Simulating crop rotations to improve estimates of nutrient losses using APSIM in HPC

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Abstract: In New Zealand, policy makers and land stewards are under pressure to change farming practices and to limit their environmental impact. Having information on such impacts is crucial for guiding policy setting and to help making decisions regarding land use change and improving management. We employed the latest advances in biophysical parameters databases, simulation modelling, and computing automation tools to develop simulations of crop rotations for all growing regions in New Zealand. The aim is to provide improved estimates of nutrient losses from cropped farmlands with a wide coverage across the country. We present here the methodology and developments made to streamline the supply of parameters and inputs to the model, the automatic creation of simulations of a variety of cropping systems, and the running of thousands of simulations in a high-performance computing (HPC) environment. These simulations were set up using the Agricultural Production Systems Simulator (APSIM). The developments include:

- Refining the parameterisation of soil properties required by APSIM and included this into the S-map engine, which then generates the soil parameters in the format required by the model.
- Organising and converting daily weather data into a format needed by APSIM. These were sourced from the Virtual Climate Station Network covering the whole country on a 5 km × 5 km grid.
- Combining the best available soil, climate, and slope data spatially. This provides a list of unique and georeferenced biophysical conditions to run the simulations.
- Defining a set of farm systems simulations based on typical New Zealand crop rotations. They were set up in APSIM with flexible rules to allow variations in management response to the variability in soils and climate.
- Setting up a pipeline for modifying and running the simulations in HPC systems. The results from these simulations are then aggregated, analysed, and linked to a spatial information system.

This presentation provides more details of the development and explores advantages and shortcomings of the methodology. We also provide examples of the outputs and discuss aspects of their testing and usage.

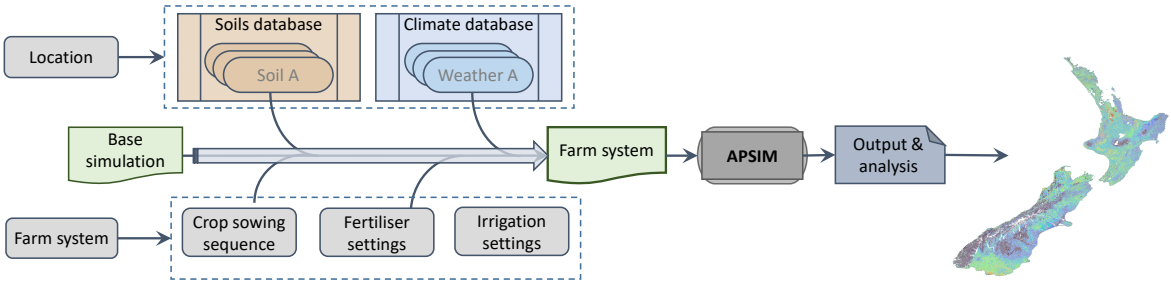

Figure 1. Schematic of pipeline developed for generating simulations of crop rotations to run in HPC

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