RAINFALL REPORTING: PAST, PRESENT FUTURE?

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ABSTRACT

Auckland Council has a comprehensive rainfall and flow gauge network, yet core data needed to run and understand our business was difficult to access and, available to only a handful of technical staff . Post event analysis of rainfall data was taking 24 hours or longer, depending on the outputs required.

Only a historical understanding of an event could be gained, due to the time required to analyse data, and limited access to the data. Council recognised the need to make data accessible to 120+ staff, and to allow reporting within minutes of rainfall occurring – and preferably to provide a forecast – to assist in event management, and preferably to give advance warning of the potential for heavy rain.

We recognised if proprietary rainfall data could be made visible via the cloud, to a wide range of people, in an intuitive GIS based environment we could better fulfil our function as a Stormwater Utility. We directly tackled this issue, and all rainfall data is now available via a web based geospatial portal, which puts the first piece of the puzzle in place.

The geospatial portal has now been extended to allow regional post event reporting, almost in real time, showing rasters, and contours for ARI across different durations across the region – post event reporting now takes a fraction of the time it took prior.

There is a need however to improve reporting, beyond the capabilities of our current point gauge network. The spatial density of rain gauges means either the most intense rainfall may be missed, or spatially overrepresented by a gauge – either way, significant bias is introduced in spatial extrapolation from point gauges.

Council have now successfully implemented Metservice rain radar via the same web portal as the gauge data.

KEYWORDS

Rainfall, Rain Radar, Event Reporting, Flooding

PRESENTER PROFILE

Kris Fordham, is a Senior Stormwater Specialist within the Waterways Planning team at Auckland Council. Kris has 15 years' experience in operational hydrology, including the installation, calibration and maintenance of monitoring sites. More recently Kris has changed focus, interpreting and analysing hydrological data for engineering and planning purposes.

1 INTRODUCTION

Measured rainfall and flow data is at the core of the Auckland Council's Healthy Waters business. Until recently this data has been stored in secure proprietary databases, which were difficult to access. This placed unnecessary workload on the few staff with access to, and knowledge of how to interrogate, these databases.

It was identified that there were strategic and operational benefits for the Healthy Waters Department that could be realised by mobilizing hydrological data, via cloud based technology. A cloud portal solution could provide easily accessible analysis and visualization tools in which to operationalize the Auckland Councils hydrometric database.

If proprietary rainfall data could be made visible via the cloud, to a wide range of people, in an intuitive GIS based environment, we could better fulfil our function as a Stormwater Utility including:

- Providing near real time operational rainfall and flow data for the region,
- Providing additional assistance to Civil Defence management and planning,
- The ability to quickly analyse and report the spatial extent and severity of rainfall events,
- The ability to provide the public with access to a single regional rainfall information service via a web portal.

Providing near real time access and event analysis of 72 rainfall sites and 67 flow site presented a challenge for data administrators and analysts within traditional time-series databases, therefore a new innovative approach was required.

As a result, the Storm-I rain gauge consolidation portal was developed to include current and historical rainfall and flow data, and associated post event analytical tools.

This paper summarises the data mobilisation initiatives implemented to date, and looks to the future where automated gauge corrected Metservice rainfall radar will be available, via the cloud based portal.

2 THE PAST

We are pretty good at collecting and storing information. The issue we struggle with is what to do with the data once it is collected and how further value can be derived from it.

One of the things that requires data mobilisation is rainfall and flow data, particularly when flooding or when heavy rain occurs.

For Healthy Waters, this is our peak demand and when our customers are most affected. In Auckland, our catchments are relatively small so we don't have long lead times to know when it is going to flood. Houses and habitable floors get flooded when water is making its way to the streams, not necessarily from streams bursting their banks. Therefore it is important for us to understand rainfall as it relates to an event, and to respond and communicate this as promptly as possible to our customers.

Post-event reporting is the practice by which significant flooding is reported after a heavy rain event, often including flooding of habitable floors. It is also common practice to

report on the AEP (Annual Exceedance Probability), or the expected frequency of such events.

In the past staff would manually analyse and interrogate 72 rainfall sites and 67 flow sites.

2.1 SAFE, SECURE AND INACCESSABLE

Traditional systems and time series databases such as Hydstra, are very good for storing and managing large amounts of data. They are also very powerful in terms of the analysis that they can perform. However they do have some limitations:

- It is difficult to spatially analyse data,
- As well as having the licencing fees you have to have someone relatively well trained in its use,
- The data is relatively inaccessible,
- The software is not intuitive, and the software has an underlying DOS look and feel to it with specialised executable programs for analysis.

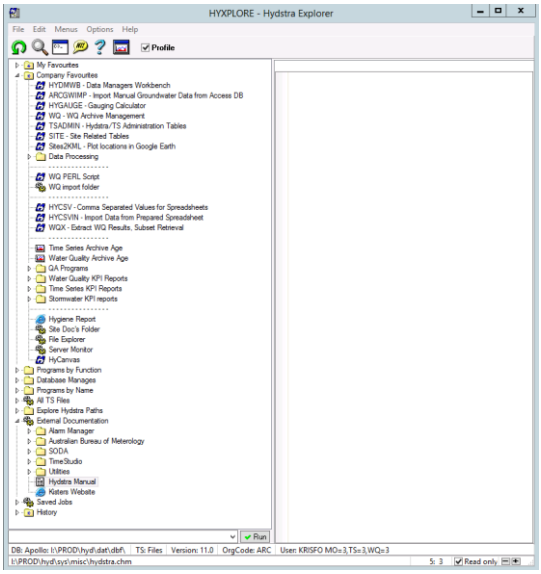

Figure 1: Hydsta Interface, Hyexplorer

As a secure hydrological archive, Hydstra works well. For staff familiar with the program and the analysis suite, Hydstra can perform the analysis required to undertake detailed hydrological reporting of storm events. However, as there are a limited number of staff available who have access and the level of experience and training required to process the data, the data remains relatively inaccessible.

So inaccessible in fact that a during a significant rainfall event in July 2015 it took three people close to 24 hours to analyse all the rainfall data and provide meaningful spatial outputs to begin to inform stakeholders what had happened, and start formalised reporting of how large an event it was and where the storm hit.

During an event not only do we have operational staff and contractors requiring event information, we have politicians, Civil Defence and ourselves wondering just how large

any given event may be. A 24-hour data processing overhead isn't a useful timeframe to enable us to effectively communicate with our customers.

We needed to improve things moving from a static analysis and reporting framework to a dynamic near real time operationalised data reporting platform where all of our data is connected and we can gain insights from other data streams.

3 THE PRESENT

We have made great progress in the mobilisation of the hydrometric network between 2015 and 2016.

By the time Auckland experienced a large rainfall event on the 29th June 2016, we were able to access data via Storm-I, a cloud based application we have built. Storm-I contains all of our rainfall data geospatially located and available in real time. The data is stored in a flat file non-proprietary format and is now live. Figure 2 shows the portal which is based on a user friendly Google Map Graphical User Interface (GUI). This enables us to view any gauge at any time.

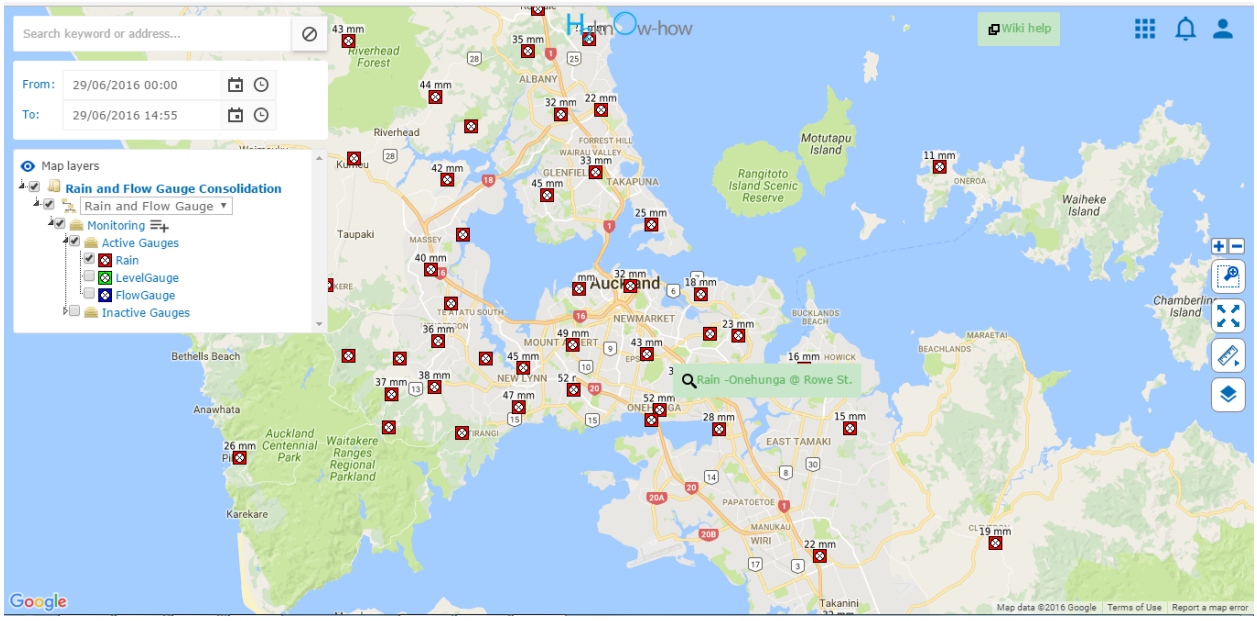

Figure 2: Storm-I Rainfall Web Portal showing gauge locations *(Storm-I web portal)*

We are now able to report on all gauges in the region in less than 1 minute; this is more than 1000 times faster than where we were a year prior to get the same data. The other major change is, instead of having one person able to access the data during business hours, we now have more than 100 people able to access the data at anytime from anywhere.

3.1 PROCESSED, SPATIAL DISPLAYED AND AVAILABLE

As we store Intensity Duration Frequency (IDF) curves within the system we are able to quickly report in graphical form. This is important to us; we want to be able to know that our network has been able to cope with the event or whether it is more of an "Act of God" and something quite extreme. Figure 3 shows an event (Red) as it relates to a 10- and 20-year event (TP108). This reporting can now be done across all sites in minutes.

Information about the recurrence interval is always what the public want to know: how often we are going to be affected by events like this? Our politicians want to be assured that our network is operating as per community expectations.

Figure 3: IDF Analysis TP108 – the measured event is plotted in red *(Storm-I web portal)*

Is having this analysis really that important? Is understanding return periods for events really that important if it only happens every 10 years or 100 years? If we operated within a city on the banks of a major river, flooding would occur infrequently. But because our region is spread across 230 relatively small catchments, houses flood in short 10-minute rainfall events through to 3-hour rainfall events. Therefore it is important for us to understand the frequency and duration of all short duration events. Within the region we have a 100-year event occurring somewhere once every few years and 10-year event much more frequently at short durations.

An added benefit from having the data accessible and spatially represented is that data can be integrated with other data streams for business intelligence reporting. Figure 4 show the rainfall data and rainfall contours for the event on the 29th of June 2016. Overlaid are all of the customer emergency requests for service (RFS) from the June event.

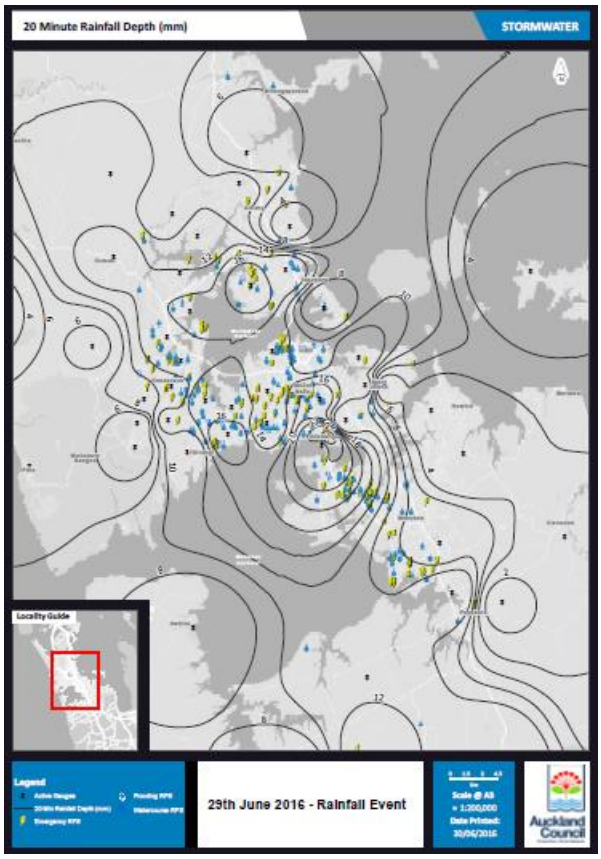

Figure 4: Rainfall depth contours and RFS for the 29th of June 2016

4 THE FUTURE

A known limitation of rain gauges is the spatial density and "catch" of rain gauges, i.e. any rain gauge will only measure the rainfall that fell immediately above the gauge. This may mean that either the most intense rainfall may be missed and not included in the analysis, or if the most localised and intense rain is incident on a gauge, the spatial extent of the high rain rated may be overestimated. In either case large biases can be introduced which makes it difficult to draw robust conclusions as part of post event reporting.

In Auckland, the shorter the duration of a rainfall event, the more localised the event tends to be. We have 50 rain gauges in the urbanised area of the region. It is estimated that to adequately spatially represent rainfall we would need 500 to 1000 rain gauges sampling the rain which falls. The deployment of this number of sites is unrealistic.

It is expected a significant improvement in post-event rainfall pattern reporting can be gained by using rain radar. This will not only allow better identification of localised intense rainfall events, but will allow accumulated rainfall over areas of interest to be determined more accurately. This will provide many reporting benefits, such as understanding the actual rainfall around areas of flooding, rather than only rainfall at the nearest gauge, which may be some distance away.

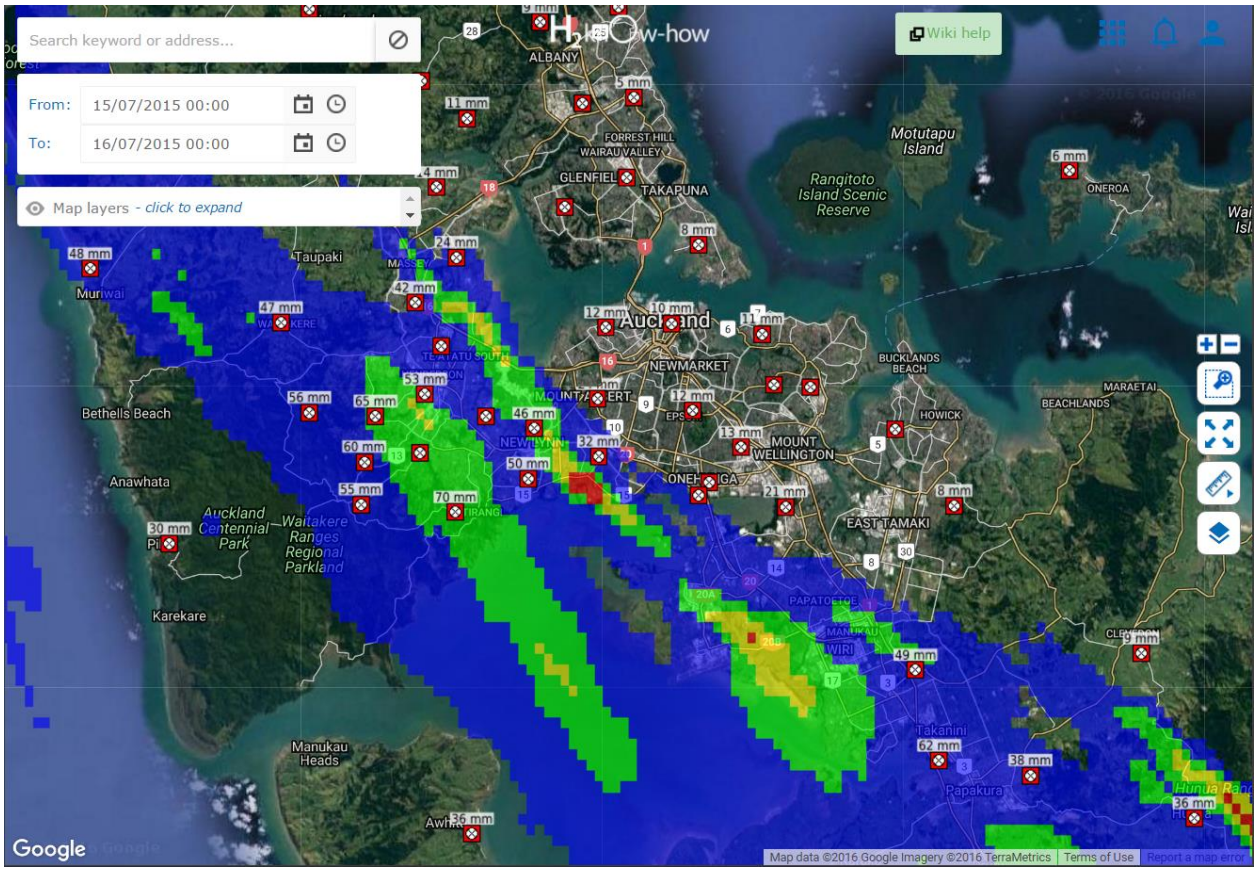

Figure 5: Corrected Rain Radar showing cumulative rainfall totals. The red indicates high rainfall *(Storm-I web portal)*

Luckily for us the region is well covered by the radar run by the NZ Met Service. We have access to the live data stream and we are using our raingauges to create gauge-corrected radar – the process of turning radar reflectivity into rainfall for each event. Now we are at the point where we are able to ingest the rain radar data, gauge-correct it using our rainfall data, and supply that through the cloud so we are able to see and feel how large each event is as it happens.

Figure 5 shows the gauge corrected rainfall for the event on the 29th of June 2016. This clearly illustrates the bands of rainfall and how the locations of the most intense rainfall were not captured in our rain gauges.

The fantastic thing about having the corrected rain radar data is that we can see the locations that experienced the highest intensities and totals. We can then relate this information back to requests for service from customers, providing a better understanding of the rainfall event.

In recent events, when we have been using the radar not only have we been able to respond to those people who have called to let us know there is an issue, we've been able to proactively check in on customers where the rainfall is the heaviest and provide assistance without being asked. We can therefore provide a much more proactive approach to incident response and rainfall event management.

5 CONCLUSIONS

We have come a long way since we amalgamated 8 councils into one. For us, having the right people working together in an aligned way is delivering excellent outcomes for our

customers and also making our own lives easier. Through making information widely available to ourselves and our suppliers we have enabled a greater understanding of the issues faced by our customers.

By bringing our hydrological information together in one place, and using the smart analytics embedded in Storm-I, integrated with strong visualisation capabilities, we are now able to make more optimal business decisions. What we are doing with Storm-I that wasn't possible 3 years ago, is that we now have billions of lines of information all accessible via the cloud in real time, operating faster than if it were running off our own network.

As a result, we no longer have to limit ourselves to the use of proprietary software to access the core data required to run our business. Making core data available to as many staff as possible greatly improves the customer experience and allows us to more readily respond and anticipate their needs. Through making information widely available to ourselves and our suppliers, we have enabled a greater understanding of the issues faced by our customers

The day before yesterday life was hard. Yesterday life got easier. And we're excited to see what tomorrow brings as we strive for best practice.

Acknowledgements

Nick Brown

Ken Williams

Tom Josephs

REFERENCES

Storm-I web portal