

# Climate Change effects

## and the importance of sand dunes



*The purpose of this article is not to provide an extensive review of the climate science, but to discuss the probable impacts that these expected changes in New Zealand's climate may have on our coastal dunes systems and highlight their importance in any long term mitigation strategies.*





### INTRODUCTION

Climate change has been one of the most debated scientific issues over the last decade. It seems that everyone has an opinion - is the climate getting warmer or cooler? Who or what is causing the apparent changes?

However, while there are uncertainties in the time scales and specific effects of climate change, the Inter-Governmental Panel on Climate Change (IPCC) predicted in 2007, with either very high or high confidence level, that in addition to other expected impacts of climate change on New Zealand:

- *By 2020, significant loss of biodiversity is projected to occur in some ecologically rich sites; and*
- *By 2050, ongoing coastal development and population growth in some areas of New Zealand are projected to exacerbate risks from sea level rise and increases in the severity and frequency of storms and coastal flooding.*

(IPCC, 2007)

Regardless of the drivers of changes in climate patterns, as average temperatures rise, climate change effects, such as sea level rise, have the potential to considerably increase existing hazard risk to New Zealand's coastal communities. This has been recognised by New Zealand scientists for some time (e.g. Healy, 1993; Gibb, 1996; Dahm and Munro, 2002).

Climate change effects on the New Zealand coastline are likely to include regional sea level rise and associated inundation of low lying areas and changes in erosion patterns; an increased number of and/or more severe storm events; and changes in wind patterns and associated changes in erosion patterns (NIWA, 2008; Ministry for the Environment 2007a, 2008b, 2008).

How vulnerable our coastal communities are to these impacts in the late 21<sup>st</sup> century will depend upon our ability and attitudes towards anticipating and adapting to likely changes. For example, inappropriate coastal development could further exacerbate the risks associated with sea level rise and increase the severity of impact from storms and coastal flooding.

Coastal sand dunes are our natural buffer between our towns, cities, other infrastructure and the sea. Dunes backing sandy beaches play an important role in the mitigation of coastal hazards and in the protection of the natural and human use values of beaches. These dunes will become increasingly important with projected climate change. Where we are able to keep existing dunes intact, or modify our use of the coastal environment to regain sand dune buffers lost by previous development, there is little doubt that we will be better protected from future climate change impacts than otherwise.

Dune restoration and management has the potential to play a significant role in meeting this challenge. Coastal foredunes provide natural and cost-effective protection from coastal erosion and flooding, while maintaining and enhancing the natural, cultural and amenity values of our beaches.





### EVIDENCE OF CLIMATE CHANGE

#### International Panel on Climate Change (IPCC)

In 2007 the IPCC published its' Fourth Assessment Report (IPCC, 2007). Some of this publication's conclusions have been subject to heated debate in the popular media, particularly the unequivocal statement linking human activity as a primary driver of modern climate change.

*The understanding of anthropogenic warming and cooling influences on climate has improved since the TAR (Third Assessment Report), leading to very high confidence that the global average net effect of human activities since 1750 has been one of warming ....*

(IPCC 2007, p4)

Despite the public controversy, it is fair to say that the vast majority of the scientific community accept that global climate change is occurring and that changes in the future have the potential to impact on both the physical and social systems our present societies currently rely.

#### National Institute for Water and Atmospheric Research (NIWA)

New Zealand's leading research agency in the field of climate change is NIWA. This organisation maintains a research programme that monitors climatic factors around New Zealand and the surrounding oceans. Amongst other evidence, this work has recorded a steady increase in sea surface and air temperatures around New Zealand (Figure 1).

The majority of international and national experts now agree that climate changes are occurring and that, in the absence of compelling evidence to the contrary, it is prudent to consider the likely impacts on our sand dunes systems and coastal communities.

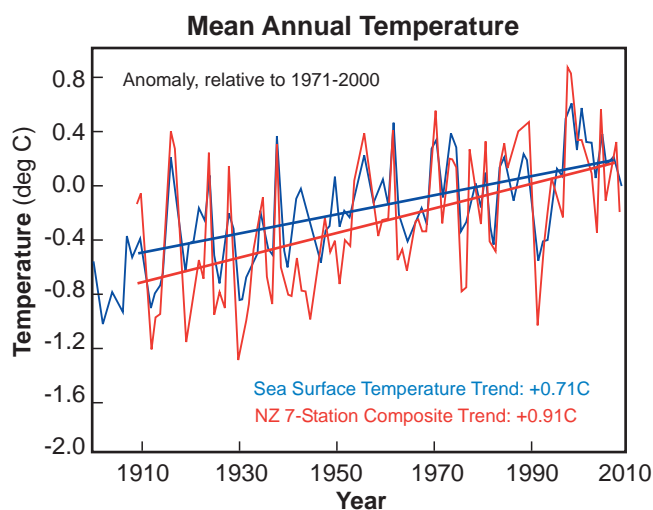
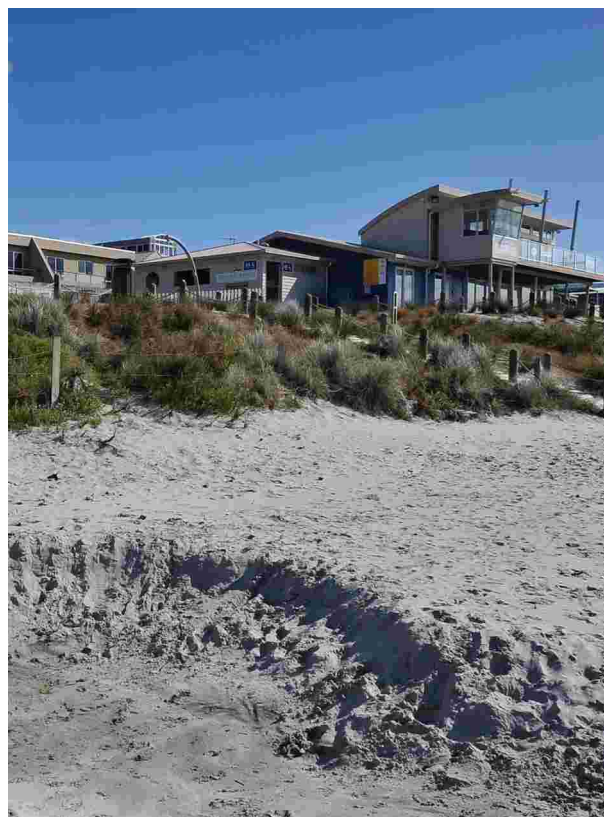


Figure 1: Mean annual air and ocean temperatures around New Zealand (Niwa, 2011).

### CLIMATE CHANGE IMPACTS ON SAND DUNES AND COASTAL COMMUNITIES

NIWA and the Ministry for the Environment expect many localised impacts of global climate change around the New Zealand coastline. Table 1 summarises these impacts and identifies likely impacts of these changes on sand dunes and coastal communities.







## Article No. 4.1 - Climate change effects

Table 1: Impacts of Climate Change on Sand dunes and Coastal Communities

Expected Climate Change Result	Potential Impact on Sand Dunes or Coastal Communities
Regional impacts of higher temperatures	<ul style="list-style-type: none"> <li>• Pest animal and weed species become more prevalent on dune systems threatening the indigenous plants and animals in some areas</li> <li>• Coastal environments are able to host new human pests (e.g. mosquitos)</li> </ul>
Rises in sea level	<ul style="list-style-type: none"> <li>• Erosion of beaches and dunes landward</li> <li>• Salt water intrusion into ground water tables impacts communities' water supplies</li> <li>• Salt water reaches further up streams and rivers changing existing ecosystems</li> </ul>
Changes to weather patterns, including predominant wind directions	<ul style="list-style-type: none"> <li>• Mobile dunes move in different directions</li> <li>• Waves consistently approach the shoreline from different angles and produce erosion</li> </ul>
Changes to ocean currents and temperature	<ul style="list-style-type: none"> <li>• Marine environments host different fauna</li> <li>• Ocean currents produce different coastal erosion patterns</li> </ul>
Increased storm surges impacts	<ul style="list-style-type: none"> <li>• Higher water levels during storm events compromise infrastructure and homes</li> </ul>
More vigorous and regular swells on western coasts	<ul style="list-style-type: none"> <li>• West coast sand dunes are subject to more frequent storm erosion events</li> </ul>
Climate-induced changes in coastal sediment supply	<ul style="list-style-type: none"> <li>• Changes to sediment supplies led to different erosion and deposition patterns around the coast</li> </ul>
Increased frequency and severity of storm events	<ul style="list-style-type: none"> <li>• Storms produce greater impacts on coastal communities</li> <li>• Insurance charges increase for coastal communities</li> </ul>



The changes outlined in Table 1 are very likely to impact this critical balance on New Zealand sand dunes. For example, in Pegasus Bay, Canterbury, shoreline erosion of up to 50 m is likely between 1980 and 2030 near the Waipara River if southerly waves are reduced up to 50% (Figure 2). Near the Waimakariri River up to 80 m of shoreline erosion could be expected if river sand is reduced by 50% (Bell et al., 2006).

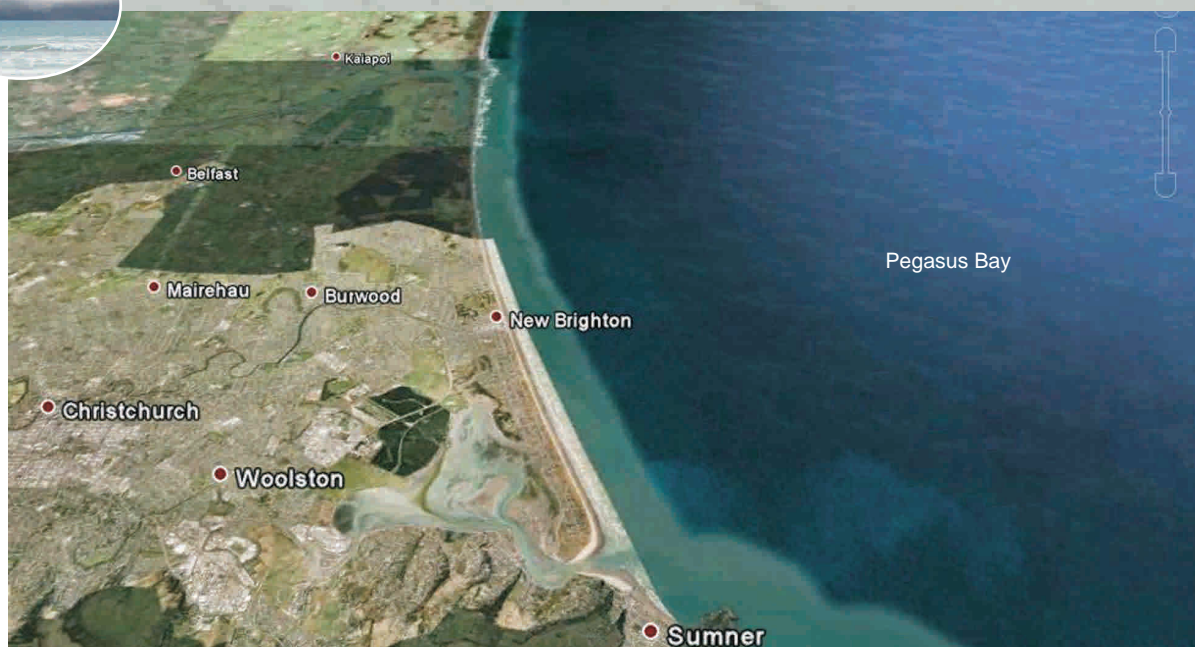


Figure 2: NIWA predicts beaches along Pegasus Bay, Canterbury will erode as a result of climate change impacts (photograph: Google Earth).

Site specific assessments are vital to form detailed predictions of local climate change impacts. However, as a rule, as sea level rises, beaches retreat to form a new profile further inland. As a result sea-level rise is virtually certain to cause greater coastal inundation, erosion, loss of wetlands and salt-water intrusion into freshwater sources (Ministry for the Environment, 2004), with impacts on infrastructure, coastal resources and existing coastal management programmes (Figure 3).



Figure3: Coastal storm scenes like this are likely to become more frequent around the New Zealand coast as a result of climate change; Left - Murrays Bay, Auckland (photograph: M. McNeil); Right - Orewa Beach, Auckland (photograph: Harley Spence).

### SAND DUNES – MITIGATING IMPACTS OF CLIMATE CHANGE

Dune restoration programmes can help mitigate the impacts of climate change effects and are an important tool to provide:

- a pro-active approach to mitigate the effects of sea level rise, and other coastal hazards
- a community education process or tool to raise awareness of likely climate change impacts
- a means of monitoring changes in local flora and fauna distributions over time

Other articles in this Dunes RestorationTrust of New Zealand Technical Handbook explain the critical role sand dunes play in buffering coastal land from the impact of coastal storms and also outlined the importance and role of native vegetation.





### Dunes Restoration and Protection

#### Restoring Foredunes

The long term protection and restoration of frontal foredunes is critical to the long term protection of coastal communities. They are an integral part of the total beach system and play a critical role in beach dynamics, particularly in the natural cycles of dune erosion and recovery. Dunes also contain sand reserves that will be essential in helping maintain beaches during natural storm cut and recovery processes (refer Dunes Restoration Trust of New Zealand Handbook Technical Article 2.2).

Natural dune form and function will become even more important in mitigating the effects of projected climate change. The potential for coastal erosion and flooding to be considerably accentuated by climate change effects (MFE, 2001) further emphasizes the importance of restoring and maintaining wide natural dune buffers along the seaward margin of coastal development - with a good cover of appropriate native sand binding vegetation to ensure natural dune building and repair.

In the words of one experienced coastal scientist,

*"The natural role of frontal dunes acting as a reservoir of sand for rare but severe storms ...and their enhancement needs to be adopted as a cornerstone of coastal management."*

*(Healy, 1993)*

### Other Values of Coastal Dunes

The protection and restoration of coastal dune systems is also required to maintain a wide range of other coastal values in the face of climate change effects.

On most sandy beaches, natural coastal dunes are central to preservation of natural character, protection and enhancement of coastal biodiversity and habitat, and the protection of landscape and other coastal amenity values (Environment Waikato, 2001). Natural dunes also have important intrinsic and scientific values (Nordstrom, 1990). In addition, coastal dunes in New Zealand have a long history of human use and frequently contain important archaeological and

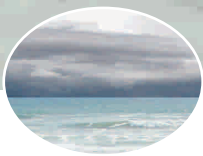


### CONCLUSIONS

Global climate change is likely to impact on New Zealand's sand dune systems. Many of the potential impacts could be very severe and adverse.

Our challenge is to manage these issues so that we can maintain and restore the hazard protection, natural character, amenity, cultural and recreational values that we as New Zealanders attach to the sand dune systems.

If New Zealanders in the future are to enjoy the full range of benefits that sand dunes have provided us for hundreds of years, then a proactive approach to protect these values is required in response to the threats that climate change poses.



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**Sustainable Management Fund**

The Ministry for the Environment does not necessarily endorse or support the content of the publication in any way.

The mission of the Dunes Trust is:

*'To see the majority of New Zealand dunes restored and sustainably managed using indigenous species by 2050'.*