Indicators and trends

Monitoring climate change adaptation

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Indicator name				Version
NA29 Drought risk to agricultural land				29/03/16
Indicator type:	Risk/opportunity	Impact	Action	
	X			

SCCAP Theme	SCCAP Objective	CCRA risk/opportunity
Natural Environment	N3: Sustain and enhance the benefits, goods and services that the natural environment provides	• AG4 Drier soils (due to warmer and drier summer conditions) • AG25/AG51/AG52 Agricultural land classification and crop suitability

At a glance
• Drought risk constrains land use options and can increase demand for irrigation water to maintain agricultural productivity. • In average years the drought risk to arable crops is small, and largely compensated by the availability of water for irrigation. • Some parts of East Scotland have shown an increase in drought risk, with further increases projected for the future across larger areas of prime agricultural land. • Land use options may be limited unless irrigation supply is increased; however this could increase water-stress in some catchments in North-East and South-East Scotland. • As an alternative to irrigation, other forms of adaptation could be developed (e.g. shifts in cropping systems and changes in varieties).

Latest Figure	Trend
Reference period 1981-2000. The area of prime land classified with moderate/severe drought risk is ca. 2.5% (using winter wheat as an indicator crop)[1]	No long-term trend in average conditions currently detected Medium confidence in the present and future assessment

[1] Prime land should be capable of growing one of the LCA indicator crops without moderate or severe drought risk. Cereals (as indicated by winter wheat) have lesser water requirements than potatoes therefore are less vulnerable to drought risk. Land not suitable for potatoes may be suitable for cereals and is therefore still classified as prime land, so wheat provides the indicator associated with prime land.

Why is this indicator important?

Drought risk is a component of Land Capability (Brown et al., 2011) that identifies constraints on land use options through limitations on water availability. This has implications for the amount of additional irrigation water that may be required to reduce moisture deficits and maintain agricultural productivity. In Land Capability for Agriculture, indicator crops are used to reference drought risk. The main indicator crops are potatoes, cereals (winter wheat/ spring barley), and grass. Of these potatoes is the only crop that is normally irrigated together with other horticulture crops because of their higher economic value. Cereals (as indicated by winter wheat) have lesser water requirements than potatoes therefore are less vulnerable to drought risk. Therefore, land not suitable for potatoes may be suitable for cereals and is hence still classified as prime land, so wheat provides the indicator associated with prime land.

Agro-climatological metrics for drought risk are empirically defined based upon the interaction between climate and local soil properties through the soil moisture balance, notably in terms of available water capacity and its ability to meet the demands of different crops. For the indicative figures, long-term averages are used (20 years is the norm for land capability) but it should be noted that there is significant year-to-year variability and the average figures do not include the frequency of extreme drought events. Hence, this indicator is for extent of drought risk rather than for frequency or severity.

Related indicators:
NA2 Area of Prime Agricultural Land (Land Capability)
NA13 Abstraction of water for irrigation

What is happening now?

A small area of Scotland that is otherwise well-suited for arable cropping is currently exposed to drought risk due to the limited available water capacity of the soil at these locations (Figure 1a). Therefore, in average years the risk to national agricultural productivity is relatively small (and largely compensated by the availability of irrigation water). However, there is evidence that the drought risk can become more pronounced in extreme years (Brown et al., 2011).

What has happened in the past?

Analysis of past change back to 1961-1980 shows no significant change in average conditions, although there is some suggestion of a small increase in risk for parts of East Scotland due to a shift in temporal averages towards higher soil moisture deficits.

What is projected to happen in the future?

Although future climate scenarios vary in terms of the degree of change that may be expected, the general inference across a range of scenarios is that there is likely to be an increase in drought risk in East Scotland. Analysis by Brown et al. (2011) (based upon two representation UKCP09 SCP scenarios for the 2050s) suggested that 40-50% of prime land may be defined as of moderate or severe risk compared to 4% for baseline (1981-2000) conditions (with winter wheat as the indicator crop). The 'at risk' areas are predominantly in East Scotland. For potatoes this magnitude of change would suggest an additional ca. 50 mm of irrigation water would be required during the summer.

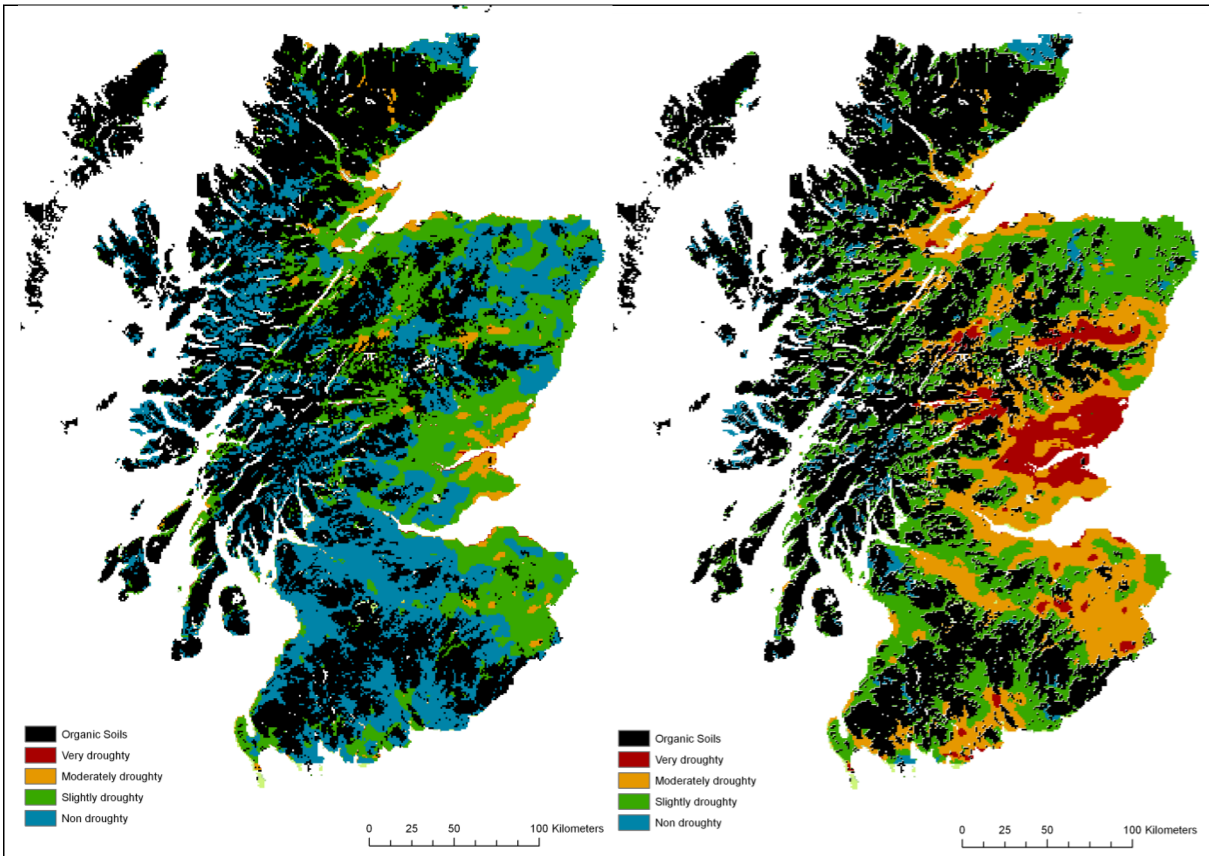

Figure 1 Drought risk for wheat a) 1981-2000; b) 2050s (HadRM3 SCP q3 scenario)

Patterns of change

Using the same 2050s climate projections, analysis for Scotland's Centre of Expertise for Waters (CREW) has identified 'hotspot' catchments based upon a continuation of current land use and management regimes, with irrigation concentrated on potatoes and horticulture (Brown et al., 2012). These hotspot catchments are particularly evident in Tayside and Fife (Figure 1b). If irrigation was extended to reduce drought risk to cereals, then water-stressed catchments would also become much more common throughout North-East and South-East Scotland. As an alternative to irrigation, other forms of adaptation could be developed (e.g. shifts in cropping systems and changes in varieties).

Interpretation of indicator trends

These results show the key influence of summer precipitation (in combination with evapotranspiration) on drought risk. At present, summer precipitation is variable from year to year and long-term averages show a complex pattern with a slight trend to increased soil moisture deficits in parts of East Scotland which can particularly affect coarse-grained drought-prone soils. This intrinsic ('natural') variability acts to confound a clear interpretation of long-term trends.

In the future, the likely trend towards drier summers (on average) shown by most climate projections means that the drought risk is expected to considerably increase and to involve large areas of prime agricultural land in East Scotland. This may limit some land use options unless irrigation supply is increased or other forms of adaptation occur.

Limitations

In addition to decadal variability, inter-annual variability is also a major factor for land use (or management) decisions associated with drought risk. This inter-annual variability may modify the average conditions (see Brown & Castellazzi, 2014).

The metrics should be considered in combination with other aspects of land capability, notably the overall assessment and wetness risk (see indicators 'NA2 Area of Prime Agricultural Land (Land Capability)' and 'NA13 Abstraction of water for irrigation').

LCA identifies potential land use and for issues related to water availability, irrigation supply also needs to be considered to evaluate the full land use implications.

References

Bibby, J.S., Douglas, H.A., Thomasson, A.J., Robertson, J.S. (1982) *Land capability classification for agriculture*. Macaulay Land Use Research Institute, Aberdeen

Brown, I., Poggio, L., Gimona, A., Castellazzi, M. (2011) Climate change, drought risk and land capability for agriculture: implications for land use in Scotland. *Regional Environmental Change,* 11, 503-518

Brown, I., Dunn, S., Matthews, K., Sample, J., Poggio, L., Miller, D. (2012) *Mapping of water supply-demand deficits with climate change and land use change.* Centre of Expertise for Water *http://www.crew.ac.uk*.

Brown, I. & Castellazzi, M. (2014) Changes in climate variability with reference to land quality and agriculture in Scotland. *International Journal of Biometeorology.* DOI: 10.1007/s00484-014-0882-9

Further information

Land Capability for Agriculture:
http://www.macaulay.ac.uk/explorescotland/lca.html
http://www.soils-scotland.gov.uk/data/lca250k

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Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	NA29 Drought risk to agricultural land
Indicator contact: Organisation or individual/s responsible for the indicator	Anna Moss (CXC, University of Dundee)
Indicator data source	Unpublished
Data link: URL for retrieving the indicator primary indicator data.	Not Available

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	1961-2011
Frequency of updates: Planned or potential updates	Update to 1991-2010 reference period
Spatial coverage: Maximum area for which data is available	National
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	Scale issues – this is national scale data using 1:250,000 soil mapping
Spatial resolution: Scale/unit for which data is collected	1km
Categorical resolution: Potential for disaggregation of data into categories	Already categorised.
Data accessibility: Restrictions on usage, relevant terms & conditions	Information needs to be used with caution due to key assumptions made

Table 3 Contributing data sources

Contributing data sources Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.
Soils (James Hutton Institute)

Climate (Met Office observed climatology and UKCP02/09)

Table 4 Indicator methodology

Indicator methodology The methodology used to create the indicator data
As per the standard LCA guidelines (Bibby et al., 1982) but modified as defined by Brown et al. (2011) to define moisture balance based upon crop-adjusted water demand and soil available water capacity. This provided drought risk for indicator crops. Further work on the links between land use and water demand for CREW are described by Brown et al. (2012)