Community-engaged network of low-cost sensors for Earthquake Early Warning (EEW) in Aotearoa New Zealand

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Joint Centre for Disaster Research
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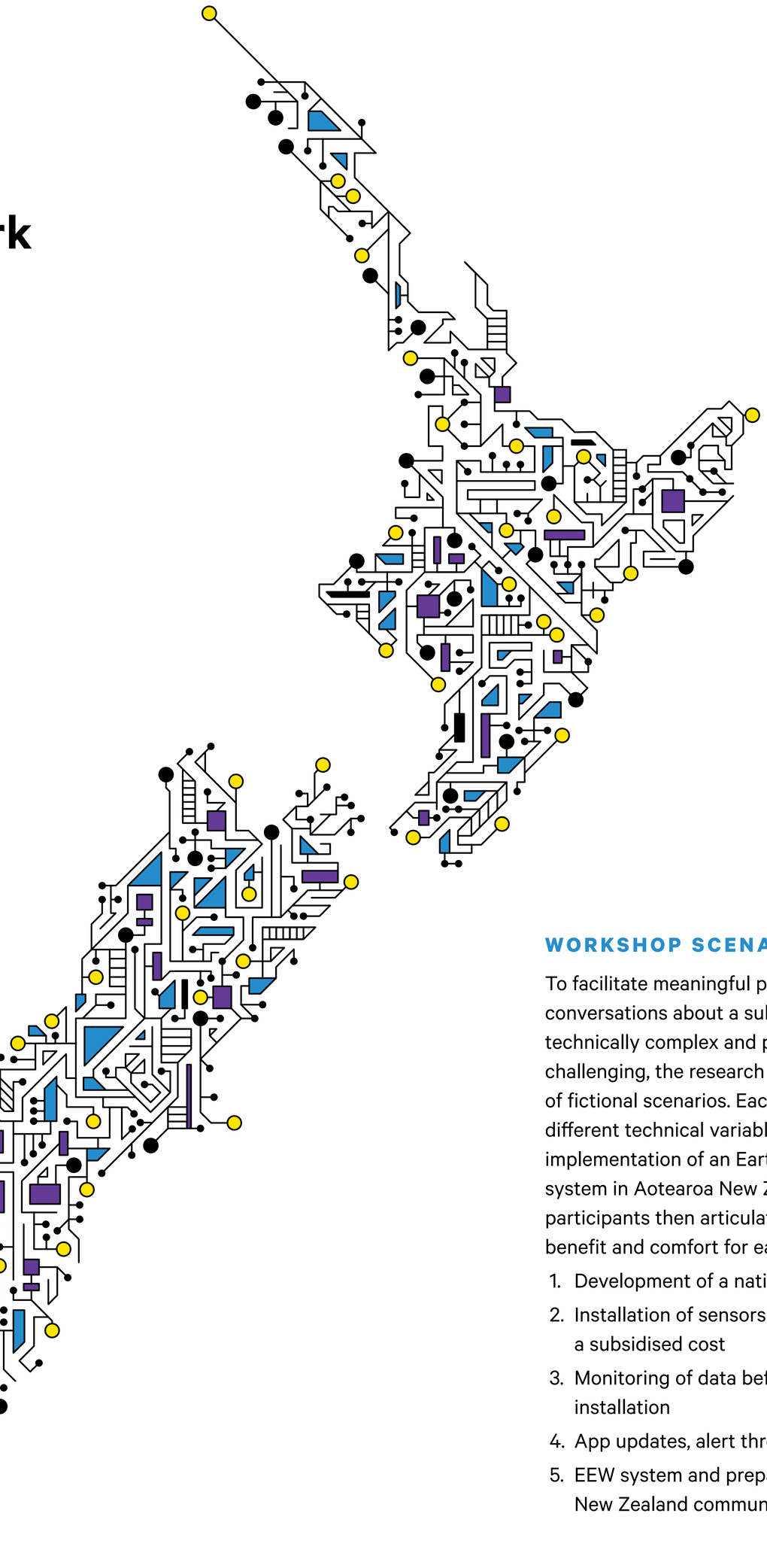
RESEARCH QUESTION

Is it feasible to form an EEW system through a community-engaged network of low-cost sensors?



BACKGROUND

Earthquake-prone countries are exploring Earthquake Early Warning (EEW) systems as a risk mitigation measure. However, establishing a comprehensive EEW system would require a substantial financial investment, and for many countries, such systems are not economically viable. For Aotearoa New Zealand, with a population of just under five million people, appropriating significant financial investments towards development of an EEW system cost-effectively is likely to be challenging.

This research project, launched in February 2020, explores the feasibility of a socio-technical EEW solution for Aotearoa New Zealand. An EEW system may be viable through interconnecting low-cost sensors and recorders through existing communication infrastructures.

The project explores the possibility of utilising emerging Internet of Things (IoT) technologies such as Micro-Electromechanical Systems (MEMS) embedded sensors. The sensors may have lower sensitivity and coarse recording systems. Hence, to operationalise this approach it may require a denser network of sensors to achieve an acceptable level of reliability and also rely on the participation and acceptance of engaged citizens.

The project is conducting two initial concurrent phases to explore the social and technical challenges and opportunities:

- Phase 1: Community-of-practice development and engagement with various communities to scope the challenges and opportunities of establishing an EEW system.
- Phase 2: Explore and examine the opportunities, capabilities, challenges and limitations of developing an earthquake early warning system and applications driven by a network of off-the-shelf MEMS devices and IoT infrastructure.

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WORKSHOP SCENARIOS

To facilitate meaningful participant conversations about a subject matter that is technically complex and potentially emotionally challenging, the research team crafted a series of fictional scenarios. Each scenario explores different technical variables contributing to the implementation of an Earthquake Early Warning system in Aotearoa New Zealand. Workshop participants then articulated their levels of trust, benefit and comfort for each scenario.

1. Development of a nation-wide EEW system
2. Installation of sensors into homes for a subsidised cost
3. Monitoring of data before and after sensor installation
4. App updates, alert thresholds and notifications
5. EEW system and preparedness in Aotearoa New Zealand communities

TIMELINE

PHASE 1

- **FEB 2020**
  - Project start
- **MAR**
  - Scoping meetings with researchers, practitioners, and industry stakeholders
- **APR**
  - Launch virtual workshop with the professional community-of-practice (CoP)
  - Launch of the CoP blog
- **MAY**
  - Webinar on Citizen Science with Prof Muki Haklay
- **JUN**
  - Webinar on Taiwan's EEW system with Prof Yih Min Wu Primary investigator initial meeting with Whakarongotai Marae
- **JUL**
  - Project team meeting with Whakarongotai Marae
  - Shared values workshop with the professional community-of-practice
  - TechWeek even: Smart resilient cities — cast and converse series
- **AUG**
  - Prototyped the community workshop with 14 participants in Wellington
  - Webinar on 'Social Science and ShakeAlert' with Dr Sara McBride
- **SEP**
  - First community workshop held in Wellington with 20 participants from migrant communities
  - Planning and stakeholder meetings for succeeding workshops
- **OCT**
  - Webinar on 'Sensors in Schools' with Raspberry Shake's educational designer Gabriel Low
  - Second community workshop to be held at the Ōrewa Library
- **NOV**
  - Third community workshop to be held in Lake Rotoiti, Nelson
  - Fourth community workshop which expects to be held at the QuakeCoRE annual conference
- **DEC**
  - Paper on shared values of the community-of-practice
  - Paper on communities for EEW
  - Planning for the succeeding workshops
- **JAN 2021**
  - Community workshops in Wellington region (CBD, Hutt Valley, Kapiti Coast)
  - Community workshop in the East Coast
  - Community workshop in Seddon
- **FEB**
  - Writing of report on the community workshops
  - Event with the CoP to discuss insights from community workshops

PHASE 2

- **FEB 2020**
  - Project start
- **MAR**
  - Acquiring different types of Low Cost Sensors
  - Scoping meetings with researchers, practitioners, and industry stakeholders
- **APR**
  - Explore findings and outcomes of previous attempts of using low-cost sensors to detect ground motion and issue warnings
- **JUN**
  - Compare and Contrast Sensor Capabilities and Specifications of acquired sensors
- **JUL**
  - Investigate mechanisms of building a mesh network consisting of low-cost sensors
- **AUG**
  - Investigate opportunities and challenges of processing and transferring of data in between low-cost sensors organised in a meshed network
- **OCT**
  - Investigate opportunities and challenges of processing and transferring of data in between low-cost sensors organised in a meshed network
- **NOV**
  - Explore opportunities and challenges implementing earthquake detection algorithms at the sensor nodes
- **JAN 2021**
  - Explore opportunities and challenges implementing earthquake detection algorithms at the sensor nodes
  - Continue with testing of the performance of different types of low-cost sensors installed in a mesh network
  - Compare and contrast the performance of different types of MEMS devices available in the market, for various seismic temporal patterns and earthquake scenarios
- **FEB**
  - Develop a taxonomy of EEW application types and evaluation of matching MEMS sensor networks relevant to NZ
  - Develop simple prototypical EEW applications driven by MEMES sensor networks based on the initial requirements gathered in Phase 1 develop simple prototypical EEW applications driven by MEMES sensor networks
- **MAR**
  - With the support of prototypical applications, make further engagement with the communities to explore specific factors and needs affecting the use and acceptance of EEW applications.
  - Identify priority EEW applications that will support specific warning needs and challenges of different communities with regard to EEW applications in NZ
- **JAN—JUN 2022**
  - Develop a Conceptual Architecture of community-engaged EEW system in NZ with the necessary and sufficient conditions of using self-healing network of off-the-shelf MEMS devices supported by IoT infrastructure

CONTACT

Want to be involved in the project?
Contact Marion Tan at M.L.Tan@massey.ac.nz

Poster designed by Matthew Law