AN URBAN RUNOFF DATABASE FOR NEW ZEALAND

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ABSTRACT (200 WORDS MAXIMUM)

NIWA is leading the development of an open-access searchable database of New Zealand urban runoff quality data. Data are being collected from organisations such as regional councils, territorial authorities, roading agencies and research institutes throughout New Zealand, many of which hold large datasets of stormwater quality data collected over the last 10 years. The aim is to provide a repository for all urban runoff data and for the dissemination of this data in a form that is fit-for-purpose for a range of uses and users. The database has been designed as an open-access web-based tool that enables analyses of variations in runoff quality by characteristics such as land-use, geographic area and type of stormwater treatment. Data are compiled into the database after quality control checking according to a prescribed protocol. The database is currently being populated and a first version of the web portal is due to go live in 2013.

KEYWORDS

Stormwater, urban runoff, database, contaminants

PRESENTER PROFILE

Jennifer Gadd is an environmental chemist working in the Urban Aquatic Environments group in NIWA's Auckland office. She is involved in a wide range of projects characterising stormwater contaminants, assessing treatment options, and investigating their fate in aquatic environments.

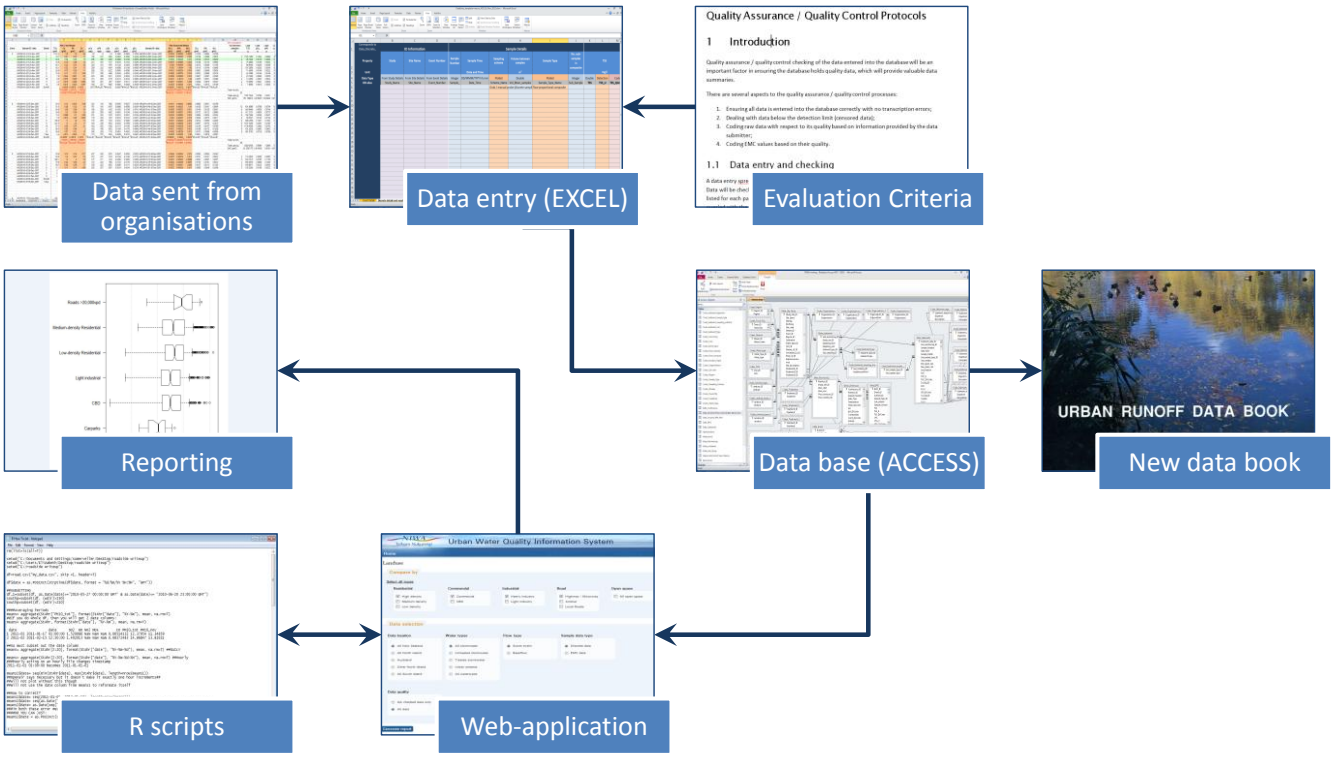
1 INTRODUCTION

Urban runoff is a major source of contamination to streams and estuaries, resulting in the transport of sediments and metal and organic contaminants to sensitive receiving environments. Assessments of urban runoff quality often rely on literature values because monitoring can be difficult and resource-hungry. Literature values are also necessary when predicting future urban runoff quality following a change in land use. Although there are recently developed tools, such as the Auckland Council Contaminant Load Mode, CLM (Timperley et al., 2010) and C-CALM (Semadeni-Davies et al., 2010), these are load-based whereas concentration is often required for effects-based assessments. One of the key references for concentration-based data is the Urban Runoff Data Book (Williamson, 1993) which is now twenty years old. Although still a very valuable reference, this pre-dates the considerable effort that has been made in the last 15-20 years to collect urban runoff data in New Zealand by organisations such as regional councils, territorial authorities, roading agencies, research institutes and Universities.

However, at the moment there is no centralised database of these data sets and many are quite inaccessible. Such data sets include those that characterise discharges and evaluate the effectiveness of stormwater treatment. To fill the need for concentration-based data and make use of the data that has been collected, NIWA is leading the development of an open-access searchable web-based database of New Zealand urban runoff quality data. The aim is to provide a repository for urban runoff data collected throughout New Zealand and for the dissemination of this valuable data to the public in relevant and meaningful formats.

The structure of the database is shown in Figure 1. Data sent to NIWA by participating organisations are first entered into a standardized data entry spreadsheet (Excel) and are assessed against a prescribed protocol. The assessed data is then entered into a relational database (Access) which underlies the web-based application which is publically available. Users can run data queries which return summary statistics and graphical summaries for a range of user-selected attribute-based comparisons (see Section 4 for an example). Once sufficient data has been entered into the database, it will be statistically analysed and reported in a data book to provide a tool specific to New Zealand conditions. This data book will be undertaken as a collaboration between the University of Auckland School of Environment and NIWA's Urban Aquatic Environments group.

Figure 1 Database structure



2 SCOPE OF THE DATABASE

The database holds data on water and sediment quality of urban stormwater and streams including physical properties and concentrations of metals, nutrients, bacteria and hydrocarbons. It also holds site and monitoring metadata such as land use, water source and sampling methods.

2.1 URBAN RUNOFF QUALITY

The database can hold water quality data for urban stormwater and streams in urban catchments. The data may include physical properties, and concentrations of solids, metals, nutrients, bacteria and hydrocarbons (see Table 1). These data may come from a single storm event, a short-term investigation over several storms, or a long-term monitoring site. The data may include single grab samples, multiple samples throughout a storm (for example using automatic samplers), or multiple samples combined before analysis. The database can also include event mean concentrations (EMCs) when available. These are treated slightly differently in the database. Continuous data, for example those collected using sondes, can also be entered into the database.

Table 1: Water quality data that can be included in the database.

Discrete data fields	Parameters
Solids	Suspended sediment concentration (SSC); total suspended solids (TSS); volatile suspended solids (VSS); availability of particle size distribution (PSD)
Physical and Chemical Characteristics	Temperature; pH; conductivity; salinity; dissolved oxygen (percentage saturation or concentration); turbidity; black disc; carbonaceous BOD5; COD; hardness (CaCO3); alkalinity
Common Metals	Total, dissolved and particulate zinc, copper and lead
Other Metals	Total and dissolved: aluminium; antimony; arsenic; cadmium; chromium; iron; magnesium; manganese; mercury; molybdenum; nickel; silver; other metals (please specify)
Bacto	*Enterococci; Escherichia coli;* Faecal Coliforms
Nutrients	Total nitrogen (TN); nitrite (NO2N); ammonium; (NH4-N); nitrate; (NO3-N); total dissolved; nitrogen (TDN); total Kjeldahl nitrogen (TKN); dissolved Kjeldahl nitrogen; total phosphorus (TP); total dissolved; phosphorus (TDP); dissolved reactive phosphorus (DRP)
Hydrocarbons	Total TPH; TPH in bands C6-C9, C10-C11, C12-C14, C15-C20, C21-C25, C26-C29, C30-C44, COil and Grease
Polycyclic Aromatic Hydrocarbons (PAH)	Total PAH; Naphthalene; Acenaphthene; Acenaphthylene; Fluorene; Anthracene; Phenanthrene; Fluoranthene; Pyrene; Benzo[a]anthracene; Chrysene; Benzo[b]fluoranthene; Benzo[j]fluoranthene; Benzo[b]fluoranthene ; + Benzo[j]fluoranthene; Benzo[k]fluoranthene; Benzo[a]pyrene (BAP); Indeno(1;2;3-c;d)pyrene; Dibenzo[a;h]anthracene; Benzo[g;h;i]perylene
Other Contaminants / indicators	Chloride; Fluoride; total and dissolved potassium and sodium

2.2 URBAN SEDIMENTS

The database can hold sediment quality data for sediments collected from the beds of urban stormwater drains and streams and as well as dust collected from roads. As with the water quality data, the sediment data may include physical properties, and/or concentrations of solids, metals, nutrients, bacteria and hydrocarbons (see Table 2).

Table 2: Sediment quality data that can be included in the database.

Data field	Parameters
Common Metals	Particulate zinc, copper and lead
Other Metals	Particulate aluminium; antimony; arsenic; cadmium; chromium; iron; magnesium; manganese; mercury; molybdenum; nickel; silver; other metals (please specify)
Digestion method for each metal analysed (see separate notes below)	Total, total recoverable; acid soluble; 2MHCl; ANZECC; Gastric
Nutrients	Total nitrogen (TN); total Kjeldahl nitrogen (TKN); total phosphorus (TP)
Hydrocarbons	Total TPH; TPH in bands C6-C9, C10-C11, C12-C14, C15-C20, C21-C25, C26-C29, C30-C44, COil and Grease
Polycyclic Aromatic Hydrocarbons (PAH)	Total PAH; Naphthalene; Acenaphthene; Acenaphthylene; Fluorene; Anthracene; Phenanthrene; Fluoranthene; Pyrene; Benzo[a]anthracene; Chrysene; Benzo[b]fluoranthene; Benzo[j]fluoranthene; Benzo[b]fluoranthene ; + Benzo[j]fluoranthene; Benzo[k]fluoranthene; Benzo[a]pyrene (BAP); Indeno(1;2;3-c;d)pyrene; Dibenzo[a;h]anthracene; Benzo[g;h;i]perylene

2.3 DATA NOT INCLUDED

The database is not intended to include state of the environment monitoring data, such marine sediment quality data. It does not include runoff data from catchments where the majority of the land use is rural.

3 METADATA INCLUDED IN THE DATABASE

3.1 INTRODUCTION

Metadata is included with the data for each sample in the database. This is information that characterizes the site where the samples were collected, and the methods used to collect samples. Not all metadata is required for each sample, although there are some items that are necessary. It is recognized that at present much of the metadata is not available for many samples, however where available, all metadata is included now as the database is being compiled. This means that in the future with the continued collection of such metadata, more complex statistical analyses will be possible and the database may be a source of information for building stormwater models.

3.2 STUDY AND SITE METADATA

The database can hold a considerable amount of metadata relating to the study and site from which the samples come from. Much of this is required information, as it indicates the general location and type of land use from which the samples were collected. This

information is used in the database outputs, e.g., for grouping the data into the major land use types. The fields listed in Table 3 below are those required for every entry into the database. There are also optional fields if additional information is supplied, such as the catchment size, percentage imperviousness of the catchment, any references that have been published using the data.

Table 3: Study and site metadata.

Study and site metadata fields	**Parameters**
Study name	Name of the study the samples were collected for. Note that several sites can come under the same study.
Study year	Year of completion for the sampling (or current year if monitoring is ongoing)
Sponsoring organisations	Organisations responsible for: • Commissioning data collection (e.g., Regional council, TAs, roading authority) • Collecting the data (e.g., in-house monitoring, consultants • Maintaining the data and submitting it to the database.
Site name	Name of sampling location (e.g, Whau @ Wolverton Road)
Easting and Northing	Map reference of the study site, including co-ordinate systems (e.g., NZ Map Grid 1949, NZTM 2000)
Town or city	Name of urban area monitoring site is located in.
Catchment	This can either be a catchment for stream samples or a stormwater system / suburb if the sample is stormwater. If the catchment is a specific contributing area such as a section of road, roof or carpark, this should be identified.
Primary land use	Low-density residential; medium-density residential; high-density residential; lid residential; commercial; cbd; light industrial; heavy industrial; open-space; mixed land use; roads >20,000vpd; roads 5000-20,000vpd; roads <5,000vpd; carparks; pasture; forest; other
Type of water body where samples were taken	Freshwater (lakes or streams); Stormwater (treated, untreated, partially treated or treatment unknown); waste water or combined storm- and wastewater
Presence of CSOs upstream	Are there any combined sewer overflows or other sewer overflow structures (e.g., pumping stations) upstream?
Stormwater treatment type 1 if present	Dry detention pond; wet detention pond; wetland; infiltration basin / trench; raingarden; swale / filter strip; oil / water separator; sand filter; proprietary filter device; proprietary hydrodynamic device; green roof; porous pavements; treatment train; street sweeping; other
Confidentiality	Is the data publically available?

3.3 WATER QUALITY METADATA

Water quality metadata relates to a description of the monitoring at each site such as the start and end dates and time of sample collection, the type of flow regulation structure present if applicable (e.g., sharp-crested v-notch weir) the flow monitoring equipment used if applicable (e.g., bubble gauge; stilling well) the type of sampling (grab sample, manual probe, automatic sampler), and the type of sample collected (e.g., flow-weighted composite; time-weighted composite; first flush; not mixed). Metadata is also collected that relates to the events sampled, such as whether it was a storm event, baseflow or continuous data (which may encompass both types). Optional information relating to the event sampled includes rainfall depth, rainfall duration, antecedent dry period, mean and peak flow rates and the total volume of stormwater in the event. Some metadata will be applicable to storm events only and it is likely that for many studies some of it is not available. However, it is hoped that over time, with increased usage of the database, those undertaking stormwater monitoring will collect such information to be included in the database and allow for future statistical analyses.

3.4 SEDIMENT QUALITY METADATA

The sediment metadata requested includes the type of sediment sampled, e.g., whether it is bed or bank sediment; street dust; suspended solids; or soils. Data are also requested on the methods used to sample the sediment, any sieving or fractionation of the sample and the digestion methods used, which is particularly relevant for the metals. This information can be applied to multiple samples at a single site i.e., at different depths.

Full lists and descriptions of the parameters included in the database, study and site metadata, water quality metadata and sediment quality metadata are available upon request from the author.

4 WEB-BASED QUERIES FOR STATISTICAL OUTPUTS

An internet front-end for the database is being developed to produce summary statistics and plots based on user selections. This will be a free open-access system that can be used by any member of the public, but is particularly suited to council staff, consultants, students and researchers. The tool consists of a front-end portal linking to a series of forms which guide the user to make selections regarding the parameters of interest, the data types and the comparisons desired. The system will then produce summary statistics and plots based on the user's selections.

The summary statistics that will be available include median, mean, percentile and number of data points. Plots will include histograms and cumulative frequency curves of the data selected, as in the example shown in Figure2. Queries can be made to compare results for differences in land-use, geographic area, water type (stormwater versus stream water) and stormwater treatment (untreated versus treated). These comparisons are shown in notched box plots separated by the various categories chosen (see example in Figure 3).

Figure 2: Example histogram of total zinc data from storm events, produced using the web-based portal.

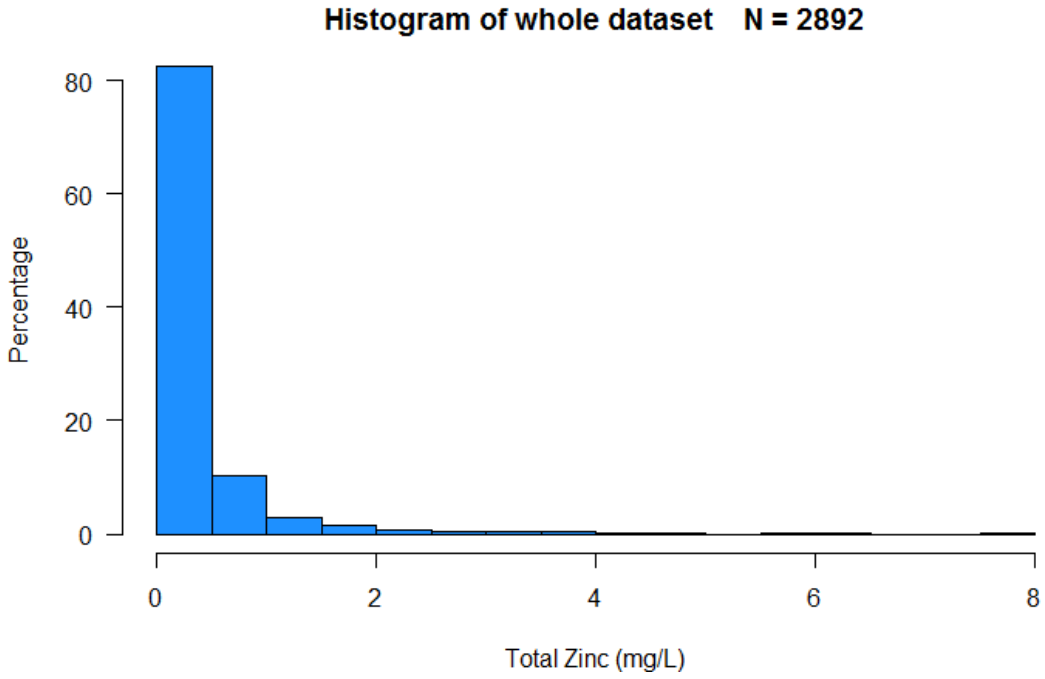
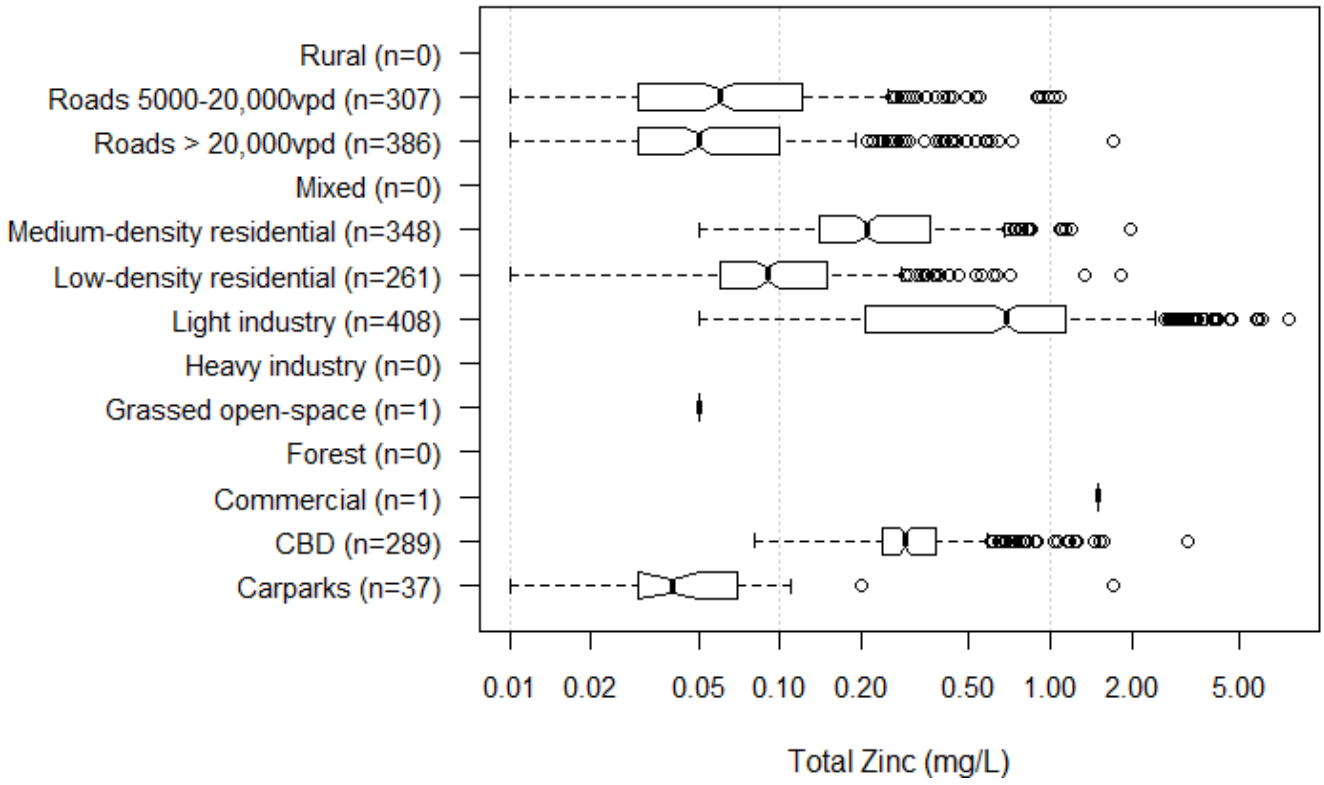


Figure 3: Example box plot with total zinc data from storm events grouped by primary land use, produced using the web-based portal.

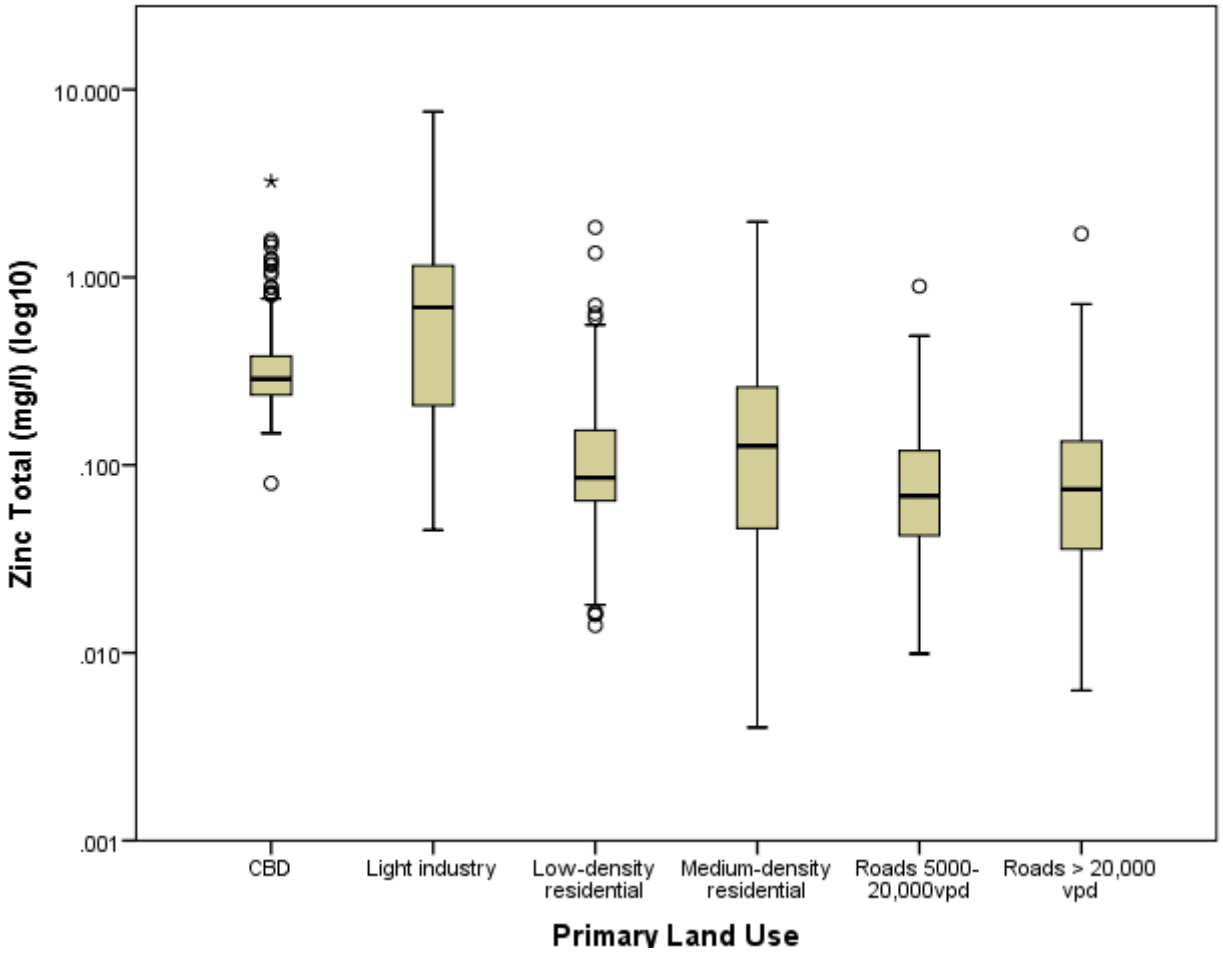


5 CASE STUDIES OF DATABASE OUTPUTS

5.1 STUDENT DISSERTATION

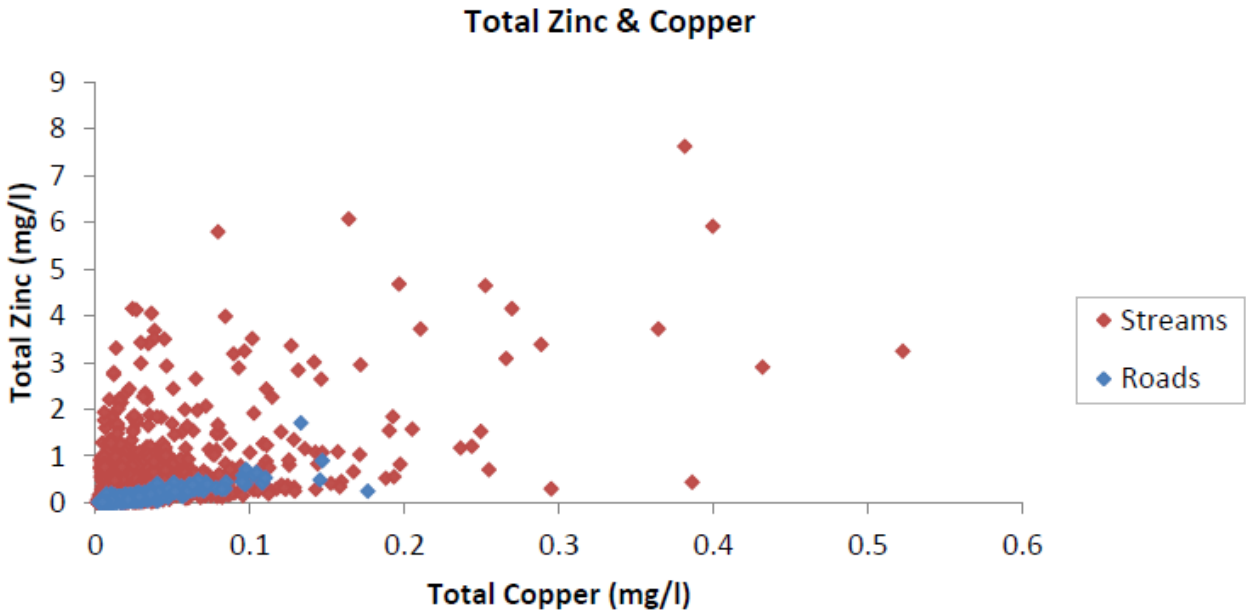
The database has been used as a source of data for a student dissertation (Garton, 2012) with the University of Auckland School of Environment. Stormwater data for different land uses in the Auckland Region (Reed and Timperley, 2004, Timperley et al., 2004 a, b, c) were extracted from the database to investigate statistical relationships between suspended solids, copper and zinc. An example of the data used is shown in Figure 4 below and shows the concentrations of total zinc for the different land uses.

Figure 4: Box plots of total Zn concentrations for each land use set to a log10 scale (from Garton 2012).



One of the findings of the statistical analyses conducted for this study indicated that the relationships between contaminants depend on the land use. For road runoff, there was a clear relationship between total copper and total zinc; however for other land uses, and for streams, which may have a variety of land uses, the relationship was much less clear (see Figure 5). A large number of other statistical analyses were conducted that are not reported here (see Garton, 2012 or contact the authors for details).

Figure 5: Scatter graph plotting the relationship between total zinc and total copper (from Garton 2012).



5.2 EVALUATION OF SOUTHLAND DATA

The database is also being used to evaluate urban runoff data collected in the Southland Region in an Envirolink funded project. This evaluation is statistically comparing Southland stormwater data to that collected elsewhere in New Zealand, and also comparing data from different land uses. Such tasks are straight-forward using the database. This project is currently in progress and we intend to include some of the results in the conference presentation.

6 CONCLUSIONS

An urban runoff database is being developed to collate the extensive data collected throughout New Zealand over the last 10 years. The database can hold many different types of monitoring data and multiple different parameters for both water and sediment quality. It can be used both as a repository for collected data and as a source of typical data where monitoring cannot be undertaken. It is hoped that the database will be of benefit to stormwater managers and researchers throughout New Zealand.

Metadata is included relating to the site and storm events monitored. This metadata enables basic statistical summaries and comparisons which will be accessible through a web-based portal where users can choose the data to include and compare. The inclusion of comprehensive metadata will allow for more complex analyses in the future as the database grows. Combining the data from multiple studies around New Zealand will allow users to examine relationships that may not have been apparent with more limited access to data.

If you would like to contribute data to the database, please contact the lead author:

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ACKNOWLEDGEMENTS

The authors would like to acknowledge the funding received from the NIWA Freshwater Research Programme (2011-2013 SCI); Auckland Council Stormwater Unit; and Envirolink (Advice grant 1228-ESRC256). We would also like to thank Matthew Davis and Judy-Ann Ansen of Auckland Council and Dr Elizabeth Fassman and Dr Asaad Shamseldin of University of Auckland School of Engineering for feedback on initial database design and peer review.

We would also like to thank the following organisations that have supplied data for the database:

Auckland Council
Christchurch City Council
Environment Canterbury
Greater Wellington Regional Council
Kaikoura District Council
Nelson City Council
New Zealand Transport Agency
Otago District Council
Environment Southland
Tauranga City Council
Waikato Regional Council
Wellington City Council

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