Chapter 8: The impacts of climate change

Climate change has the potential to significantly disrupt the natural capital of Derbyshire; the predicted changes in temperature and rainfall patterns in particular will alter growing conditions, meaning that some places become less suitable for supporting particular species and habitats, while other places become more suitable.

This is significant because for natural capital, the 'what' (what species, habitats, soils etc.) is very important for determining the level of benefits people can derive. Equally important is the 'where'; where in the landscape those assets are located, because the level of ecosystem service delivered by an asset depends on where it is situated in the landscape, and how that relates to other assets.

Climate change will not affect all assets equally, and it is important to understand how changing extents and distribution of natural assets could affect ecosystem services in Derbyshire; which places could come under more pressure and require more support.

This section presents an overview of some of the climatic trends that are projected to occur in Derbyshire, based on two sources of climate data; UKCP18[27] (for analysis of changes in agricultural land grade), and WorldClim[28] (for analysis of bioclimatic variables).

Climate change models are complex, and it is important to recognise the spatial limitations of the data, which is of coarser spatial resolution than the datasets used for production of the habitat map and ecosystem service maps. However, the data provide a valuable insight into the types of changes that will be faced by Derbyshire, and how these could impact natural capital and ecosystem service delivery.

Rainfall and temperature changes

Rainfall and temperature trends were investigated through analysis of WorldClim bioclimatic data. Analysis of the maximum temperature of the warmest month of the year (WorldClim Bioclimatic variable 5) identified that maximum temperatures are predicted to increase by 8oC consistently throughout Derbyshire by 2080.

Temperature increases, and an increase in heatwave events, are particularly significant for densely populated and deprived urban areas, where there is a greater risk of heat stroke and other impacts on health and well-being. To mitigate the effects of heat, green corridors and cooling features such as trees and wetlands are expected to become increasingly valuable, particularly in urban environments.

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[27] https://www.metoffice.gov.uk/research/approach/collaboration/ukcp
[28] https://www.worldclim.org

Temperature increases also influence the distribution of many species. Derbyshire is currently at the northern limit of the distribution of many native ‘southern’ species; e.g. wild service tree (Sorbus torminalis), and the southern limit of the distribution of many native ‘northern’ species; e.g. northern brown argus butterfly (Aricia artaxerxes). Temperature changes could alter the distribution of native species in Derbyshire, through the impact of changes in site suitability or competition from other species.

Temperature seasonality (WorldClim bioclimatic variable 4) is expected to increase throughout Derbyshire between the present day and 2080 (Figure 79), meaning that heat waves are predicted to become more frequent. However, there is spatial variation in the magnitude of these changes; lowland areas, which coincide with the most productive agricultural land, are predicted to experience greater fluctuations in temperature than the uplands; this will increase pressure on farmers and pose an increased risk to agricultural food production.

Two aspects of precipitation were analysed; annual precipitation, and the seasonality of rainfall (coefficient of variation). Annual precipitation describes the total rainfall received during the course of the year, while the seasonality of precipitation describes how spread out throughout the year the precipitation events are. A comparison was undertaken between rainfall parameters for the present day (based on WorldClim historical average data) and modelled data for 2080 under climate change scenario Shared Socio-economic Pathway (SSP) 370 (Meinshausen et al., 2020).

The analysis showed that very little change in annual precipitation between the present day and 2080, with a maximum of 4mm difference in rainfall received at any location; this is not a significant change in the total annual rainfall. However, visualisation of the change in seasonality of rainfall (WorldClim bioclimatic variable 15) identifies that there will be changes in the pattern of precipitation events Figure 81. This means that although the total amount of rainfall received throughout the year in 2080 will be very similar to that of today, the seasonality will increase; the rainfall will fall in sharper, more intense bursts, with longer dry periods between them. The northern and upland parts of Derbyshire are predicted to be subjected to greater change in seasonality than the lowlands; while seasonality throughout the lowlands is predicted to double compared to the present day, the uplands are predicted to experience a six-fold increase in seasonality.

This trend is very significant for agriculture, habitats and individual species, as the required amount of rainfall may be less likely to fall at key times of year, for example to support germination and fruiting, or to stop ponds from drying out. Conversely, more intense bursts of rainfall are likely to increase surface water runoff increasing, flood risk, and causing soil erosion and water quality issues. This highlights the importance of taking early action in support of natural flood management, soil conservation, and protection of waterbodies from harmful inputs.

Blanket bog and other rainfall-fed habitats are particularly vulnerable to climate change. These habitats support unique flora and fauna, and are also extremely valuable for their surface water regulation and carbon storage properties, due to the underlying peat layer. Peatland habitats are key targets for habitat maintenance and restoration in order to protect and enhance these vital ecosystem services, but there is a risk that these habitats will become less resilient under climate change due to changes in hydrology; should the habitats not receive enough rainfall, the conditions will not be suitable for peat formation, making peat restoration projects less likely to succeed. Furthermore, damaged peatlands would be less able to recover, and be more likely to become a source of carbon emissions than those which sequester carbon.

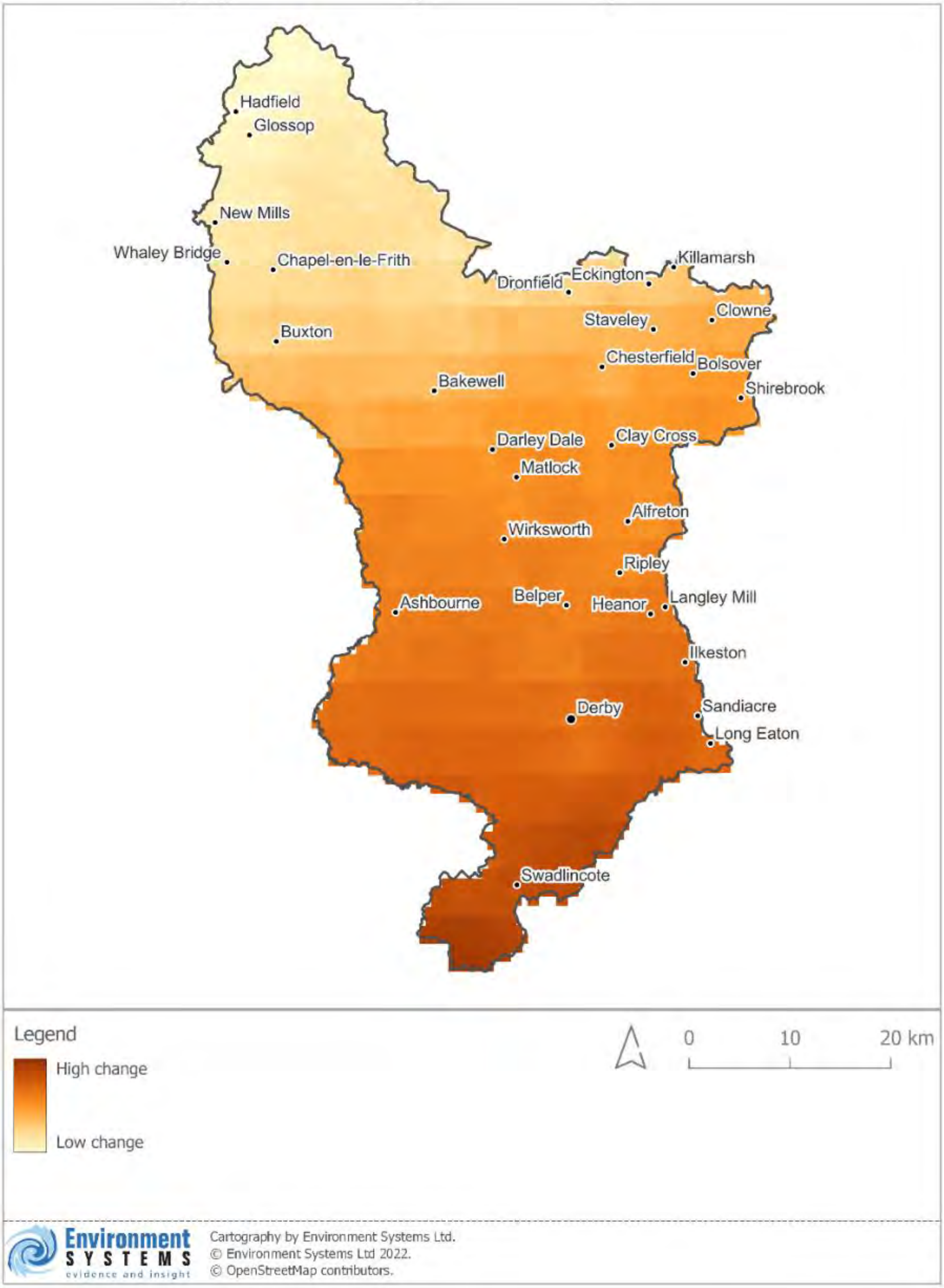

Figure 78: Change in seasonality due to temperature between the present day and 2080 (WorldClim ssp370)Impacts on habitats

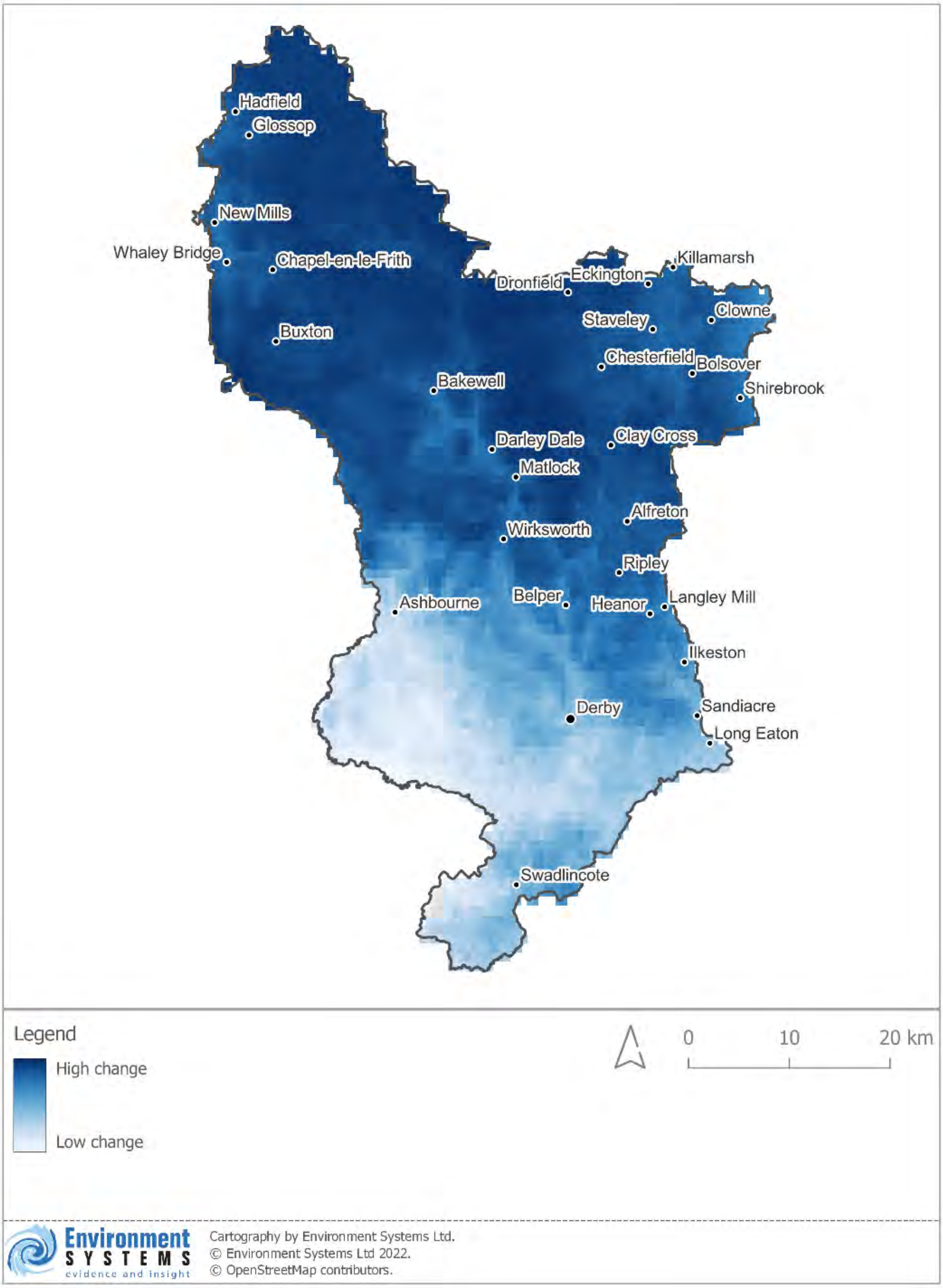

Figure 79: Change in seasonality due to precipitation between the present day and 2080 (WorldClim ssp370)Impacts on habitats

Although little difference in annual rainfall is predicted to occur throughout Derbyshire as a whole, the predicted change could be significant for habitats that are currently located at the extreme limit of their biophysical range. Analysis of trends in annual average rainfall (Figure 81) and the number of field capacity days (the number of days at which the soil pores are fully hydrated under gravity (Figure 83); shows a predicted decrease in the area of land where hydrological conditions will support the formation of blanket bog (although existing habitat could be stable if managed appropriately). This means that blanket bog habitats (peatlands) will come under increasing pressure due to climate change induced changes to hydrological conditions.

Parts of Kinder Scout, running south to the peaks of Brown Knoll and Lords Seat are predicted to become particularly vulnerable as they are located at the edge of the areas that are currently hydrologically suitable for peatland formation, and in the future peat formation is predicted to become less achievable. This provides a strong argument for targeting peatland restoration measures to this vulnerable area; by restoring peatlands the existing carbon stock locked away in the peat will be more resistant to oxidation due to drying-out. At the same time, protecting the peat resource also maintains the important water-regulating function of peat.

The management practice of burning heather moorland poses a risk to peat formation and peat condition if not controlled. However, under-managed moorlands build up large quantities of woody or dead heather, which are a significant wildfire risk. Therefore, woodland management plans must balance peat formation, habitat and species goals with wildfire risk, economics and logistical considerations.

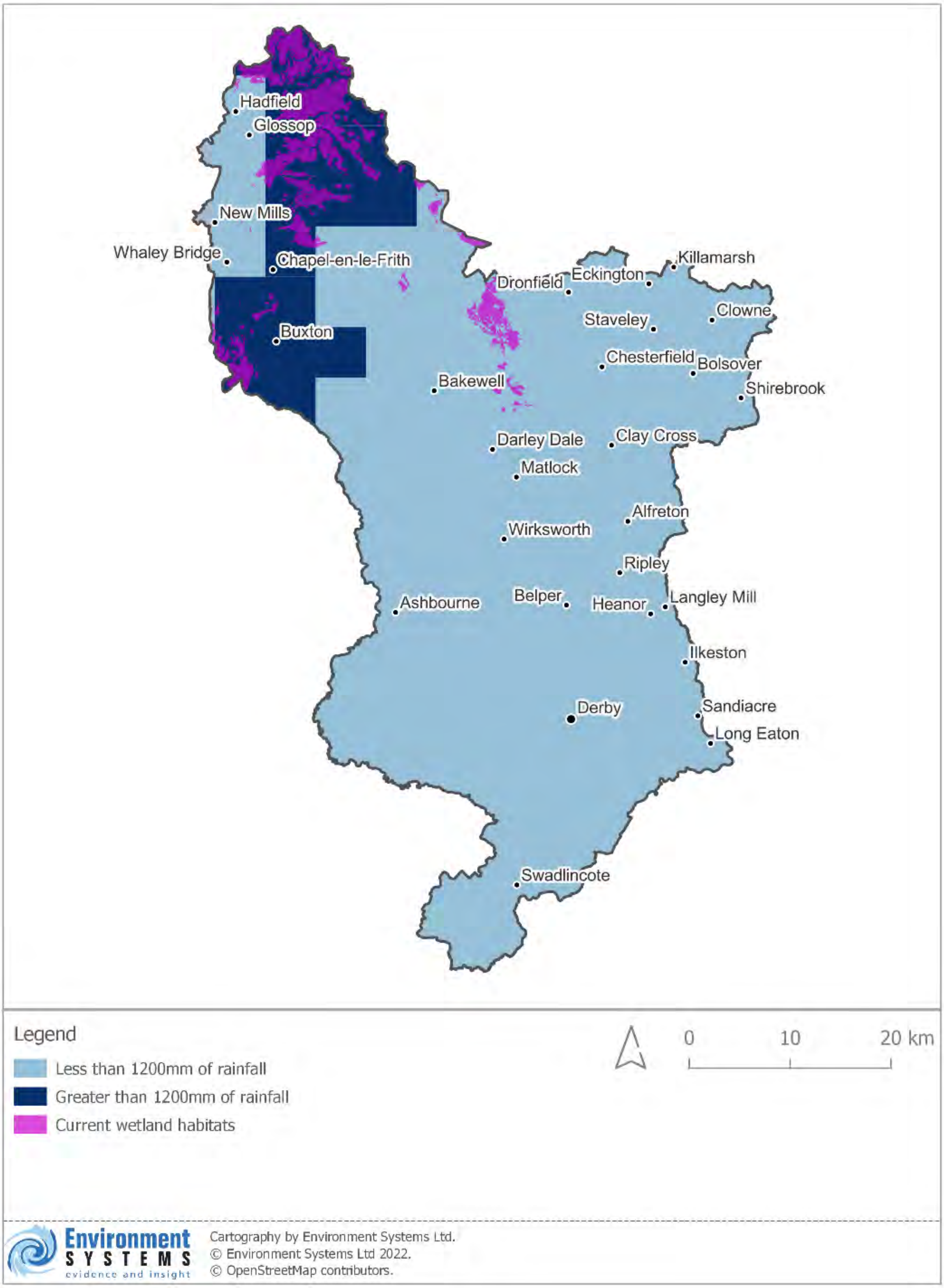

Figure 80: Comparison of areas receiving at least 1200mm Annual Average Rainfall in the present day (UKCP18 RCP 6.0)

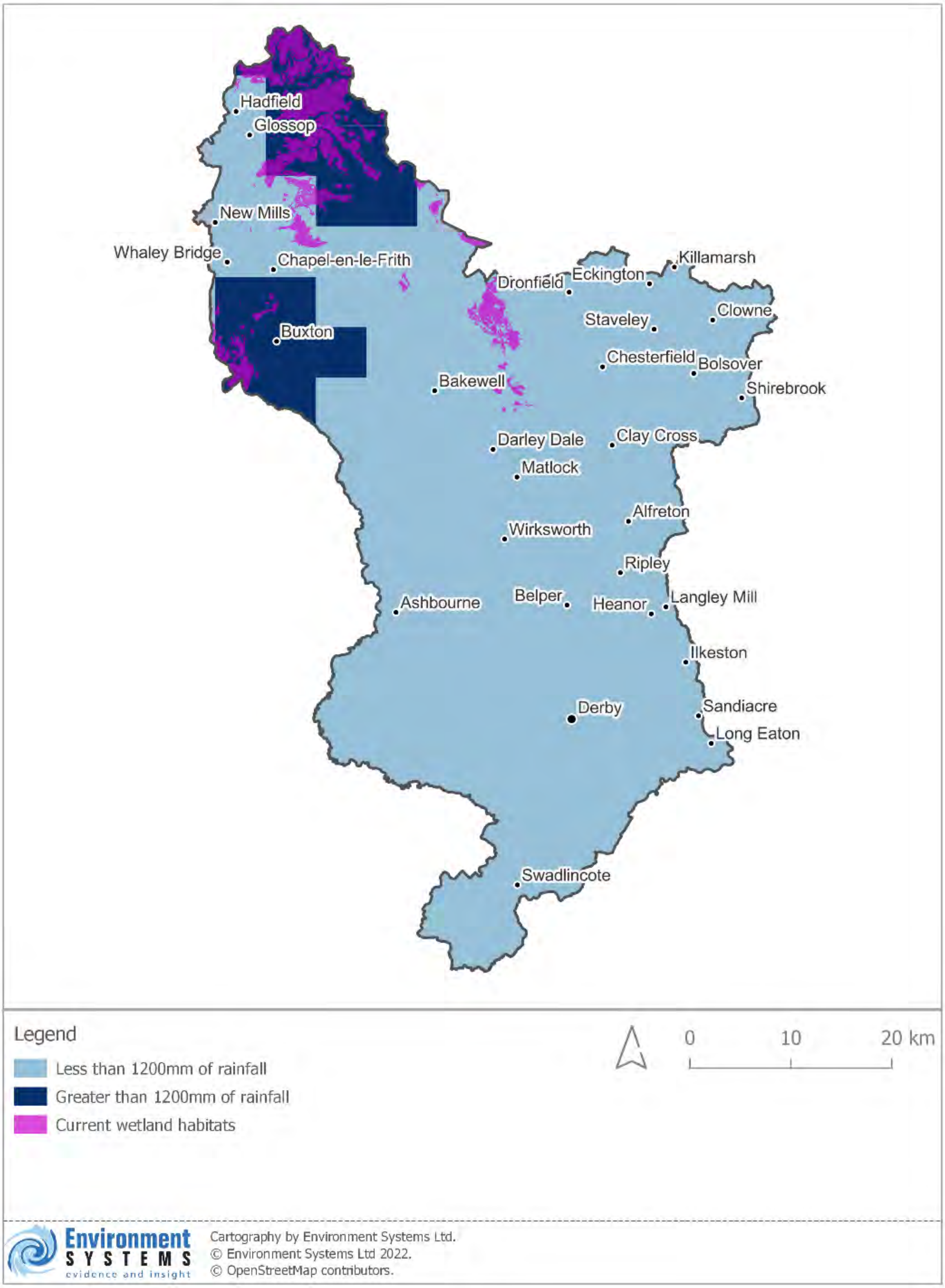

Figure 81: Comparison of areas receiving at least 1200mm Annual Average Rainfall in 2080 (UKCP18 RCP 6.0)

Impacts on agricultural land quality

Soil moisture characteristics are a fundamental component of the Agricultural Land Classification, which grades the land according to its capability for farming. Changes in temperature and precipitation patterns affect the soil moisture status, and different soil types will be affected by these changes to different extents according to their physical properties (i.e. the proportion of sand, silt, clay and organic matter) and management practice.

Figure 84 illustrates how agricultural land capability is predicted to change between the present day and 2080. Most areas will not see a change in the overall ALC grade, although the nature of the main limiting factors could change (for example a soil that is currently limited by wetness could by 2080 become limited instead by another factor, but retain the same grade overall if the level of limitation is comparable). Some areas have the potential to improve in soil quality for agriculture; these areas are located near the upland fringes, which suggests that they are currently limited by soil wetness, but under climate change (particularly the trend of increasing precipitation and temperature seasonality; longer hot/dry spells) these soils become less limited by wetness, and the climate more favourable for crop growth.

Conversely, some areas display a decrease in agricultural land quality by 2080. An analysis of the main limiting factor in ALC terms reveals that this change is largely due to an increase in soil drought conditions. Figure 86 shows a substantial increase in areas where drought becomes a main, or joint equal, limiting factor for agriculture; and this includes significant areas of land that is currently good quality, Grade 2 and Grade 3 land, around the Chesterfield/ S Yorkshire Notts & Derbyshire Coalfield area, and in the Trent Valley. In these areas, particular consideration should be given towards supporting agricultural management practices for enhancing soil carbon (which improves soil moisture retention), increasing on-farm water storage (including wetland creation), agroforestry, or growing alternative, drought resilient crop varieties.

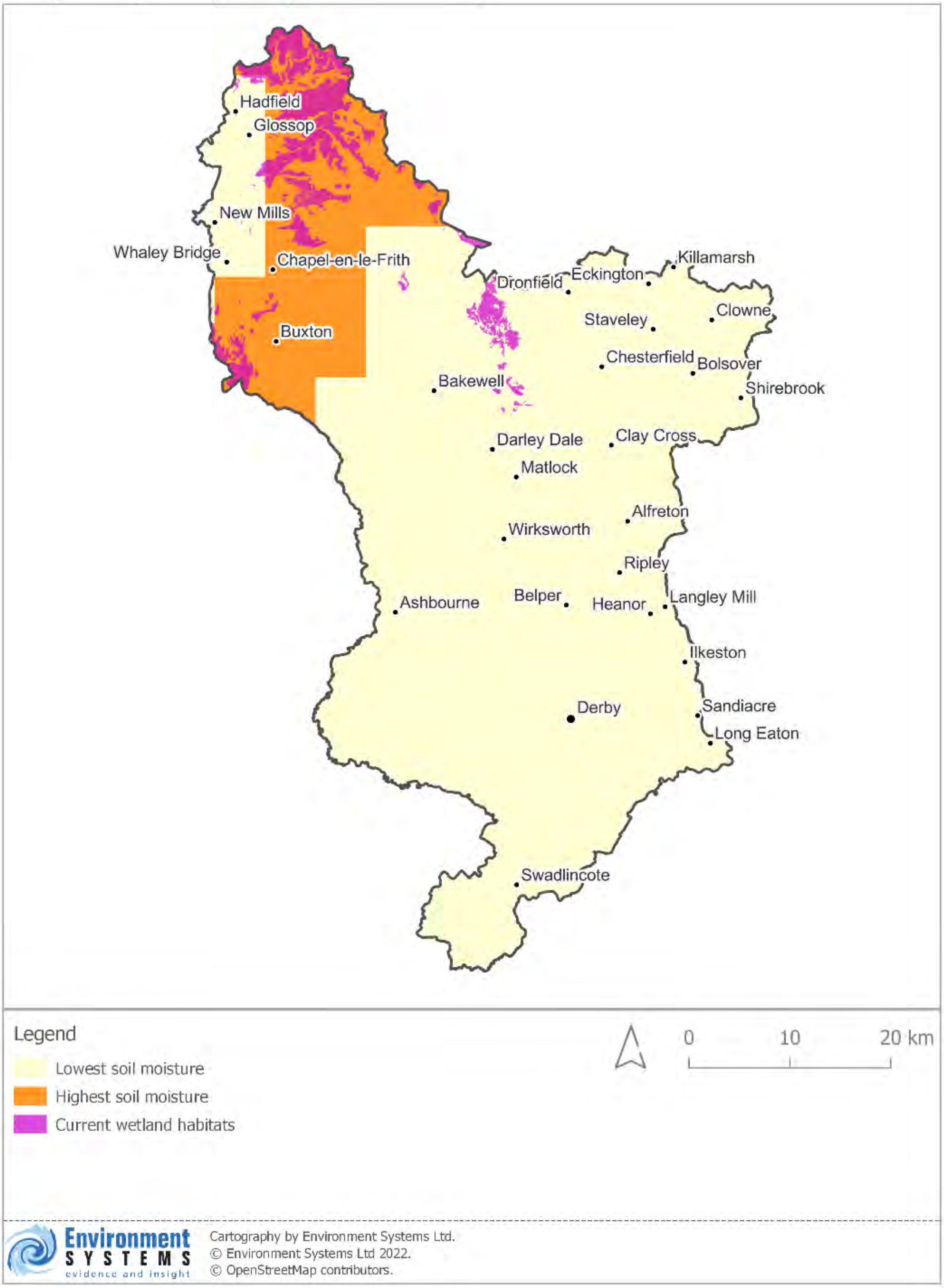

Figure 82: Comparison of areas where the soil experiences at least 270 Field Capacity Days in the present day (UKCP18 RCP 6.0)

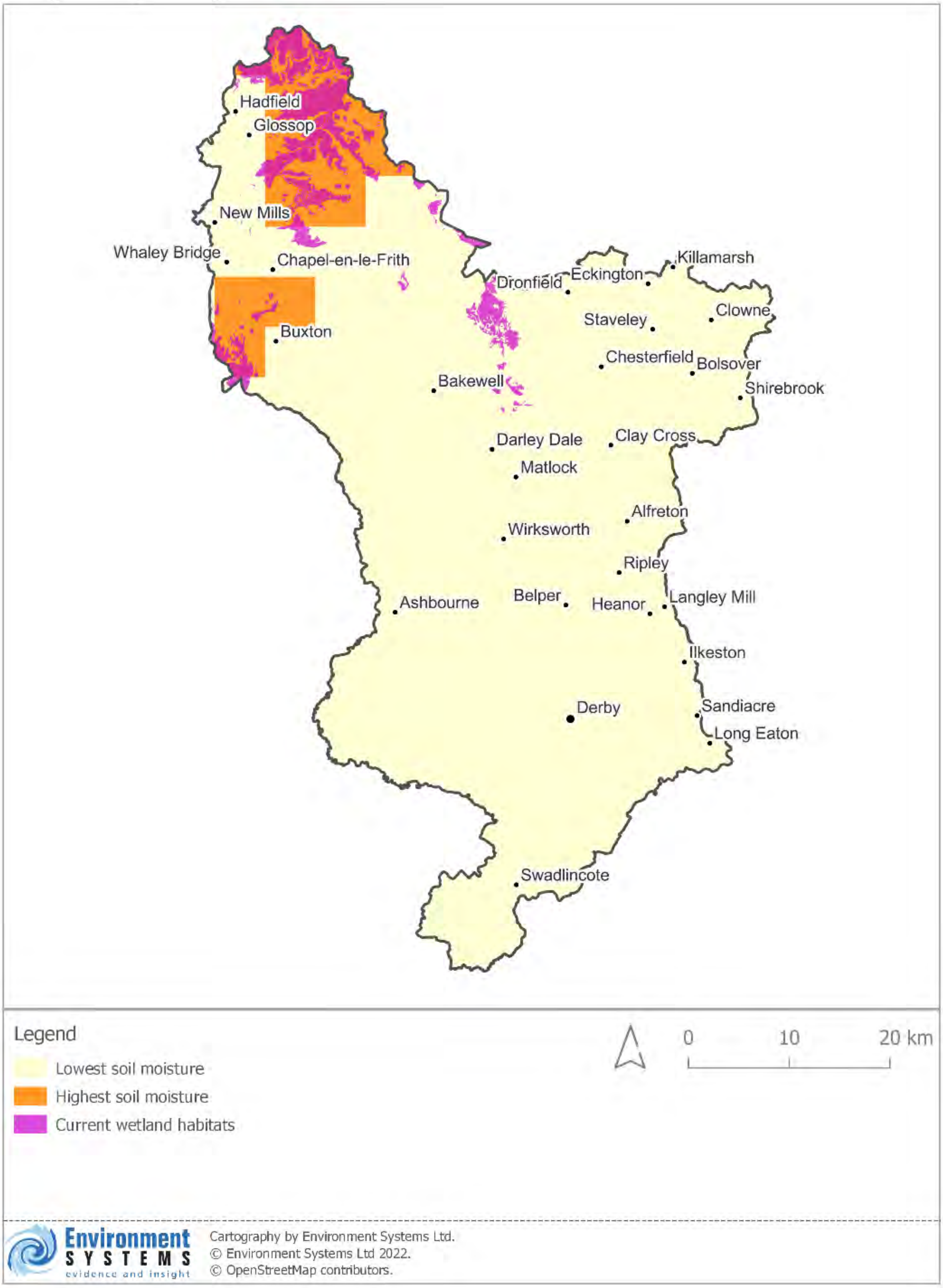

Figure 83: Comparison of areas where the soil experiences at least 270 Field Capacity Days in 2080 (UKCP18 RCP 6.0)

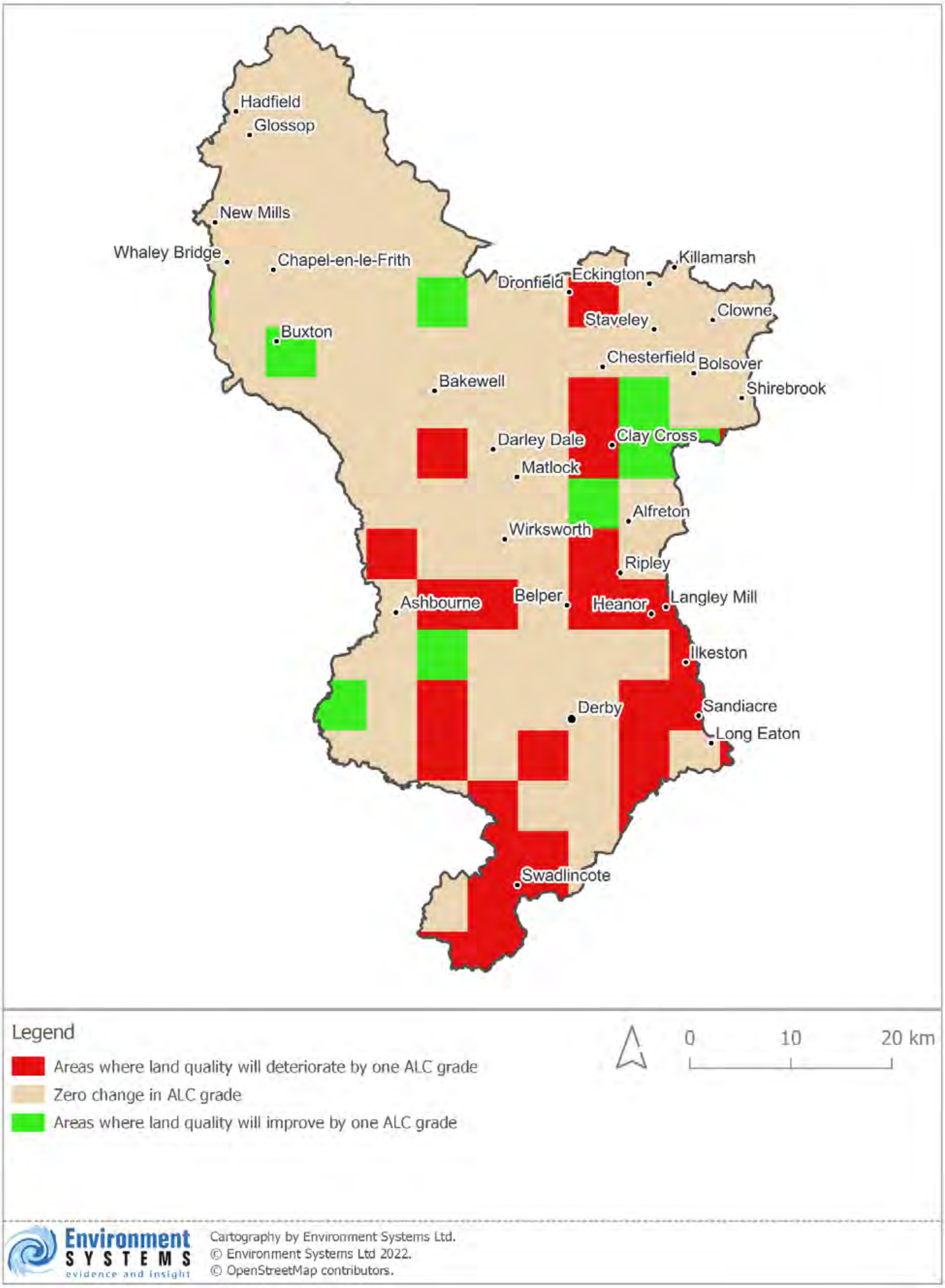

Figure 84: Predicted changes in Agricultural Land Classification grade between the present day and 2080 (UKCP18 RCP 6.0)

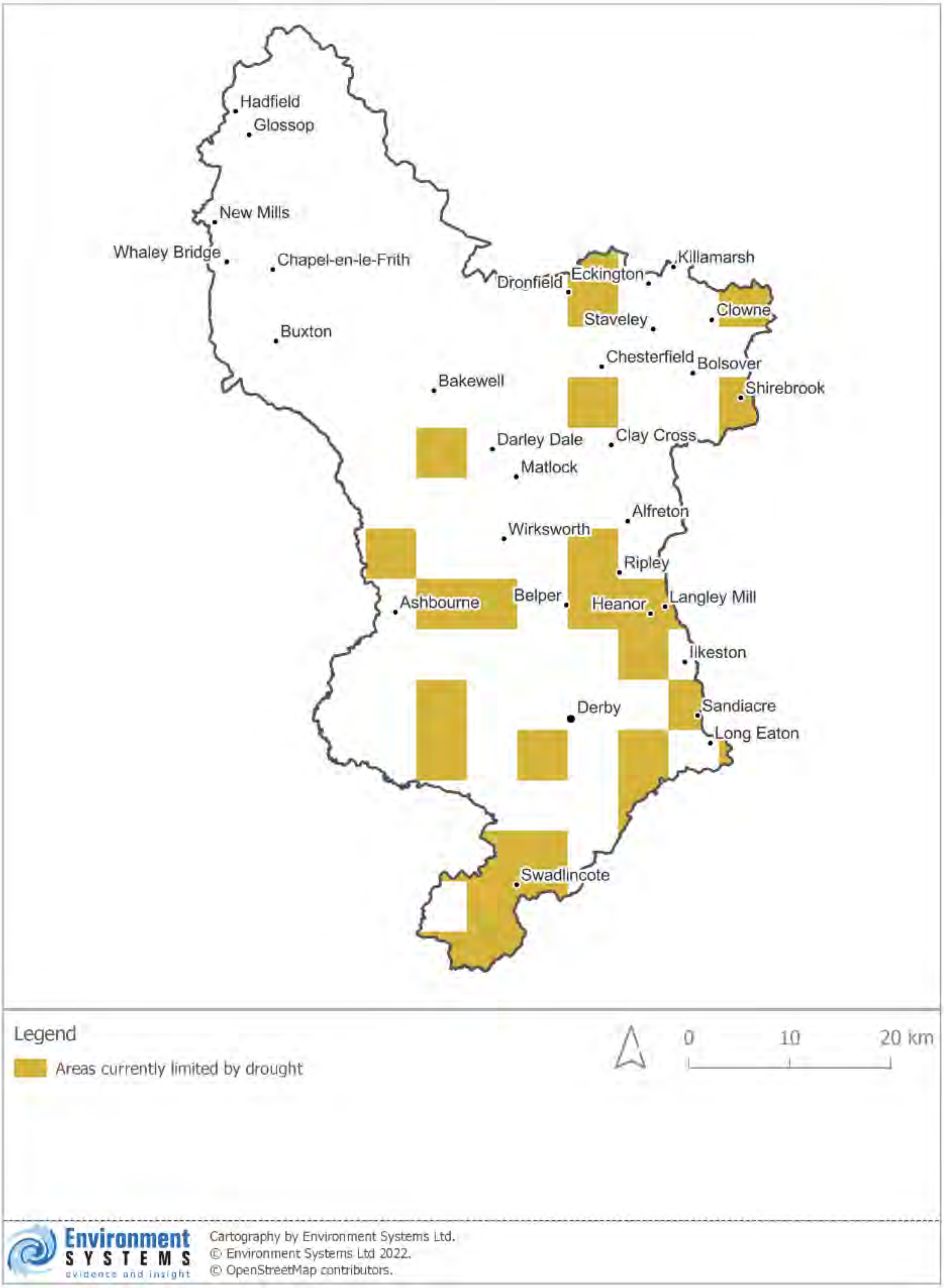

Figure 85: Areas where drought is a significant limiting factor for agriculture: present day UKCP18 RCP 6.0

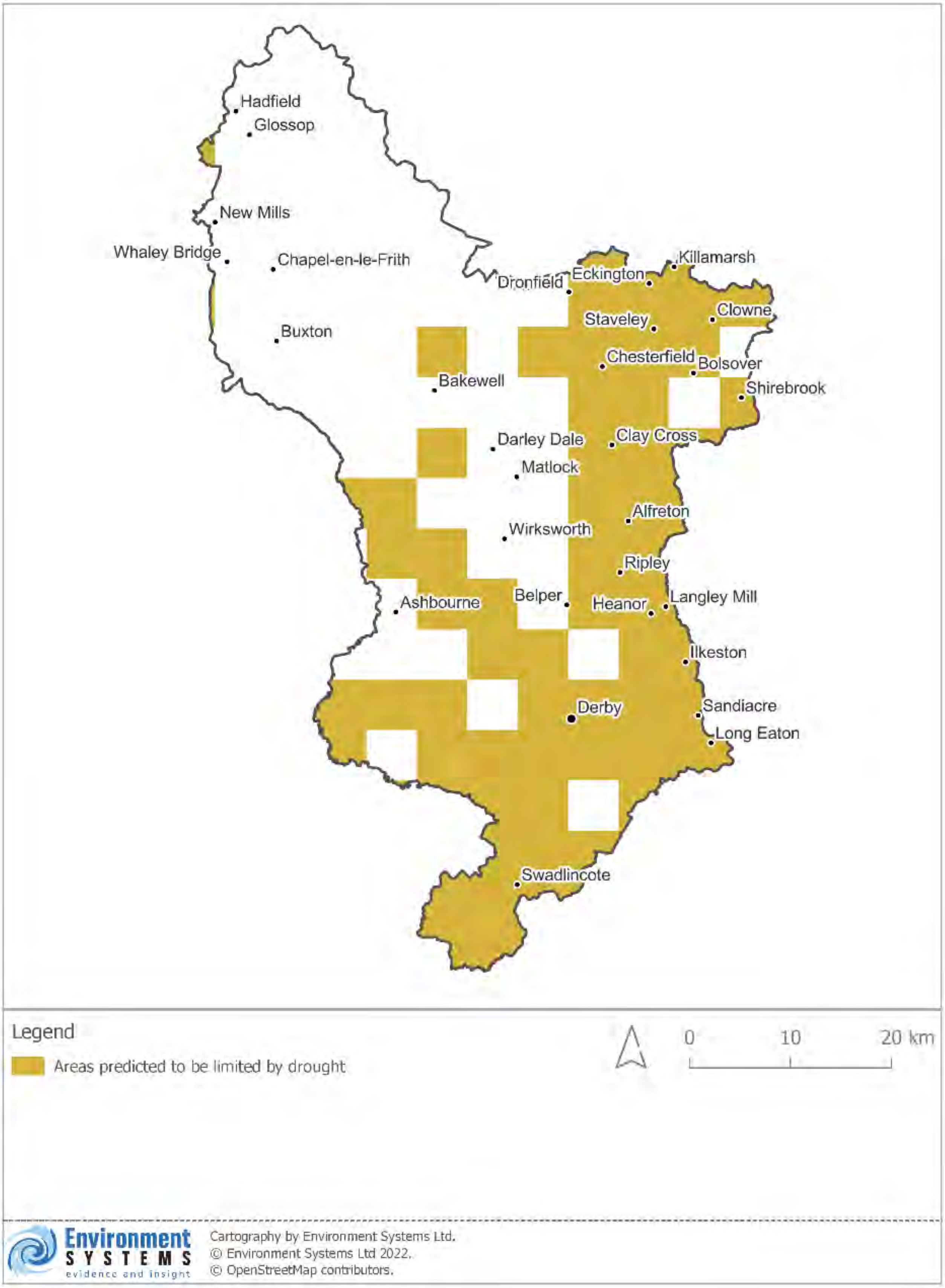

Figure 86: Areas where drought is a significant limiting factor for agriculture: 2080, UKCP18 RCP 6.0