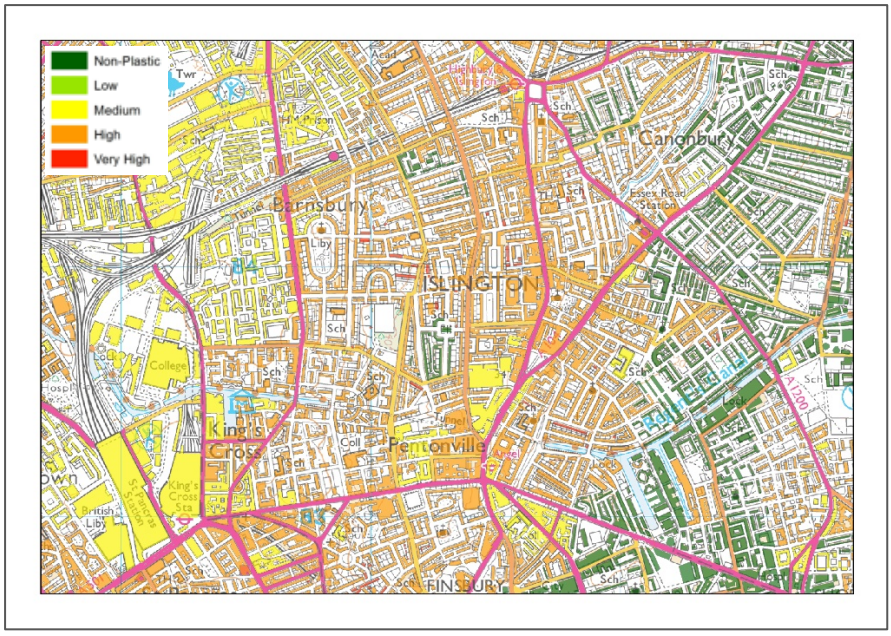
British Geological Survey

# User Guide for the British Geological Survey Property Subsidence Assessment Dataset

Digital Programme

Open Report OR/20/005



BRITISH GEOLOGICAL SURVEY

DIGITAL PROGRAMME

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# User Guide for the British Geological Survey Property Subsidence Assessment Dataset

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Image of BGS Property Subsidence Assessment building dataset for an area in London

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Keyworth, Nottingham British Geological Survey 2020

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# Foreword

This report presents a description and review of the dataset developed by the British Geological Survey (BGS) to produce a national scale assessment of Shrink-Swell ground instability hazard for home owners and the insurance industry. The product builds upon susceptibility modelling of Shrink–Swell hazard and the GeoSure dataset to include a property susceptibility due to the geology, location of trees and building conditions.  The purpose of this user guide is to enable those licensing this dataset to have a better appreciation of how the data set has been created and therefore better understand the potential applications and limitations that the dataset may have.

# Acknowledgements

A number of individuals in the Earth Observation and Engineering Geology and Infrastructure Programmes have contributed to the project and helped compile this report. This assistance has been received at all stages of the study. In addition to the collection and processing of data, many individuals have freely given their advice, and provided the local knowledge.

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Figure 2 Coverage of the BGS Property Subsidence Assessment dataset (left) and detailed view of the attributed building polygons (right). The National Grid and other Ordnance Survey data © Crown Copyright and database rights 2019. Ordnance Survey Licence No. 100021290 EUL ..... 13

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# Summary

This report describes the BGS Property Subsidence Assessment data product. The methods used to create the component datasets have been critically assessed and its fitness for purpose determined by specialists in BGS.

The BGS Property Subsidence Assessment data product looks specifically at the geological factors that influence the susceptibility to Shrink-Swell hazard and combines these with the level of susceptibility due to proximity to trees and the characteristics of a building to provide a more complete understanding of all factors involved.

This document outlines the background to why the dataset was created, its potential uses and gives a brief description of the data layers. Technical information regarding the GIS and how the data was created is described and advice is provided on using the dataset.

# 1 Introduction

The British Geological Survey (BGS) is a world-leading geological survey, focusing on public-good science for government, and research to understand earth and environmental processes.

We are the UK's premier provider of objective and authoritative geoscientific data, information and knowledge to help society to:

- use its natural resources responsibly
- manage environmental change
- be resilient to environmental hazards

We provide expert services and impartial advice in all areas of geoscience. As a public sector organisation, we are responsible for advising the UK Government on all aspects of geoscience as well as providing impartial geological advice to industry, academia and the public. Our client base is drawn from the public and private sectors both in the UK and internationally.

The BGS is a component body of the Natural Environment Research Council (NERC), part of UK Research and Innovation (UKRI).

**DATA PRODUCTS**

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.

The BGS Property Subsidence Assessment dataset provides an indication of the susceptibility to Shrink-Swell at two spatial scales; namely building level and postcode level. The building level dataset are comprised of OS open building polygons (area) with associated attributes. At the building scale these attributes give a shrink-swell hazard score and score for each of the susceptibility factors that are used to derive the overall score. At the postcode scale the dataset is made up of a table of postcodes with an associated hazard score.

This data product and accompanying document provides information for users on the susceptibility to shrink-swell subsidence given the characteristics of a building, the geological properties, and tree proximity.

Further information on all the digital data provided by the BGS can be found on our website at Data Products or by contacting

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# 2 About the BGS Property Subsidence Assessment Dataset

## 2.1 BACKGROUND

Public understanding of the effect of ground conditions to the safety of their property and the implication for the value and maintenance of their property is growing. Protection against damage and Insurance is a necessary consideration for any property purchaser or owner.

Most standard Building Insurance policies in Great Britain cover residential and small and medium-sized Enterprise (SME) property. Based on investigations into user needs within the Insurance sector, a gap was identified to further establish a dataset assessing the specific risk of subsidence, ground heave and landslide movement and the associated risks of damage to buildings which are covered under a Buildings Insurance policy.

In response to this, the British Geological Survey initiated a development programme to produce datasets that identified and assessed potential geohazards threatening the human environment in Great Britain. The BGS produce a series of GIS digital maps identifying areas of potential natural ground movement hazard in Great Britain , called **GeoSure.** First released in 2003, these have been frequently updated and developed as new, improved, geological information is gained. There are six separate hazards considered in the suite (shrink-swell clays, landslides, soluble rocks, running sand, compressible ground and collapsible deposits). Further information is available in the GeoSure User Guide (Lee and Diaz Doce, 2018).

In 2005, BGS used the GeoSure datasets to make an interpretation of ground instability insurance risk for the British property insurance industry. This was released as the **GeoSure Insurance Product (GIP)** (Lee et al, 2019) and represents the combined effects of the six 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 with a breakdown into the component hazards.

The **BGS Property Subsidence Assessment** dataset builds upon the above datasets specifically for shrink–swell hazards. The **BGS Property Subsidence Assessment** dataset uses a combination of best available geology, tree location and property related information. The purpose of the dataset is to provide information on ground movement (predominately due to shrink–swell) across England and Wales for the property report and insurance sectors.

## 2.2 WHO MIGHT REQUIRE THIS DATA?

The **BGS Property Subsidence Assessment (PSA)** dataset has been designed to offer insurers and homeowners access to a better understanding of the shrink-swell hazard at both the property and postcode levels. Subsidence hazards as a result of clay soils, inadequate foundation structures, and tree presence/proximity, may lead to financial loss for anyone involved in the ownership or management of property, including developers, householders or local government. These costs could include increased insurance premiums, depressed house prices and, in some cases, require engineering works to stabilise land or property. .

The identification of shrink-swell related subsidence prone areas, alongside the inclusion of potential sources to exacerbate this phenomena, can better inform insurers and homeowners and form the basis to make decisions concerning prevention and remediation. The product enhances geological information obtained from GeoSure Insurance Product (GIP) and GeoSure and includes a risk element for the housing stock at Postcode and Building level.

## 2.3 WHAT THE BGS PROPERTY SUBSIDENCE ASSESSMENT DATASET SHOWS?

The BGS Property Subsidence Assessment dataset gives a calculated subsidence hazard score at either the building scale or postcode scale. Data is provided in a Geographical Information System (GIS) format for the building data or a .csv file for the postcode data, and identifies the potential shrink-swell hazard associated with the geology, building type and tree proximity in England and Wales.

Clay-rich soil and rocks have an ability to shrink and swell with changes in moisture content. 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. The BGS Property Subsidence Assessment dataset is derived via the weighted integration of relevant input datasets on geology, tree location and building characteristics. Building level information is then further scaled to obtain a hazard score at postcode level. The underlying input modules are explained in brief below:

The dataset incorporates data analyses using six input modules:

**Geology - 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. The amount of shrinkage and swelling is dependent on the type of soil, and therefore the geological formation, on which the structure us built. The BGS GeoSure (Shrink–Swell) layer is used as the base dataset to identify areas with higher volume change potential (Lee and Diaz Doce, 2018).

**Age of property**

Due to changes in foundation design and building regulations, age of a property gives an indication of the potential foundation depth likely to be associated with the building. This information is reported for the property specifically, derived from census Lower layer Super Output Area (LSOA) results.

**Drainage**

Building practice changed from using clay to plastic pipes in 1950. Clay pipes have a higher propensity to crack as a result of shrink-swell and resulting ground movement, and therefore exacerbate possible movement in the vicinity of the cracks. This information is reported for the property specifically, derived from Office for National Statistics Lower layer Super Output Area (LSOA) data.

**Building Type**

The type of building (e.g. bungalow, terrace house) has an influence on the potential extent of structural damage, should movement occur. Damage to a structure is possible when as little 3% volume expansion takes place, and especially when these movements are unevenly distributed beneath a foundation or property. This information is reported for the property specifically, this information is derived from census Lower layer Super Output Area (LSOA) results, where counts of property type within the LSOA includes a breakdown by bungalow, terraced, flat/maisonette, semi-detached and detached.

**Number of storeys**

The height of building has an influence on the resultant structural damage should movement occur, especially when these movements are unevenly distributed beneath a foundation or property. This information is derived for each building from the census Lower layer Super Output Area (LSOA)

results, where counts on property type includes a breakdown by bungalow, terraced, flat/maisonette, semi-detached and detached, and the number of stories is inferred from the dataset.

**Trees**

Many subsidence insurance claims are linked to tree damage. Damage may occur as tree roots take up water from the soil, causing the ground to dry out and shrink causing uneven settlement. This occurs predominately during the spring and summer months. Areas with many older houses and old style shallow foundations can be seriously affected.

The tree input layer is derived from the Bluesky National Tree Map (Bluesky information sourced from Bluesky International Limited, Bluesky data and imagery are protected by Copyright), locating trees over 3m in height. The data has been buffered to produce zones of potential tree influence. Buildings are classified in the model according to the location of a nearby tree and thus and inferred risk of increased susceptibility. This is based on work by Cutler and Richardson (1989).

# 3 Technical Information

## 3.1 INPUT DATA

The following input data are used to create the PSA dataset.

| Input Dataset | Release Date / version |
|---|---|
| **OS OpenMap Local building polygons** | April 2020 |
| **GeoSure shrink-swell** | Version 8 |
| **National Tree Map (Bluesky)** | 2019 |
| **Office for National Statistics (UK property build period)** | 2014, based on 2011 Census data |
| **Office for National Statistics (UK property type)** | 2014, based on 2011 Census data |
| **OS Code Point open** | April 2020 |

Table 1 Input datasets used and their version number / release date.

## 3.2 SCALE

The BGS Property Subsidence Assessment dataset is created at the property scale; however it must be recognised that the scale of input data varies and may therefore introduce scale dependent inaccuracies. These are explained as follows:

The GeoSure input dataset is produced for use at 1:50 000 scale providing 50 m ground resolution, this data is itself composed of geological field observations made primarily at 1:10 000 scales and site-specific geotechnical soil tests.

Housing input data is sourced from the office for national statistics LSOA data.

The LSOA polygons cover every house in Great Britain, however each LSOA polygon covers several houses and provides the statistics for these houses. For example: the attributes of a LSOA polygon will provide the number of houses for each housing age bracket, the number of houses for each house type etc. Although the data tells us that there are 12 houses built between 1920 and 1930 and 18 built between 1940 and 1950 it does not tell us which house has which age. It has therefore been necessary to determine the majority value for the polygon and assign this to all

buildings within the polygon, in the above case all 30 buildings would be classified as built between 1940 and 1950. This obviously means some buildings within the polygon are miss-classified, however this is the best data currently available.

### 3.3 DESCRIPTION OF THE DATASET

The BGS Property Subsidence Assessment dataset is published at two scales:

1. Building scale – BGS Property Subsidence Assessment (Building)
2. Postcode scale – BGS Property Subsidence Assessment (Postcode)

The BGS Property Subsidence Assessment dataset is published as GIS shapefiles at the building scale and as flat files (such as .csv) for the postcode data.

#### 3.3.1 BGS Property Subsidence Assessment dataset at building level

This dataset is composed of building polygons with attributes (Table 1) concerning the susceptibility of a building polygon to Shrink-Swell related subsidence.

It is named BGS_PSA_Buildings_region_v1 where region is: ew_ne, ew_nw, ew_em, ew_wm, ew_se, or ew_sw. Where 'ew' stands for England and Wales; ne is north east, nw is north west, em is east midlands, wm is west midlands, se is south east and sw is south west.

This product is based on the building polygons supplied in the OS Open Map Local dataset (April 2020). It is worth noting that although each building in England and Wales is covered by a polygon within this dataset, it does not necessarily follow that each building has its own individual polygon. Since this is an open dataset buildings have been grouped into a single polygon. For example two semi-detached houses are often represented by a single polygon as are a row of terraced houses.

| FIELD NAME | DESCRIPTION | RANGE OF VALUES |
|---|---|---|
| **FID** | An automatically generated sequential unique identifier | An automatically generated sequential unique identifier |
| **Shape** | The type of shape (polygon, point or line) for the object storing the data, in this case a polygon representing the boundary of the postcode | Polygon |
| **ID** | OS OpenMap local building ID, carried over from the OS dataset. | OS OpenMap local building ID, carried over from the OS dataset. |
| **Trees** | **T**ree **D**ensity **D**istance: A score (1-10) for the building indicating the subsidence susceptibility due to the distance from a given density of trees. [Zero value = No data] | 1 to 10<br>10 indicating buildings with the highest susceptibility to the effect of trees and 1 indicating buildings with the lowest susceptibility to the effect of trees and |
| **Geology** | A score (1-10) for the building indicating the subsidence susceptibility due to the underlying geology [Zero value = No data] | 1 to 10<br>10 indicating buildings with the highest susceptibility due to the presence of shrinks swell prone geology and 1 indicating buildings with the lowest susceptibility due to the presence of shrinks swell prone geology |

| | | |
|---|---|---|
| **Age** | A score (1-10) for the building indicating the subsidence susceptibility due to the age of a building and hence foundation depth. | 1 to 10<br>Used as an indication of foundation conditions. 10 indicating buildings with poorest foundations and hence higher susceptibility to shrink swell motions and 1 indicating buildings with the most resistant foundations |
| **Drainage** | A score (1-10) for the building indicating the subsidence susceptibility due to drainage failure. | 1 to 10<br>10 indicating buildings with drainage most likely to break and introduce water into the ground and 1 indicating buildings with the most resistant drainage |
| **Storey** | A score (1-10) for the building indicating the subsidence susceptibility due to the number of storeys in a building | 1 to 10<br>10 indicating the building with least number of stories therefore likely to have poorer foundations and 1 indicating the highest buildings which are therefore likely to have better designed foundations. |
| **Type** | A score (1-10) for the building indicating the subsidence susceptibility due to the building type (detached, bungalow etc.). | 1 to 10<br>10 indicating the building with least support from adjacent buildings and 1 indicating buildings with the most support from adjacent buildings. |
| **PSA** | The normalised hazard score in the range of 1-100 | 1-100<br>1 – least susceptible, 100 – most susceptible |
| **PSAClass** | The class of the hazard score (Non-Plastic, Low, Medium, High, Very High). | Non-plastic – this means the underlying geology is non-plastic and therefore cannot undergo any change in volume and therefore cannot have shrink–swell related subsidence.<br>Low – A low susceptibility to shrink–swell related subsidence<br>Medium - A medium susceptibility to shrink–swell related subsidence<br>High – A high susceptibility to shrink–swell related subsidence<br>Very High- A very high susceptibility to shrink–swell related subsidence |
| **XCEN** | The X coordinate, in British National Grid, of the centre point of the building polygon | |
| **YCEN** | The Y coordinate, in British National Grid, of the centre point of the building polygon | |
| **Version** | Name and Version Number of dataset | BGS_PSA_Buildings_ew_[region]V1 |

Table 2 Attribute table field descriptions and possible values for the building polygons within the BGS Property Subsidence Assessment Dataset

### 3.3.2 How to interpret the building level data

The building level data not only provides the overall combined hazard score and hazard class but also provides hazard scores relating to the various input factors (geology, tree distance, foundation depth, property stories and type and drainage). These scores allow the user to understand the contribution of an input factor to the level of hazard. For example if a hazard score falls into a high class they might be able to understand that this is mostly due to the geology and type of foundation of the building. Examples are given in Figure 1.

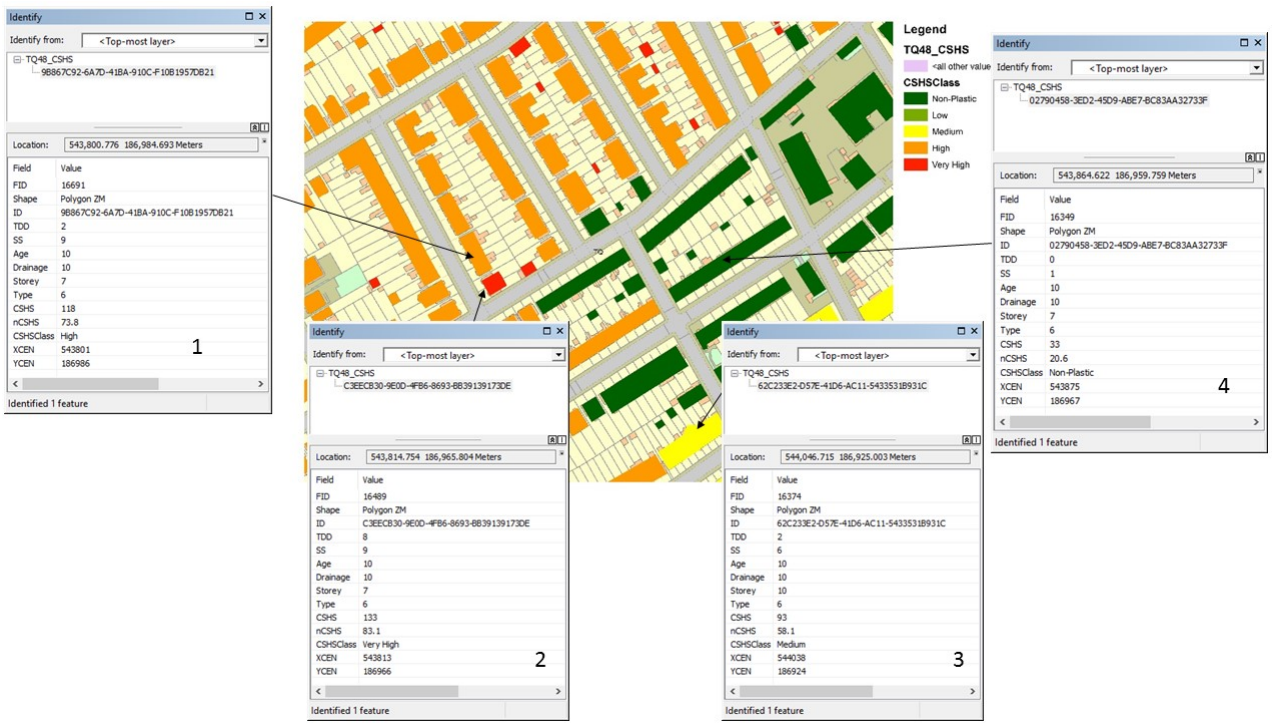


Figure 1 The BGS Property Subsidence Assessment dataset at building level, OS Open Map buildings are coloured according to the hazard class. Insets show the attribute values for 4 examples where the hazard score varies. Background is OS MasterMap for reference. (The National Grid and other Ordnance Survey data © Crown Copyright and database rights 2019. Ordnance Survey Licence No. 100021290 EUL)

Building number 1 in Figure 1 has a high hazard score class, the contributions from the input factors are Geology, Age (foundation depth) and drainage.

Next door is building number 2 which has a very high hazard score class, the contributions from the input factors are the same as building 1 but there are trees within the critical distance to this building. These trees are therefore increasing the shrink swell hazard sufficiently to push it into the next category.

Building number 3 in Figure 1 is a medium hazard score class, here the geology is showing a medium susceptibility to shrink swell and the trees are not having much of an influence, so whilst the building factors are the same as the other examples the overall score is lower.

Building number 4 in Figure 1 is classed as non-plastic geology, here the property factors of age, type, stories and drainage are all high however, the house is on a geology type which is not prone to shrink swell.

Along with being useful to understand the overall hazard score the input factors scores are useful in their own right.

### 3.3.3 BGS Property Subsidence Assessment dataset at postcode level

This product is comprised of a table (.csv) of postcodes with associated hazard score classification. It is named BGS Property Subsidence Assessment (Postcode).

| FIELD NAME | DESCRIPTION | DESCRIPTION |
|---|---|---|
| **FID** | An automatically generated sequential unique identifier | 0 - X |
| **Postcode** | The postcode | The postcode in format NG12 5GG |
| **NBuildings** | The number of buildings within the postcode | 0 - X |
| **TotArea** | The area enclosed by the postcode | The area enclosed by the postcode |
| **PSA** | The normalised hazard score in the range of 1-100 | 1-100<br>1 – least susceptible, 100 – most susceptible |
| **PSAClass** | The classified hazard score (Non-plastic, Low, Medium, High, Very-High). | Non-plastic – this means the underlying geology is non-plastic and therefore cannot undergo any change in volume and therefore cannot have shrink–swell related subsidence.<br>Low – A low susceptibility to shrink–swell related subsidence<br>Medium - A medium susceptibility to shrink–swell related subsidence<br>High – A high susceptibility to shrink–swell related subsidence<br>Very High- A very high susceptibility to shrink–swell related subsidence |
| **Version** | Name and Version Number of dataset | BGS_PSA_Postcode_V1 |

Table 3 Attribute table field descriptions and possible values for the Postcode data.

## 3.4 GENERATION OF THE BGS PROPERTY SUBSIDENCE ASSESSMENT HAZARD SCORE

The BGS Property Subsidence Assessment hazard score is produced via the weighted combination of the input modules. Weighting is used to load the influence of those factors which have a larger role to play in the susceptibility.

The algorithm is calculated at the building polygon scale – i.e. the most detailed level of information available. To generate the postcode level products the building information is aggregated in to the postcode polygons.

## 3.5 DATASET HISTORY

This is the first version of the Property Subsidence Assessment dataset.

BGS is continually surveying and improving the geological maps. Our Products are based upon the most up to date information available and BGS is committed to improving its datasets as more information becomes available.

## 3.6 COVERAGE

This first version of the PSA dataset is provided to identify susceptibility to shrink–swell hazards in England and Wales, supplied at postcode and building level. Data for Scotland is not yet available due to the unavailability of the National Tree Map.

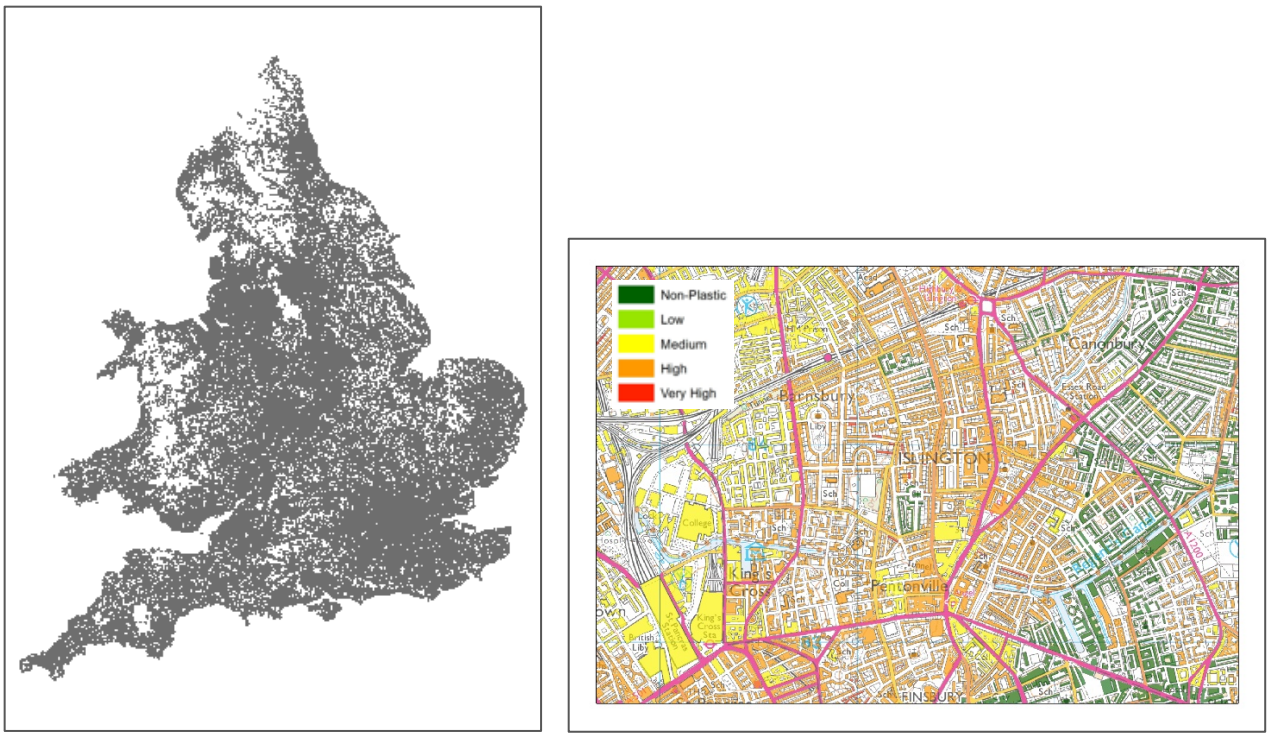


Figure 2 Coverage of the BGS Property Subsidence Assessment dataset (left) and detailed view of the attributed building polygons (right). The National Grid and other Ordnance Survey data © Crown Copyright and database rights 2019. Ordnance Survey Licence No. 100021290 EUL

## 3.7 DATA FORMAT

The BGS Property Subsidence Assessment dataset (buildings) has been created as vector polygons and are available in ESRI ArcGIS formats, including shapefiles and geodatabase. Other formats could be supplied on request and at additional cost. In addition the BGS Property Subsidence Assessment has been generalised to postcode level data and is available as a flat file (typically a CSV).

## 3.8 LIMITATIONS & CONSIDERATIONS

- The BGS Property Subsidence Assessment dataset uses OS Open Map building polygons. These are often representative of more than one building, therefore addresses are not attached to the building polygons and hence the polygons are designed to be used with spatial queries in a GIS. BGS are able to produce specific address based hazard score but this would incur additional license costs as the user would need to license the OS Master Map service.

- The BGS Property Subsidence Assessment dataset only considers the hazard of shrink-swell, it does not provide any information on other geohazards and should not be used for purposes other than the assessment of shrink–swell related hazards.
- The BGS Property Subsidence Assessment dataset is concerned with potential ground stability related to NATURAL shrink–swell geological conditions only.
- The BGS Property Subsidence Assessment dataset does NOT cover any man-made hazards. The only exception to this is the account for the introduction of water into a deposit via drainage failure, however this is based on the assumption of a property's likely drainage type according to its age.
- Office for National Statistics LSOA data is used to derive an individual buildings housing input factors. The data for the housing factor is therefore based on a specific measure of the most common factor value in the LSOA polygon. This may not be the actual information for a specific building.
- BGS PSA is based on, and limited to, the input datasets including OS open buildings, Office for National Statistics data, Bluesky National Tree Map and BGS GeoSure shrink-swell.
- An indication of natural ground instability related to shrink–swell 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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# 4 Licensing Information

The British Geological Survey does not sell its digital mapping data to external parties. Instead, BGS grants external parties a licence to use this data, subject to certain standard terms and conditions. In general, a licence fee will be payable based on the type of data, the number of users, and the duration (years) of a licence.

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- reproduce extracts from the data up to A3 for use in external analogue (paper/hard copy) or non-queryable electronic (e.g. secured .pdf) format: to meet a public task duty; fulfil a statutory requirement; and/or as part of academic or other non-commercial research

But **will not** be permitted to:

- provide a bureau service for others or incorporate the data in the generation of products or services for commercial purposes
- sell, assign, sublicense, rent, lend or otherwise transfer (any part of) the dataset(s) or the licence
- place (any part of) the dataset(s) on the Internet

The BGS is committed to ensuring that all the digital data it holds which is released to external parties under licence has been through a robust internal approval process, to ensure that geoscientific standards and corporate quality assurance standards are maintained. This approval

process is intended to ensure that all data released: (i) is quality assured; (ii) meets agreed BGS data management standards; (iii) is not in breach of any 3rd party intellectual property rights, or other contractual issues (such as confidentiality issues), that would mean that release of the data is not appropriate.

When the BGS digital datasets are revised any upgrades will be automatically supplied to the licensee, at no additional cost. Geological map datasets are revised on a periodic rather than on an annual basis, licensees will therefore not automatically receive a new dataset each year unless changes have been made to the data.

*These are general comments for guidance only.* A licensee of BGS's digital data is provided with full details of the basis on which individual BGS datasets licensed to them are supplied.

If you have any doubts about whether your proposed use of the BGS data will be covered by a BGS digital licence, the BGS Intellectual Property Rights (IPR) section will be happy to discuss this with you and can be contacted through the following email address: iprdigital@bgs.ac.uk. BGS IPR will usually be able to provide reassurance that the licence will cover individual user requirements and/or to include additional 'special conditions' in the licence documentation, addressing specific requirements within BGS's permitted usage.

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# References

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: https://envirolib.apps.nerc.ac.uk/olibcgi.

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