

INFORMATION SYSTEMS

Monitoring Standards and Technologies for the compilation and reporting of water quality data across New Zealand (DRAFT)

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Legislative context for environmental monitoring

The New Zealand Resource Management Act 1991 (RMA) is the primary piece of New Zealand legislation that sets out how to manage the environment.

The purpose of the RMA is to promote the sustainable management of natural and physical resources. In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while:

- (a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
- (b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
- (c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

While this Act was being drafted, the most significant local government reform in New Zealand in over a century saw the amalgamation of some 850 local bodies into 86 regional and territorial authorities¹ in 1989. With changes during the intervening 27 years, the current tally sits at 67 territorial authorities (11 city councils, 51 district councils and six unitary councils) and 11 regional councils.

Responsibility is given to these territorial authorities, under RMA section 35(2)(a) to monitor “the **state** of the whole or any part of the **environment** of its region or district” (emphasis added). Section 30(1) identifies specific functions for regional councils (and unitary councils). Of particular note is section 30(1)(a), where every regional council shall give effect to the Act through “the establishment, implementation, and review of objectives, policies and methods to achieve **integrated management of the natural and physical resources of the region**” (emphasis added).

Within this statutory framework, regional and unitary councils set about establishing monitoring networks, either completely new or built from pre-existing networks operated by antecedent organisations, to assess the “state of the ... environment”.

Implementation of water quality monitoring at the regional level

As part of implementation of the RMA, the regional and unitary councils were required to consider the “integrated management of the natural and physical resources of [their] region”. With limited direction and input from the national level about where, how and why to monitor, this regional focus led to a national

¹ https://en.wikipedia.org/wiki/1989_local_government_reforms.

scale monitoring network focused on regional issues, without necessarily being representative of the country as a whole. By 2009, this regionally focused approach to water quality monitoring across the country led to inconsistencies in the methodologies applied to site selection, parameters measured, methods selected to sample, and analytical approaches taken to assess and report monitoring data.

The only consistent water quality monitoring at the national level was the National Rivers Water Quality Network (NRWQN), which was established in 1989 for the purpose of reporting the state of water quality in New Zealand. Water quality data for the NRWQN has the benefit of being collected by a single agency (the National Institute of Water and Atmospheric Research - NIWA) but the weakness of this data set is that it spans only 77 sites which are representative of large rivers only.

The strength in the Regional datasets were the number of sites available (>1,000) for analysis. However, site selection was often driven by individual projects/regional plan requirements without a view of a national picture; i.e. regional monitoring was built for regional reporting.

The development of a National Environmental Reporting Portal

In 2009, the Land and Water Forum was established with the objective to develop a shared vision and a common way forward to effectively manage New Zealand's water resources, through a stakeholder-led collaborative process. The Land and Water Forum brings together a range of industry groups, environmental and recreational NGOs, iwi (representatives of pre-European Māori society), scientists, and other organisations with a stake in freshwater and land management. The Forum's members are joined by active observers from local and central government.

At the time of the establishment of the Land and Water Forum, there was a prevailing view, and some reports in the media², that moves were being made through this forum, and within central government, to look for alternatives to regional councils to deliver on environmental outcomes. It was suggested that these outcomes would be better delivered through a national Environmental Protection Agency.

In response, and to demonstrate the important role of regional councils to deliver policy and decision-making at the local level, it was agreed to provide a single view of water quality monitoring outcomes for the country³. This was to be a first stage towards the regional sector providing a more cohesive environmental view across the country.

In late 2009, with the goal of delivering a website capable of presenting water quality data at site, catchment, regional and national scales, work was undertaken by the regional sector to compile regional water quality summaries (noting that there had been national studies using this data previously). Politically, this was challenging due to the sensitivity around the potential for bad press, and the perceived inability to control the message once the data was published and shared.

Several years later, and after some initially tentative steps, a transformation was evident within the sector regarding the release of environmental data holdings to the public through a single portal. Council governance was able to see the potential of a website as a tool to tell a comprehensive story about water quality within individual regions, addressing public misconceptions and explaining why there were differences across the country. It provided a platform for the sector to start having a common conversation with the public.

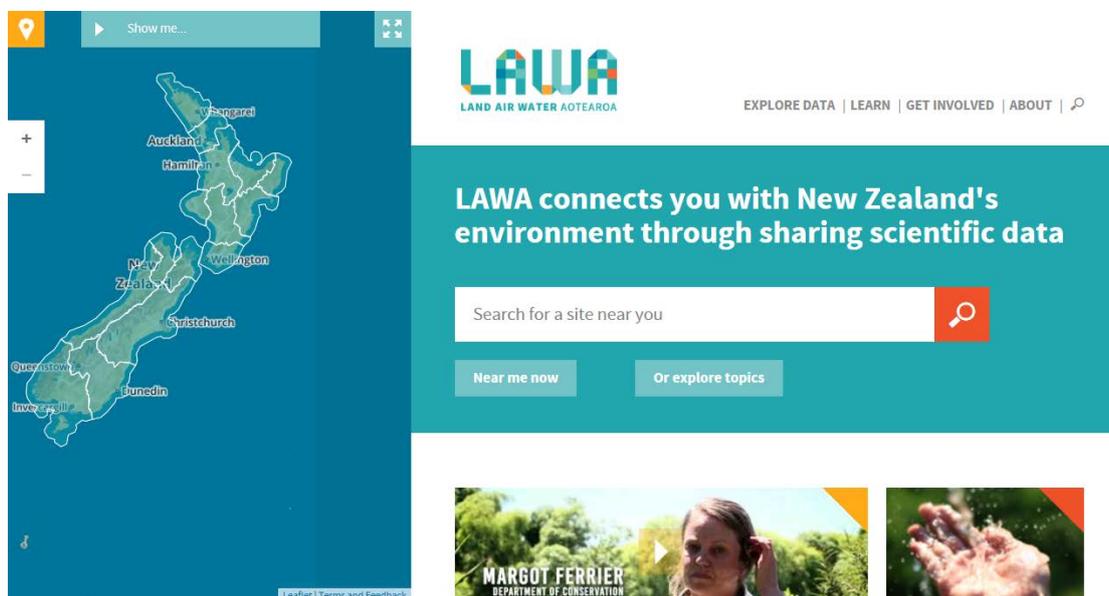
² www.stuff.co.nz/environment/2311414/Regional-councils-may-be-axed.

³ This single decision has been the catalyst for a fundamental shift in council attitude towards having a common approach to monitoring across New Zealand. This shift has been driven from within the councils, led by council Chair's and CE's.

With confidence in the delivery method, a more ambitious goal was set: the Land Air Water Aotearoa (LAWA⁴) website, designed to inform the general public about the state of New Zealand's environment to assist communities with decision-making around natural resource use whilst maintaining the resource for future generations. The sector changed from location-based silos, (focused on catchment/regional issues), to what could be termed a franchise approach to achieving national reporting outcomes. This approach was made successful through the establishment of good representative governance for the sector and partner organisations. With top-down commitment, the direction of councils could be aligned around common reporting goals where all parties had an interest in successful outcomes.

From a partnership between the Regional Sector, Massey University and the Cawthron Institute, with funding from the Tindall foundation, the project grew to incorporate the National level reporting carried out by the Ministry for the Environment (MfE) in late 2012. The LAWA website (Figure 1) was officially launched in March 2013 displaying the state and trend of river water quality for over 1000 monitoring sites across New Zealand over the period January 2004 – December 2012.

Figure 1 Land Air Water Aotearoa Website home page: www.lawa.org.nz



Through the success of the collaborative reporting for river water quality across New Zealand for LAWA, and the introduction of the Environmental Reporting Bill, the Environmental Monitoring and Reporting (EMaR) structure was established between the Regional Sector and MfE in 2013. The objective of the EMaR project is to expand LAWA to develop and operate an integrated regional/national environmental data collection network (encompassing air quality, water quality, water quantity, land and biodiversity) to enable easy data access for multiple users.

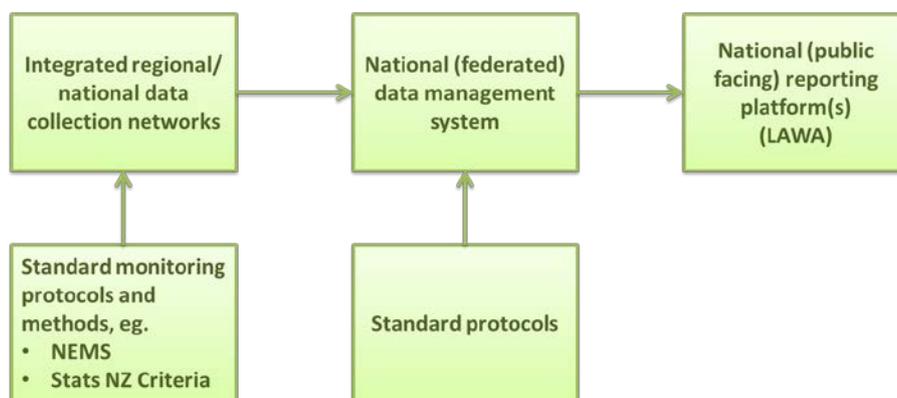
The Environmental Monitoring and Reporting structure (EMaR)

⁴ The Land, Air, Water Aotearoa (LAWA) website (<http://www.lawa.org.nz>) brings together environmental monitoring data from all of New Zealand's regional councils and NIWA, as well as presenting information provided by the Ministry for the Environment. Initially, a collaboration between New Zealand's 16 regional and unitary councils, LAWA is now a partnership between the councils, Cawthron Institute, Ministry for the Environment and Massey University and has been supported by the Tindall Foundation.

Within EMaR, there are eight project groups (Air Quality, Water Quantity, River Water Quality, Lake Water Quality, Groundwater Water Quality, Coastal Water Quality, Land, Biosecurity/Biodiversity) and the Federated National Data System team, with one of the Regional Councils/Unitary authorities as project leader supported by two other councils and a representative from MfE.

Figure 2 depicts the requirements of each project group. Essentially each group is required to establish an integrated regional/national data collection network utilising standard monitoring protocols and data collection/management and analysis practices that meet Statistics New Zealand’s approval. Information is to be delivered through the National Federated Data Management System utilising standard protocols and international data exchange standards. Information will be presented on National reporting platforms, of which LAWA is one, but there may be others. Currently, the LAWA website hosts river, lake and coastal water quality data, and surface and groundwater consumption and allocation data. The full EMaR framework is expected to be completed progressively over the next three to five years.

Figure 2 Framework for the EMaR project



Moving towards a federated national data infrastructure for environmental information

Challenges

Accessing data from different parties (councils, central government, research and academic institutions, and private sources) for LAWA has traditionally required the physical transfer of data via spreadsheets. This has long been the bane of both the data provider and the data consumer. Despite relatively uniform data requests, data is provided in many different formats (file, nomenclature and data structures). This is not only an issue for the LAWA analysts but for any analyst wishing to draw a picture of water quality in New Zealand.

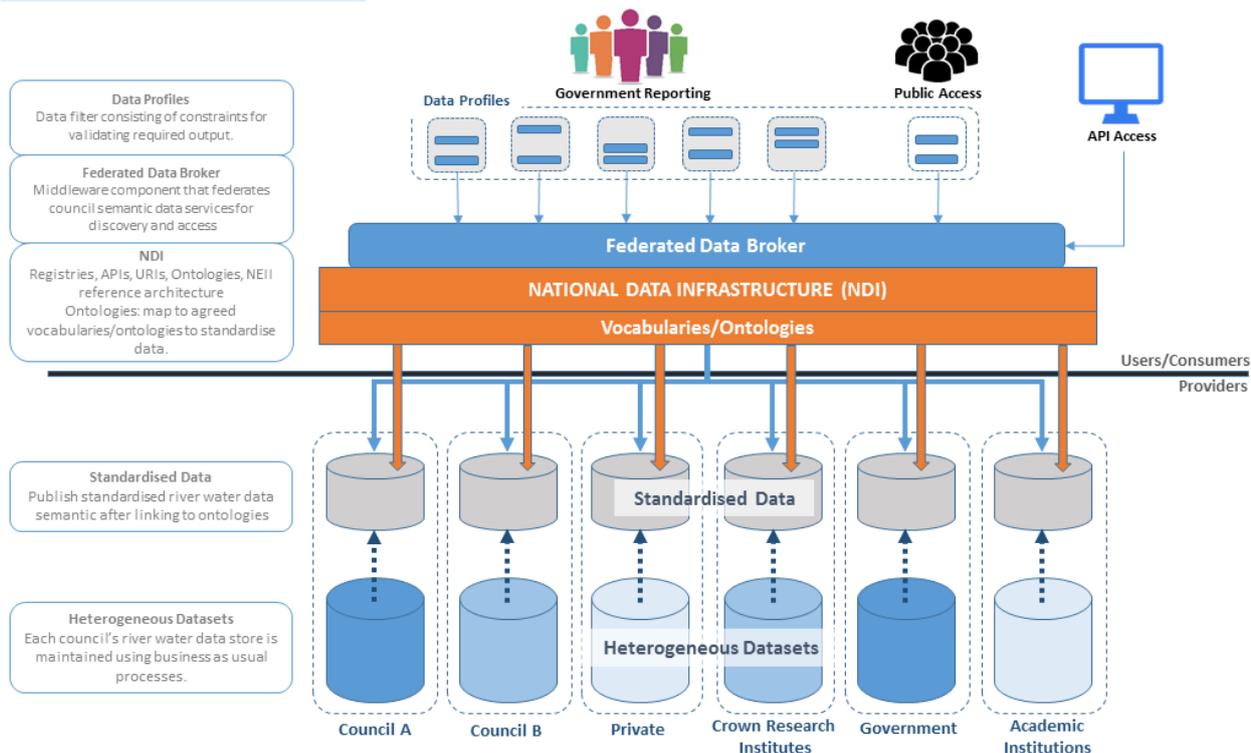
Proposal to use international standards for data requests and responses

In the geospatial world, and recognising that there are a range of different software vendors with different proprietary formats, standards for data requests (SOS 2.0) and data responses (WaterML 2.0) were established by the Open Geospatial Consortium (OGC), an international voluntary consensus standards organisation. These standards evolved out of existing standards from the UK, Europe, USA and Australia, and were designed to allow data to be shared in a platform-neutral manner, simplifying data exchange locally, and globally. Recently, this approach has been adapted to time-series data with the publication of a time-series data exchange standard, further simplifying the exchange of data.

At the international scale, New Zealand participates in a global data exchange project, coordinated by GEO, to build a Global Earth Observation System of Systems (GEOSS). This is a long-term project,

covering multiple environmental domains and societal benefit areas. For the water domain, the GEOSS Architecture Implementation Pilot 7 (AIP-7) has successfully demonstrated use of OGC Standards (SOS 2.0 / WaterML 2.0) for data exchange mechanism in 2014. New Zealand has subsequently proposed to utilise these standards to support LAWA and to enable wider data re-use within New Zealand and internationally (as demonstrated in Figure 3).

Figure 3 Proposed Federated National Data Framework for Water Data in New Zealand



While the proposition is simple, there are still additional standards to be developed to ensure published data adhere to agreed vocabularies and agreed data collection methods. A further complication is around common monitoring site labelling. There is the potential, that without adequate coordination across every party publishing data, data could be mistaken for the wrong location. Just as agreed standards are required for vocabularies and data collection, an authoritative sites system is required that all agencies reference.

Under the EMaR structure, a Federated National Data Service (FNDS) team has been established. The FNDS team are responsible for assisting and championing the implementation of international standards for sharing data across the different domains.

The development of common technical standards for water quality monitoring in New Zealand

In parallel to the development of LAWA for water quality, the Local Authority Environmental Monitoring Group⁵ embarked on the development of National Environmental Monitoring Standards (NEMS).

The NEMS are technical standards that provide best practice methods for the collection, analysis and archival of environmental data. The first series of NEMS documents were initially focused on developing

⁵ The New Zealand the Local Authority Environmental Monitoring Group (LAEMG) comprises mostly of Hydrologists from councils, in partnership with NIWA, and under the authority of the MfE and the Regional Chief Executive Officers.

standards for hydrological and continuously monitored water quality parameters (e.g. turbidity, dissolved oxygen). All standards are developed using specialist technical working groups, and once drafted, are released to the industry for public submission. Due to the nature of environmental monitoring, and the infancy of standard development in New Zealand, these documents are reviewed after the first two years of publishing to ensure they are both practical and achieving national consistency.

The NEMS published to date are⁶:

- Safe Acquisition of Field Data in and Around Fresh Water – Code of Practice (2013);
- Dissolved Oxygen Recording – Measurement, Processing and Archiving of Dissolved Oxygen Data (2013);
- Open Channel Flow Measurement – Measurement, Processing and Archiving of Open Channel Flow Data (2013);
- National Quality Code Schema (2013);
- Soil Water Measurement – Measurement, Processing and Archiving of Soil Water Content Data (2013);
- Rainfall Recording – Measurement, Processing and Archiving of Rainfall Intensity Data (2013);
- Turbidity Recording – Measurement, Processing and Archiving of Turbidity Data (2013);
- Water Meter Data – Acquisition of Electronic Data from Water Meters for Water Resource Management (2013);
- Water Temperature Recording – Measurement, Processing and Archiving of Water Temperature Data (2013).
- Water Level Recording – Measurement, Processing and Archiving of Water Level Data (2013).
- Rating Curves – Construction of Stage-Discharge and Velocity-index Ratings (2016).

The archival and storage components of the NEMS include a quality coding aspect. The NEMS for discrete water quality monitoring is currently under development. The standard will cover all aspects of water quality monitoring post-network design and will represent best practice from collection through laboratory analysis, to archival and long term storage of data. The standard is likely to be released for public submission in June 2016.

The quality coding aspect ensures that there is a common framework across sectors for describing the quality of data to the analyst and prevents decisions being made based on poor quality data and assumptions. Not only that, but the public has paid for the data (through general taxes) and deserve to be able to use it and use it with confidence.

The local nature of water quality monitoring, and the selection of monitoring parameters and methods have been the biggest challenges to date in compiling a robust assessment of water quality across NZ using the regional datasets.

Conclusions

Following the reorganisation of New Zealand local government in 1989, the journey from regional/project focused water quality monitoring to the adoption of nationally consistent frameworks has taken almost 25 years.

Through the endeavours of partnerships across the sector, with central government and with research institutions, the establishment of National Environmental Monitoring Standards has driven both better

⁶ The NEMS documents are available on LAWA: [www.lawa.org.nz/learn/factsheets/\(nems\)-national-environmental-monitoring-standards/](http://www.lawa.org.nz/learn/factsheets/(nems)-national-environmental-monitoring-standards/).

practice and capacity to support monitoring outcomes and the sustainable management of New Zealand waterways.

Further, the establishment of a framework to support rapid online delivery of monitoring data and information (supported by the NEMS), will bring about an improved utilisation of reliable real-time and historical water quality data for a range of users to inform business, recreational and environmental decisions. This will free-up significant overheads in delivering on routine data requests, from organisations such as regional councils, and redirect effort into additional monitoring or policy work.

Lastly, the growth of monitoring networks, based on sound standards, combined with the ability to deliver the collected data to the people who need it almost immediately, will transform how the country as a whole can utilise and benefit from regional investments in not only water quality monitoring, but environmental monitoring more broadly.