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NATURAL ENVIRONMENT RESEARCH COUNCIL

User Guide for the Shrink-Swell 3D (GeoSure Extra) dataset v1.0

GeoAnalytics & Modelling Programme

Open Report OR/16/043

BRITISH GEOLOGICAL SURVEY

GEOANALYTICS & MODELLING PROGRAMME

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User Guide for the Shrink-Swell 3D (GeoSure Extra) dataset v1.0

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SW corner 0,0
Centre point 350000,550000
NE corner 700000,1300000

Map

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Summary

This report describes the national scale Shrink–Swell in 3D (GeoSure Extra) dataset. The methods used to create the dataset have been critically assessed and its fitness for purpose determined by specialists in BGS.

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

Acknowledgements

A number of individuals in the GeoAnalytics & Modelling and Engineering Geology Programmes have contributed to the project. 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. Key staff have helped to review draft chapters of this report.

1 Introduction

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.

The GeoSure dataset comprises six different Geographical Information System (GIS) layers, with each layer representing a different natural ground stability hazard that occurs in Great Britain. The GeoSure datasets are polygon (area) layers, which are described using a straightforward A to E potential hazard classification.

This document provides information for users on an additional dataset for the assessment of the 3D Shrink–Swell properties of the London area.

Further information on all the digital data provided by the BGS can be found on our website at http://www.bgs.ac.uk/data/digitaldata/digitaldata.cfm or by contacting:

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2 About the Shrink–Swell 3D Dataset

2.1 BACKGROUND

Public understanding of the effect of ground conditions on the safety of their property and the implication for the value of their property is growing. Local councils are under increasing pressure from central government to provide environmental information. Information about geological hazards is needed, in particular, the identification of areas with a potential for ground movement.

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. Along with the GeoSure ground stability datasets, the programme also generated:

- Superficial Deposit Thickness Models
- Scans of onshore borehole logs for Great Britain
- Scans of geology and historic topography maps
- Ground permeability data
- Susceptibility to groundwater flooding data
- Geological indicators of past flooding data
- Environmental sensitivity data
- GIS data identifying potential radon hazard
- Soil Parent Material Model
- Non-coal mining hazards data

2.2 WHO MIGHT REQUIRE THIS DATA?

Natural ground stability hazards 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, engineering works to stabilise land or property. These hazards may also impact on anyone involved in the construction of large structures (deep foundations, basements), infrastructure networks (road or rail) or utility companies. The 3D properties of these materials can be used to identify potential problems at surface, in the shallow sub-surface or deeper underground (e.g. tunnels). Armed with knowledge about potential hazards, preventative steps can be put in place to alleviate the impact of the hazard to people, property and infrastructure. The cost of such prevention may be very low, and is often many times lower than the repair bill following ground movement.

The identification of ground instability and other geological hazards can assist regional planners; rapidly identifying areas with potential problems and aid local government offices in making development plans by helping to define land suited to different uses. Other users of these data may include developers, construction companies, consulting engineers, builders, loss adjusters, the insurance industry, architects and surveyors.

2.3 WHAT THE DATASET SHOWS?

This addition to the GeoSure ground stability data consists of a single data layer in Geographical Information System (GIS) format that identifies areas of potential shrink–swell hazard, in three dimensional space, at intervals down to 20m in the London Lithoframe (see (http://www.bgs.ac.uk/services/3Dgeology/lithoframe.html)) area of Great Britain.

It is essentially a regional hazard susceptibility map. This data has been produced by geologists, geotechnical specialists and information developers at the British Geological Survey and is presented as a GIS data layer. Swelling clays can change

volume due to variation in moisture, this can cause ground movement, particularly in the upper two metres of the ground, or where excavated and exposed, 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 that might cause changes to the ground conditions. Such changes can affect building foundations, pipes or services.

3 Technical Information

3.1 DEFINITIONS

Hazard: A potentially damaging event or phenomenon.

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

For example, a shrinkable clay could be perceived as a hazard, but the likelihood of it causing structural damage 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 stability 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.

3.2 SCALE

The 3D Shrink–Swell for GeoSure natural ground stability dataset is produced for use at 1:50 000 scale providing 50m ground resolution.

3.3 ATTRIBUTE TABLE FIELD DESCRIPTIONS

3.3.1 ShrinkSwell3D layer

This data layer provides information on the primary key ‘Form’ (Geological Formation), the secondary key ‘VCP’ (Dominant Volume Change Potential) and the tertiary key ‘Range’ (Volume Change Potential Range).

Table 1: Attribute Table ShrinkSwell3D layer

Field Name	Field Description
Form00m (Depth bgl)	Geological Formation code (LEX)
VCP00m	Dominant VCP code (Classification of hazard on a scale of A – E classed by VCP rating)
Range00m	VCP Range code (Classification of hazard on a scale of A – E classed by VCP rating)
Form01m	Geological Formation code (LEX)
VCP01m	Dominant VCP code (Classification of hazard on a scale of A – E classed by VCP rating)
Range01m	VCP Range code (Classification of hazard on a scale of A – E classed by VCP rating)
Form02m	Geological Formation code (LEX)
VCP02m	Dominant VCP code (Classification of hazard on a scale of A – E classed by VCP rating)
Range02m	VCP Range code (Classification of hazard on a scale of A – E classed by VCP rating)
Form03m	Geological Formation code (LEX)
VCP03m	Dominant VCP code (Classification of hazard on a scale of A – E classed by VCP rating)
Range03m	VCP Range code (Classification of hazard on a scale of A – E classed by VCP rating)
Form04m	Geological Formation code (LEX)
VCP04m	Dominant VCP code (Classification of hazard on a scale of A – E classed by VCP rating)
Range04m	VCP Range code (Classification of hazard on a scale of A – E classed by VCP rating)
Form05m	Geological Formation code (LEX)
VCP05m	Dominant VCP code (Classification of hazard on a scale of A – E classed by VCP rating)
Range05m	VCP Range code (Classification of hazard on a scale of A – E classed by VCP rating)
Form10m	Geological Formation code (LEX)
VCP10m	Dominant VCP code (Classification of hazard on a scale of A – E classed by VCP rating)
Range10m	VCP Range code (Classification of hazard on a scale of A – E classed by VCP rating)

Form15m	Geological Formation code (LEX)
VCP15m	Dominant VCP code (Classification of hazard on a scale of A – E classed by VCP rating)
Range15m	VCP Range code (Classification of hazard on a scale of A – E classed by VCP rating)
Form20m	Geological Formation code (LEX)
VCP20m	Dominant VCP code (Classification of hazard on a scale of A – E classed by VCP rating)
Range20m	VCP Range code (Classification of hazard on a scale of A – E classed by VCP rating)
VERSION	Dataset name and version number

Table 2: Geosure Shrink-Swell Legend

CLASS	SHRINK–SWELL DESCRIPTION
A	Ground conditions predominantly non-plastic
B	Ground conditions predominantly low plasticity
C	Ground conditions predominantly medium plasticity
D	Ground conditions predominantly high plasticity
E	Ground conditions predominantly very-high plasticity
U	Unknown

3.4 CREATION OF THE DATASET

The hazard GIS layer is rated on an A – E classification (representing increasing hazard).

To produce the Shrink–Swell 3D for GeoSure natural ground stability data layer an assessment of hazard is made by:

- Identifying the factors that are involved in creating the hazard
- Assessing which are thought to be present at each location
- Assessing how significant they are thought to be at each location

The factors are then combined to estimate the level of hazard.

GeoSure 3D shrink-swell data are created from a stack of grids that represent all the litho-stratigraphic formations within the area at depths relative to OD. The grids did not need to be continuous over the area, but did need to show where the surface was present. Using the Nextmap DTM and a custom Python script, the formation present at specific depths below ground level was identified. This was done for 50m x 50m cells across the London Lithoframe area. Two output feature classes were produced. The first attributed the cell with Formation (Volume Change Potential (VCP) Code),

the second with VCP Code (Formation). This allows the feature classes to be classified either by formation or VCP code within the GIS.

The level of potential hazard does not mean that a damaging event is going to happen but is an indication of how many causative factors may be present and how severe they are thought to be. Thus the hazard assessment method can be used to indicate how vulnerable areas are to experiencing hazard events and of how frequently these hazard events might be expected to occur.

Use of this data can help manage land to its best advantage, safely and with the lower likelihood of financial loss. Shrink-Swell soils can have a damaging effect in tunnels and other underground spaces where specialist supports may be required; the 3D hazard map would help to identify areas for further investigation before construction begins.

3.5 COVERAGE

The Shrink–Swell 3D dataset is based on the BGS London Lithoframe model and consists of twelve 20km x 20km squares, based around London. The squares are oriented in a 6 by 2 formation, making the full extent 120km x 40km (4800km^2). The extent of these eight data layers is shown in Figure 1.

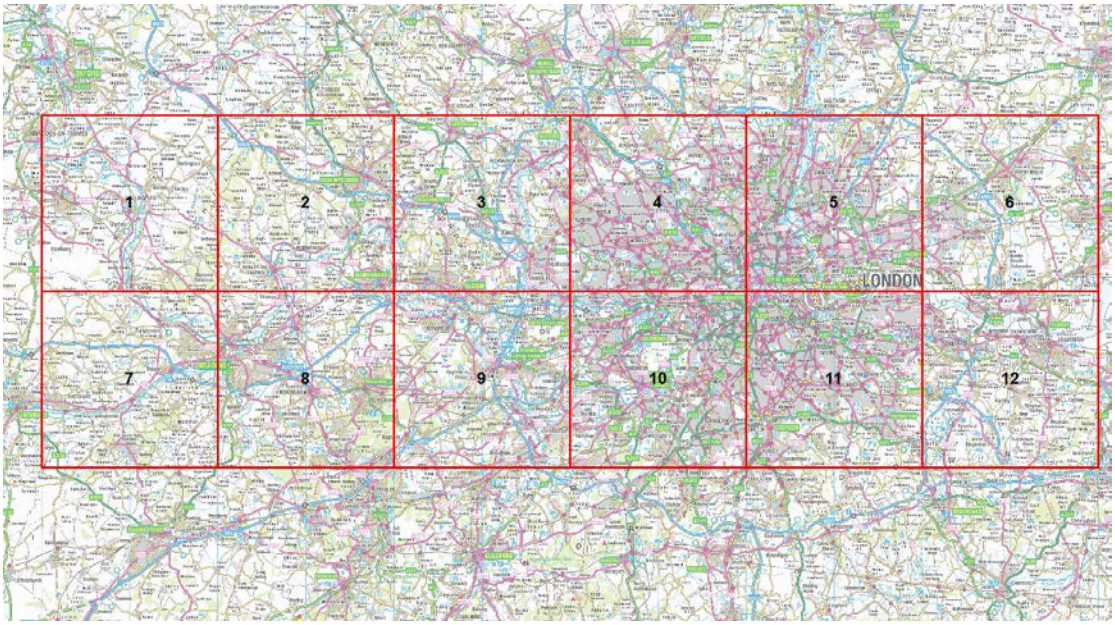

Figure 1: Coverage of the Shrink–Swell 3D dataset

3.6 DATA FORMAT

The GeoSure natural ground stability dataset, along with this additional dataset, has been created as vector polygons 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.

3.7 LIMITATIONS

- The Shrink–Swell 3D dataset is based on the London Lithoframe (1:10 000 scale) dataset. The depths of the lithostratigraphic layers are based on a combination of 1:10 000 scale mapping, 922 cross-sections and 7174 boreholes across the area.
- GeoSure is concerned with potential ground stability related to NATURAL geological conditions only.
- GeoSure Shrink-Swell 3D 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 shrink–swell at depth does not necessarily mean that a location will be affected by ground movement or subsidence and will not necessarily be propagated to surface. Such an assessment can only be made by inspection of the area by a qualified professional.
- Use of this data at depth i.e. for tunnels, cuttings, basements, foundations etc. should be used as advisory as a desk study aid and not as a substitute for a full site investigation.
- Shrink–Swell 3D geology at surface may not match DigMap geology due to minor inaccuracies when assigning a value at a 50m cell resolution.
- Shrink–Swell 3D values at surface may not be equivalent to Geosure Shrink–Swell values[1] due to the fact that Geosure is calculated for the top 5m and Shrink–Swell 3D is an ‘actual’ value at surface.

[***Note[1]*:** There is a 4.7% difference between the calculated values of Shrink–Swell 3D and GeoSure Shrink–Swell with a value of +/- 1 class difference or greater (2.5% with >2 classes)]

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