Enhanced Natural Perils Directory

Summary

The Natural Perils Directory (NPD) geohazards models for England, Scotland and Wales have been used by the insurance and re-insurance industry for over 20 years. This document lays out some of the most recent developments to NPD, including future climate impacts on subsidence rates, and tree-enhanced subsidence models.

Clay related subsidence

Because the dominant form of subsidence in the UK is clay related subsidence, this is the model towards which we have directed most of our attention. When shrinkable-clay soils loose water, their volume can shrink by up to 20%. Therefore, to accurately model the subsidence risk, we need information on both the soil shrinkage potential and the soil moisture status.

The soil has been mapped by the Soil Surveys of England Wales and Scotland. Soil is complex, and highly spatially variable even over short distances. As a result, we have provided two different 'views' of the shrink-swell potential; the dominant and worst case scenario. The dominant class takes the most commonly mapped shrink-swell class in each mapped polygon. The worst case scenario considers the highest shrinkable soil which makes up at least 5% of the polygon.

Soil moisture is controlled primarily by weather and vegetation - the interaction between precipitation and evapotranspiration. Not all vegetation is as efficient at removing water from the soil. Although the pattern is complex, and varies with seasons, trees can require significantly more water resources than smaller vegetation. Therefore, to model the clay-subsidence risk as accurately as possible, we consider three key datasets: soil, weather and trees:

Table 1 - Factors used in predicting clay related subsidence

Factor	Dataset	Contribution
Soil	The National Soil Map	The potential of the soil to shrink and swell
Weather	Historic Weather Data	Depth of dry soil in a typical summer
Weather	Future 2030/2050 Climate Models	Depth of dry soil in a future summer
Trees	The National Tree Map	The expected impact of trees on soil moisture levels

Clay Subsidence Potential Soil Moisture Deficit Climate Models

We provide both historic (1961-1990) and future (2030's and 2050's) climate models for the potential soil moisture deficit (PSMD). This is effectively the depth to which the soil dries out in the summer, and is calculated from the precipitation and evapotranspiration from a short grass sward.

With the historic (1961-1990) data, we provide several climate perturbations to represent hotter summers that would be likely to occur every 3, 6, 15, 45 and 150 years, based on the distribution of the historic data.

Because our future models are based on the UKCP09 probabilistic climate projections, we provide three views for both the 2030 and 2050 time periods; 10% (unlikely to be less / wetter than) 50% (average) and 90% (unlikely to be greater / drier than). The model your company chooses to use is dependent on your risk appetite, but we are always happy to discuss options with you.

Trees

We have integrated a version of Bluesky's National Tree Map into our Natural Perils Directory data. This data maps every tree (greater than 3 m high) in England and Wales, and every tree within 50 m of a property in Scotland. For the purposes of subsidence modelling, we have classified the trees into 5 height categories, as described in Table 2.

Table 2 - Tree height classes

Code	Tree height
0	no tree
1	trees >5 m
2	trees 5-10 m
3	trees 10-20 m
4	trees 20-30 m
5	trees >30 m

From our initial investigations (looking at rate of failure of water infrastructure), we have determined that trees have the greatest impact on ground movement related failures in the highest shrink-swell soils. Interestingly, it appears to be the smaller trees (classes 1 and 2) which have a greater impact on the rate of bursts. We would be keen to continue this investigation with property claims data.

Bespoke Hazard Ratings

Because different companies can have quite different appetites for risk, we are pleased to provide you with the data from which we make our calculations, so that you can alter the weightings or resulting classes to more accurately match your risk appetite. As such, we provide you with two clay soil codes (dominant and worst case scenario), a wide range of climate scenarios and a 5-class tree model (see Table 3). Each of these factors can be examined (individually, or as group) alongside your portfolio and claims history data. On the basis of such investigations, we are happy to prepare bespoke ratings for individual companies.

Other Geohazards

The Natural Perils Directory comprises a number of other geohazard assessments, which are described in much more detail in the full NPD manual. An overview is provided here.

Other forms of subsidence

Subsidence damage is the result of ground movement at and around foundation depth. The kinds of soil effects directly associated with ground movement include:

- Clays: shrinkage and swelling of clays, known as clay-related subsidence (as discussed above)
- Sands: sandy soils susceptible to sub-surface erosion, causing sand-related subsidence;
- Silts: silty soils associated with heave under frosty conditions causing silt-related subsidence;
- Soft soils: soft (alluvial and peat) soils being compressible and susceptible to soft soil-related subsidence;
- Peats: peat, which shrinks considerably on drying causing peat-related subsidence.

Other natural mechanisms are known to cause ground movement and foundation subsidence, including mining subsidence, landslip, solifluction and the formation of swallow holes. At present, the NPD database does not attempt to model these latter causes, concentrating instead on the soil related subsidence types noted above. Of these, it is universally accepted that clay-related movement caused from shrink-swell is by far the most extensive cause of soil-related subsidence in Great Britain and together with the other soil related hazards represents approximately 70-80% of soil subsidence cases.

Flood Extent

The inundation of properties by flood water can occur in a number of circumstances. Surface run-off can collect on low-lying land from upslope following heavy rainfall. More commonly rivers, lakes and/or the sea extend beyond their normal limits as a result of prolonged or intense rainfall, unusually high tides and/or extreme wind events. Water damage to properties and their contents is often compounded by the deposition of sediment transported in suspension in the flood waters. The spatial distribution of such waterborne sediment (alluvium) is one basis upon which land that has been subject to historical flooding can be mapped, and this forms a basis for the present-day flooding extent vulnerability assessment in NPD.

Riverine, lacustrine (lake) and marine alluvial soils are identified distinctly within the British soil classification. Combining soil mapping units that are dominated by soil series developed in alluvium across Great Britain is used in NPD to identify most of the land that has been subject to flooding in the past and which must therefore be considered potentially vulnerable to flooding in the present, especially so in circumstances where flood defence measures fail.

Peat soils are identified as a major group in the British soil classification system. Specific peat soils form in hollows and depressions and can become saturated leading to surface water inundation.

Wind Exposure

Wind exposure vulnerability is based upon several inter-related factors including prolonged wind speed, gustiness, wind direction and air temperature. NPD contains a summary wind exposure assessment made available for the whole of England, Wales and Scotland.

Wind speeds are measured by anemometers at a standard height of 10 m above the ground surface in an attempt to record uninterrupted air flow. However, the assessment of exposure is often affected by local circumstances. The instruments are sometimes subject to the effect of locally increased or decreased wind speeds caused by neighbouring buildings, structures or uneven topography. Also, landforms can generate local air circulation through differential heating of land of varying slope and aspect. The NPD wind exposure dataset, compiled at the time the national soil map was created, is based on meteorological information as well as observations made of prolonged exposure to wind on vegetation.

Table 3 - eNPD fields and descriptions

Field Name	Example	Description
OBJECTID	759	id field
FID_NTM_Merge_NT82	1	id field
Tree	4	0 = no tree; 1-5 = trees of increasing height
FID_NT82	236	id field
NPD_ID	93501	id field
DOM_SSWELL	2	soil shrink-swell class (dominant)
PSMD_B	2	1961-1990 potential soil moisture deficit band
SS_WC	3	soil shrink-swell class (worst case)
NPDF_ID	318712	id field
PB_3	2	1 in 3 year potential soil moisture deficit band
PB_6	3	1 in 6 year potential soil moisture deficit band
PB_15	4	1 in 15 year potential soil moisture deficit band
PB_45	5	1 in 45 year potential soil moisture deficit band
PB_150	6	1 in 150 year potential soil moisture deficit band
PB_30_10	2	2030's low (10%) predicted potential soil moisture deficit band
PB_30_50	4	2030's medium (50%) predicted potential soil moisture deficit band
PB_30_90	7	2030's high (90%) predicted potential soil moisture deficit band
PB_50_10	2	2050's low (10%) predicted potential soil moisture deficit band
PB_50_50	5	2050's medium (50%) predicted potential soil moisture deficit band
PB_50_90	7	2050's high (90%) predicted potential soil moisture deficit band
NPD_FT_ID	318712.4	id field
NPD_FT_ID_1	318712.4	id field
FID	765	id field
NPD_ID_1	93501	id field
NPDF_ID_1	318712	id field
CLAY	2	(Soil (SS_WC) + Climate (PSMD_B)) Clay subsidence (1-9)(low-high)
CLAYTree	2	(Soil + Climate + Tree) Clay subsidence (0-10)(low-high)
CLAY_3	2	(Soil + 1 in 3 Climate) Clay subsidence (1-9)(low-high)
CLAY_6	3	(Soil + 1 in 6 Climate) Clay subsidence (1-9)(low-high)
CLAY_15	4	(Soil + 1 in 15 Climate) Clay subsidence (1-9)(low-high)
CLAY_45	5	(Soil + 1 in 45 Climate) Clay subsidence (1-9)(low-high)
CLAY_150	5	(Soil + 1 in 150 Climate) Clay subsidence (1-9)(low-high)
CLAY_3010	2	(Soil + 2030(10%) Climate) Clay subsidence (1-9)(low-high)
CLAY_3050	4	(Soil + 2030(50%) Climate) Clay subsidence (1-9)(low-high)
CLAY_3090	5	(Soil + 2030(90%) Climate) Clay subsidence (1-9)(low-high)
CLAY_5010	2	(Soil + 2050(10%) Climate) Clay subsidence (1-9)(low-high)
CLAY_5050	5	(Soil + 2050(50%) Climate) Clay subsidence (1-9)(low-high)
CLAY_5090	5	(Soil + 2050(90%) Climate) Clay subsidence (1-9)(low-high)
Flood	0	Historic flood extent
Flood_Detailed	0	Historic flood extent (detailed type)
Peat_Dom	0	Peat shrinkage hazard (0 = low; 1 = high)
Sand_Dom	0	Sand washout hazard (0 = low; 2 = high)
Silt_Dom	0	Frost heave hazard (0 = low; 1 = high)
Soft_Dom	0	Soft and compressible soils hazard (0 = low; 1 = high)
Exp	2	Wind Exposure (0 = low; 4 = high)
Tree_1	4	0 = no tree; 1-5 = trees of increasing height
Shape_Length	119.992074	GIS field
Shape_Area	273.7277	GIS field