Product Release Note

Software	Groundwater Flood Map (National)
Version	High Resolution 5m V2.3
Author	Dr Maxine Zaidman
Date	June 2017

1 Introduction

Groundwater flooding is the term used to describe flooding caused by unusually high groundwater levels. It occurs as excess water emerging at the ground surface or within manmade underground structures such as basements. Groundwater flooding tends to be more persistent than surface water flooding, in some cases lasting for weeks or months, and it can result in significant damage to property.

JBA has developed a range of Groundwater Flood Map products at national scale. The high resolution product is based on detailed source datasets and also represents the relationship between peak groundwater levels and return period thus allowing the characterisation of risk for a specific flood return period. Processing is carried out on a 5m raster grid, although final outputs are represented in vector (polygon) format.

2 Product details: Groundwater Flood Map 5m Resolution v2.3

2.1 Description of product

The high resolution product provides a detailed assessment of groundwater flood hazard. The source data utilised, modelling technique applied and degree of calibration undertaken are commensurate with the enhanced resolution of the map. The modelling involves simulating groundwater levels for a range of return periods (including 75, 100 and 200-years). Groundwater levels are then compared to ground surface levels to determine the head difference in m; a zero head suggesting artesian discharge of groundwater at the ground surface. Head difference is defined on a 5m grid.

V2.3 categorises the head difference (m) into five feature classes (Table 1) **based on the 100-year model** outputs. Note that there is little variation in class designations between different return periods. This is because groundwater levels close to valley bottoms may not change significantly between different return periods (as they are capped by the ground surface) even though groundwater emergence rates may increase. Away from valley areas groundwater levels do change significantly between return periods, but peak levels are usually well below ground surface and therefore fall into the same risk category regardless of return period.

2.2 Data format

V2.3. is normally supplied as an ArcGIS feature class geodatabase (.gdb file) or ArcGIS shapefile (.shp).

2.3 Recommendations for utilisation

The product is suitable for general broad-scale assessment of the groundwater flood hazard in an area, but is not explicitly designed for the assessment of flood hazard at the scale of a single property. In high risk areas a site-specific risk assessment for groundwater flooding is recommended to fully inform on the likelihood of flooding.

2.4 Updates

JBA will update the map periodically as source datasets are updated or as more calibration data becomes available.

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Table 1 - Groundwater Flood Hazard Classification supplied as an additional layer in 5m v1.1

Groundwater head difference (m)*	Gridcode	Class label
0 to 0.025	4	Groundwater levels are either at very near (within 0.025m of) the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
0.025 to 0.5	3	Groundwater levels are between 0.025m and 0.5m below the ground surface in the 100-year return period flood event. Within this zone there is a risk of groundwater flooding to surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally.
0.5 to 5	2	Groundwater levels are between 0.5m and 5m below the ground surface in the 100-year return period flood event There is a risk of flooding to subsurface assets but surface manifestation of groundwater is unlikely.
>5	1	Groundwater levels are at least 5m below the ground surface in the 100-year return period flood event. Flooding from groundwater is not likely.
N/A	0	No risk. This zone is deemed as having a negligible risk from groundwater flooding due to the nature of the local geological deposits.
*Difference is defined as ground surface in mAOD minus modelled groundwater table in mAOD.		

3 Derivation

3.1 Methodology

The methodology used to derive the High Resolution Groundwater Flood Map v2.3 remains the Intellectual Property of JBA Consulting and is commercially confidential. The broad development stages were as follows:

- Use of an empirical hydrogeological model to derive the groundwater water table surface. This model takes account of topography, groundwater recharge volumes and spatial variations in in aquifer storage properties. Bedrock geology and superficial deposits are both considered, in the latter case the thickness of deposit being used to infer whether the bedrock exerts the greater impact on local / near-surface groundwater levels. Geology is categorised on the basis of the British Geological Survey DiGMapGB-50 and Superficial Deposits Thickness (1:50,000 scale) data.

- Application of the above model to determine the water table surface in a design groundwater flood. This involved determining the magnitude and spatial variations of the groundwater recharge volume associated with each design event based on an extreme value analysis of historical winter rainfall data. Steps in this process were:
  1. calculating how much excess rainfall would need to be absorbed by the ground during the course of a T-year return period winter (applied values of T include 75, 100 and 200 years);
  2. determining the effect of this rainfall on the location of the water table, taking into account the water-holding properties of the local rock strata;
  3. identifying where groundwater levels rise towards the surface; and the presence of local surface deposits that can stop water emerging at the surface;
  4. comparing the modelled water table heights to maximum recorded groundwater levels and validating the map based on areas historically affected by groundwater flooding.

  The rainfall loading applied to the model was determined through an analysis of gridded (50km) monthly resolution rainfall data for the whole of the UK. The source data used in this analysis was the 110-year long CRU TS3.2 dataset obtained under an Open Government Licence v3.0. Assuming that only rainfall over the December to February period inclusive contributes effectively to groundwater recharge, a series of cumulative winter rainfall totals was extracted for each year in the dataset (1901 to 2011) for each grid square. A statistical frequency analysis was applied to each series, using the GLO distribution to determine the peak cumulative totals for a range of design return periods for each 50km grid square. To increase the spatial resolution of this dataset to a more meaningful 1km resolution, a smoothing and spatial interpolation process was subsequent applied to the gridded estimates. This involved the application of a smoothing and adjustment algorithm calibrated using gridded annual rainfall totals (SAAR values) at 50km and 1km resolution respectively, to ensure any assumed downscaling was realistic and reflected expected spatial variations in rainfall.

- Defining the depth to groundwater based on differences between calculated groundwater levels and ground surface elevations, and defining groundwater flood hazard zones based on calculated depth to groundwater. Ground levels are based on the Airbus 5m digital terrain model.
- Calibration and checking of the flood hazard map comparing the modelled water table heights to maximum recorded groundwater levels and validating the map based on areas historically affected by groundwater flooding.

3.2 Contributory Datasets

Geology is categorised on the basis of the British Geological Survey DiGMapGB-50 and Superficial Deposits Thickness (1:50,000 scale) data. Ground levels are based on the Airbus 5m digital terrain model. These are used under licence with due royalties.

The following datasets inform the product:

1) Used under licence with due royalties

- British Geological Survey (BGS):
  - Digital geology mapping at 1:50,000 scale (DiGMapGB-50)
  - Superficial Deposits Thickness at 1:50,000 scale
- Airbus Defence and Spate Limited:
  - Bare earth digital terrain model from LiDAR supplied in 5m raster format

2) Public sector information licensed under the Open Government Licence v3.0.

- Environment Agency
  - Observed groundwater levels in selected monitoring boreholes
- Ordnance Survey
  - Digital Terrain Model (Terrain50)
  - Water features (Meridian 2 and VectorMap_Vector)
- University of East Anglia Climatic Research Unit (CRU)
  - CRU TS3.20 gridded month-by-month variations in climate (including rainfall) for 1901-2011 based on a 0.5x0.5º grid. See Jones, P.D.; Harris, I. (2013): CRU TS3.20: Climatic Research Unit (CRU) Time-Series (TS) Version 3.20 of High Resolution Gridded Data of Month-by-month Variation in Climate (Jan. 1901 - Dec. 2011). NCAS British Atmospheric Data Centre, *April 2013. See* http://catalogue.ceda.ac.uk/uuid/2949a8a25b375c9e323c53f6b6cb2a3a.

4 Use restrictions and disclaimers

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