change Overview

Our climate is changing and the scientific evidence indicates that human activities are driving this phenomenon. Climate change is a large-scale, long-term shift in the planet's weather patterns or average temperatures. Earth has had tropical climates and ice ages many times in its 4.5 billion years. Since the last ice age, which ended about 11,000 years ago, Earth's climate has been relatively stable at about 14 °C (as an average temperature). However, in recent years, the average temperature has been increasing. The average temperature has risen by 0.89 °C from 1901 to 2012. Compared with climate change patterns throughout Earth's history, the rate of temperature rise since the Industrial Revolution is extremely high. The high level effects of the increase in average temperatures are summarised below:

Changing rainfall: Changes in annual and seasonal precipitation have been observed in some parts of the globe. Rainfall has increased in the mid-latitudes of the northern hemisphere since the beginning of the 20th century. There are also changes between seasons in different regions. For example, the UK's summer rainfall is decreasing on average, while winter rainfall is increasing. There is also evidence that heavy rainfall events have become more intensive, especially over North America. Some recent extreme flood and drought events lie outside the bounds of what might be considered normal in terms of frequency and intensity. This is in line with what might be expected from climate change. (Met Office, 2015)

Sea level rises: Since 1900, sea levels have risen by about 19 cm globally, on average. The rate of sea-level rise has increased in recent decades. (Met Office, 2015)

Retreating glaciers: Glaciers all over the world - in the Alps, Rockies, Andes, Himalayas, Africa and Alaska - are melting and the rate of shrinkage has increased in recent decades. (Met Office, 2015)

Sea ice: Arctic sea-ice has been declining since the late 1970s, reducing by about 4%, or 0.6 million square kilometres (an area about the size of Madagascar) per decade. At the same time Antarctic sea-ice has increased, but at a slower rate of about 1.5% per decade. (Met Office, 2015)

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Ice sheets: The Greenland and Antarctic ice sheets, which between them store the majority of the world's fresh water, are both shrinking at an accelerating rate. (Met Office, 2015)

Even though global warming is often expressed as a single figure, such as a 4 deg C or 2 deg C rise in temperature over the whole planet's surface, the effect will not be spread evenly. Higher temperatures, fresh water shortages, higher sea levels and extreme weather events will each affect regions differently. A region's vulnerability will depend not only on the nature and level of climate change, but on the capacity of local systems and populations to adapt to change. The planet faces a range of scenarios depending on the level of continuing greenhouse gas emissions. Some change is inevitable but the extent and severity of long-term climate disruption depends on future emissions (Met Office, 2015).

Therefore, the climate screening tool allows the user to select the region of operational interest to provide the most suitable regional projections, albeit based on global models (see the Data Sources section). These regions are known as Giorgi Regions, with the exception of northern Europe (Giorgi, 2000), see Figure 2. Northern Europe has been split into two blocks – Northern Europe and the Nordics (Finland, Norway and Sweden). Additional data extractions and analysis have been undertaken to produce these blocks for the climate screening tool. These blocks have been created in order to provide a Nordic focus to the tool and aim to better represent the change in climate in these two blocks. However, it should be noted that the resolution of these models is coarse and further bespoke assessments may be required if a risk is identified to further quantify the risk and develop appropriate mitigation and adaption actions.

Representative Concentration Pathways

The amount of warming we see will depend on emissions of greenhouse gases, changes in land use, and other factors – such as emissions of aerosols, which can have either a temporary cooling or a warming effect on the climate depending on their type. These alternative views of future 'forcings' must be accounted for when making projections of the future. This is often done using what are known as representative concentration pathways (RCPs). These indicate possible trajectories of greenhouse gas (and aerosol) concentrations over the 21st Century. They do not prescribe the emissions that lead to these concentrations. Four standard RCPs are used, which are identified by the equivalent increase in radiative heating that the greenhouse gas

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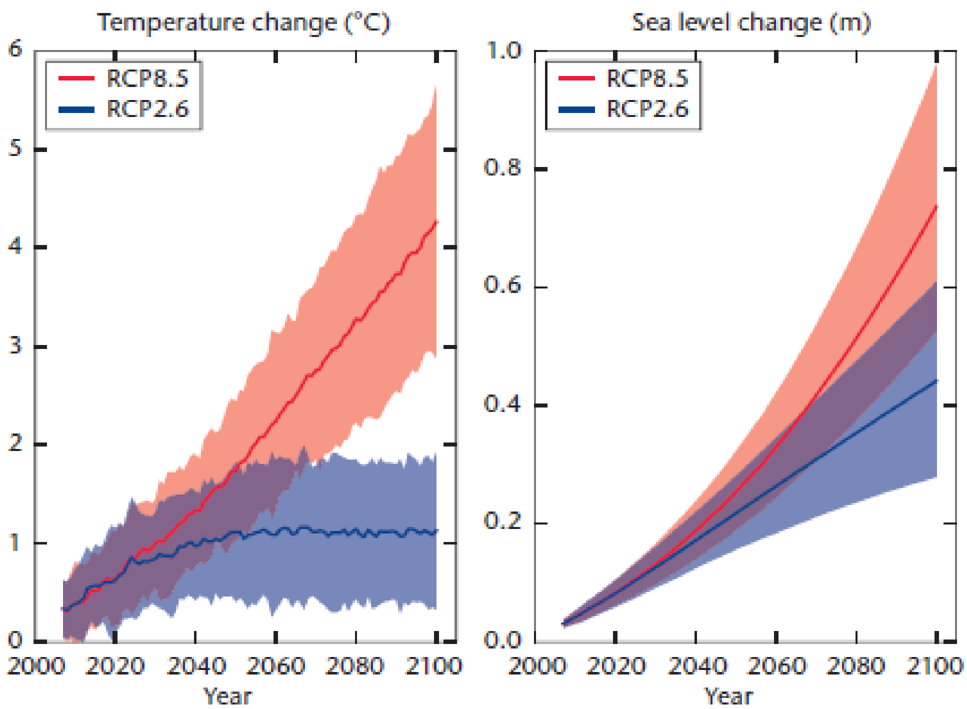
concentrations result in by 2100. RCP2.6 has concentrations of greenhouse gases peaking early in the 21st century, before falling rapidly by 2100, whereas RCP8.5 has continued increases in atmospheric greenhouse gas concentrations throughout the 21st century. The projected trends in temperature and sea level rise are presented in Figure 1. RCP8.5 is the "Business-as-usual" scenario with rising radiative forcing pathway leading to 8.5 W/m2 (~1370 ppm CO2) by 2100 or an increase in global average temperature to 4°C above pre-industrial values by 2100. A further two, RCP4.5 and RCP6.0, are intermediate pathways. Studying potential future change using these scenarios helps guide our understanding of the emissions levels that are likely to avoid potentially dangerous climate change and informing adaptation on global, regional and local scales.

To provide a broadly high impact scenario all data used in the climate screening tool are from climate projections for the RCP8.5 scenario. It is likely that mitigation efforts will reduce warming in the future but it is best practice in risk assessment to consider low probability and high consequence events. It is also possible that climate changes will be greater than those in the RCP8.5 scenario, particularly for sea level rise because much higher increase of ca. 2 m cannot be ruled out in the event of greater melting of the ice sheets.

Figure 1: Climate model projections of global mean surface temperature and sea level change relative to the period 1986-2005. Data source: IPCC AR5.



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COP21

In 2015, the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP21) was held. These discussions were the most important climate negotiations since the Kyoto Protocol came into force in 1997. The outcome of the discussions was that 195 countries adopted the first-ever universal, legally binding global climate deal. This included agreement on a long-term goal of keeping the increase in global average temperature to below 2 °C above pre-industrial levels. This requires significant effort to reduce emissions beyond what has been promised in Intended Nationally Determined Contributions (INDCs).

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Data Sources

Intergovernmental Panel on Climate Change & The Royal Netherlands Meteorological Institute (KNMI)

The projected changes in near surface temperature and precipitation were extracted from the Coupled Model Intercomparison Project Phase 5 (CMIP5) (IPCC Fifth Assessment Report (AR5) Atlas subset) models. The data were extracted as a relative change from 1985-2005 (baseline) to 2081-2100 (projection) under the RCP8.5 scenario.

Details about the IPCC and access to all reports can be found at:
http://www.ipcc.ch/

The Northern Europe Giorgi region was divided into two smaller blocks – Scandinavia and Northern Europe using data downloaded from the KNMI website for the same set of models. Note: All other datasets/parameters for Scandinavia (outlined below) have been extracted from the Northern Europe Giorgi region due to uncertainties over the scientific validity as the models are coarsely resolved.

Further information about these datasets can be found at:
https://climexp.knmi.nl/plot_atlas_form.py

Human Dynamics of Climate Change

The majority of the data used in the climate screening tool was extracted from the Human Dynamics of Climate Change (HDCC) project which was undertaken by the UK Met Office. The project aimed to illustrate some of the impacts of climate and population change in the context of a globalised world. For more information about the model simulations and the derived dataset can be found at:

http://www.metoffice.gov.uk/media/pdf/n/d/HDCC_technical_report.pdf

http://www.metoffice.gov.uk/climate-guide/climate-change/impacts/human-dynamics/

The data were extracted as a relative change from 1981-2010 (baseline) to 2071-2100 (projection) under the RCP8.5 scenario.

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ND-GAIN

The Notre Dame Global Adaptation Index (ND-GAIN) provides numerical scores for each country based on its vulnerability and readiness to implement adaptation solutions to climate change. These data were used to understand the socioeconomic risks to climate change in the climate screening tool. More information about how these scores are derived can be found at:
http://www3.nd.edu/~nchawla/methodology.pdf

In order to produce vulnerability, readiness and the ND-GAIN scores for each of the terrestrial blocks in the climate screening tool the average (mean) value for each of the countries intersected by the blocks was calculated. These scores are presented in the tool in the "2. Score card" and "3. Data" worksheets. In addition, the ND-GAIN score is carried forward into the Overall Risk Rating, see Overall Risk Rating section.

Global Flood Risk Analyzer

The Global Flood Risk Analyzer was developed by Deltares and partners to assess the potential GDP loss, affected population and urban damage for each country globally. More information about the tool can be found at:
http://www.wri.org/resources/maps/aqueduct-global-flood-analyzer

Data were extracted from this tool to quantify the flood risks to gross domestic product (GDP) under the RCP8.5 scenario by 2030. A range of results are presented in the "3.Data" worksheet for different storm events ranging from a 1 in 1 year storms to a 1 in 1000 year storm. In order to produce these data for the terrestrial blocks an average (mean) value was taken for the countries intersected by the block.

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Figure 2: Geographical Overview of terrestrial blocks.

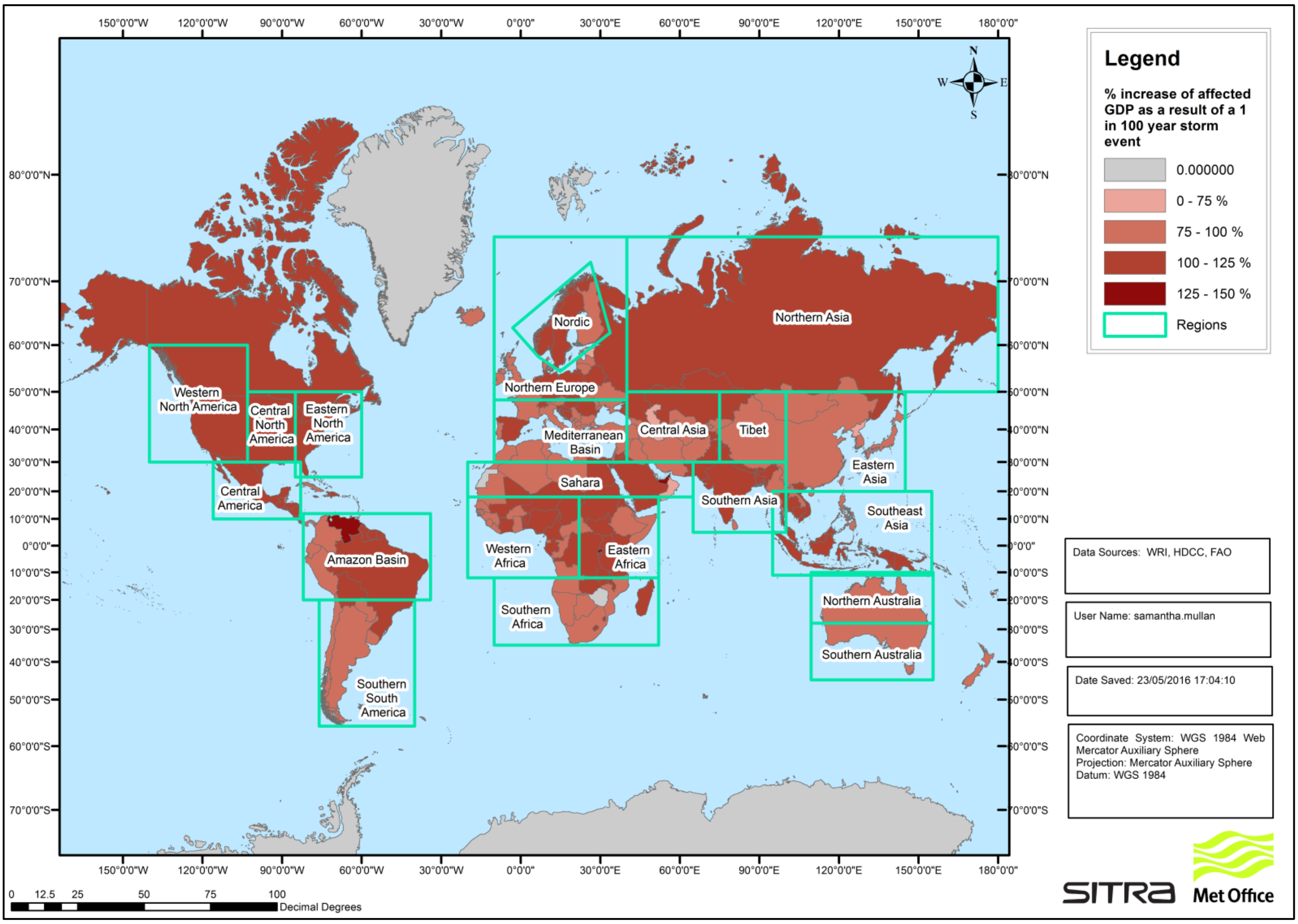

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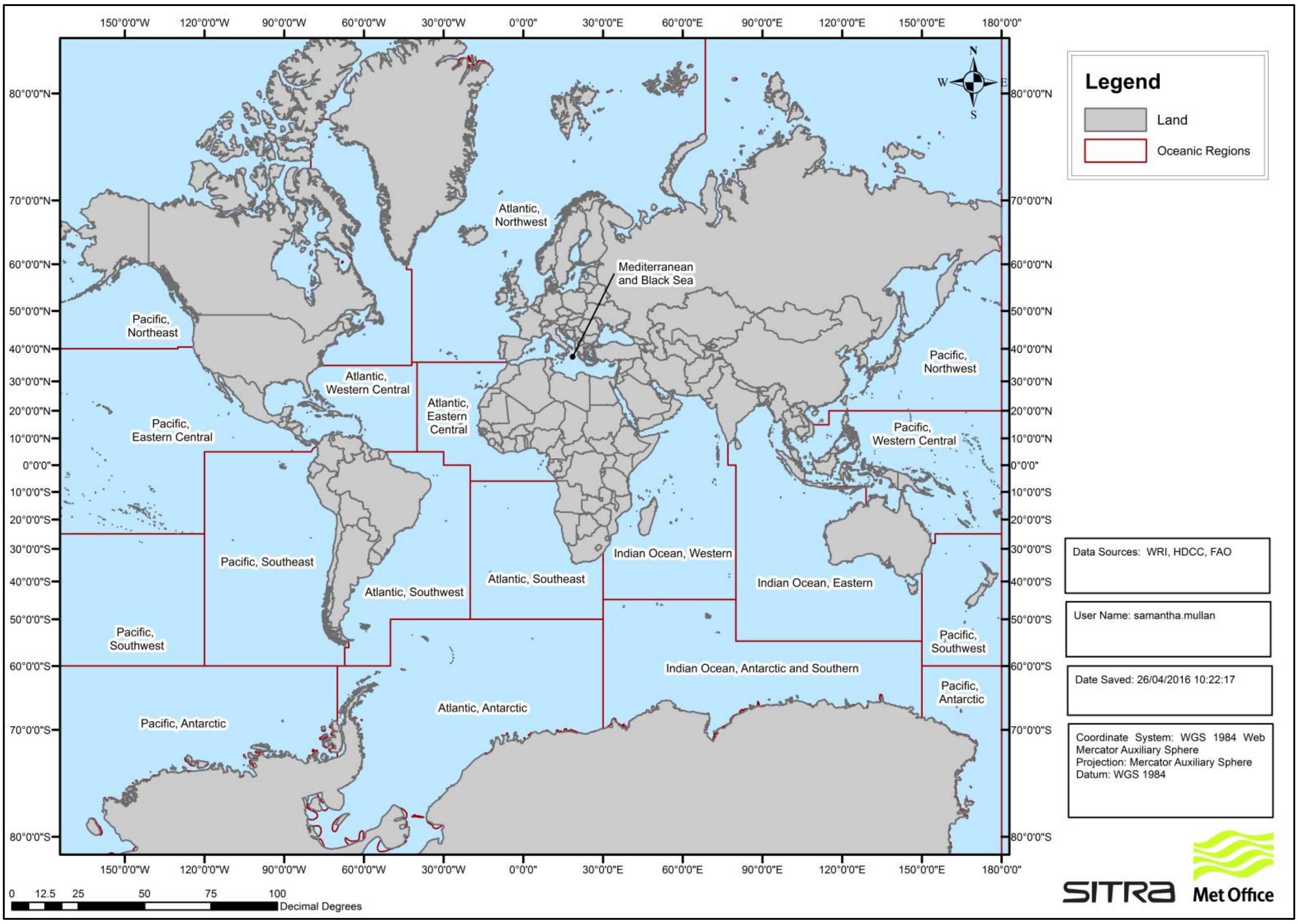
Figure 3: Geographical Overview of oceanic blocks.



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Overall Risk Rating

The climate screening tool presents an Overall Risk Rating to help contextualise the results and data for the user. This score has been developed by the UK Met Office for the climate screening tool. The tool will calculate one of four qualitative scores – Very High, High, Medium or Low, see Table 1. These scores have been numerically calculated as a function of the socio-economic vulnerability (ND-GAIN score, see ND-GAIN section) and the relative severity of projected climatic change for the selected block.

The assessed biophysical parameters (temperature, flooding, drought, crops, sea level rise, shipping choke points and fish catch) were all normalised to provide a relative score of the change projected in the region to the maximum projected change globally, i.e. the projected change of the block/ maximum change of all blocks. Therefore, the block with the maximum projected change had a biophysical score for the parameter of one.

The biophysical scores then have weightings applied depending on which business sector the user selects in the “1.Control” worksheet. The applied weightings are presented in Table 2 and Table 3. By applying the weightings a climate change score is calculated.

Finally, the following equation is applied to calculate the Overall Risk Rating.

$$\left(climate\ change\ score * \frac{2}{3}\right) + \left(\left(\frac{100 - NDGAIN\ score}{100}\right) * \frac{1}{3}\right) = Overall\ Risk\ Rating$$

Thresholds are then applied to determine a qualitative risk, exceeding 0.66, 0.44 and 0.22 for Very High, High and Medium respectively.

Examples Overall Risk Ratings for different business sectors across the assessed regions, with and without coastal infrastructure and shipping are presented in Annex II.

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Table 1: Overall Risk Ratings with associated context and potential actions

Overall Risk Rating	Context and Potential Actions
Very High	A very high score indicates that there is a significant risk to businesses operating in the selected selector and region. In order to determine effective and strategic mitigation measures and to quantify the risk a detailed local or regional study may be required.
High	A high score indicates that there is a relatively significant risk to businesses operating in the selected selector and region. In order to determine effective and strategic mitigation measures and to quantify the risk a detailed local or regional study may be required.
Medium	A medium score indicates that there is a moderate risk to businesses operating in the selected selector and region. In order to determine whether strategic mitigation measures are required and to quantify the risk a detailed local or regional study may be required.
Low	A low score indicates that there is a relatively insignificant risk to businesses operating in the selected selector and region. If an aspect of operations may be significantly affected by weather and climate then a local study may be required to quantify the risk.

Table 2: The applied weighting of biophysical parameters if operations have a coastal or shipping dependency.

Parameter	Temperature	Flooding	Drought	Crops	Sea level rise	Shipping Choke Points	Fish Catch
Transportation	0.2	0.3	0.1		0.2	0.2	
Agriculture, forestry and fishing	0.1	0.05	0.05	0.5			0.3
Wholesale and retail trade	0.3	0.15	0.05	0.1	0.1	0.2	0.1
Manufacturing	0.3	0.35			0.15	0.2	
Construction	0.3	0.15			0.15	0.4	
Information and communication	0.5	0.2	0.05	0.05	0.1	0.1	
Energy	0.2	0.3	0.3	0.1	0.1		
Other industries (incl. water)	0.2	0.3	0.3	0.1	0.1		

Table 3: The applied weighting of biophysical parameters if operations do not have a coastal or shipping dependency.

Parameter	Temperature	Flooding	Drought	Crops	Sea level rise	Shipping Choke Points	Fish Catch
Transportation	0.6	0.3	0.1				
Agriculture, forestry and fishing	0.1	0.05	0.05	0.5			0.3
Wholesale and retail trade	0.5	0.2	0.1	0.1			0.1
Manufacturing	0.6	0.2	0.1	0.1			
Construction	0.4	0.4	0.1	0.1			
Information and communication	0.7	0.2	0.05	0.05			
Energy	0.2	0.35	0.35	0.1			
Other industries (incl.water)	0.2	0.35	0.35	0.1			

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Annex I

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Accreditations

Notre Dame –Global Adaptation Index (ND-GAIN) - University of Notre dame, © 2014 Copyright Notre Dame Global Adaptation Index, http://creativecommons.org/licenses/by/3.0/legalcode, http://index.gain.org/

Flood analyzer data -World Resources Institue, http://creativecommons.org/licenses/by/3.0/legalcode, http://floods.wri.org/#/

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The Royal Netherlands Meteorological Institute (KNMI) - https://climexp.knmi.nl/plot_atlas_form.py?id=someone@somewhere

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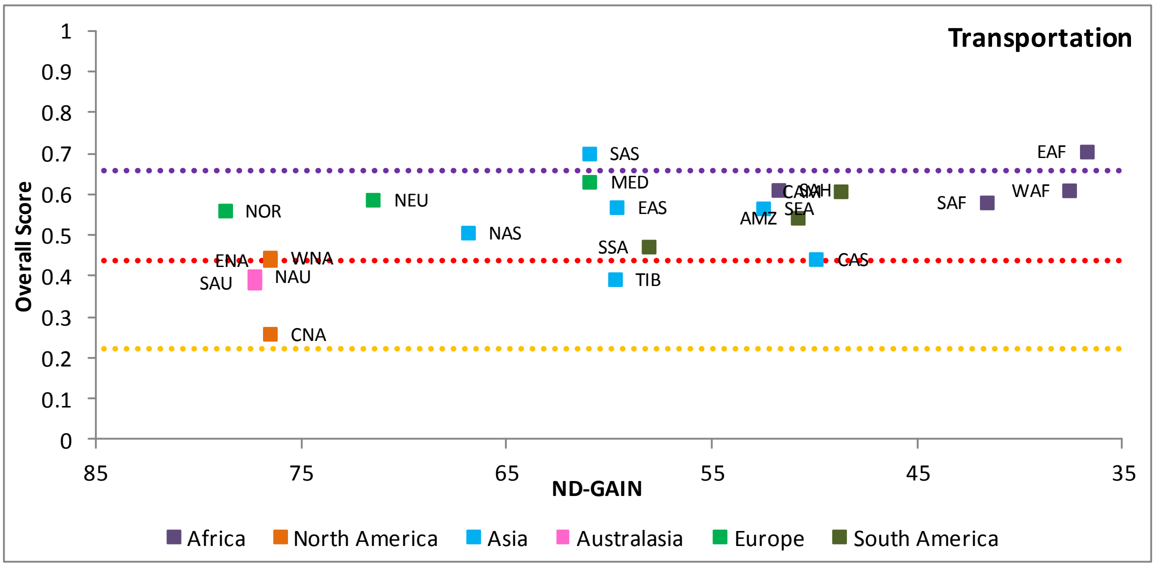
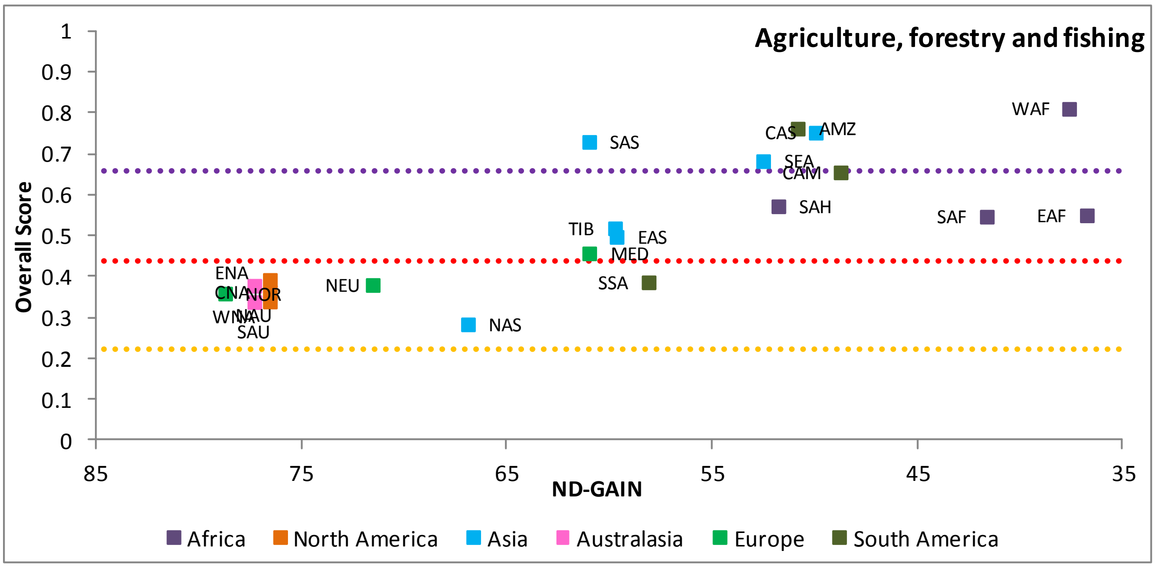
Annex II

The plots presented below provide examples of the Overall Risk Score against the regional ND-GAIN score. Values above the purple, red and yellow line indicate a Very High, High and Medium overall risk scores respectively. Points further to the right of the x-axis indicate a higher socio economic vulnerability to climate change and are less able to adapt. Points higher on the y-axis indicate higher Overall Risk Ratings.

The plots below present the different Overall Risk Rating achieved for each terrestrial region *with* coastal infrastructure.





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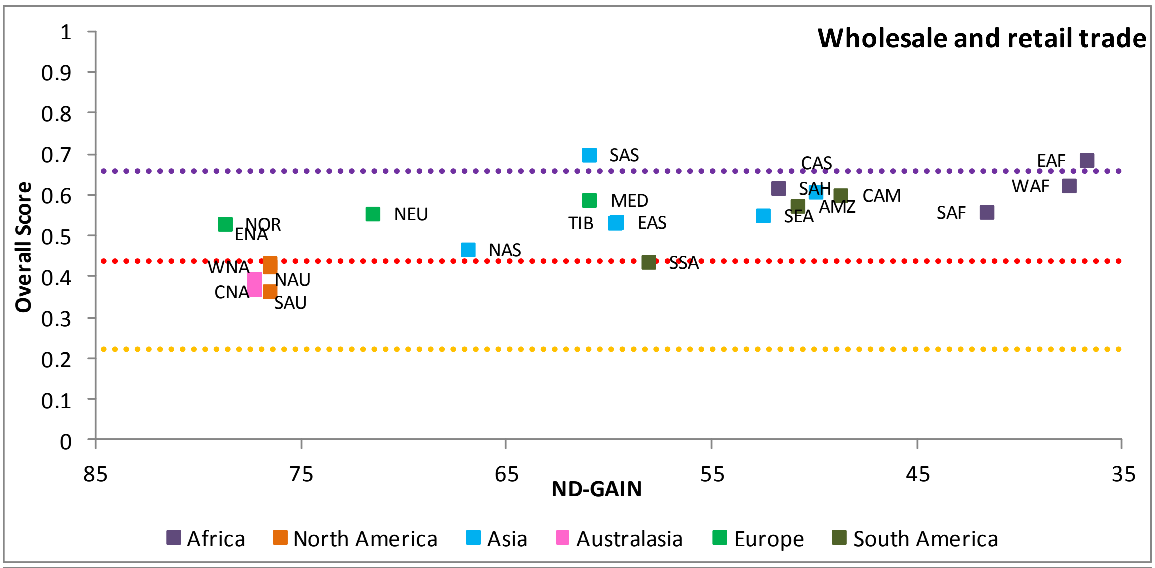

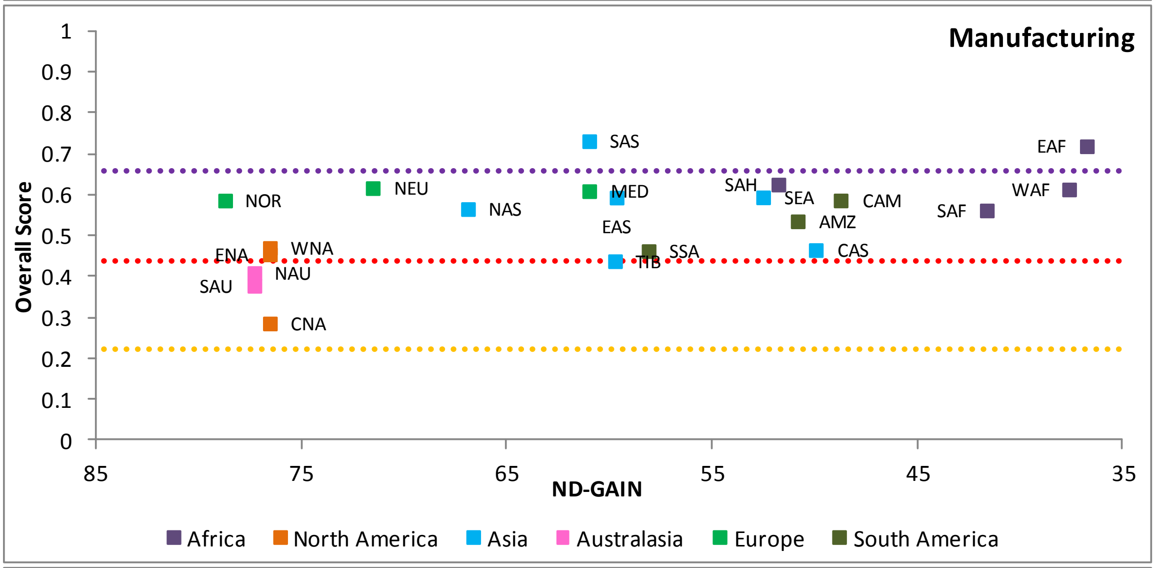

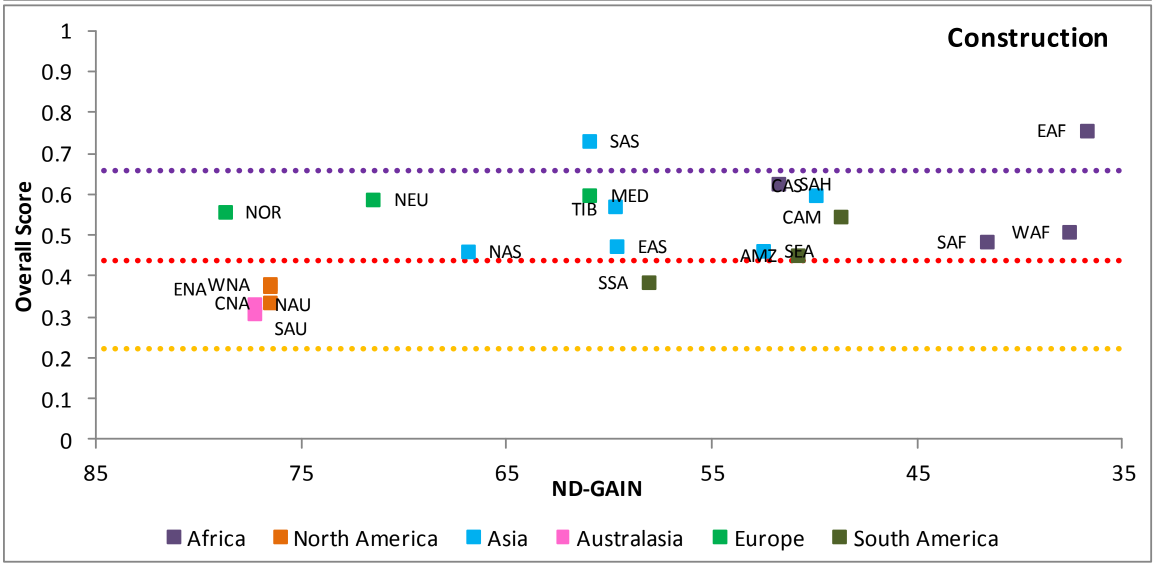

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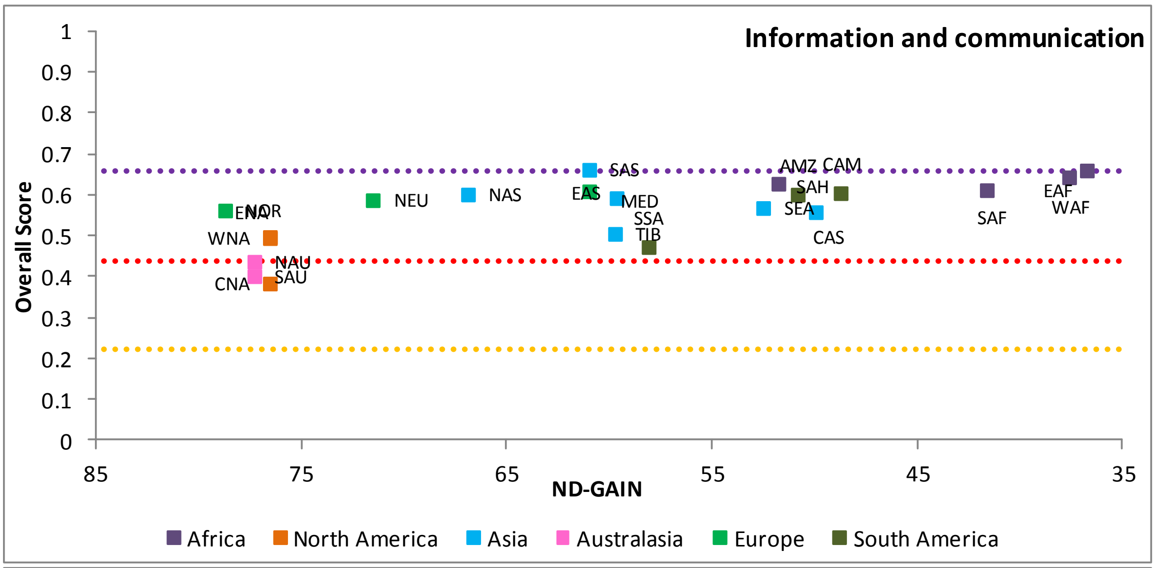

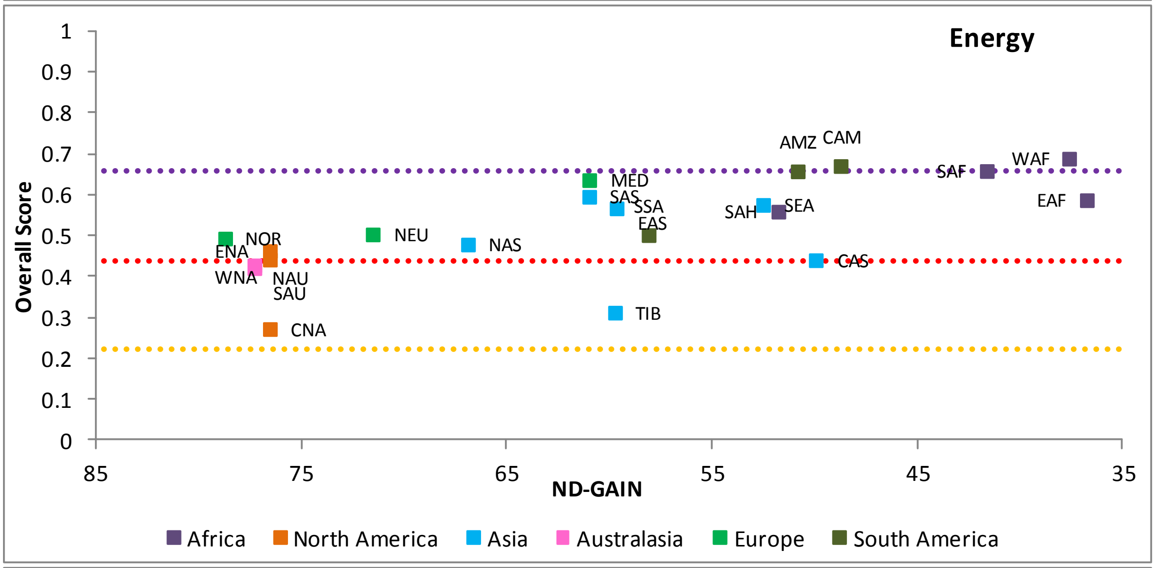

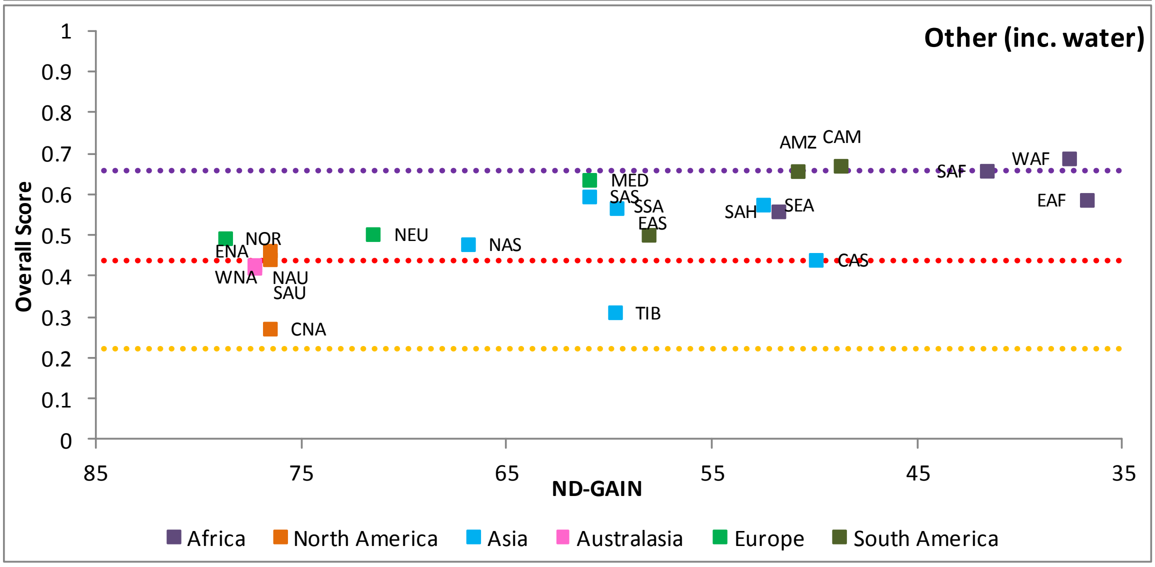

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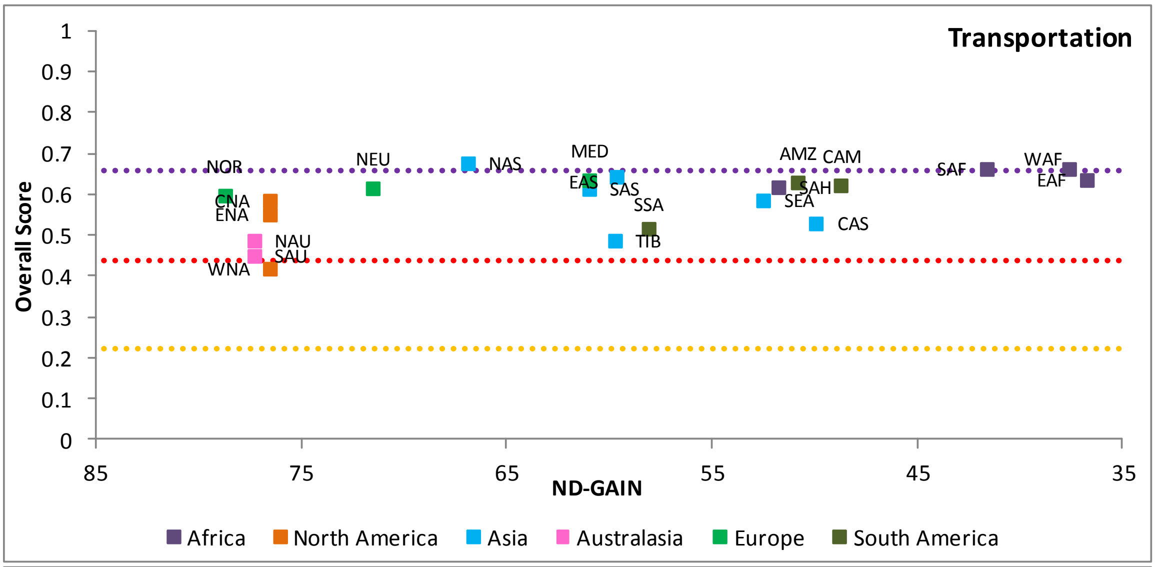
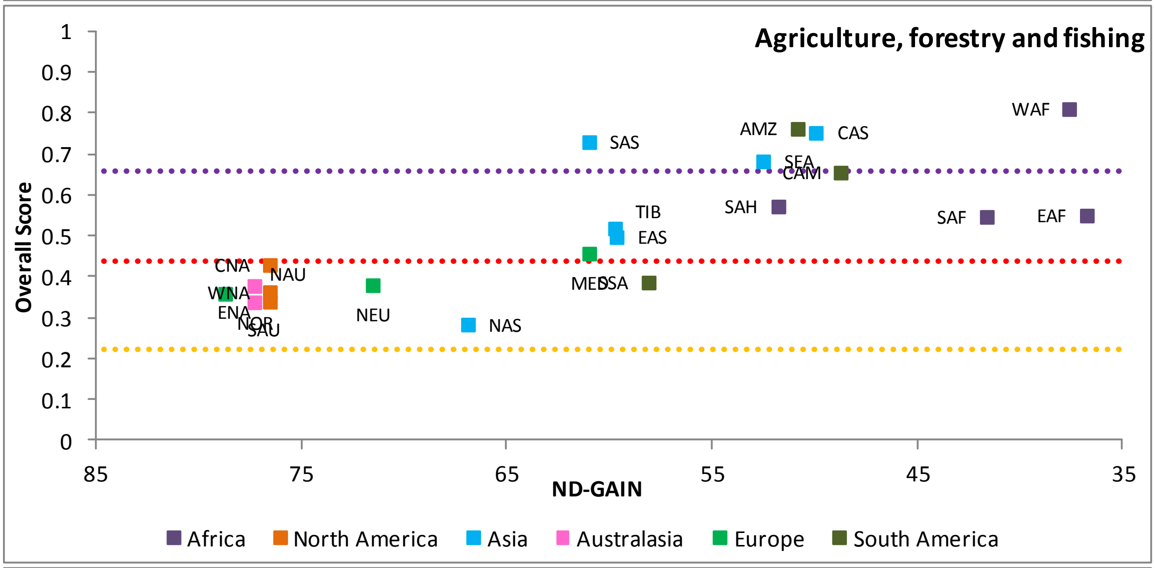
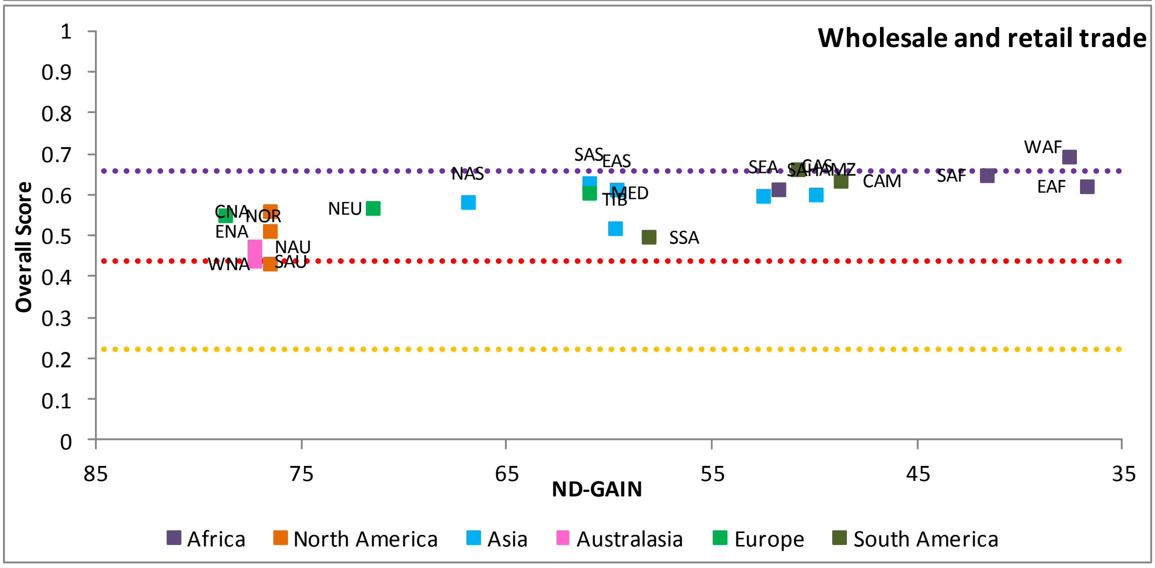
The plots below present the different Overall Risk Rating achieved for each terrestrial region *without* coastal infrastructure.







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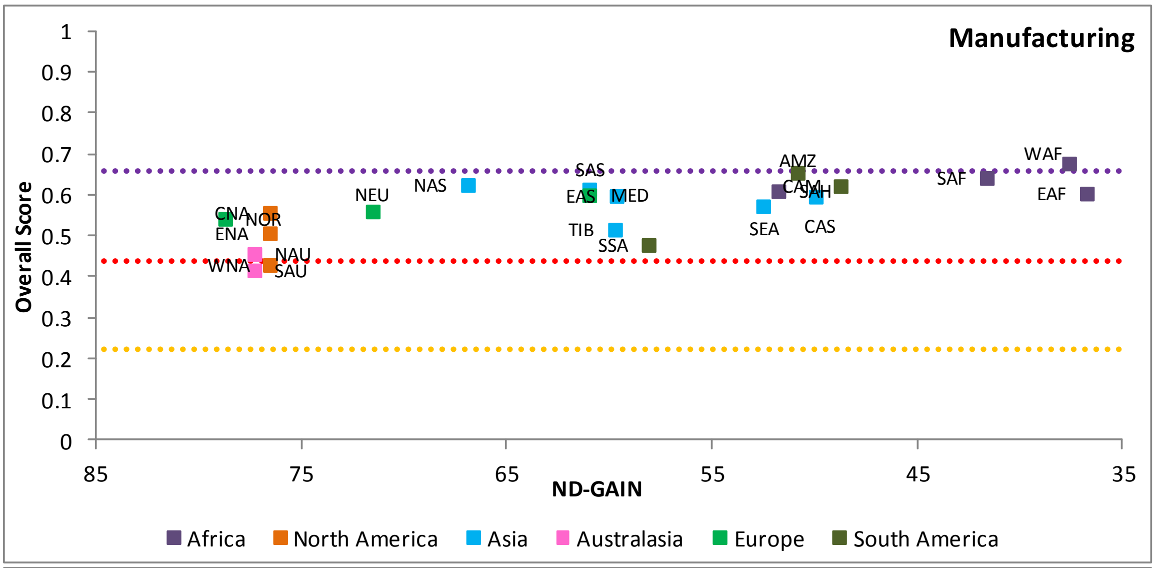

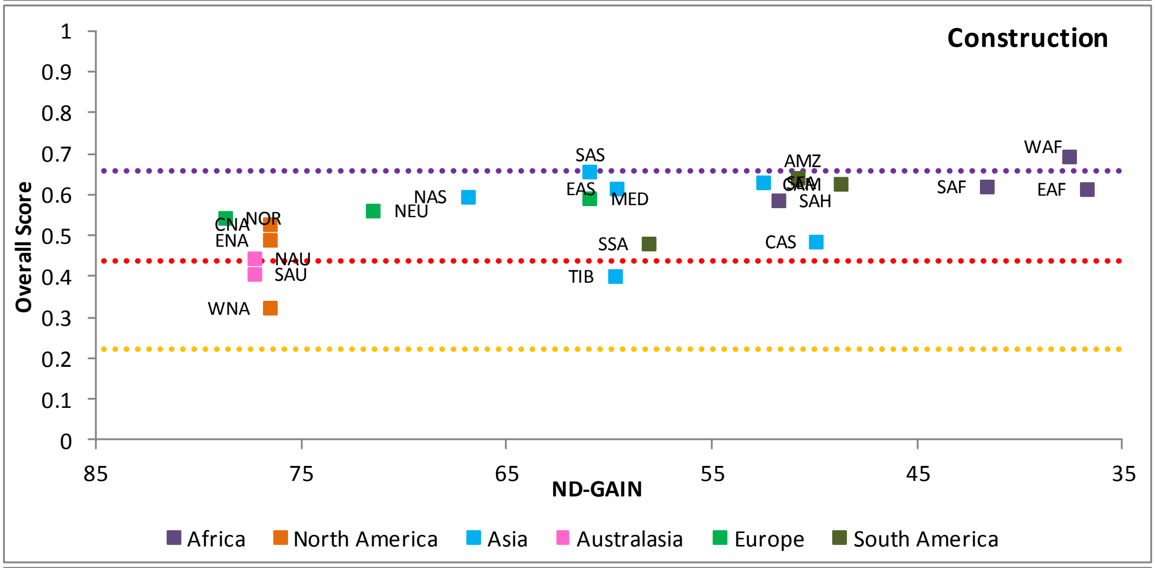

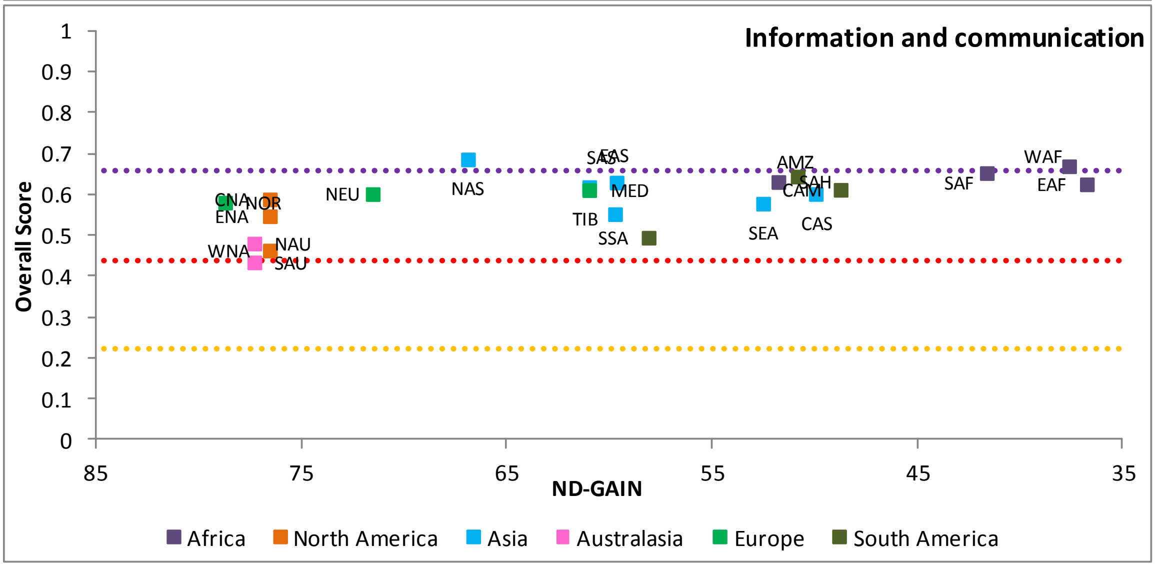

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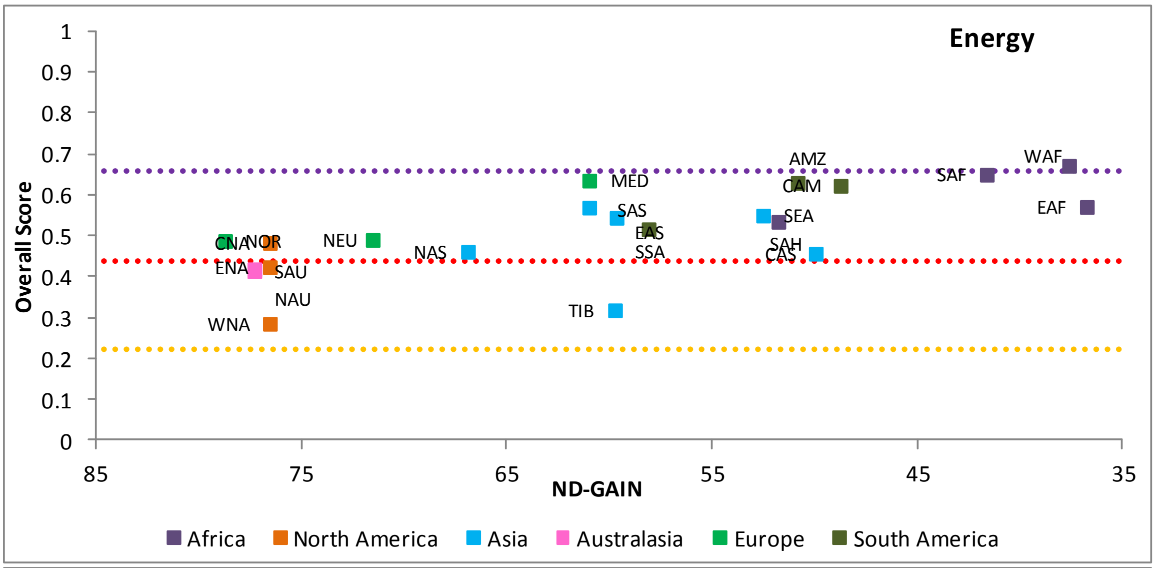

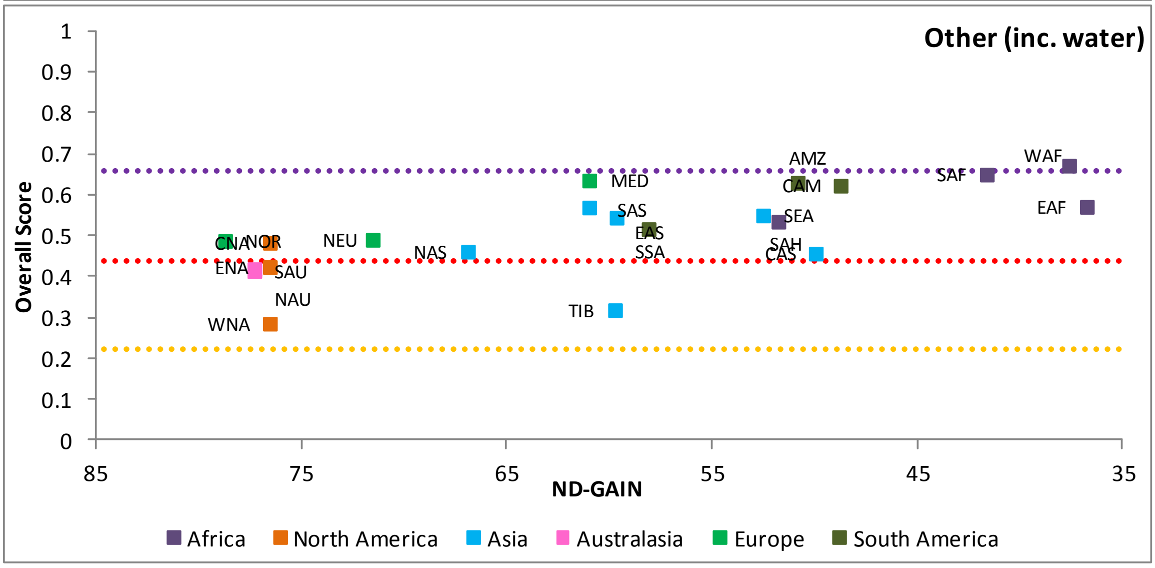

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