Australasian Hydrographer

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AUSTRALIAN HYDROGRAPHERS ASSOCIATION

AHA

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Contents

Acknowledgement of Country

The AHA acknowledges the Australian Aboriginal and Torres Strait Islander peoples of this nation. We acknowledge the traditional custodians of the lands on which our association is located and where we conduct our business. We pay our respects to ancestors and Elders past, present and emerging. The AHA is committed to honouring Australian Aboriginal and Torres Strait Islander peoples' unique cultural and spiritual relationships to the land, waters and seas and their rich contribution to society.

JACQUIE BELLHOUSE

Editor-In-Chief's Introduction

We are halfway through the calendar year already and would you believe it almost a full year with the expanded editorial team in action.

On reflection how are we doing? Are we hitting the mark or are there things we need to improve on?

To be frank, it has actually been quite a challenge this year. Assembling the *Australasian Hydrographer* with the limitations imposed by restrictions on gatherings have really challenged the team. Usually we would have a stockpile of papers from the latest conference to augment our quarter to quarter submissions. Not to mention the lack of get togethers impact on the editorial team's opportunity to interact with you and gather feedback on our efforts.

As such the team is sending out a call to arms. Please continue to send in your papers/articles/stories. Without our members' contributions we wouldn't have an *Australasian Hydrographer* and I am 100% sure your fellow Hydrographers would appreciate the reading material.

This month we are pleased to be able to present a wonderful (albeit a little tongue in cheek) paper from Rick Deckard (AKA Greg Yeo) providing an account of the *2021 South Coast Floods*, as a primarily office based "drogy" (who, sadly, has never experienced the thrill of gauging a flood); I really appreciated Greg's flair.

Additionally we also have a range of papers looking at where our Water Monitoring Guidelines come from (WaMSTeC), and the latest in Data Management *"South Australia's Department of Environment & Water Migrates their Entire Data Analytics"* thanks to Nicole Nally

Jacquie Bellhouse CPH
Editor-In-Chief

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ARRAN CORBETT

From the President

It is time for a mid-year check in. How are we travelling, are we meeting our goals and are we on track to meet our long-term objectives? Taking time to reflect on progress and performance is important for all stages and levels of our careers. Whether you are leading a large hydrographic team, maintaining a huge network of sites or simply responsible for yourself and a couple of bores, the imperative remains. It is time to celebrate your wins and/or adjust your strategy.

In recent times we have seen a trend towards legally defendable data, compliance, and operational water management. Part of this change challenge that I have been involved with recently is using rapidly changing systems technology to facilitate this emerging trend. I am sure that with a bit of focus on the statistical analysis of our measurements and datasets we can get there. All of this starts with good field practice, metadata recoding and verification. Something to keep in mind as we re-set our strategy for the medium to long term.

The AHA is itself a continually evolving beast, we must be as the challenges meeting our members' needs constantly change. Yes, the core business of how we do our job remains basically the same but the pressures and demands on the why, not to mention the scrutiny on quality appears to be on the move. Are we still hitting the mark with our members? Restrictions on gatherings have greatly reduced the opportunity for our committee to interact with you. Can I ask when you stop for reflection, please reflect on the AHA and what it means for you. How can we help you meet your goals?

Arran Corbett CPH
AHA President

Reintroducing the Water Monitoring Standardisation Technical Committee (WaMSTeC) the Birthplace of your National Guidelines

Jacquie Bellhouse CPH, WaMSTeC Secretariat, Perth, WA

Background

In December 2010, in association with a range of initiatives resulting from the *Water Act 2007* (Cth), the Bureau of Meteorology (BoM) invited water information stakeholders to participate in the Water Information Standards Business Forum (the Forum). The Forum was a national body of water industry representatives including the Bureau tasked with coordinating the development of water information standards. Forum membership was drawn from hydrometric data collecting organisations across Australia, both public and private sector, which were determined to support or have a stake in the water information industry.

The Forum ceased to operate in October 2014, but its primary functions and activities, valued by its attendees, transitioned to the Water Monitoring Standardisation Technical Committee (WaMSTeC). Forum members were invited to continue involvement in coordination of water resource monitoring standardisation activities via WaMSTeC.

At October 2014, 26 member organisations transferred from the Forum to the WaMSTeC. Today its voluntary membership includes representatives from government, private sector, industry and research organisations. The membership provides a very broad representation from the water resources sector with representatives that have the management and technical expertise to initiate, develop and review water industry standards and guidelines.

The first of the functions listed in the WaMSTeC *'Terms of Reference'* involves identifying priority areas for guidelines and standards development and providing feedback at various stages in their development. This and the final endorsement of guidelines and standards are WaMSTeC's principal functions.

Relevant industry bodies and Technical Reference Groups (TRGs) also play an important role in the development and review of standards and guidelines prior to their submission to WaMSTeC for endorsement.

WaMSTeC Membership

Membership of the WaMSTeC is not only open to organisations that have obligations under the *Water Act 2007* but also includes organisations that provide services to water resource monitoring organisations in water measurement, data transmission, data collation, storage and management. Any organisations wishing to join the WaMSTeC can contact the Bureau and include details of their interest and expertise in the field of water resource monitoring standardisation. The Bureau will forward the request to the current WaMSTeC secretariat.

At June 2021 there were 27 registered member organisations of WaMSTeC.

All member organisations are asked to provide representatives to WaMSTeC that can:

- contribute out of session input to the development and review of standards, guidelines, and technical papers
- attend WaMSTeC meetings in person or via video conferencing (currently held twice a year)
- represent their organisation(s) at WaMSTeC meetings in endorsement decision actions; and
- consider contributing in the roles of chair and secretariat as part of the collaborative committee management arrangements (the secretariat and chair are voluntary positions shared between member organisations on a rotating basis)

Because of the technical nature of the work and wide scope of expertise required in surface water, groundwater, water quality monitoring and data quality, member organisations have always been welcome to have more than one representative contribute to WaMSTeC's work. WaMSTeC has always welcomed such input and appreciates industry contribution of knowledge and expertise to the development of water industry standards and guidelines.

The Birth of a Guideline

In order for a new Guideline to be endorsed and published it must go through a five step process: -

Step 1: Registration of a draft guideline

A sponsor presents a draft guideline to the WaMSTeC secretariat for registration in the endorsement process. The sponsor is also required to submit an accompanying context document. The purpose of the context document is to state the benefit of the guideline and give context in relation to any existing similar guidelines or standards.

The WaMSTeC secretariat registers the draft guideline and accompanying context document and alerts the WaMSTeC representatives.

Step 2: Initial WaMSTeC review and decision to proceed

WaMSTeC undertakes initial review and assessment of the guideline and decides whether the guideline will continue through the endorsement process.

The WaMSTeC secretariat calls for nominations from WaMSTeC representatives with relevant expertise to undertake the initial review of a registered draft guideline and context document. The initial review is undertaken out of session by a sub-committee comprising a minimum of three WaMSTeC representatives plus the WaMSTeC secretariat.

On completion of the review, the WaMSTeC sub-committee reports to the WaMSTeC chairperson on the extent to which the draft guideline satisfies the review criteria. The report will contain a recommendation that the chairperson either

- allow the draft guideline to proceed to the next step of the endorsement process; or
- request further work by the sponsor before proceeding.

Step 3: Industry consultation and detailed technical review

This step involves relevant industry experts in the detailed review and drafting of the guideline; to revise and improve the draft guideline to a point where it is generally accepted by industry as technically sound, fit for purpose and able to be feasibly implemented. This is a vital step in ensuring industry stakeholder support and acceptance for the draft guideline. WaMSTeC will rely heavily on the integrity of this step when making the final endorsement decision.

Step 4: WaMSTeC endorsement

When determined it is ready for endorsement by the WaMSTeC, the draft guideline is submitted to the committee along with a Basis for Endorsement (BFE) document. The purpose of the BFE is to clearly state the rationale for endorsement of the guideline and provide WaMSTeC members with sufficient supporting information to make an informed decision.

Should endorsement be achieved, the BFE document is published along with the endorsed guideline.

The draft guideline and accompanying BFE are made available to all WaMSTeC representatives no less than four weeks before the scheduled meeting, at which time it is to be considered for endorsement. The sponsor will present the case for endorsement to the WaMSTeC meeting which will decide either:

- to endorse the guideline; or
- not to endorse the guideline in its current form.

If not endorsed, the WaMSTeC secretariat documents issues raised by WaMSTeC representatives, and proposes solutions. The sponsor is then required to address these prior to re-entering the guideline into the endorsement process.

If the Guideline is endorsed the WaMSTeC chairperson acknowledges endorsement, while the WaMSTeC secretariat (with support of the BoM) completes any pre-publication checks to ensure consistency of format and term usage. The guideline is also assigned a unique identifier to allow appropriate referencing.

Step 5. Publication and promotion

Following its endorsement the Guideline is published on the BoM Website and becomes a part of the ongoing guideline governance process which includes periodic reviews.[1]

The Endorsement of a Guideline

During the endorsement of draft guideline, while there may be multiple members, each organisation has a single decision voice (i.e. one voice per organisation). A 70 percent majority is also necessary to support endorsement. Organisations can also choose to abstain because of lack of expertise or relevance of a particular guideline to their business.

Progress to Date

Since its formulation in late 2014 the WaMSTeC has not only overseen and endorsed updates to the original ten Hydrometric Guidelines, including the addition of additional detail previously unavailable, but has also granted permission for the development of three additional guidelines.

Currently the guidelines on *Application of Surface Velocity Methods for Velocity* and *Open Channel Discharge Measurements* have completed the industry consultation and detailed technical review stage and will shortly be submitted to WaMSTeC for final endorsement. These guidelines are not only a first for Australia but are also an international first with feedback on the draft received from France, Canada, US and New Zealand.

Additionally, guidelines for *Gauging Site Control Classification/Stream Discharge Relationship Accuracy* and *Hydroacoustic Suspended Sediment Measurements* are currently moving through the initial 2 stages of development.

In all not a bad effort from a large group of volunteers who are spread nationwide!

[1] Find links to published guidelines on AHA website aha.net.au > Information > National Industry Guidelines

South Australia's Department of Environment & Water Migrates their Entire Data Analytics

Nicole Nally, Aquatic Informatics, Greater Melbourne Area, Vic

Introduction

South Australia is typically the driest state on the driest continent (with the exception of Antarctica), yet it has one of the world's largest artesian basins in the world, stretching 1.06 million km². The Murray River Basin supplies irrigation for large-scale, diverse agriculture and supplies drinking water to the 1.3 million residents living in the City of Adelaide. The Department of Environment & Water (DEW) is responsible for the vitality and sustainability of this water ecosystem which involves monitoring and managing a lot of data to ensure fair water sharing, flood control, and maintaining of water quality through controlling barrages that open the lower lakes to the ocean.

The Challenge

In 2015 the Premier of South Australia mandated an open data policy requiring all public agencies to make their data accessible by the public. Peter Baylis, Project Manager at the Department of Environment & Water said:

"Around the same time, we had a public scientist requesting data on the salinity of water as it passes through the system. While we were collecting lots of data, our old system was not capable of analysing and displaying the information in a meaningful way. After an in-depth search, we still could not find the data he was requesting. "It was clear that we needed something modern and intuitive so our employees and other stakeholders could get what they were looking for in a timely manner."

DEW went about the next logical step of upgrading their data management system but determined their ageing legacy system couldn't support Open Data or provide the Australian Bureau of Meteorology (BoM) and the South Australian State Emergency Service (SES) with real time data for emergency flood management. *"This was a timely and painful exercise, and the data was unreliable,"* said Peter Baylis.

Another challenge that DEW and many of its partner agencies are now facing is an ageing workforce on the verge of retirement. These personnel hold vast knowledge and a deep understanding of the idiosyncrasies of a legacy system that come with experience. The new generation has been raised on cutting edge technology that is intuitive and user-friendly; learning a legacy system is not only unproductive, it's demotivating.

The overall legacy system's poor performance came to a head during a severe weather event in 2016 that resulted in a state-wide power blackout that caused a major disruption to the water data network and security, followed by flooding from the storm. "This was a wake-up call for us", said Peter Baylis, "There was no redundancy in the system to deal with a simultaneous power failure and flood event, and we only had one experienced IT person who was able to jerry-rig a solution on his laptop to access the critical data we needed to manage the flood waters."

The Solution

In the search for an intuitive and reliable data management system, DEW developed a comprehensive wish list of 117 features from all their stakeholders and invited three companies to demonstrate what they could satisfy on the list. "It was by far the most comprehensive two hour showcasing of the *Aquarius* capabilities, but DEW has an enormous responsibility in managing the Murray River Basin, and what they were asking for was an absolute necessity to doing the job right." said CEO of *Aquatic Informatics*, Ed Quilty, who worked with the project team to ensure all the requirements would be met.

With over 3,200 monitoring locations and 17,000+ data sets, DEW delivers critical information to several external stakeholders such as: BoM, SES and the Murray-Darling Basin Authority (MDBA). There are also several DEW business units working with that data, including surface water operations, surface water science, groundwater operations, groundwater science, and IT. Needless to say, the enormity of the project and the importance of getting it right required two years of product development and another year for deployment to all stakeholders.

The complexity of the project required the use of the full Aquarius software suite to acquire, process, and model DEW's data in real time. Dedicated team managers from DEW and Aquatic Informatics migrated the old data to the new system to ensure no historical information was lost; this would prove especially advantageous in using the new program's trend and prediction analytic tools. The project team also worked to configure the functionality to meet the specific needs of DEW and its stakeholders.

A critical component of the project involved the enablement of real-time decision making for the operation of the Goolwa Barrages. The barrages play a vital role in South Australia's ability to provide fresh water for irrigation. Comprised of five low-head diversion dams with gate control, the Goolwa Barrages are used to reduce salinity levels in the lower reaches of the River Murray and the associated lakes, as well as limit reverse flow of seawater into the lakes during storms, high swells, and high tides. Prior to this project, essential calculations used in the operation of the barrages were being done in Excel and then emailed to South Australia Water (SAW) operators at Goolwa. The SAW operator then opened the gate, and emailed DEW to confirm which gate or gates had been opened. Since moving to Aquarius, SAW operators now access a new Goolwa barrage calculator through a real-time dashboard that is easily accessible. Prior to Aquarius this process took three hours; now all data and actions are in real time, and both parties have visibility into gate status through the shared dashboard.

Figure 1. Goolwa barrages.

One key issue the new software was required to solve was the ability to quickly process large amounts of data, and to subsequently make said data available to stakeholders in an easy-to-understand format. "The old system limited how many surface water sites we could poll during a severe storm event and also the frequency at which we could pull the data. This meant we sometimes had to make a difficult compromise regarding which sites would be updated during storm events, and which ones would miss out on the regular update cycles" said Peter Baylis. Access to all data during times of crisis enables better, more informed decision-making. Access to all network data was a critical requirement for Murray River operations, and other surface water sites during significant rainfall events. The new system allows DEW to poll all surface water sites at five-minute intervals with no loss of data, enabling SES and MDBA to act quicker and have confidence in the accuracy of the data.

Auditing and tracking were another important area that Aquarius was brought in to fix. The old data review and approval process was time-consuming and as a result would sometimes be overlooked, which compromised data integrity. The new program automates this process and gives field managers the ability to audit grade thresholds for uploaded data on a monthly basis. "Now when publishing data to external agencies like BoM or our internal customers, we have greater confidence in the information presented and our ability to trace any adjustments back to the source or raw data" said Peter Baylis. This is significant when the MDBA or other Commonwealth agencies question the provenance of the data and processes around data governance.

The new software is designed to automate workflows by extracting data, turning it into meaningful information, and making it available to stakeholders that require it to do their job. By automating processes human error from manual entry is reduced, and by using complex algorithms the data becomes more meaningful. In addition, the intuitive user interface for the Aquarius platform makes it easy for anyone to input or retrieve data regardless of their device. This is especially valuable for the next generation of employees to easily access information from anywhere and draw insight from the data to improve the management of water resources, without having to learn how to navigate a legacy data system.

"Now I feel confident as I retire, that DEW's data is in good hands and that the new employees have the right tools to ensure the Murray River Basin continues to be sustainably-managed for generations to come," said Peter Baylis.

Figure 2. Peter Baylis with water sampling equipment.

Flood Runner — A dystopian account of the 2021 South Coast floods

Rick Deckard (AKA Greg Yeo), WaterNSW, Tumut NSW

Abstract

This is a true story (albeit a little tongue in cheek). The events depicted here took place on the South Coast of New South Wales, Australia, in 2021. At the request of the survivors, the names have been changed. Out of respect for the dead, the rest has been told exactly as it occurred.

Prologue

It was a cool, bleak morning and an ominous dark sky promised the rain would only get heavier. Reports of floods had been flooding in over the weekend, the North Coast, the Central Coast, Sydney. Now the deluge had the South Coast firmly in its grasp.

It was Monday the 22nd of March. Hydrographers, or 'drogys' from the South East (HSE), weary from a weekend of R&R, wiped the sleep from their eyes as they turned on their Lenovos. Bleary eyed, they tried logging onto Hydstra to scan through their sites on HYTELVIEW. The news that greeted them was more bitter than the coffee by their keyboards. Hydstra was down! From what little that could be gleaned of the situation, the North and Metro teams were up to their necks in floods. The Bega Team Leader, ironically known as 'The Beggar' (but that's what we called anyone from Bega) was going to be in for a rough time with his team of rough riders. It was very likely the Bega Team would be in over their heads.

As the Team's Toolbox Meeting approached, the 'Chief' put the call out. This was not going to be an ordinary Monday morning meeting. This was going to involve everyone, from Tumut to Albury and Wagga Wagga. Bega would not be left on its own.

As the meeting began the Chief outlined the dire situation Bega faced. So many rivers and so many high flows. But limited resources and the threat of being cut off; how best to deploy the teams? It was decided to keep The Beggar and his rough riders close by, rather than risk losing them up north. And so, the call went out, "Who will cover the North?"

There was a pause from the hardened drogys of the HSE, for they knew what this meant. Drogys spend most of their time doing wading gaugings in low flows. Those that chased high gaugings were thought to be mad, known as 'Flood Runners.' Then, an unexpected voice could be heard over MS Teams, "I'll go". 'The Planner' was keen to show his brothers-in-waders that he still had what it takes to undertake fieldwork. As the shame swept over us the guilt started to build within me. I'd done some flood running in the past. I wasn't proud of it, no drogy was, it was just something that had to be done. Finally, the guilt got the better of me. I would sacrifice my scheduled trip to the tropical oasis of Cowra for the blighted Batemans Bay. "I'll go too" I interjected.

Time to repack, I won't need my Hawaiian shirt anymore, I need a raincoat.

The Deployment

The drive from Tumut to Batemans Bay was long and arduous, broken only by the compulsory 10 minute rest every 2 hours. The plan was to meet The Planner in downtown Batemans and hit the ground running Tuesday morning. The closer to the coast I got, the more the sky darkened … and so did I. Out on the wild windswept plains between Bungendore and Braidwood I came across the Shoalhaven River at Warri. Thinking I'd be due another compulsory 10 minute rest before long, I decided to pull in.

At first glance I was impressed. "There's gotta be well over a hundred cumecs there" I said to no one in particular. No one answered. Out of the corner of my eye I noticed something, something only another Drogy would notice. It was the tell-tale sign that a gauging station had once graced this site. Or perhaps one still did? On the far bank there they were, poking out of the overgrown riparian vegetation. It looked like it could be a whole range of them. I drove back over the bridge to investigate. And there it was, a green concrete well liner, the other tell-tale sign of a South Coast gauging station. I got out of the 'old bus', into the rain and made my way down the bank. The only thing wetter than rain coming down was the underbrush brushing my pants. I should have gone to Cowra. But there they were, staff gauges. Time to get some readings.

It was about then the fragments of memory started coming back to me, like a long-lost relationship that ended badly, I thought I'd put it all behind me. I had once looked at this rating table, a random scatter of gaugings in the bottom left and a deserted wasteland up to the right. I got on the blower to 'The Tech', my one source of intel. "I need anything you can give me on Warri" I said. "I've got a stage height of 4.565. What kind of discharge are we looking at? And when was the last time we had a gauging around this height?"

The reply was a little more than I'd been hoping for, but it was still far from good. There was a gauging at 4.800 metres, but it was done in the age of giants, 1952. There was a closer gauging at 4.394 metres, but that was back in the industrial age of 1925. There had not been a gauging over 3 metres since 1975. Despite lacking the steam power of the 1920s, or the superhuman strength of the 50s, something had to be done. It was time to see where The Planner was? I'd just changed our plans.

First Blood

The Planner was only half an hour away. This gave me time to do a quick risk assessment and scout out the area for a good gauging section. Upstream appeared relatively smooth and laminar, relative to downstream at least. I was apprehensive of the risk of fouling motors on riparian vegetation along the banks and submerged trees in the channel. Without any knowledge of what the streambed was like I was going to have to rely on feedback from the Doppler, … and instinct. Such is the life of a drogy. Sigh…I could have been sunning myself in Cowra by now.

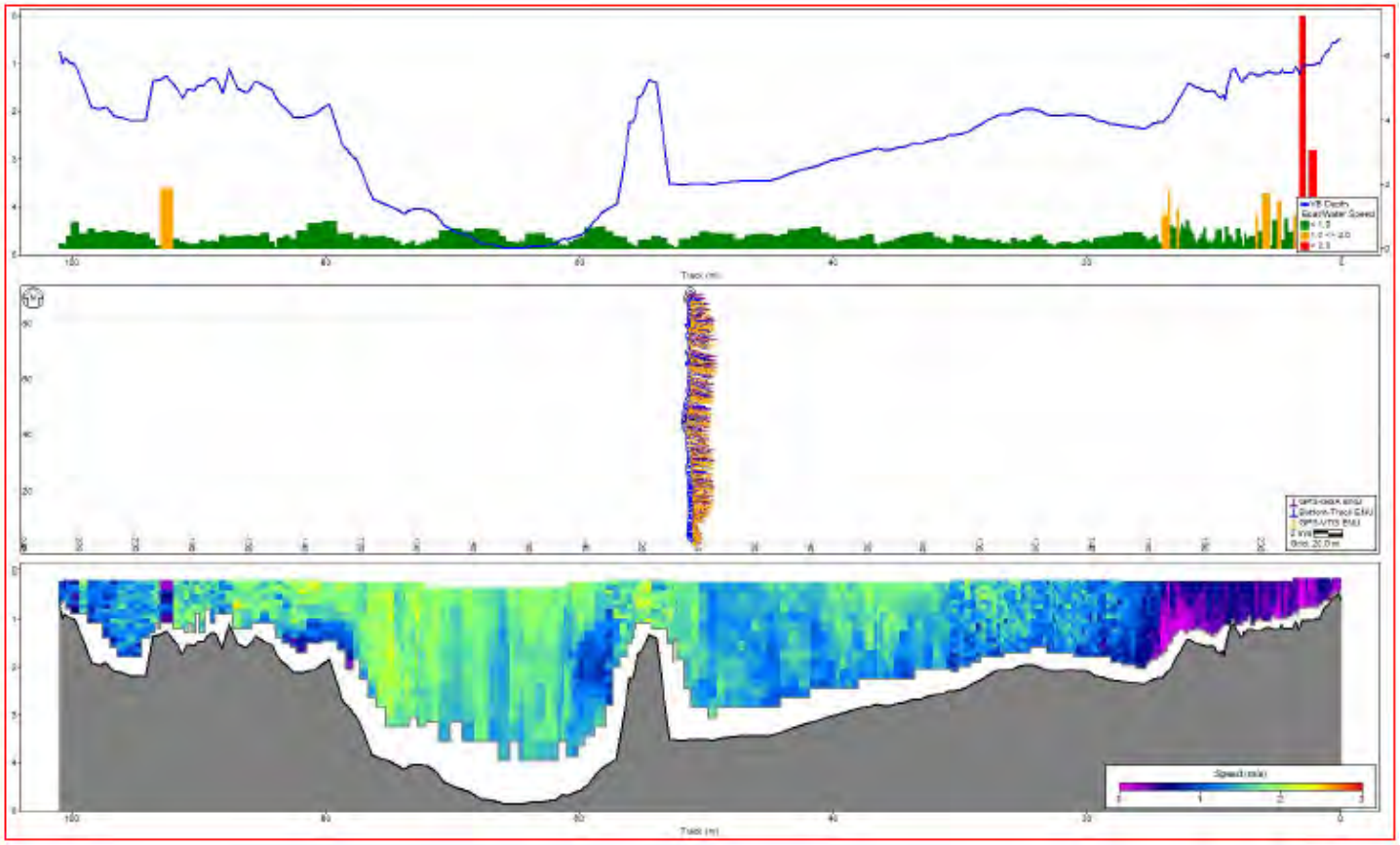
I found a half decent place to launch 'Yella Terra' the Q-boat, half decent by drogy standards, a steep eroded goat trail for anyone else. It looked solid so I reversed the old bus down, I wasn't keen on breaking another leg trying to manhandle Yella Terra down that trail. If the old bus was gonna complain about getting out at least the winch was pointing in the right direction.

Figure 1. Shoalhaven River at Warri panorama. Photo by Shaun Gleeson, aka The Planner.

By the time The Planner showed up I was fitting out Yella Terra with M9-2095, an ageing ADCP that had been upgraded several times to keep it going but didn't always communicate that well; a bit like me only I never got upgraded. After a cursory nod at the river we got down to business and identified risks and planned our attack. We didn't have to proceed if we deemed it too dangerous, that was the procedure. But The Planner got his device out, formalised the 'Start Card' and informed The Chief. After all in this day and age, it's Yella Terra that's being thrown to the lions, not the drogy. Would Yella Terra be up to the task at hand? Honestly Yella Terra had a checkered past, much like M9-2095 and myself, numerous breaks and parts replaced. I couldn't shake the ominous feeling that any failure now would result in a turbulent ride for M9-2095 down to Nowra, if it made it that far without getting smashed to bits!

From the launch I gingerly manoeuvred Yella Terra upstream to a place seemingly suitable for a gauging. We were at least 100 m upstream of the point where the river turned into a white torrent. I estimated the surface velocity to be over 2 m/s and probably less than 3 m/s. If I got it right, we should have at least half a minute to try and retrieve Yella Terra if something goes wrong, less if I got it wrong.

After running diagnostics and calibration tests we were ready to go. We started with a loop test, as much to see what was beneath the surface as checking for a moving bed. Despite being a little rusty, The Planner soon got into the swing of RiverSurveyor Live (RSL), constantly calling out depths and velocities, pulling me up when my boat speed exceeded water velocity. After poking Yella Terra around a bit we were able to discern the bad from the ugly, the hazards to avoid and the obstacles to go around. There appeared to be a submerged island beyond the middle, or perhaps it was the low flow bank? It was both bad and ugly with trees protruding in places. We found a path through and were able to get some decent transects. The far-left bank was covered in thick bush and blackberries. If Yella Terra was to get stuck there it'd be a nightmare to get out. We decided not to push our luck and maintained at least a half metre of depth, hoping a stray strand of blackberry didn't further blacken our bleak day. This left us with an edge of 10 m, but there was little velocity and therefore an insignificant volume in the grand scheme of things.



Duration	Track (m)	DMG (m)	Width (m)	Area (m2)	Mean Speed (m/s)	Boat Speed (m/s)	Left Q (m3/s)	Right Q (m3/s)	Total Q (m3/s)	ɔp Corrected Tota (m3/s)	% Measured (%)
0:04:12	101.75	86.18	103.175	238.861	1.325	0.404	2.36	0.09	316.372	--	71.7
0:02:51	94.55	85.97	102.974	243.078	1.267	0.553	4.45	0.09	308.092	--	71.1
0:04:51	112.20	89.34	106.345	244.716	1.297	0.386	2.27	0.05	317.374	--	71.7
0:02:32	93.73	80.98	97.982	247.437	1.268	0.545	11.41	0.06	313.662	--	70.0
0:04:40	104.77	85.73	102.727	237.136	1.326	0.374	5.72	0.15	314.487	--	71.2
0:02:54	103.59	84.89	101.889	249.501	1.303	0.595	13.33	0.06	324.978	--	69.6
0:03:41	101.77	85.52	102.515	243.493	1.298	0.476	6.59	0.08	315.827	0.000	70.9
0:00:52	6.29	2.46	2.460	4.381	0.024	0.090	4.29	0.03	5.045	0.000	0.8
0.000	0.062	0.029	0.024	0.018	0.018	0.189	0.651	0.365	0.016	0.000	0.011

Figure 2. Shoalhaven River at Warri panorama transect.

The first four transects appeared reasonable considering the conditions, our widths varying from 98 – 106 m, areas from 237 – 247 m^2 and discharge 308 – 317 cumecs (m^3/s). I'd normally be accepting of 3%, but I had a gut feeling questions might be asked. So, as we were there already set up, we slugged it out for another couple of transects. This always feels like dicing with the devil, throw me an outlier now, you bastard!

And there it was, the last transect. Width OK, area a little high, volume high. Not high enough for RSL to turn scarlet and abuse me for pushing it, but high enough to bother me. On second glance it counters the second transect that was a little low. The average has come in around the median so it will have to do. After checking the staff gauge, The Planner and I call it a day and get down to The Bay to find a seedy dive to lay our heads for the night. As long as it's dry, that's all that matters.

The Clyde

Tuesday, 23 March and I pulled my reluctant body out of the hard-lumpy motel bed. I attempted to stretch out the aches and pains throughout my body, but shortly gave up, they were here to stay. It had been a lousy night. Rain had pelted down thunderously on the thin iron roof all night. But it wasn't all bad, at least this motel room didn't leak, not over the bed at least. I dressed quickly and scooped up the pile of batteries I had charging overnight. I needed a caffeine hit if I was going to start this day. It seemed The Planner had similar ideas.

I grimaced as I sipped the brown ooze they call coffee in The Bay. It was bitter and terrible, just what I needed. The Planner knocked his coffee back without so much as a twitch. This was a familiar poison. In a previous life The Bay had been his beat. I hoped he wasn't too rusty, we needed his navigational skills today. As I continued grimacing at the brown muck in my cup The Planner got into a conference on the blower to Chief and The Beggar to plan the days attack. It looked like The Beggar and his rough riders were going to have their waders full again in the south, they too had a long night of hard rain. The Planner and I were going to cover the north, get what we can as best we can, try not to lose anything, particularly ourselves. We can only try.

We headed further north, driving through the torrential rain. Visibility was low. I thought back to the morning's Start Card, "drive to the conditions," there was no way around it. I wondered how the morning was shaping up in sunny Cowra.

After what seemed an age of splashing our way up the Princess Highway, we turned off the tarmac and started climbing east. Now the challenge begins. This is the Upper Clyde; rough country only visited by foresters, drogys and the insane. Unsure which category we were in, we pushed on, we had a job to do.

After countless turns up muddy trails that wound endlessly into the hills, we came to a clearing. Yesterday had been like a bath in Inox for The Planner, there was no rust today. This was gauging station Clyde River at Brooman. At least the instrumentation shelter was in a clearing, the rest was like a primordial rainforest in inner Borneo. Will questions be asked if I put a machete on P-card?

Like a well-oiled machine we swung into action. The Clyde River was more like a sleeping giant in comparison with the Shoalhaven. It was one huge slug crawling along at a seemingly sedate pace. But it was deep. I don't think I've ever measured anything that deep before. It maxed out at over 10 metres, but still well within M9-2095 specs. But at that height we had riparian vegetation both submerged and protruding everywhere. It looked like it might be a right bastard to measure.

Figure 3. Clyde River at Brooman.

Standing over the left bank I was able to manoeuvre Yella Terra competently to about 4 metres off before vegetation started interfering with M9-2095's beams. There wasn't much velocity between us, so I settled on that. The far-right bank was another matter, a lot more vegetation with whole trees rearing their ugly heads out of the water, just waiting to snag Yella Terra, or play havoc with M9-2095's beams. It was going to be difficult steering through that from a distance of over 70 metres away. Yella Terra survived yesterday by keeping a wide berth so we tried that approach. Again, the velocity died right off on the far-bank so a 10-metre edge shouldn't be too bad. Surprisingly, everything went off without a hitch. Before long we had four very neat transects. We were well over 800 seconds, or 900 if you're old school like me. So not wanting to push fate, I pushed F8. We still had to get out of this asylum.

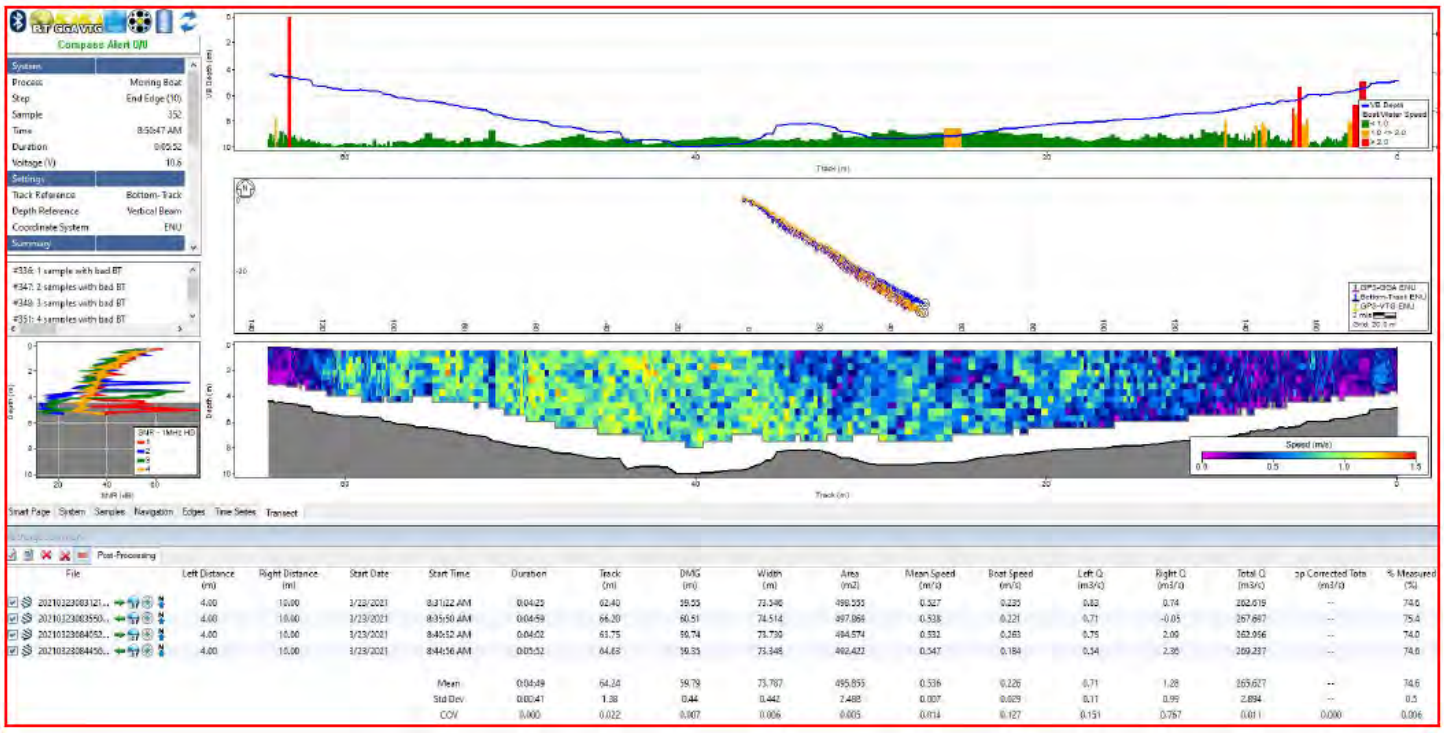


Figure 4. Clyde River at Brooman transect.

The Hunt for Buckenbowra

The Planner and I made our way out of the hills and back to something more civilised, although anybody who has been to The Bay over summer holidays wouldn't call it civilised. It was time for more of the russet drug they served in cafes and a regroup with Chief and The Beggar. There had been some high gauging's in the past at most sites it seemed, the one exception being Buckenbowra. Behind closed doors it was referred to as "That *ucken Bowra." The Planner planned to change that. Today we were in the right place at the right time. We were going to be the first to get a high gauging and it would be 'Bucken-beautiful.'

As it turns out Buckenbowra should have been named Rome. It seemed nearly every road in the district led to Buckenbowra. It was just a question of which road to take. This should be easy.

The rain had eased to something less spiteful as we ventured up the Kings Highway. This seemed like a good omen. I glanced regularly out the side window at the swollen Nelligen Creek pulsing by. It didn't have far to go before it'd start clawing its way across the highway. This should have rung alarm bells. We turned off the King, the hunt for Buckenbowra begins.

We'd not gotten far when we came across a crossing, Nelligen Creek, however it was not letting us through this way. All is at hand, the Planner guiding us back to the ramshackle settlement of oyster farmers called Nelligen. Before long we are out in the hills again. This is country where permaculturalists seek out an existence, biodomes over vegie patches, sodden rainbow flags hanging limp. As we climb higher the country becomes steeper and rougher, now the domain of hillbilly squatters, their highly modified 4WDs like gargoyles guarding their coarse driveways. As we thrust our way through the mud and puddles, ever deeper into the hills, signs of habitation cease. Not even bandits would bother to hide out here. I breathe easy. This is home. This is where drogys roam.

The Planner came to a halt. We'd hit another obstacle. The crossing didn't seem that bad, but the tree caught across it did. The water looked too swift to be attempting any kind of removal. Driving over it seemed an unnecessary risk and we'd been warned about unnecessary risks. We turned back, there are still many roads to Buckenbowra.

Figure 5. The first attempt at crossing.

As the day wore on it became apparent that all roads may lead to Buckenbowra, but bridges are few and far between. The next several hours were spent in a futile attempt to find a way through, only to be turned back by another crossing, too deep, too fast, and too risky. A credit to The Planner for his determination to break Buckenbowra, but it was not to be. 'That *ucken Bowra.' The one piece of useful data gained was there's no access to 'That *ucken Bowra' in the wet.

Figure 6. The second crossing.

Figure 7. The third crossing.

Figure 8. The fourth crossing.

Quandary

Having been defeated by Buckenbowra we picked our way back to The Bay. Neither of us could stomach any more of The Bay's caffeinated sludge. It was hard enough having to break the bad news to Chief without swallowing that stuff.

You could hear Chief trying to hide the disappointment from his voice, covering it with "but you guys are safe, you didn't lose anything or break anything." Except we lost a high gauging I said to myself. "Unlike the guys here, they broke the Q-boat" Chief continued. I almost missed that. But there was more.

"Lots of rain in the Deua, might be looking at 60,000 meg at Moruya. Be warned though, landslide has closed Brown Mountain, if you come down to Bega you might be trapped" said Chief.

The Planner and I looked at each other. As much as we wanted to help the Bega rough riders, Beggars the lot of them, could we risk the loss of Yella Terra? That would have implications elsewhere. If Brown Mountain has gone then Clyde Mountain might be next? We could be stuck on the coast for a very long time. Easter is only around the corner; you do not want to get stuck on the coast during Easter. We considered what we could do in the area, Brooman again and Moruya? But they had both been gauged at high stages before. Perhaps the answer lay elsewhere? The Shoalhaven had gone up. Warri needed the gauging's. That would put us out of harm's way, above the escarpment and off the coast. It was now a race to get up The Clyde before it had a landslide.

We rolled into Braidwood for the night, thankful we had escaped the coast. However, we were shocked at what we found. It was dry yes, but this was much less expected. The surprise on their faces showed they were equally surprised to come across fellow drogys doing a flood run. This was a team of Men-of-Angle, tall strong men of hard chiselled features. Before long fluids of crafted amber were being passed around. The only thing more bitter than a Batemans Bay coffee being the hops of a boutique double IPA. The night rolled on into the early hours, trading stories of great gauging's past and present. As a parting gift in the morning, the Men-of-Angle introduced us to Deer Head, purveyors of the finest brekky wrap's and burgers anywhere. Thank you and amen Men-of-Angle.

World Warri II

With breakfast done and dusted it was time to revisit Warri. The Shoalhaven was up around 300 mm on Monday's visit. This should serve as good confirmation of Monday's results. Although a little dusty from the evenings indulgence, we were in high spirits. We knew this monster now. We knew how to approach it. We knew how to make it bend to our will. We knew how to get a decent result.

Following the book, we did a loop test before starting any transects. M9-2095 had one of its tantrums, stating

> "ERROR: Loop Closure Error not in the Upstream Direction.
>
> REPEAT LOOP or USE STATIONARY TEST."

This is not uncommon from M9-2095, it just needs a bit of time to warm up and figure out where it's pointing. Perhaps the M9 had a few last night as well? Really who could blame it, putting its life on the line in these flooding rivers time and time again. And we, the ones putting it out there no longer share its fate when things go sour. Sorry M9-2095, that is just the world we live in now.

I ease Yella Terra back out, maintaining a steady course through the turbulence, getting constant feedback from The Planner "good depth, steady, you're going orange, back it off, that's it, getting shallow now." This guy needs to get out of the office more often, we need good drogys like this in the field. This time M9-2095 has its wits sorted, it knows where it is, and knows Moving Bed Velocity < 1% of Mean Velocity – No Correction Recommended. That is music to my ears. Time to let M9-2095 dance its beams all over this river and get some transects.

We follow much the same path as we did on Monday. The first 2 transects vary a bit, widths 107 – 115, areas 285 – 291, discharge 442 – 419. We'll see how things look after another couple of transects, but I'll probably be up for 6, or even 8 transects the way this is shaping up. I probably pushed Yella Terra a little hard on the way back. I need to resist the current a little more, I was getting a little orange through the middle there. M9-2095 can only dance so fast, it needs time to find its feet, to track the bottom. Giving it more time to dance should pay off with a more consistent result, or so the theory goes.

The next transect started like any other, nice, and easy, drifting Yella Terra out until it hits some velocity. As Yella Terra noses into some decent flow I spin the motors up, maintaining as straight a line as I can as Yella Terra gets buffeted around by competing currents. We pass halfway and all is well, perhaps not smooth sailing, but it never is in these conditions. This is where the peak velocities are. M9-2095 tells me it's nudging just past 2.6 metres per second. It's doing a great job out there, dancing madly through the turbulence and obstacles unseen to us on the surface. But never get complacent with a monster.

Figure 9. Below, back to Warri by S. Gleeson (possibly moments before near tragedy).

Then it happened!

Yella Terra starts slipping off the line. I give some more throttle. Yella Terra bumps along, a little sluggish but makes it back to the line. It happens again. I realise there's no more throttle to give. In an instant I know what's happened and slew hard left for home.

I have little more than 30 seconds to save both Yella Terra and M9-2095. They have both been indispensable members of the Tumut Team. This was not the easy retirement they were due. This would be the equivalent of a Viking burial, minus the flames.

The current picks up Yella Terra and hurtles it downstream. The surface velocity seemed more than 3 metres per second.

**White water 70 m away.*

It's too far away. Heading straight for home will not save them. I angle 45 degrees into the flow to buy more time. Yella Terra struggles with what little energy is left. Still slipping backwards, but not as fast now. But on this angle there's further to go.

**White water 50 m away.*

Can Yella Terra keep it up? The sudden drop earlier doesn't fill me with confidence.

**White water 40 m away.*

As Yella Terra emerges from the peak velocity the backwards progression eases. But it's short lived. The power is fading. There's still a way to go.

**White water 30 m away.*

Inching closer, but the bank is further away than danger. "Come on!" I yell, "Don't let this bastard take you"!

White water 20 m away.

Yella Terra, graceful as it slowly buffets in the water as it continued to drift backwards to certain doom. With what little strength remained, Yella Terra struggled to squeeze the props forward in vain.

White water 10 m away.

Then I lost sight of Yella Terra. It was an honour serving with you Yella Terra and M9-2095, go rest in peace.

"Yeah, I got it" I heard The Planner scream.

In the lee of the tree blocking my view, Yella Terra had found some still water to clamber out of certain doom. There will be no sacrifice too the Viking Gods!

A rummage through the old bus failed to find any suitably charged batteries. Rather than endanger Yella Terra and M9-2095 again by running on half a charge, we decided to end the gauging there. They had done enough on this day. Only 2 transects, but it was a result and sometimes you have to take what you can get.

The next time Shoalhaven gets angry the Planner or myself might not be there, but some drogy doing a flood run may be, they might even get a bigger gauging?

Epilogue

The Planner and I parted ways shortly after that, never to see each other again. I presume he resumed his role in the office. But I am sure he will remember the time he stepped back into waders and tell tales of it to his kin and any lost drogy who by chance stumbles into his office. I myself sped off to the next flood, I'd heard Yass River was on the rise.

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