

Dune restoration

as a mitigation strategy for the
management of coastal hazards

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Introduction

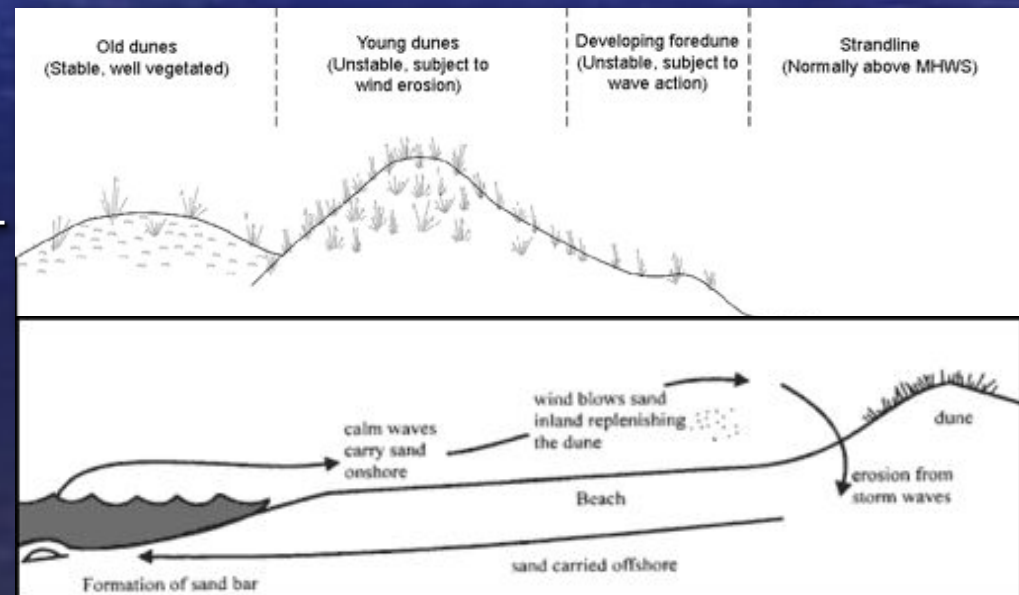
- Coastal dunes protect backshore from
 - Storm waves
 - Storm surges
 - Tsunamis
 - Sea level riseand associated erosion
- This talk will consider
 - How dunes function to provide protection
 - How dune restoration can increase the level of protection



Storm surge - Omaha Beach - 2001

Coastal dunes

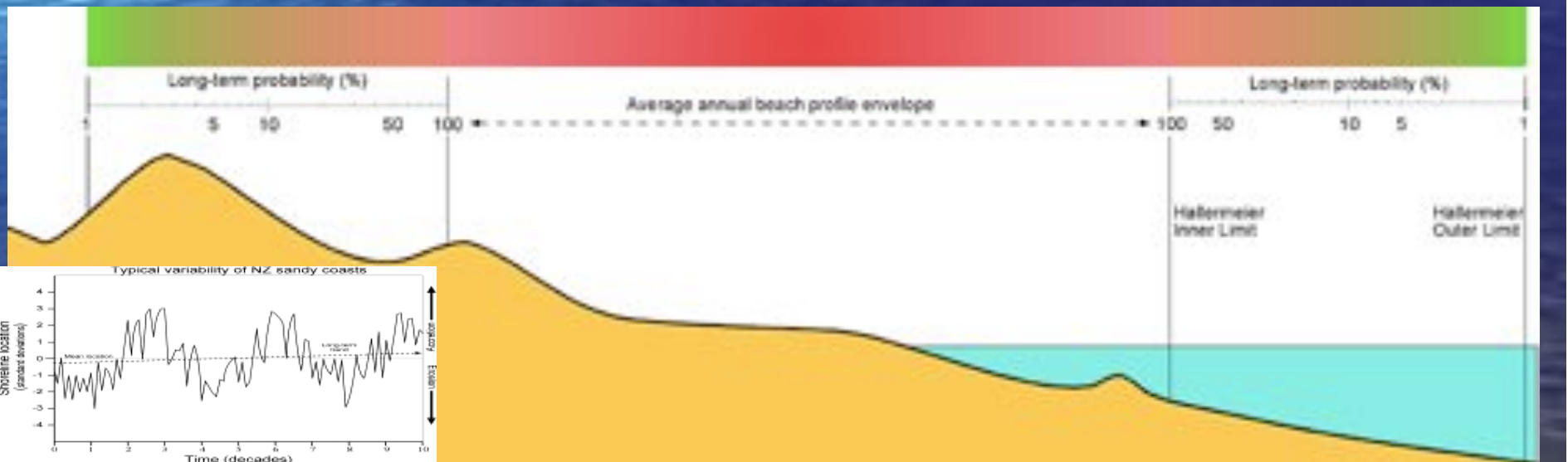
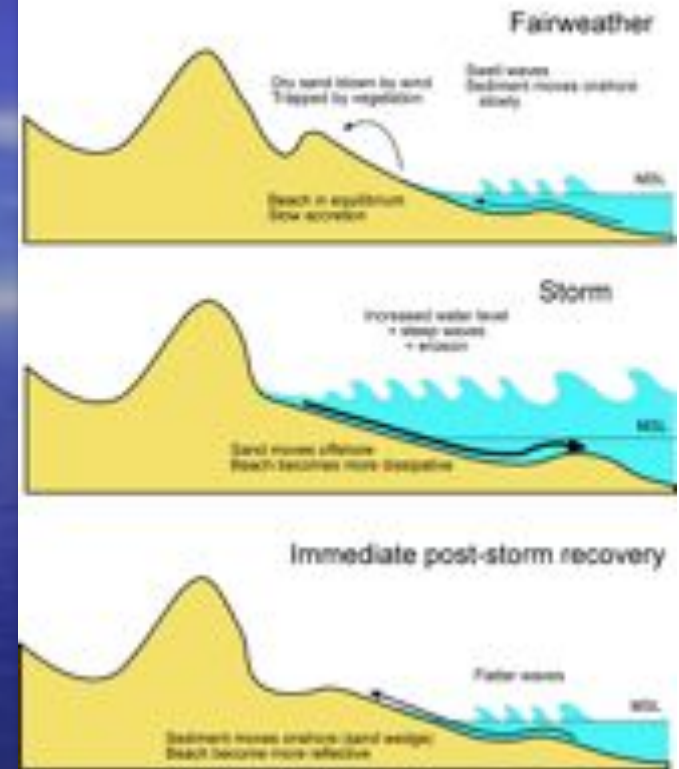
- Provide store of sediment to protect hinterland from
 - Storm surges
 - Coastal erosion
 - Sea level rise
 - Tsunami
- Also ...
 - Important coastal ecosystem
 - Filter rainwater & groundwater
 - Stabilise wind-blown sand
- Formed by vegetation trapping wind-blown sand
 - Requires
 - Supply of dry sand
 - Onshore winds



Coastal erosion

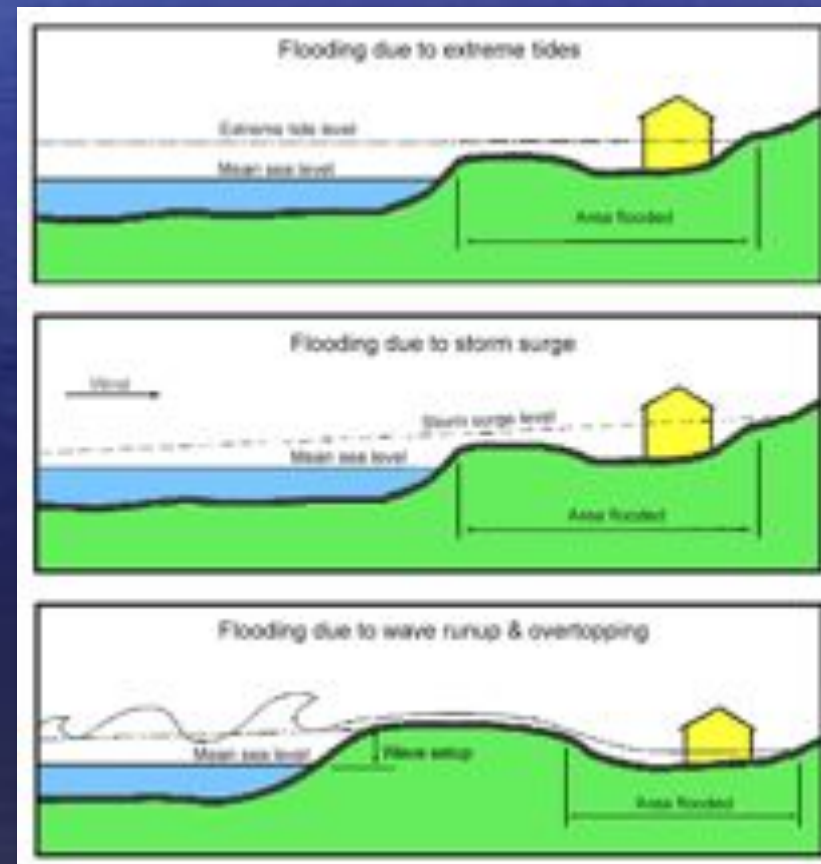
- NZ sandy beaches dominated by cyclic erosion + accretion trends
 - Define a beach envelope
 - Seaward limit = closure depth
 - Landward limit = limit of erosion
- Extent of erosion depends on
 - Frequency & magnitude of storms
 - Volume of sand in dunes
 - Dune restoration increases volume & improves post-storm recovery

Natural beach cycles



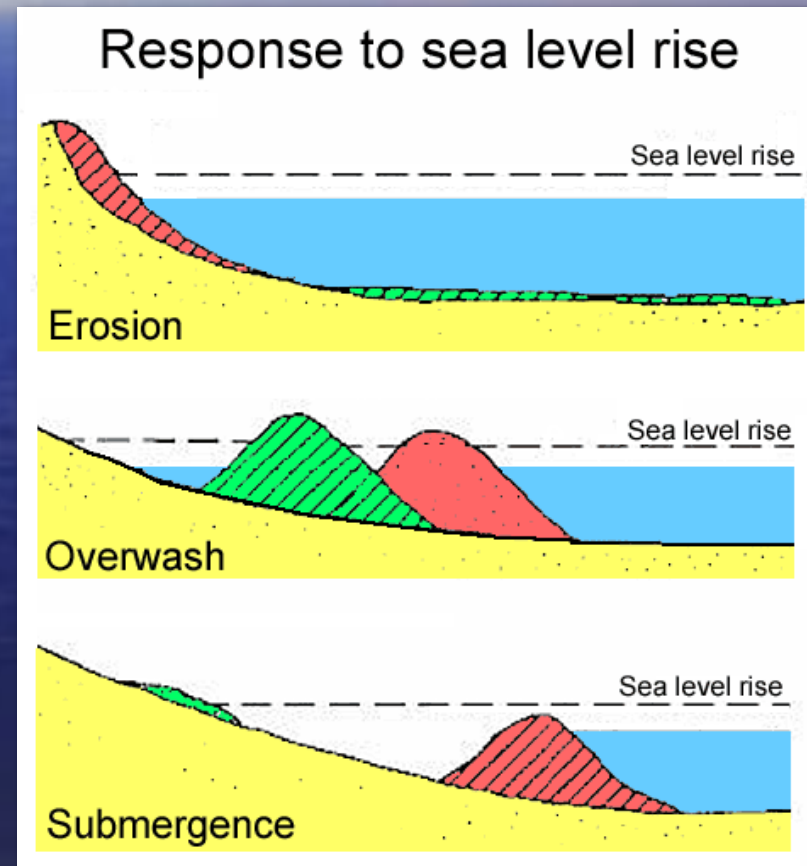
Storm surges

- Storm surges increase water level at coast
 - More likely to flood
 - Height increases inland
 - Waves reach higher up beach
- Dune height & width controls overtopping
 - Porosity important for reducing effect of wave runup



Sea level rise

- For sandy coasts sea level rise may result in
 - Erosion
 - Overwash
 - Barrier migration
 - Submergence
- Impact depends on excess sand volume available
 - Equilibrium profile concept
 - Excess sand mitigates against sea level rise
 - Provides a buffer



Tsunami



- Sissano Tsunami 1998
 - Local community had removed vegetation and dune seaward of village to improve access
 - Contributed to increased tsunami impact on village
 - Images represent ~250 m section of coastline
- Vegetated dunes disrupt tsunami
 - Restrict inundation
 - Reduce impact forces
 - Deep roots are better than shallow roots
 - Dense stems are better than sparse stems



NZ coastal dunelands

Ocean Beach, Kawhia



Marram, lupin and other plants were introduced to stabilise dunelands



Marram

- NZ coastal dunelands total area estimated to originally be 129,500ha
- Area of drifting sand
 - By 1880 ~ 40,000ha
 - By 1909 >120,000ha
- So, a century ago ~95% of NZ's dune lands were degraded sufficiently to allow them to be blown about at the whim of the wind

“In few places has the impact of people on fragile ecosystems been more damaging than on coasts where loose sandy soils lie vulnerable to frequent strong winds.” (McKelvey 1999)

Introduced vegetation

- Introduced as quick, interim solution to sand drift
 - Include escaped garden plants
- Less effective than native species due to
 - Less tolerant of immersion by sea water
 - Most are killed by immersion
 - Formation of dense shallow root masses
 - Leads to collapses of slabs of “turf”
 - Lack of deep roots that influence dune and beach drainage
- Impedes recovery of beach & dune after erosion
 - Require vegetation to re-establish quickly to trap post-storm sediment influx



Daisies



Kikuyu Grass



Marram & Lupin

Native dune binding plants



Spinifex *Spinifex sericeus* – Very abundant



Pingao *Desmoschoenus spiralis* – Threatened



Sand Tussock *Austrofestuca littoralis* – Threatened



Beach Spurge *Euphorbia glauca* – Near extinction

Four native front dune species. All have a useful and unique *high tolerance* of salt-water, enabling them to rapidly *colonise sand* returning to the beach after storms

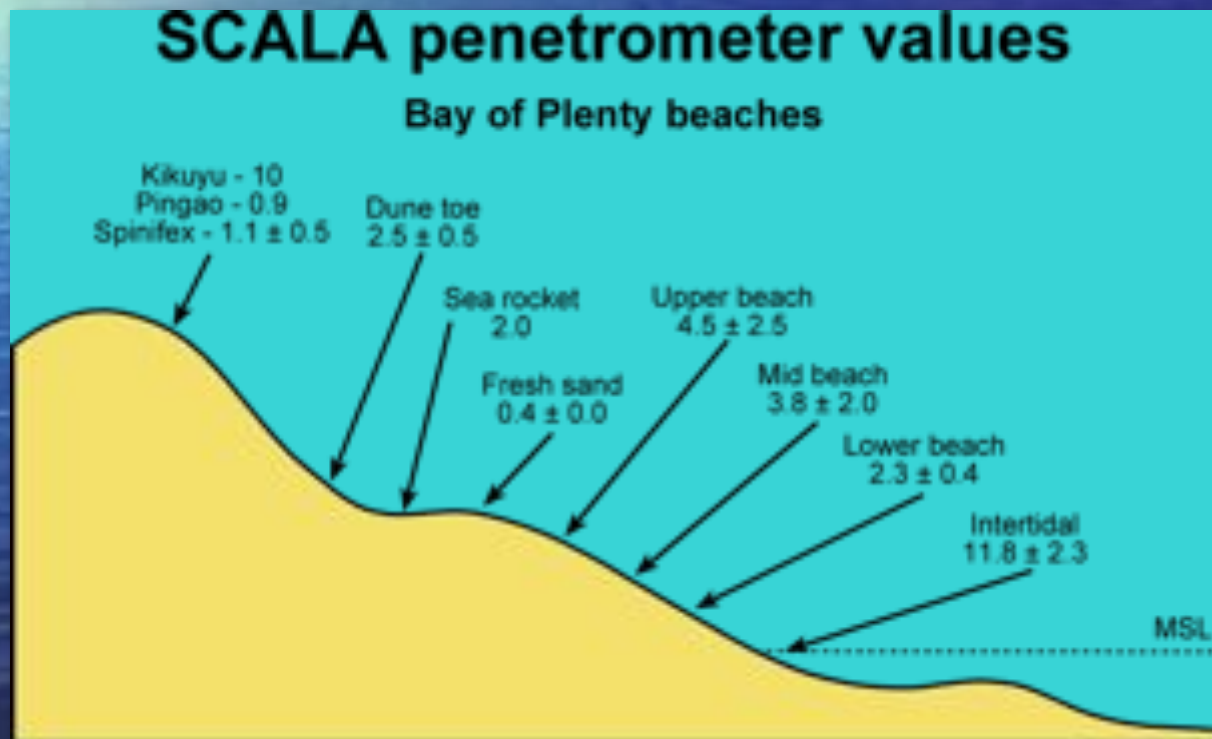
Native vegetation

- More tolerant of salt-water
 - Some derive nutrients from inundation
 - Organic content of foam?
- Produce lower, more porous dunes
 - May be an age effect
 - Increased porosity allows wave runup to drain more freely
- Have deeper roots
 - Plants dislodged by wave erosion can continue to grow afterwards
- Re-establish rapidly after erosion
 - Can trap post-storm sediment influx



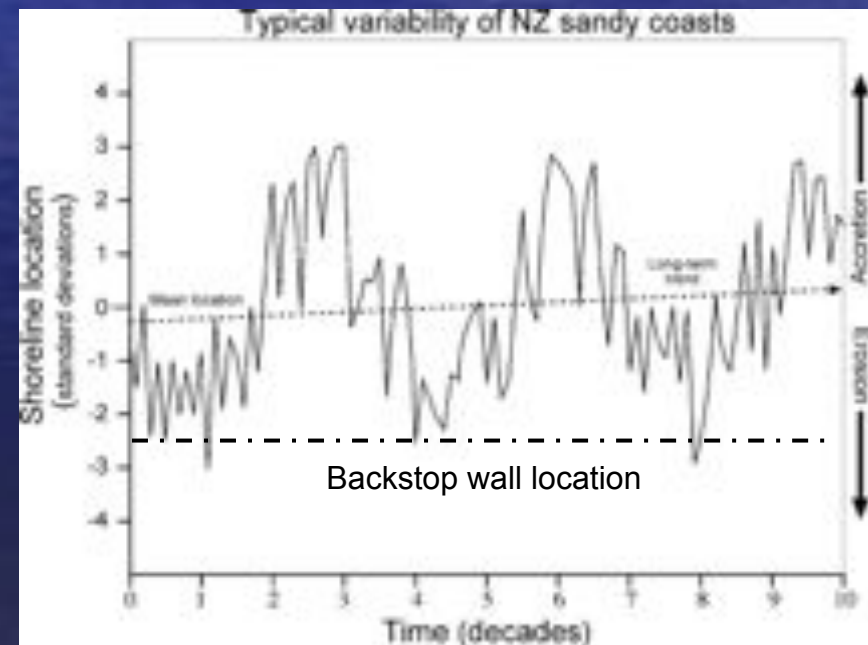
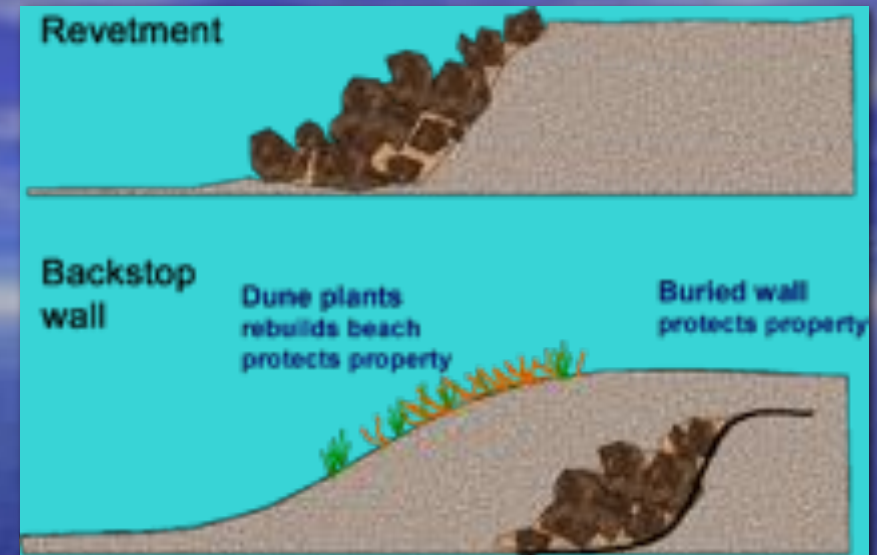
Porosity

- Measured resistance to penetration
 - Number of drops to achieve 30 cm penetration by SCALA
- Proxy for porosity
 - Higher value \Rightarrow lower porosity
- Resistance much lower for dunes with native vegetation



Backstop wall

- Seawall buried within restored dune
 - Landward of “normal” seawall location
- Provides added insurance against worst-case scenario
 - Protection for periods of prolonged erosion
- Allows natural beach processes to function most of time
 - Minimises negative impacts of seawalls



Waihi Beach, 1910

Waihi Beach



- Dune vegetation removed by grazing stock
 - Lupin planted to reduce sand drift in 1920s
- Streams diverted
 - Waihi Stream moved south
 - Brighton Reserve stream moved to Two Mile Creek & combined with swamp drains
- Sand mined
 - Air Force sand-blasting of aircraft during 1940s
- Development of subdivisions

Waihi Beach

Storm surge limit 1972



- Heavily modified
 - Loss of dune vegetation
 - Diversion of stream
 - Sand mining
- Subject to flooding
 - Chilean Tsunami 1960
 - Storm surges
 - 1968, 1972
- Planting of pingao + spinifex has resulted in dune formation
 - Now sufficiently high to limit and prevent flooding



Waihi Beach 1995



Waihi Beach 2006

Summary

- Restored dunes provide protection from coastal hazards
 - Coastal erosion
 - Storm surge & waves
 - Sea level rise
 - Tsunami

