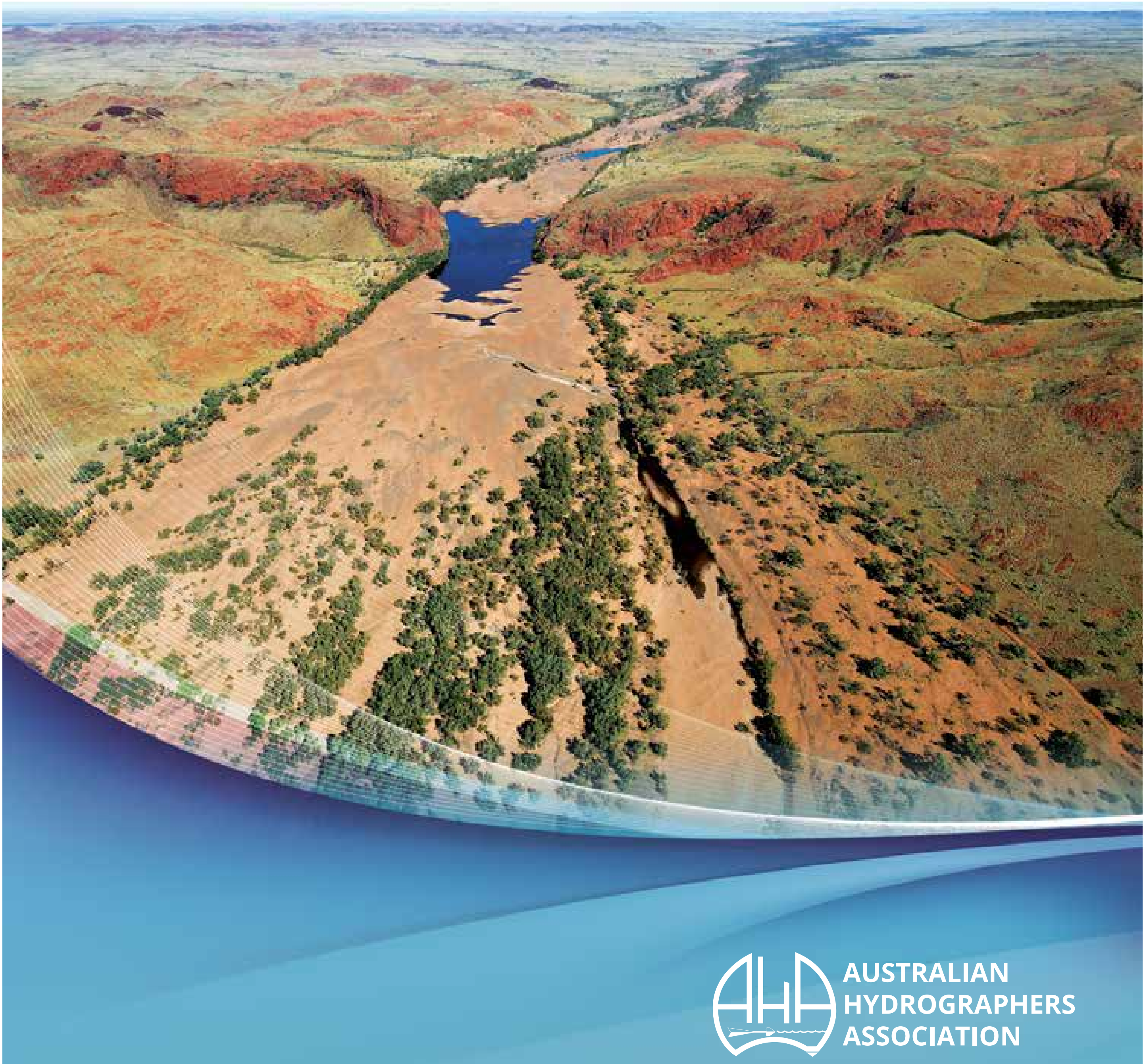
Australasian Hydrographer
June 2022



AUSTRALIAN HYDROGRAPHERS ASSOCIATION

AHA

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Photo Credit:
Tom Marsh, EWS Australia

Photo Information:
Shaw River (Mundabullangana, WA)

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

An Outgoing Editor-In-Chief's Farewell

It is with some sadness but much more excitement that I write this, my final Editor in Chief blurb. Sadness that I will no longer get to be the first to read about all of your endeavours but excitement for the Australasian Hydrographer's future with Zac at the helm.

It wasn't without some trepidation that I became the Editor of the Australasian Hydrographer in 2015, I had had huge shoes to fill and very few contacts in the wider community. I however have never regretted the decision.

I am proud to say that thanks my and the AHA Committees hard work the publication has progressed from a twice yearly to a quarterly edition in the process becoming one of the most viewed items on the AHA Website. The added bonus for me, the opportunity to travel the country and meet a so many wonderful and passionate hydrographers. The highlight, the day Zac, a previous recruit to the profession, joined the Editorial team. I hope you welcome Zac with as much warmth and enthusiasm as you did me.

As for what next? I am retiring from the Australasian Hydrographer so I can concentrate on my career, with a particular focus on the Climate Change challenge, and my family. Two equally significant challenges I am sure you will agree.

I will still be floating around within the Hydrographic stream (pun intended) and I hope that if you see me you will say hello – to help I have finally updated my photo (grey hair, glasses and all)!

Jacquie Bellhouse BSC CPH

Providing Australia with Water Information

Australian Government
Bureau of Meteorology

www.bom.gov.au/water

Have you checked out the Bureau of Meteorology's water information web pages recently?

They provide a comprehensive and reliable picture of Australia's water resources for the benefit of all water users.

The published water information is based on data provided by almost 200 organisations across Australia. Working closely with data providers and stakeholders, a portfolio of water information products has been developed covering historic information and trends; current status; forecasts; and planning tools to provide users with both a local and national perspective on water resources in Australia. Key products include:

Water Data

- Water Data Online provides a single access point to data for more than 6000 monitoring stations across Australia.
- Water storages dashboard compares daily water levels and volumes for more than 300 storages.
- Design Rainfalls provide Intensity-Frequency-Duration rainfall estimates for designing hydraulic structures.
- Australian Water Market website tracks and reports water trading.

Water Status

- Our suite of national water assessment products, groundwater information products, National Water Account and Urban Performance Report provide information to support water policy and planning.
- The Landscape Water Balance Model assists in understanding how catchments have responded to rainfall and runoff both currently and in the past.

Water Forecasts

- The 7-day streamflow forecasting service and Seasonal Streamflow Forecasts provide streamflow forecasts to assist river operators with decision-making.

MORE INFORMATION

For more information come and talk to us at Booth 13; visit www.bom.gov.au/water or send an email to waterinfor@bom.gov.au

Zac Ward

And a *Hello* from the Incoming Editor-In-Chief

As I mentioned in the last edition of the Australasian Hydrographer a massive thank you and farewell to our exiting Editor-In-Chief and all-round epic Hydrographer Jacquie. You will be sorely missed and definitely leave some very large shoes to fill, I hope I can do the role justice.

A short bit of background about myself (for those who don't know me yet), I have spent the last 15 years building my hydrographic career in Western Australia working for the Water Corporation (government water utility/provider) and inducting/training the newest breed of budding hydrographic trainee's to the in's & out's of water measurement and data analysis. The last year of my career has resulted in a small pivot to the private industry where I'm extremely lucky to now be working for an amazing, innovative, up and coming remote monitoring company called EWS Australia. Still surrounded by some very talented and passionate hydrographic professionals I am continuing to enjoy the challenge and uniqueness of this industry with massive improvements/innovations in the satellite telemetry and non-contact measurement space fuelling my passion and interest.

I'd like to finish by saying that we're more and more in desperate need for not just articles, but also hydrographic photos, landscapes, etc for upcoming issues and covers. I encourage members to not be strangers, please reach-out with material, photos, topics, or even just to tell us how we're doing. I'm always excited and eager to meet fellow hydrographers particularly across the ditch. Here's to the next chapter of the AHA and hopefully seeing some fellow members face-to-face in the coming years.

Zac Ward CPH

Arran Corbett

From the President

As another financial year draws to a close, we usually find ourselves pulling together our budgets and our plans for the year to come. Given such a prolonged period of interruptions, thanks to pandemics and disrupted weather patterns, it is hard not to look at the impending wet season without thinking "what next?!" Thankfully as a I write the BoM are calling our recent run of La Nina conditions over with only a moderate chance of return later in the year.

It is hard to know where to focus our efforts in terms of resilience uplift for our monitoring networks. Do we build our elevated platforms higher, do we increase the size of our firebreaks, is non-contact measurement now viable? One answer that I keep coming back to is telemetry and telemetry redundancy. From the simple addition of a daily heartbeat to the more complex fail over redundancy, there are options available and we need to start baking them in to our systems. Next time you are on-site, stop and have a think about what you can do to ensure the data your station collects will continue to make it through.

From a water industry perspective, the importance of our skills as professional Hydrographers is on the rise. Many jurisdictions are increasing their focus on accurate measurement of water use and increased compliance capability. Many of the tools and techniques now emerging fall squarely in the realm of the hydrographic skill set. This week the ABC released the following article highlighting the fantastic efforts of Dr Ivars Reinfeld and the team at NSW Natural Resources Access Regulator (NRAR) https://www.abc.net.au/news/2022-06-18/water-cops-oversee-transformation-of-nsw-water-use/101157954. This media piece highlights the application of technology for both direct measurement and for triage (early detection). Trust that we will be lobbying to ensure that Hydrographers continue to be recognised as Duly Qualified People (DQPs) and as such are entrusted to install equipment or make the measurements that NRAR (and others) require.

On the committee front, we continue to build our own capability with Association Executive Services (AES) joining us in support of the administrative function. We are confident that Nick and the team at AES will get up to speed quickly and we will all benefit from having a greater level of support. This will free our volunteer committee's time to focusing on increasing member value.

It's a great time to be in this industry and an even better time to be part of the AHA! Thanks for your continued support and I look forwards to catching up with you all in person ASAP...

Thanks,

Arran

Rural Water Futures, Emerging Water Technologies

Scoping Document – June 2021
Department of Regional Development, Manufacturing and Water, QLD

Summary

The provision of high-quality water management outcomes is highly dependent on the collection, analysis and interpretation of data to drive informed decision making and compliance activities. The Hydrometric Networks and Remote Sensing (HNRS) Program outlines a multi-year investment delivered between the relevant States and governing bodies to improve the equitable and sustainable use of water resources within the Murray Darling Basin area and beyond.

A core component of the HNRS includes research activities to inform future investments into new operational technologies that can be used to enable front line staff and water users with the tools they need to get the job done. Ongoing technology innovation in the areas of Internet of Things (IoT), data communications, sensing and measurement, combined with increasing demand to expand the measurement footprint have resulted in the development of this scoping report. The findings of the scoping report should be leveraged by jurisdictions to consider new and emerging approaches when investing in measurement and monitoring services.

This scoping document has included a high-level assessment of a range of emerging technologies in five key areas, including:

- **Measurement:** In-field technologies that collect vital resource measurement data via sensors and other capabilities.
- **Telemetry:** Communications systems that transmit measurement data for the purposes of analysis.
- **Data Exchange:** Sharing of data between systems, organisations and people.
- **Analysis:** Transforming raw data into information, intelligence, and insights to drive awareness and decision making.
- **Platforms and Systems:** The underpinning systems and platforms that support day to day operations.

The scoping document has been a collaborative effort between a range interested stakeholders, including:

- State Governments, including the Queensland Government (Lead), New South Wales Government, Western Australian Government and Tasmanian Government
- The Commonwealth Government; and
- Related agencies, authorities, and entities.

Identified stakeholders were engaged via a series of interactive workshops that collected vital information to understand the current state environment, future state requirements and where emerging technologies have already been deployed in pilot or trial areas.

A summary of the major findings of the high-level scoping document include:

- A range of new emerging technologies relating to lower cost, lower power, longer life sensors have a strong potential to extend the scale and reach of measurement services.
- Small form factor edge computing can conduct complex calculations at the point of data capture, increasing monitoring performance in remote areas.
- New low-power wide area networks and low earth orbit satellite technologies are extending the communications services into new remote and regional areas.
- Data capture, aggregation and exchange services are growing in maturity and are universally considered central to growth.
- Cloud based data processing using Image Velocimetry / Videogrammetry (SSIV / STIV) to provide viable alternatives to current approach.
- New approaches to Cloud-based systems and platforms are enabling a new approach to water management systems that are more agile and responsive to business and customer needs.
- As emerging technologies are adopted, workforce evolution must be considered as roles change over time (i.e., less task orientated internal focus, increase in outcomes focus, closer to the water user).

Purpose and Use

The Emerging Water Monitoring Technologies Scoping Document was developed in early 2021 in close collaboration with Australia's foremost water management organisations and related subject matter experts. As detailed, representatives from the following major stakeholder organisations were involved in the development of this document:

- Queensland Government, Department of Regional Development, Manufacturing and Water.
- NSW Government, Natural Resources Access Regulator.
- Tasmanian Government, Department of Primary Industries, Parks, Water and Environment.
- Western Australia Government, Department of Water and Environmental Regulation.
- Commonwealth Government, Murray Darling Basin Authority.
- Water NSW.
- Snowy Hydro; and
- University of Queensland.

Major Stakeholders

The findings of the scoping document should be used by water organisations to inform future investments in water monitoring, measurement, management, and compliance services as part of a national approach to continuing to improve water services.

The scoping document itself is a living artefact and will be updated as new and emerging technologies enter the marketplace and start to further enhance existing infrastructure and services. Through these advancements a more responsive water environment is anticipated and will deliver new benefits to water users through open and transparent resource management.

Emerging Technologies Scope

The Emerging Water Monitoring Technologies Scoping Document has focused upon five key areas to identify and carry out a high-level assessment of the range of technologies emerging across the nation.

The scoping report has been developed in accordance with the identified delivery roadmap.

1. MEASUREMENT

Water measurement equipment, including industry advancements and future innovation will be considered against traditional deployment approaches and use cases.

2. TELEMETRY

Emerging telemetry services will be assessed against traditional approaches, including public and private narrow and broadband capabilities.

3. DATA EXCHANGE

Highly interoperable data exchange capabilities that promote access and reuse of water information will feature at the center of the scoping considerations.

4. ANALYSIS

The future state scope will have a strong focus on how to apply improvements in commoditised analytics and other algorithms such as AI and ML to improve water management outcomes.

5. PLATFORMS AND SYSTEMS

Underpinning the elements within the scoping document will be the how legacy and emerging water management systems can improve situational awareness and customer experience.

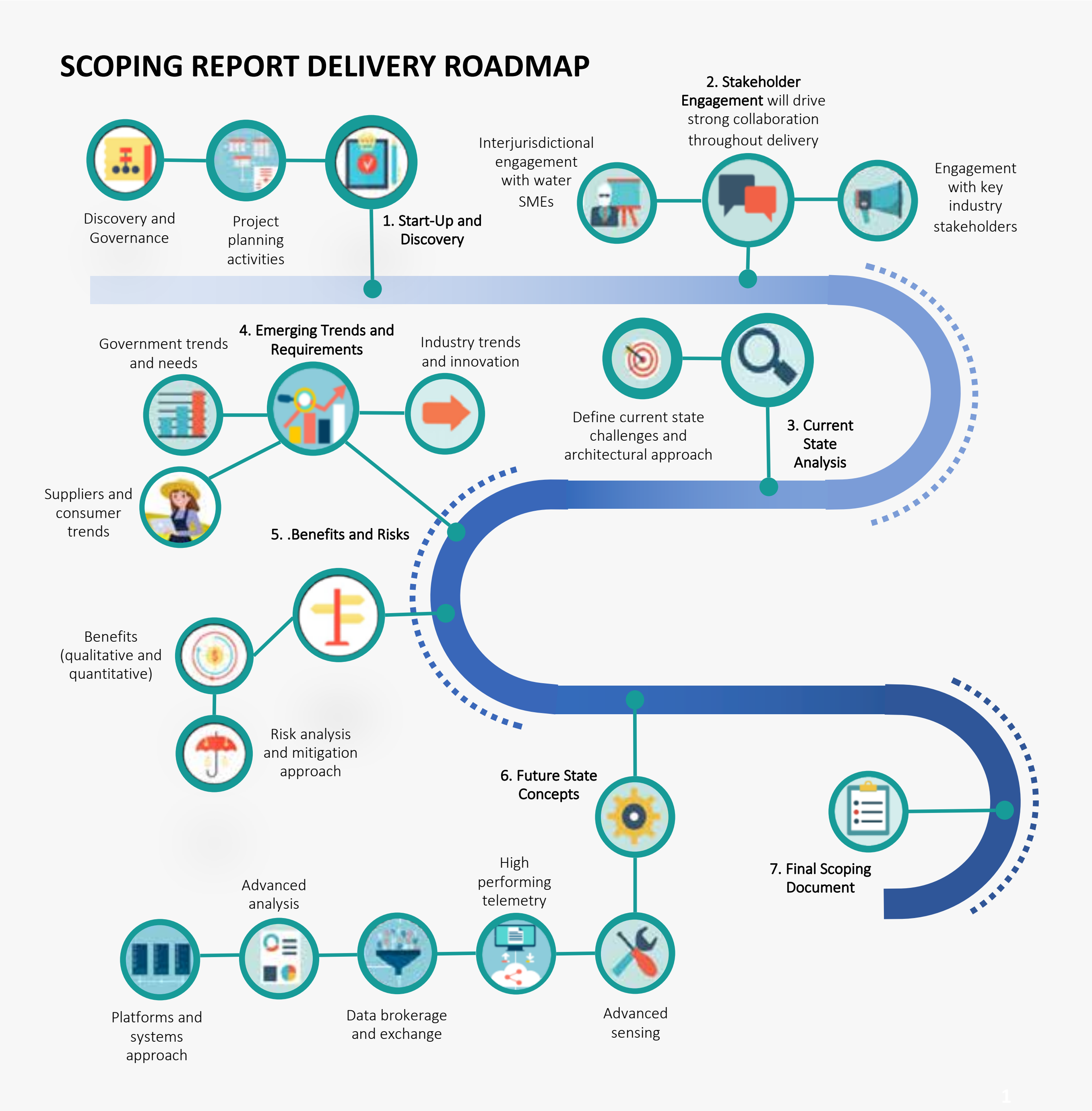


Figure 1: Emerging Technologies Scope.

Water Management Value Chain

The term *'water management value chain'* describes the different functions and activities that comprise the water business nationally. As depicted below, the water management chain has been divided into six business domains that represent the core functions of the water business.

Water Planning: Water planning considers how the resource can be responsibly and sustainably used, and sets the objectives and rules for resource management, through a consultative and scientifically informed planning process.

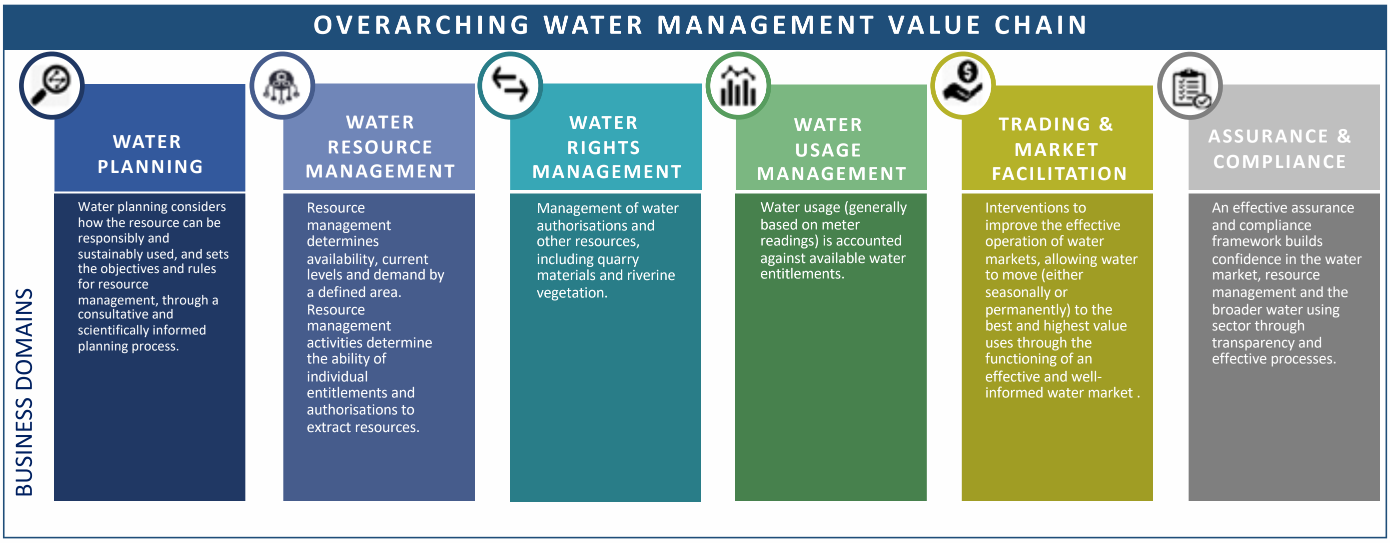
Water Resource Management: Resource management determines availability, current levels and demand by a defined area. Resource management activities determine the ability of individual entitlements and authorisations to extract resources.

Water Rights Management: Management of water authorisations and other resources, including quarry materials and riverine vegetation.

Water Usage Management: Water usage (generally based on meter readings) is accounted against available water entitlements.

Trademark & Market Facilitation: Interventions to improve the effective operation of water markets, allowing water to move (either seasonally or permanently) to the best and highest value uses through the functioning of an effective and well-informed water market.

Assurance & Compliance: An effective assurance and compliance framework builds confidence in the water market, resource management and the broader water using sector through transparency and effective processes.



Drivers

A number of compelling drivers are forcing change in the way water management activities are conducted across the nation. A number of these drivers are detailed. Two key issues – operational safety and situational awareness and decision making at the heart of the identified drivers.

Increased Reach

The reach of traditional technology solutions is limited and there is a drive to enable increased water monitoring and measurement in more places across the nation to gain more accurate and reliable information.

Reduced Complexity

Current technologies utilised in terms of measurement, telemetry, data exchange, analysis and platforms and systems are complex and there is a desire to simplify these technologies to support better water management.

Value for Money

In this fiscal environment, Government expenditure must be focused upon achieving value for money through adopting solutions that enable greater reach and optimisation of spend.

Leverage

A range of deployed non-water infrastructure (private and public) can be leveraged for the purposes of data collection and analysis (industry, consumer and government).

Utilise

Advancing technologies are rapidly emerging in the market and utilisation will enable more effective water management across the nation.

Operational Safety

The current water measurement methods require staff attendance at site, which places staff in high risk, hazardous situations to travel to as well as collect data.

Awareness & Decision Making

The availability of rich data across the water management value chain will enable higher levels of situational awareness to better inform decision making for all stakeholders.

Low Cost, High Accuracy Sensing

Low-cost sensing technology is emerging and needs to be leveraged, balanced with high accuracy capabilities and requirements.

Predictive Analysis

The technology currently used is mostly limited to reactive analysis, rather than enabling predictive analysis to inform decision making.

Timeliness of Information

The remote nature of water monitoring stations can impact upon the timeliness of data, delaying decision making when it is needed most.

Accuracy & Validated Information

It is imperative that accurate and validated data be available to inform decision making for the water business.

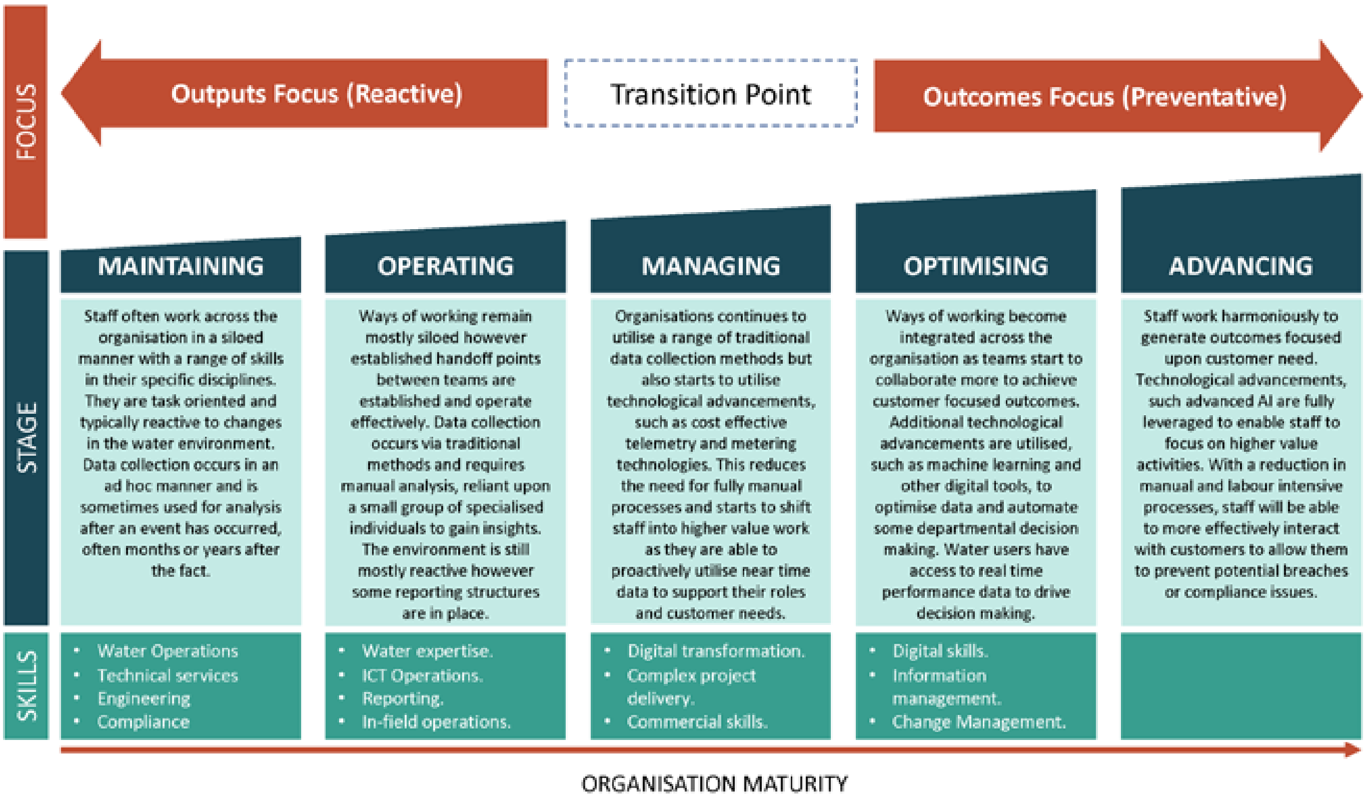
Responsive Operations

New technologies will enable more responsive deployment of measurement and monitoring services, reducing the time to deploy new in field capabilities.

Change Management

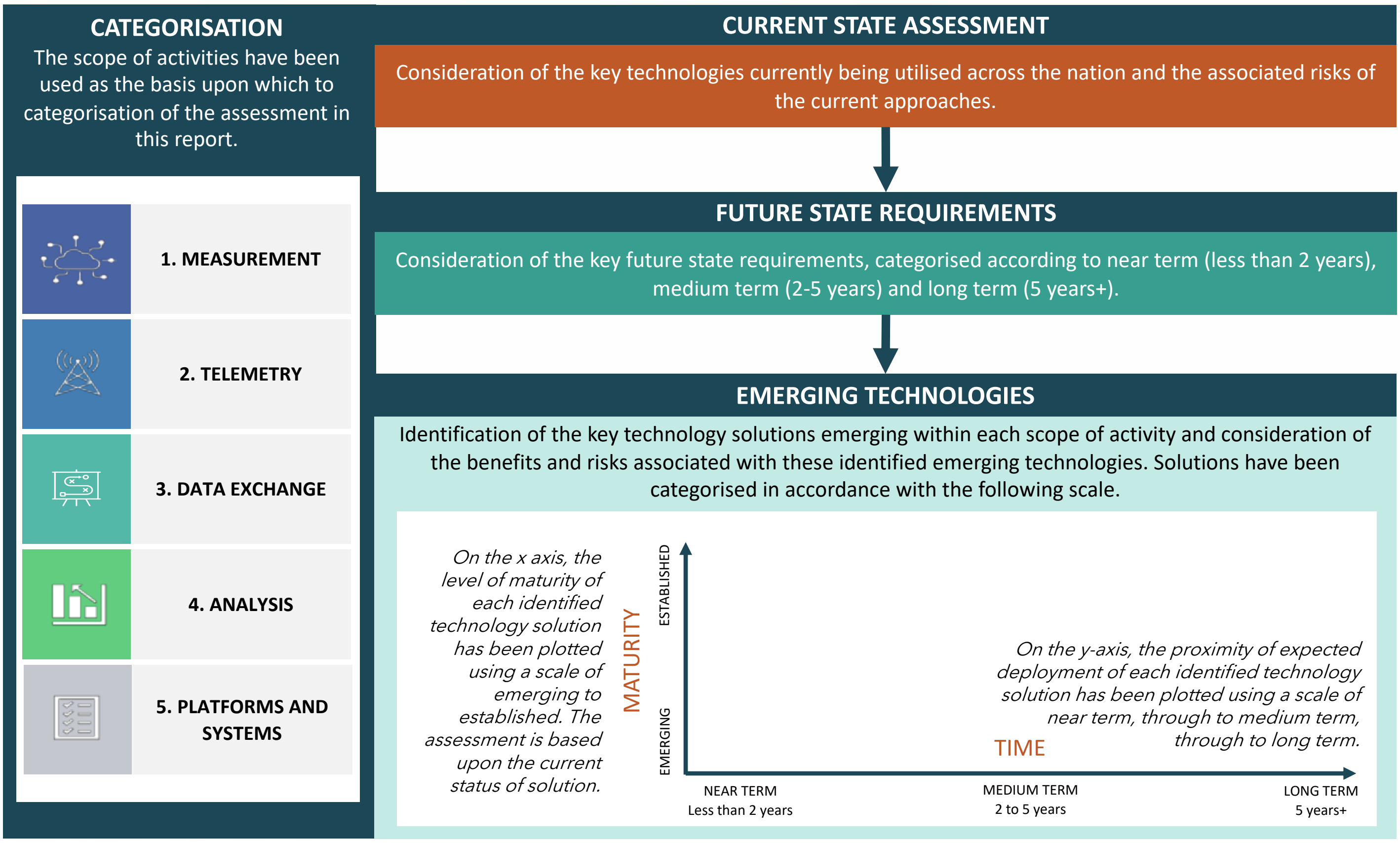
The adoption of emerging technologies will have a significant impact upon the water business workforce across Government departments and agencies. Roles are expected to adapt significantly over time, change from a mainly internal, task orientated focus to becoming outcomes focused with the water user at the heart of all decisions. This change will enable staff to complete higher value activities further up the water value chain.

Workforce evolution is therefore a key factor that must be considered to support this change in focus. Effective cultural change and change management will be critical to enable departments to effectively transition staff into higher value activities.



Emerging Technologies Assessment Approach

This Scoping Report has been developed to consider the water monitoring technologies that are emerging across Australia. Across the identified scope of activities previously outlined on page 5, a range of elements have been considered to gain a better understanding of both the current state and the potential future state.



Consideration 1: Measurement

Current State Assessment & Future State Requirements

Measurement

Water measurement equipment, including industry advancements and future innovation will be considered against traditional deployment approaches and use cases.

The global explosion of new and innovative ways to conduct in field operations with advancing technologies has had an impact on a range of industries that operate in remote and more harsh operating environments (e.g., agriculture, mining, etc). The future of water measurement is currently and will continue to be shaped be new and emerging technologies that have the potential to transform traditional approaches to water measurement. Whilst the opportunities associated with advancements in field deployments may yield a range of benefits, they need to be balanced against accuracy, reliability, and operational impacts.

Current State Assessment

Key Technology Currently Deployed

- Fixed monitoring stations, including:
  - Huts with solar and supporting battery services.
  - Telecommunications equipment; and
  - Measurement and gauging sensors.

- Field deployable solutions including:
  - Legacy mechanical sensors / self-powered;
  - Open channel / closed pipe / wells / shafts; and
  - Soil / nitrate / evaporation / bubblers / probes.
- Use case specific technologies, such as:
  - Lidar solutions for mapping.
  - ADCP; and
  - Space Time Image Velocimetry (STIV).

Key Risks Associated with Current State

- The costs associated with deployment and maintenance of traditional measurement technologies are high (up to $190,000 per site).
- Deployment timeframes are elongated.
- The fixed nature of some solutions reduces deployment flexibility.
- The remote nature of monitoring stations can impact data quality and timeliness.
- Risk to staff (maintaining and conducting in field measurements Asset management is operationally intensive and not always efficient.
- Technologies require complex calibrations (some).

Future State Requirements

Near Term (less than 2 years)

- Continue to utilise traditional monitoring solutions that will be augmented with emerging technologies.
- Where use cases permit, deploy fit for purpose emerging technologies in pilot and/or trial environments.
- Measure benefits and report findings to other stakeholders.

Medium Term (2-5 years)

- Extend the deployment of lower power, lower cost sensors to provide infill coverage.
- Increase the use of field deployable solutions that may be a precursor to more permanent stations or to address immediate requirements.
- Include crowd sourced measurement for analysis.

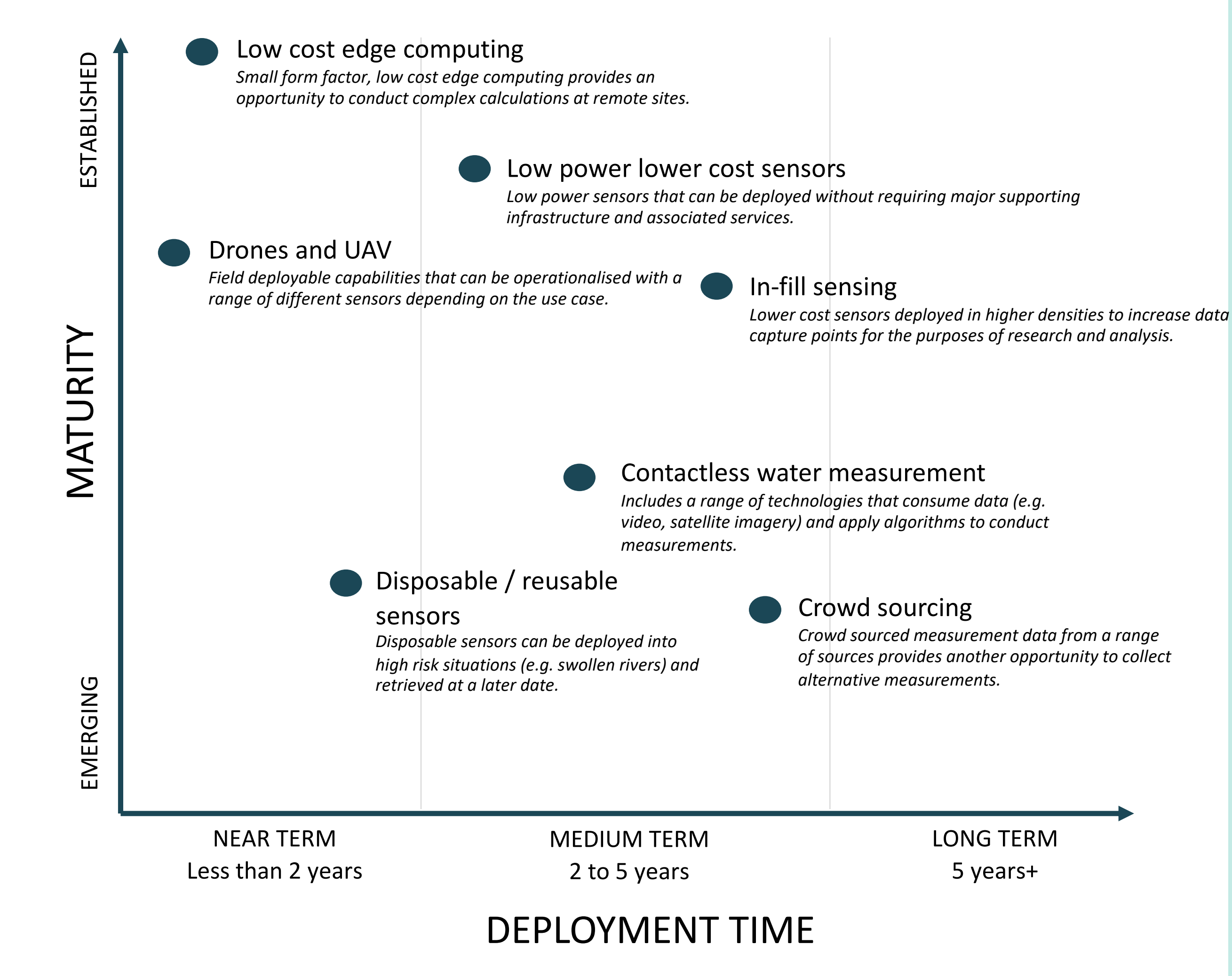
Long Term (5 years+)

- As emerging sensing and measurement technologies evolve and mature, consider long term integration as part of asset replacement and engagement programs.

Emerging Technologies

Emerging measurement technologies are currently experiencing a surge in available products, due largely to a global IoT push across a range of diverse sectors. The key benefits and risks associated with emerging measurement technologies are detailed below.

EMERGING TECHNOLOGIES



NOTE: Qualitative analysis only based upon inputs from agency workshops and preliminary market research.

Benefits

- Long battery life sensors may reduce the costs associated with deployment of new sites, including associated infrastructure such as power.
- More cost-effective sensors may allow stakeholders to optimise spend and extend reach in terms of deployed capabilities.
- Deployable/disposable sensors enable short term deployments that remove the need to place staff in hazardous circumstances.
- Drones offer new levels of configurability to meet specific use cases and are likely to optimise operational efficiency.
- UAV also offer new capabilities to mapping at scale (e.g. farm and resource).
- Contactless measurement solutions, combined with other emerging technologies, have the potential to transform the traditional approach to measurement, using data points from many locations (video, low-cost sensors, drones, etc) to complete measurement activities.

Risks

- Emerging measurement technologies need to operate in parallel with existing deployments, greatly increasing the workload for operational teams.
- The accuracy of new measurement technologies may not meet quality levels, requiring further investment to develop.
- An increased number of sensors deployed in the field will have an ongoing impact to operational management and maintenance, increasing workload.
- There is a potential environmental impact associated with 'disposable' solutions.
- The level of accuracy associated with some emerging technology solutions may not meet data accuracy requirements and should be carefully monitored.

Consideration 2: Telemetry

Emerging telemetry services will be assessed against traditional approaches, including public and private narrow and broadband capabilities.

The communication of important data from measurement and monitoring sites is a vital supporting technology that plays a major role in the timeliness of field data used be operations staff and water users.

Whilst traditional telemetry systems have largely served their purpose, a new found desire for rich data include images and video are driving an increased demand for high bandwidth services that can improve situational awareness and enable new measurement capability (e.g. STIV). The diverse and remote nature of Australian water resources also creates an on-going challenge with coverage that has traditionally created challenges deploying advanced measurement and monitoring in remote areas without introducing labour intensive measurement processes. New and emerging telemetry technologies are fulfilling these gaps in a range of areas, providing new opportunities to achieve improved and extended water measurement capabilities.

Current State

Key Technology Currently Deployed

- Long Term Evolution (LTE) wireless services, including:
  - 3G – Deployed but being decommissioned.
  - 4G – Deployed where available; and
  - 5G – Very limited deployment.
- Private narrowband services (e.g. Sigfox) where agencies have an available service (limited deployment).
- Public narrowband services (Telstra, Optus) including NBIoT are mostly in trial modes.
- Satellite technologies (Inmarsat, Sky muster, etc) are used where no alternatives exist for remote sites.
- Point to point microwave service.
- High bandwidth fixed service (GWIP / GBIP).
- VHF & UHF Radios / GPM / P25 / SMS.

Key Risks Associated with Current State

- Traditional approaches can be unreliable and when failure occurs, limited information is available to troubleshoot, triggering on-site operational response.
- The ACMA frequency harmonisation work will negatively impact a range of 3G sites, triggering deployment of alternative solutions.
- The costs associated with traditional telemetry approaches can be high, especially where satellite is deployed, limiting data capabilities.
- The reach of traditional telemetry solutions are limited, hindering automated monitoring in some locations, especially where budget pressure exist.
- Public infrastructure can be prone to disruption when measurement data is needed most (i.e. during disaster situations).

Future State Requirements

Near Term (less than 2 years)

- Better connection in remote areas with more cost-effective solutions for the transmission of basic measurement data.
- Trials with new low power network options, including temporary deployment scenarios.
- Baseline and measure improvements to inform future design.

Medium Term (2-5 years)

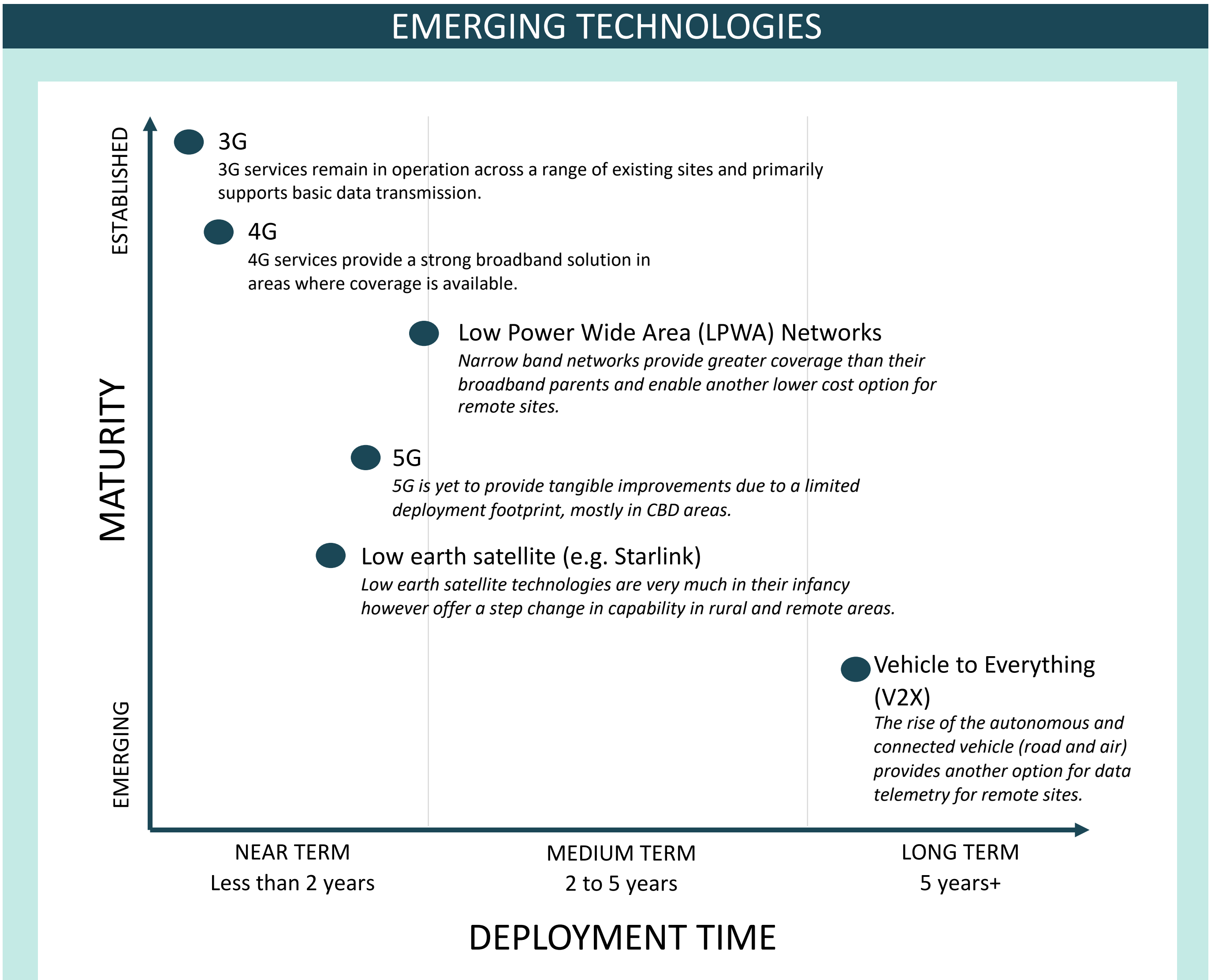
- Deploy and leverage advanced satellite services into very remote areas.
- Increase the volume and frequency of data collection using new telemetry services.
- Increase sensor density in targeted areas with NBIoT devices and supporting sensors.

Long Term (5 years+)

- Continue to modernise telemetry networks where need dictates.
- Commence leveraging V2X, including how those technologies relate to drones and other mesh networks as they emerge.

Emerging Technologies

The identified emerging technologies relating to telemetry offer water monitoring a range of benefits and risks across a series of alterative use cases. The key benefits and risks are detailed below.



NOTE: Qualitative analysis only based upon inputs from agency workshops and preliminary market research.

Benefits

- Increased reach of LPWA networks in the near term was identified as a major opportunity to deploy sensors into areas that were either inaccessible or required expensive satellite-based solutions.
- Lower cost alternatives allow more data to be transmitted over low bandwidth telemetry services, providing more information on general site health.
- As LTE networks continue to expand, more rich data can be collected from a range of sites without incurring significant costs.
- Future advancements in high bandwidth, low latency satellite solutions, such as starlink, enable transformation of very remote sites into high bandwidth sites.
- V2X solutions provide a new opportunity to burst data from remote sites when compatible vehicles come into range.
- Better connectivity will improve overall site monitoring, enabling targeted maintenance and several other efficiency benefits.

Risks

- Some new technologies have the potential to increase ongoing costs for data, especially where large volumes are being transmitted.
- LPWA and LTE remain reliant upon cell technologies that are prone to disruption during disaster events.
- The power budget for new telemetry services may trigger major investments at some monitoring sites.

Consideration 3: Data Exchange

Highly interoperable data exchange capabilities that promote access and reuse of water information will feature at the center of the scoping considerations.

One of the most important aspects of the water management value chain is the ability to exchange data and information securely with a broad range of stakeholders. With a renewed focus on openness, transparency and water management bodies collecting more data than ever before, the development of new services that can both consume and publish data is considered to be core to achieving the desired future state. Historically, water data has been collected and stored in silos, driven either by the ICT systems architecture or the operational responsibilities defined both within, and across water management agencies. The current state has promoted a lack of trust in water data, with numerous sources of truth and in some circumstances, contradictory data. This environment is highly reliant upon staff to extract and interpret data in off platform ways of working such as spreadsheets, greatly impacting the overall timeliness of data where is it needed most.

Current State

Key Technology Currently Deployed

- Hydstra / Aquarius / Neon / Data Lake.
- AWS / Azure.
- FTP / SFTP / spreadsheets / email.
- APIs based on need / SCATA for raw data.
- Public and private web portals.
- Differing data formats and classifications across exchanges.
- Role based access not centralised.
- Some automated (sharing with BOM) / some manual.
- Data timely declassification.
- Water Market Pilar / River Management System / Comms System / DataMart / AHA.
- Farm Bot, Goana Agg, Taggle – Unsecured mart Systems.

Key Risks Associated with Current State

- Some integrations are in place but there is still a significant amount of manual data translation into spreadsheets.
- Processes occur off platform.
- Data exchange does not occur in a timely manner, which has an economic impact.
- Compliance activities are not conducted in proximity to data collection, often occurring months if not years after the breach.
- Not accessible for certain water users.
- Often reliant upon single points of knowledge or capability.
- Multiple points of truth exist for data across the water business.

Future State Requirements

Near Term (less than 2 years)

- Establish data standards and catalogue to drive a common approach.
- Define interoperability framework for major layers of interaction.
- Establish data lakes and other technologies to house data and allow basic and initial data sharing.

Medium Term (2-5 years)

- Establish initial integrations for defined interoperability use cases (within each state and cross border).
- Extend data sets available for consumption inside and outside of each agency.
- Incorporation of unqualified data sets (crowd sourced).

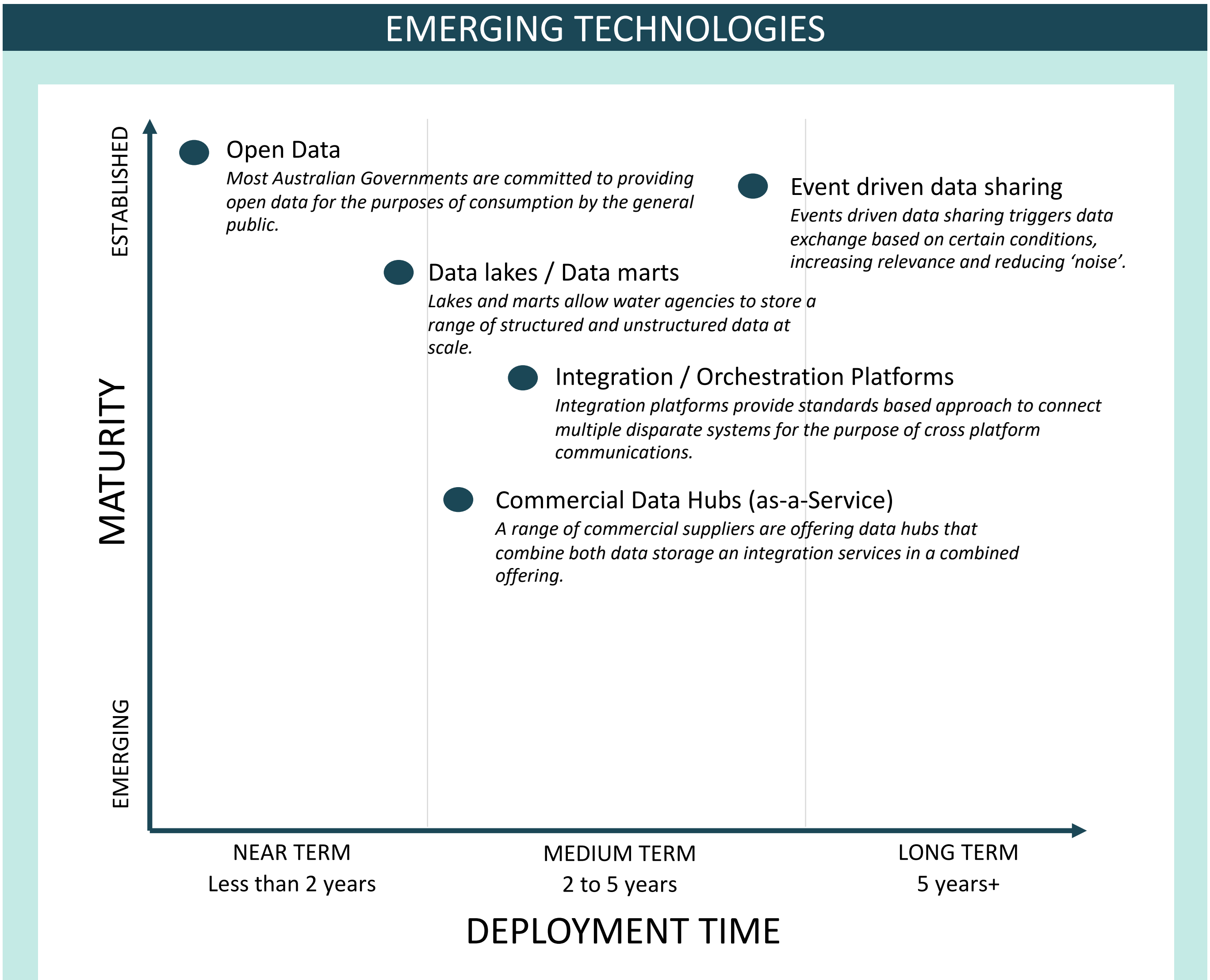
Long Term (5 years+)

- Automated machine to machine interactions based on triggers and events.

Emerging Technologies

Data is the lifeblood of water management and is a direct contributor to the economic benefits of water use within the context of responsible resource management.

The key benefits and risks associated with emerging data exchange technologies are detailed below.



NOTE: Qualitative analysis only based upon inputs from agency workshops and preliminary market research.

Benefits

- Improved data exchange will enable open and transparent data to be consumed and published more broadly to meet the diverse range of stakeholder needs.
- Through the implementation of data standards and catalogues, a standardised and repeatable approach to data collection will be implemented.
- Technology solutions, such as data lakes, will establish a source of truth that can be accessed by the necessary stakeholders. This reduces the need for different stakeholder groups to collect data and duplicate effort and also improves the consistency and accuracy of data held.

- A range of operational efficiencies will be generated as off platform ways of working are eliminated and standardised data processes are implemented to support the emerging technological solutions.
- Data will be highly available and accessible in a timelier manner to support decisions at the time needed most.
- The implementation of the emerging technologies will ensure appropriate levels of security are applied.

Risks

- The current data environment is large and complex requiring a multiyear effort and long-term commitment to drive measurable change.
- Often requires significant investment in supporting technologies.
- Legacy systems may not support modern integration standards, requiring customised and bespoke customisation.
- A national approach to data exchange at all layers will need to balance competing priorities are requirements across a diverse group of stakeholders.

Consideration 4: Analysis

The future state scope will have a strong focus on how to apply improvements in commoditised analytics and other algorithms such as AI and ML to improve water management outcomes.

The analysis of measurement data is often combined with a range of data sources to create information that needs to suit a diverse range of needs across the water value chain. Currently, data analysis activities are either conducted on platforms that may only have a narrow view of water resources or, often, by specialist staff. Where manual data analysis is undertaken, it requires water experts to aggregate data form multiple locations that typically takes a significant amount of time to undertake. As water agencies improve data management capabilities, a major opportunity exists to employ the use of emerging technologies such as AI and machine learning to conduct predictive data analysis. The case for AI is very strong in compliance matters whereby anomalies can be detected early, allowing action to be taken. Whilst new data analysis services are quickly evolving, they ultimately rely upon the timely provision of quality data to realise their intended benefits.

Current State

Key Technology Currently Deployed

- Rule based analysis – scripts, sets, pathways, parameters, R / Python code.
- Manual analysis / using Excel.
- Visualisation tools / dashboards / GIS.
- Developing a data lake.
- Mix of automatic and manual analysis, some real-time.
- HeGrass Modelling to extend curve beyond gauge.
- Neon Data & Eagle IO.
- Commercial contract have more high end sensors & telemetry with real-time analysis and device repair.
- Different quality needs / rating.
- Different risk profile including mainstream media.

Key Risks Associated with Current State

- Hybrids of aggregation, automated and manual analysis can yield varying results.
- Non-standard quality needs, quality rating and missing quality data.
- Different risk profile associated with published data.
- Cultural perception about publishing data and the quality rating being removed or ignored by media.
- Off-platform analysis.
- Slow manual analysis.
- There is no centralised repository for state or national data analysis.

Future State Requirements

Near Term (less than 2 years)

- Increased use of data visualisation tools for internal and external purposes (Dashboards, GIS).
- Trials and pilots with Cloud-based processing of measurement data, including application of videogrammetry such as the use of STIV algorithms.

Medium Term (2-5 years)

- As data sources grow and become more accessible, machine learning trials will be established and introduce predictive analysis of water trends.
- Combined data mash-ups drive new hypothesis and modelling capabilities in a range of water use cases.
- Open data allows external organisations to participate in data analysis and insights.

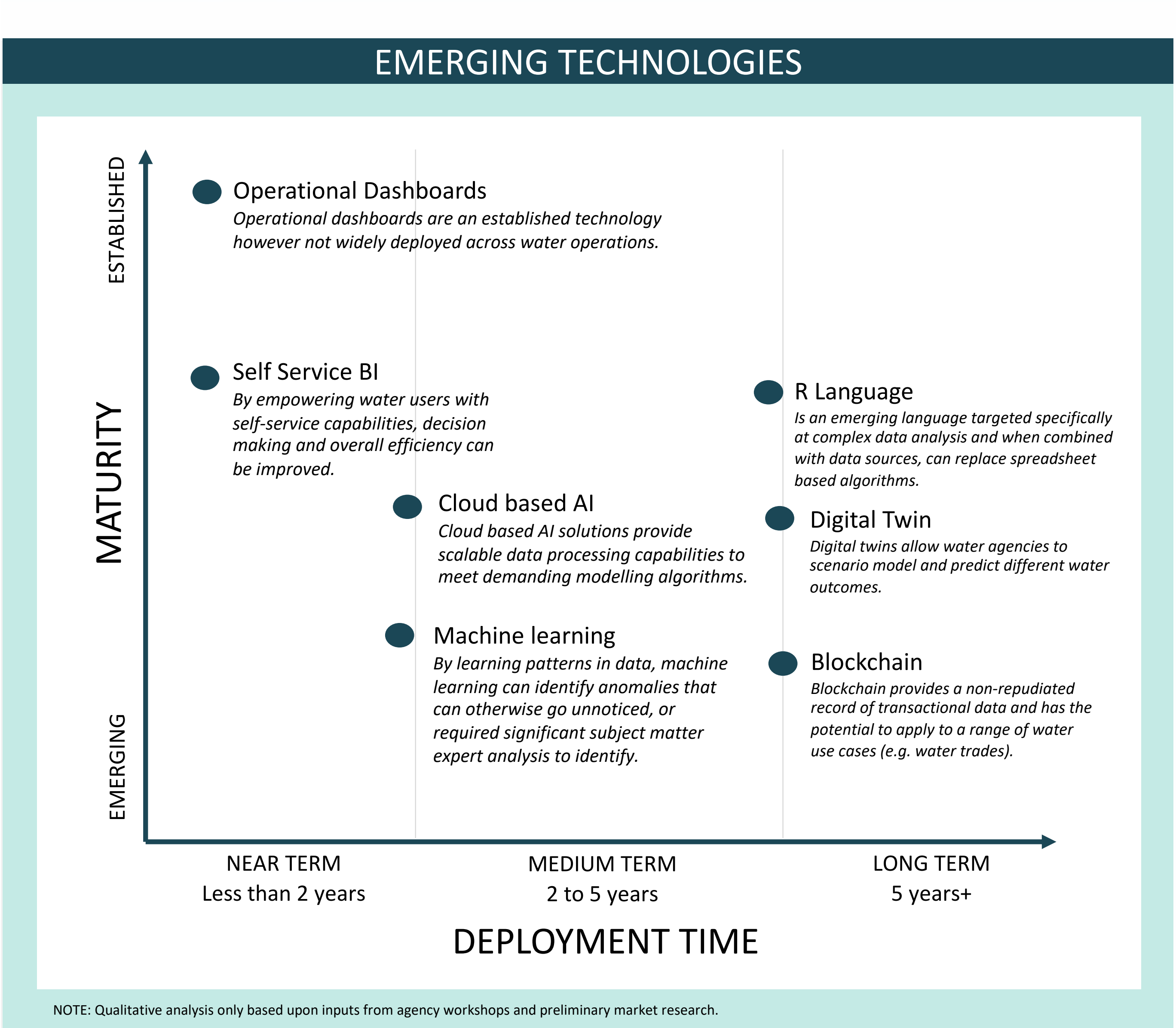
Long Term (5 years+)

- Complex calculations such as water accounting are completed using advanced Cloud based algorithms.
- Operational and infield activities are driven by the application of predictive analytics.
- Water sharing / trading and use are become real time activities, driving a new generation of economic activity in related sectors.

Emerging Technologies

The analysis of raw data to create information, insights and intelligence is where value creation is at its highest for water stakeholders. With a broad range of emerging technologies supporting improvements in this area, the importance of data quality and timeliness are vital contributing factors to success.

The key benefits and risks associated with these emerging technologies are detailed below.



Benefits

- Predictive analysis allows water agencies to identify compliance issues earlier than previously possible to mitigate the impact on water resources.
- By empowering water users with intelligence and insights, benefits are anticipated through a more self-regulating water environment founded on openness and transparency.
- The future adoption of new machine-based analysis will create new opportunities for water agencies to consider new roles that focus on higher value activities.
- The future mitigation of spreadsheet-based analysis will open up access to a range of new use cases and mitigate the risks associated with current ways of working.
- New technologies, such as blockchain, can create new water markets, allowing trades to occur in a faster, more transparent manner with non-repudiated records.

Risks

- Improve data analysis is nearly entirely reliant upon the provision of high-quality data that is easily accessible. Whilst simpler data analysis capabilities can be deployed in the short term, they will typically be preceded by data improvements.
- The accuracy of data inputs for the purposes of analysis can have a material impact on the quality of improved intelligence and operational decision-making outcomes.
- Improvements in data analysis will come at an additional cost and may need to be staged when prioritised against other water investments.
- A future transition from data collection into more advanced data analysis will require a new skill set that will require a range of new organisational capabilities.

Consideration 5: Platforms & Systems

Underpinning the elements within the scoping document will be the how legacy and emerging water management systems can improve situational awareness and customer experience.

The underpinning platforms and systems that deliver day-to-day water operations across the water management value chain are vitally important to current water services and business processes. Typically, most jurisdictions are hindered by legacy water management systems that are no longer fit for purpose or at risk in terms of technology currency and supportability. In addition, increasing expectations relating to the provision of new online services are cumulatively driving a range of investments across Australia to address these underlying issues whilst providing water users with suitable portals and online services. Where historically industry specific water management systems have dominated the landscape, new approaches are targeting the use of configurable cloud platforms (e.g. CRM) as a mechanism to build new internal and external services over time.

Current State

Key Technology Currently Deployed

- Industry specific systems (e.g. Hydstra / HydroTel).
- Eagle IO.
- Aquarius DB.
- Neon.
- Data Lake.
- Web services / portals.
- Cloud Azure / AWS.
- Excel.
- Azri Dashboard.
- Drop Box / Google Forms.

Key Risks Associated with Current State

- A number of water management systems are classified as 'at-risk' either nearing or at end of life.
- Disparate and often siloed systems inhibit service delivery and create manual processes.
- Multiple solutions are required for different purposes, creating integration challenges.
- Functionality limitations create off platform ways of working, impacting data quality and accuracy.
- Limited workflows and automation drive manual ways of working for business processes and services.
- User interfaces are not always intuitive.
- Digital services for water users are limited and often require traditional services.

Future State Requirements

Near Term (less than 2 years)

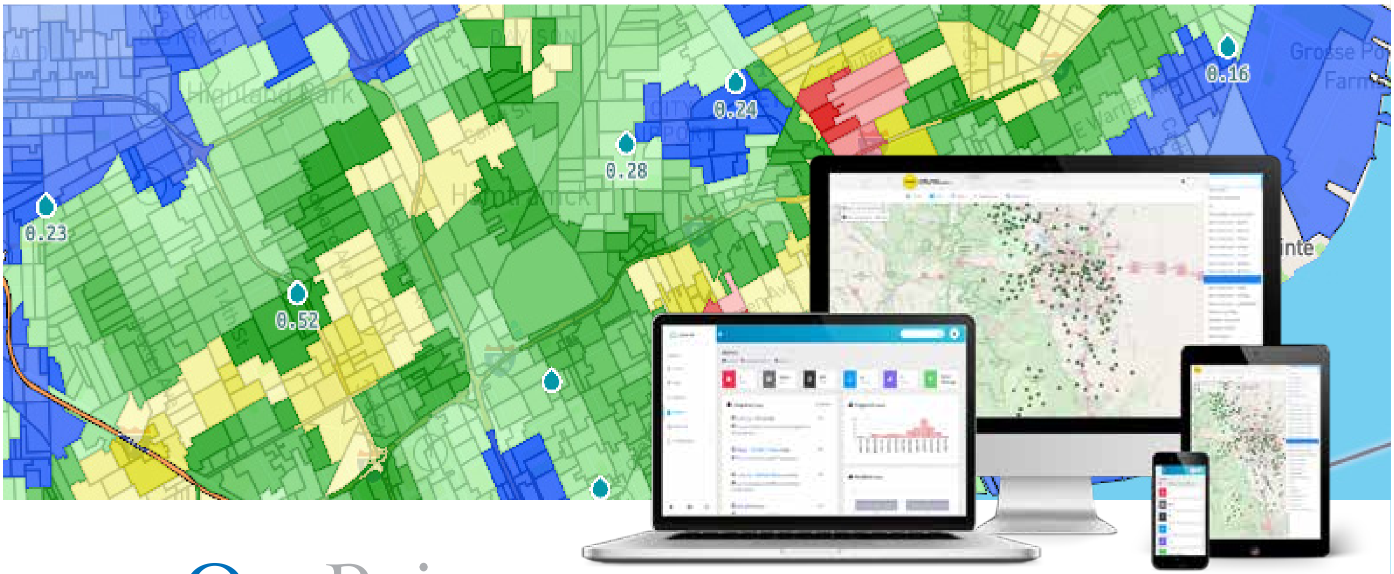
- Modernise digital services for water users via portals, apps and other tools.
- Increase mobile services for compliance officers.
- Progress the planning and design stages for replacement internal water platforms.
- Establish architectural standards where appropriate.

Medium Term (2-5 years)

- Commence the replacement / augmentation of some water management systems.
- Extend digital service functionality to include broader set of services across the water management value chain.
- Build automation into internal systems to increase efficiency.

Long Term (5 years+)

- After the establishment of mature platforms and systems, refocus the operating model higher up the value chain.
- Deploy a range of new services relating to predictive analysis and services that take preventative action.



Impact & Opportunity

Four major opportunity areas were identified throughout the development of the scoping document that align with the drivers for change. Each of these major opportunity areas and their impact are outlined providing the basis for more detailed benefits realisation planning for future investments.

Opportunities

REACH

By deploying a range of emerging technologies where use-cases permit, water operations teams can extend the reach of water resources measurement and monitoring capabilities. This is especially relevant where water resources requirements may be seasonal in nature (e.g., intermittent measurement requirement), remote or inaccessible or as a precursor for new monitoring sites prior to investment into more long-term solutions.

SAFETY

Emerging technologies reduce the need to place people into potentially hazardous situations through the use of capabilities such as drones, disposable sensors, and contactless water monitoring. Not only does this opportunity promote improved safety outcomes, a range of emerging technologies are also highly mobile, reducing the time to deploy and the subsequent timeframe to become operational.

AWARENESS & DECISION MAKING

By improving the volume and quality of monitoring and measurement data at a range of scales (e.g., user, farm, resource, region) a better overall picture can be achieved in terms of water use and performance. When combined with new data aggregation, visualization and other digital services, awareness and decision making can be extended beyond water specialists and assist with decision making on the ground by both water users and other related stakeholders.

PREDICTIVE WATER MANAGEMENT

Currently, a range of water management and intervention activities happen after the fact and in some circumstances months after an event has occurred. As more monitoring and measurement data is collected, the deployment of AI and similar emerging technologies can reduce the time between the identification of an anomaly and the associated mitigating actions.

Impact

Reach

- Increased value for money.
- Better monitoring and measurement in remote locations.
- Increased accuracy.
- Reduced the time to deploy in field capabilities.

Safety

- Hazard reduction for operational staff taking water measurements.
- Hazard reduction for operational staff maintaining sites.
- Deployment of highly skilled water operations teams to higher value activities.

Awareness & Decision Making

- Effectiveness of decision making.
- Change behaviours within the water use environment.
- Improve openness and transparency of water use and performance.

Predictive Water Management

- Shift from reactive to proactive water management and operations.
- Improved detection of water use anomalies.
- More effective compliance activities.

Use-Cases

The stakeholders involved in the development of the Scoping Report identified a number of technologies that were being utilised by way of trials or pilots to attempt to prove the validity of a new water monitoring technological advancement.

Three key advancements have been considered in the Scoping Report, with a summary of each detailed in the following use cases.

CONTACTLESS WATER FLOW MONITORING

In early 2021, the Department of Regional Development, Manufacturing and Water in Queensland completed a proof of concept with a market supplier to deliver contactless water flow monitoring via an enterprise grade commercial solution to further prove claimed capabilities in a real-world setting.

USE OF DRONES

Many departments use drones including but not limited to, NRAR, DPIPWE, UQ and SnowyHydro. NRAR has 50 pilots and 20 drones that are vital for gathering data and is active in requesting modernisation of drone legislation. DPIPWE uses drones for STIV / SSIV. SnowyHydro must get special permission to fly drones in National Parks for monitoring water ways.

LOW COST, DISPOSABLE MEASUREMENT TOOLS

During rare, extremely high flow events departments prefer to be able to gather some data rather than no data even if the quality of that data is low. This has been achieved in the past using disposable low-cost sensors that are fixed to trees in water ways and then retrieved once flow events have passed.

Contactless Water Flow Monitoring

To develop a more sustainable future state and address current state risks and issues, the DRDMW in Queensland recently conducted an open market expression of interest (EOI) to identify new and emerging technologies that could deliver contactless water flow monitoring via an enterprise grade commercial solution. As a result of the EOI process, a supplier was shortlisted to complete a proof of concept (PoC) to further prove claimed capabilities in a real-world setting. The solution was based upon the following major characteristics:

- Site based video capture of water resources via fixed CCTV and a range of other video sources.
- Remote Cloud based (SSIV) processing of video images to determine height, flow and discharge.
- An option for a local site based SSIV /videogrammetry processing solution where telemetry is limited to narrowband services (e.g., satellite).
- Integration with existing departmental systems for the purposes of data exchange via API.

Trial of app based SSIV processing.

PoC SITES

Site One – Numinbah

- High bandwidth site / LTE 4G
- Medium flow site
- 240V mains to 1x 50Ah battery / IR capable
- Videos transferred & processed in cloud

Site Two – Gowrie Creek

- Low bandwidth site / LTE-M / NB-IoT
- Low flow site
- 2x 40W solar panels to 2x 45Ah batteries
- Videos processed locally

Emerging Technologies

1. MEASUREMENT

SSIV was proven as an effective measurement algorithm however challenges with optical water height measurement requires refinement.

2. TELEMETRY

Both narrow and broadband technologies were used throughout the PoC to transmit a range of data including rich video for centralised processing and smaller data packets where on-site SSIV processing was undertaken.

3. DATA EXCHANGE

Cloud-services provided the foundation for data exchange, with video content automatically bring added to Cloud-services for processing and further analysis.

4. ANALYSIS

Data analysis was visualized within several supporting tools both within the PoC solution and via data export into other tools and services.

5. PLATFORMS AND SYSTEMS

The PoC validated a blended platform ecosystem, with local on-premises systems interacting with Cloud environments as part of the end of end solution.

Key Findings and Lessons

The key findings from the PoC included:

- Overall, the PoC yielded positive results in terms of the possibilities regarding contactless water flow measurement.
- Optical height measurement was a major issue that impacted data accuracy and requires remediation prior to further consideration.
- Site configuration and calibration was mostly a streamlined and uncomplicated process.
- The emerging nature of the service offering displayed varying levels of solution and commercial maturity.
- That collaborative co-design and development was beneficial to all parties and operated effectively.
- That the use of the PoC was a valuable next step to further tests claimed capability of the proposed solution prior to making long term commitments.
- Australian use-cases pushed the solution software beyond its current functionality, in some areas.
- Local (on-site) SSIV/videogrammetry processing allowed contactless water flow measurement to be conducted in remote sites with limited telemetry options.

Use of Drones

Drone hardware and software systems have gradually become cheaper over the years. Piloting software and active crash avoidance systems have made them accessible to almost any organisation. On board cameras have made them great for visual inspection and image velocimetry/videogrammetry.

These features also make drones excellent candidate for additional modifications.

- Many organisations use drones for remote visual inspections.
- Some organisations use drones for image velocimetry/videogrammetry such as STIV.
- NRAR has 50 pilots and 20 drones that are vital for gathering data and is active in requesting modernisation of drone legislation.
- DPIPWE uses drones for STIV/SSIV capture and analysis.
- Snowy Hydro must get special permission to fly drones in National Parks for monitoring water ways.
- UQ has worked with commercial companies to develop drone winch water measurement systems.

Example Usage

2013 Severe Tropical Cyclone Debbie

- Disposable devices were deployed in advance of moving cyclone.
- Devices were attached to fixed objects such as tree or star pickets.
- 50 $150 devices with only SD cards deployed to capture broad spectrum data.
- Devices used to measure the turbidity of peak events which historically has been a knowledge gap area.

Emerging Technologies

1. MEASUREMENT

Relatively low cost and easy to use deployment tool that can be used for visual inspection or deployment of other high-cost sensors.

2. TELEMETRY

Drones can be used with 4G telemetry to transmit data and or be used with an SD card to store and manually retrieve data.

3. DATA EXCHANGE

Drone data can be manually or automatically added to data exchange networks.

4. ANALYSIS

Drone data can be analyzed in traditional methods depending on the type of measurement. Certain analysis could possibly be done on-board on a phone receiving the data.

5. PLATFORMS AND SYSTEMS

A variety of drone types and sensors can be deployed depending upon need. The most basic can be COTS drones and cameras while other can be completely custom.

Key Findings and Lessons

Some key findings and lessons include:

- Drones are relatively new, cheap, easy to use visual monitoring tools.
- Improvements in automated and assisted drone flying has made the technology much more accessible and applicable to a broader set of use cases, including asset management.
- Cheap drones can be used to deploy expensive measurement units, such as on a winch, into water which can include depth sounders, temperature sensors, pH sensors, turbidity, and / or chlorophyl sensors.
- Drones can be used to access areas that are not safe to access such as during high flows or that are crocodile infected.
- Legislation can be restrictive depending on the size of the drone being flown.
- Legislation could be modernised to allow certain government agencies to fly beyond visual line of sight to allow the gathering of vital data.
- National Park drone flight rules could also be modernised to reduce red tape required to allow certain government agencies to fly and gather data.

Low-Cost Disposable Measurement Tool

As technological capability expands and as the need to gather greater amount of data increases, various organisations have started to trial lower cost disposable measurement tools. Historically high-quality measurements were always required and typically required high-cost measurement tools with commercial offerings costing as much as $3000 to $4000 per water measuring unit. As technology becomes cheaper, lower cost disposable tools can be used to gather data in conjunction with other tools. Solutions have had the following characteristics:

- Simple light interference devices used to detect turbidity.
- Devices costing about $150 including assemble cost with no telemetry and just an SD card for data retrieval.
- Use of washing machine technology to detect sediment during high flow / flood event of 10 to 100 times greater than the mean flow rates of around 5 to 10 milligram per litre.
- Data recovered after the event with half of all devices lost or damaged.

Example Usage

2013 Severe Tropical Cyclone Debbie

- Disposable devices were deployed in advance of moving cyclone.
- Devices were attached to fixed objects such as tree or star pickets.
- 50 $150 devices with only SD cards deployed to capture broad spectrum data.
- Devices used to measure the turbidity of peak events which historically has been a knowledge gap area.

Emerging Technologies

1. MEASUREMENT

Low-cost disposable measurement tools were invaluable to gather data in extreme flow events that would otherwise go unmeasured due to high sensor cost.

2. TELEMETRY

Initial tools did not include telemetry in order to keep costs down. Future prototypes will include telemetry capabilities.

3. DATA EXCHANGE

Initial low-cost sensors utilise SD cards which are manually retrieved, and data is manually copied into data exchange networks.

4. ANALYSIS

Turbidity data gathered via these tools can be analysed via traditional methods.

5. PLATFORMS AND SYSTEMS

Washing machine sensors have been found to be an effective cheap measurement tool for low cost turbidly sensors built in-house.

Key Findings and Lessons

Some key findings and lessons include:

- Time to deploy is greatly reduced compared to fixed infrastructure where disposable / reusable measurement tools are employed.
- Enables measurement and monitoring to be conducted in locations for a shorter time periods (e.g. For a specific event or study).
- Cheap disposable measurement tools can occasionally result in better quality turbidly results than some more expensive commercial offerings. (Reuse of washing machine parts).
- Deployment of multiple cheap turbidity sensors during high flow events has been invaluable to closing the knowledge gap of such events.
- Attaching sensors to trees or carefully placed star pickets was sufficient to gathering data required for a range of use cases, reducing the need for fixed infrastructure.
- The value of gathered data has been enough to foster image in future prototypes with 4G telemetry in order to ensure less data loss due to lost or damaged devices.
- The use of lower cost sensors assists organisations is finite budgets to extend the measurement footprint, compared to more expensive sensors and associated infrastructure.
- Whilst lower cost sensors have proven effective in a range of deployments, they are not considered to be suitable for all situations and must interoperate within a rich sensing ecosystem to achieve high quality outcomes.

Technical, Conceptual and Organisational Solutions for the Quality Assurance of Hydrometric Data

Dirk Schwanenberg, Uwe Haß and Simon Gockel

Abstract

Increasing data volumes and decreasing human resources limit the continuation of established, often manual quality control processes. In response to this challenge, we suggest automating data validation processes and providing users with tools to supervise and intervene. This paper deals with technical, conceptual and organizational aspects of such an implementation in a modern software solution. This includes the verification of data flow from the sensor into the database, conceptual data validation and data editing tools, as well as software support for business processes.

Summary

- Quality control efficiency improves significantly when the process is automated, instead of users being a required component of the process, whilst still allowing users to supervise and intervene.
- Multi-parameter validation processes can detect a significant portion of outlying or erroneous data.
- Spatially validation processes and graphical result inspection are ideally suited automated processes with data manager intervention easily facilitated.
- The software-based running of business processes results in transparent and reproducible data handling.

Introduction

Quality control of hydrometric data is a complex task for the organisations involved. Due to an increasing amount of data (in terms of both measurement frequency and the number of parameters measured), the availability of new input data streams (for example from remote sensing) and a tendency towards decreasing human resources in public administration, established processes which are often based on many manual steps, are reaching their limits. A manual process is throughput performance limiting, particularly when data is used in real-time systems such as flood prediction.

Accordingly, the application of the methodology described above is presented in this context. We propose the use of a paradigm referred to as 'over-the-loop' in hydrological prediction [1]. It automates quality control, provides users with summary reports on problems that may occur and offers them the appropriate intervention options for data processing. In contrast to the established approach, also known as 'in-the-loop', the efficiency of quality control can be significantly increased. Furthermore, dependencies on manual processing are reduced.

In the following sections, we will discuss technical, conceptual and organisational aspects of the implementation of quality control in a modern software solution, using the example of WISKI7 on the basis of two practical cases: for the joint system of State Office for the Environment (LfU) and Service Centres for Rural Areas (DLR) in Rhineland-Palatinate, as well as the Federal Office for the Environment (FOEN) in Switzerland.

Methodology

Technical Components

The technical part of quality control involves the verification of correct data flow from the sensor to the database, together with the subsequent processing steps. The challenge is to monitor multiple related processes in such a way that the overall data flow can be evaluated. For this purpose, WISKI7 collects and analyses all relevant logs and messages from all system components. The key to creating a process chain from multiple processes, and thus a more efficient analysis of the overall behaviour of the system, is to define consistent start and end points for individual processes.

The above process is supplemented by the recording of system metrics, which is state of the art in IT. On the one hand this includes general technical metrics such as the use of CPU or memory on a computer, and on the other hand deals with usage-based metrics of the hydrological database, such as the number of open import or processing jobs. Such metrics are used by IT Administrators to monitor system performance with software tools such as Zabbix or Nagios, and to intervene in case of problems. Furthermore, the metrics also provide business users with useful information on the system and enable the compare the performance between a client's test and production systems, between different software releases, or between various client systems with different architectures.

Conceptual Components

In conceptual or subject matter related quality control, the availability of data and its quality is the matter for consideration. For this purpose, automatic validation algorithms can be used as a first step. The available algorithms range from simple approaches, such as controlling the bandwidth of a measurement, controlling the gradient in a time-series or detecting persistent readings, to complex methods, such as checking for internal consistency of the various parameters of a station or identifying the presence of spatial correlation between different time series. The application of more complex methods in particular results in two essential requirements for software implementation. Firstly, when developing or adapting complex rules, having an Application Programming Interface (API) which closely interacts with the hydrological database is indispensable. And secondly, it is necessary to have a user-friendly Graphical User Interface (GUI), in order that the user may check results after the automatic validation and edit data if necessary.

From a technical point of view, the validation algorithms can be executed synchronously or asynchronously. The classic example of a synchronous execution is the validation of data and further processing immediately following the import of a time-series. Such a design can ensure that the original time-series and derived time series are always consistent. Alternatively, validation can also be carried out synchronously in the run-up to a further use of that data, for example if current data is to be used as part of a prediction. The concept reaches its limits when data changes at a high frequency or when datasets have to be related to one another. In this case, an asynchronous execution, i.e., running at regular and scheduled intervals, is a more suitable choice. For example, validation of the spatial consistency of rainfall stations only makes sense if all the data from an entire measuring network is available at a certain point in time.

The compilation of a set of validation checks for a measurement network customarily proceeds from simple, synchronous procedures through to more complex methods with an asynchronous execution. An essential requirement for this is to be able to define the order in which these checks are executed and to have the capacity to use previous results in a check which is currently taking place. For example, this means, that data can be cleaned up in simple checks, e.g., above limit values, before more complex processes, such as checking the inner consistency of different time series at a station or carrying out spatial comparisons.

Organisational Components

A common procedure in many hydrological services continues to be the regular, possibly multi-stage manual review of all measured time-series. On the one hand, the process is time-consuming, as an editor is obliged to work through the entire duration of a time-series. On the other hand, such work can only be carried out with a certain delay and depending on the available resources. An editor is thus part of the process chain, and so this procedure is referred to as 'in-the-loop' in the context of hydrological prediction [1]. With this setup, there is significant potential for an increase in efficiency on two counts; firstly, the validation can be carried out via regularly running automated validation algorithms, and secondly, the user can be provided with tools for monitoring, and potentially intervening with, the automated validation (Figure. 1).

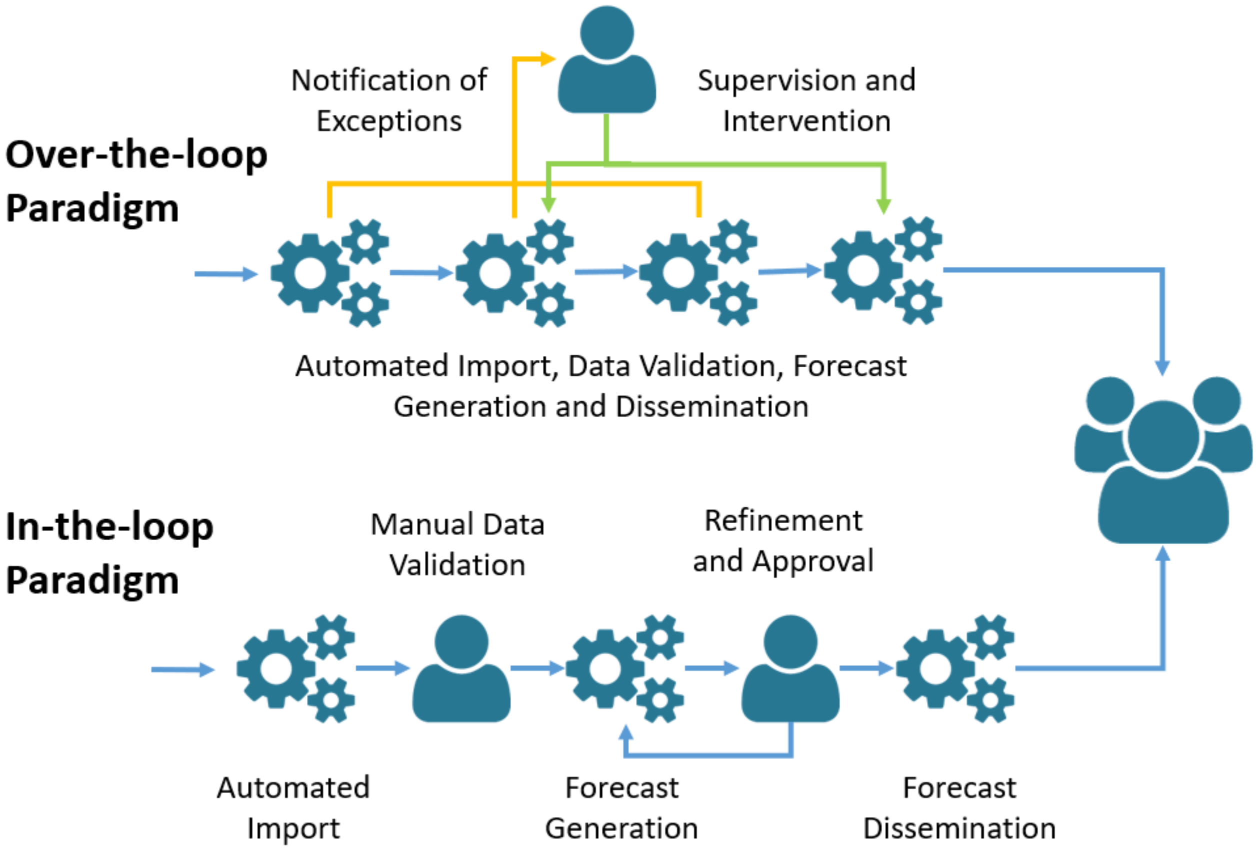


Figure 1: Comparison of user interaction, in an example of workflow beginning at the acquisition of data and ending with the calculation of a forecast (Source: [1]).

Another advantage of this approach, known as 'over-the-loop', is that it provides a quality assured data for real-time applications such as flood prediction, as the data quality after automated validation prior to testing is usually better than the raw data itself.

The results of a validation are stored in separate WISKI7 time-series and are also aggregated to the level of parameters and stations in a so-called 'score'. This mechanism makes it possible to display concise validation results for a station or measuring network, from which it can be determined whether or not it is necessary to go deeper into the analysis of individual parameters or time-series. The approach also allows for the storage, review, and analysis of raw and validated data.

Based on these tools, the interaction of the system with the user, or the users amongst themselves, can now be described via business processes, and depicted through the appropriate software. While classic GUIs have implemented rigid business processes in the past, modern specification languages such as UML or BPMN now offer the possibility to define processes flexibly and then store them in the software as workflows. This means that existing processes of individual organisations can be specifically addressed without adjustments in the software.

Figure 2 shows an example of a multi-stage data validation process through BPMN, with a high-frequency data validation process as a first stage, where the process is pushed to manual editing only as required, and a low-frequency complete review and explicit release of the data by the data editing workers as a second stage.

a.

b.

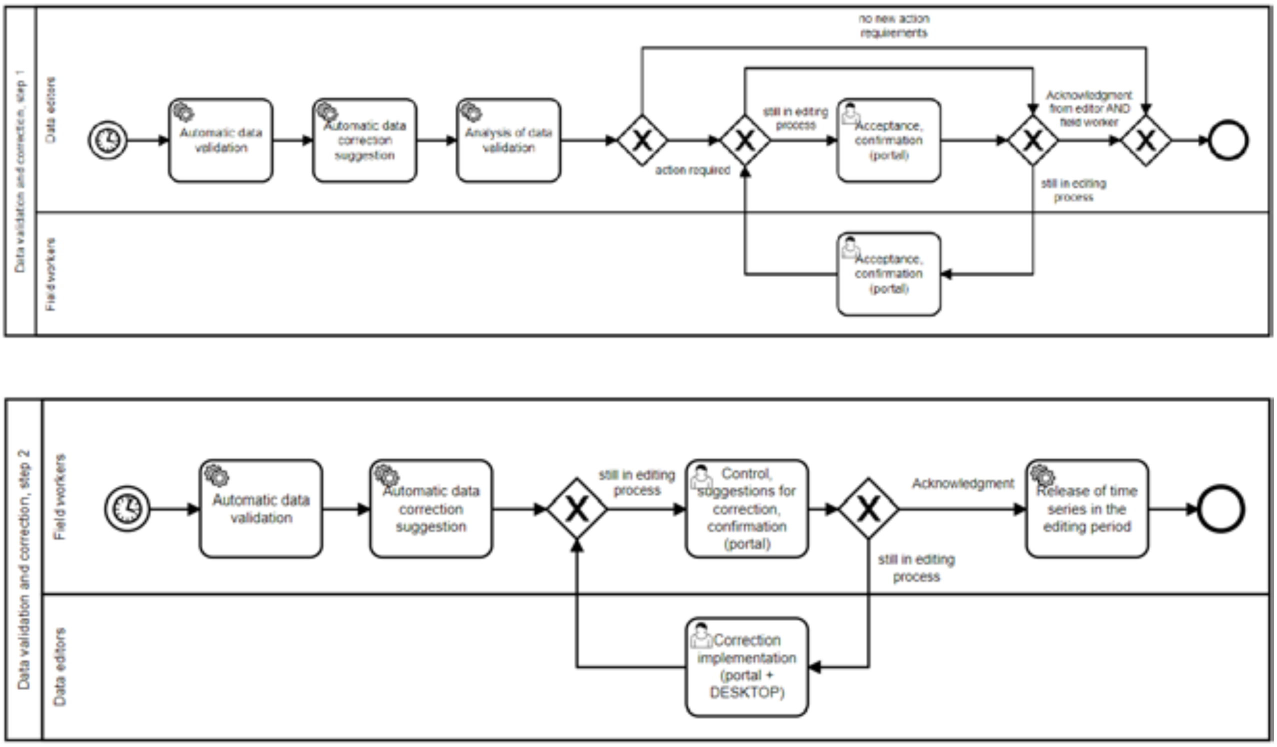


Figure 2: Example of a multi-level data validation with a) a high-frequency data validation and escalation to the processors only if action is required, and b) a low-frequency complete review and explicit release of the data by the processors.

Implementation and Results

The concepts described above were developed in close cooperation with the FOEN, LfU and DLR, and implemented in software specifications, largely as part of the development of the new data validation framework in WISKI7. This framework provides the user with three new vertically integrated applications with web-based GUIs (Figure 3).

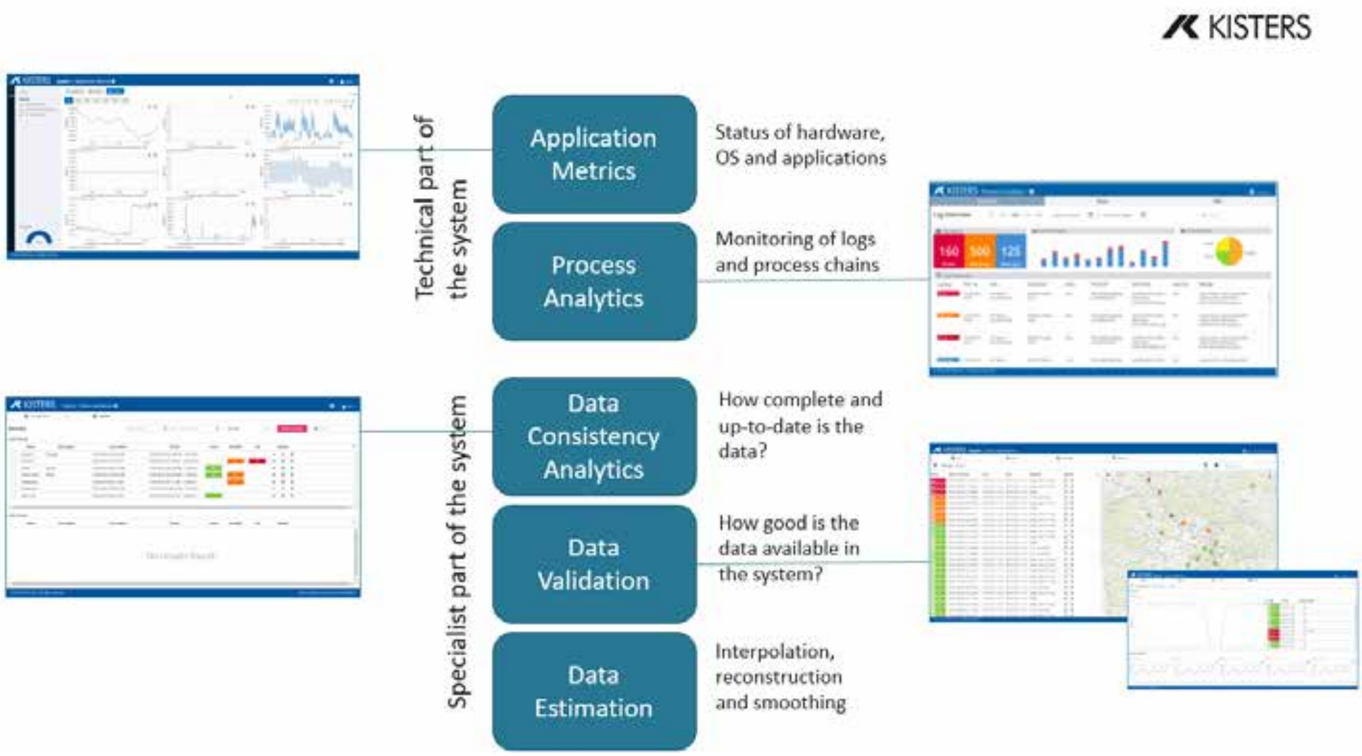


Figure 3: Technical and specialist components of quality control using the example of the WISKI7 system of the LfU and DLR in Rhineland-Palatinate.

The 'Application Metrics' application provides access to system and application metrics. Monitoring of the technical system also includes the analysis of logs and system messages as well as the evaluation of process chains.

In the 'Data Consistency and Validation' application, it is possible to define technical validation rules, combine various measuring network rules into an ordered sequence, and plan their performance. Results are then displayed in an overview of all instances, while individual instances are visualised in a table or map. If necessary, the user can access the data at a more detailed level and edit the time series in which problems have been detected. An essential feature of the application is an API for establishing user specific algorithms. These can be implemented in Python by the user and fully integrated into the application.

One focus of the application is on the validation of meteorological data using spatial validation methods and the internal consistency between meteorological parameters.

Figure 4 shows a result of the spatial null value test of the meteorological measuring network during the period of a constant precipitation event. The conspicuous absence of rainfall at the Mayschoß station could suggest that there is a faulty rain gauge or other equipment problem at the site.

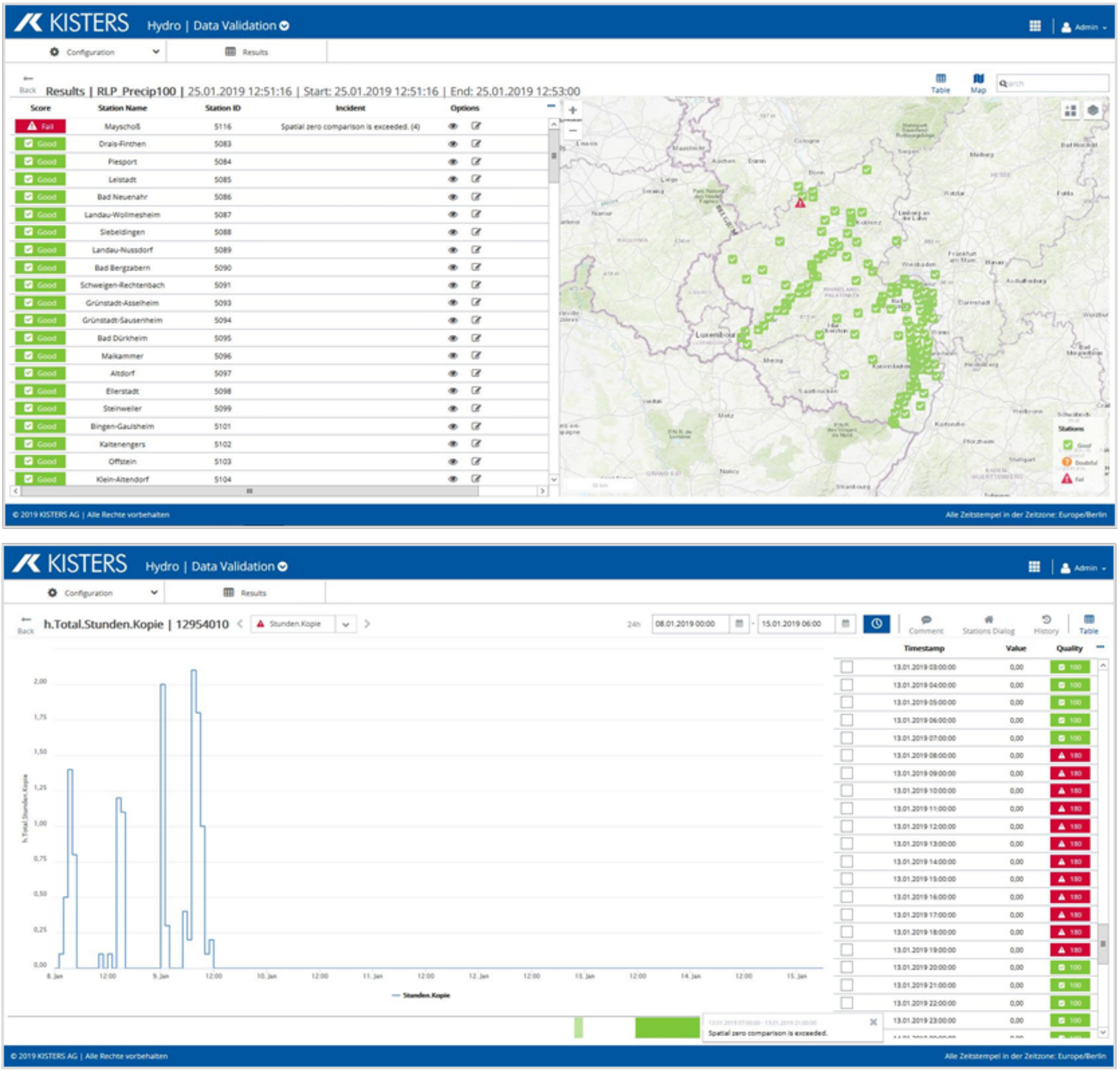


Figure 4: Detection of a faulty tilt sensor at the Mayschoß station, Rhineland-Palatinate via a spatial comparison with neighboring stations.

Conclusion

The presented concepts and their software implementation in the new data validation framework of WISKI7 offer compact specialist applications to efficiently carry out automated data validation and, as required, to enable user validation actions. With decreasing human resources, this is a building block to ensure a high-quality database in hydrometry.

References

[1] Schwanenberg, D.; Natschke, M.; Todini, E. and Reggiani, P. (2017): *Scientific, technical and institutional challenges towards next-generation operational flood risk management decision support systems*, International Journal of River Basin Management, 16:3, 345-352, DOI: 10.1080/15715124.2017.1411924

AUSTRALIAN
HYDROGRAPHERS
ASSOCIATION