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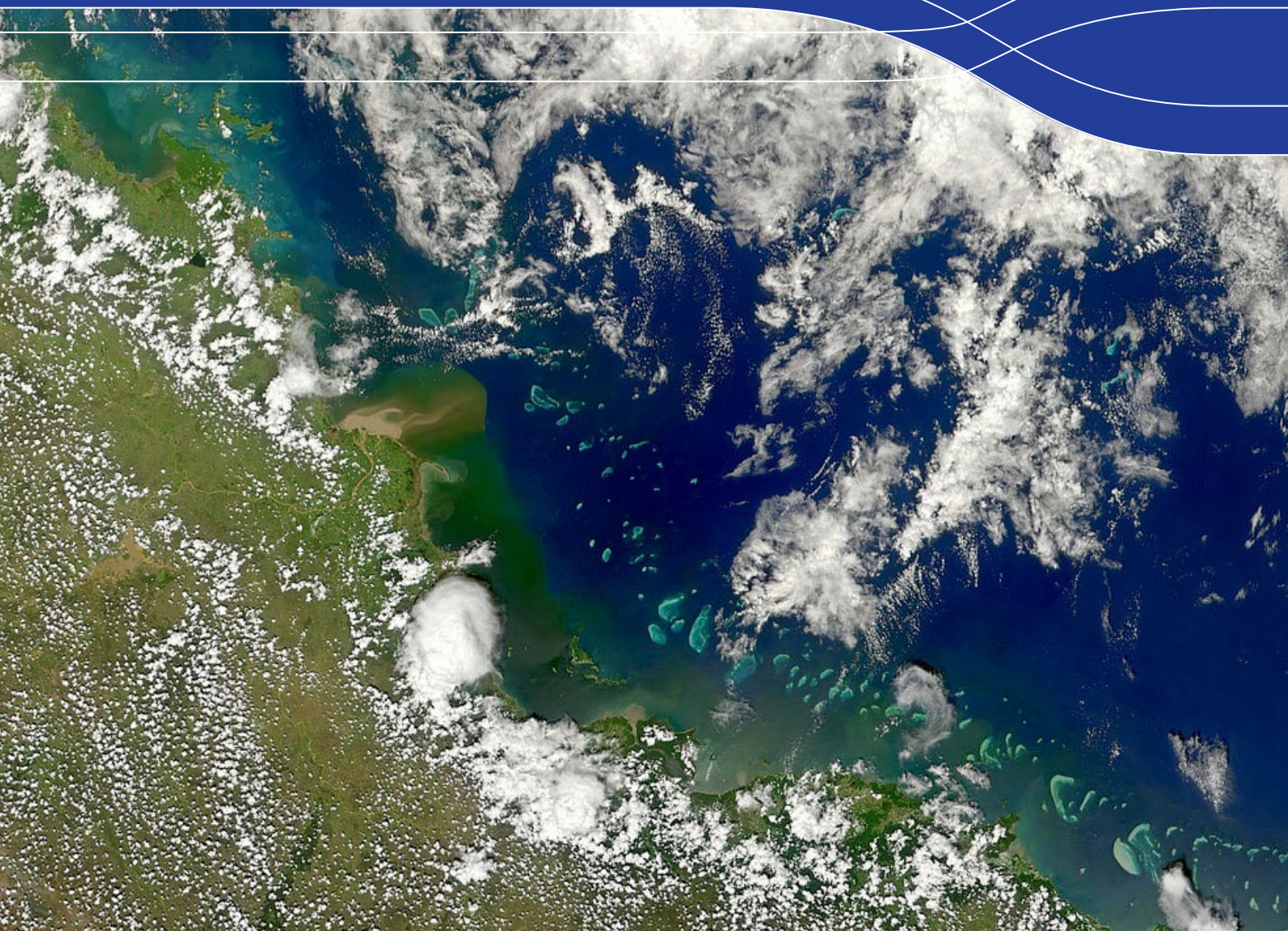


Monitoring for practice change in Great Barrier Reef catchments

Improving the quality of water-draining agricultural land in catchments adjacent to the Great Barrier Reef (GBR) remains a very high priority. While reductions in loads of key pollutants have been achieved in recent years, the present trend is seen as insufficient to achieve the long term recovery of key environmental values in the GBR, such as corals and sea grass beds[1].

Tracking progress in relation to better water quality (WQ) requires monitoring. Historically, WQ monitoring in GBR catchments has been patchy and tended to focus on end-of-catchment sediment and nutrient loads. Both the Australian and the Queensland governments are intending to increase investments into WQ monitoring.

In this discussion paper we offer some principles and a conceptual framework to guide the design of enterprise to sub-catchment level integrated monitoring systems, embedded within an action learning paradigm to influence practice change. With this we aim to stimulate a broader discussion between research, government and community stakeholders in the lead up to future investments in additional WQ monitoring systems, as well as providing input into the design of the Reef Integrated Monitoring and Reporting Program (RIMReP).

Challenges and general principles for monitoring

PURPOSE OF MONITORING – monitoring purpose needs to clear. Generally, the purpose of GBR-wide WQ monitoring systems is reporting as well as provision of data for modelling. In these systems, there is little or no direct connection between the WQ reported at the mouth of a river and the impact of land management practices carried out by individual farmers and other land managers at a particular point in the landscape. This has led to attempts to establish localised systems directed more at using WQ monitoring as a learning tool to support practice change[2]. Monitoring for compliance is another rationale for setting up monitoring systems.

SCOPE OF MONITORING SYSTEM – land managers integrate many variables in their decision making (e.g. related to climate, markets, input costs; but also to values, beliefs, experiential and Indigenous knowledge), and WQ parameters are generally not the most important parameters for decision making in the context of enterprise profitability. Hence, WQ monitoring should be embedded within systems that monitor enterprise performance in a range of domains (e.g. Digital Homestead – https://digitalhomestead.org).

LINKING OBSERVATIONS TO ACTIONS - relevant practice data (e.g. cattle/unit area, timing and amount of fertiliser applied) needs to be simultaneously captured with immediate downstream WQ data in order to drive change. This is necessary to systematically improve the set of observations at farm and enterprise scale that connect management actions to enterprise environmental responses, so that cause-effect relationships and attribution of those are obvious to all. This requires development of cost effective enterprise scale monitoring options that can be integrated with other observations and modelling to progressively close the loop of action to WQ outcomes, whilst providing co-benefits of productivity improvements to growers and other land managers.

ENGAGEMENT IN DESIGN AND OPERATION OF MONITORING SYSTEM – for monitoring systems to be effective as learning tools to catalyse practice change it is imperative that they be co-designed, tailored to the enterprise, including aspects of clarity of purpose and scope of monitoring, institutional arrangements regarding data accessibility and treatment, as well as long term resourcing and operational protocols. Joint system conceptualisation may be a useful entry point for this process.

Monitoring systems are usually costly, hence stakeholder involvement is also necessary to share costs of system maintenance and responsibilities for operation.

CHOICE OF INDICATORS AND FREQUENCY OF MEASUREMENTS – WQ and many production parameters are challenging to observe. Uncertainties arise from variable lag times between source and monitoring points (depending on transport processes and pollutant), and ambiguity of attribution to a particular practice. Technical issues include the need for real-time monitoring to capture spiky events and sufficient density of monitoring points to deal with spatial variability and to enable aggregation from paddock to sub-catchment scale. Choice of location is important to clearly discern signals in relation to source (e.g. DIN in surface versus ground water). Containing costs and managing complexity of monitoring systems requires surrogate or indirect monitoring approaches, such as nitrogen surplus methods, or ground biomass estimation methods, that provide a stepping stone to a fully instrumented smart farm.

Transparency, access to, interpretation and uses of monitoring data – concerns about transparency, access and privacy of data collected at farm scale needs to be addressed with land holders. These are central themes, which if left unresolved, have the potential to limit the informed and consensual participation of all stakeholders in data acquisition systems. Trusted information and advice networks are important for land holders in mediating the benefits and risk of engaging in monitoring and data systems[3].

General framework

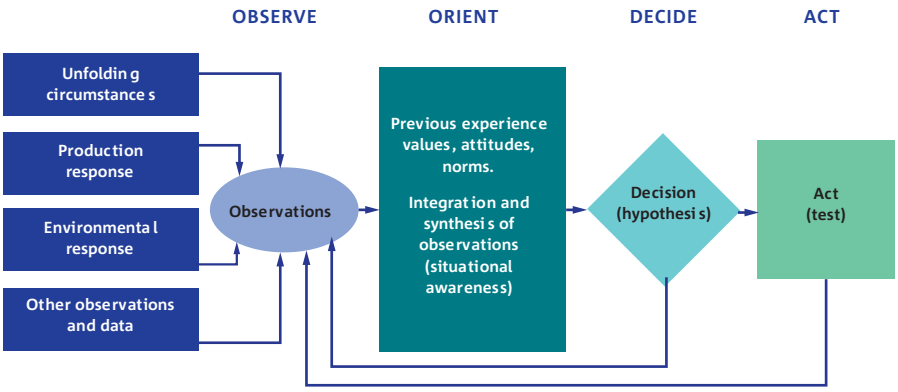
Understanding the social context for achieving management change is critical[4]. An understanding of attitudes and norms that influence how decisions are made provide a critical foundation from which to embark on social change processes. Additionally, providing the incentives that add value to the grower or producer are another part of the puzzle, as they will more likely change management decisions if there is a productivity or profitability benefit. With this in mind, we suggest that integrated monitoring systems for practice change need to be built around an observation to action model (below) that describes how observations drive actions through the steps of orientation and decisions (loosely derived from the Observe-Orient-Decide-Act model[5]).

OBSERVE – while a monitoring system might specifically target production and environmental response variables, there are other inputs shaping the observation. Key questions revolve around what parameters are observed, at what cost, through what means (direct, indirect), frequency (intermittent, real-time), and how these observations are 'packaged' and conveyed to the observer.

ORIENT – orientation brings together values, attitudes and norms, together with multiple other sources of knowledge, including previous experience and Indigenous knowledge, and integrates observations to develop feasible decisions which will lead to management change. Understanding how 'objective' observations are mediated by values, beliefs and knowledge systems is critical, and requires engagement.

DECIDE – a decision from observation and orientation may not necessarily lead to Act, or might only occur after the observe-orient-decide loop has been run several times. Engagement (e.g. by one-on-one extension; peer-to-peer interactions) can influence the likelihood of a decision leading to Act, as it changes the cognitive factors within the orient step.

ACT – the result of the action itself becomes part of the next cycle of observations, either reinforcing the action through changes in the orient phase, or it is discarded in favour of another action or returned to the previous state.



Benefits of integrated monitoring systems for practice change

Drawing on the above principles and adaptive learning loop, we propose that integrated monitoring systems for practice change can:

- Work much more effectively within a broader change management understanding because they are co-developed and owned by all involved stakeholders.
- Provide information at enterprise scale that can be trusted and acted on to enhance productivity or profitability while achieving the co-benefit of water quality outcomes.
- Span scales, from enterprise to whole of system, from sensors to decisions, while being embedded within the existing, end-of-catchment monitoring systems.

Next Steps

Our understanding of these key gaps and challenges provides a way forward to transform the way that monitoring is used to generate on farm productivity, profitability whilst achieving WQ benefits. We would welcome entering a wider engagement and discussion with partners on this topic.

References

1.Kroon, F. et al., 2016. Towards protecting the Great Barrier Reef from land-based pollution. Global Change Biology 22, 1985–2002.

2.Davis, A. and J. Waterhouse. 2016. Sub-catchment scale monitoring, modelling and extension design to support reef water quality improvement in sugarcane catchments. TropWATER/JCU. http://nesptropical.edu.au/wp-content/uploads/2016/07/NESP-TWQ-1.8-FINAL-REPORT-A.pdf

3.Jakku, E. et al. 2016. Big Data, trust and collaboration. Exploring the socio-technical enabling conditions for big data in the grains industry. CSIRO Research Report.

4.Benn, Karen Elizabeth (2013) The barriers to adoption of recommended fertiliser use practices by sugarcane growers in the Wet Tropics. PhD thesis, James Cook University

5.Boyd, JR. 1976. The OODA Loop. Accessed from http://pogoarchives.org/m/dni/john_boyd_compendium/essence_of_winning_losing.pdf

CSIRO's GBR Discussion Papers are prepared by domain specialists drawn from across all of CSIRO's business units. For more information on this paper please contact Peter Fitch (Peter.Fitch@csiro.au) or Christian Roth (Christian.Roth@csiro.au).

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