Stakeholder Communique (May 2020)

Harnessing the power of satellites to deliver benefits for environmental monitoring on the ground

The principle aim of mine dewatering is to facilitate the extraction of valuable resources that extend beneath the water table. Despite the careful design of discharge programs, dewatering can adversely affect the water requirements of groundwater dependent vegetation (GDV) located in the drawdown zone. Therefore, it is important to monitor for signs of water stress on GDV, which has traditionally relied on ground-based observations. Digital Earth Australia (DEA) has compiled an Open Data Cube (ODC) of Earth Observation (EO) imagery that has the potential to improve vegetation monitoring plans in a variety of ways.

Firstly, EO imagery can be used to map the locations of likely GDV over entire tenements to narrow down what actually needs to be monitored thus reducing time and survey effort (Figure 1A). Secondly, satellite sensors collect data at intervals far more regularly than ground-based surveys allowing for rapid and current updating and targeted inspection to locations that appear to be in decline (Figure 1B). Finally, a large back catalogue can be leveraged to assist comparison of present vegetation health to a range of baseline scenarios including, in many cases, before the commencement of any dewatering. This can be used to quantify a distance in numerical space ("CVA Magnitude") from an ideal or representative period to current conditions, where larger magnitudes signal greater change (Figure 1C).

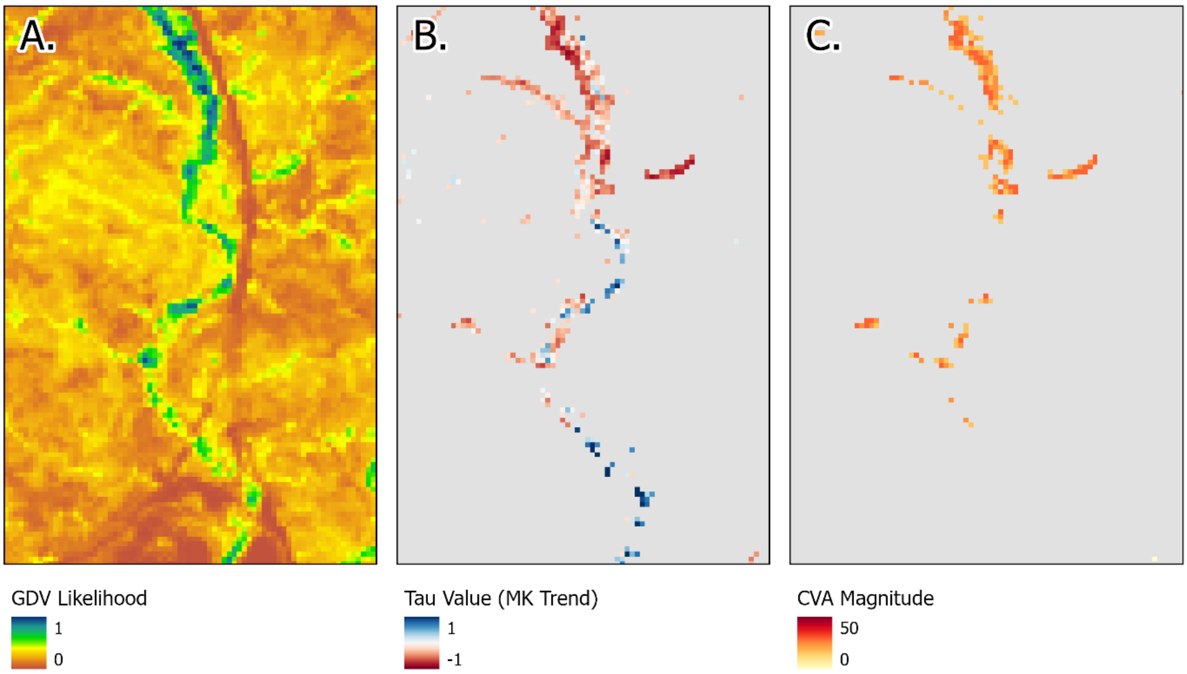

Figure 1 – A. GDV likelihood models are used to reduce the search space for ground-based surveys. B. Trend maps can be used to direct field crews to areas of declining health. Areas of dark red were vegetated areas that had continuously declined over a range of dates. C. Maps of Magnitude show loss between a chosen baseline and present day. Areas of dark orange were healthier at baseline.

In August 2019 we reported on the work underway by Curtin University researchers [Dr. Todd Robinson (Lead), Lewis Trotter (Research Fellow) and Dr. Adam Cross (Research Fellow)] in consultation with mining companies (Roy Hill and BHP) who had developed GDV likelihood models using seasonal imagery from the ODC. The GDV-likelihood models used a knowledge-driven approach, which requires no upfront field validation. Models are based on annual stability, greenness and moisture, with a disproportionate amount of weight given to dry season parameters. These models reduced the search space for GDV and provided the guidance for field crews to collect validation data using tablet technology. Close to 1 000 data points were collected in a matter of days over three study areas in the southeast Pilbara bioregion of Western Australia.

Using the validation data, models were permuted in pursuit of the best vegetation index. It was determined the moisture adjusted vegetation index (MAVI) outperformed more commonly used indices including NDVI and SAVI irrespective of platform (Landsat or Sentinel) or study area. The team also identified improvements in spatial resolution (30 m vs 10 m) to correspond with improvements in accuracy. Hence, Sentinel appears to be the optimal analysis ready dataset in the cube for GDV-likelihood modelling. However, it lacks an archive for identifying GDV that may already be in poor health, testing the significance of trend analyses and is less useful for determining benchmarks that pre-date mine disturbance. Landsat has continuity assurance and a c. 35-year library. Sentinel has no such assurances and has an expected mission life of seven years. As a contingency, the team have designed the GDV-toolset to accept either as input.

A GDV tool kit was developed incorporating the developed models (Figure 1) ensuring translation of research outputs into an interactive tool. The tool was developed using Jupyter Notebook, which is an open-source web application that allows the creation of "documents" that contain executable python code to assist the ingestion of the ODC and automate its processing. Workshops were run in January 2020 to demonstrate how to use the tool and enable project partners to run the models over areas of interest. Michelle Antao, Environmental Officer at the Department of Water and Environmental Regulation (DWER) commented, "I have been impressed with the progress made to date as demonstrated in the workshop and am very supportive of the approach." Further she stated, "at this point in its development I anticipate that this methodology will provide an effective tool to assist in identifying GDV at a landscape scale. As the tool is further tested and developed through stage two it may also provide a useful tool to support GDV change detection and response initiation".

Stage two refers to the next phase of research which was identified and agreed upon through a workshop involving key mining companies in the Pilbara including BHP, Roy Hill, Rio Tinto, Atlas Iron and Fortescue as well as DWER and other consulting companies. It aims to further extend the current GDV likelihood models to assist prioritisation of ground-based response by including a suite of remotely sensed derivatives. It will also include near real-time detection of GDV health decline and develop and deploy a user-friendly interface using a consultative approach.

This extensive collaboration ensures research is not duplicated and all parties are able to leverage time, funding and resources. The project has been facilitated by FrontierSI and Curtin University and will commence in June 2020.

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END OF COMMUNICATION