ecological effects of the Christchurch February earthquake on our city estuary

summary & management recommendations

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

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Why Did We Do These Studies?


Searush bed / EOS Ecology

The 22 February 2011 earthquake was likely to have adversely affected the Avon-Heathcote Estuary/Ihutai because of changes in bed height and bathymetry (depth measurement), large areas of liquefaction throughout the estuary, and from the input of raw wastewater that was being pumped into the Avon/Ōtākaro and Heathcote/Ōpāwaho rivers and the estuary. Environment Canterbury and the Christchurch City Council therefore arranged studies to assess the changes to the morphology and habitat condition of the estuary and responses of macroalgae to nutrients, to determine the potential effects of the earthquake on the estuary's ecology. Ongoing long term monitoring of pathogen levels in cockles was also used to assess the effect on food safety. These studies were undertaken by NIWA and the University of Canterbury, with cockle monitoring by EOS Ecology. Here we summarise the results for morphological and habitat effects (reported in Hicks *et al.* (2011) and in an unpublished data report by the University of Canterbury (Schiel *et al.* 2011)), and the ongoing cockle monitoring, while the work on algal responses is to be reported in June 2012.


Avon-Heathcote Estuary/Ituhai / EOS Ecology

PEOPLE INVOLVED:

NIWA Taihoro Nukurangi: Alastair Suren, John Zeldis, Murray Hicks, Ude Shankar, Richard Measures, Jo Bind, Jade Arnold

UC University of Canterbury: Dave Schiel, Jen Skilton, Paul South

EOS Ecology — Aquatic Research & Science Communication Consultants: Shelley McMurtrie

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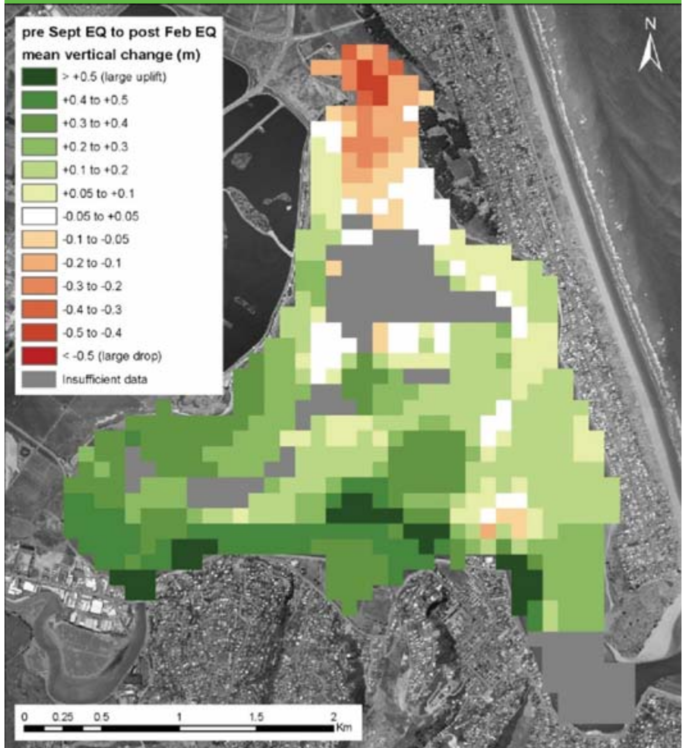
1 Morphological Effects



Map of elevation change due to September 2010 and February 2011 earthquakes. Green areas have risen, brown areas have sunk. Grey areas (within estuary) have no reliable information. Overall pattern is downward tilting to north. Outlier patches likely reflect current-driven shifts in channels and banks / NIWA

SUMMARY OF NIWA REPORT
Mapping Earthquake Induced Topographical Change and Liquefaction in the Avon-Heathcote Estuary, July 2011

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a. UPLIFT & SUBSIDENCE

This study examined topographical data before and after the earthquakes to:

1. check whether the estuary's topography had changed,
2. identify areas where the seabed had risen or fallen,
3. assess how this affected coverage of the seabed at different phases by the tide,
4. assess what the net changes may have been.

The study used airborne LiDAR data where available, but, unfortunately, substantial parts of the estuary were covered by water when these surveys were done. Ground surveys and echo-sounding surveys were also used where possible to complete the topographical analysis. The following topographical changes were documented:

1. The northern part of the estuary at the Avon River mouth has subsided by 0.2–0.5 m from its previous level. This will lead to flooding along this shore with extreme high tides and erosion of the reed banks. Natural sedimentation may infill this depression over decades, but the pace will be too slow to mitigate the hazard.
2. The southern part of the estuary, including the estuary mouth and the Heathcote River mouth, has risen by 0.3–0.5 m. This will affect recreational sailing.
3. Areas exposed at mid-tide have increased by 18% on average over the estuary, but particularly in the south-western part of the estuary. This will influence wave-energy distribution, substrate stability and habitat for biota (flora and fauna).
4. The estuary has had an average elevation rise of about 0.14 m. This suggests a reduction in the tidal prism[1] volume of around 1 million m^3, which is about 14% of the mean tidal prism volume. This may cause the inlet to narrow and the tidal deltas to shrink by around 15–20%; the surplus sand may nourish the adjacent beaches.

Over years (possibly decades), the estuary is expected to naturally adjust its channels as it adjusts to, and reworks the earthquake-imposed topography.

b. LIQUEFACTION

Liquefaction could smother estuarine biota and exhume sediments potentially contaminated with heavy metals, organic matter or nutrients buried under the estuary bed. We examined aerial photographs and measured the location, size and abundance of liquefaction mounds. A startlingly large density of liquefaction mounds was found – ranging from 500–3200 mounds per hectare – greatest at the old city outfall discharge point in the western estuary. The areal coverage was greatest (35–39%) along the eastern part of the estuary (Brighton Spit shore), where mound size also tended to be larger (up to 5 m^2 per mound). The proportion of the estuary bed covered by liquefaction mounds was substantial (~20–40%) for the sampled areas, and visual inspection of the imagery indicated that this was reasonably representative of the whole estuary.

RECOMMENDATIONS:

1. **Future LiDAR surveys should be flown at low tide.**
2. **Given close links between flows in the lower Avon and tidal and drainage conditions of the estuary, it is suggested that an overall hydrodynamic model coupling the Avon River to the estuary be developed. This would be used to investigate the extent and potential consequences of tidal prism change.**

[1] Tidal prism: the volume of water in an estuary between mean high tide and mean low tide.

2 Estuarine Habitat

Liquefaction mounds at Humphreys Dr / EOS Ecology

Field sites / NIWA

SUMMARY OF NIWA REPORT
Effects of the Canterbury earthquakes on Avon-Heathcote Estuary/Ihutai ecology, September 2011

CLICK TO DOWNLOAD FULL REPORT

estuary

University of Canterbury researchers undertook field work at six sites in the estuary where they quantified the following:

1. Differences in the invertebrate fauna dwelling in the estuarine sediments in liquefaction mounds and adjacent pre-existing natural areas.
2. The proportion of each site covered by mounds.
3. The average size and height of mounds.
4. Analysis of grain size, organic content and heavy metals of the sediments in mounds and adjacent pre-existing natural areas.

Overall, fewer species were found in the two-month old mounds than in adjacent natural areas, but differences also varied by site. For example, very few animals were recorded in either habitat at the Humphreys Basin site. The highest number of species in natural areas averaged 11 species per sampling core, whereas for mounds it averaged only 7.5 species per core. Invertebrate density was generally higher in natural areas than in mounds, but this pattern was not consistent between sites. Overall, the Heathcote, Plover, Discharge and Humphreys Basin sites had the fewest individuals in mounds, perhaps reflecting the type of fauna present at those sites.

Transect sampling showed the mounds covered between 30–65% of the estuary surface with the percent cover varying with location within the estuary. Mound height was highly variable, averaging 90–110 cm at two locations and as low as 20 cm at another location. Mound perimeters also varied greatly across sites, averaging 12–13 m, but were smaller at the Discharge and Humphreys sites. The grain size of mound sediment was different to that of the adjacent natural area sediment. Mounds generally had a larger grain size than adjacent natural areas. Mounds were also firmer and composed of coarser material, whereas adjacent natural sediments were dominated by fines. Heavy metal concentrations were usually higher in natural areas than mounds, but this varied by site. Some metal concentrations were higher at sites closest to rivers, reflecting historical pollution in these areas. Organic content was 2–3 times higher in natural areas than in mounds. The natural areas also had a much higher variability in organic content, whereas that of mounds was fairly consistent.

RECOMMENDATIONS:

There clearly has been substantial damage to the pre-existing biota due to burial over large areas. However, the liquefaction sediments contain lower concentrations of heavy metals and organic matter than the pre-existing surficial mudflats, and as such do not represent a threat to estuarine ecology. These liquefaction sediments may accelerate estuary rehabilitation by burying any pre-existing polluted sediment. The liquefaction sediments will, over time, be redistributed over the pre-existing sediment topography, and will be recolonized by biota. While we recommend that nothing be done to hasten this process, we recommend that its rate be monitored and that assessments be made as to its long-term effects relative to pre-earthquake conditions.

The change in the bathymetry of the estuary described above in section 1, will probably affect distributions of chemical and biotic features of the estuary on an ongoing basis, especially in the south-west and north of the estuary where the changes in bed height were largest. Again, while we do not recommend that this be remediated (apart from any flood protection measures which may be undertaken), we recommend that the effects on chemistry and ecology be monitored to assess long-term implications of the inundation change.

3 Food Safety of Cockles

Collecting cockles in the estuary / EOS Ecology

Quarterly monitoring of bacteria (*E. coli*) and virus (norovirus) levels in cockles at five sites around the Avon-Heathcote Estuary/Ihutai has been ongoing for the last three years. This work is part of a long-term monitoring programme EOS Ecology is undertaking for the Christchurch City Council looking at the effect of no longer discharging treated wastewater into the estuary. By chance this monitoring occurred within a month after the February 2011 earthquake, so we could also see how the sewage overflows to the city's rivers and estuary affected the food safety of cockles.

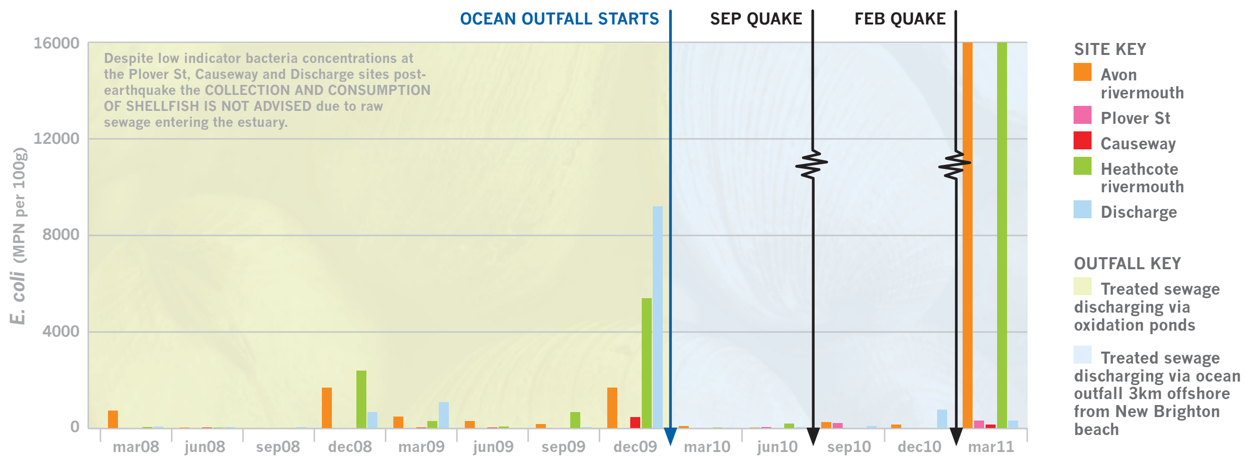
Bacteria (*E. coli*) levels dramatically increased after the February earthquake. The levels in cockles at the two river mouth sites were almost twice as high as any previous record when treated wastewater was discharged into the estuary, and over four times as high as levels once the discharge was removed.

An assessment of relative levels of norovirus by ESR showed a similar pattern, with 'extremely high' levels in cockles near the two river mouths following the February earthquake. These levels are uncommon in New Zealand shellfish. Noroviruses are highly infectious and as they can survive high temperatures (up to 60°C) and have a low infection dose, lightly cooking shellfish before consumption may not be sufficient to prevent illness.

The higher levels of bacteria and viruses in shellfish by the river mouths following the February earthquake is directly related to untreated sewage entering the rivers as a result of damage to the sewerage network. Without treatment the bacteria and viruses from human faeces and vomit would survive in the water and fine sediment, which is then filtered out of the water by shellfish as they feed. The gut of shellfish makes for a wonderful environment for these pathogens, where they can survive for weeks.

RECOMMENDATIONS:

1. **At this stage gathering of shellfish from the estuary for eating should not be undertaken. Further signage or public messages should be made to ensure the public continues to be aware of this situation.**
2. **Quarterly monitoring will continue while there remain sewage overflows into the rivers or estuary. When the overflows cease monitoring will occur on a monthly basis, so that we can inform the public when bacteria and virus levels in cockles return to pre-earthquake levels.**



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