Empowering decision making for sustainable development through environmental digital twins

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The Geospatial Research Institute Toi Hangarau is a world class centre of interdisciplinary geospatial expertise in New Zealand.

We conduct interdisciplinary partnership-based geospatial research across the social and physical sciences.

2. Hobbs et al. 2022, [https://doi.org/10.1016/j.socscimed.2022.114801](https://doi.org/10.1016/j.socscimed.2022.114801)
4. Schindler et al. 2020, [https://doi.org/10.1061/(ASCE)UP.1943-5444.0000575](https://doi.org/10.1061/(ASCE)UP.1943-5444.0000575)
5. Dionisio et al. 2021, [https://doi.org/10.1111/nzg.12299](https://doi.org/10.1111/nzg.12299)
8. Rongowai: [https://spoc.blogs.auckland.ac.nz](https://spoc.blogs.auckland.ac.nz)

Background image: Te Wei Pounamu, Aotearoa; South Island, New Zealand: David Garcia @mapmaperdavid
What’s a digital twin?

....a virtual representation of the real world

- With real-time data integration, analysis, prediction and visualisation.
- Can range from individual entities (e.g. a building) to urban areas, to the globe.
- An enabler: automated processing and analysis removes barriers for decision makers.

Victoria Digital Twin, Australia
https://vic.digitaltwin.terria.io/
Digital twin examples

New Zealand
- Digital Twin identified as priority in National Infrastructure Strategy
- Flooding Digital Twin Research Project
- Wellington Digital Twin

Queensland
- Queensland Digital Twin – Statewide, and supporting the SEQ City Deal
- Brisbane Digital Twin
- Cross River Rail

ANZLIC
- Digital Twin Principles
- Framework for Spatially Enabled Digital Twins
SSSI – Spatial Digital Twin: Special Interest Group

New South Wales – Spatial Digital Twin: Live.NSW
- Morriset (Lake Macquarie Council) Digital Twin
- Sydney Water – Digital Twin Program
- Liveable Cities Digital Twin Research Project – UNSW, Liverpool City Council, DCS, AURIN...

Victoria –
- City of Melbourne Digital Twin
- Digital Twin Victoria, including
  - Statewide Digital Twin
  - Fishermans Bend Digital Twin Pilot
  - e-Comply planning demonstrator

Tasmania
- Greater Hobart Digital Twin – supporting the City Deal
- Launceston Digital Twin

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USA
- Boston, New York, San Francisco

Singapore
- Virtual Singapore

India
- Amarvati, Andra Pradesh

Europe
- Vienna, Zurich, Rotterdam, Flanders, Athens, Pilsen, Helsinki ....

ANZLIC
- Digital Twin Principles
- Framework for Spatially Enabled Digital Twins
SSSI – Spatial Digital Twin: Special Interest Group
• Environmental digital twins:
  – Can be an enabler for decision makers towards the SDGs through automated processing of data and predictive capabilities.
  – Form key components of development of a geospatial knowledge infrastructure.

• This talk:
  1. Explore possibilities through a prototype under development for flood risk assessment and management
  2. Call for embedding computational models within a framework of interconnected digital twins

Destination Earth (DesdinE):
https://www.esa.int/Applications/Observing_the_Earth/Destination_Earth
The challenge: Flood risk management and mitigation requires substantial amounts of spatial data related to infrastructure and the environment, making it expensive to develop suitable risk assessments or scenarios, particularly when the information needed is time-critical.

Towards a National Digital Twin for Flood Resilience in New Zealand

✓ A prototype digital twin to improve flood risk assessment and emergency management.
✓ Automated analysis:
  • Generation of flood models for user defined areas.
  • Running of multiple standardised or user-defined flood scenarios.
  • Assessment of flood impacts across the scenarios.
✓ Interface for visualisation of flood impacts and scenario control.
✓ Inclusion of real-time information during an event, predictive analytics.
✓ Open source and open data.

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Rob Deakin (Land Information New Zealand)

Follow the code development (or contribute!)
https://github.com/GeospatialResearch/Digital-Twins

Updates via Twitter: @geospatialnz
Towards a National Digital Twin for Flood Resilience in New Zealand

CURRENT MAIN TECH STACK COMPONENTS:
Automated data ingest

User’s area of interest

Roads
Rail
Buildings

DT DATABASE
Vector Data
Generation of model input data

Automated production of “hydraulically conditioned” model grid from LiDAR point cloud and supporting data.

LiDAR point cloud (LINZ/ Open Topography)

Waimakariri River

Kaiapoi

Model grid, processed using: https://github.com/rosepearson/GeoFabrics
Generation of model input data

Automated standardised scenarios, or from observed data.

Rainfall design storm
High perigean-spring “king” tide level
River flow design hydrograph

Annual exceedance probability = 0.02 (50 year average recurrence interval)

Buildings data: https://data.linz.govt.nz/layer/101290-nz-building-outlines

Graph: Number vs Depth of flooded buildings
Hazard assessment: Automated assessment of flood impact within the Digital Twin: **flooded roads**

Scenario comparison: e.g., change in 50-year flood event depth in 2080 (RCP 8.5), accounting for increased rainfall, river flow and sea level rise.
Digital Twin for Flood Resilience

Front-end initial mock-up (CesiumJS)
Summary

- Successful prototype demonstration, now for next phase of development
- Automation = Faster = More scenarios = More detailed information = Better decisions (?)
- Additional development needed...
  - e.g., Inclusion of additional scenarios, real-time data, storm drainage, visualisation in VR/AR
  - Creation of an API for machine connection.
  - Additional flood model softwares

Final thoughts

Models in digital twins...
- Automating models and scenarios removes barriers
- An important component of the development of a spatial knowledge infrastructure
- Linking multiple digital twins is needed

Some challenges...
- Standards!
- Additional use cases are needed
- Software needs to be open source
- Computational requirements
Thank you, tēnā koutou katoa, धन्यवाद
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