MEMO

To: Sher Khan

Cc:

From: Antoinette Tan

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Subject: Kerikeri Model Update & Reruns

Northland Regional council (NRC) have requested some updates to be made to the Kerikeri MIKE FLOOD model, to improve the accuracy of the water level predictions and the waterRIDE mapping. The model was run for the three baseline scenarios 10 year, 50 year and 100 year with climate change, but it was not run for the three special spillway options which were delivered previously. This work follows on from the Kerikeri model update that was completed by DHI in May of 2017.

waterRIDE Mapping

The waterRIDE mapping was completed by Tonkin + Taylor as subcontractors to DHI. NRC identified some issues with the mapping that they requested improvement on. These issues were:

- Water levels are unrealistic on the right bank floodplain near Golf View road and Amokura drive, the water levels are mounding in the area which appears unrealistic when observing the raw model results.
- Flood extent shapefiles and the rasters of water levels were not lining up with each other.
- The flood extent was not stretched and smoothed, and holes and islands were not removed in the processed results. Some 1D river channels were not included in the flood extent.

The following processing has been undertaken to fix the issues above:

1. 1D/2D results were converted from the three Kerikeri model scenarios to waterRIDE format. This involved:
    - Converting three Mike 11 scenarios results to 2D using waterRIDE. 1D result cross sections (based on maximum dx set in the Mike 11 network) were manually adjusted so that cross sections do not overlap, and so that 1D results cover the river voids in the 2D mesh domain.
    - Converting three Mike 21 Flexible-Mesh scenarios results to waterRIDE format
    - Extrapolating the outputs from 1) to establish flood extents. Note that this was done using the automated procedures only.
2. Additional post-processing of outputs included:
    - Smoothing of flood plain and
    - Removing small holes (dry islands) in the flood plain (less than 200m^2)
3. Deliverables include the following:

- waterRIDE files for all the three scenarios
- Shapefiles of flood extents mapped to a 1m DEM.

The following assumptions were made when processing the waterRIDE outputs.

- The results have been post-processed using the DEM provided without applying any XY global adjustment.
- The 1D post-processed flood extent and curvature of the 1m DEM has not been manually assessed. The accuracy of extents/curvature relies on the way the 1D network and the mesh river voids have been digitised.
- Combining the 1D and 2D flood extents has been carried out using the automated procedures only.
- Manual editing of flood plains has only been allowed for where:
  - Breaks or discontinuation in results occur
  - Interpolation of 1D cross sections causes negative depths
  - Lateral link connections are skewed and flooding in 2D does not correspond with bank level flooding in 1D.

Improving accuracy of the model

The MIKE FLOOD model has the main channels modelled in the 1D MIKE 11 model and the floodplains modelled in the 2D MIKE 21 FM model. NRC have identified a number of locations where the water level results are not matching between the 1D model and the adjacent 2D floodplain. These differences occurred at levels where the water levels in the two models should have equalised. Upon investigation, it was discovered that depth tolerances used in the lateral linkages were set higher than necessary, and that this, along with some lateral link connection skewing, was contributing to the large differences in adjacent 1D/2D water levels.

Lateral links facilitate the flow of water between the 1D and 2D models. For these links, a Depth Tolerance factor is used to smooth flow direction change transitions by adjusting the equations used when the water level difference falls below the specified value; this helps to prevent numerical instabilities in the model. Depth tolerances of 0.2m and 0.3m had previously been used in the model, but in this update, we were able to universally reduce this parameter to 0.1m.

To address the issue of lateral link skewing, numerous lateral links were broken into smaller lengths, with particular attention paid to confluences and meandering segments. The original model contained 222 distinct lateral links, while in the updated model there are now 342.

NRC identified the Lake Manuwai and Pangaere Stream branches to be of particular concern in regard to water level results, with differences of up to a 1 metre noticed between the 1D and 2D 100yr results. With the additional lateral link segments, and adjusted depth tolerance parameters, re-running the 100yr simulation produced 1D/2D water levels that were typically within a 0.1m range. The 50yr and 10yr results showed similar consistency.

	Old Model			Updated Model		
Branch/chainage	1D Levels	2D Levels	Difference	1D Levels	2D Levels LB/RB	Difference
Lake Manuwai 1191m	128.38	127.9	0.5m	128.95	128.91/128.97	0.04m
Pangaere 1961m	130.6	129.6	1.0m	13.31	130.31/130.40	0.09m
Pangaere 2221m				129.80	129.85/129.81	0.05m
Pangaere 3004m				128.55	128.60/128.51	0.05m
Pangaere 4118.5m				126.67	126.68/126.67	0.02m
Pangaere 5462m				125.07	125.02/125.11	0.05m
Pangaere 6200m				122.91	122.90/122.83	0.07m

Pangaere 1961m to 6200m	Conflicting levels in this section of the river	Levels typically consistent within 0.1m

Along with the updates to the lateral links the model was checked to ensure overall stability and sensibility of results. The model was run using the MIKE 2016 version with Service Pack 3 which differs from the earlier work, which was run with an earlier MIKE version.

Checks were made in the MIKE 11 model to assess the areas with the largest fluctuations in discharge, these were located at some of the weir structures but were localised issues and did not appear to be impacting the water levels or generating any significant amount of water to invalidate the model results. Some areas where discontinuities in water level were observed in the old results were not present in the new results, indicating that the update of the model version and the lateral links has improved the results overall.

Two areas of concern in the model still remain which relate to the model schematisation. The first is at the upstream end of the Maungaparerua Stream and the Pungaere Stream where the floodplain extends to the model boundary, Figure 1. Because of this the model may be overpredicting water levels at these two locations and care should be taken when interpreting results in these areas. The other point of concern is at the downstream boundary where the 2D model does not include an outflow boundary, all water is instead bounded by the MIKE 11 model. This area would operate better if the 1D model ended with a standard link to the 2D and the tide boundary was controlled solely by the 2D model. Alternatively, the 2D coastal boundary may not need to be explicitly modelled and all flow could be directed into the 1D model and this used as the sole boundary instead. We do not believe that these issues will have significant implications to the model results, however it is recommended that these could be improved the next time the model is updated.

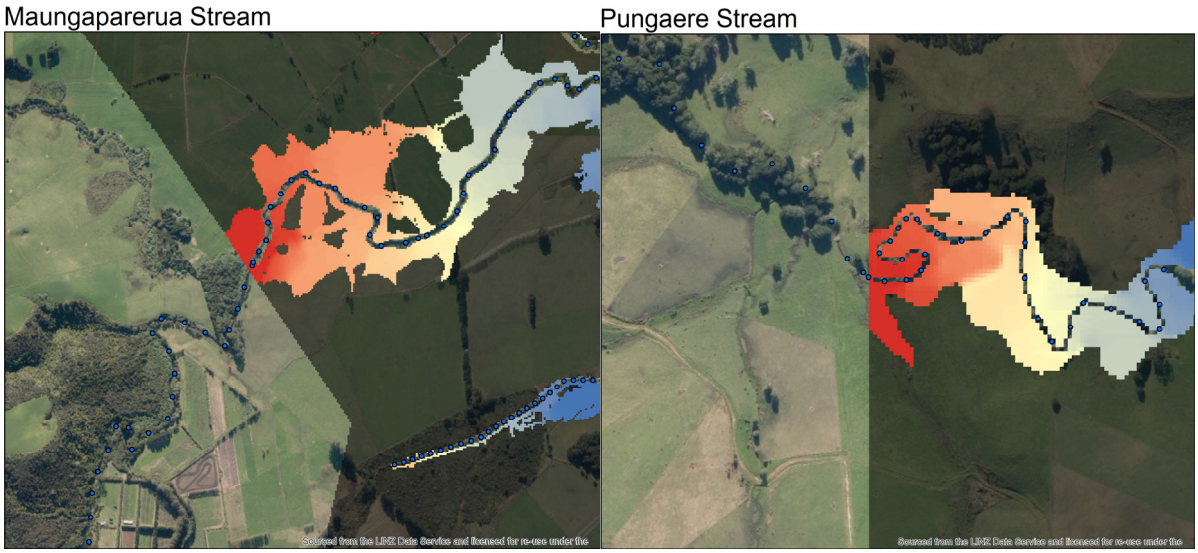

Figure 1: Flood results hitting upstream model boundary

Overall the updates applied to the model have improved the model accuracy and the results will be more reliable for use in setting floor levels etc.