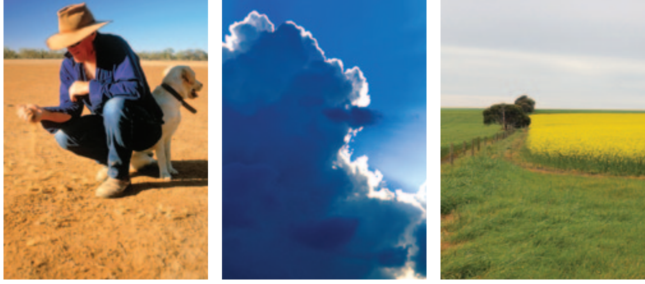
South Eastern Australian
Climate Initiative



Understanding future changes in climate and streamflow

Estimating climate change impact on future climate and streamflow

Estimating future streamflow under a changed climate involves three main components as summarised in Figure 1. Firstly, global climate models are used to project future climate change. Secondly, the results from the global climate models are 'downscaled' to the region of interest and its weather patterns. Finally, the downscaled future climate series are used to drive hydrological models to estimate future streamflow.

There is uncertainty in each of the modelling components. The first source of uncertainty is the future level of greenhouse gas emissions. The second is how the global climate (in particular global temperature) will respond to these emissions. To quantify and reduce the uncertainty, SEACI researchers have assessed the global climate models used by the Intergovernmental Panel on Climate Change (IPCC), and place more weight on the projections from the better models.

The global climate models operate on a very coarse spatial resolution. For example, Victoria is typically represented by less than five grid cells. For regional and catchment hydrological modelling, SEACI researchers use statistical and dynamic downscaling models to downscale daily rainfall and other climate variables to the catchment scale. A third source of uncertainty therefore is how regional and local climates (in particular rainfall) will respond to the changes in the global climate.

The downscaled future daily climate series are then used to drive hydrological models which estimate future streamflow. Runoff and streamflow are mainly influenced by rainfall, with a 1% change in mean annual rainfall in south-eastern Australia generally amplified as a 2% to 3% change in mean annual runoff. Runoff will also be affected by changes in potential evaporation, dominant hydrological processes, vegetation response, and surface–atmosphere feedbacks in a warmer and higher CO_2 environment. The uncertainties associated with these changes in runoff therefore represent a fourth source of uncertainty. Ways of reducing these uncertainties are being investigated by SEACI researchers.

Future rainfall and streamflow projections for south-eastern Australia

The majority of global climate model simulations indicate that south-eastern Australia will, on average, be drier in the future, particularly across the far south of the region. This is consistent with the expected changes in the large-scale atmospheric and oceanic drivers of rainfall in this region in a warmer world. Although the average rainfall and streamflow in south-eastern Australia are projected to decline, extreme rainfall events are likely to be more intense because warmer temperatures will provide stronger

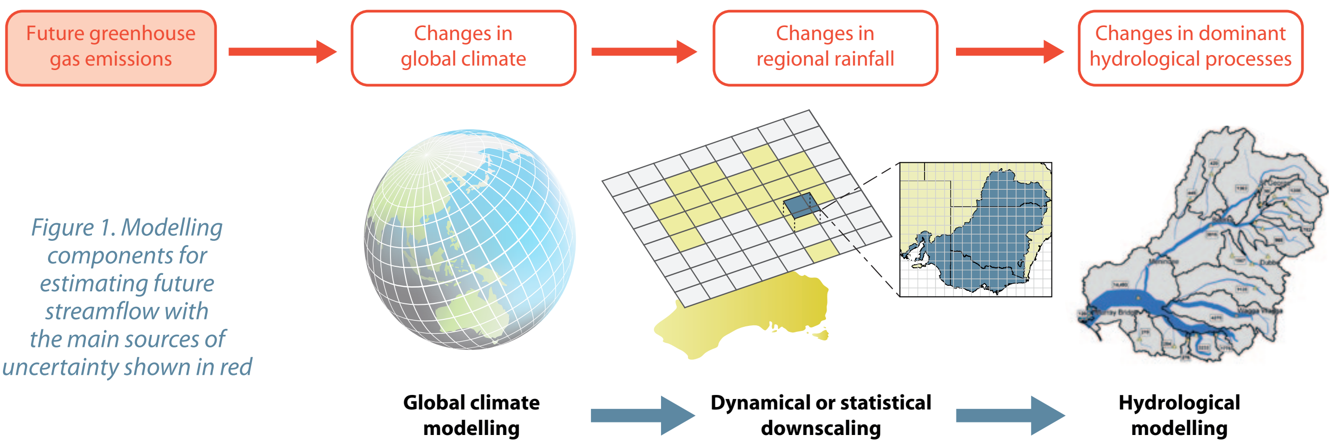


Figure 1. Modelling components for estimating future streamflow with the main sources of uncertainty shown in red

SEACI is a partnership between the CSIRO Water for a Healthy Country Flagship, the Bureau of Meteorology, the Murray–Darling Basin Authority, the Victorian Department of Sustainability and Environment, and the Australian Government Department of Climate Change and Energy Efficiency.

convection and an increased capacity for moisture to be held in the air. These higher-intensity storms will increase flood risks, cause greater storm and sewer runoff in urban areas, and increase erosion and nutrient delivery to waterways, particularly during high-runoff events following dry periods.

Figure 2 shows the projected changes in future average annual rainfall and runoff modelled by SEACI researchers using future climate series downscaled from the global climate model projections. The plots show the change in average annual rainfall and runoff for a 1°C global warming (the projected warming by ~2030 relative to ~1990). Projected declines in rainfall and runoff will be greater for higher global warming and for the more distant future.

The wet, median and dry estimates in Figure 2 show the range of projected change representing the uncertainty.

Averaged across the northern half of the region (north of 33°S; corresponding to the latitude just north of Sydney), the median estimate is a decline in average annual rainfall of 3% (range of –12% to +4%) and decline in runoff of 10% (range of –30% to +14%). Averaged across the southern half of the region (south of 33°S) the median reductions in rainfall and runoff tend to be larger and are more consistent across the vast majority of projections, with a median decline in average annual rainfall of 4% (range of –9% to 0%) and decline in runoff of 12% (range of –24% to –1%).

The future climate for south-eastern Australia will be one that still produces droughts and floods, but where the average annual rainfall and runoff is likely to be lower. The low river flows experienced during the Millennium Drought may be expected to recur more frequently in the future.

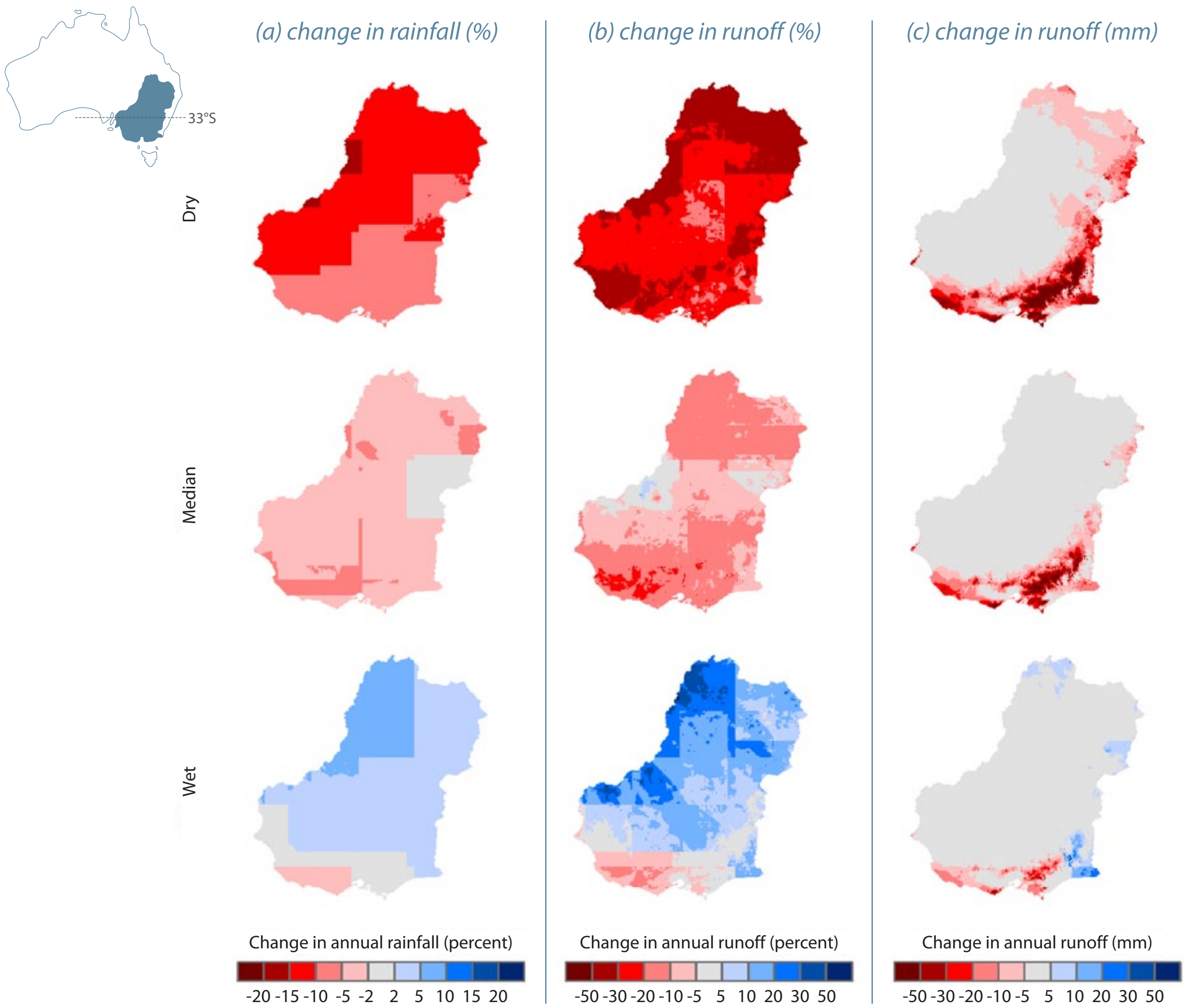


Figure 2. Changes in modelled mean annual runoff (for ~2030 relative to ~1990 global temperature) across south-eastern Australia (Murray–Darling Basin and Victoria) showing the median result and the wet and dry extremes of the possible range for (a) rainfall, and runoff: (b) percent, (c) millimetres

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The suite of four factsheets is available from www.seaci.org or by emailing seaci@csiro.au