Using machine learning to infer the occurrence of extreme precipitation events in climate model output

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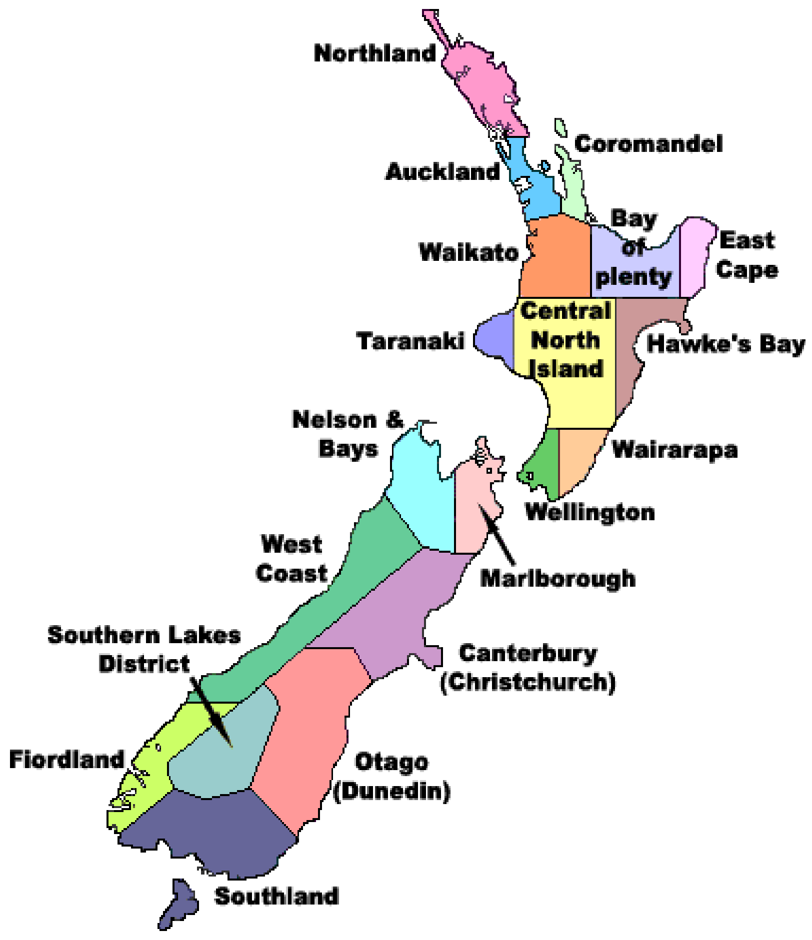
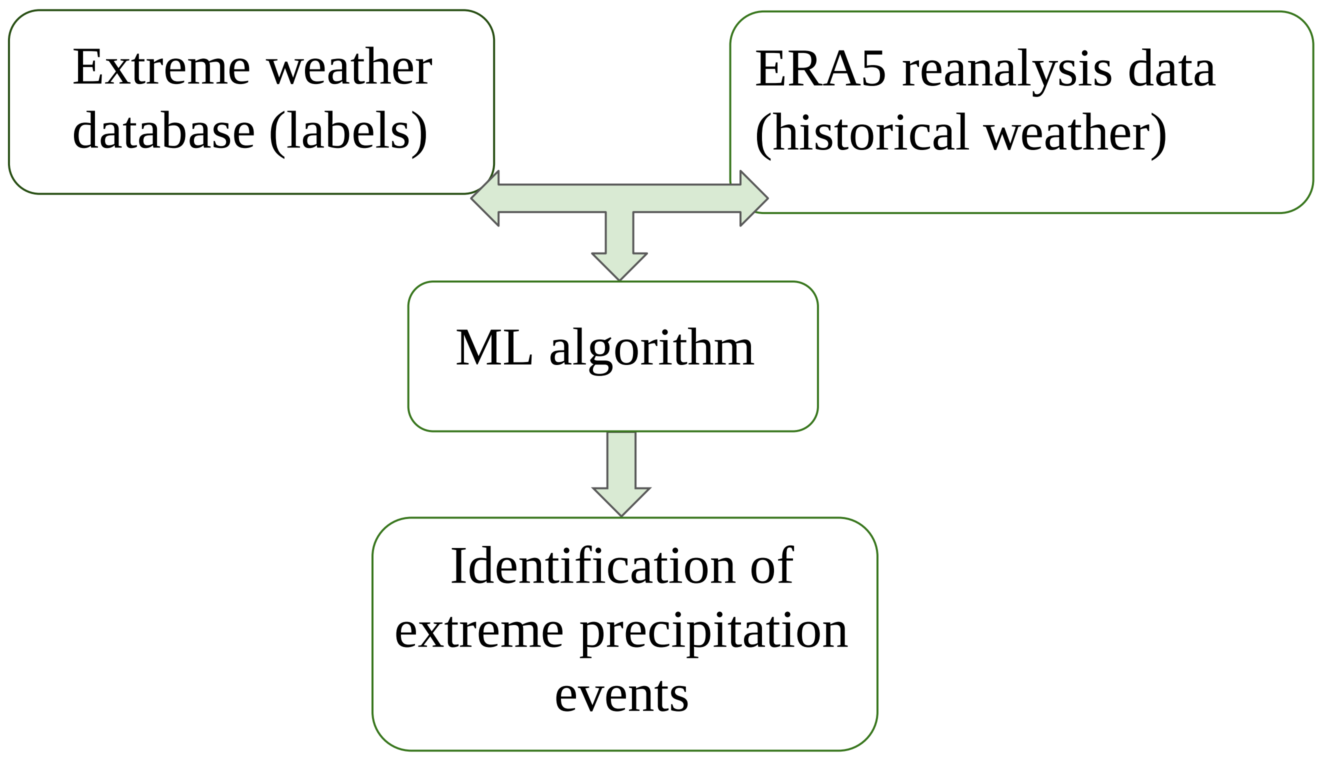


Motivation

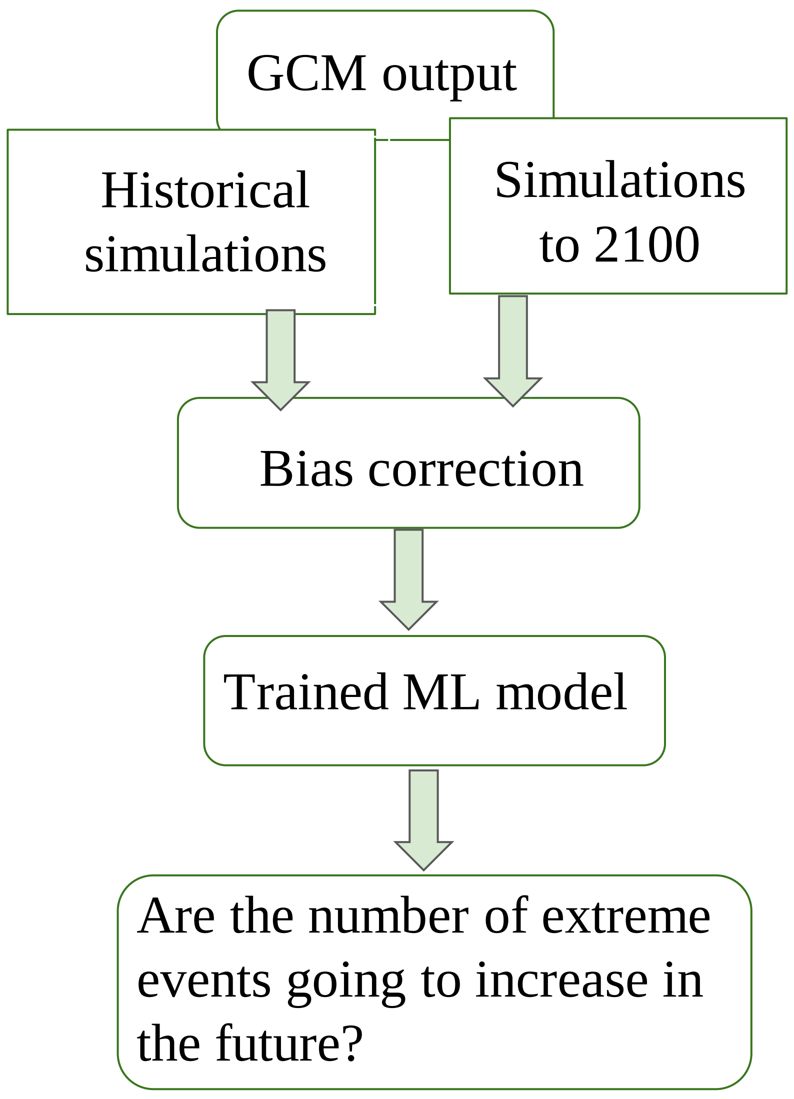
Extreme precipitation events (EPEs) have a significant impact on New Zealand, causing loss of life and property, damaging important infrastructure such as bridges, leading to long-term economic effects. Climate change is increasing the likelihood of EPEs in many regions of New Zealand. However, EPEs often occur at spatial scales that are too small to be resolved by global climate models (GCMs) and potentially also too small to be resolved by regional climate models (RCMs). If we are to use GCM projections of future changes in climate to infer changes in the frequency and severity of EPEs, then methods need to be developed that can be used to infer the existence of those events in GCM output.

Approach

We developed a machine learning classification algorithm to detect historical occurrences of EPEs in ERA5 reanalysis data (such as temperature, mean sea-level pressure and total column water). The training dataset used here is the recently developed database of historical extreme weather events for New Zealand from 1996 to 2019 and rain gauge measurements.



Application

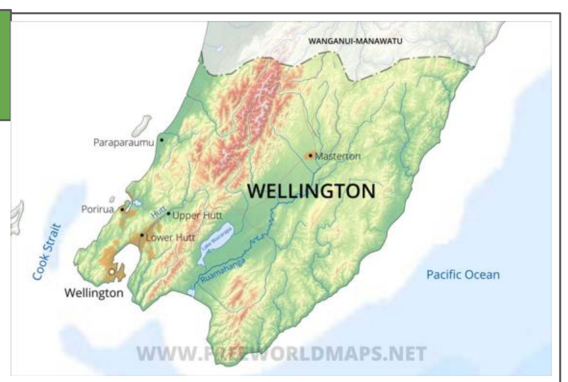


GCM model output obtained from the CMIP6 database will be first bias corrected before being processed in a similar manner as the ERA5 data.

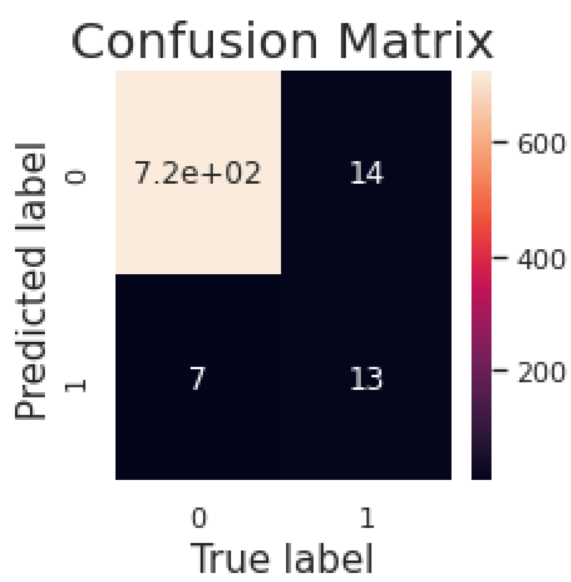
Historical GCM simulations will be used as validation and as a baseline for the expected number of EPEs in the current climate.

GCM projections will be used to identify future EPEs up to 2100 including uncertainties in these estimates.

Case study



- First we apply the ML model to data from Wellington region.
- SMOTETomek upsample method is used to balance the data.
- XGBoost algorithm is used to built the model.
- GridSearchCV hyperparameter tuning is applied for the optimisation.



Accuracy : 0.97

Area under the curve: 0.81

	Precision	Recall	F1-score
Label 0	0.99	0.98	0.99
Label 1	0.48	0.65	0.55

Ongoing research

- Next step is to combine all regions, and build classification algorithms to predict the extreme precipitation events for each region.
- Feature extraction method such as self organising map and dimensionality reduction method such as principal component analysis will be used to pre-process ERA5 reanalysis data.
- Neural networks will be designed to predict the likelihood of extreme precipitation events in different regions around New Zealand.

Acknowledgement

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