Cross-cutting uncertainties

1 April 2014 (1530-1800h), Session 1.6.2
(chaired by F Ewert and R Rötter; rapporteur: M Rivington)
FACCE MACSUR Mid-term Conference at Sassari/SARDINIA

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CONTENTS

• Uncertainty – and how it has been treated in the past in CC impact projections
• Integrated regional assessment in MACSUR
• Uncertainty and risk assessment in MACSUR
• Outlook
Definitions:
Ignorance, uncertainty, error, accuracy, precision, risk

(=> presentation M Rivington)
Objectives of uncertainty evaluation

• To estimate uncertainty
  – important for model developers, users, stakeholders

• To understand what is driving uncertainty
  – in order to prioritize improvement efforts
Estimating uncertainty

• **Three approaches:**
  1) Based on error in hindcasts (*based on difference between simulated and observed*)
  2) Based on sources of error (*model input, model parameters...*)
  3) Based multiple models /inter-comparison (*ensemble modelling approach...*)
Conv. CC IA meth. /Winners /Loosers; mean changes; Here: Potential changes in cereal yields, A2 (Parry et al., 2004)
Uncertainty in biophysical impact modelling

Modelling and regionalisation

GCM
*Climate change projections*

(Down-)Scaling/Regionalisation
*(delta change, RCM bias correction, weather generator)*

*Climate scenario data*

(Plant-soil) Impact models
*Impact projections at different spatiotemporal scales*

Climate is changing...

Shift in PDF of July temperatures
S Finland (Source: Räsänen 2010)

Figure 1 | Estimated CO2 emissions over the past three decades compared with the IS92, SRES and the RCPs. The SA90 data are not shown, but the most relevant (SA90-A) is similar to IS92-A and IS92-F. The uncertainty in historical emissions is ±15% (one standard deviation). Scenario data is generally reported at decadal intervals and we use linear interpolation for intermediate years.

(Source: Peters, 2013; Nat Clim Change)

Figure 4 | European summer temperatures for 1500–2010. The upper panel shows the statistical frequency distribution of European (35° N, 70° N; 25° E, 40° E) summer land-temperature anomalies (relative to the 1970–1999 period) for the 1500–2010 period (vertical lines). The five warmest and coldest summers are highlighted. Grey bars represent the distribution for the 1500–2002 period with a Gaussian fit shown in black. The lower panel shows the running decadal frequency of extreme summers, defined as those with a temperature above the ninety-fifth percentile of the 1500–2002 distribution. A ten-year smoothing is applied. Reproduced with permission from ref. 69, © 2011 AAAS.

(Source: Coumou & Rahmsdorf, 2012)
Projected changes in mean temperature and precipitation during March-August for selected stations in Finland

Changes in T and PRECIP for time periods 2011-2040, 2041-2070 and 2071-2100 compared with 1971–2000 for six representative locations relevant for agricultural production in Finland (see Fig.). Six GCMs (CCCMA CGCM 3 1, CSIRO MK 3 5, GISS MODEL E R, IPSL CM4, MIROC 3 2 MEDRES and BCCR BCM 2 0) are presented.

Source: Rötter et al. 2013
Model intercomparison
COST 734 (blind test, current climate); AgMIP wheat (partially and fully calibrated, current and future)


Modelling chain from climate via crop to economic

(source: Nelson et al 2014, PNAS)
Need for INTEGRATION

UNCERTAINTY caused by ...

SSP, scenarios, e.g. New technologies /their diffusion?
Model deficiencies/ lack of data /scaling and model linkage
Short-term variability/volatility
MACSUR Regional Pilot Studies

Multitude of approaches – one direction is upscaling from farm level (for typical farm types) of mitigative adaptation Options via region/national to supra-national scales – also taking Into account other Sustainable Development Goals – e.g. In NORFASYS (Rötter et al., 2013)
Uncertainty and risk in MACSUR
- Approaches pursued so far:
  
  • Use of multi-model ensembles to evaluate uncertainty and causes of uncertainty
    Building on experience in COST action 734 and AgMIP

  • Use of Impact Response Surface Method overlaid with joint probabilities of projected changes in T and Precip
    Building on experience in modelling CC impacts in Finnish ecosystems (S Fronzek & T Carter) and in the framework of the ENSEMBLES project (Special Issue in NHESS; Carter et al. 2011); related to C3MP (Ruane/AgMIP)
Probability density functions of spring barley yields during 1971-2000 and 2071-2100 under selected climate change scenarios at Utti

Rötter et al., 2013
IRS : Methods and data

- Impact response surfaces (IRS) were constructed from the results of the model simulations.
- IRSs represent the sensitivity of modelled crop yield to incremental changes in precipitation (vertical) and temperature (horizontal), here represented as absolute yields (baseline ~ 7500 kg/ha).

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Pirttioja et al, in prep
Constructing impact response surfaces for analysing risk of crop yield shortfall

2050 CO₂ 522 ppm

Precipitation change (%)

Temperature change (°C)

<95% <75% <50% <25%

7.4.2014 Nina Pirttioja, SYKE
Change through coordinated international efforts

- **one avenue towards more robust** global results: AgMIP (www.agmip.org)
- regionally/EU: Modelling European Agriculture with Climate Change for Food Security (www.macsur.eu)
- *Both networks coordinate efforts to improve agricultural models and develop common protocols to systematize modelling for the assessment of climate change impacts on crop production. They emphasize the importance of integrating biophysical and socioeconomic analysis from farm to global scale*
- *Some conclusions form Oslo, 10-12 Feb*:  a continuous monitoring of the ‘state of knowledge’ is proposed. e.g. To be coordinated by AgMIP  closely collab. FACCE-MACSUR.

- **another avenue** is international support to building bottom-up “low-regret” adaptation strategies in response to an uncertain climate and utilizing a.o. response diversity in management e.g. for climate resilient cropping systems *(can also be supported by crop modelling; see, Kahiluoto et al., 2014a,b)*
Further reading

• Kahiluoto, H. et al., The role of modelling in building climate resilience in cropping systems. Chapter 13 in J’Fuhrer & P Gregory, CABI (in press)

• Presentations in the uncertainty session 1.1 of the CropM Oslo International Symposium, 10-12 February 2014 at www.macsur.eu