Australasian Hydrographer

June 2016

Above image:
Remnants of Gauging hut at
G8140044 Flora River Upstream
of Kathleen Falls after 850mm in 3 days. Gauging hut had
a floor level of 14m; the event peak height was 16.7m.
Inset: Gauging Hut (constructed late
1960s) before the flood event.

AUSTRALIAN
HYDROGRAPHERS
ASSOCIATION

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JACQUIE BELLHOUSE

Editor's Introduction

Welcome to the June 2016 Issue of the AHA Journal. Wow what a busy and productive 6 months it has been!

Thank you to the Hydrographic community your prolific contributions to the June 2016 journal. I hope that our fellow members find some inspiration within these pages. If you do by chance feel motivated to contribute, please don't feel you need to wait for the next call for articles, put some notes together now and send them through. To quote a fellow sandgroper and my predecessor Frank Davies "the profession of hydrography has always benefited by learning from other's experiences".

I in particular took a lot of learnings from Corey Baird's article on Catchment Area determination using the Bureau of Meteorology's Australian Hydrological Geospatial Fabric (Geofabric) for delineating watershed. For me this article is a great demonstration of the practical application and benefits of the toolset.

To provide further context to the ADCP Regatta report, you may have seen in the December eNews, Mic Clayton has provided two articles covering both the inaugural Australian ADCP Regatta and the New Zealand Hydrological Society's recent annual Technical Workshop in Gisborne. Both articles are great examples of recent opportunities for professional development and peer collaboration.

Our Hydrographic profile this month is for the AHA's Treasurer of over 30 years, Max Hayes. As usual please keep your nominations for hydrographic profiles coming in. Profiles for Hydrographers of all levels of age, gender and background are appreciated.

Lastly since our last journal in November there has been a changing of the guard with our President of almost a decade, Bill Steen and our Professional Development Officer and Vice President Paul Langshaw retiring. Both Paul and Bill leave big shoes to fill and I for one am grateful for their outstanding contributions to both the AHA and this Journal.

In their stead the committee has elected Bill Barratt as President and Simon Cruickshank as Vice President until the next Annual General meeting.

Please see our Vice Presidents update on the other notable changes within the Association since the last Journal in November 2015:-

Regards
Jacquie Bellhouse
Journal Editor

SIMON CRUICKSHANK

A Word from the Vice President

This is an exciting time for AHA. Under previous president Bill Steen, the association has grown significantly. Now the association has the opportunity to become more professional and improve the delivery of services to its members.

Some of the most notable changes since the November 2015 Journal include:-

A New Governance model…

Under the new Governance Model:-

- The Committee sets policies and directions;
- The Chief Executive Officer is responsible for implementing Committee policies. The AHA National Office fills the role of CEO;
- Where a committee member works on implementing board policies, such as editing the journal, publicity (including preparing and sending email blasts), and website maintenance, they answer to the CEO, not to the committee;
- The CEO is empowered to do whatever it takes to implement policies, subject to limitations set by the Committee;
- The committee defines performance metrics (KPIs) for performance of the CEO.

The new model is already proving successful with roll out of a number of new initiatives facilitated without delay. Previously operational decisions were frequently held over to meetings, now meetings focus on strategic issues.

Developments in Training...

The AHA is pleased to announce that John Skinner has been appointed as AHA Training Consultant. Read more about John's appointment on the AHA website **aha.net.au** … click on **Information > News**. In association with John's appointment the AHA has also documented and implemented new management processes.

Significant changes in the training space are afoot: **training.gov.au**, the National Register of Vocational Education and Training (VET) in Australia, has announced that a new Diploma will be launched in 2017. As a result all the current AHA training courses require updating. If you are part way through the Diploma and have specific questions about these changes please contact John Skinner at **training@aha.net.au**.

Recent and ongoing restructuring by several jurisdictions around Australia is likely to result in greater competition for vacancies in the future. Increasingly employers, especially those in the private sector are looking to employ certified and qualified staff as part of their QA system and to gain a competitive point of difference.

Changes to Membership…

In response to requests from a number of companies, a new Bulk Membership category was launched whilst the old corporate membership has been discontinued. In essence the more members signed up from a company, the greater the discount.

Since its introduction a number of companies have taken up bulk memberships, if your company is interested please contact the National Office.

Partnership...

The AHA now offers a range of benefits to companies who sign up as partners. Benefits include high profile and representation at AHA Conference.

Since its introduction, ten organisations have signed up as Partners for the 2015-16 financial year.

AHA 2016 Conference...

The National Office is now the Conference organiser and as such has been busy assembling a team to assist the **call for papers** and developing the program.

It is encouraging to see that most of the available conference sponsorship opportunities are already sold for the October 2016 Conference in Canberra.

A New website...

By now we hope you have seen our new website (**aha.net.au**). The site has a bright new fresh look that will also enable it to work on newer technologies such as phones and tablets.

I look forward to catching up with you at the Conference in October.

Regards
Simon Cruickshank
Vice President AHA

Catchment Area Determination

An investigation into using the Geofabric toolset for delineating watershed

Corey Baird
Department of Land Resource Management, Northern Territory

This report provides an analysis and evaluation of the prospective opportunity the Bureau of Metrologies' Australian Hydrological Geospatial Fabric (Geofabric) offers in to delineating watershed for gauging stations in the Northern Territory's Department of Land Resource Management (the Department) surface water network. The project's aim is to determine whether the Geofabric's results are sufficiently aligned with, or proved more accurate than catchment area data presently stored in the Department's water database Hydstra.

Introduction

Context

Drainage basins and their associated catchment area are fundamental elements of hydrology. They are both ecologically & economically important. Catchment area is an important piece of the rainfall/runoff relationship and for understanding relative catchment and sub-catchment flow contributions.

Currently there are a number of gauging stations in the in the Northern Territory's Department of Land Resource Management's Hydstra database missing Catchment Area values. This project sought to find an appropriate method to fill ~3000 catchment area values.

Historic Methods

Catchment boundaries for the Department of Land Resource Management's (the Department) gauging stations were traditionally delineated using a planimeter and 1:250,000 topographic maps. Hydrographers traced the perceived catchment boundary using contour lines and received the catchment area figure on the instrument itself. These values were then entered into the Department's water database, Hydstra. These steps hold many potential sources for error, from incorrect boundary delineation through to the data entry process.

Modern Methods

Computer aided methods for hydrological tasks and calculations have gained considerable traction in recent years. These processes, while relying absolutely on high quality inputs and the discretion of the user, are capable of providing accurate and repeatable results.

The Bureau of Metrology's (the Bureau) Australian Hydrological Geospatial Fabric (Geofabric) is a software package comprised of Australian hydrological data and spatial analytical tools intending to aide water information processing (**www.bom.gov.au/water/geofabric/**). Through a topologically complete (i.e. a connected and directional) stream network and pre-rendered basin catchment areas, built from digital elevation models, catchment area can be derived for any given coordinates.

While the calculation processes are procedural, the Geofabric database required preparation, and the toolset required input over multiple steps. Firstly, a subset of the Australia-wide data was produced for the Northern Territory.

Calculating catchment size is an interactive, multi-step process driven by a menu system (Figure 1); users are required to input coordinates, synchronise these with the internal network topology and finally instruct the Geofabric toolset to calculate catchment boundaries and area according to a number of options.

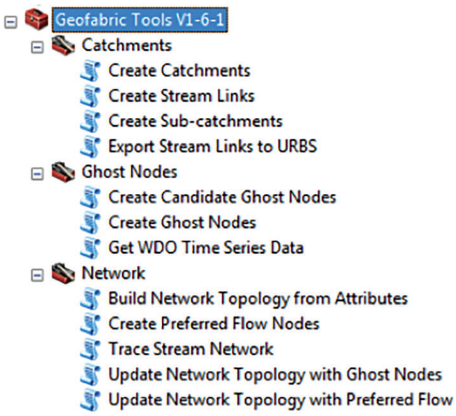

Figure 1: Menu driven tools required for deriving catchment.

With these parameters set, and the importing of gauging station geospatial coordinates, the Geofabric toolset is able to derive and display catchment area and boundaries representing the gauging station watershed.

Suitability of the Geofabric

The project aimed to determine the viability of using the Geofabric to calculate catchment area for three scenarios:

1. New gauging stations requiring catchment area calculations,
2. Existing gauging stations missing catchment area values, and
3. Existing sites with catchment area values present.

Scenario 1 & 2 share many similarities and were treated together accordingly. Scenario 3 provided the opportunity to test the Geofabric product against catchment areas derived by experienced hydrographers.

To begin the project, four catchments distributed south and east of Darwin were selected. From within these catchment areas, all gauging stations with a reported 'Catchment Area' were extracted from the Hydstra database (Table 1 and Figure 2).

The Geofabric was then used to calculate catchments for each individual station and report catchment area in square kilometres (km^2).

Table 1 Regions and Stations used in the project

Basin Region	Internal Code	# Gauging Stations	# Successfully Completed
Adelaide River Basin	G817x	29	28
Katherine / Daly Basin	G814x	38	35
Finniss River & Darwin River Basins	G815x	44	33
East Alligator River Basin	G821x	21	20
	TOTAL:	**132**	**116**

Figure 2 shows the gauging stations contained within the respective river basin regions.

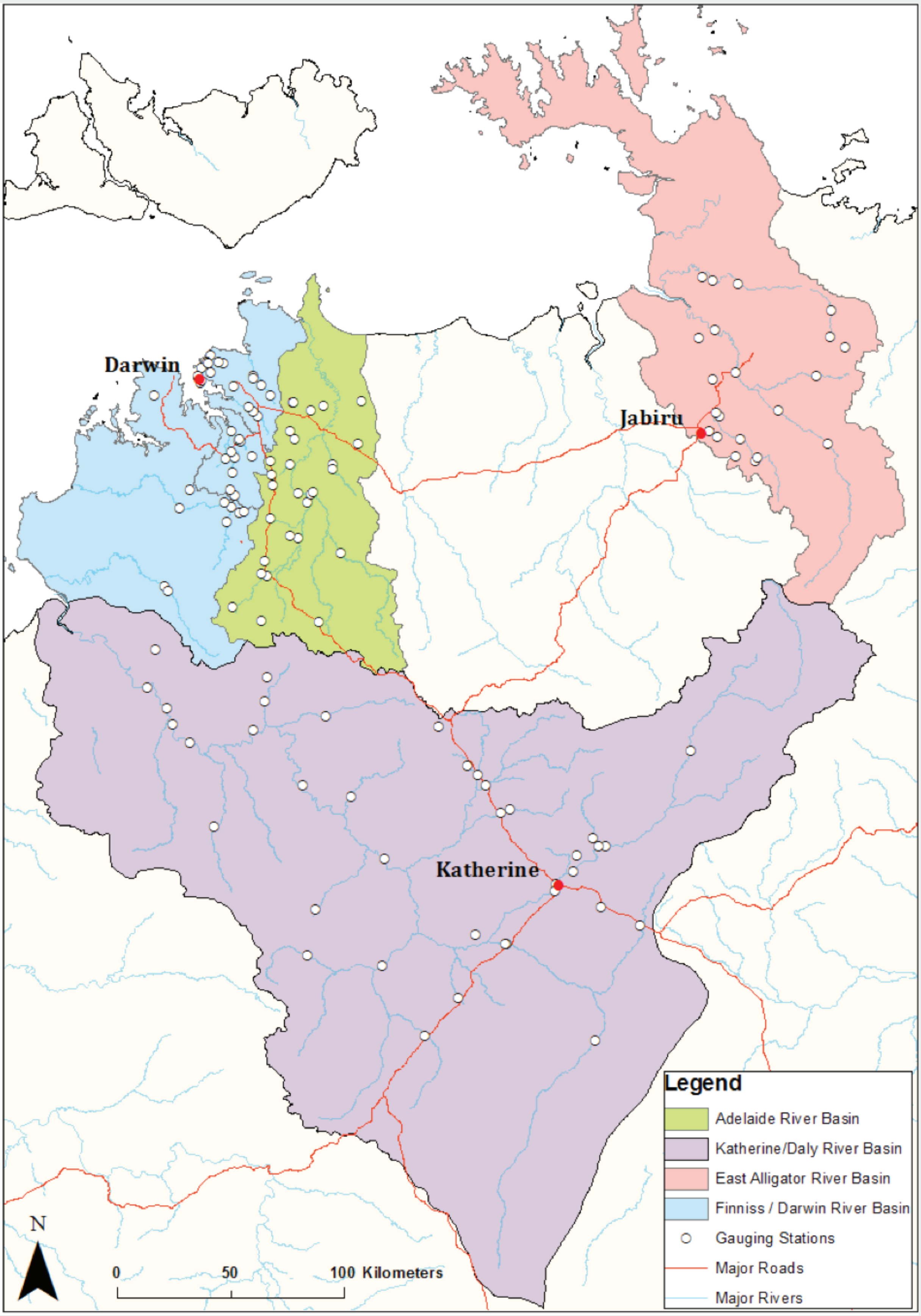

Figure 2: Geofabric generated catchment areas with associated Gauging stations.

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The Geofabric was supplied with 132 gauging stations, and successfully derived catchment area for 116 stations. Of the completed stations, forty were found to have discrepancies of over 10% when compared to the values, stored within Hydstra. Sixteen stations failed to complete the delineation process, of these a majority were discounted from the process due to falling outside the stream search radius, however a minority failed due to unspecified errors within the final phase of catchment creation.

The Geofabric calculated boundaries were verified against 1:50,000 topographic maps, while the calculated catchment area values were compared against related entries in Hydstra. These two methods allowed visual inspection of Geofabric's results and provided a means for comparison between the two systems.

Discussion

The Geofabric is a convenient, precise, consistent and transparent method for calculating catchment area. The Geofabric identified a number of erroneous values, stored within Hydstra, and provided reasonable alternative values. The Geofabric excelled at:

- Calculating sub-catchment area values for:
  - o Small-medium sized areas (~1 km^2 – ~200 km^2);
  - o Monitoring stations located close to large cities (Darwin).
- Identifying errors in pre-existing values.

However, the current version of the Geofabric has limited, though still workable, application within:

- Urban and built up areas;
- Large (~200 km^2 and above) & remote areas.

While otherwise considered good practice, these limitations demand that the Geofabric results undergo manual checking and verification by hydrographers. While it is possible to use alternative data sources to improve resolution and stream network accuracy, it is a somewhat impractical and arduous task. If the user is prepared to go to such lengths, it is suggested the internal ArcMap Hydrological toolset may actually prove easier.

Fortunately, as the Bureau continues to release updated datasets derived from higher resolution data, stream networks will increasingly represent reality; hopefully removing the aforementioned limitations. Regardless of the data source, catchment delineation is constrained by an inherent inaccuracy present in all digital elevation models (DEM).

In relation to the end user, the Geofabric process can be highly automated using ArcMap models (Figure 3). The hydrographer needs only to input station coordinates (individually, or using Comma Separated Value (CSV) files), and the ensuing operations run automatically according to a pre-defined model. To become a standard tool used by Hydrographers, within the Department, documentation, protocols and guidelines will need to be developed. While the Bureau does provide documentation for the Geofabric, these are generalised operations not specific to the Northern Territory.

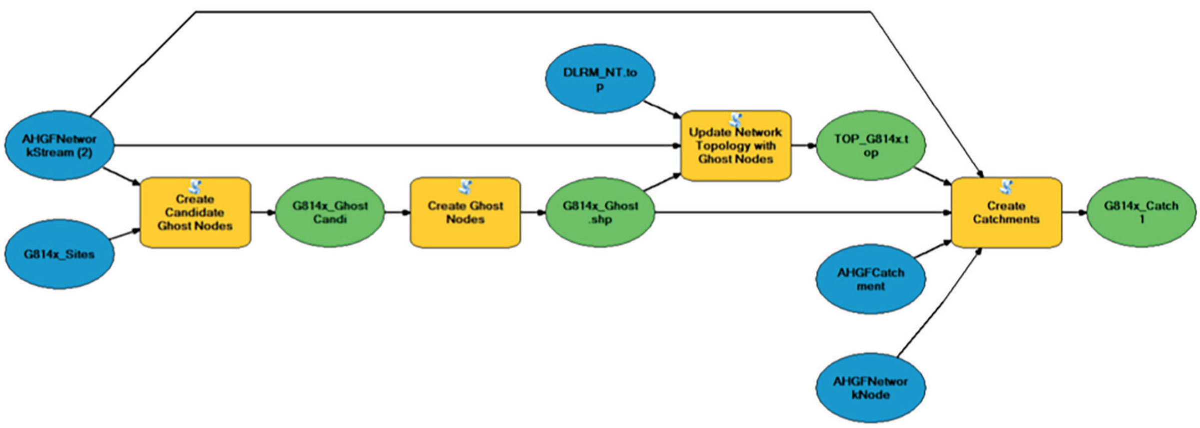

Figure 3: ArcMap Model to streamline the catchment creation process.

Advantages

Transparency & Consistency

Results returned by the Geofabric toolset are afforded an inherent transparency and consistency owing to the procedural nature of the calculations. To generate the catchment area data, the Geofabric iterates through a static model, i.e. the model and the data is identical each run. During this process each step can be identified and the calculations investigated. This is important for accountability, as well as verification. It allows the Department to have confidence in the results they use for modelling or publish externally. These steps have the added benefit of conferring consistency and repeatability; if ran 100 times, the same result will be achieved every time. Furthermore, the operation of the Geofabric generates data, which can be stored for reference and inspection.

Revisable

The Geofabric's generated data can be checked at any time to upgrade or degrade the quality of the data, or to alter previous results. If for example data is lost, station GPS coordinates are changed, or the Geofabric datasets are updated, the user can instruct the Geofabric toolset to redo the calculations.

Verifiable

A number of mechanisms allow for the derived values and catchment boundaries to be verified. This can occur visually, or with logical checks. Storage of data allows the result to be verified presently, but also in the future when new data may become available.

Ease of use

Working with the Geofabric requires an understanding of some software intricacies; however, the process is fairly streamlined and can be completed in a few small steps. Indeed, knowledge of hydrological processes is not a requirement for the generation of catchment boundaries and values, therefore allowing calculations of an entire network at once, which can then be verified by an experienced hydrographer.

Limitations

Delineation Process

Geofabric calculations provided consistent and usable results, particularly for catchment regions close to Darwin, however the software does face a number of minor problems and inconsistencies:

- Catchments involving urban coastal areas resulted in unverifiable catchment boundaries. It is hypothesised that for urban areas the Geofabric is incapable of calculating drainage systems and therefore over-estimates the total catchment area. Furthermore, the Geofabric often fails to incorporate gauging stations in the calculations when located in urban areas (Figure 4).

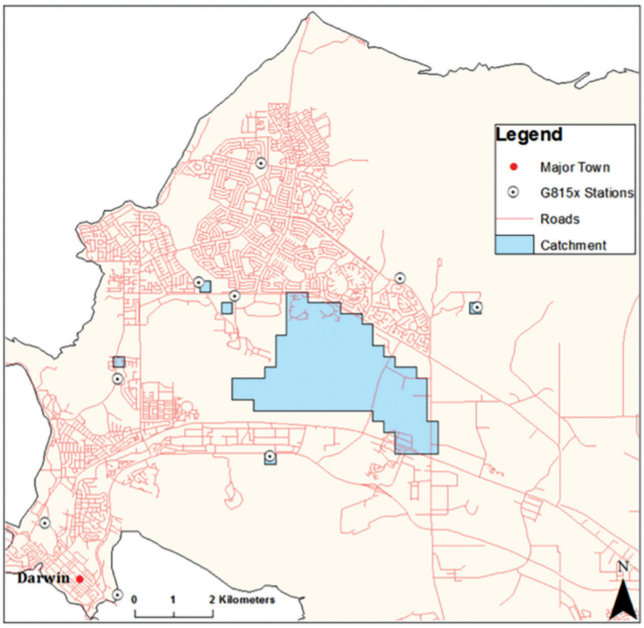

Figure 4: Urban coastal region with generated catchment shown.

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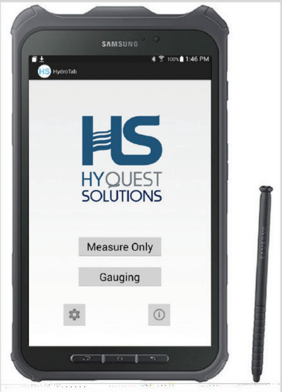

Features:

* Low powered (up to 11 hours battery life)
* Capture and transmission of images from field sites
* GPS feature (to record location)
* Waterproof and shock proof case (IP67)
* Easy to read screen in high levels of sunlight
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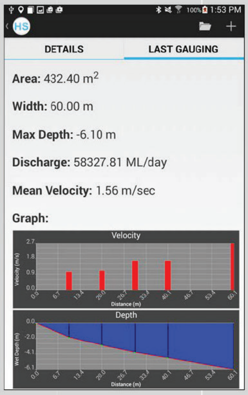

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* Support for the testing of HS and non-HS Rain Gauges alike through custom product setup
* Run in feature allowing a set number of tips to be passed through prior to calibration
* Live update of historical tip count throughout the test
* Progress tracking of test and individual runs
* Database storage of historical results
* Automatic generation of calibration reports (print and/or PDF format)

For further information please contact Mike Lysaght:
T: +61 2 9601 2022 E: mike.lysaght@hyquestsolutions.com.au

- Large topographically featureless catchment areas calculated by the Geofabric proved difficult to verify. This is simply due to their scale, and the myriad of elevation changes, creeks and streams found within the area.
- The Geofabric derived catchment boundaries may extend well beyond isolated streams, or conversely, ignore them. Further, the boundaries seem to 'cut' across the land, indicating a lack of real-world data for these areas. This is not necessarily a fault of Geofabric, as determining watershed boundaries from DEM's are difficult in such flat and arid areas such as the Northern Territory outback.
- Distance from Darwin correlated with larger disparity between the values stored within Hydstra and the Geofabric's results. It is hypothesised that the Geofabric's data for remote areas is less complete and perhaps of a lower resolution than those close to major cities.

Location

As the Geofabric modelling process relies on stream topology; user coordinates for gauging stations are actually relocated to a node on the closest stream, and only from this point can catchment area be derived. Therefore,

- Geofabric ghost nodes were being placed at different stream locations than the actual physical station. This can cause an issue, for example, whereby a node may be placed downstream of a junction rather than upstream, thus dramatically increasing reported catchment area and presenting the differences between Geofabric 's results and the values stored within Hydstra.
- Imprecise station coordinates can result in nodes placed on incorrect streams.

These limitations exemplify the process the Geofabric takes. It is a 'dumb' program performing calculations with available data; it does not possess river name intelligence nor is it capable of perform verification checks.

Verifying Results

Validation methods need to be simple yet effective in routinely catching errors. Currently, the Geofabric doesn't have any validation methods. Therefore, the following methods have been proposed for the Department.

Visual Checks

Visual inspection of the catchment boundaries overlaid on topographic maps provide an immediate check on whether the boundary and thus catchment value is realistic. Interestingly, the Departments stream network layer, Geofabric stream's layer and the topographic maps show divergence in stream location, rendering verification of some locations problematic. The following ideas are proposed to remove reliance from technology, and explore logical avenues for verification:-

Name of station

Gauging stations often reference their position along the river in their name (e.g. Manton River Upstream Manton Dam). This can be used advantageously for verification to ensure:

- Nodes were created on the correct river,
- Nodes were created in the correct position (Upstream or Downstream of a notable location)

Proportional Area

As stations continue downstream of a river system, distance along stream and proportional share of catchment area should increase.

Enhancements

The Geofabric toolset does not currently allow for easy manipulation of calculated boundaries. The ability for users to re-draw the boundaries and having the toolset automatically recalculate the catchment area would be welcomed.

Users would also benefit from the Geofabric toolset implementing an internal 'clipping' function, providing an outline polygon or manually inputting the extent of the desired area, resulting in a geodatabase created with all required networks and cartographic elements for processing. Furthermore, while the Geofabric toolset already streamlines the process of catchment delineation, it could further improve efficiency if shipped with ArcMap models for the different spatial modelling tasks commonly performed. These feature would further simplify the process, and allow end-users to use the product without impedance.

The toolset requires clearer instructions and help dialogs. Options and parameters are often masked by jargon, and others prove unhelpful in describing the outcome of engaging the option. Likewise, error reporting seems to be limited. Ghost nodes are often excluded in calculations, yet no description of the error is provided.

Hydstra Imports and Requirements

Alterations

Alterations to the Hydstra database will be required to accommodate the new information. While 'Catchment Area' already exists within Hydstra, other information such as calculation method (e.g. planimeter or Geofabric V3), and an assessment of the quality of Geofabric's results are worthwhile inclusions. A mock-up is presented in Figure 5.

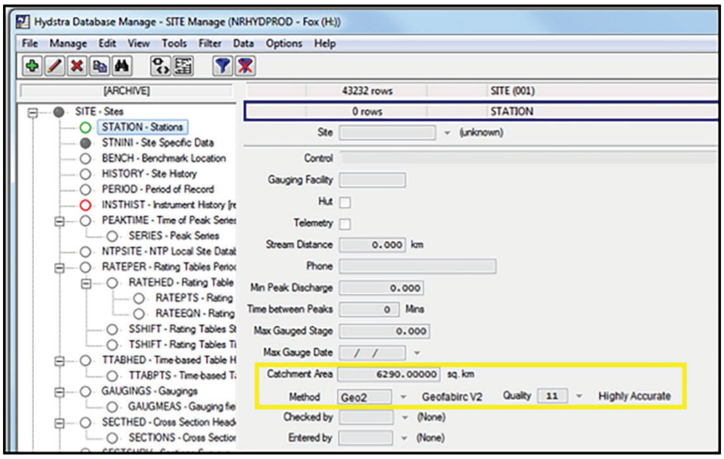


Figure 5: Mock-up Hydstra schema.

Database Population

Populating Hydstra is considered a forked approach.

The three scenarios are:

1. Newly Constructed sites from the implementation of this process
2. Pre-existing sites without catchment are data, and
3. Sites with catchment area data already entered.

The pathway for 1 & 2 are identical, and will be considered together.

Scenario 1 & 2 - Newly Constructed Sites & Sites without Catchment are values

For sites already existing in Hydstra but without a Catchment area value, SQL commands will be used. SQL allows for rapid population of values without data entry errors. One-off new sites will be entered manually and checked by another hydrographer to ensure correct data entry.

Scenario 3 – Sites with Catchment Area Data

Where the data stored within Hydstra and the Geofabric conflict, validation methods as previously described can be used to determine how realistic the Geofabric values are. It is recommended that unless noticeably erroneous, the Geofabric value be taken. If the Geofabric error is suspicious, the value stored within Hydstra should be kept, whereupon after the Geofabric dataset is updated the model can be run again for these sites with conflict and checked to see if the higher resolution models help with the delineation.

Procedural Recommendations

The following is an overview of the procedures recommended for using the Geofabric to develop catchment areas for new sites. This section aims to provide a general guide as to the workload demand and level of understanding the user will require. This procedure holds true for all three approaches.

Workflow

Delineating Catchment Area

To complete the task, the user must first create a .csv file containing the site name with associated latitude and longitude. The user then imports the csv file into the ArcMap model. The Geofabric will then procedurally create the desired outputs. The tool 'Export Feature Attributes to ASCII' will then automatically be engaged to produce an output .csv file with the results. Alternatively, catchment area can be used in an interactive step-by-step fashion:

Import Coordinates > *Create Ghost Node Candidates* > *Create Ghost Nodes* > *Update Network Topology* > *Create Catchment Area* > *Export Catchment Area table to CSV*

Regardless of the path taken, the catchment area boundaries should be checked using best resolution available topographic maps in ArcMap, and any suspect values are tested against the aforementioned validation checks.

Conflict resolution for Scenario 3

When considering Scenario 3 (Existing sites with catchment area values present), it is imperative to have a strategy for managing conflicting values. The decision will rely on performing the previously discussed validation checks. If it is determined that the Geofabric value is likely correct then it will be included into the database.

Storage of Raw & Processed Data

Storage of all data - raw and processed - will be a requirement within the Department. It allows future users and clients to query and comprehend the logic behind decisions and reached values. It is recommended that spatial data be saved in ArcGIS's native format of a geodatabase (a. gdb is a compressed file structure used by ArcMap), while all other data – coordinates and area values – should be saved in a .csv format.

Working with Hydstra

Populating the 'Catchment Area' field will be achieved with the use of SQL. SQL commands can input data directly into the Hydstra database from a .csv file containing the required area values associated with station numbers. Workflow for new stations will not change, as Hydstra will only require the input of two additional items – *Method and Confidence:-*

Method

Method outlines the processes whereby the catchment area value was derived. This could be entered as a manual calculation, or a value returned by the Geofabric. If the Geofabric toolset was used, it is important to note which version, as version changed will likely affect the result. Further, it allows a user to go back and rework the calculation using the correct version.

Confidence

The confidence of a value is integral to all data. It allows users to choose when and how the value can or cannot be used. The confidence of a catchment area value will indicate whether the user checked the value, and to what extent it was checked. I.e. A quick visual inspection, compared against topographic maps, or if it has passed by verification checks outlined in preceding sections.

Required Documentation

Documentation will be required for all functions and processes involved in using Geofabric. This includes the creation of a custom sub-catchment of the data to fit the Northern Territory region, and manually creating site locations and watershed calculations. Documentation should also encompass a list of possible errors and a means to resolution. Furthermore, guidelines for verifying and validating the catchment boundaries and catchment area values will prove vital in standardising quality codes. It is therefore recommended that documentation be created for the following subsets of operations and use cases:

Geofabric:

- Setting up Geofabric from scratch;
- Importing sites, and site lists into ArcMap;
- Working with individual tools in the Geofabric toolbox;
- Managing errors and inconsistencies produced by Geofabric;
- Verification of created catchment boundaries and gauging station location;
- Exporting created catchment values for use in Hydstra.

SQL:

- Using SQL commands to generate site lists for Geofabric;
- Using SQL to populate Hydstra fields.

Key Learning Points

Precise location

Precise location of monitoring stations is vital for achieving accurate catchment area results. Incorrect coordinates have the potential to dramatically change calculated catchment area values. This has implications particularly for water quality monitoring, but certainly affects all modelling and analysis with the derived value. Thus, ensuring station coordinates accurately reflect gauging stations or monitoring points is an important first step in the process to delineate catchments using the Geofabric.

Validation processes

Validation is a crucial step in the delineation process. The Geofabric toolset does not make educated guesses or informed decisions on catchment delineation; it follows a one-dimensional script to produce calculated boundaries and area values. The toolset does not check the produced data, therefore following validation procedures allows for inconsistencies and errors to be found, whether these are errors associated with data entry, station location accuracy or stream network topology.

Data Resolution

The Geofabric product requires improved resolution in certain areas, particularly in remote locations. Increased resolution will improve stream location accuracy. Fortunately, the tools and datasets are currently under active development, and the Bureau intends to release the next version in 2017.

Conclusion

At the completion of the project, it was determined that the Geofabric is capable of capturing catchment area values for gauging stations across the Northern Territory. While the current release Geofabric is *not* capable of replicating all the existing values stored within Hydstra, the toolset has revealed that it is not necessarily a desirable outcome; the Geofabric finding errors in Hydstra's reported catchment areas; likely to be associated with instrument or data entry errors.

While the Geofabric product is unfit for providing catchment area data *automatically*, the results are *more likely* to be closer to *actual* catchment areas than the Hydstra values for *most* locations. While many derived catchment areas are within a 10% margin of Hydstra values, some fell drastically outside this range, therefore requiring all existing catchment boundaries to undergo validation checks. For unpopulated catchment data for both new and old sites, the Geofabric toolset provides a viable and useful option to calculate and populate the fields. For populated fields, Geofabric serves as a capable tool of finding and overwriting errors.

The department has operated 502 Gauging Stations, with 365 of these having associated catchment area values. The project considered 116 stations across four catchments. In terms of performance, the Geofabric was able to delineate 88% of supplied stations and of these, 34% (40 of 116) had a discrepancy of greater than 10% when compared to Hydstra values. Geofabric rejected some stations due to distance from stream, however some were also rejected without an error message.

Investigation through topographic maps, satellite imagery and external elevation models indicate that the Geofabric results are generally consistent. Moreover, the release of Geofabric V3 (early 2017) will dramatically increase the precision and accuracy of the results.

Geofabric determination of catchment area gives transparency, consistency, repeatability and verifiability to catchment area values; the processes are documented; the files and data stored, and the catchment boundaries remain viewable for investigation. The Department will use the Geofabric generated catchment data for:

1. New gauging stations requiring catchment area calculations;
2. Existing gauging stations missing catchment area values; and also
3. Existing sites with catchment area values present.

To be incorporated into the Departments database; the catchment areas must pass the validation checks. However, based on current version of the Geofabric toolset, The Department recognises some locations (such as urban areas) will not be included in the process. All new sites will use the Geofabric method to determine catchment area.

The project has determined that the Geofabric product is a viable addition to the hydrographer's toolkit being capable of delineating catchment area to a satisfactory level. Even though inconsistencies were found, the results still provided a transparent and accountable approach to calculating catchment area, something which existing traditional methods do not offer.

References

Bureau of Meteorology 2013, *Australian Hydrological Geospatial Fabric (Geofabric)* as available from **www.bom.gov.au/water/geofabric/**, accessed 26 April 2016.

AHA Member Profile - Max Hayes

Describe your current role?

I was the Hydrographer in Charge at Gippsland Water until 1995 before starting my own hydrographic consultancy undertaking all aspects of hydrographic work. More recently I have reduced my activities and now undertake water sampling for various authorities in the Gippsland region.

I am presently the treasurer for the AHA, a position I've held continuously for over 30 years.

What hydrographic or other qualifications - relevant to your role - do you have?

I commenced in with Latrobe Valley Water and Sewerage Board in 1957. In those days when I commenced in the Hydrographic Team there wasn't any formal qualification, basically you learnt on the job. However I partially completed the original Water Resources Certificate in the late 70s'.

I was lucky to have good mentors who help shape my career, and I can accredit my long career in Hydrography to Bill Barratt and Alex Springall.

What are your major achievements?

Learning from Bill Barratt and Alex Springall provided me with the opportunity to improve the monitoring networks throughout Gippsland [Basin 26 for those that remember the original basin number system].

I undertook all aspects of hydrography finally leading to my appointment as the Hydrographer in Charge at Gippsland Water.

Throughout my career I needed to adapt to changes in data collection. This included the adaptation of what was then the foundation of the industry movement into electronic and automated systems, eventually replacing the old mechanical equipment.

Where has hydrography taken you in the world?

Through my career in hydrography plus my ongoing role as secretary of the AHA I have been provided with the opportunity to meet people from all walks of life. The AHA conference in particular has also introduced me to fellow hydrographers from around the world.

One of my fond memories was one of the first AHA conference I attended at Warragamba Dam [I think around 1982] were I had the privilege of meeting the first Papua New Guinea hydrographers to attend an AHA conference .

How did your career related to hydrography commence?

I was working for Latrobe Valley Water and Sewerage Board and I was basically tapped in the shoulder and told "sit there" and suddenly I was part of the hydrographic team. Prior to moving to the team I worked in various other parts of the Board.

Was there anyone who had a major influence on your career?

Many people played a role in the development of my career but as mentioned Bill Barratt and Alex Springall played a major role in influencing me.

What has been the most memorable experience in your career?

Gauging a major flood event at Rosedale back in 1978. It was the sheer volume of water and the area that was inundated that I remember plus the experience in measuring it. The flow we measured was approximately 120,000 cusecs [Bill Barratt would recall the exact amount].

What makes hydrography interesting?

The variety and nature of the work, the changes in technology etc. and the people I worked with, made the job interesting. There was never a dull day.

What do you do when you are not at work?

I'm an avid golf player and anyone who is ever passing through Traralgon will find me at Toongabbie Gold Club.

Where do you see hydrography in 50 years?

I'd like to see that hydrography continues into the future and that the work undertaken by hydrographers is valued by the community.

Australian ADCP Regatta 2015

Mic Clayton
Snowy Hydro Limited, New South Wales

In late November 2015, the Hydrographic Team of Snowy Hydro Limited (SHL) hosted a two day Acoustic Doppler Current Profiler (ADCP) Regatta on the Swampy Plains River downstream of Khancoban, in southern New South Wales. The initiative was prompted by observations of the success of similar Regatta events in New Zealand, hosted by the New Zealand Hydrological Society Technical Group, in recent years.

Twenty one participants from six organizations (representing four states) attended the inaugural Australian regatta, with representatives from two suppliers, Xylem Analytics and Hyquest Solutions also participating in a technical advice capacity.[1]

Participating organisations were:

- Snowy Hydro Limited;
- ALS Global – Sydney and Melbourne;
- DPI Water – Albury and Tumut;
- Ventia Utility Services – Victoria (previously Theiss Services);
- Department of Environment, Water and Natural Resources (SA) ; and
- Department of Water (WA) - South West Region.

The mix of participants included State government bodies, hydrometric services companies and corporations. This article describes the design of the event, results and outcomes from the Regatta and a summary of future proposed Regatta focus points.

Results and other outcomes of the Regatta data have been presented without identifying organisations or individuals in this report. The participating organisations are welcome to contact the author for identification of their individual results.

A preliminary presentation of results and discussion of the Regatta was subsequently made to the November, 2015 meeting of the Water Monitoring Standardisation Technical Committee (WaMSTeC).

Regatta Objectives

The objectives for the inaugural Regatta were designed in order to get a feel for how the profession is utilising ADCP technology and the resultant data outputs. The event also provided the opportunity for professionals to assess how they are aligning their processes and procedures with the *'National Industry Guidelines for hydrometric monitoring, Part 8, Application of Acoustic Doppler Current Profilers to Measure Discharge in Open Channels', BoM 2013.*

It was intended that the Regatta outcomes would also provide focus opportunities for future events.

The objectives of the Regatta were to:

- Validate organisation ADCP equipment performance by conducting comparison measurements and provide information to enable assessment of repeatability of data outputs;
- Provide opportunities to compare and share knowledge on data collection techniques, procedures, instruments and application in a potential variety of field conditions amongst practitioners and peers;

[1] Advice of the proposed Regatta was by general notice to the hydrographic community via AHA Linked In, AHA e-news, AHA website and other social media avenues. Advice of the activity was also distributed to WaMSTeC members. Suppliers were not directly approached to participate but responded to these avenues of notification.

- Provide an opportunity for practitioners/organisations to ‘pressure test’ and discuss application of ADCP discharge measurement techniques and processes against the *National Industry Guidelines for hydrometric monitoring, Part 8, Application of Acoustic Doppler Current Profilers to Measure Discharge in Open Channels, BoM 2013*;
- Provide an opportunity to test and compare with other practitioners a variety of deployment modes and/or methods (moving boat, remote control, GPS referenced moving boat, stationary methods etc.);
- Compile a report on results and outcomes for knowledge sharing amongst the National Hydrometric Industry;
- Enable opportunity for continuous improvement discussions between practitioners with regards to the effectiveness/practicalities of the Guideline, application of techniques and instrument and gauging hardware applications;
- Potential for contact with suppliers/manufacturers to provide technical expertise with ADCP and ancillary equipment used in ADCP discharge measurements (not intended as a sales pitch by suppliers but an opportunity to for suppliers to provide on-site technical advice, support, trouble shooting etc. with regards to the use of their products by practitioners using their equipment).

Regatta Format

Over the two days the Regatta format comprised of a mix of workshop discussions, in field discharge measurements and summarising of results.

Prior to the event a participant survey was circulated to obtain background information regarding current ADCP use, application of the National Guideline and to understand what participants were expecting from the workshop. This pre-regatta survey was also made available to the profession nationwide so that a broader picture of ADCP use could be obtained and presented, providing a springboard for discussion.

Participants were also asked to contribute to a post regatta survey, providing feedback about the event, content covered; suggested topics for future Regatta foci and to sound out future hosting opportunities.

There were no registration costs for participants as SHL, as hosts for the event, provided meeting facilities and morning teas/lunches, over the course of the two days. Participants also used their own equipment.

As the Regatta and workshop activities were conducted at SHL premises and site locations, the Regatta was conducted under SHL Clean Green and Safe protocols and processes for visitors to SHL operational areas.

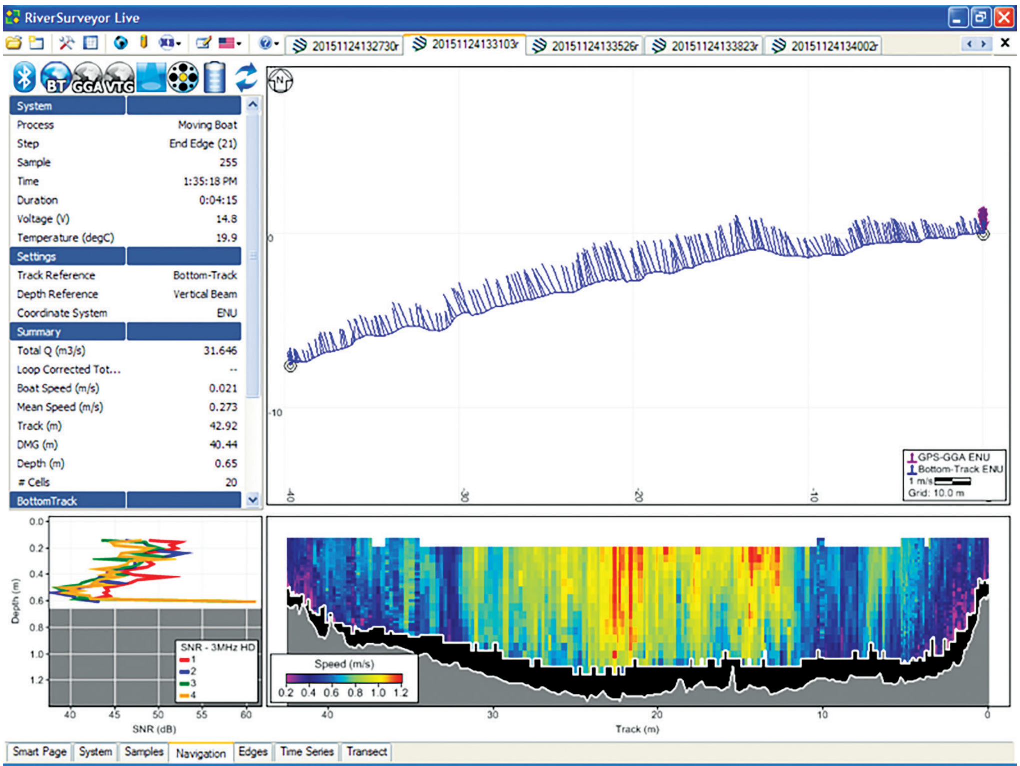
The Regatta Location and Stream Flow Characteristics

The Swampy Plains River downstream of Khancoban Dam provided an easily accessible and safe location with the opportunity to provide a predictable flow from the dam for the field component of the Regatta. The location also provided:

- Access to an SHL owned bridge location from which to gauge, use as a means to cross the river and set up lines safely, if required;
- A steady flow in the range of 30 to 32 cumecs (2600 ML/D);
- A channel section, approximately 40 to 50 metres wide, with a cobble and larger rock bed with low levels of suspended material in the flows;
- Maximum depths and vertical mean velocities within the potential flow range are 1 to 2.5 metres, and 0.5 to 2 m/s respectively;

- The reach provided potential to contain a number of hydraulic features that can come into play with regards to a discharge measurement's accuracy/repeatability (slow water, edge backwater, bridge pylons, swift flows, shallow edges etc.) that would vary under a range of flow releases.

Bridge crossing Regatta Location.



A Typical Cross Section measured at the Regatta.

Regatta Process and Results

The SHL rated release from Khancoban Dam, for the Regatta, was a mean of 30.8 cumecs, with a variation from 30.5 to 31.2 during the afternoon (slight impacts from upstream generation occurring through the pondage may have created the variation in release through the spillway gates.)

Twenty three discharge measurements were completed during this period. The mean Q of these measurements was 30.3 cumecs. This mean is used as the mean reference point for comparing the data presented.

Participants conducted measurements based on their organisational procedures and protocols. Raw (as is in field) discharge results were tabulated with nil or minimal post processing applied. This permitted the organisations to interpret their individual techniques and results against overall peer results and techniques. Extensive post processing techniques did not form part of the exercise on this occasion as it was considered that these post gauging data techniques are another topic for future Regattas.

Both Sontek and RDI equipment were equally represented with models used including the Sontek S5, M9, and Teledyne RDI's RiverRay, River Pro, Stream Pro units. Measurement techniques were also equally distributed with 11 stationary measurements and 12 moving transect methods employed.

Deployment covered a wide range of methods including:

- Temporary tagline;
- NIWA traveller (**https://www.niwa.co.nz/our-services/instruments/instrumentsystems/products/water-flow-instruments/adcp_traveller**);
- Hyquest Flying Fox (**http://www.hyquestsolutions.com/products-services/products-hardware/water-flow/flying-fox-system/**);
- Oceanscience Q Boat (**http://www.oceanscience.com/products/q-boats/home.aspx**);
- Bridge gauging.

Discharge Result Comparison

Taking the adopted mean of all measurement sets, 30.3 cumecs, the deviations of individual measurements are presented as per Figure 1. Measurement Method (Stationary/Moving) and product model are indicated in the figure for each result.

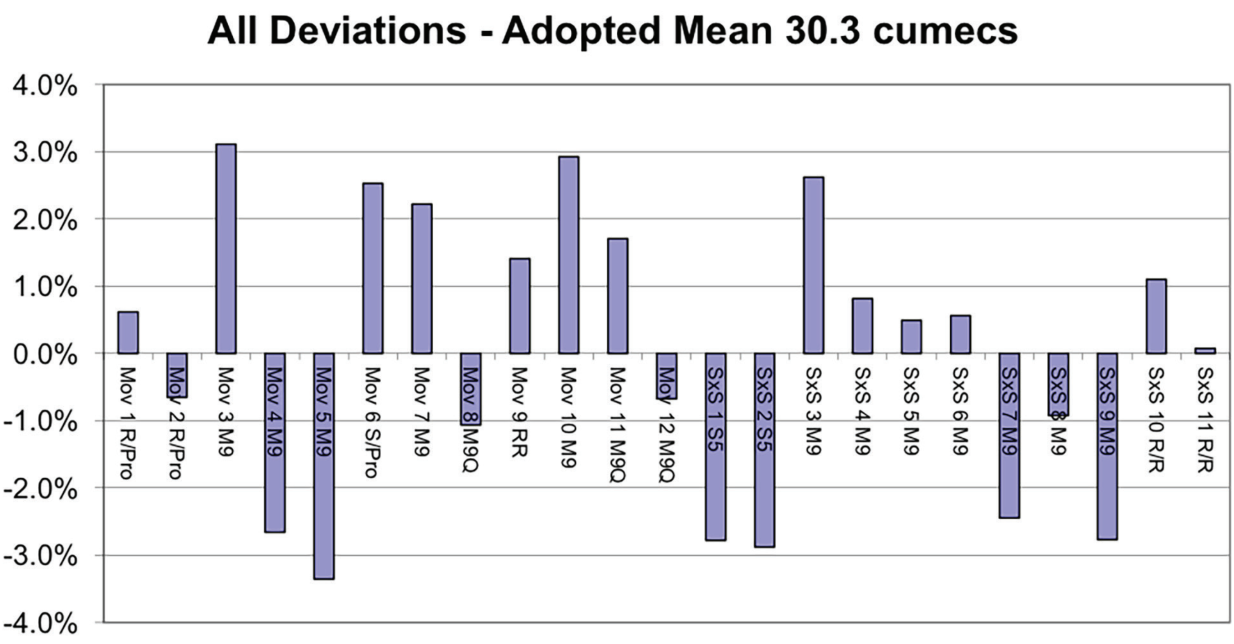


Figure 1: Comparison of all measurements against mean of all measurements.
(Note: Measurements have been grouped into Moving Method to left of graph, Stationary Method to right of graph)

All results were within +/- 4% of the mean of all measurements, ***with over 90% of results within +/-3% of the mean.***

In achieving these results participants:

- Undertook measurements as per their own organsiational procedures;
- Supplied a flow figure with minimal or no post processing.

Discussion around these outcomes indicated:

- A number of participants were 'pleased' that their results aligned well with the group results;
- The benchmarking of results against other industry peers provided participants with a greater confidence with their procedures and processes and alignment with industry norms/guidelines;
- A further boost in confidence in using and trusting ADCP technology.

Exposure Time Assessment and Commentary

Time of exposure for ADCP gaugings is specifically defined in the quality assessment guide of the National guidelines (an acceptable minimum being 800 seconds for a complete discharge measurement). For stationary method this is the sum of the times at each vertical while with moving boat it is the sum of exposure times for the accepted transects used to calculate the final discharge. Timing of less than 800 seconds is permitted however the guideline matrix downgrades the final quality ranking of the result.

Figure 2 compares the exposure times for 20 gaugings (note: three exposure times were unavailable at time of collation).

The mean exposure time of these 20 measurements was 1183 seconds.

Differentiating between moving boat and stationary methods gave means of:

- Moving Mean – 1178 seconds;
- Stationary Method – 1187 seconds.

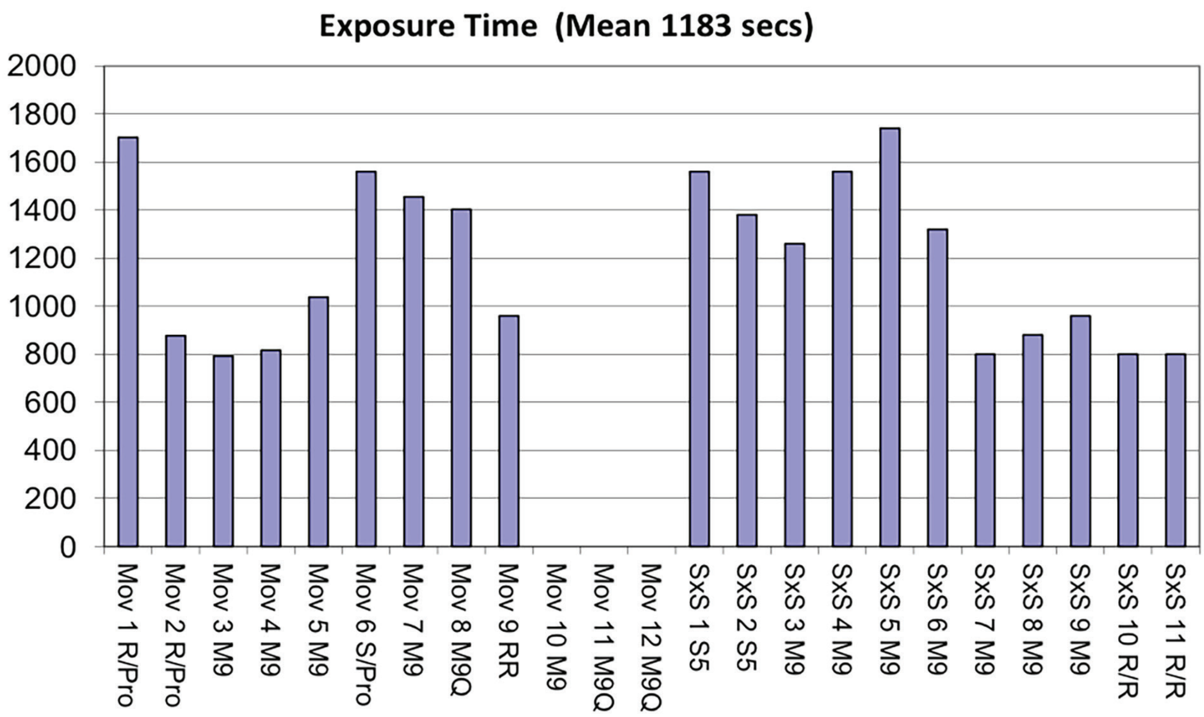


Figure 2: Time of Exposure Comparison (seconds).
(Note: Measurements have been grouped into Moving Method to left of graph, Stationary Method to right of graph. Three results were unavailable at time of collation)

These exposure results tend to indicate that, from this sample set, there is actually very little time saving advantage between the two methods during the measurement process. There is however potential for some time savings in regards to preparing for measurement through the use of remote control Q boats, or using existing infrastructure such as travellers, permanent lines or bridges.

Simplistic aspects that may affect the differing time of exposure include:

Moving Boat:

- Keeping boat speed at less than the water speed;
- Extended sections of slower flows in a section resulting in reduced boat speed in those sections;
- Some larger times in the results may also have been due to a level of unfamiliarity, with the section and flow conditions, by visiting groups. In this instance the first transects may have provided visitors with a 'feel' for the section allowing them to move the boat quicker during later transects.

Stationary:

- Individual vertical exposure time – from general discussion it appeared that 40 second minimums were being used at each vertical with some using 60 seconds per vertical;
- Number of verticals measured in the cross section can vary with stream width to align with aspects of AS3778 – maintain a less than 10% flow in a section or aim for the required number of verticals;
- Spacing of verticals through the section – e.g. defining the stream bed rather than fixed spacing to improve area calculation while still targeting less than 10% flow per section;
- As with moving boat some measurements with longer exposure times may have resulted from operator unfamiliarity with the stream section and flow conditions.

Generally, in discussion with the participants, it appears that trying to achieve 800 seconds exposure time was not the aim of the teams but rather measuring to the conditions encountered.

Moving Bed Conditions

Moving bed conditions were one aspect of ADCP measurement that was not tested during the Regatta. Being a clean rocky/larger gibber river reach with virtually nil stream vegetation, the location for this Regatta is not prone to moving bed effects. Moving bed conditions were indicated as a desirable stream condition for future regattas.

Post Regatta Discussions and Survey

Presentation of the preliminary results summary was made in a workshop session before the group spent a short time with the two suppliers for demonstration and presentation of equipment at another gauging station upstream of Khancoban Dam.

The post Regatta survey, conducted with participants, sought further feedback on topics that were discussed generally in the workshop session including:

- Workshop content;
- Logistics of attending a regional location for workshops such as these;
- Further focus themes for future workshops; and
- Other general comments.

A significant topic raised during this discussion was the application of calculation/computation features contained in the software running the ADCP platform and vendor QA tools. It was subsequently highlighted that an item that should be covered in future workshops is the application of the extrapolation computations for unmeasured sections in the ADCP profile.

In the software the user can define various fits (power fit, straight, user defined etc.), one participant highlighting that different fits can have significant impacts on the final discharge measurement. The Guideline (Part 8) makes reference to using third party tools to assess extrapolation techniques post measurement. This issue was considered a significant future workshop area.

Participants tended to agree that the gauging location was "too perfect" as the reach was quite regular, lacked moving bed conditions and other major interferences that can complicate an ADCP measurement. Interference of the flow from the bridge pylons caused insignificant issues at the flow rate, though it is known that at greater flow rates at this site the pylon interference does become significant.

Reflecting on the "perfectness" of the river, and not having a variety of stream complications that could cloud interpretation of comparative exercises such as this, the participants agreed that this was probably a good aspect for this inaugural regatta as it focused assessment of results on:

- Gaining confidence in the accuracy and repeatability of data from the equipment;
- Testing organisational processes and procedures against peers/National Guidelines;
- Comparison of moving boat and stationary deployment techniques;
- Enabled future regatta topics to be highlighted.

Group discussion of equipment and technical applications with Xylem Analytics and HyQuest representatives.

Future Regattas

All participants agreed that the Regatta was an excellent practical opportunity for professional development and peer collaboration and should be conducted on a regular basis.

As a result of the feedback received a number of focus areas/structure topics are recommended for future regattas.

Suggested content for future regattas (in order of highest to lowest responses):

- A location to challenge processes and technology with a mix of good and bad sections;
- A location with access to a variety of sites in close proximity to each other;
- Understanding the impacts of 'computation' options within ADCP software on results and data quality/accuracy;
- Sites that permit more focus on testing and correcting for moving bed conditions,
- Sites that also have velocity indexing technology installed (to test aspects of Hydrometric Guideline 9, BoM 2013);
- Safety solutions for different scenarios;
- Salinity impacts on ADCP measurements;
- Dealing with salt wedges/temperature lenses;
- Test more aspects of Hydrometric Guideline 8 under a wider range of conditions;
- Test organisational Standard Operating Procedures (SOPs) under less friendly stream sections.

Some participants have indicated an in principle support for hosting/assisting with future and many supported the concept that the Australian Hydrographers Association would be an appropriate forum for hosting/supporting future Regattas, in conjunction with conferences or as standalone professional development opportunities, on a regular basis.

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Acknowledgements

This inaugural Regatta event was made possible with the professional support of Snowy Hydro Limited and the Hydrographic Team of SHL who assisted with logistics and safety aspects of the regatta at the field locations.

Thanks is also extended to Andrew Nolan (Manager, Water and Environment) for supporting the professional development of staff through this initiative and Drew Twigg (Area Manager, Murray Region) for the provision of meeting facilities at Khancoban.

The participation of HyQuest and Xylem Analytics in a technical advice capacity was greatly appreciated.

Meeting Changing Expectations – (technology, data outputs, health and safety)

New Zealand Hydrological Society – 2016 Technical Workshop, Gisborne, North Island.

Mic Clayton
Snowy Hydro Limited, New South Wales

The New Zealand Hydrological Society recently held its annual Technical Workshop at Gisborne on the North Island of New Zealand. The workshop also incorporated an ADCP Regatta.

The workshop theme was *"Meeting Changing Expectations (technology, data outputs, health and safety)"*.

Over 80 field hydrologists from Regional Councils, power utilities, private consultancies and university/research teams participated in the workshop with seventy of those participating/observing the Regatta day. Participants weren't just Kiwis but included the US, Canadian, French and Australian participants.

The Regatta was held on the Waimata River approximately 10 minutes from Gisborne Town Centre. The river reach provided a variety of good to poor options from a discharge measurement point of view resulting in an interesting range of results.

While the site provided difficulties for good flow measurement sections (weed, rocky, uneven) this in turn generated quite robust discussions about something more important than how expensive your bit of kit is – and that is, understanding the primary importance of site selection and recognising the limitations of the technology or technique you are using!

Regatta Activity at the Waimata River, Gisborne.

The workshop days provided a great range of presentations, coupled with breakout groups to discuss issues relevant to the New Zealand field hydrology scene.

A session on alternative gauging techniques provided a great deal of interest with a presentation from Jerome Le Coz from the National Research Institute of Science and Technology for Environment and Agriculture in France on the use of handheld radars and video image analysis of extreme flood events using Fudaa-LSPIV software being developed by his team of researchers (**http://onlinelibrary.wiley.com/doi/10.1002/hyp.10532/full**).

Terry Kenney from the USGS discussed further analysis of Index Velocity techniques and technology being utilised in their programs and the philosophy of shift rating techniques employed widely in the US.

Dilution gauging trails have been occurring in New Zealand over the last year or so and there was also discussion on findings regarding this technique using Sommer tracer systems (**http://www.sommer.at/en/products/water/tracer-system-tq-f**).

It isn't just extreme flood events of interest in NZ though and an alternative system for awkward slow weedy gauging involving Rising Bubbles, currently under development, was presented to the forum by Thomas Wilding (Hawke's Bay Regional Council).

The results from the recent Regatta in New South Wales and the New Zealand Regatta were also presented and interpreted rounding out the day.

The next day's presentations, highlighted how data collectors are coping with transformation of their data sets into the National Environmental Monitoring Standards (NEMS) regime, in regard to quality and their impressions regarding how new Health and Safety Legislation introduced in the week of the workshop may impact on monitoring activities.

Angela Perks from Auckland Council introduced tools and apps they are developing and implementing in their team, in line with organisational safety protocols, as a safety decision process before they depart the office. Using real time data the teams are provided with information that assists with decisions regarding working alone or within multi member teams for the day, decisions on accessing streams under elevated flow conditions and so on. The presentation was an interesting example of effectively planning for the job at hand taking into account the safety of those involved in the tasks.

Stuart Hamilton (Aquatic Informatics) challenged the view that staring at dots on a computer screen in 2D space will eventually provide the magic revelation to a rating curve dilemma! These dots (hard data) will always need the soft data that we acquire through our senses. What the river physically looks and feels like in the real world to de-mystify a rating curve development is equally, if not more important, than those gauging points on the computer screen. It was a very entertaining perspective on this area of our work.

Rounding out the workshop, in the graveyard shift, Lennie Palmer from Trust Power highlighted the challenges around meeting NEMS and changing compliance issues. He highlighted how some data is being collected for a specific purpose and is fit for that purpose only. However in a world of changing data expectations and compliances there is potential for unintended cost burdens on some organisations and smaller utilities/companies in order to meet new or changing expectations.

During the workshop a small contingent of trade exhibitors were present and provided with the opportunity of 5 minute bursts of presentation time to the forum on their products and developments in technology. Companies who elected to take up this opportunity included: HyQuest Solutions, Envco, NIWA, Powerbox, Aquatic Informatics and Van Walt.

Rounding off an excellent workshop event, Envco displayed what could be the latest fashion trend in parts of New Zealand, Mudderboots. De3signed to enable easier walking in mud, swampy areas and over snow Mudderboots (pictured below) are certainly an interesting potential addition to your PPE kit!

Envco Mudderboots.

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done... ByFriday PED03