A future built on imagination

Graeme O'Neill

WHERE do scientists begin when called upon to predict the future? In preference to tea leaves or Tarot, they usually focus firmly on the past.

When it comes to predicting climate in Australia, however, the past is poorly documented. Long-term weather records for many regions simply don't exist.

Given this lack of data, and the fact that patterns of climate variability take decades to emerge – perhaps as long as a human lifetime – scientists must seek other foundations for their prophesy.

One solution is to develop computer models that 'imagine' long weather sequences. These are called stochastic models and they can be used to help manage risk in the face of climatic uncertainty.

Stochastic models exist for other countries, but none are particularly good at simulating Australia's climate, which is erratic and ranges from tropical to temperate. The task of developing a 'home-grown' variety rests with Dr Bryson Bates and his colleagues from the Division of Water Resources at Perth.

Bates says stochastic models generate long weather sequences from sparse data. They are not intended for real-world weather prediction, but will generate synthetic climatic 'histories' of a century or more that conform to known patterns of climatic variability in particular regions.

He says Australia's climate varies widely over time, as well as geographically. Arid-zone regions can have their 'average' yearly rainfall dumped in one downpour, and even cities such as Sydney can receive almost their average annual total in a few weeks.

Such extremes affect the quantity and quality of Australia's water resources. In the absence of detailed, long-sequence records for much of Australia, synthetic records from the stochastic models will help planners and managers deal with climate variation and its impacts on rural and urban environments.

Bates says the division is also investigating how climate change, in the form of global warming, might affect the frequency of droughts and floods. He says a small change in climate may increase the frequency of very rare events such as once-a-century floods.

'We are studying regional rainfall models and point models of daily rainfall, maximum and minimum temperatures, and solar radiation,' Bates says. 'Humidity and wind will be incorporated in the point models at a later date. The long-term goal is to develop a regional model for all these climatic variables.'

The model will aid studies of the behaviour of environmental systems that are climate-driven. These include landscape processes such as erosion; water quality in lakes and streams; the design of water storages; and flow allocations from water-storage systems for irrigation, or for ameliorating algal blooms.

Cooking up a storm

In the past, an inadequate understanding of climate variability may have resulted in under-design of dams and other large structures, drainage systems, and even domestic housing. One part of the CSIRO's multi-divisional program on climate variability is concerned with the impact of extreme weather events on the built environment.

At the Division of Atmospheric Research, Dr Debbie Abbs has been simulating the impacts of extreme rainfall events.

Abbs says that several years ago, the Bureau of Meteorology changed the way it estimated probable maximum precipitation (PMP). The result is that many of Australia's large dams may not meet design specifications for flows during extreme rainfall events. This is a matter of concern to states or authorities looking after these dams, because they may need to undertake costly remedial works to upgrade spillways.

The revised probable maximum precipitation estimates are already a source of controversy. The Sydney Water Board proposes to increase the height of Warragamba Dam by more than 20 metres. Conservationists are opposing the plan because the larger reservoir behind the dam would flood a much larger area of bushland containing rare plants and animals.

Abbs is developing a computer model of extreme wind and rainfall events associated with phenomena such as east-coast lows and tropical cyclones. She is testing its predictions against real events such as the torrential downpour associated with the intense low-pressure system that caused extensive flooding in suburban Sydney in August, 1986.

A high-resolution model that can be 'nested' within the grid of a larger-scale, general circulation model, and driven by the boundary conditions provided by the larger-scale model, is also being developed. By simulating regional topography, the model will account for wind patterns and their effect in focusing storms, and drainage patterns that will allow the area of local flooding and wind damage to be predicted.

Abbs hopes to couple her high-resolution model to rainfall-run-off models and link it with geographic information systems (GIS) being developed by Dr Peter Newton's research team at CSIRO's Division of Building, Construction and Engineering at Highett, Victoria.

Dr Gerry Trinidad, GIS analyst with the Highett group, says predictive models will be linked with geographic information as a means of estimating the impacts of extreme climatic events – destructive winds, hailstorms and torrential downpours – on urban environments. Such events not only disrupt communities, but impose enormous costs on the insurance industry.

Trinidad says the sprawl of suburbia into rural areas profoundly alters local hydrology. In extreme rainfall events, hectares of bitumen, tiled roofs and footpaths impede natural infiltration and focus run-off, producing local flash-floods of the type seen in the Melbourne suburbs of Wembee and Carrum after a brief, intense storm in early 1995.

The GIS group at Highett wants to deliver an integrated product that decision-makers could use to assess the impacts of extreme events, such as the extent of flooding, and the location of disadvantaged communities. The group will also study other natural hazards such as cyclones, wind storms and hail.

'Cyclones are rare, but averaged over time, the costs are significant,' Trinidad says. 'In Townsville, half of housing infrastructure is damaged annually by cyclones.

'Our research group is looking at making structures resistant to extreme conditions, but because community resources are often limited, it is not always economical to design for such extreme events. One is forced to look at other ways of managing their impacts.

'If the Division of Atmospheric Research can simulate past cyclones or intense storms, we could generate scenarios useful to urban planners.

'The August 1986 storm in Sydney affected 400 000 people and the damage bill was $49 million in today's dollar values. If it happened today, it would affect 600 000 people; population density has changed, changing the run-off characteristics in a way that would amplify the storm's effects.'

Bill van Aken

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Extreme weather events affect both natural and built environments.
Above: Scientists are developing models that simulate the impact of extreme weather events on large structures such as dams and drainage systems.
Left: A model that accounts for regional climate variability is being developed to aid studies of environmental systems that are climate-driven. These include landscape processes such as erosion; water quality in lakes and streams; the design of water storages; and flow allocations from water-storage systems for irrigation, or for ameliorating algal blooms.