# CHES FOR THE GREY RIVER CATCHMENT

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## Aims

CHES (Cumulative Hydrological Effects Simulator) is a NIWA developed ArcGIS add-in that simulates stream flows across a catchment resulting from consented abstractions under given abstraction rules. CHES is then able to model instream and out of stream attributes, such as fish habitat availability and reliability of water supply. This tool has been applied to the Grey River Catchment (South Island, New Zealand) under a Community Engagement Fund project with the West Coast Regional Council. As part of the selected catchment is subject to surface water and ground water interactions, TopNet-GW (Yang et al. 2015) conceptual model was used to supply modified mean daily surface water flows for the last 40 years at every reach in the catchment. These flows were used in CHES to drive simulation of fish habitat change and reliability of water abstraction supply for several different management scenarios. The scenarios aim to inform the council of abstraction scenarios that could be taken and inform stakeholders of the interplay of abstracted amount and change in fish habitat.

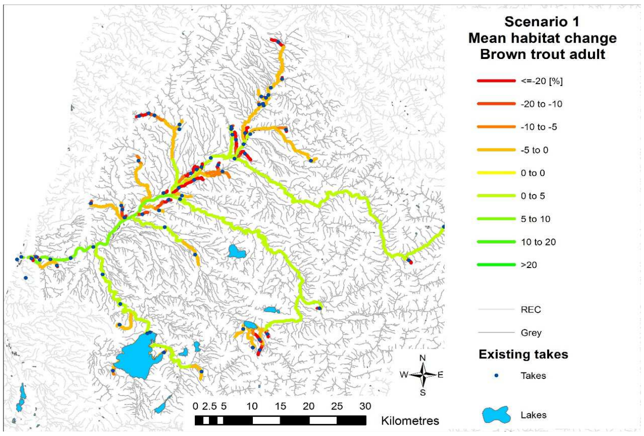
## Method

The simulation of instream and out of stream attributes in CHES requires the provision of mean daily surface water flows for every reach in the catchment. This is provided by the conceptual TopNet-GW model, which has been developed as part of the Waterscape program to better represent surface water-groundwater-streambed interaction as part of the TopNet model. Council spot gauging data for 11 different sites throughout the catchment, each visited up to eight times, were used to refine the initial TopNet calibration on the Grey driven by continuous flow gaugings from Grey at Dobson and Grey at New Waipuna. The implementation of the spot gaugings within the TopNet-GW model improved the predicted flows (reduction in difference between modelled and measured flows), when compared with a TopNet model without the conceptual ground water module. Hence, for all locations on the river network the hydrological consequences of water use can be more accurately characterised at a daily time-step across multiple years. This allows the user to develop an understanding of how natural variations in river flow (e.g., dry vs. normal vs. wet years) affect the availability of water for existing and potential new users, both under current and potential future limit and licencing regimes. A key feature of CHES is the ability to simulate the addition of new water takes, storages, dams or diversions in a catchment. Within the CHES interface a user is able to define the characteristics (e.g., location, volume, timing, limits, and storage properties) of a proposed new take. This can be added to the catchment and the impacts on hydrology, reliability of supply for existing users and instream values can be evaluated.

## Results

Four different management scenarios were executed within CHES: i) maximum consented abstraction, ii) proposed NES (National Environmental Standards) rules (NPS-FM, MfE 2014), iii) a hypothetical scenario of a new off-line storage abstraction so that an additional 500 cows could be supplied with water, and iv) a climate change scenario (the average of the 12 global climate model scenarios under A1B from the IPCC's third assessment round, IPCC 2001).
For scenario i): Results show that for 78 abstractions simulated, there are 45 abstractors that can take all their allocated water more than 97.5% of the time. Current consent conditions mean that on average across the Grey River catchment there is a 3.6% reduction in physical habitat available for adult brown trout compared with natural flows, with habitat reduction occurring 38% of the time. For 260 river reaches the habitat would decrease on average (see Figure 1), whereas for 391 river reaches the habitat would increase, for a total of 651 river reaches downstream of any abstraction.

a)




b)

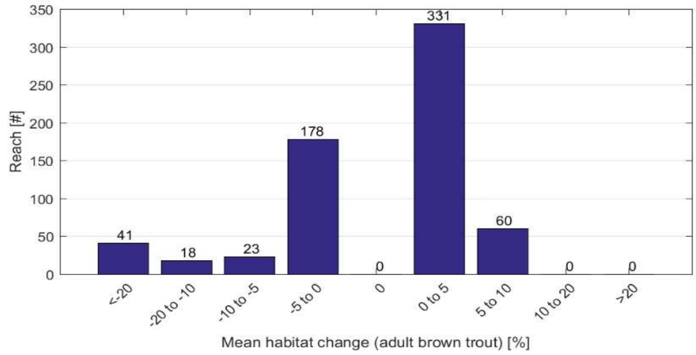



Figure 1: Mean habitat change for adult brown trout as a result of current abstraction (scenario i)) presented as (a) a map and (b) a histogram.

For scenario ii): Reliability of abstraction would drop to 92%, with a much smaller volume of water being allocated based on the NES rules. Habitat availability for brown trout would increase on average by 3.3%.

For scenario iii): Enough water needs to be abstracted for drinking, cleaning of dairy sheds and irrigating a sufficient area of pasture. CHES was used to determine the optimal volume of the off-line storage dam of 86,400 $m^3$, giving ample drinking and cleaning water and an irrigation reliability of >95%.

For scenario iv): Results show that, in general, the south-eastern part of the Grey River catchment will experience a reduction in Mean Annual Low Flow (MALF) and the north-western part of the catchment will experience an increase in MALF, with a mean change across all reaches in the catchment being an increase in MALF of 51 l/s and an increase in minimum flows (lowest flow in the hydrological time series) of 94 l/s. These increases in low flows result in no change in reliability for a typical abstractor, however, there will be some abstractors with less reliable supply (with the worst case being a 6% reduction in the proportion of time an abstractor can take their full allocation) and some abstractors will have more reliable supply (with the best case being a 157% increase). In terms of habitat availability under climate change, on average across all reaches there is a 0.2% reduction in habitat availability for adult brown trout (compared to current conditions). For longfin eels the results are similar with an average reduction in habitat availability of 0.3%.

**References**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