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Application of high-frequency, real-time data for a fertiliser management decision-support system

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RESEARCH OBJECTIVES

The purpose of the project, overall, is to look at ways to contribute to nutrient runoff mitigation and how real-time sensors can be used to monitor and provide strategies to achieve this. Currently, the project focuses on the collection and application of high-frequency, real-time data to assist in the development of a Decision-Support System (DSS). However, the scope will shift once completed to compare the runoff effects of biofertilisers as an enhanced efficiency product, with traditional chemical methods. This aspect is interesting academically as it provides the opportunity to measure the viability of alternative fertiliser sources in terms of their cost, practicality, and environmental benefits.

RESEARCH QUESTION

The main research questions that are being addressed are:

- Can changes in water quality be accurately measured along a single-branched river system?
- Do observable patterns between different water quality analytes exist within high-frequency data, and can these patterns be correlated using neural networks?
- Can agriculture anecdotal or applied nutrient concentrations over croplands be modelled to find correlations with physicochemical water quality parameters?
- Can the DSS provide financial benefits to stakeholders by reducing runoff and hence, mitigate fertiliser losses?

RESEARCH BENEFITS

This research is needed given the surge in global population over the past half-century, which has created several significant issues that require addressing, one of which is the deterioration of waterways, resulting from a growing need to use more fertilisers for food production. With this growth in global population, the demand for food has also drastically risen. Consequently, food demand is expected to rise anywhere from 59% to 98% by 2050, meaning that farmers will have to produce more food per unit of land and use more water and agrochemicals. As a result, the agriculture sector will need significant global reforms to manage the environmental, socio-economic and food security issues.

FINDINGS TO DATE

Nitrate plays a significant role for crop growth. However, elevated levels in waterways have been shown to cause eutrophication, and subsequently lower water quality, leading to fish kill events and the overall degradation of water systems, as evidenced in the Great Barrier Reef (GBR). Given that substantial changes in water quality can occur in short time-periods, typical monitoring and analysis methods (such as grab samples) do not provide timely data to decision-makers, hindering the ability to act promptly to improve waterways. Consequently, mobile monitoring stations were developed to measure nitrate and physicochemical water quality parameters remotely, in real-time, and at very high frequencies (15-minute intervals). Sensors installed in the stations were deployed in the field, where data highlighted remarkable intra-daily changes in creeks' nutrient concentrations from, for example, tidal cycles, thus reinforcing the necessity to regularly monitor sensitive waterways.

The GBR presents a greater challenge to monitoring, as the initial pilot study only had small nutrient fluxes. However, due to the higher levels of agricultural activity around the GBR region, it is emphasised that such accurate, real-time data could be critical to expand the knowledge of the fate and source of nutrients in critical waterways, providing the potential for machine learning to develop predictive and optimisation models to mitigate the issue. Consequently, coupling the versatility of a mobile monitoring station with the added benefits of compensated high-frequency, real-time data provides significant opportunities to assist in fertiliser management programs for agriculture and aquaculture runoff, as well as the preservation of environmentally sensitive areas.