# Scrutinising the Prediction of Liquefaction through New Zealand Case Histories

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## Background

Liquefaction induced land damage has been identified in more than 13 notable New Zealand earthquakes within the past 150 years, as presented on the timeline below. Following the 2010-2011 Canterbury Earthquake Sequence (CES), the consequences of liquefaction were witnessed first-hand in the city of Christchurch and as a result the demand for understanding this phenomenon was heightened. Government, local councils, insurers and many other stakeholders are now looking to research and understand their exposure to this natural hazard.

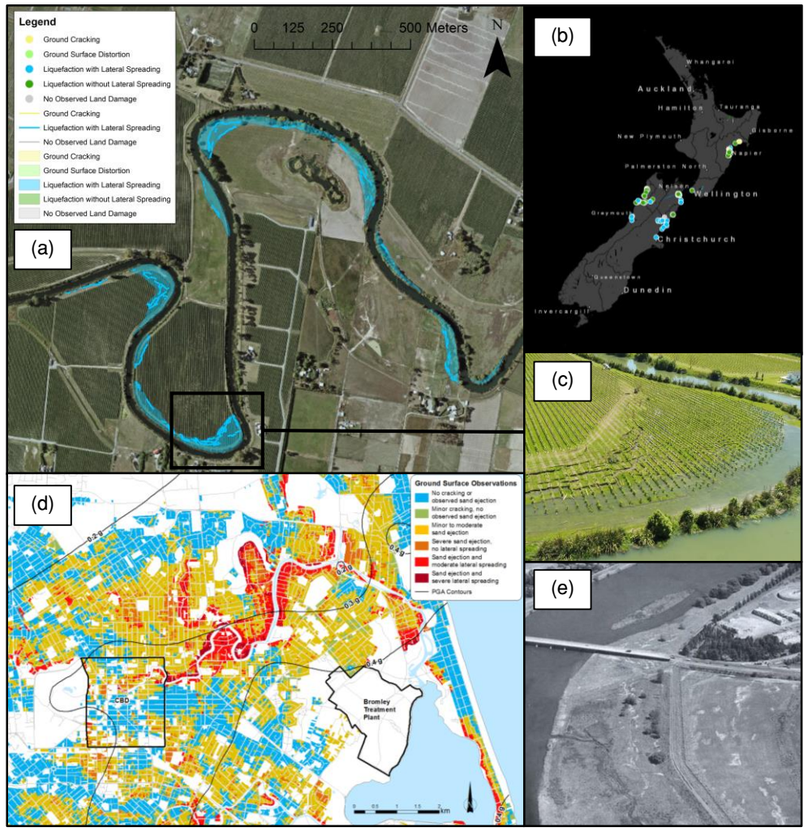
## Project Objectives

This study, operating within a wider collaborative research focus, aims to deepen the understanding of liquefaction through a number of key objectives:

- Recent and historical cases of liquefaction identified through personal records, photos archives, published accounts, reports and post-event reconnaissance are collated into a centralised geospatial database, the New Zealand Historic Liquefaction Database (NZHLDB). Examples of these observations are presented in the adjacent figure.
- Focusing on the Marlborough region, the collated observations following the 2016 Kaikoura earthquake and the 1848 and 1855 Wairarapa earthquakes are compared with that predicted by the simplified methodologies using geotechnical data available for the area on the New Zealand Geotechnical Database (NZGD).
- Comparison of cases of liquefaction and no liquefaction manifestation with local geomorphic variability provide insights into the geologic and topographic settings which typically result in liquefaction manifestation.

## Insights

Manifestation of liquefaction during recent large earthquakes is very strongly correlated with depositional setting of meandering rivers. These correlations highlight the crucial role that geomorphic mapping and depth to groundwater assessments have in identifying areas that are potentially liquefiable.

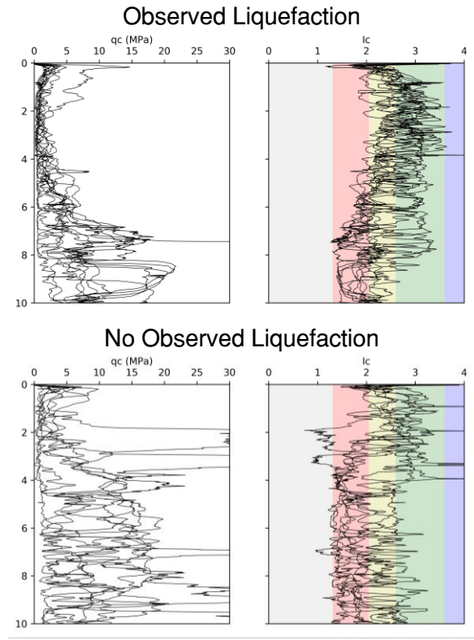



*(a) Mapping of the extensive liquefaction manifestation along the Opaoa River caused by the 2016 Kaikoura earthquake (b) NZHLDB overview – capability to map various modes of damage including lateral spreading, free field liquefaction etc. (c) Recent record of liquefaction and lateral spreading along the Opaoa River (d) Map of the worst liquefaction-induced land damage through the CES (e) Historic record of liquefaction at Landing Road, Whakatane caused by the 1987 Edgecumbe earthquake.*


*Timeline of earthquakes known to have caused liquefaction represented by moment magnitudes*

## Simplified Analyses

In prior research limited comparison between subsurface profiles derived from geotechnical investigations, geomorphic variability and observations of liquefaction manifestation have been made. By utilising the NZHLDB, case studies can be obtained for which to identify commonalities between sites that did and did not liquefy. These case histories can be used to scrutinise the predictive efficacy of the simplified methods. Cone Penetration Test (CPT) soundings conducted in eastern Blenheim following the Kaikoura earthquake demonstrate the differences between sites which liquefied and sites that did not. CPTs that correlate with reported liquefaction indicate loose sediments that comprise silty sands to sandy silts ($I_C$ 1.31-2.6). Sites of no reported liquefaction can be attributed to having a higher cyclic resistance which exhibit higher densities and complex interlayered profiles.




*CPT soundings ($q_c$ and $I_c$) along with averaged groundwater estimates of sites that did and did not liquefy during the recent 2016 Kaikoura earthquake.*

## Future Work

- Further interrogation of the Blenheim case history dataset available through the NZHLDB.
- Demonstrate the limits and shortcomings of the simplified liquefaction frameworks.

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