Central Lancashire Level 1 SFRA - Appendix F

Climate Change Modelling

Final

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Contents

Executive Summary

JBA were commissioned by Preston City Council, on behalf of the Central Lancashire Local Plan Team in 2023 to deliver climate change uplifted models for various watercourses located in the Central Lancashire 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 24 models were selected to be updated and to produce updated modelled results and outlines. 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, which were applied to the 3.3% (2% if unavailable) and 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 3.3% (2% if unavailable), 0.5% and 1% AEP design events. For these models, sea levels were risen by 1.01m (Higher central) and 1.41m (Upper end) for Cumulative Sea level rise in the 2000 to 2125 epoch.

Out of the requested models to update, some have been ruled out for various reasons, such as being outside of the Central Lancashire area, having unreferenced geometry, or missing data. A full list of the models that could not be run are listed in Section 6.2 of the SFRA report.

1 Central Lancashire Climate Change Modelling

1.1 Introduction

In 2023, JBA were commissioned by Preston City Council, on behalf of the Central Lancashire Local Plan Team, to produce updated model outputs in line with current climate change guidance.

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]. Additionally, some of the models were predominantly influenced by tidal risk. As such, CC uplifts were applied to the tidal boundaries to represent the Upper End and Higher Central allowances for the cumulative rise from 2000 to 2125.

Figure 1-1 shows the locations of available models that were considered for this study. 32 models in all were initially assessed for suitability. An initial review of the modelling found that some models were overlapping, or the same area was covered by more recent modelling. Some others were found mostly, or entirely, outside of the Central Lancashire boundary, incomplete or not georeferenced. The ones with missing data files have been reported back to the Environment Agency, with some having been completed and updated. A few models could not be updated due to severe instabilities.

23 models were selected to be re-modelled with climate change uplifts. This figure omits the models which had been found as incomplete and for which the EA could not provide the missing data. The models supplied were of varying ages and types and have been reviewed and run where possible to produce the desired deliverables.

1 Flood risk assessments: climate change allowances

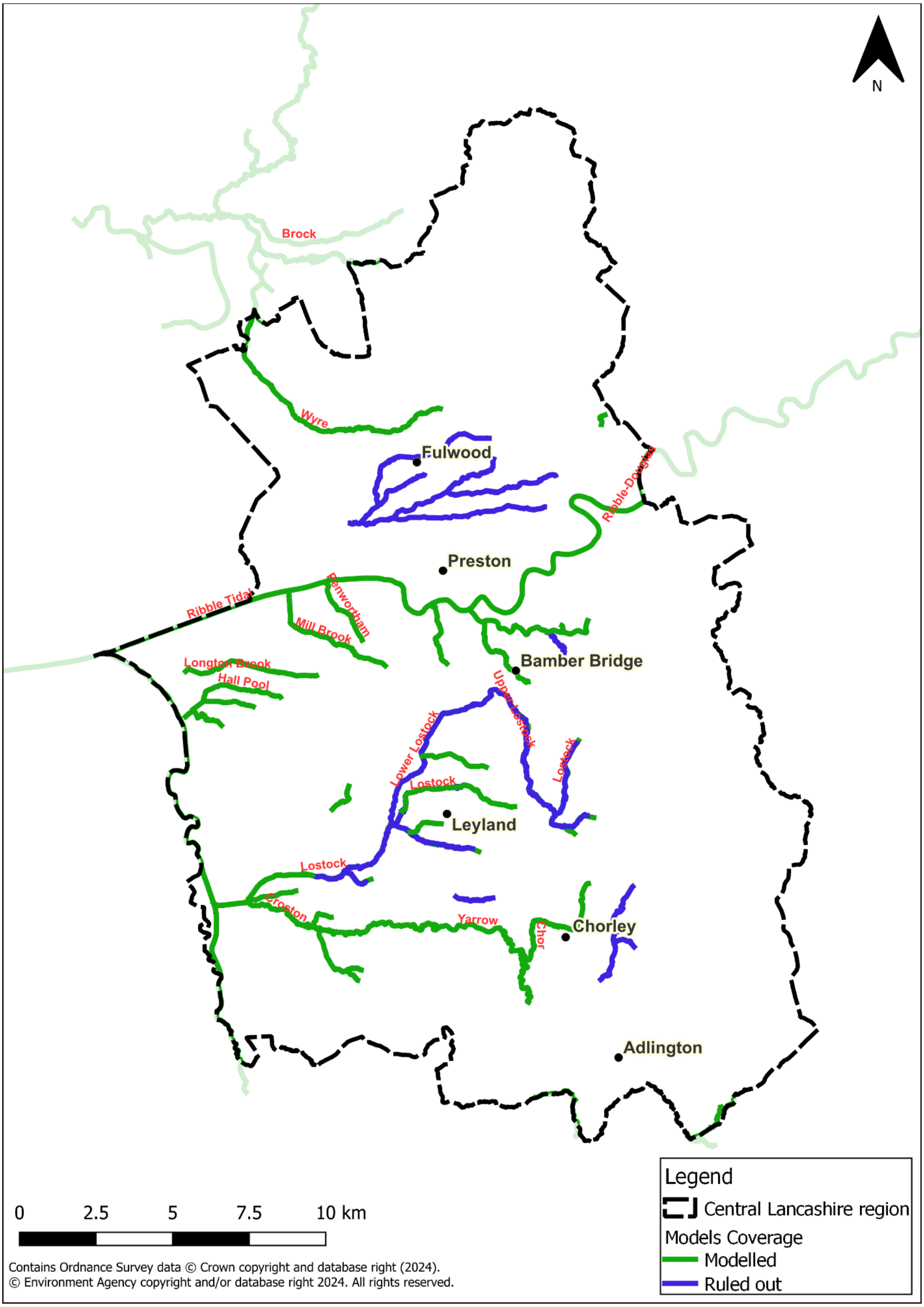

Figure 1-1 Location of models within Central Lancashire

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., both 1D run and results, geometry files)
- 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)
- Incompatible modelling software

For all models we tried to run the Q100 present day event in a QA process meant to identify any issues, like high instabilities, crashes, or missing data. During this QA process we checked for:

- water level progression in the long profile for the 1D models, looking for unusual variations
- model convergence, particularly where convergence and iterations tolerances reported in the .bmp files for the 1D models were exceeded, unusual spikes in inflows/outflows
- inspected the 1D results files (.zzd) for warnings and errors that could lead to erroneous water level calculation
- water level contained in cross-sections for the 1D models, dflood variable exceedance
- compared flood outlines against existing runs
- particularly for the 2D models or domains, checked on mass error and negative depths occurrences
- unusual bumps in the water level and velocity rasters for the 2D models or domains

The initial screening revealed that several models were unable to be run. For some models, missing files were able to be generated upon further investigation, so no further actions were required. Where missing files were not able to be generated, these were requested from the Environment Agency (EA). 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:

- Limited or no use of scenarios/events in TUFLOW, which are now commonplace and often standard in contemporary modelling methods
- Missing files, i.e., ied files which contain the event data/hydrology to be used in the model
- Missing key commands in TUFLOW used for outputting ASCII grids and other desired 2D outputs

- Model instabilities, particularly negative depths in the 1D domain which can cause the model to crash.

Where possible, missing files were re-created based on existing data and re-runs, i.e., event data files. Some issues related to software updates or models having been moved from their original location were sorted by editing the simulation control files, most commonly to avoid TUFLOW error 0004 reporting on outdated MI files.

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 3.3% (2% if unavailable) and 1% AEP with the appropriate peak flow increases applied, typically by multiplying the scaling factors. Any previous factors were multiplied by the same values before being applied to the inflows.
- Any models using bc_dbase repositories were updated also by the appropriate values.
- For tidal models, CC uplifts were applied to the tidal boundaries to represent the Higher Central and Upper End allowances for the cumulative rise from 2000 to 2125. These uplifts level rises were added to the 3.3% (2% if unavailable), 1% and 0.5% AEP events.
- Present day events were re-modelled with the latest/newer versions of the software. New model run files were created in all cases.
    - TUFLOW 2020 and 2023 versions were used
    - Flood Modeller versions 4, 5 and 7 were used
- 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, flood extents and animation plots across the scenarios and events of the same model.
- Post-processing of results is further detailed in Section 1.4.

1.3.1 Climate change uplifts

Table 1-1 notes the recommended peak flow uplifts for the management catchments covering the Central Lancashire area. The location of each model was assessed and assigned a management catchment, and the respective peak flow uplift percentages were applied.

Table 1-1 Recommended peak river flow allowances for the Wyre, Ribble and Douglas management catchments

Management catchment	Allowance category	Total potential change anticipated for peak river flows (based on a 1981 to 2000 baseline)		
		2020s (2015-2039)	2050s (2040-2069)	2080s (2070-2125)
Wyre	Upper end	29%	44%	67%
	Higher central	22%	29%	44%
	Central	18%	23%	35%
Ribble	Upper end	27%	44%	71%
	Higher central	19%	29%	46%
	Central	16%	23%	36%
Douglas	Upper end	24%	45%	79%
	Higher central	15%	26%	47%
	Central	12%	19%	35%

For the tidal models, the tidal curves have also been updated for the climate change scenarios. Tidal curves were generated for the higher central and upper end cumulative rise from 2000 to 2125, in line with the recommended best practice.

1.4 Results

Post-processing of results consisted in:

- Converting the raster grids into flood outlines as shapefiles, for the 2D models.
- For the 1D models (where a raster grid is not output through modelling), we first extended some of the cross-sections in the model's geometry to ensure enough coverage of the DTM around the 1D domain, then the peak water levels calculated at each 1D node were interpolated into a continuous water surface and intersected with the DTM, retaining the surface water above the DTM elevation. The newest and most accurate available DTM was used (1m resolution), publicly available on gov.uk. As a last step, all unconnected patches in the water surface were carefully inspected and removed where we found there would be no natural connectivity to the main body water in the 1D domain.

Typically, for each model resulted 5 different outlines (2 present day events, the 3.3% AEP event plus the Higher Central CC allowance and the 1% AEP event with the Higher Central and Upper End CC allowance). For models where Defended /Undefended scenarios were modelled separately, the defended scenario was run for the 3.3% AEP event and the undefended scenario was ran for the 1% AEP event.

For models with tidal curves, the Upper End and Higher Central sea level rise allowances for the cumulative rise from 2000 to 2125 were modelled. This resulted in an additional set of results for each climate change uplift. Models with a tidal element typically resulted in 13 different outlines:

- The **present day**:
    - Functional floodplain (3.3% AEP event or 5% where unavailable)
    - 1% AEP event
    - 0.5% AEP event
- The 3.3% (where available), 1% and 0.5% AEP events plus **Higher Central** peak river flow climate change allowance with:
    - The Higher Central sea level rise allowance for the cumulative rise from 2000 to 2125
    - The Upper End sea level rise allowance for the cumulative rise from 2000 to 2125
- The 1% and 0.5% AEP events plus **Upper End** peak river flow climate change allowance with:
    - The Higher Central sea level rise allowance for the cumulative rise from 2000 to 2125
    - The Upper End sea level rise allowance for the cumulative rise from 2000 to 2125

The climate change uplifted flood outlines are shown on the SFRA interactive maps.

For the Ribble-Douglas 2010 model, Ribble-dominant and Douglas-dominant events had been set up in the model. This meant for each flood event, there were two model scenarios to run. This model also has tidal curves. Therefore, in total, 26 flood outlines were created. These outlines are exactly as explained above but with a Ribble-dominant and Douglas-dominant scenario for each flood event.

1.4.1 Model results files

The main outputs of this study consist of the updated model results, including outputs from Flood Modeller/TUFLOW, these being 2D ASCII grids for depth, water level, velocity, and hazard.

1.4.2 GIS outlines

GIS polygons in shapefile format were derived for each modelled design event, scenario, and model. These were produced by converting ASCII grids into polygons using QGIS for the 1D-2D models or using the 1D Mapping Tool in Flood Modeller for the 1D only models.

1.5 Limitations, recommendations, and conclusions

This study has produced updated flood extents for both 1D and 2D models.

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 2003, 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. Additionally, the older the model the higher the chances that the geometry may have changed (cross-sections geometry may have altered due to new works, natural channel aggradation or degradation or even river restoration projects or structures may have been added or removed). The LIDAR which is utilised in the models is dated and there is likely new updated LiDAR available.

In some instances, the 3.3% AEP hydrology was not available with the provided (existing) model so the closest available was used, typically 2% AEP as a proxy.

Particularly for the 1D only models, the intersection between the peak water surface calculated in the 1D model and the DTM gives far less accurate results than the actual 2D modelling using the same DTM, therefore we recommend using these results as a proxy only, envisaging to reconstruct the model as 1D-2D (outside the scope of this project).

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