Hazards (including Faultlines and Coastal), Energy and Infrastructure - TTPP Submission
27 November 2023. Paul Finlay 2 p.m. S408 pages 37 and 127

Keywords: Energy - electricity generation and supply, Land, Subdivision allocation - Westport, Greymouth, Hokitika, Faultlines, Tasman Sea - Tsunami, Liquefaction, Climate Change resulting Hazards, Electricity Generation, Dept. of Conservation land, National Parks.

Energy
In 1993, the author spent the early morning hours of the winter working on the challenge

"The West Coast is so much water, the East Coast (of the S.I.) needs:- is it possible to send the water east, where it is needed for irrigation and possible electricity generation." - Paddy Blanchfield M.P for Westland.

Result
The last glacial age 13,000 ~10,000 years b.p. had a higher degree of aggradation on the east than the west. Consider the 800mH of overburden on some hidden faults of Canterbury e.g. noted and researched post the Darfield earthquake.

However, there was one and only one small valley, in Westland albeit in a National Park, in an extraordinary geological and geomorphological structure, that had a river tributary of a major West Coast River, higher than its east coast elevation. The measured low flow summer 1993/19940 was 15 cumecs and the flood possibly 500 cumecs. The rainfall is high, 5000 ~6,000 per annum. Visits to the only hut in the valley showed five visitors per year.

Situation 2023
The water stressed area (lack of water, drought under Climate Change) is now demanding the water for human water reticulation, including towns (plural) expansion, tourist needs especially in summer the peak of the N.Z. tourist season, irrigation for crop cultivation, the water needs for a major N.Z. export, and the water increase for power generation already under the jurisdiction and administration of N.Z. Power companies.
There are already exisiting dam(s) and power generation on the major east coast rivers.

The outlet of a simple tunnel, c. 1.5m diameter (consider the Amethyst Power Project in HariHari) under the mountain approx. 10 ~11 km length. The outlet is near the top head of the Catchment of a stream and outflow to an east coast tributary stream leading to the inlet of a major east coast lake(s).
Using only 5 cumecs for power generation, with the top of penstock at the immediate outlet east after the tunnel, and a generating head of 50 mH and efficiency of 80%, the power available is 2MW at the stream itself. The extra power available for existing downstream power projects is to be computed.
Using 50% of the flood on the small tributary river, to divert to the East Coast would have some 72 million m3 of water 'donated' to the East Coast.

Importance of the scheme
The new government (2023) has in policy, relinquished the Lake Onslow Storage Project.

Already, in previous El Nino Climate Change event, a critical shortage of water and problematic power generation resulted.

There was, and will be, a critical period(s) of heavy frosts in which N.Z. achieved a chronic lack of full power supply.

The scheme and permission of DoC under the TTPP would reduce the reliability oof the Huntly Power Project for generation.

Recommendation
That provision be made for the use of Dept. of Conservation land, (inlet and tunnel), National Park for where proven need and reinstatement of any earthworks by bond and signing off, can be done.

West Coast
There is the several small power schemes on the West Coast in which a pipeline, penstock is required for power generation.
West Coast electricity Supply Generation is presently relying to a degree on the Lake Coleridge Power Scheme.

Philosophy
The West Coast is governed in the next 50 years by the sudden dynamic of the rupture of the Alpine Fault.
This earthquake, M8.2, will also affect the islands of Stewart Id. and the North Id. as far as Palmerston North in the Wellington Province.
The entire North Island will be affected by a shutdown in electricity supply.

Wherefore, given the high rainfall, relatively steep terrain and the potential of the known schemes bordering the eastern Paparoa Range (Rough River and streams), the pluton - the Hohonu Range (the potential for a high head dairy farmer supply at Rotomanu), the Crooked River run of river scheme and the considered power schemes for South Westland.

Recommendation
that, the TTPP include the potential for such schemes where it can be demonstrated that reinstatement of any earthworks by bond and signing off, can be done.

It is critical that the West Coast have an independent power supply.

Subdivisions

(i) **New Westport town**

From S.H. being existing Bald Hill Farm at elevation 60m a.s.l. downhill through to Alma Road, 20m a.s.l.

Designated Area = existing Westport town + 50% for future urban growth.

(ii) **Charleston**

Designate 500m2 sections for extension of Charleston as a town. Also include one section of any any sections as in Historical and Cultural values below.

(iii) **Greymouth**

a. Beyond Dunollie and before Rapahoe - between S.H. 6 and Twelve Apostles Range

200m (boundary no build line to the foreshore). The new line from the foreshore of the true left bank of Seven Mile stream, Rapahoe, as a subdivision, back to the Mines Rescue road of the Seven Mile Straight (S.H. 6).

With a community treated water supply from the Coal Creek Greymouth treated supply, with renewal of the considered asbestos pipe reticulation system(s).
Separate community three stage minimum Effluent System including oxidation pond(s).
Section sizes 1012m2 and less according to the Unitary National subdivisions planning schedule. Subdivisions under the administration of the Grey District Council, but the land per se, designated as extension under the considered (50 year) TTPP plan.

b. Cobden

Former 57.85 Ha Minehan ~ Keeney dairy farms, 16 North Beach Road -Cudmore farm (for sale).
Designate as Subdivision with new rainfall runoff from roofs and streets to Lake Ryan with outfall to the Tasman Sea. Do not overload Range Creek, and add to flooding in lower Bright Street and Nelson Quay.
Designate sewage collection with collection system to the low area between Lake Ryan and lower Munro Street using 30 day dual oxidation ponds (similar to Hokitika north). Outflow to the Tasman Sea, as at Hokitika north..

(iv) **Hokitika**

With the present raised bedload of the Hokitika River, and which will be be raised further (aggradation) with the river transport of multiple landslides Alpine Fault Rupture for some considered 50 years post AF8 event.

The following needed considerations for Hokitika:-

(i) Sea level rise to the year of the consideration of coastal Hazard Te Tai Poutini Plan,

(ii) Flood elevation with Climate Change rainfall intensity, (including Bombogenesis), and the colloquial term, now, of atmospheric river of Rain

(iii) Liquefaction of the business area in a major earthquake event

It is noted that near the Hokitika River, there are liquefiable deposits. Near the coastal Zone of the seaside of the Tasman Sea, there are liquefiable deposits.
It is known that the water table for the Hokitika business area of the construction of new buildings (e.g. Mitre 10,) was 1m below G.L. at high tide and 2m at low tide.

Wherefore, designate A NEW BUSINESS AREA for HOKITIKA, which will have solid foundations, be not be flood prone (as Westport is) and be above sea level + tsunami of 8mH max. (Refer Reference 1 above), nor be subject to liquefaction in a major seismic event.

That provision be made on the TTPP, of the northern land for the extension of Hokitika airport.

3. S.H. 6 Diversion and New Franz Josef Town

Give consideration to designating on the plan, an area similar to the exisiting area sufficiently north and west of the Alpine Fault, *and* to include the relocation of S.H. 6 to follow the glacial moraine spur over the Tatare River and to the Waiho/Waiau River with an elevated inclined new suspension bridge over the Waiho/Waiau River, to the true left bank of the Waiho/Waiau River.

Engineering Philosophy - moving west (away from) the Alpine Fault.

Photo. Locate the S.H. 6 diversion on the glacial moraine with a suspension bridge to the south side of Waiho/Waiau River

4. Historical and Cultural Values

Designate in all historical West Coast towns an area of approx. 1012 m2 for an historical archives building, to two storey level for each site.

Faultline Hazard

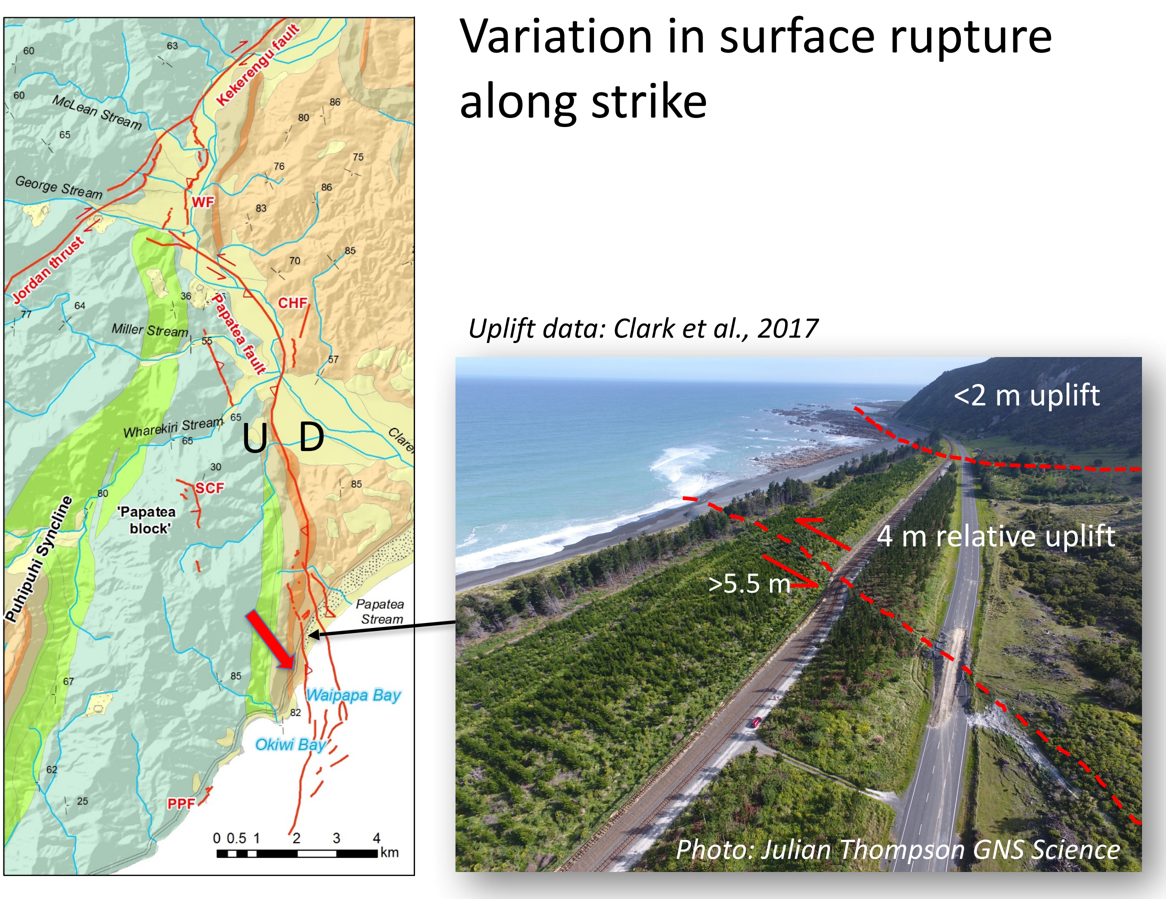
Recommendations

That all known faultiness be shown on the Tai Poutini Plans as a special Hazard Plan.

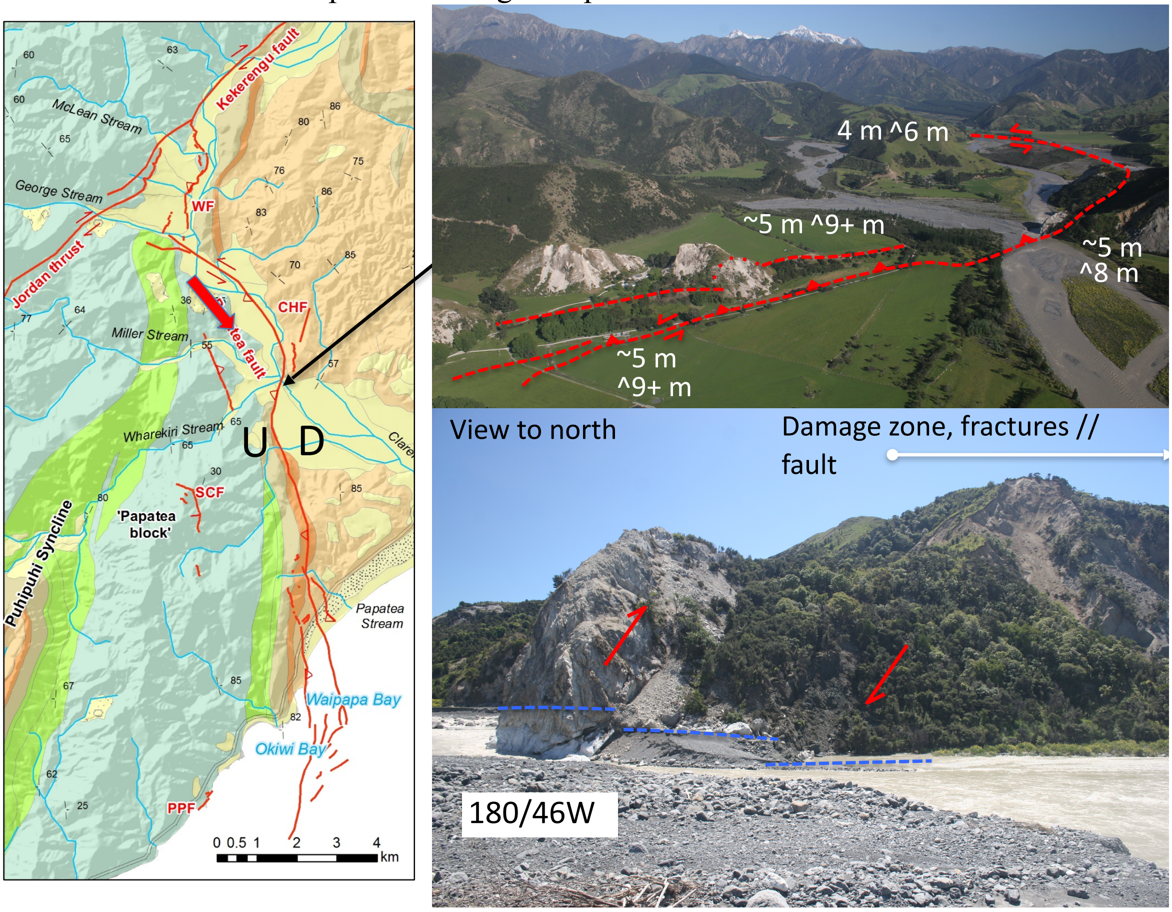
These are shown on the GNS West Coast Geological plans. These include the Fraser Fault, Kumara Fault and the 75% probability Alpine Fault M8.2 stress release (earthquake) within the next 50 years (reference Prof. Townend of Victoria University March 2022).

This significance of the faults ***west*** of the Alpine Fault is post Alpine Fault rupture (AF8 8m horizontal movement) is explained by the fact that the movement of the West Coast on the Indo - Australian Plate is not uniformly moved in itself .
The tectonic stress is non linearly pressured from the Alpine Fault directly west to the Tasman Sea. M7 seismic ruptures will result post Alpine Fault Rupture, in spasmodic time intervals, according to the resisting strength of the Indo - Pacific Plate.
For the West Coast segment, the transfer of the resultant tectonic stress will occur, with the stress transfer moving over West Coast land to the Cape Foulwind Fault (in the Tasman Sea) and the South Westland Fault (also in the Tasman Sea).

Photo illustrating the non uniform uplift of a fault.



The effect of mountains in uplift- reducing the uplift



Recommendation - Faultines

Similarly, it cannot be expected that there will be a *uniform* whole movement of the West Coast from the Alpine Fault Rupture towards the South Westland Fault and the Cape Foulwind (Tasman Sea) Fault.

Wherefore, logic strongly implies that the faults in between the Alpine Fault and the Tasman Sea Faults would be reactivated post Alpine Fault rupture.

Wherefore, show these zones with a 200m no build zone either zone of the faults. The 200m distance is taken from the outside of the fault (each line width). Give the fault, per se, a width of 30m. 30m is taken from Harold Wellman's communication of the 'standard width of the Alpine Fault. Apply in the absence of data, to all faults

Recommendation -Tsunami

Background - Paleo West Coast tsunami

Forming of Okarito Spit forming the Lagoon

From the 1826 Caswell Sound Earthquake - Paleo evidence

Okarito spit of a tsunami generated by the Caswell Sound seismic event.

Goff et al (2004) propose a tsunami as the mechanism for the lowering of the Okarito 'lagoon' in a sudden of rush energy event.

Further evidence are two reports of a drowned Maori Village at Poherua Lagoon, known as Saltwater Lagoon, 11 km north of Okarito. The first report was from Thomas Brunner in 1848 (republished in Pascoe 1952) and the second report was from Engr. Arthur Dudley Dobson who wrote:

"At Poherua Lagoon there had been at one time a Maori Village of considerable size, the stumps of the posts of the houses showing plainly . . . . .The land had sunk . . . .as these traces could be seen at dead low water spring tides." (Dobson ,1930, p72.)

Explorer Dobson also noted that the Maori were unaware the Village had ever existed, which suggest to us (Nichol et al 2007) that the subsidence (of the sea coast at Poherua Lagoon) and abandonment of the Maori Village occurred well before the 19th century.

It is conclusive that there was subsidence in the Okarito lagoon. This can occur with loose sedimentary deposits which are non consolidated by natural overburden, and more so by liquefaction.

A possible location of the former (abandoned) Maori Pa is Ulipa Hil 27m a.s.m.l. near Shag Bay, in the south west corner of Saltwater lagoon.

Is the 1826 Caswell Sound earthquake a long term precursor of a pending Alpine Fault event? We do not know.

West Coast Earthquakes – paleo

Seaweed genes

Reported by AAAS in **Science** and also Reported in the **New York Times**

Reporter Charlotte Harvey July 15 2020

800 years ago (2020 – 800 = year 1220), 25 km of ocean bed was thrust up off the coast of the N.Z. South Island.

Research evidence

Evidence: Genes of bull kelp, the genes are different form from the undisturbed bull kelp.

Bull kelp has the scientific name nereocystis rimurapa is an algae, colour brown.

From Reference 1

West Coast Regional Flood Control Assets

Supplement 9 David Elms,

11 August 2017

That the 5 mH and the 8 mH plus sea level rise as in the formula below lines be shown on the full length (ignoring headlands, where inapplicable).

The lines to be shown as contour in the colour blue. Blue for water.

A Potential Local Tsunami Source

The Cook Canyon and the Hokitika Canyon have steep sides with the potential for Earthquake induced submarine landslides and turbidite slides. The turbidite slides are sensitive particularly so, with the 100 million cubic metres of sand and mud from the movement of the littoral drift along the West Coast per annum.

The potential for both local and severe West Coast Tsunami from this source must be taken into account. No research exists to date on this potential. A rule of thumb needs to be applied.

Formula 1

Coastal Hazard accommodating Sea Level rise to year 2050. Base is mean low tide. Consider base (Datum) as the 1937 Lyttleton low tide.

No Tsunami

Coastal Hazard Contour = Sea Level Rise of 0.85m (to year 2050) + 3.5 mH for King tide + 0.6m for atmospheric storm surge + wave run up height from 6mH wave on top of the King tide and Atmospheric Surge on the Tasman Sea.

Including Tsunami

Including far away (Coral Sea, Pacific Ocean) Tsunami = **Formula 1** + 5 mH

Including local Tsunami = **Formula 1** + 8mH local Tsunami from Cook Canyon, Hokitika Canyon, post Alpine Fault South Westland Fault Rupture *within* the next 50 years, or post Alpine Fault and Cape Foulwind Fault Rupture.

Alpine Fault Rupture event – mitigation and preparation

- Begin Stage II *Engineering* Preparation

The negative – a critical worker in the immediate long term recovery is a personnel liability post AF8 with damage to their house and injury to family.

Wherefore: implement timber floor foundation bracing and strengthening to survive torsion S wave shaking in M8.2 seismic event of 2 + minutes and torsion. It is not covered in the AS/NZS 1170 Code.

Alpine Fault Rupture understanding

400m width of the Alpine Fault will ensure the sudden demolition of natives trees (which are of course cantilevered) in the 3 minutes of Seismic Wave shaking. Evidence of such with Research available in Historical, and Paleo data.

Wherefore, provide on the TTPP
An Alpine Fault Zone with permitted strategic slow tree cutting for an AF8 Forest Zone of 400m width.

Trees on Fault line Kaikoura seismic event, did not survive Seismic wave shaking
With acknowledgement to Russ Van Dissen presentation

If you do not plan effectively, do not worry, the seismic event will do it for you

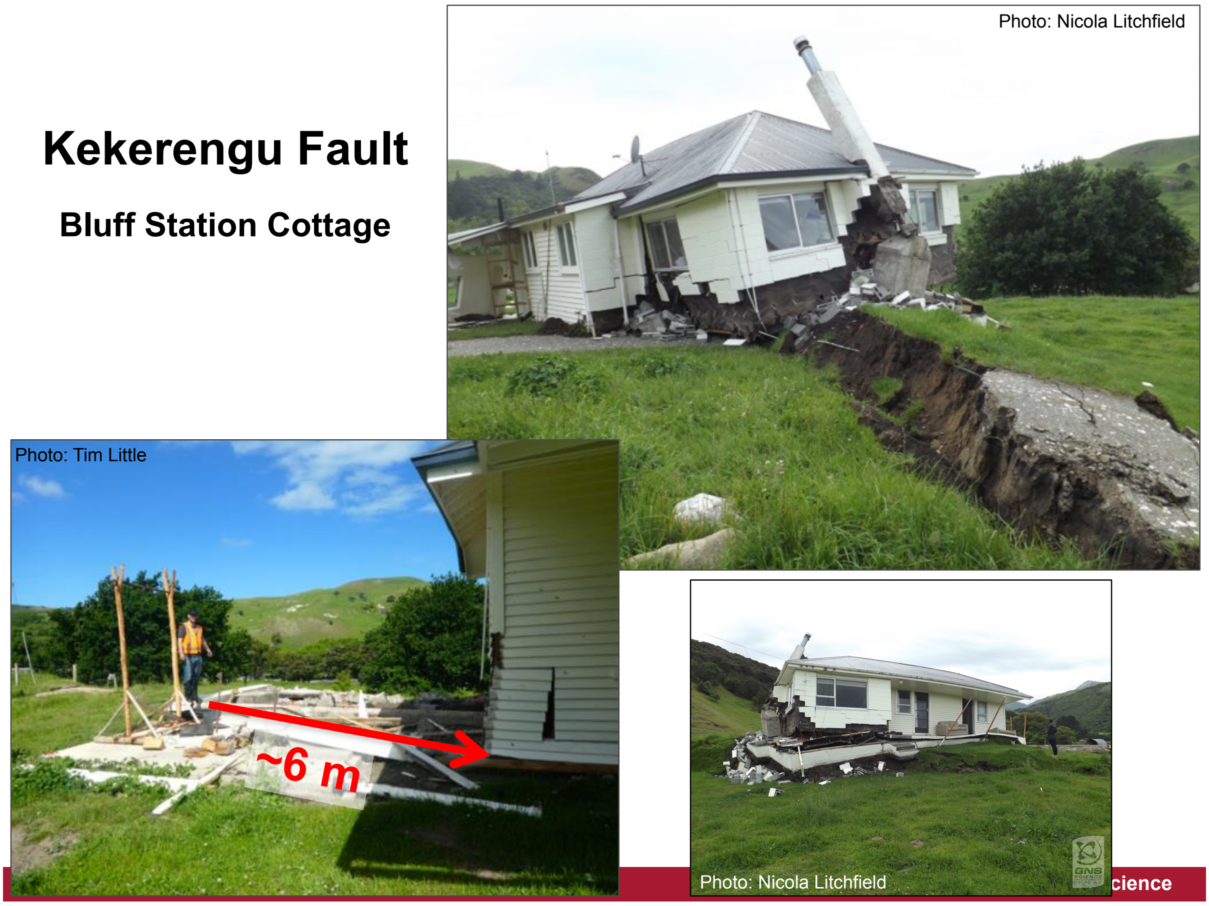


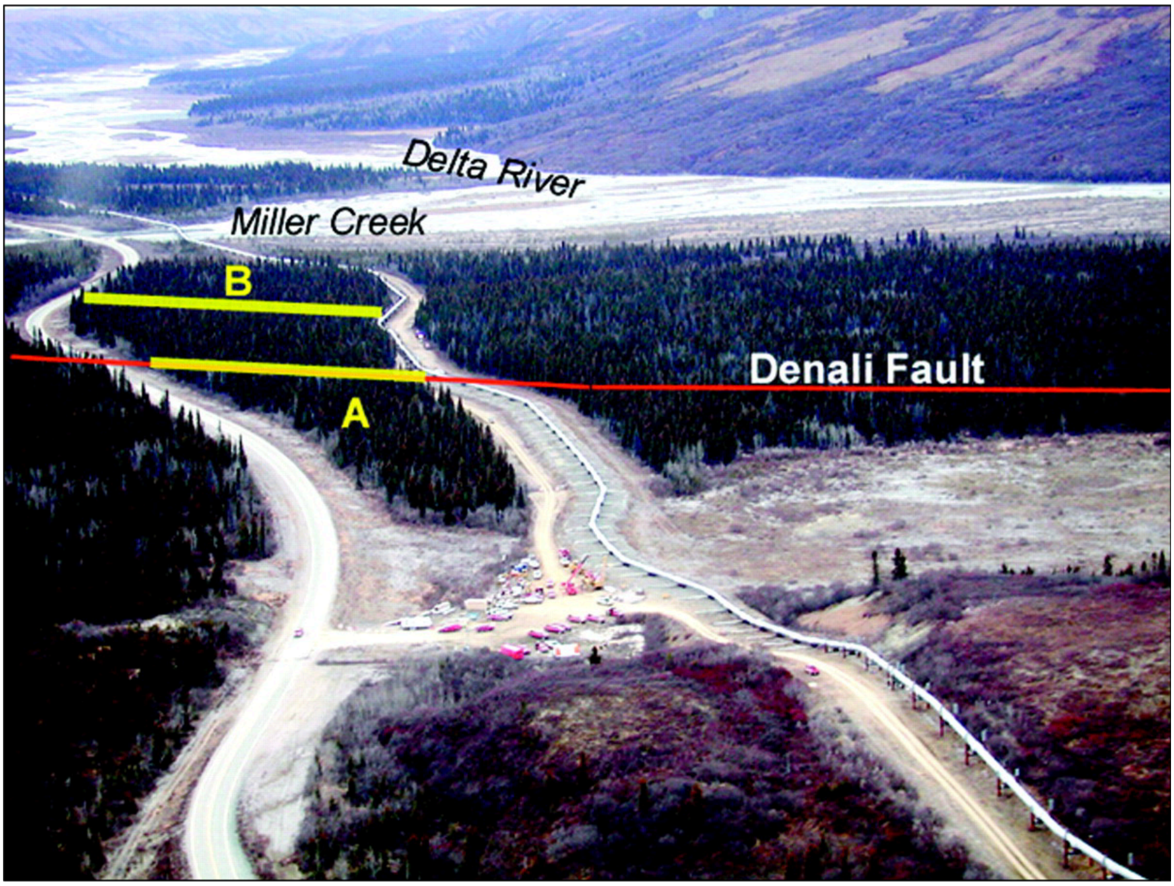
Photo collage and presentation with acknowledgement to GNS Seismologist Russ Van Dissen and Nicola Litchfield

The Chorus Optic Cable at Inchbonnie

The Optic cable crosses the Alpine Fault. No allowance has been constructed in - situ for an 8m horizontal movement.

How to plan for this?

- see the photos overleaf



And when the seismic event occurred

The pipeline was not damaged

All West Coast Helicopter sheds

- Strengthen helicopter sheds with wall and roof bracing
- Helicopter mobile platforms attract rolling in AF8 seismic event. Consider blocks
- Helicopter tie downs to prevent rotor damage
- Each helicopter owner to have own seismic aviation fuel storage tanks with ties min. 1000 litre tanks (plural) for emergency aviation fuel storage
- Source of aviation fuel from the Geelong Refinery. Shipping in coastal vessels to Jackson Bay and Westport.

West Coast Civil Defence teams – build up and back up.
The concept of street/community/cell groups

- Towns
  Each long street to have minimum two civil defence leaders
- Country areas incl. West Coast dairy farms - timber floor houses houses and sheds to have house foundation bracing strengthening to resist Alpine Fault rupture torsion. Team leaders (plural for each area) to be appointed

Buller River - Te Kuha Hydrological station – the importance of and suggested WCRC co-operation and West Coast control of and rapid availability of data

WCRC Hydrologist

- Take the Westport 2021 flood and place on that level, a spring tide for future flood levels. Place that for the Westport coastal areas on an additional river storm surge (waves) up the Buller River. (600 mm?)

Franz Josef - S.H.6 relocation and new bridge

- west side of Lake Mapourika, on the right hand side of a new relocated highway, some 6 km away from the Alpine Fault.

Effect of storm surge on the West Coast

The phenomenon of atmospheric forcing on sea level

From 1 July~6 July 2016, there was a slow, subtle build up of atmospheric pressure in the Tasman Sea to 1040 millibars. The sea swell was simply 2 metres in height. To the east of New Zealand, the atmospheric pressure was below 1000 millibars.

Yet, observation of the armoured rubbish dump wall of the Cobden Tiphead and Domett Esplanade showed continuous waves, continuously seven in number battering the tiphead and sea wall.
The longshore drift from the south was operating.

Armoured Wall Maintenance

The sea is lifting up (suction) heavy gravels from the sea bed and depositing such on the top of the local Cobden Rubbish Dump armour wall. The outwash is high energy which erodes the consolidated sand and is effectively doing so behind the armoured wall.

Maintenance requires the placement of simple granite stones to infill the wall air areas and thus, slow the sea waters' return to the swash zone.
But the question from a Rapahoe resident, is valid. What is the life of the armoured wall? The answer is we simply do not know, as yet. Standby.

Photo 1
Cobden Armoured |Wall. Simple maintenance for the temporary wall - infill the gaps and hollows.
Photo author

Photo 2
Domett Esplanade, Cobden. Extension pre the high spring tides of Thursday 1 August 2019. Note the wave deposited Grey River flood driftwood.
Photo author

Reflective wave
There is a distinct reflective wave at the convex area (facing the sea) of Jellyman Park, Cobden. This reflective wave occurs at all stages of the tide.
At low tide, the reflective wave is easily observed eroding the convex zone by its energy to the lower swash zone, so that the convex zone is 500 mm lower than Domett Esplanade zone. The author calls the meeting of the reflective wave at low tide, a swordfish wave. Indeed it can be a 'travelling' wave. It is a beautiful sight to observe.

But, below is not Resilient Coastal Engineering
In Cyclones Fehi and Gita, the wave attack was 20~40 meters horizontal. This has severely eroded in places, the beach gravel and sand. This occurred from Karamea to O'Neil's Beach. The burning question for the Cobden beach gravel and sand, is where has the gravel and sand gone?
At Point Elizabeth there is a sloping 28 degree limestone/mudstone headland.

The Rapahoe beach is not a beach of high accumulation of the Cobden gravel. Is there a deep trench at Pt. Elizabeth that takes this gravel and sand far out to sea?

Indeed, Rapahoe Beach out to the sea attacked islets (in geological time) is a very shallow zone. So the waves can simply roll in and that they do.

Further along the sea coast north, there is a transition of headland to beach gravels before Barrytown. This is a danger area to S.H.6 and requires better engineering urgent protective consideration.

Photo 3
Before Barrytown looking south. Note the wave attack on the armoured wall now jumbled, the rounded greywacke by the wave attack, and the use of sandstone, a non resilient rock. Poor coastal engineering
Photo author

Photo 4
Before Barrytown looking north. S.H. 6 under threat. sandstone, a non resilient rock. Poor coastal engineering
Photo author

Fox River S.H. 6
After the Inangahua Earthquake, the author recalls a landslide in the Fox River (north) holding back the bedload of the river. Aggradation occurred behind the landslide (upstream) and erosion of the river bed on the downstream side of the landslide. The sea attacked and my relative's batch was taken out to sea.
Now, that year was 1969, and this is 2019, some fifty years later.

There appears to be three different attacks by the sea:-

1. Sand coast - Hokitika, O'Neil's Beach, Westport Airport

2. Gravel loss threatening the Cobden Tiphead Rubbish dump

   and

3. Headland to Beach transition zone (Barrytown S.H. 6 at Punakaiki).

The east coast has the loss of the Waitaki River gravels held back by the hydro dams and attack at the rear of Waitkai Boys High School and further north at Timaru.

Replenishment
The general southerly movement of sand (the offshore sandbar) and gravel along the West Coast is of the order of 30 ~100 Mm^3 per year. What nature has taken, return to nature. This is the long term approach known as soft engineering. For the Grey River, the dredge Mawhera in keeping the berth depth open for the K class Colliers, was known to grind, load and then dump its load about 500~1000 metres from the Cobden Tiphead. Figures are held in the West Coast Regional Council for the floods in the Grey River verses the yearly loss of this facility.

Threat to Infrastructure
Infrastructure threatened by simple atmospheric forcing, *plus* sea level rise *plus* cyclone *plus* high spring tides *plus* bombogenesis are the Westport runway airfield, the Hokitika oxidation ponds, Bruce Bay S.H. 6 highway . . . .

What does this mean?

Recently, at Griffiths University, the author lectured to senior researchers on the future threat of Climate Change to infrastructure. It was shared that the phenomenon of atmospheric sea level in the Coral Sea some 1500 km from the Gold Coast gives heightened waves and swell in the Tasman Sea, even on fine days. There is now full time recording for the phenomenon from buoys in the Coral Sea and cameras on the Gold Coast pier.
Forcing from atmospheric pressure is what happened in the Tasman Sea from July 1~6 2019. There was no wind to speak of. No bombogenesis. No spring tide.

What is bombogenesis?
Bombogenesis is the sudden drop from high pressure zone to low pressure zone within a day. The classic great bomobogensis was the meeting of the Arctic snowstorm with the Caribbean Cyclone in the U.S. last winter. And which event won? The Arctic snowstorm did with 400 mm depth of early winter snow all the way to Boston.

Photo 5
Satellite image of the result of the 'fight' in the Bombogensis of Jan 2018.
Photo courtesy NOAA

Storm surge
The greatest storm surge occurred in Cyclone Haiyan, in the City of Tacloban in Leyte, Philippines. The author observed that the runway of Tacloban airport was but some 1.5m

above the normal high tide level. With atmospheric forcing in the Pacific Ocean plus high tide, plus cyclone wind of 315 kph gust, the city of Tacloban and its many inhabitants were drowned. The storm surge came with speed and a height of some 7 mH.
Some 6,000 residents were lost.

The author recalls talking to a devastated survivor hugging a dog at the Port of Cebu after the Cyclone event. “I lost all my family. All I have now, is my survivor with me, my dog. I am going to Mindanao to begin a new life.”

Climate Change is real and personal.

Paul T. Finlay M.E. (Civil)
Research and Resilience Engineer

Author Paul Finlay M.E. (Civil) is a former Climate Change Professor, and is a Greymouth Resident. He is the author of the CLIMATE CHANGE SYLLABUS, Preparations for the Alpine Fault Event and AREC/SAR and six international research papers on earthquake effects and landslides.

Background - Alpine Fault Rupture
With acknowledgements to GNS

Research conducted at the University of Otago and GNS Science in the last few years has revealed that a large Alpine Fault earthquake will trigger a cascade of environmental effects that could persist for up to 50 years ***after*** the next earthquake. Violent shaking along the entire length of the earthquake rupture will trigger large landslides in steep topography and weaken hillslopes making them more susceptible to landsliding in subsequent storms.

As West Coast rivers and streams transport material produced by this landsliding down stream, alluvial fans and floodplains will agrade rapidly causing rivers to change their course abruptly and more frequently. The cascade of impacts has the potential to chronically affect towns, road, communications and power infrastructure for decades after the earthquake.

Additionally, aftershocks triggered by the main earthquake could be expected to be as large as M7 and to continue for many years. Thus, the effects of the next big Alpine Fault earthquake will extend well beyond the immediate period of damage and disruption.