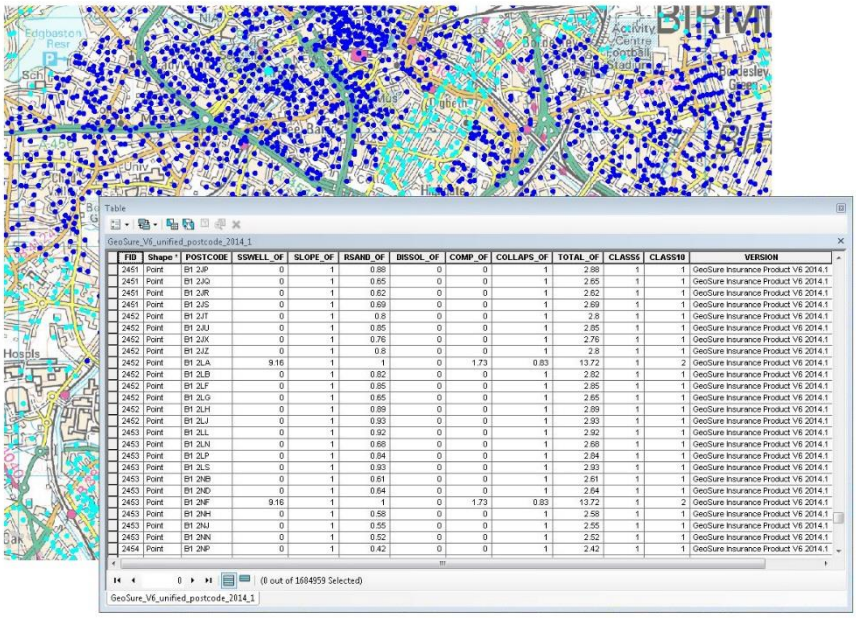
British Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

User Guide for the GeoSure Insurance Product (version 7)

Environmental Modelling PROGRAMME

Open Report OR/15/021



BRITISH GEOLOGICAL SURVEY

ENVIRONMENTAL MODELLING PROGRAMME

OPEN REPORT OR/15/021

User Guide for the GeoSure Insurance Product (version 7)

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The GeoSure Insurance Product (GIP) dataset.

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BRITISH GEOLOGICAL SURVEY

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The British Geological Survey is a component body of the Natural Environment Research Council.

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Founded in 1835, the British Geological Survey (BGS) is the world's oldest national geological survey and the United Kingdom's premier centre for earth science information and expertise. The BGS provides expert services and impartial advice in all areas of geoscience. Our client base is drawn from the public and private sectors both in the UK and internationally.

Our innovative digital data products aim to help describe the ground surface and what's beneath across the whole of Great Britain. These digital products are based on the outputs of the BGS survey and research programmes and our substantial national data holdings. This data coupled with our in-house Geoscientific knowledge are combined to provide products relevant to a wide range of users in central and local government, insurance and housing industry, engineering and environmental business, and the British public.

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2 About the GeoSure Insurance Product (GIP) Dataset

2.1 DATASET INTRODUCTION

The GeoSure Insurance Product (GIP) provides the potential insurance risk due to natural ground movement. It incorporates the combined effects of the 6 GeoSure hazards on (low-rise) buildings and links these to a postcode database – the Derived Postcode Database. A series of GIS (Geographical Information System) maps show the most significant hazard areas. The ground movement, or subsidence, hazards included are landslides, shrink-swell clays, soluble rocks, running sands, compressible ground and collapsible deposits.

This document accompanies the latest **Version 7** release (May 2015) of the GeoSure Insurance Product and included Derived Postcode Database.

For more information on the full GeoSure dataset, please refer to the '*User Guide for the GeoSure dataset (version 7)*'.

2.2 BACKGROUND

The GeoSure Insurance Product (including the Derived Postcode Database) represents the end of an interpretation process, starting with the BGS Digital Geological Map of Great Britain at the 1:50 000 scale (called **DiGMapGB-50**, first released as Version 1 in 2003). This digital map is the definitive record of the types of rocks underlying Great Britain (excluding Northern Ireland), as represented by various layers, starting with bedrock and moving up to overlying superficial layers.

In 2003, the BGS published a series of GIS digital maps identifying areas of potential natural ground movement hazard in the UK, called **GeoSure**, which are frequently updated. There are six separate hazards considered – shrink-swell clays, landslides, soluble rocks, running sand, compressible ground and collapsible deposits (see Appendix 1 for descriptions of these hazards). These maps were derived by combining the rock classification scheme (RCS) information from DiGMapGB-50 with a series of other factors which may cause the geological hazards (e.g. steep slopes, groundwater).

In 2005, BGS used the GeoSure maps to make an interpretation of subsidence insurance risk for the British property insurance industry, released as the new **GeoSure Insurance Product (GIP)**. This represents the combined effects of the 6 GeoSure hazards on low-rise buildings in a postcode database – the **Derived Postcode Database** – which can be accompanied by GIS maps showing the most significant hazard areas. The combined hazard is represented numerically in the Derived Postcode Database as the *Total Occurrence Factor*, with a breakdown into the component hazards. More detail on this is described below.

2.3 WHO MIGHT REQUIRE THIS DATA?

This dataset has been specifically developed for the insurance of low-rise buildings. The GeoSure datasets have been developed to identify the potential hazard for low-rise buildings and those with shallow foundations of less than 2 metres.

2.4 WHAT THE DATASET SHOWS?

The full GeoSure Insurance Product comprises six **GeoSure Hazard 'Visualisation' (HV)** layers and the **GeoSure Derived Postcode Database (DPD)**.

2.4.1 GeoSure Hazard 'Visualisation' layers

The six HV layers are GIS polygon layers representing where the most **significant** hazard potential exists. This does not mean that areas outside of these polygons have no hazard potential, only that the hazard potential is less significant. These derived HV layers should not be used on their own as a means of assessing the hazard potential of a specific location. These visualisation layers should ONLY be used in conjunction with the DPD in order to fully assess the hazard potential. These layers are intended to give the user a visual representation of the distribution of significant hazards.

2.4.2 GeoSure Derived Postcode Database

The DPD is a stand-alone database, which can be provided separately to the visualisation layers in the full GeoSure Insurance Product. This product uses Code-Point® Open data to relate postcodes to Ordnance Survey grid references. The use of Code-Point® Open data is governed by

the OS OpenData™ licence and is subject to the terms at: http://www.ordnancesurvey.co.uk/business-and-government/licensing/using-creating-data-with-os-products/os-opendata.html. The DPD contains a normalised hazard rating for each of the 6 GeoSure themes hazards (i.e. each GeoSure theme has been balanced against each other) and a combined unified hazard rating for each postcode in Great Britain.

3 Technical Information

The HV layers data is produced for use at 1:50 000 scale providing 50 m ground resolution. This data is routinely released in ESRI shapefile formats. Other formats such as MapInfo TAB are available on request. The standard data supplied to customers has polygons or areas in a single layer or theme.

The name of the output files contain information on the version of the GeoSure data and the version of the postcode centroids used in the calculations. For example, *GeoSure_v7_unified_postcode_2015_1* means that the GeoSure version 7 and Ordnance Survey Code-Point® Open version 2015.1 were used.

3.1 DEFINITIONS

Hazard: Exposure or vulnerability to injury or loss.

Risk: The impact of the hazard on people, property or capital.

For example, a flight of stairs could be perceived as a hazard, but the likelihood of falling down them would be the risk.

A high hazard does not necessarily translate to a high risk. For example, if a particular location has a relatively high ground instability hazard, but the properties that are built there have taken this into account, and are designed to withstand the hazard, they will not have a comparable level of risk. This is because the likelihood of the hazard causing any loss has been reduced due to the design of the property.

GeoSure does not identify the cost of a hazard being realised, and therefore does not consider risk. GeoSure only examines the conditions that leave an area exposed to a hazard. It is therefore a hazard dataset.

3.2 SCALE

The GeoSure Insurance Product (GIP) dataset is produced for use at 1:50 000 scale providing 50 m ground resolution.

3.3 FIELD DESCRIPTIONS

Table 1 GeoSure Hazard 'Visualisation' layers

Field name	Field description
TILE	Ordnance Survey grid square
ORIG_FID	Unique Feature ID
VERSION	Dataset name and version number

Table 2 GeoSure Derived Postcode Database

Field name	Field description
POSTCODE	Postcode
COLLAPS_OF	Collapsible occurrence factor
COMP_OF	Compressible occurrence factor
DISSOL_OF	Soluble rocks occurrence factor
RSAND_OF	Running sand occurrence factor
SLOPE_OF	Landslide occurrence factor
SSWELL_OF	Shrink swell occurrence factor
TOTAL_OF	Sum of the six hazard occurrence factors for each postcode
CLASS5	The Total_of column is classified into 5 classes using natural breaks (Jenk's Classification), values of 1-5
CLASS10	The Total_of column is classified into 10 classes using natural breaks (Jenk's Classification), values of 1-10
VERSION	Dataset name and version number

3.4 CREATION OF THE DATASET

3.4.1 GeoSure Hazard 'Visualisation' layers

The six HV layers are directly derived from the master GeoSure hazard layers as follows:

- Each of the six master GeoSure hazard layers is already classed into 5 classes A-E (see Table 3). Classes D and E are selected from each of the master layers to create six new Hazard Visualisation (HV) layers.
- The polygons in each of the new HV layers are dissolved to remove boundaries between classes D and E to improve performance and reduce complexity.

3.4.2 GeoSure Derived Postcode Database

In detail, the methodology behind producing the DPD is as follows:

- The postcode centroids layer (derived from Ordnance Survey Code-Point® Open data) is buffered using a value of 300 metres. This value takes into account the variability in size of postcodes (250 metres) and the 50 metres cartographic precision of the Digital Geological

Map of Great Britain at the 1:50 000 scale (DiGMapGB-50) data that is used as the geological basis for the GeoSure hazard layers.

- The methodology involves balancing (normalising) the 6 GeoSure natural ground stability hazards against each other in relation to their spatial coverage. The GeoSure maps themselves have a fivefold coding (A to E), and the balancing exercise involves comparing each level across the six hazards e.g. comparing a level C shrink-swell clay area with a level C running sand area. The comparison is done by estimating how *frequently* a ground movement event may occur that could have the potential to damage a property (in particular, low-rise buildings). Each level of each of the hazards is given an 'occurrence factor' (as shown in Table 3), which can then be added together to derive a Total Occurrence Factor (TOF) at a particular location (e.g. within a given postcode).

Table 3 Normalisation table for GeoSure hazards applied to low rise structures for the insurance industry.

		Landslide		Compressible		Running sand		Shrink-swell		Soluble rocks		Collapsible	
Class	Nominal Score	Occurrence rating	Unified rating	Occurrence rating	Unified rating	Occurrence rating	Unified rating	Occurrence rating	Unified rating	Occurrence rating	Unified rating	Occurrence rating	Unified rating
A	100	0	0	0	0	0	0	0	0	0	0	0	0
B	100	0.001	0.1	0.001	0.1	0.001	0.1	0.001	1	0.001	0.1	0.001	0.1
C	100	0.002	0.2	0.002	0.2	0.001	0.1	0.02	2	0.002	0.2	0.001	0.1
D	100	0.01	1	0.01	1	0.002	0.2	0.1	10	0.005	0.5	0.002	0.2
E	100	0.02	2	0.1	10	0.005	0.5	0.2	20	0.01	1	0.005	0.5

Key to definitions.

Class — The coding system for the 6 GeoSure natural ground movement hazards shown in the column headers

Nominal score — Numeric representation of the Class Codes in order to allow combination with the occurrence rating

Occurrence Rating — The estimated frequency of the hazard potential being realised in terms of damage to buildings with shallow foundations (less than 2 metres deep). Table 4 below shows the scale used for the occurrence rating.

Unified Rating — The result of the nominal score times the occurrence rating.

Table 4 Calibration of the hazard Occurrence Rating.

Estimated Frequency of Occurrence	Numerical Representation of Estimated Frequency of Occurrence	Occurrence Rating
once in 1 years	1/1	1
once in 5 years	1/5	0.2
once in 10 years	1/10	0.1
once in 20 years	1/20	0.05
once in 50 years	1/50	0.02
once in 100 years	1/100	0.01
once in 200 years	1/200	0.005
once in 500 years	1/500	0.002
once in 1000 years	1/1000	0.001

Before use in the DPD, these unified rating values in the table are then multiplied by 10 to allow the use of integer values. For example a class "D" shrink swell pixel will have a value of 10 x 10 = 100. This is to enable geo-processing operations to compute weighted averages for each postcode area.

Therefore the ranges of the data in the DPD are as follows:

Collapsible Deposits Occurrence Factor: 0-5

Compressible Ground Occurrence Factor: 0-100

Soluble Rocks Occurrence Factor: 0-10

Running Sand Occurrence Factor: 0-5

Shrink-Swell Occurrence Factor: 0-200

Landslides Occurrence Factor: 0-20

Although there is a theoretical maximum TOF of 5+100+10+5+200+20 = 340, the maximum score achieved under existing geological conditions is 213.

- Using a GIS, the Total Occurrence Factor (TOF) values for each hazard are converted to 6 grids representing each of the 6 GeoSure layers.

- In order to assign a score to each postcode unit, statistics are calculated using the buffered postcode layer in conjunction with each of the six TOF hazard feature layers. This process considers each hazard in turn and calculates the average values proportional to their spatial coverage, that occur within each of the 300m circular buffered postcode areas. These average values for each hazard are then added to the output Derived Postcode Database as 'occurrence factors'.

Figure 1 and Figure 2 show the distribution of the data within the DPD, as represented by the numbers of postcodes plotted against the Total Occurrence Factor (TOF). The total range of the TOF is 0-213. The distribution is quite stepped. This is because the GeoSure hazard rating is broken down into the five classes (A-E). Although the change in hazard between each class is incremental (E is one step worse than D is one step worse than C and so on) the likely occurrence of each level of hazard may vary by an order of magnitude between classes. Figure 1 and Figure 2 also show how natural breaks have been selected using the Jenks' Classification method in the distribution in order to derive the fivefold (Class 5) and tenfold (Class 10) classifications displayed in the DPD (last two columns of Figure 1).

These classifications are provided in order to aid interpretation of the hazard scale and also to allow easier representation of the data in mapping tools (e.g. by colouring up the postcode points in a GIS if so wished).

In detail, the Total Occurrence Factor (TOF) class breaks in the DPD in version 7 of the GeoSure Insurance Product are as follows (against the overall 0-213 scale of the TOF):

Class 5 breaks are: 0,14,27,52,115,213

Class 10 breaks are: 0,7,17,24,29,36,52,107,116,133,213

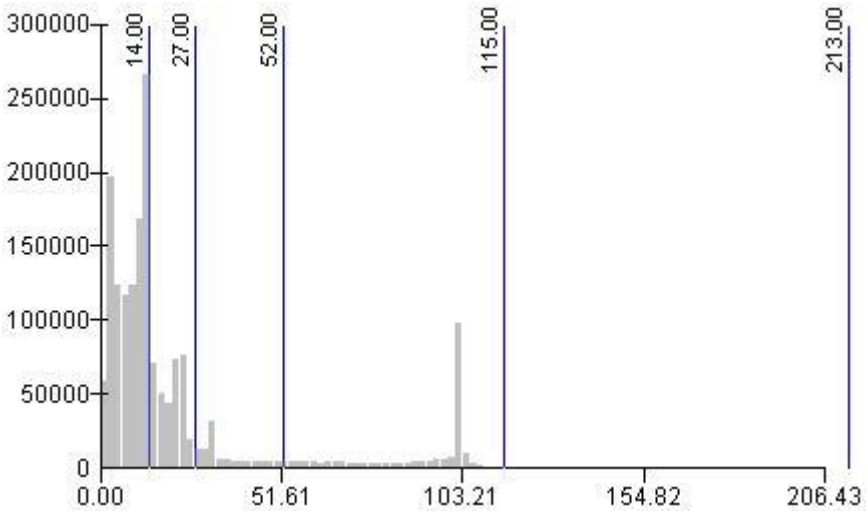

Figure 1 Distribution of postcodes in the DPD against the TOF (0-213) range; also showing position of the Class 5 natural breaks.

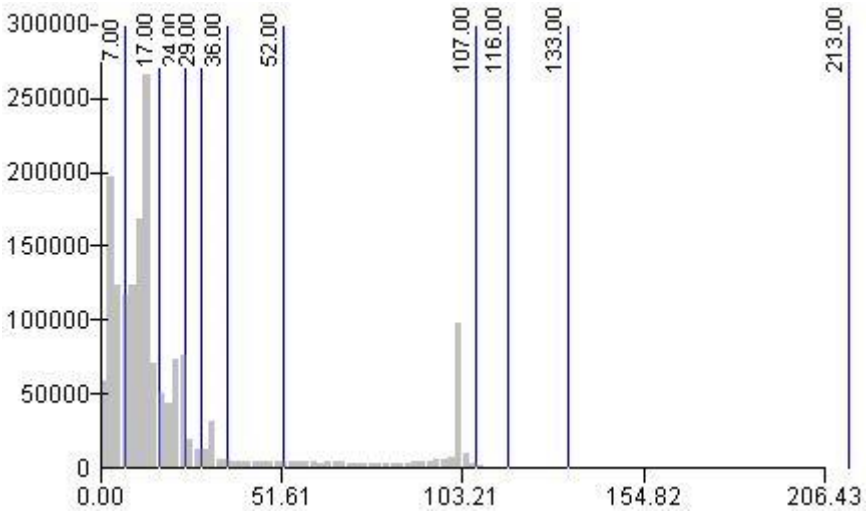

Figure 2 Distribution of postcodes in the DPD against the TOF (0-213) range; also showing position of the Class 10 natural breaks.

3.5 INTERPRETING THE TOTAL OCCURRENCE FACTOR SCALE IN THE DERIVED POSTCODE DATABASE

The results from the DPD have been compared against the geological maps, to make the following broad correlations and recommendations for use of the 0-213 Total Occurrence Factor (TOF) scale.

These recommendations, particularly in terms of predicting insurance risk, should only be treated as a guide. The GeoSure Insurance Product is essentially 'geological' in nature, as a predictor of natural ground movement. Any predicted levels of insurance risk due to this ground movement are necessarily qualitative and could only be tested quantitatively against external insurance datasets (e.g. claims data) or the experience of insurance professionals.

TOF values of 95+

Very high TOF values, of greater than c.95 (i.e. upper Class 4 and Class 5 of the fivefold Class 5 division) are almost entirely the result of shrink-swell hazard and/or compressible ground with high GeoSure ratings. This is a reflection of the widespread nature of these hazards and their significance in terms of ground movement. For example, shrink-swell clays with high GeoSure ratings (such as London Clay) are very widespread in SE England.

The very highest TOF ratings result from those areas with a high GeoSure rating for compressible ground AND a high GeoSure rating for shrink-swell. In reality, this occurs where clays with a high shrink-swell potential are overlain by peaty ground, which is a relatively rare geological occurrence (e.g. in North East Anglia). Therefore, TOF values in the 95+ range should be considered a *very significant* hazard to low-rise buildings and a *very significant* insurance risk, and usually mean highly shrink-swell clays and/or very compressible (peaty) ground are present.

Reference to the individual Occurrence Factors in the DPD (and comparing the values to their ranges as quoted above) and/or to the HV layers in the GIS should indicate to users which of the hazards are present.

TOF values of 40-94

TOF values within the range 40-94 range (upper Class 3 and lower Class 4 of the fivefold Class 5 division) are relatively rare in the dataset (Figure 1) because of the way the data has been calculated. If values in this range are encountered they may result from the contribution of a single hazard or the combined effects of two or more hazards.

In general terms, TOF values towards the top end of this 40-95 range (i.e. into Class 4) indicate that one or more hazards may be present that are a *significant* hazard to a low-rise building and of *significant* insurance risk. Again, in general terms only, TOF values towards the lower end of the range (i.e. into Class 3) indicate that one or more hazards may be present, but that they are only likely to be of *possible* hazard to a low-rise building and of *possible* insurance risk, particularly if modifications are made to the ground, for example, changes to groundwater by tree removal, or building work.

Reference to the individual Occurrence Factors in the DPD (and comparing the values to their ranges as quoted above) and/or to the HV layers in the GIS should indicate to users which of the hazards are present.

TOF values of 10 to 39

TOF values in the 10-39 range (higher Class1, Class 2, and lower Class 3 on the fivefold Class 5 scale), which are common in the dataset, indicate some form of natural ground stability hazard being present at a level which may cause ground movement.

The combination of anticipated severity of any hazard event and frequency of the hazard event means, however, that it is only likely to be of *possible* concern for property insurance. However, in such areas, caution should still be exercised as local variations in the geology, or local effects (for example, changes to groundwater by tree removal) or modifications to the ground, could exacerbate the effects of these hazards such that they may become of concern to property stability.

Reference to the individual Occurrence Factors in the DPD (and comparing the values to their ranges as quoted above) should indicate to users which of the hazards are present.

TOF values of 1-9

TOF values in the 1-9 range (lower Class 1 on the Class 5 scale), which are common in the dataset, indicate the presence of one or more ground movement hazards, but at a level which is likely to be *insignificant* in terms of property insurance.

TOF values of 0

Zero TOF values indicate that no GeoSure hazards are mapped at that location.

3.6 DATASET HISTORY

The GeoSure Insurance Product is directly derived from the master GeoSure dataset. The GeoSure dataset is re-processed frequently so as to consider any enhancements in the understanding of the processes that drive the hazards. It is also re-processed in response to better data becoming available; this includes any new or improved geological mapping. This approach enables GeoSure to be based upon the most up to date information available.

The GeoSure Insurance Product is re-issued following updates to the Ordnance Survey Code-Point® Open database.

3.7 COVERAGE

Data is provided for Great Britain. The Isle of Man is not covered.

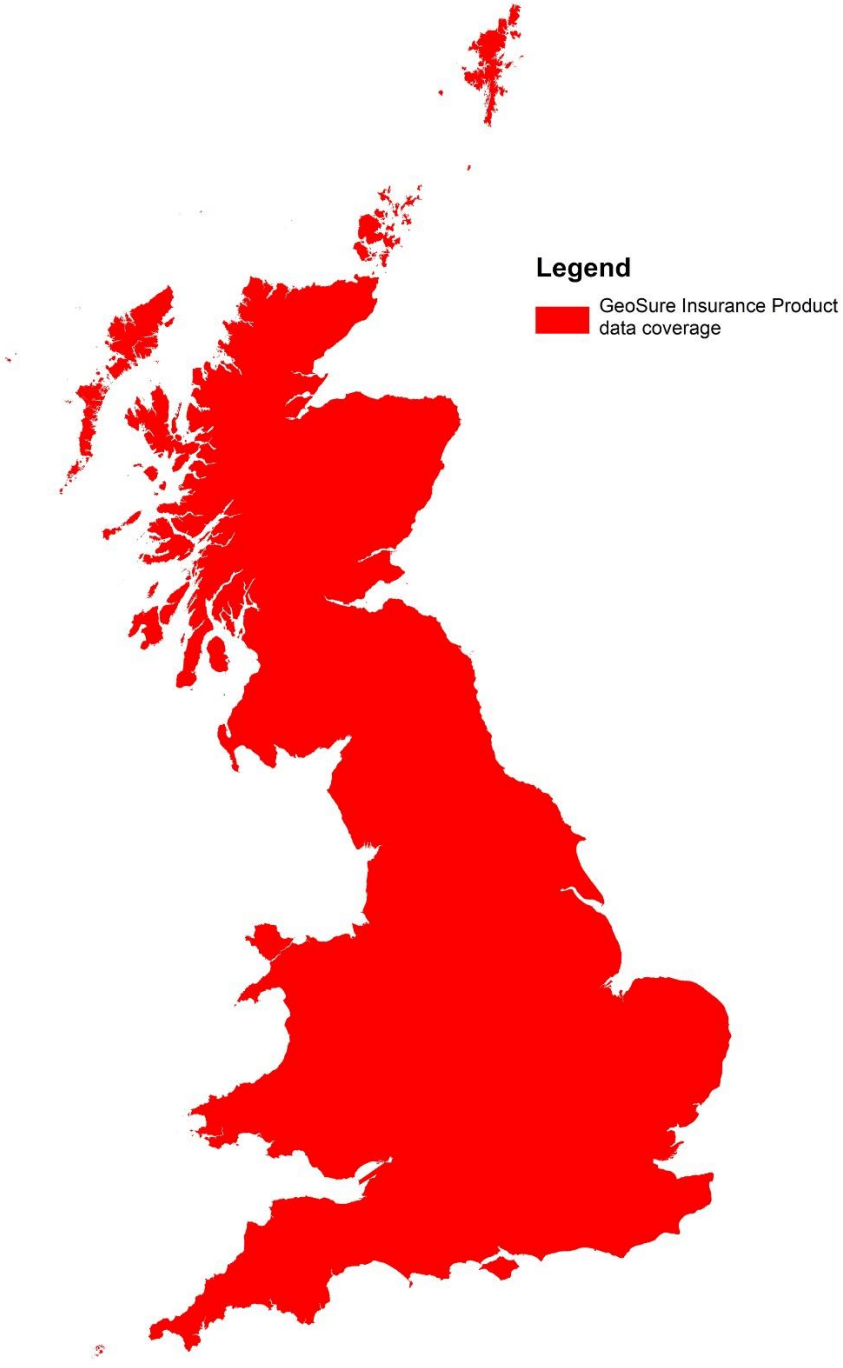

Figure 3 The coverage of the GeoSure Insurance Product (GIP) dataset

3.8 DATA FORMAT

The GeoSure Insurance Product (GIP) dataset has been created as point data and are available in a range of GIS formats, including ArcGIS (.shp), ArcInfo Coverages and MapInfo (.tab). More specialised formats may be available but may incur additional processing costs.

3.9 LIMITATIONS

- The spatial resolution of the HV layers data is the same as the GeoSure data they are derived from, which, therefore, requires that a minimum search radius of 50m around a site or property be utilized in any application (in addition to any site, property or other search area).
- Licensing of any GIS software (e.g. ESRI) and topographical information (e.g. Ordnance Survey) used when displaying HV layers is the responsibility of the end users.
- GeoSure is concerned with potential ground stability related to NATURAL geological conditions only. GeoSure does NOT cover any man-made hazards, such as contaminated land or mining. The only exception to this is the Compressible Ground hazard layer, which does consider man-made ground e.g. landfill.
- GeoSure is based on, and limited to, an interpretation of the records in the possession of The British Geological Survey at the time the dataset was created.
- An indication of natural ground instability does not necessarily mean that a location will be affected by ground movement or subsidence. Such an assessment can only be made by inspection of the area by a qualified professional.

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Appendix 1 : Descriptions of the GeoSure hazards

The six Natural Ground Stability hazards assessed by GeoSure are as follows:

Shrink Swell

Swelling clays can change volume due to variation in moisture, this can cause ground movement, particularly in the upper two metres of the ground that may affect many foundations. Ground moisture variations may be related to a number of factors, including weather variations, vegetation effects (particularly growth or removal of trees) and the activities of people. Such changes can affect building foundations, pipes or services.

Landslides (Slope Instability)

Slope instability occurs when particular slope characteristics (such as geology, gradient, sources of water, drainage, or the actions of people) combine to make the slope unstable. Downslope movement of materials, such as a landslide or rockfall may cause damage, such as a loss of support to foundations or services or, in rare cases, impact damage to buildings.

Soluble Rocks (Dissolution)

Ground dissolution occurs when certain types of rocks, containing layers of soluble material, get wet and the soluble material dissolves. This can cause underground cavities to develop. These cavities reduce support to the ground above and can lead to a collapse of overlying rocks.

Compressible Ground

Some types of ground may contain layers of very soft materials like peat or some clays. These may compress if loaded by overlying structures, or if the groundwater level changes. This compression may result in depression of the ground surface, potentially disturbing foundations and services.

Collapsible Deposits

Some kinds of rocks and soils may collapse when a load (such as a building or road traffic) is placed on them, especially when they become saturated. Such collapse may cause damage to overlying property or services.

Running Sand

Some rocks can contain loosely packed sandy layers that can become fluidised by water flowing through them. Such sands can ‘run’, potentially removing support from overlying buildings and causing damage.