Tourism, the weather and future changes

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Today’s presentation

• Overview
• Current Weather and Tourism
• Climate Change in NZ
• Ski fields and Future Snow
• Questions
What is this research project about?

Tourism often depends on the weather for participation, satisfaction, safety, business viability etc.

Climate models predict increasing temperatures, changing intensity and distribution of rainfall, decreased snow cover, and sea level rise.
Tourist Satisfaction

- Being clean and unpolluted: 23%, 9.1
- Un-crowded spaces: 14%, 8.9
- Natural landscapes and scenery: 23%, 9.5
- Weather: 11%, 7.7
- Roads and driving experience: 13%, 8.2
- Vibrant urban atmosphere: 16%, 7.8

Note: (1) Sample size n = 5,352

Source: Tourism New Zealand Visitor Experience Monitor 2008/09
Tourists’ disappointment

- In 2008, 3139 (59.3%) international tourists could *not* report any disappointment.
- Depending on season:

<table>
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<th>Quarter of interview</th>
<th>1 (Jan-Mar)</th>
<th>2 (Apr-June)</th>
<th>3 (Jul-Sep)</th>
<th>4 (Oct-Dec)</th>
<th>Total</th>
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<tbody>
<tr>
<td>None</td>
<td>24.9%</td>
<td>25.3%</td>
<td>25.6%</td>
<td>24.2%</td>
<td>100.0%</td>
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<tr>
<td>Other</td>
<td>27.1%</td>
<td>24.0%</td>
<td>22.4%</td>
<td>26.6%</td>
<td>100.0%</td>
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<tr>
<td>Weather related</td>
<td>20.3%</td>
<td>26.8%</td>
<td>28.3%</td>
<td>24.5%</td>
<td>100.0%</td>
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Weather versus Climate

“Climate is what you expect, weather is what you get.”

Climate change is a change in the long-term average expected weather conditions.

Climate change is likely to matter whenever tourist or operator expectations about the average weather matter – and when the actual weather being different from these expectations has major consequences.
Weather vs average climate

Schematic example: warmer temperatures

probability of occurrence

adapted range

expected annual average damage / costs

Low T

average

damage threshold

High T

expected annual average damage / costs
Weather vs average climate

- Change in mean temperature
- Expected annual average damage / costs
- Adapted range
- Low T
- High T
- Average
Weather vs average climate

- Change in mean temperature and heat waves
- Adapted range
- Expected annual average damage / costs
- Damage threshold
- Low T
- High T
- Average
Time horizons

• Our study will focus on present variability and direction of change, and short-term adaptation options ...

• ... but also consider future scenarios:
  – Infrastructure (e.g. roads, marinas)
  – Importance of sector for entire region
  – Interdependence with other demands on same natural resources
  – Management of hazards (e.g. avalanches)
  – Value of business assets for operation
Seasonality

Wanaka

Queenstown
Tourists and the weather (the summer season)
Weather impacts on tourists

- **Rain**: flooding, slips, bridges washed away, damage to walking tracks, river flooding, cancellation of commercial activities;

- **Wind**: road closure, danger from falling trees, debris, slips, high seas close coast roads, disruption to water and air transport (scheduled and scenic), power outages, cancellation of commercial activities;

- **Fog**: transport disruptions, commercial activity cancellations;

- **Drought and hot spells**: closure of recreation areas, damage to road and rail infrastructure, fire risks, algae bloom in rivers and beaches, water shortages, low lake and river levels (less scenic, cancellation of activities), increases in wasps/mosquitoes;

- **Unseasonal weather**: outdoor recreationists, rescue attempts difficult.
Tourists and the weather

Asked if they changed either the length of time they stayed in places, their travel route or their intended activities as a result of the weather

<table>
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<th></th>
<th>No</th>
<th>To some extent</th>
<th>Often</th>
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<tbody>
<tr>
<td>Length of time (N=433)</td>
<td>65.6%</td>
<td>28.9%</td>
<td>5.5%</td>
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<tr>
<td>Route (N=415)</td>
<td>75.9</td>
<td>21.4%</td>
<td>2.7%</td>
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<tr>
<td>Activity (N=324)</td>
<td>48.1</td>
<td>47.5%</td>
<td>4.3%</td>
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Impacts in the Southern Lakes

• Less vulnerable than many other destinations
• Milford road and glaciers affected
  – Queenstown and Wanaka benefit
• Differences between international and domestic tourists
  – International tourists minimal scope to change
  – Safety issues

Appeal for safety in outdoors

We hear stories of visitors attempting the Tongariro Alpine Crossing in jandals, while others don’t carry supplies because they assume there’s a shop on the Hipuia.

“We hear stories of visitors attempting the Tongariro Alpine Crossing in jandals, while others don’t carry supplies because they assume there’s a shop on the Hipuia.”

Otago Daily Times: Jan 08, 2010

OUTDOOR SAFETY CODE
1. Plan your trip.
2. Tell someone your plans.
3. Be aware of the weather.
4. Prepare your kit.
5. Take sufficient supplies.

“We call on everyone — not just those who work in the tourism industry — when they’re planning a trip to New Zealand to consider the environmental impact of their visit.”
Impacts in the Southern Lakes

- More impact in winter season
  - Snow fall, frost: access problems, safety
  - Heavy rain: flooding, evacuations
  - Fog: airport closure
  - Wind: power disruptions
- Snowfall positive for skifields/often negative in other respects
Tourist bus, car crash into forest

By MATTHEW BRANDT

Black Ice is believed to be a cause of accidents on State Highway 6, where two coaches collided in a forest. The coach, which had 44 passengers, was involved in a crash that killed a tourist and injured five others, according to reports.

Heavy snow, gales cause traffic chaos

By TRACEY REHBEIN

On State Highway 6, near Queenstown, one of the coaches was stuck in the snow, causing traffic chaos.

Heavy snow disrupts travel, causes road crashes

By JOANNE CARROLL

Up to 15 buses were stuck on a New Zealand’s worst roads, causing delays and traffic jams. The group, predominantly backpackers aged 20s and 30s, was stranded in the forest for three days, before being rescued.

Snowfall made to order for final day

By SOPHIE MCLEAN

The heavy snowfall that blanketed the Otago region on Tuesday was expected to continue, with more snow expected in the coming days.
Otago Daily Times: May 19, 2009

Fronts bring mountains of snow

BY TRACY REID

TWO fronts brought a month's worth of precipitation to the Wakatipu in two days, although neither field plans to open early.

Remarksable Ski Area manager Hamish McGonigle said the weekend's snowfall was welcome for Remarkables ski patrol, but did not plan to open early. "We need a good month's worth of snow to open," he said.

Mr Lawrence said another heavy snowfall was needed to hit the resort late last night and this morning, but "it's going to bring even more snow".

He was "pretty confident" the snow would stick around until after the weekend, when it may be able to open.

The Remarkables would follow Mt Hutt's footsteps on opening day, he said.

"We're on track to open by the end of next week, but we're weather-dependent," he said.

Mr Lawrence said he would assist Mt Hutt in getting open as early as possible, when the conditions are right.

The Remarkables would then open when the season opens.

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Otago Daily Times: May 19, 2009

Good snowfalls for opening

BY MATTHEW HAGGART

FRESH powder snow greeted those first to hit the slopes at Treble Cone's season opening yesterday morning.

Snow fell throughout the day at the field, creating great skiing and riding conditions.

"The snowstorm which blanketed Treble Cone yesterday brought snow to the bottom of the skier's access road and left Wanaka resident Simon Williams impressed with the conditions.

"It's fabulous out there. I've been three runs and god have got to get to work now, but we were riding in knee-deep powder," he told the Otago Daily Times.

Mrs Thomas said the skifield access road maintenance team was busy keeping the roads clear for visitors to the mountain, caught out while travelling up the access road.

The skifield's weatherman said the snow storm was "pretty confident" the snow would stick around until after the weekend, when it may be able to open.

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At Cardrona Alpine Resort, ski patrol manager Mike McRae said the skifield was "in a good place to open" and had been "very busy" preparing for the season.

"It's looking good for the weekend," he said.

Wind damage disrupts power supply

BY MATTHEW HAGGART

A STRONG northwest wind caused disruption to power and phone lines yesterday, when a power line was brought down by the high winds.

Oxbridge Resort managing director Tony Williams said the power company Delta was working to restore power to the area.

The power supply to the accommodation complex was affected by a broken power line outside the hotel, about 2pm yesterday.

Back-up generators were used to provide electricity to the resort until the power line was restored.

"It's been a pretty busy day," Mr Williams said.

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AND IN CASE OF BAD WEATHER...
ALWAYS HAVE A SURVIVAL PLAN!
Future Climate
Past & predicted future temperatures
Observed changes: greenhouse gases

CO₂ increase is due to human activities

Source: Raupach (2009)
Projected Future Temperatures

- Projected warming in 21st century is expected to be
- **Greatest** over land and at most northern latitudes
- **Least** over the Southern Oceans and parts of the North Atlantic Ocean
NZ Temperature Projections 2090s

- Increase of about 2°C by 2090 for mid-range scenario
- This is about the present annual difference between Wellington & Auckland
- An unusually warm year now could be the norm in 30-50 years and a cool year by 2100
- We expect fewer frosts, more very hot days

Average annual mean changes for A1B 2090s projections (12 model average)
NZ Rainfall Projections 2090s

- Reduction in annual rainfall in most of the east coast & north of the NI, coastal Canterbury and coastal Marlborough.
- Increase in annual rainfall in west & south of the South Island.
- Seasonal precipitation changes:
  - Winter & spring: Increased westerly winds - For both islands drier in E & N, wetter in W.
- Extreme rainfall: Heavy rainfall likely to get heavier &/or more frequent
  - for a mid-range scenario a 1-in-100 year event now could become a 1-in-50 year event by the end of the century.

Average annual mean changes for A1B 2090s projections (12model average)
Average annual mean changes for A1B 2040s projections (12 model average)
The NIWA snow model

• Temperature-index model

  – Basic snow model:

    \[
    \frac{d\text{SWE}}{dt} = a_s - m_s - s_s
    \]

    \[
    m_s = \begin{cases} 
    M_f(T - T_{\text{melt}}), & T \geq T_{\text{melt}} \\
    0, & T < T_{\text{melt}} \text{ or SWE} = 0
    \end{cases}
    \]

    \[
    a_s = \begin{cases} 
    0, & T \geq T_{\text{accm}} \\
    p, & T < T_{\text{accm}}
    \end{cases}
    \]

  – Temporal variability in the melt factor
    – Seasonal variability
    – Albedo
    – Enhanced melt during rain-on-snow events

    \[
    M_f = \max(\bar{M}_f + \delta M^{\text{seas}}_f + \delta M^{\alpha}_f + \delta M^{\text{ros}}_f, 0)
    \]

  – Used hourly time step for 20 years, for 258,307 independent modelling elements.
Results - overview

• Simulations and calibration of historical seasonal snow
  (Using hydrology calibration)

• Effects of climate change on seasonal snow in New Zealand for the 2040s* and 2090s** (A1B scenario)
  – Snow durations
  – Fraction of precipitation that is snow
  – Maximum snow accumulation per year

* The 2040s is the average for a twenty year period from 2030-2049.
** The 2090s is the average for a twenty year period from 2080-2099.
Maps of maximum snow (SWE) for the 9 year period (1998-2006)
20 year example time series
Indexed changes in maximum snow accumulation

Under a 12 model average A1B emissions scenario compared to the current

Percentage difference (compared to current) in maximum snow accumulation (average within 100m elevation bands) for the:

- **2040s** (green)
  - 40% reduction at 1000m, and a 10% reduction at 2000m
- **2090s** (blue)
  - 60% reduction at 1000m, and a 30% reduction at 2000m

Under a 12 model average A1B emissions scenario

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Change in snow duration

Frequency distribution of snow duration for Central Otago (1000m-1500m) for the:
1990s (red) 2040s (green) 2090s (blue)

Median 1990s duration (0.37y) 4.44 months
Median 2040s duration (0.34y) 4.08 months
Median 2090s duration (0.29y) 3.48 months

By the 2090s the median (50\textsuperscript{th} percentile) snow duration will be similar to the current 10\textsuperscript{th} percentile snow duration

Under a 12 model average A1B emissions scenario

*The 1990s is the average for a twenty year period from 1980-1999. See previous note for the 2040s and 2090s periods
Tourism and changes in seasonal snow

• At nearly all elevations, and all models, the 2040s and 2090s scenarios result in a decrease in snow:
  – maximum snow accumulation in each year
  – snow duration
  – percentage of precipitation that falls as snow
• Substantial reduction in snow accumulation along the spine of the Main Divide (below approximately 2900m)
• This will potentially effect the tourist resource:
  – Ski fields
  – Scenic views
• This will potentially effect hazards to tourism:
  – E.g. Snow avalanches & Flooding

Caveat: We have not considered the change in frequency of extreme events and these can be critical for a good / bad season.
Changes in Trans-Tasman Ski tourism

• Previous work in Australia indicated much more extreme impact of climate change on snow
  – The area with at least 60 days of snow cover shrinks by 18-60% by 2020, and 38-96% by 2050 (Hennessey, 2003)

• Work in NZ indicates much less change

• Current research aims to compare impact directly – Same model / same scenarios

• Will also consider changes in travel behaviours and concept of the need for “nursing grounds”
Snow lines: Coping range, impacts, adaptation and vulnerability

Elevation of skifield snowline

Stationary Climate & Coping Range

Changing Climate

Vulnerable

Adaptation

Coping Range

Planning Horizon

Last 50 years

Next XX years

Source: after Roger Jones (CSIRO)
Adaptation to climate change

• Snow making

• Improved snow management

• Moving facilities higher or higher skifields

• Diversification of ski fields into 4 season destinations

• Changing customer expectations

• New customers from other regions
Indirect impacts of climate change

- Less and less snow in Australia
- More tourists from Australia
- Glaciers as a rarer phenomena
- Climate refugees
- Air miles debate and long haul visitors
- Tourist scrutiny of local carbon footprint

Alpine Based Tourism
Summary

- Weather events already impact tourism business in a big way
  - Wind – scenic flights
  - Extreme events – road closures
- Significant climate change is expected
  - Snow and ice will be very sensitive
  - Their services for tourism will be reduced, but the remaining snow resource will become more valuable
- Indirect effects from climate change, but other powerful drivers are just as likely to shape tourism of the future
Acknowledgements

• New Zealand’s Foundation for Research Science and Technology (FRST):
  – C01X0804 “Regional Modelling of Future New Zealand Climate”
  – LINX0903 “Tourism and Climate Change”
• The Ski Areas Association of New Zealand (SAANZ)
• Participants in our survey and interviews
• Tourism stakeholders who provide input into this project
Questions

- More information on www.lincoln.ac.nz/leap