implementation of management practices, policies, and programs targeted at restoring water quality in Chesapeake Bay and its tributaries for the benefit of living resources and to protect human health. A primary objective of these long-term efforts has been to reduce nutrient loading, specifically nitrogen and phosphorus, to Chesapeake Bay. In 2010, the U.S. Environmental Protection Agency established regulation that mandated a 25% reduction in nitrogen and a 24% reduction in phosphorus loading to Chesapeake Bay by the year 2025. At least 60% of the nutrient loading reduction was to be achieved by 2017. Utilizing water flow and water quality data collected from approximately 250 monitoring stations throughout the Chesapeake Bay watershed and a sophisticated suite of modeling tools, nitrogen and phosphorus loading rates can be subdivided by geographic regions, land use and origination source. The current status of attainment of nutrient loading reduction goals in Chesapeake Bay will be discussed.

Zhang Y.-F., Thorburn P., Fitch P.

Abstract number–72 SSIM – A deep learning approach for recovering missing time series sensor data

Yi-Fan Zhang
Agriculture & Food, CSIRO, Brisbane, QLD, 4067, Australia.
email: Yi-Fan.Zhang@csiro.au

Peter Thorburn
Agriculture & Food, CSIRO, Brisbane, QLD, 4067, Australia.

Peter Fitch
Land & Water, CSIRO, Canberra, ACT, 2601, Australia.

Wireless sensor networks are in widespread use in various application areas. These areas include agriculture, industry and environment. High frequency measurements can reveal complex temporal dynamics that may be obscured by traditional sampling methods. Higher numbers of measurements offer new insights into the inner workings of a monitored system. However, the issue of missing data is relatively common in wireless sensor networks. Missing data can have a significant effect on the conclusions that can be drawn from the data. Although a plethora of methods have been proposed for imputing sensor data, limitations still exist. Firstly, most methods give poor estimates when a consecutive number of data are missing. Secondly, some methods reconstruct missing data based on other parameters monitored simultaneously. When all the data are missing, these methods are no longer effective. Thirdly, the performance of deep learning methods relies highly on a massive number of training data. Moreover in many scenarios, it is difficult to obtain large volumes of data from wireless sensor networks. Hence, we propose a new sequence-to-sequence imputation model (SSIM) for recovering missing data in wireless sensor networks. The SSIM uses the state-of-the-art sequence-to-sequence deep learning architecture, and the Long Short Term Memory Network is chosen to utilize both the past and future information for a given time. Moreover, a variable-length sliding window algorithm is developed to generate a large number of training samples so the SSIM can be trained with small data sets. We evaluate the SSIM by using real-world time series data from a water quality monitoring network in Australia. Compared to methods like ARIMA, Seasonal ARIMA, Matrix Factorization, Multivariate Imputation by Chained Equations and Expectation Maximization, the proposed SSIM achieves up to 69.2%, 70.3%, 98.3% and 76% improvements in terms of the RMSE, MAE, MAPE and SMAPE respectively, when recovering missing data sequences of three different lengths. The SSIM is

therefore a promising approach for data quality control in wireless sensor networks.

Workman M., Willis G.

Abstract number–73 Nitrogen limit-setting and allocation of discharge rights in New Zealand

MARTIN WORKMAN & GERARD WILLIS
Water Directorate, Ministry for the Environment, Environment House
23 Kate Sheppard Place, Thorndon, Wellington, New Zealand
martin.workman@mfe.govt.nz

New Zealand's national water policy framework has promoted the setting of individual property-scale limits on diffuse discharges of nitrogen to achieve regionally defined catchment loads and in-stream concentrations. This policy is being rolled out progressively across New Zealand's 16 regions – each governed by its own democratically elected council.
Because each regional council has significant discretion over the in-stream concentrations and catchment loads and the methods of, and approach to, property-scale limit setting to achieve those loads and concentrations, there has been significant variation in approaches taken. That variation relates both to the design of policy and the processes used to develop policy with affected stakeholders and communities.
This paper will consider the range of approaches taken to date and the lessons learnt. Particular emphasis is given to two cases studies.
• The first is the iconic Lake Rotorua catchment where a catchment nitrogen load was established through significant stakeholder engagement and which implements an agreement between central and regional government that involves a full range of regulatory and non regulatory measures to achieve a reduction of 320 tonnes of N to the lake by 2032.
• The second is the Manawatu River catchment being an intensively used agricultural catchment where limits were set with much less stakeholder engagement and by applying different policy imperatives. Implementation of limits in this catchment has encountered significant difficulties.

The case studies illustrate some of the more vexing issues in diffuse discharge management in the New Zealand context. Those issues include whether the setting of property-scale limits should relate to, and recognise, existing land use and discharge levels, or be developed independently of existing land use and leaching rates (reflecting a desire to more equitably or efficiently share the assimilative capacity of waterways amongst rural land owners/producers).

The policy conundrum presented by setting property-scale limits to achieve a fixed catchment load raises allocation and distributional issues that are difficult for regulators to resolve and which are resulting in much legal action. This has caused the New Zealand Government to consider whether an alternative national allocation framework should be imposed over the otherwise largely devolved management system. Such consideration could include a greater emphasis on market mechanisms. In addition, and as a further complication, the Government is considering how to address rights and interests of Maori, the indigenous people of Aotearoa/New Zealand.
