MEMO

TO	TWT Whaitua Expert Panels and Committee
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DATE	30 January 2020

FOR YOUR INFORMATION

Predicted impacts of climate change on key hydrological statistics

This memo provides a summary of predicted hydrological outcomes for streams and rivers in the Te Whanganui a Tara Whaitua under different climate change scenarios. It is intended to help inform Whaitua Committee decision making and be a reference document for Expert Panels reporting to the Committee.

Background

In 2017, a report titled *Climate change and variability – Wellington region*[1] was prepared by NIWA (Pearce et al 2017) for GWRC. The report used downscaled results from global climate models to predict future outcomes across the region for a range of biophysical variables and environmental impacts. Summary findings from the main technical report have subsequently been reported[2].

One of the impacts the NIWA report looked at was the likely change in river flows under various emission pathways for two future time slices, mid-century (being 2036 to 2056) and late century (2086 to 2099). Downscaled climate projection data were input to a TopNet runoff model to generate predictions for three key flow statistics, **mean annual low flow** (MALF), **mean flow** and **mean annual flood** (MAF). Results were aggregated to Strahler Order 3 reaches of the River Environment Classification (REC). Pearce et al (2017) provide further discussion on the methods and approach taken to the hydrology modelling and the associated uncertainty.

This memo takes a closer look at some of the original modelling outputs and provides a little more commentary than previous reporting on the distribution of results within the Te Whanganui a Tara Whaitua. The base hydrological modelling data for this exercise were provided by NIWA (as REC attribute tables).

1 https://www.gw.govt.nz/assets/Climate-change/Climate-Change-and-Variability-report-Wlgtn-Regn-High-Res-with-Appendix.pdf
2 For example, https://www.gw.govt.nz/assets/Climate-change-2/WhaituaClimateChangeprojections.pdf

Results

Figures A1 to A3 provide maps showing river reach predictions for MALF, mean flow and MAF for the Te Whanganui a Tara Whaitua. These are essentially reproductions of the maps in Figures 6-14,6-15 and 6-16 of the Pearce et al (2017) full report, but with spatial and legend scaling to enable further distinction of patterns in the Whaitua area. Two emissions pathways (4.5 and 8.5) are presented for each time slice in alignment with the choices made for broader Whaitua Committee decision-making.

A key presentation difference is that in this memo any departure from baseline of less than 10 per cent *in either direction* (ie increase or decrease) has been grouped into the same category for mapping, although split out in histogram form. This mapping category describes changes that, in terms of absolute flow rates, are slight enough so as to be barely detectable through standard gauging techniques, a benchmark commonly used when considering whether a change might be significant from an effects point of view. The full report maps zero (no change) and then two wide categories on either side (0 to 20 percent increase or decrease). Both versions have some merit depending on the interpretations relating to yield or instream consequences that are being made.

Mean annual low flow (MALF)

Figures 1 and A1 show how MALF is expected to change under moderate and high emission pathways in spatial and histogram form.

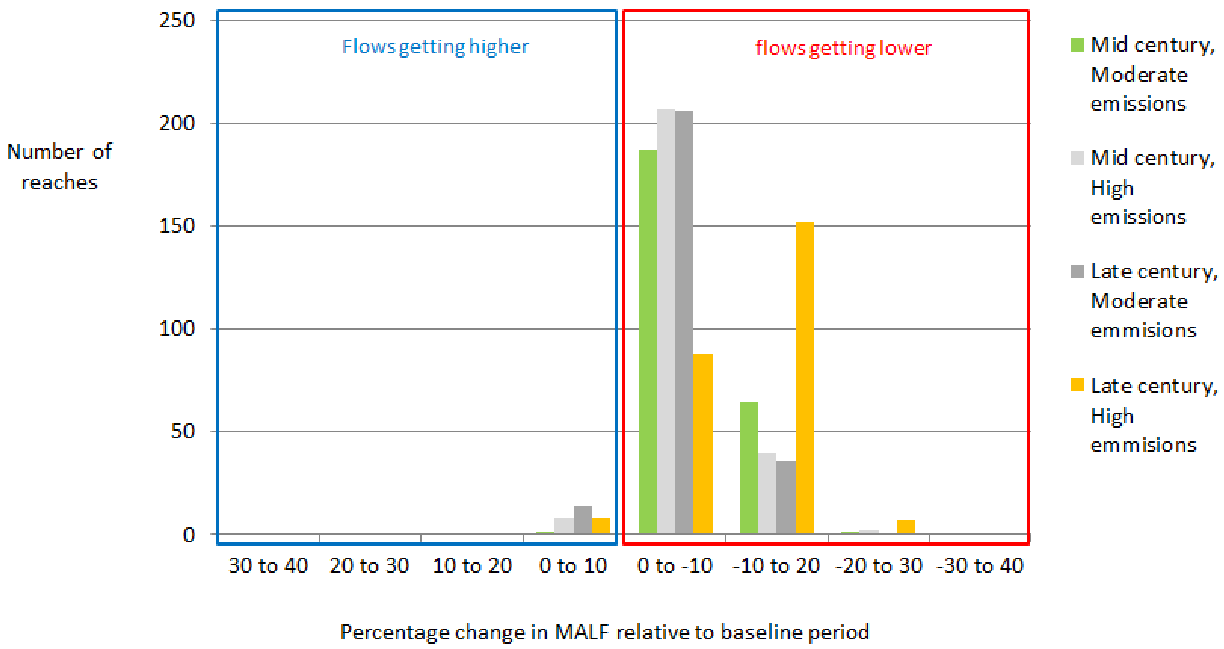


Figure 1. Histogram showing number of reaches in the Te Whanganui a Tara Whaitua in each category of percentage change in MALF relative to baseline period (multi-model median change).

Key points from both figures are:

- MALF is expected to reduce across all catchments and under all modelled scenarios of the Whaitua (only a very small number of reaches – less than 10 – show a marginal increase under the highest emission scenario at late century);
- Under three of the four modelled scenarios (those relating to mid-century and/or moderate emission pathways) a large majority of reaches have predicted MALF reductions of less than 10 per cent. In the late century, high emission pathway scenario there is a shift to the large majority of reaches having MALF reductions of 10 to 20 per cent (highlighted in Figure 1);
- One reach, a tributary of the Mangaroa River, has a predicted MALF reduction of 20 to 30 per cent under three of the four scenarios. Five other reaches in the same general part of the Whaitua also fall into this category but only under the late century, high emission scenario;
- In general terms, MALF is predicted to decline more in the central and eastern catchments (Hutt, Wainuiomata, Orongorongo) than the western catchments, mainly the small stream catchments around the Wellington peninsula.

Mean discharge

Figures 2 and A2 show how mean discharge is expected to change under moderate and high emission pathways in spatial and histogram form.

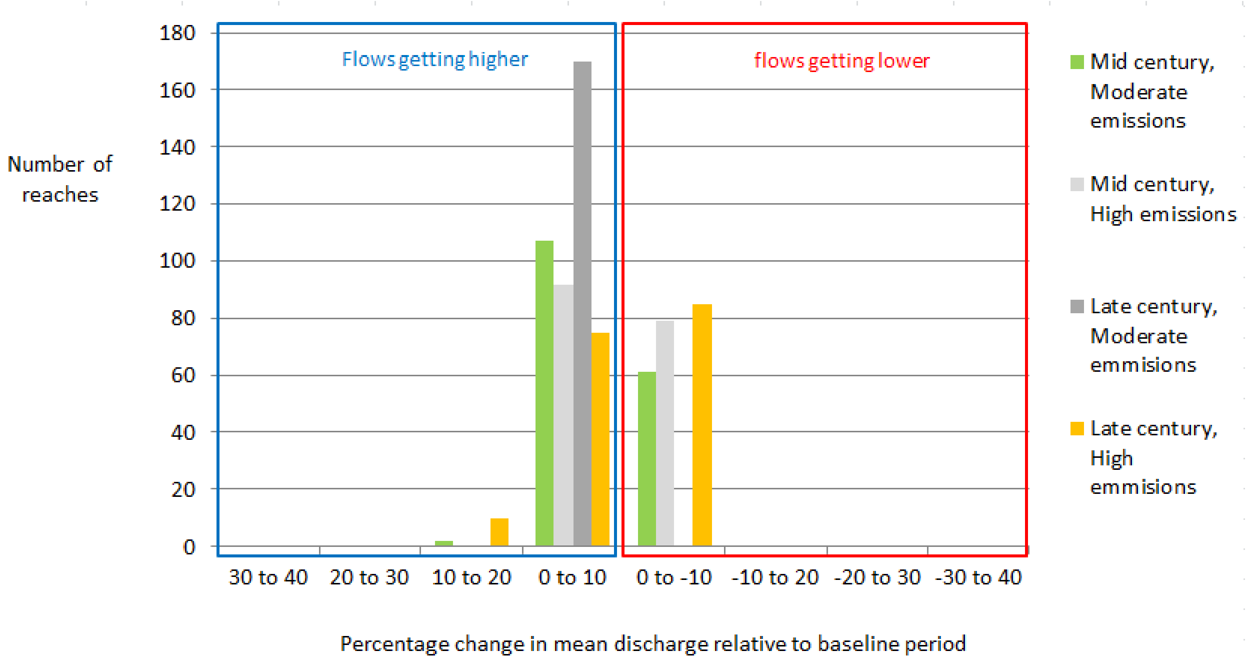


Figure 2. Histogram showing number of reaches in the Te Whanganui a Tara Whaitua in each category of percentage change in mean discharge relative to baseline period (multi-model median change).

Key points from both figures are:

- Predicted changes in mean discharge are relatively modest (essentially within 10 percent of the baseline period) across all scenarios and across all parts of the Whaitua;
- Under the mid-century, moderate emission scenario more reaches are predicted to have slightly increased mean discharge than decreased and the opposite is true for the late century, high emission scenario;
- In general terms, the declines in mean discharge are predicted to occur more in the central and eastern catchments (Hutt, Wainuiomata, Orongorongo) and increases in the western stream catchments, including those around the Wellington peninsula. This spatial pattern is shown clearly in the full report (Figure 6-14) although, as noted above and highlighted in Figure A2, care should be taken in reading too much into this as the differences are marginal either way from baseline.

Mean annual flood (MAF)

Figures 3 and A3 show how MAF is expected to change under moderate and high emission pathways in spatial and histogram form.

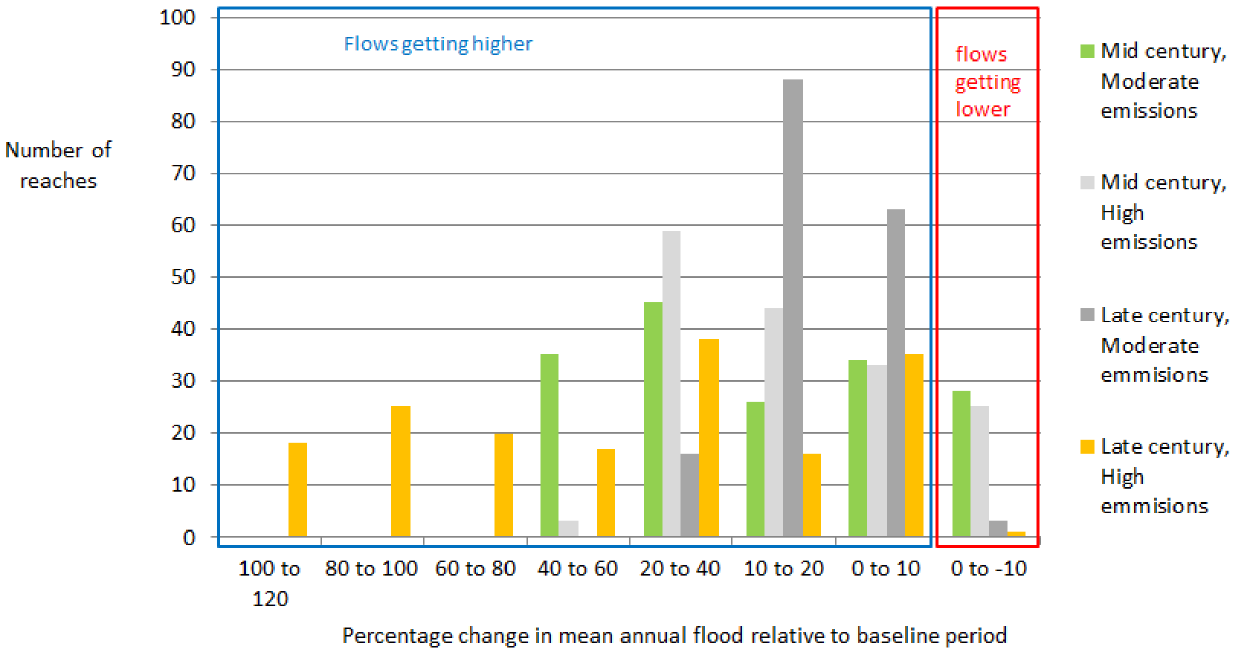


Figure 3. Histogram showing number of reaches in the Te Whanganui a Tara Whaitua in each category of percentage change in MAF relative to baseline period (multi-model median change).

Key points from both figures are:

- MAF is expected to increase almost exclusively across all catchments and under all modelled scenarios of the Whaitua;
- Increases in MAF are predicted to be greater than 10 per cent in a large majority of reaches across all scenarios;
- The Hutt catchment and tributary rivers stand out as having the most modest changes while the southwest streams are predicted to increase by more than 40 per cent under moderate emission mid-century scenarios and 60 to 120 percent in the higher emission scenarios;

Summary

Commentary in this memo is consistent with that reported elsewhere but provides a little further nuance to assist with using the climate change projections in Whaitua decision making on river outcomes.

A key point of difference relates to the impression formed here about MALF predictions compared with those formed previously from the Pearce et al (2017) report. For example, predicted decreases in MALF of up to 40% have been reported[2] for the Te Whanganui a Tara Whaitua. While this is not technically incorrect (based on the outer bound value of wide bands of change previously reported), the impression here is one of more modest decline. Very few reaches have MALF declines of greater than 20 per cent (less than 10 out of 250) and none of these was over 30 per cent. The large majority of reaches under the most extreme scenario were in the range 10 and 20 per cent reduction from baseline.

In providing this additional interpretation it is not forgotten that the overall uncertainty associated with hydrological modelling from downscaled climate change models is high (see Pearce et al 2017) and care should be taken to not overstretch on conclusions from any of the predictions.

Figure 1. Predicted change in MALF (multi-model median percentage change from present day)

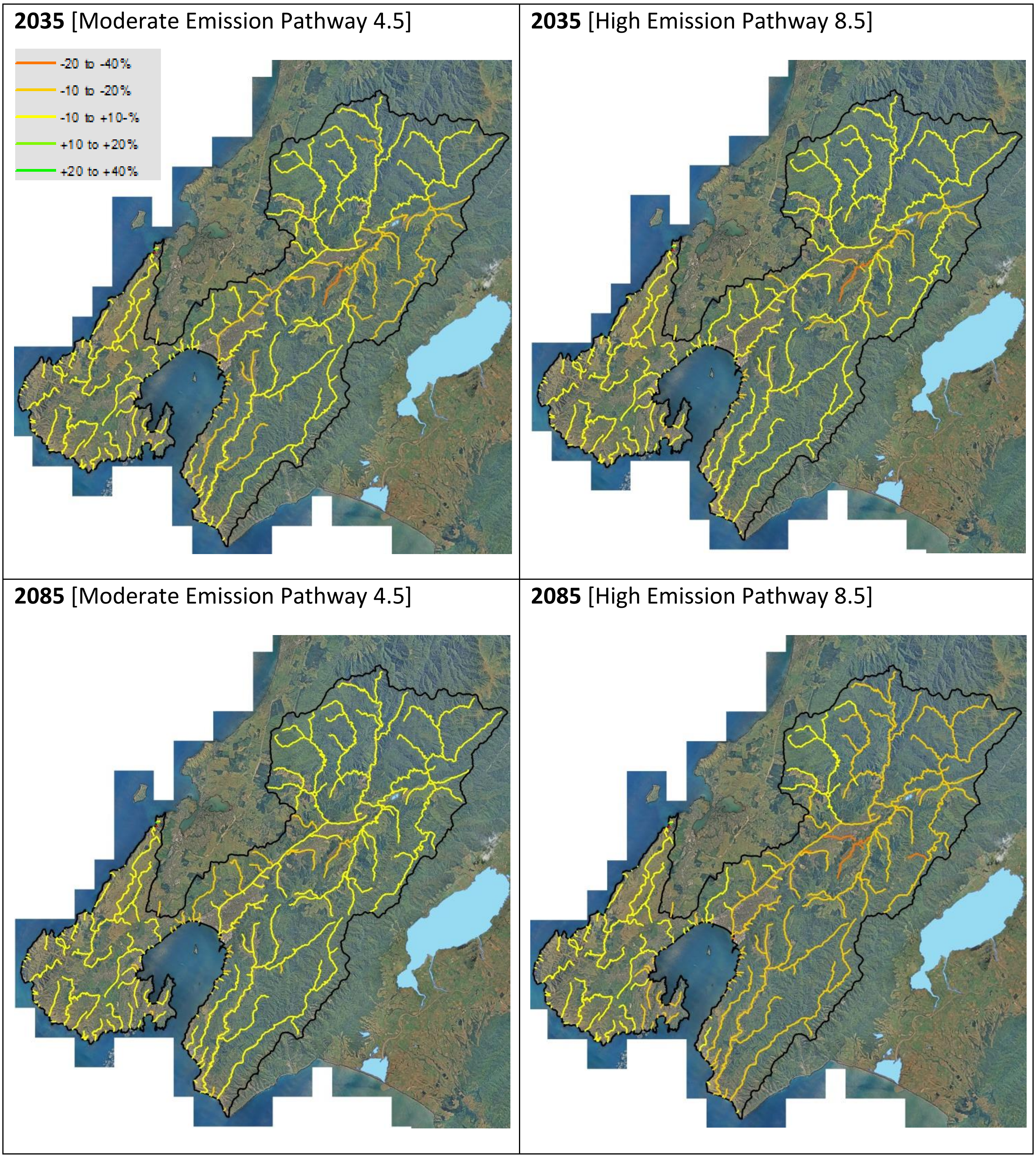
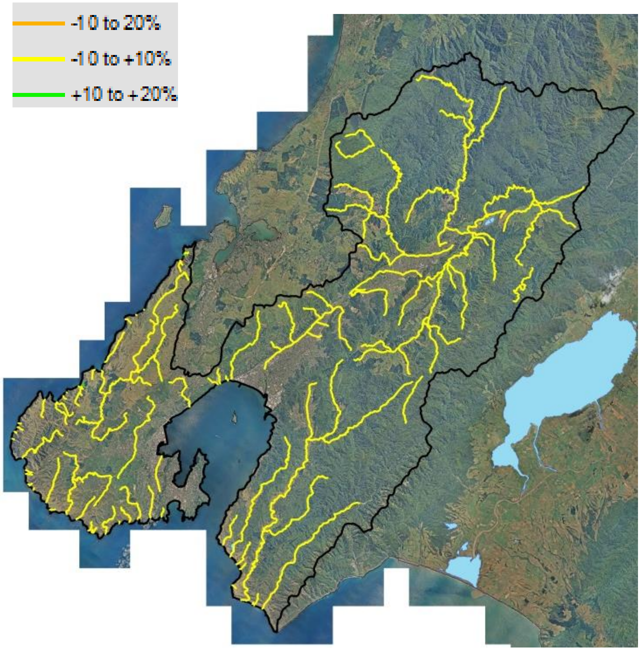
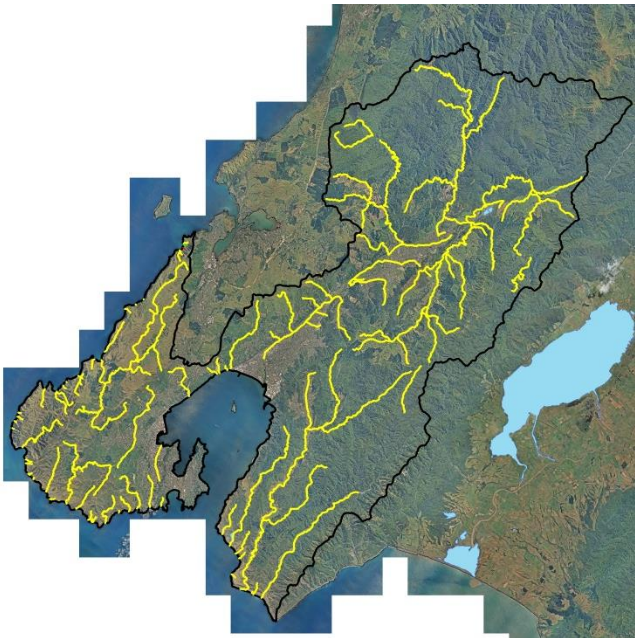


Figure 2. Predicted change in mean discharge (multi-model median percentage change from present day)

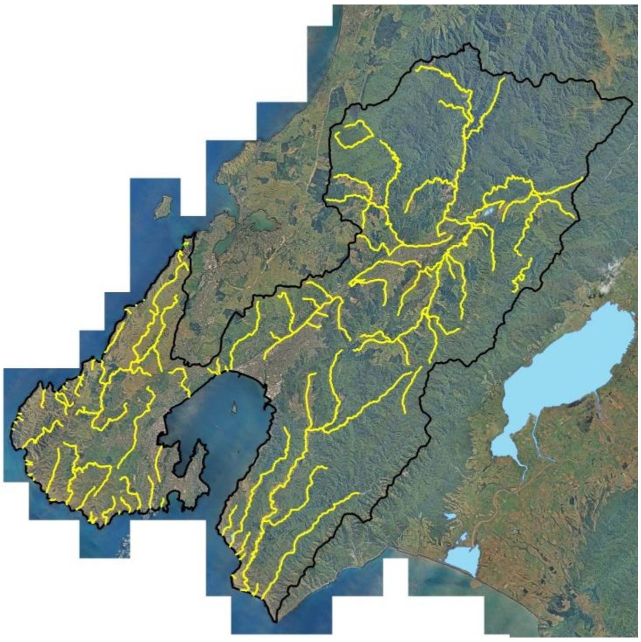
2035 [Moderate Emission Pathway 4.5]



2035 [High Emission Pathway 8.5]



2085 [Moderate Emission Pathway 4.5]



2085 [High Emission Pathway 8.5]

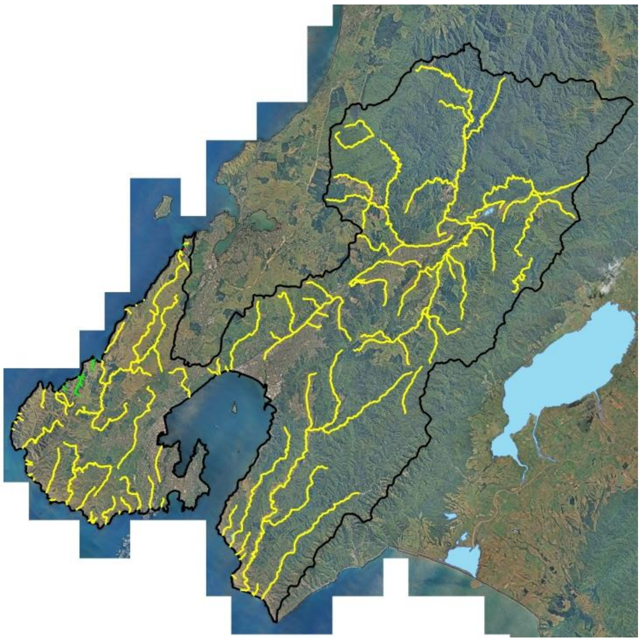
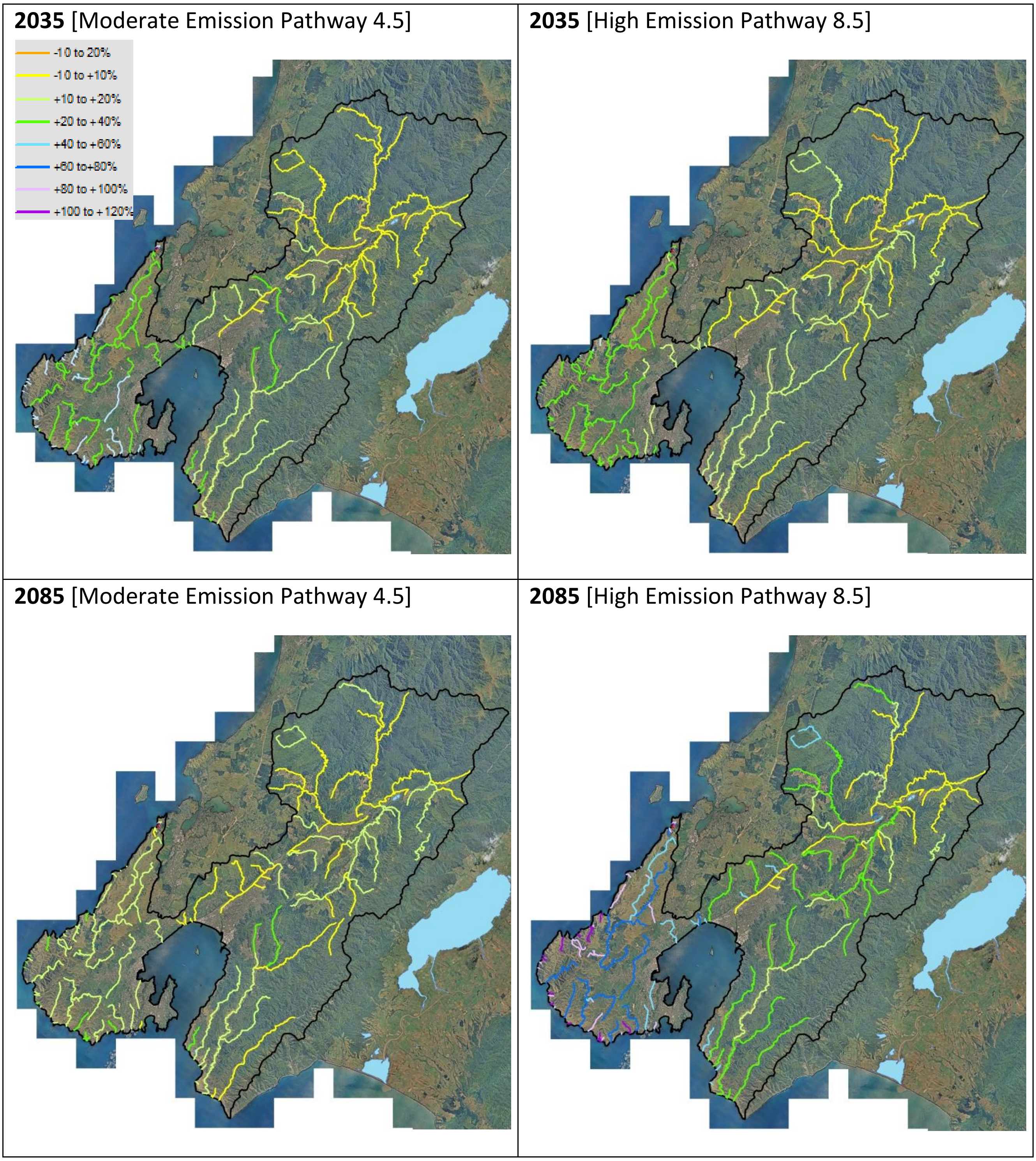


Figure 3. Predicted change in mean annual flood (multi-model median percentage change from present day)



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