P_24.9.1

Lancaster Level 1 Strategic Flood Risk Assessment – Climate Change Modelling

Draft Report

June 2021

www.jbaconsulting.com

LANCASTER CITY COUNCIL
Promoting City, Coast & Countryside

JBA project manager

Mike Williamson
JBA Consulting
Second Floor
Phoenix House
Lakeside Drive
Centre Park
Warrington
WA1 1RX

Revision History

Revision Ref/Date	Amendments	Issued to
Draft Report / 30 June 2021	-	Fiona Clark

Contract

This report describes work commissioned by Fiona Clark, on behalf of Lancaster City Council, by an email dated 21 December 2020. Lancaster City Council's representative for the contract was Fiona Clark. Jonathan Porteous and Laura Thompson of JBA Consulting carried out this work.

Prepared by .... Jonathan Porteous BSc MSc

Analyst

Prepared by .... Laura Thompson BSc

Technical Assistant

Reviewed by .... Kevin Frodsham BSc DipMath MSc PhD FGS ARSM

Senior Modeller

Purpose

This document has been prepared as a Draft Report for Lancaster City Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by Lancaster City Council for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to Lancaster City Council.

Carbon Footprint

A printed copy of the main text in this document will result in a carbon footprint of 49g if 100% post-consumer recycled paper is used and 63g if primary-source paper is used. These figures assume the report is printed in black and white on A4 paper and in duplex.

JBA is aiming to reduce its per capita carbon emissions.

Executive summary

JBA were commissioned by the Lancaster City Council in 2020 to deliver updated model deliverables for various models located in the Lancaster City Council region. These deliverables focused upon updating the modelled results in accordance with current climate change guidance, as required by the latest UKCP18 values.

For the study, a list of 12 models were selected to be updated and to produce updated modelled results and outlines to support the update of the councils current Level 1 Strategic Flood Risk Assessment (SFRA). It was not considered part of the project scope to update the models themselves with the goal of producing updated results only, i.e. no changes were made to model geometry, structure representation or model schematisation.

The standard modelling method of representing the effects of climate change by increasing the hydrological inflows by values according to UKCP18 guidance in the North West region, these equate to increases of 45%, 60% and 75% respectively which were applied to the 5% (4% if unavailable), 1% and 0.1% AEP design events. Some of the models supplied for this project were predominantly tidally influenced and as such these models were run for the 5% (4% if unavailable), 0.5% and 0.1% AEP design events. For these models, sea levels were risen by 11.2mm (Higher central) and 16.3mm (Upper end) for the 2096 to 2125 epoch, and by 1.01m (Higher central) and 1.41m (Upper end) for Cumulative sea level rise in the 2000 to 2125 epoch.

Final project deliverables include updated climate change model result files and cleaned GIS outlines of the flood extents and MapEdit processed GIS files. Below are some further details on the models included:

Of the 12 models supplied:

- 4 HEC-RAS (1D/2D)
- 1 ESTRY/TUFLOW (1D/2D within TUFLOW)
- 7 ISIS/TUFLOW (1D/2D)

Contents

Abbreviations

1D	One dimensional (modelling)
2D	Two dimensional (modelling)
1D-2D	Linked one dimensional – two dimensional (modelling)
AEP	Annual Exceedance Probability
ASCII	American Standard character set for information interchange
CC	Climate Change
DTM	Digital Terrain Model
EA	Environment Agency
ESTRY	1D modelling component of TUFLOW
FMPro	Flood Modeller Pro
FRISM	Flood Risk Metrics (JBA geographical processing tool)
GIS	Geographical Information System
HEC-RAS	1D-2D Modelling Software developed by the US Army Corps of Engineers
ISIS	Hydrology and hydraulic modelling software (precursor to FMPro)
LIDAR	Light Detection and Ranging
MB	Mass balance
RBD	River Basin District
TUFLOW	Two-dimensional Unsteady FLOW (hydraulic modelling software)

1 Lancaster SFRA Climate Change Modelling

1.1 Introduction

In 2021, JBA were commissioned by the Lancaster City Council to produce updated outputs for current climate change guidance to support an update of their Level 1 SFRA.

Previously, the effects of climate change (CC) on models were typically represented by increasing all the hydrological inflows by 20%. Current Guidance, released in March 2016, uses the location of the watercourse in relation to river basin districts to what the fluvial increases are to be applied[1]. Ahead of the publication of updated allowances in line with UKCP18 guidance, increases of 45%, 60% and 75% for the 2080s epoch were agreed with the EA to be representative of the Lune management catchment and were thus applied to each model. Additionally, one set of models was predominantly influenced by tidal risk with no fluvial impacts. As such, CC increases were applied to the tidal boundary for two epochs. Sea levels were raised by 11.2mm (Higher Central) and 16.3mm (Upper End) for the 2096 to 2125 epoch. Sea levels were raised by 1.01m (Higher central) and 1.41m (Upper end) for the cumulative sea level rise between the 2000 to 2125 epoch.

12 models in all were selected to be re-modelled with climate change uplifts. The models supplied were of varying ages and types and have been reviewed and run where possible to produce the desired deliverables.

1.2 Initial model screening

All models were subject to an initial screening to ascertain whether there were any obvious reasons as to why the model would be unlikely to run or produce appropriate results. This included:

- Missing model files (i.e. initial conditions)
- Missing units (i.e. hydrological boundaries)
- Unclear modelling units or methods (i.e. anything not clearly explained in the accompanying reports relating to how certain aspects of the model were built)

The initial screening revealed that several files were missing. These missing files were often able to be generated upon further investigation, so no further actions were required. Other reasons as to why a model may not be able to run were only discovered through further interrogation of the supplied data, most often when trying to run them, i.e. stability issues.

Some common issues which were encountered in multiple models:

- Lack of georeferenced model nodes/structures including any supplied gxy
- Limited or no use of scenarios/events in TUFLOW, which are now commonplace and often standard in contemporary modelling methods
- Path length issues i.e. too long, non-connected directories and drives
- Missing initial condition files
- Missing key commands in TUFLOW used for outputting ASCII grids and other desired 2D outputs
- TUFLOW initialisation or other FORTRAN errors

1.2.1 Supplied data

Of the 12 supplied models:

- 1 ESTRY/TUFLOW (1D/2D within TUFLOW)
- 7 ISIS/TUFLOW (1D/2D)
- 4 HEC-RAS (1D/2D)

---

1 https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1

1.3 Model Simulations

The model simulations followed a broadly similar process outlined below:

- General check of which data has been supplied, acts as an additional check if anything was missed in the initial screening and to familiarise the modeller with the folder structure.
- Create new inflow boundaries from the existing 5% (4% if unavailable), 1% and 0.1% AEP with the appropriate increases of 45%, 60% and 75% applied, typically by multiplying the scaling factors by 1.4 and so on. Any previous factors were multiplied by the same values before being applied to the inflows.
- Any models using bc_dbase's were updated also by the appropriate values.
- For tidal models, the effects of CC were calculated as a rise in sea level which was then applied to the appropriate boundary or dataset. These sea level rises were added to the 5% (4% if unavailable), 0.5% and 0.1% AEP events. Sea level rises of 11.2mm (Higher central) and 16.3mm (Upper end) were modelled for the 2096 to 2125 epoch, whilst rises of 1.01m (Higher central) and 1.41m (Upper end) were modelled for cumulative sea level rise in the 2000 to 2125 epoch.
- New model run files were created for the CC runs.
- Folder structure and naming convention was kept the same to match the original model format as close as possible.
- Checks were performed on the completed models, comparing maximum stage, final cumulative mass balance (MB), 2D water level grids and animation plots.
- Post-processing of results is further detailed in Section 1.4 Results.

Further information related to each individual model can be found in an accompanying technical note in Model Appendix 3

1.4 Results

All the modelled results and outputs from this study can be found in Model Appendix 1: Model Deliverables. The modelled flood outlines for climate change are presented on the SFRA maps in Appendix A.

1.4.1 Model Results Files

The main deliverables of this study consist of the updated model results, including outputs from Flood Modeller/TUFLOW and HEC-RAS. The former being namely 2D ASCII grids for depth, water level, velocity and hazard. 2D depth ASCII grids have been produced for this study.

1.4.2 GIS Outlines

GIS polygons in shapefile format were supplied for each modelled design event, modelled scenario and model. These were produced by converting ASCII grids into polygons using FRISM (an in-house JBA geoprocessing tool). These outlines were merged into a single part polygon and 'geometrically cleaned' to remove any dry <200m^2 and wet island <10m^2.

1.5 Limitations, recommendations and conclusions

This study has produced updated flood extents including depths, level, hazard and flow grids for where models had a 2D component.

The main limitation to this study is that the models and model results have not been formally reviewed by the Environment Agency, at this stage. Additionally, the hydrology for each model has not been updated for this study. With some of the models dating as far back as 2009, it is not the ideal starting point from which to run new CC uplifts, however it was beyond the scope of this study to update the hydrology for each model.

All of the supplied EA models were able to be run through, however for several of the models, the 0.1% AEP events plus climate change simulations were unstable and could not be run. Best efforts were made to run these models without drastically altering the existing mode for these events, however the models would require too much work to stabilise them, which was beyond the scope of the study. Some did have issues with regards to missing data, unclear scaling factors used in the original hydrology or severe instability within the model. With these cases, further investigation of these models was required for them to be run.

Model Appendices

1 Model Deliverables

2 Model Log

3 Technical Modelling Note

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

Registered Office
1 Broughton Park
Old Lane North
Broughton
SKIPTON
North Yorkshire
BD23 3FD
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
www.jbaconsulting.com
Follow us:

Jeremy Benn Associates Limited

Registered in England 3246693

JBA Group Ltd is certified to:
ISO 9001:2015
ISO 14001:2015
ISO:45001:2018