BGS INFORMATICS

User Guide: British Geological Survey Property Subsidence Assessment

Open report OR/24/002

British Geological Survey

BRITISH GEOLOGICAL SURVEY

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OPEN REPORT OR/24/002

User Guide for the British Geological Survey Property Subsidence Assessment Dataset

L Bateson, L Jones, A Hulbert, S Dorward, R Chahel

Contributor/editor

K Lee, K Freeborough.

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Front cover

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

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The British Geological Survey carries out the geological survey of Great Britain and Northern Ireland (the latter as an agency service for the government of Northern Ireland), and of the surrounding continental shelf, as well as basic research projects. It also undertakes programmes of technical aid in geology in developing countries.

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British Geological Survey offices

Nicker Hill, Keyworth,
Nottingham NG12 5GG
Tel 0115 936 3100

BGS Central Enquiries Desk
Tel 0115 936 3143
email enquiries@bgs.ac.uk

BGS Sales
Tel 0115 936 3241
email sales@bgs.ac.uk

The Lyell Centre, Research Avenue South,
Edinburgh EH14 4AP
Tel 0131 667 1000
email scotsales@bgs.ac.uk

Natural History Museum, Cromwell Road,
London SW7 5BD
Tel 020 7589 4090
Tel 020 7942 5344/45
email bgslondon@bgs.ac.uk

Cardiff University, Main Building, Park Place,
Cardiff CF10 3AT
Tel 029 2167 4280

Maclean Building, Crowmarsh Gifford,
Wallingford OX10 8BB
Tel 01491 838800

Geological Survey of Northern Ireland, Department of Enterprise, Trade & Investment, Dundonald House, Upper Newtownards Road, Ballymiscaw,
Belfast, BT4 3SB
Tel 01232 666595
www.bgs.ac.uk/gsni/

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon SN2 1EU
Tel 01793 411500 Fax 01793 411501
www.nerc.ac.uk

UK Research and Innovation, Polaris House,
Swindon SN2 1FL
Tel 01793 444000
www.ukri.org

Website www.bgs.ac.uk
Shop online at www.geologyshop.com

Foreword

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

BGS produces a wide range of data products that align to Government policy and stakeholder needs. These include baseline geological data, engineering properties and geohazards datasets. These products are developed using in-house scientific and digital expertise and are based on the outputs of our research programmes and substantial national data holdings.

Our products are supported by stakeholder focus groups, identification of gaps in current knowledge and policy assessments. They help to improve understanding and communication of the impact of geo-environmental properties and hazards in Great Britain, thereby improving society's resilience and enabling people, businesses, and the government to make better-informed decisions.

Acknowledgments

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This user guide was updated by R Chahel, with editorial input from K Lee and K Freeborough. We would particularly like to acknowledge L Bateson, K Freeborough and L Jones for their scientific expertise contributing to this product update.

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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.

This user guide provides the information required to enable the reader to understand and use this BGS data product.

1 Introduction

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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 Map Local 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 OS CodePoint Open 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

BGS Data Services
British Geological Survey
Environmental Science Centre
Keyworth, Nottingham. NG12 5GG
Direct tel. +44(0)115 936 3143
email digitaldata@bgs.ac.uk

1.1 BACKGROUND TO THE DATASET

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 Great Britain for the property report and insurance sectors.

Figure 1 Example of the building-level data Contains Ordnance Survey data © Crown Copyright and database rights 2024. OS AC0000824781. Contains National Statistics data © Crown copyright and database right 2024. Contains information sourced from Bluesky International Limited.

1.2 WHAT THE DATASET INCLUDES

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 .txt file for the postcode data, and identifies the potential shrink-swell hazard associated with the geology, building type and tree proximity in Great Britain.

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 building polygon, derived from Office for National Statistics Lower Layer Super Output Area (LSOA) results where counts of property age within each LSOA includes a breakdown by age into 12 property period categories.

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 building polygon, derived from Office for National Statistics Lower layer Super Output Area (LSOA) data where counts of property age within each LSOA includes a breakdown by age into 12 property period categories.

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 building polygon, derived from Office for National Statistics 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 reported for the building polygon, derived from Office for National Statistics 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 Bluesky's 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).

1.3 WHY THE DATASET IS USEFUL

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 that 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 Case studies

2.1 CASE STUDY 1: ENHANCING POST-CODE LEVEL PROPERTY INSURANCE DECISIONS WITH THE PSA DATASET

2.1.1 The Problem

Property insurance companies are tasked with accurately assessing and pricing insurance policies to protect against various risks, including subsidence and ground movement. However, the existing datasets and risk assessment tools available often fall short in providing the depth of information necessary for thorough evaluation. These datasets lack granularity and fail to encompass the diverse range of factors that contribute to subsidence hazards. As a result, insurance companies face challenges in accurately assessing property subsidence risks, leading to potential underwriting losses and customer dissatisfaction.

2.1.2 The Challenge

The challenge for property insurance companies lies in improving their risk assessment process to better serve their clients and manage their portfolios effectively. Without access to comprehensive and detailed datasets, insurance companies struggle to gain a holistic understanding of subsidence hazards and make informed underwriting decisions. Traditional datasets and industry-standard risk assessment tools do not offer the level of granularity required to assess the specific factors contributing to subsidence risks accurately. Consequently, insurance companies face difficulties in accurately evaluating property subsidence hazards and may inadvertently expose themselves to increased financial risks and operational inefficiencies.

2.1.3 The Solution

In response to these challenges, property insurance companies can leverage the BGS Property Subsidence Assessment (PSA) dataset, currently available at postcode-level for insurance use, to enhance their risk assessment frameworks. The PSA dataset offers a more detailed and nuanced analysis of subsidence hazards by incorporating various geological, environmental, and property-related factors. By integrating the PSA dataset into their risk assessment platforms, property insurance companies can improve their ability to assess property subsidence risks with greater precision and accuracy.

Technical Advantages:

1. Granular Analysis: The PSA dataset provides granular insights into shrink-swell hazards at both building and postcode levels, allowing insurance companies to assess risks with greater precision. This granularity enables insurers to identify high-risk areas more accurately and tailor their risk mitigation strategies accordingly.
2. Comprehensive Factors: By considering factors such as geological composition, property age, drainage systems, building type, number of storeys, and tree proximity, the PSA dataset offers a comprehensive understanding of subsidence risks. This multifaceted approach ensures that insurers have access to a wealth of information to inform their underwriting decisions effectively.
3. Customized Risk Profiles: Insurance companies can develop customized risk profiles for different properties using the PSA dataset, enabling tailored insurance solutions and more accurate pricing strategies. By understanding the specific risk factors potentially associated with each property, insurers can offer personalized insurance coverage that aligns with their clients' needs and risk tolerance.
4. Proactive Risk Mitigation: Understanding the factors contributing to subsidence hazards allows insurance companies to work with property owners to implement proactive risk mitigation strategies. By identifying potential areas of concern and collaborating with property owners to address underlying issues, insurers can reduce the likelihood of

claims and associated costs, ultimately enhancing their bottom line and customer satisfaction.

By leveraging the technical advantages of the PSA dataset, property insurance companies can enhance their risk assessment processes, make more informed underwriting decisions, and ultimately improve customer satisfaction while reducing underwriting losses. This proactive approach not only strengthens insurers' risk management capabilities but also fosters stronger relationships with clients based on trust and transparency.

2.2 CASE STUDY 2: ENHANCING BUILDING-LEVEL PROPERTY INSIGHTS WITH THE PSA DATASET

2.2.1 The Problem

Between January and June 2022, the UK experienced the driest weather in over 40 years, culminating with the hottest days on record in July when temperatures exceeded 40°C for the first time. These unprecedented hot, dry conditions will have resulted in levels of clay shrinkage never previously experienced in the UK and significant rainfall will be necessary to promote their recovery.

2.2.2 The Challenge

The identification of shrink–swell-related subsidence-prone buildings, alongside the inclusion of potential additional factors that could exacerbate this phenomenon, can better inform homeowners and form the basis to make decisions concerning prevention and remediation. The BGS PSA dataset provides insurers and homeowners access to a better understanding of the shrink–swell hazard at both the individual property and postcode level for England and Wales. It builds upon the BGS GeoSure shrink–swell data, which highlights the susceptibility of the local geology to shrink and swell, by mapping the hazard to the individual building polygon and considering the following additional susceptibility or influencing factors.

2.2.3 The Solution

The PSA data is currently licenced for distribution across our Value Added Resellers in report formats. These reports are commonly available as site specific assessments, alongside multiple other datasets, and provide an indication of natural ground instability related to shrink–swell subsidence. These types of reports are often used in the conveyancing market.

3 Methodology

3.1 OVERVIEW

The methodology employed for the creation of the BGS Property Subsidence Assessment dataset combines various geospatial analyses and datasets to ensure a scientifically robust and accurate output. The hazard assessment considers the susceptibility of ground movement, particularly related to shrink-swell hazards, across Great Britain.

3.2 SOURCE DATASETS

The BGS Property Subsidence Assessment dataset is built upon several key source datasets, including:

1. **BGS GeoSure Shrink-Swell Data Product:** This dataset identifies areas of potential geological hazard in Great Britain related to shrink-swell phenomena.
2. **OS OpenMap Local Building Polygons:** Provides building footprints and attributes, allowing for the assessment of individual buildings' susceptibility to subsidence.

3. **National Tree Map (Bluesky):** Offers information on the distribution and density of trees, which can influence ground moisture content and contribute to subsidence risk.
4. **Office for National Statistics (UK Property Build Period and Type) Lower layer Super Output Area (LSOA):** Provides data on the age and type of properties, which can indicate variations in foundation design and susceptibility to subsidence. A Lower Layer Super Output Area (LSOA) is a geographic area used in England and Wales for reporting small area statistics. They have an average population of between 1000 and 3000 people, or between 400 and 1200 households.
5. **OS Code Point Open and OS Code Point with Polygons:** Provides postcode and building location data, essential for spatial analysis and aggregation of building-level assessments to the postcode level.

The methodology involves the following broad steps:

1. **Integration of Source Datasets**: The source datasets are integrated to create a comprehensive geospatial database, combining information on geology, building characteristics, tree distribution, and property age/type.
2. **Analysis and Weighting**: Geospatial analyses are performed to assess the susceptibility of individual buildings to shrink-swell hazards based on factors such as geology, tree proximity, foundation depth, building type, and drainage. These factors are weighted based on their importance in contributing to subsidence risk.
3. **Aggregation to Postcode Level**: Building-level assessments are aggregated to the postcode level, providing a summary of subsidence risk for broader geographical areas.
4. **Normalization and Classification**: Hazard scores are normalized and classified into categories (e.g., low, medium, high) to facilitate interpretation and decision-making.
5. **Documentation and Versioning**: Detailed technical documentation is prepared, outlining the methodology, source datasets, processing steps, and limitations. The dataset is versioned to track updates and changes over time.

The methodology adopted for the BGS Property Subsidence Assessment dataset ensures its capacity to furnish valuable insights into property susceptibility to shrink-swell hazards. Through the integration of diverse datasets and meticulous geospatial analyses, this dataset delivers robust information crucial for insurers, homeowners, developers, and local governments in effectively assessing and mitigating subsidence risks.

Central to the dataset's functionality is the BGS Property Subsidence Assessment hazard score, which is derived through a weighted combination of input modules. Weighting factors are applied to emphasize the influence of variables that play a significant role in susceptibility. This algorithm operates at the building polygon scale, representing the most granular level of information available. To provide postcode-level insights, the building data is aggregated to the corresponding postcode polygons, ensuring broader applicability and accessibility of the assessment results. This hierarchical approach enables stakeholders to access both detailed property-level assessments and broader geographic risk profiles, facilitating informed decision-making and proactive risk management strategies.

4 Technical Information

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

Input Dataset	Release Date / Version
OS OpenMap Local building polygons	October 2023
GeoSure shrink-swell	Version 8
National Tree Map (Bluesky™)	2023
Office for National Statistics (UK property build period) Lower layer Super Output Area (LSOA)	2014, based on 2011 Census data
Office for National Statistics (UK property type) Lower layer Super Output Area (LSOA)	2014, based on 2011 Census data
OS Code Point open	October 2023
OS Code Point with polygons	October 2023

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

4.1 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.

4.2 COVERAGE

This version of the PSA dataset is provided to identify susceptibility to shrink–swell hazards in Great Britian, supplied at postcode and building level.

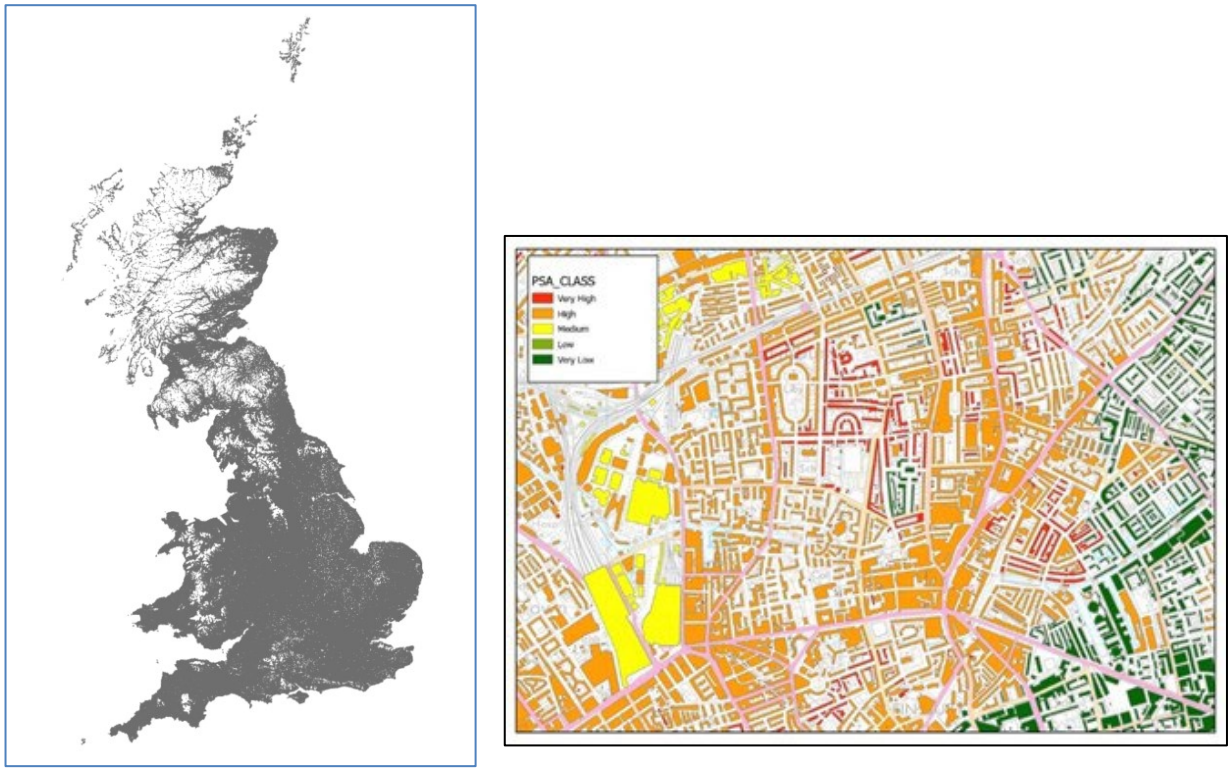

Figure 2 Coverage of the BGS Property Subsidence Assessment dataset (left) and detailed view of the attributed building polygons (right). Contains Ordnance Survey data © Crown Copyright and database rights 2024. OS AC0000824781. Contains National Statistics data © Crown copyright and database right 2024. Contains information sourced from Bluesky International Limited.

4.3 ATTRIBUTE DESCRIPTION

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 .txt for the postcode data).

4.3.1 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_version where region is: ew_ne, ew_nw, ew_em, ew_wm, ew_se, ew_sw, sct_e, sct_ne, sct_nw, or sct_w. 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, ‘sw’ is south west, ‘sct’ is Scotland, ‘e’ is east, and ‘w’ is west. ‘Version’ indicates the OS data used to produce the PSA. October 2023_3 is the version number added to the end of the file name, this indicates that the PSA data has been built upon the OS Open Map Local October 2023 data.

This product is based on the building polygons supplied in the OS Open Map Local dataset (October 2023). It is worth noting that although each building in Great Britain 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	Contains the geometry data	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 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
GEOLOGY	A score (1-10) for the building indicating the subsidence susceptibility due to the underlying geology [Zero value = No data]	1 to 10 10 indicating buildings with the highest susceptibility due to the presence of shrink–swell prone geology and 1 indicating buildings with the lowest susceptibility due to the presence of shrink–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 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 Used as an indication of potential drainage failure.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 Used as an indication of potential number of storeys. 10 indicating buildings 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 Used as an indication of potential type of building. 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 1 – least susceptible, 100 – most susceptible
PSA_CLASS	The class of the hazard score (Very low, Low, Medium, High, Very High).	Very low – This very low hazard class can be present where the geology is showing as low to medium susceptibility to shrink–swell however there are no influences from trees, and the property factors of age, type, stories and drainage have minimal influence; or where the building is situated on very low to non-plastic geology, and therefore has very low susceptibility to shrink swell regardless of the indicated property factors Low – A low susceptibility to shrink–swell related subsidence Medium - A medium susceptibility to shrink–swell related subsidence High – A high susceptibility to shrink–swell related subsidence 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_[region]_Oct2023_3

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

4.3.2 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 3.

Figure 3 The BGS Property Subsidence Assessment dataset at building level, OS Open Map Local 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. Contains Ordnance Survey data © Crown Copyright and database rights 2024. OS AC0000824781. Contains National Statistics data © Crown copyright and database right 2024. Contains information sourced from Bluesky International Limited.

Building number 1 in Figure 3 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 3 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 3 is classed as very low hazard score class, 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.

4.3.3 BGS Property Subsidence Assessment dataset at postcode level

This product is comprised of a table (.txt) and/or shapefile (.shp) of postcodes with associated hazard score classification. It is named BGS Property Subsidence Assessment (Postcode).

FIELD NAME	FIELD DESCRIPTION	EXPLANATION
FID	An automatically generated sequential unique identifier	0 - X
POSTCODE	The postcode	The postcode in format NG12 5GG
PSA	The normalised hazard score in the range of 1-100	1-100 1 – least susceptible, 100 – most susceptible
PSA_CLASS	The classified hazard score (NoData, Very low, Low, Medium, High, Very-High).	NoData – postcodes that contain no building polygons from the OS Open Map Local dataset and therefore no hazard score. Very low – This very low hazard class can be present where the geology is showing as low to medium susceptibility to shrink–swell however there are no influences from trees, and the property factors of age, type, stories and drainage have minimal influence; or where the building is situated on very low to non-plastic geology, and therefore has very low susceptibility to shrink swell regardless of the indicated property factors. Low – A low susceptibility to shrink–swell related subsidence Medium - A medium susceptibility to shrink–swell related subsidence High – A high susceptibility to shrink–swell related subsidence Very High- A very high susceptibility to shrink–swell related subsidence
POSTCODE_X	The X coordinate, in British National Grid, of the centre point of the postcode	
POSTCODE_Y	The Y coordinate, in British National Grid, of the centre point of the postcode	
VERSION	Name and Version Number of dataset	BGS_PSA_Postcodes_GB_Oct2023_3

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

4.4 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 txt).

4.5 DATASET DESCRIPTION

The output dataset is a shapefile for Great Britain, this is too large for delivery as a single file and therefore is split into regions as shown in Table 4.

The PSA dataset will be updated once per year to incorporate updates to the underlying OS Open Map Local data. This will follow the October OS updates. The dataset version numbering will therefore indicate which OS data has been used and follow the format of:

_MthYYYY_Q

Where Mth is the Month of the OS update and YYYY is the year of the OS update and Q is the quarter of the OS update. Therefore _Oct2023_3 indicates that the version is built upon the OS data form October 2023 in Quarter 3.

Filename	Meaning
BGS_PSA_Buildings_ew_em_Oct2023_3.shp	PSA for OS Open Map Local building polygons for the East Midlands (em) region of England and Wales (ew). Version = October 2023 Quarter 3.
BGS_PSA_Buildings_ew_ne_ Oct2023_3.shp	PSA for OS Open Map Local building polygons for the North East (ne) region of England and Wales (ew). Version = October 2023 Quarter 3.
BGS_PSA_Buildings_ew_nw_ Oct2023_3.shp	PSA for OS Open Map Local building polygons for the North West (nw) region of England and Wales (ew). Version = October 2023 Quarter 3.
BGS_PSA_Buildings_ew_se_ Oct2023_3.shp	PSA for OS Open Map Local building polygons for the South East (se) region of England and Wales (ew). Version = October 2023 Quarter 3.
BGS_PSA_Buildings_ew_sw_ Oct2023_3.shp	PSA for OS Open Map Local building polygons for the South West (sw) region of England and Wales (ew). Version = October 2023 Quarter 3.
BGS_PSA_Buildings_ew_wm_ Oct2023_3.shp	PSA for OS Open Map Local building polygons for West Midlands (wm) region of England and Wales (ew). Version = October 2023 Quarter 3.
BGS_PSA_Postcodes_GB_ Oct2023_3.txt **BGS_PSA_Postcodes_GB_ Oct2023_3.shp**	PSA for OS CodePoint Open postcode points for Great Britian(GB). Version = October 2023 Quarter 3.
BGS_PSA_Buildings_sct_e_ Oct2023_3.shp	PSA for OS Open Map Local building polygons for East (e) region of Scotland (sct). Version = October 2023 Quarter 3.
BGS_PSA_Buildings_sct_ne_ Oct2023_3.shp	PSA for OS Open Map Local building polygons for North East (ne) region of Scotland (sct). Version = October 2023 Quarter 3.

BGS_PSA_Buildings_sct_nw_ Oct2023_3.shp	PSA for OS Open Map Local building polygons for North West (nw) region of Scotland (sct). Version = October 2023 Quarter 3.
BGS_PSA_Buildings_sct_w_ Oct2023_3.shp	PSA for OS Open Map Local building polygons for West (w) region of Scotland (sct). Version = October 2023 Quarter 3.

Table 4: Output file names.

4.6 DATASET HISTORY

BGS is continually improving and updating its data and is committed to improving PSA as more information becomes available. These updates are in line with updates to source datasets, including the OS Open Map Local and the Bluesky tree datasets. In addition, when there is an update to the underlying geology, this will also be incorporated into a new version of the PSA. Below is an outline of the data history of PSA.

BGS_PSA_*_Apr2020_3 (Version 1, released 2020): Derived from BGS GeoSure shrink-swell V8, OS Open Map Local Oct2020_3, and Bluesky's National Tree Map™ 2019.

BGS_PSA_*_Apr2021_1 (Version 2, released 2021): Derived from BGS GeoSure shrink-swell V8, OS Open Map Local Oct2021_1, and Bluesky's National Tree Map™ 2021. Large scale changes are due to changes in the National Tree Map dataset.

BGS_PSA_*_Apr2022_1 (Version 3, released 2022): Derived from BGS GeoSure shrink-swell V8, OS Open Map Local Apr2022_1, and Bluesky's National Tree Map™ 2022. Large scale changes are due to changes in processing of the Bluesky National Tree Map™.

BGS_PSA_*_Apr2023_1 (Version 4, released 2023): Derived from BGS GeoSure shrink-swell V8, OS Open Map Local Apr2023_1, and Bluesky National Tree Map 2023.

BGS_PSA_*_Oct2023_3 (Version 5, released 2024): Derived from BGS GeoSure shrink-swell V8, OS Open Map Local Apr2023_1, and Bluesky's National Tree Map™ 2023. This update includes the new release of the Bluesky National Tree Map™ tree coverage for Scotland. Additional updates to the class boundaries and descriptions have been incorporated to further clarify the data interpretations. A summary is provided here and further details in Appendix 1.

- tree updates Bluesky National Tree Map™
- update to England, Wales and Scotland as tree data is now available.
- buildings updates from OS – this OS data release contains a large number of updates.
- updates to OS postcode polygons/areas.
- updates to the PSA algorithm have been incorporated to ensure updated research is fed in and class boundaries are accurately depicted.
- update of the class name and description for the lower class from non-plastic to very low to more accurately depict the hazard susceptibility and as a result of feedback from users. This has also altered some of the class boundaries slightly.

4.7 DISPLAYING THE DATA

PSA Class	RED	GREEN	BLUE	HEX	LOOKS LIKE
Very Low	0	97	0	006100	
Low	122	171	0	7AAB00	
Medium	255	255	0	FFFF00	
High	255	153	0	FF9900	
Very High	255	34	0	FF2200	

5 Licencing the data

5.1 BGS LICENCE TERMS

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 and geographical extent of data, the number of users, and the duration (years) of a licence.

All recipients of a licence (potential licensees) are required to return a signed digital data licence document before authorisation for release of BGS digital data is given.

Please use the following acknowledgement when using BGS Property Subsidence Assessment:

- BGS Property Subsidence Assessment licenced data: 'Derived from BGS Digital Data under Licence (cite your licence number) British Geological Survey © UKRI. All rights reserved.'

Further details about licensing BGS data can be found on our web page https://www.bgs.ac.uk/information-hub/licensing/.

For more information on the availability of data or to obtain a quote for licensing the data, please email digitaldata@bgs.ac.uk. For any questions related to the licence agreement or to discuss your proposed usage of the data, please email iprdigital@bgs.ac.uk.

5.2 CONTACT INFORMATION

For all data and licensing enquiries please contact:
BGS Data Services
British Geological Survey
Environmental Science Centre
Keyworth
Nottingham
NG12 5GG
Direct Tel: +44(0)115 936 3143
Email: digitaldata@bgs.ac.uk

6 Limitations

6.1 DATA CONTENT

The BGS Property Subsidence Assessment dataset has been constructed by combining various datasets including OS Open Map Local building polygons, Office for National Statistics (ONS) data, Bluesky's National Tree Map™, and BGS GeoSure shrink-swell data. Consequently, the values within this dataset are limited by the components on which they are based. Given the methodology described within this document, the values provided here are to the best of our knowledge and current data holdings. PSA is a complex methodology subject to, and sensitive to, changes in one or more input layers. BGS has no control over the externally changed data and that these changes in inputs can, on occasion lead to revision of scores by one or more classes

6.2 SCALE

The BGS Property Subsidence Assessment dataset is formulated at the property scale, but it's imperative to acknowledge the variability in input data scale, potentially introducing scale-dependent inaccuracies. The GeoSure input dataset, designed for 1:50 000 scale usage with a ground resolution of 50 meters, is primarily composed of geological field observations made at 1:10 000 scales and site-specific geotechnical soil tests. Additionally, housing input data is derived from the Office for National Statistics LSOA data and provides statistics at the polygon level, covering multiple houses without specifying individual attributes. To address this, majority value statistical distributions are applied uniformly within polygons, inevitably leading to misclassification of some buildings. While these limitations affect the precision and accuracy of the assessment, it represents the best available data for property subsidence analysis, urging users to interpret results with caution and consideration of these constraints.

6.3 ACCURACY AND UNCERTAINTY

The accuracy of the BGS Property Subsidence Assessment dataset is subject to several sources of uncertainty. These include the variability in input data sources, the scale-dependent inaccuracies introduced by the differing scales of input data, and the limitations inherent in the methodology used to create the dataset. While efforts have been made to mitigate these uncertainties, users should interpret the data with caution and be aware of the potential limitations.

6.4 ARTEFACTS

Artefacts may be present in the dataset due to factors such as data processing techniques, data aggregation, and limitations within in the source data. These artefacts could manifest as anomalies or inconsistencies in the dataset and may affect the interpretation of the data. Users should always be aware that seemingly small changes in inputs from other sources CAN have an impact on outcomes. Users should also be aware that spatial objects from non BGS sources may contain geometry components/features that other BGS products would not normally allow (e.g. multipart). Therefore, users should exercise diligence when analyzing the dataset and be aware of the possibility of artefacts.

6.5 DISCLAIMER

The BGS Property Subsidence Assessment dataset is provided for informational purposes only. While efforts have been made to ensure the accuracy and reliability of the data, the British Geological Survey (BGS) makes no guarantees regarding the completeness, accuracy, or suitability of the dataset for any particular purpose. Users are responsible for independently verifying the data and should not rely solely on the information provided in the dataset for decision-making purposes.

7 Frequently asked questions

Q: What does the BGS Property Subsidence Assessment dataset show?
A: This dataset provides an assessment of susceptibility to shrink–swell hazards at both building and postcode levels in Great Britain. It includes hazard scores and classifications based on factors such as geology, tree density distance, building age, drainage, and building type.

Q: **What scale are these data provided at?**
A: The dataset is formulated at the property scale and is intended for use at this scale. However, users should be aware of the scale-dependent inaccuracies introduced by the varying scales of input data sources.

Q: How accurate is this dataset?
A: The accuracy of the dataset is subject to various uncertainties, including those associated with input data sources, data processing, and methodology. While efforts have been made to mitigate these uncertainties, users should interpret the data with caution.

Q: How often will this dataset be updated?
A: This dataset is updated annually to incorporate changes in the underlying data sources, such as OS Open Map Local (buildings) and Bluesky's National Tree Map™. Updates are prioritized based on the availability of new data and resources.

Q: Can I use this dataset as part of a commercial application?
A: This dataset is available under specific licensing terms from the British Geological Survey (BGS). Users are advised to refer to the terms of their license or contact iprdigital@bgs.ac.uk for further information regarding commercial usage.

Q: Are the dataset values real-world observations or predictions?
A: The dataset values are derived from a combination of real-world observations and predictions based on factors such as geological data, tree density distance, building age, and drainage. However, users should be aware of the limitations and uncertainties associated with these predictions.

Q: In what formats can these data be provided?
A: The dataset is provided in vector formats suitable for use in Geographic Information Systems (GIS), such as shapefiles and geodatabases. Users can Contact the digital data team - British Geological Survey (bgs.ac.uk) for information on specialized formats or additional processing options.

Glossary

Term	Explanation
ArcGIS	Geographic information system (GIS) software for working with maps and geographic information maintained by the Environmental Systems Research Institute (ESRI).
Artificial Ground	Ground surface has been significantly modified by human activity. Examples include recent anthropogenic or artificially modified ground where the ground surface has been significantly modified by human activity including quarrying, landscaping, land-raise, cuttings and embankments.
Bedrock	The main mass of rocks forming the earth, laid down prior to 2.588 million years ago. Present everywhere, whether exposed at the surface in rocky outcrops or concealed beneath superficial deposits, artificial ground or water. Formerly called solid.
Digital Terrain Mode (DTM)	Digital elevation model (DEM) that incorporates the elevation of important topographic features on the land.
Geohazard	Geological and environmental conditions, involving long and short-term processes which may lead to widespread damage. There are many different types of geohazard with different natural and artificial processes causing them to occur. All have the potential to create problems for development of the human environment and threats to the safety and well-being of people. Geohazards can develop quickly (seconds or minutes) in response to the processes that drive them, or take tens, hundreds, or thousands of years to develop to a point where they pose a danger. They are found in most parts of the world, including marine and fluvial environments.
Geotechnical	The application of technology to engineering problems caused by geological factors.
Ground Stability	The potential for upward, sideways or sinking movement of the ground (natural or man-made deposits) e.g. subsidence.
Hazard	A potentially damaging event or phenomenon.
Hazard rating	Scale or classification used to indicate low to high degree of identified threat.
Hazard susceptibility	Likelihood of a vulnerability occurring at a given location.
Lithology	Rocks maybe defined in terms of their general characteristics of appearance: colour, texture and composition. Some lithologies may require a microscope or chemical analysis for the latter to be fully determined.
Lithostratigraphy	Age and lithology. Many rocks are deposited in layers or strata and the sequence of these strata can be correlated from place to place. These sequences of different rocks are used to establish the changing geological conditions or geological history of the area through time. The description, definition and naming of these layered or stratified rock sequences is termed lithostratigraphy (rock stratigraphy). Lithostratigraphy is fundamental to most geological studies. Rock units are described using their gross

	compositional or lithological characteristics and named according to their perceived rank (order) in a formal hierarchy. The main lithostratigraphic ranks in this hierarchy are: Bed (lowest) > Member > Formation > Subgroup > Group > Supergroup (highest). The units are usually named after a geographical locality, typically the place where exposures were first described.
Non-plastic ground conditions	Not capable of being deformed continuously and permanently in any direction without rupture.
Plasticity	Ability of rock to undergo deformation without cracking, fracturing or rupturing.
Polygon	Polygons are a representation of areas. A polygon is defined as a closed line or perimeter completely enclosing a contiguous space and is made up of one or more links.
Qualitative Classification	Qualitative data approximates and characterizes, it can be observed and recorded. This data type is non-numerical in nature. It is collected through methods of observations, allowing the determination of traits and characteristics.
Quaternary	A geological time period covering the last 2.6 million years.
Quaternary Deposits	All unconsolidated material deposited in the last 2.6 million years.
Resolution	Resolution expresses the size of the smallest object in a spatial data set that can be described. It refers to the amount of detail that can be discerned. It is also known as granularity.
Risk	The impact of a hazard on people, property or capital.
Scale	The relation between the dimensions of features on a map and the geographic objects they represent on the earth, commonly expressed as a fraction or a ratio. A map scale of 1/100,000 or 1:100,000 means that one unit of measure on the map equals 100,000 on the earth.
Shapefile	The shapefile format is a geospatial vector data format for geographic information system software. It is developed and regulated by Esri as a mostly open specification for data interoperability among Esri and other GIS software products.
Shrink–Swell	Material containing clay minerals changes in volume (up or down) due to the variation in water content in the deposits, causing the ground to shrink or swell.
Subsidence	The process by which the ground beneath a building sinks to a lower level, pulling the property's foundations down with it.
Shrink-Swell motions	The cyclical expansion and contraction of soil due to changes in moisture content, often leading to ground movement and potential subsidence.
Superficial	The youngest geological deposits formed during the most recent period of geological time, the Quaternary. They date from about 2.6 million years ago to the present.
Vector	A representation of the spatial extent of geographic features using geometric elements (such as point, curve, and surface) in a coordinate space.

References

Cutler, D. F. and Richardson, I. B. K. (1989) Tree Roots and Buildings. *2nd Edition. Longman Scientific & Technical, Harlow*, Middlesex, England.

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Appendix 1

Summary of changes for BGS_PSA_Buildings_*_Oct2023

This version of BGS Property Subsidence Assessment has seen multiple updates and improvements to the methodology, data classes and input datasets. This Appendix provides a summary of the changes made and quantifies the impact of these combined changes on the deliverable outputs.

INPUT DATA CHANGES

Bluesky National Tree Map (NTM)

In 2023 Bluesky released an update to their National Tree Map which extended coverage to Scotland. The lack of tree data for Scotland was the preventative factor restricting PSA coverage to England and Wales. With this update from Bluesky PSA can now be generated with national coverage for Great Britain and as such the extent of the dataset has increased significantly with the **addition of 1511436 additional buildings and 105211 postcodes.**

OS Open Map Local Buildings

The October 2023 release of OS buildings deviated from the previous version in the scale of changes to the number of building polygons added and removed. Analysis of previous versions of PSA built upon OS Open Map Local Buildings from April 2021, April 2022 and April 2023 show that the OS dataset receives periodic updates regarding the inclusion and removal of with new and old buildings. These changes are seemingly not applied to every release of OS Open Map Local Buildings, rather bulk updates applied periodically. As such there is significant variation in the scale of change in the building polygons between PSA releases.

	April2021 vs April2022	April2022 vs April2023	April2023 vs Oct2023
No. of building polygons present in previous PSA version but absent in latest	249344	0	106327
No. of building polygons present in latest PSA version but absent in previous	59937	0	29902

Changes in the extents of building footprints can result in new lithologies being intersected which have a different susceptibility to shrink-swell. Since PSA offers a worst-case scenario assessment this can cause significant changes in PSA class for a building from one release of PSA to another. The majority have remained within 1 class of the previous PSA release.

Difference in Class	Count	%
4	52	0.000%
3	93	0.001%
2	1895	0.014%
1	1635361	12.282%

0	11592814	87.067%
-1	84503	0.635%
-2	117	0.001%
-3	50	0.000%
-4	3	0.000%

OS Postcodes

Similarly the OS Code-Point postcodes dataset has undergone the standard periodic update of polygon extents and additional polygons reflecting the amended boundaries of existing postcodes and creation of new postcodes which will also contribute to PSA changes between releases.

METHODOLOGY CHANGES

PSA class descriptions

The lowest class, previously ‘Non-plastic’ has been renamed ‘Very low’ and the description has been updated. This is in response to feedback that the previous naming caused confusion about how this class related to GeoSure shrink-swell susceptibility polygons. GeoSure shrink-swell is an input into PSA reflecting the geological susceptibility of deposits to shrink and swell. Previously the definition of the lowest PSA class was absolute in stating these deposits could not change volume whereas in reality a property in the lowest PSA class can be situated on low to medium shrink-swell susceptibility deposits but with no additional influencing factors to increase the shrink-swell susceptibility, falls into the lowest PSA class. As such the naming and description of the lowest PSA class has now been brought in line with the rest of the classification scheme (Very high, High, Medium, Low, Very low).

PSA algorithm

In order to feed in the latest research, additional updates to the class boundaries and descriptions have been incorporated to further clarify the data interpretations. Class boundaries have been amended to prevent clay-rich deposits (which are potentially capable of shrinking and swelling) from being scored ‘Very Low’ in PSA as a result of favourable additional influencing factors not exacerbating the susceptibility to subsidence. Also, ensuring that the classification is sensitive to non-rounded values and therefore classification boundaries are more accurate.

The overall changes with this release are:

No. buildings increased in PSA class	1637401	12.298%
No change	11592814	87.067%
No. buildings decreased in PSA class	84673	0.636%