Final Report – Enhancing Situational Awareness for Extreme Weather Response

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1. Purpose and Intended Outcomes

The primary purpose of this project was to enhance the situational awareness capabilities of Civil Defence and Emergency Management (CDEM) agencies during extreme weather and flood events. The project sought to achieve this by developing and operationalising advanced digital tools that leverage artificial intelligence (AI) and machine learning. The intended outcomes were to provide emergency responders and decision-makers with timely, structured, and spatially explicit information to improve intelligence products and flood response. The project specifically focused on creating two practical tools: a Citizen Science Reporting App and a River Level Prediction Tool. These tools were designed not only to enhance situational intelligence during response events but also to support risk awareness and preparedness.

2. Successes and Challenges

The project was completed on time and under budget, delivering two functional digital tools that are now publicly available. One of the notable successes was the collaboration with the New Zealand Flood Pics initiative, which allowed the integration of user-submitted photos with AI-generated image descriptions. This significantly enhanced the Citizen Science Reporting App, enabling near real-time automated analysis of submitted images. The second tool, a River Level Prediction Tool, was also successfully developed and deployed online at https://visualizer.nzflood.services/. It allows users to explore forecast river levels via a web-based spatial interface. Despite these achievements, some challenges were encountered. The AI image summarisation function, while effective, is still prone to occasional hallucinations depending on the complexity of the images. Additionally, while the current domain for the River Level Prediction Tool is functional, a long-term hosting arrangement—ideally within Waikato Regional Council's infrastructure—remains an outstanding issue to ensure sustainability.

3. Description of Project Products

Two main products were delivered through this project. The first is the Citizen Science Reporting App, a platform that enables members of the public to submit real-time

photographs of flooding or severe weather impacts. This tool was enhanced through integration with New Zealand Flood Pics and utilises artificial intelligence to generate descriptive summaries of the submitted images. These summaries are designed to provide rapid situational insights to emergency operations teams.

The AI engine for this feature uses a Vision-Language Model (VLM), specifically a fine-tuned implementation based on LLaVa-Next. This model interprets visual data and produces text summaries, assisting in quick interpretation of on-the-ground conditions. While highly effective, the model occasionally generates erroneous interpretations—referred to as hallucinations—especially when the image content is ambiguous or poorly lit. Ongoing refinement and tuning are expected to reduce these occurrences.

The second product is the River Level Prediction Tool, a web-based spatial interface accessible at https://visualizer.nzflood.services/. It provides a user-friendly and interactive method for visualising river level forecasts, thus supporting both operational decision-making and public awareness for the Tairua, Opitonui and Kauaeranga rivers. It provides users with visualised river level forecasts using a suite of machine learning models. These include Long Short-Term Memory (LSTM) networks, LSTM combined with Bayesian Neural Networks, and Transformer-based models. The system also includes a fallback mechanism for situations where upstream data sources are temporarily unavailable, ensuring uninterrupted availability of predictions. This tool supports proactive planning and communication during flood events and is publicly available. A visualization is provided in Figure 1.

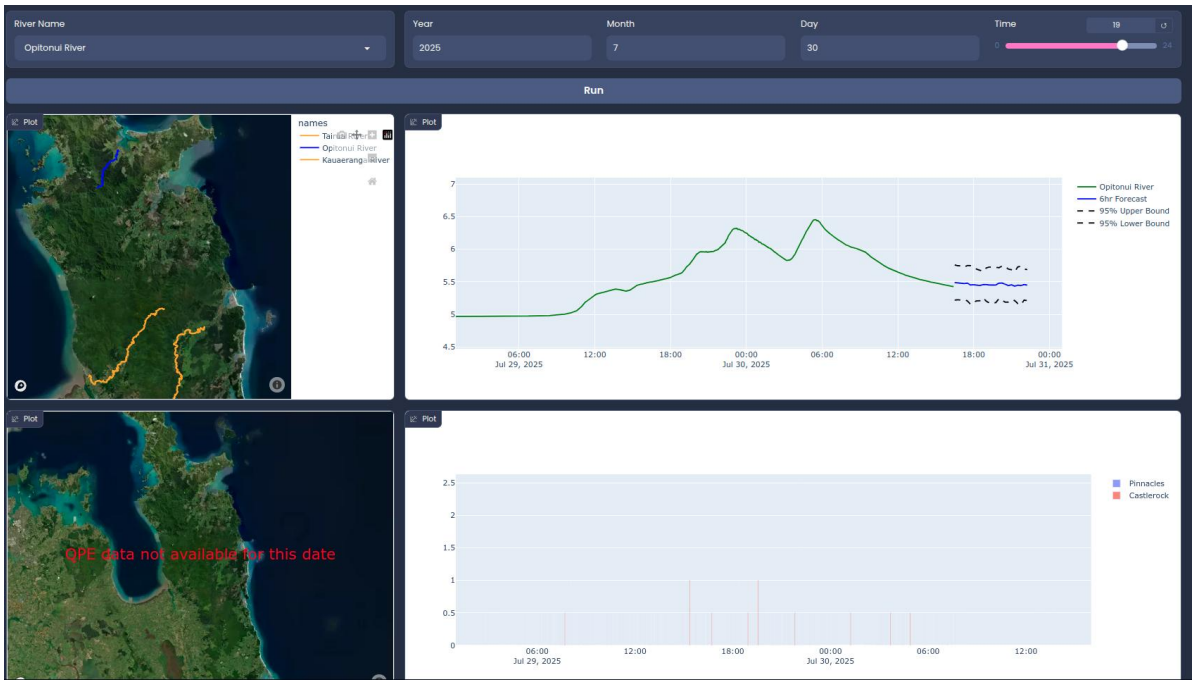

Figure 1: Screenshot of the River Level Prediction Tool on July 30th, 2025.

4. Project Management and Delivery

The project was managed by Dr Christo Rautenbach from the Resilience Team at Waikato Regional Council. He was supported by internal colleagues from both the Flood Response and Resilience teams. The development and technical implementation were carried out in close collaboration with the University of Waikato, particularly through the Artificial Intelligence Institute and in partnership with the TAIAO research project (https://taiao.ai/). This relationship provided access to advanced AI expertise and previously developed models from the TAIAO programme, which were adapted and operationalised for flood emergency use. The project involved regular coordination meetings, iterative development cycles, and feedback loops with CDEM stakeholders to ensure the tools were aligned with user needs and CIMS protocols.

5. Funding Arrangements and Budget Expenditure

The project was funded primarily through the CDEM Resilience Fund, with a total approved budget of up to $99,000. Additional in-kind contributions were made by Waikato Regional Council and the University of Waikato. The budget was managed prudently, with careful oversight to ensure all deliverables were achieved within the allocated amount. Major expenditures included the development of the web-based platform, the implementation of AI models, and the delivery of stakeholder engagement and training workshops. The project remained under budget, in part due to effective collaboration with existing initiatives and the use of open-source technologies.

Planned vs Actual Expenditure Summary

Milestone / Item	Planned Cost (NZD) + GST	Actual Cost (NZD)	Variance (NZD)
Milestone 1 – Workshop and Setting the Scene	$8,000	$5,250	$2,750
Milestone 2 – Web-based Platform Development	$35,000	$10,000	$25,000
Milestone 3 – Artificial Intelligence Models	$40,000	$40,000	$0
Milestone 4 – Deployment	$8,000	$1,000	$7000

Milestone 5 – Training Workshops	$8,000	$5,250	$2,750
Project Management	$0	$27,100	$27,100
Total	**$99,000**	**$88,600**	**$10,400**

6. Access to Products and Materials

The River Level Prediction Tool is currently accessible via the web domain https://visualizer.nzflood.services/. It is publicly available and updated regularly with new data. The Citizen Science Reporting App is hosted and maintained in partnership with the NZ Flood Pics platform, ensuring that the tool remains integrated with existing public communication channels. The AI models, code, and associated documentation developed as part of this project are open-source and can be shared with other CDEM Groups upon request.

7. Lessons Identified

A number of lessons emerged throughout the delivery of this project. Early and ongoing collaboration with external partners such as NZ Flood Pics proved essential to enhancing the functionality and uptake of the tools. Furthermore, engaging stakeholders throughout the development process ensured that the tools addressed real-world operational needs and were fit for purpose. One technical lesson was the importance of continuously evaluating AI outputs, as models can still produce incorrect or ambiguous results. Additionally, the need for sustainable hosting and maintenance plans became evident as the tools neared deployment.

8. Ongoing Costs and Sustainability

The primary ongoing cost is associated with hosting and maintaining the cloud-based platform for the River Level Prediction Tool. These costs are expected to be absorbed by Waikato Regional Council, with discussions underway about transitioning hosting to internal infrastructure. Any future upgrades or improvements to the tools may require further investment, but the intention is that they be maintained as part of core emergency management capabilities. As noted, NEMA is not expected to contribute to ongoing operational expenses.

9. Additional Materials and Engagement

A selection of screenshots, technical documentation, and user feedback from workshops and training sessions is available and can be appended or provided upon request. Public

engagement with the tools has been positive, with interest from other regions in exploring their use. Media coverage was limited due to the proof-of-concept nature of the deployment, but internal communications and newsletters were used to promote the tools within Council and partner organisations.