Vulnerability and adaptation of winter tourism in Tyrol and Bavaria
Overview

- Climate-trend
- Snow reliable ski resorts today / 2050
- Technical snow reliability
- Future (of) snow-making
Climatic trends – Temperature

Hopfgarten (Dezember 1964 - 2000)

Kitzbühel (Dezember 1979 - 2000)

St. Anton (Dezember 1957 - 2000)

Galtür (Dezember 1951 - 2000)

Trawöger 2003
Climatic trends - Temperature

- Hopfgarten (Jänner 1964 - 2000)
- Kitzbühel (Jänner 1979 - 2000)
- St. Anton (Jänner 1957 - 2000)
- Galtür (Jänner 1951 - 2000)

Trawöger 2003
Climatic trends – Winter sport days


- Tage mit > 30 cm Schnee
- Tage mit > 15 cm Schnee
- Trendlinie (> 30 cm Schnee)
- Trendlinie (> 15 cm Schnee)


- Tage mit > 30 cm Schnee
- Tage mit > 15 cm Schnee
- Trendlinie (> 30 cm Schnee)
- Trendlinie (> 15 cm Schnee)

**St. Anton (1960/61 - 1998/99)**

- Tage mit > 30 cm Schnee
- Trend-/Regressionslinie


- Tage mit > 30 cm Schnee
- Trend-/Regressionslinie
Snow reliability

<table>
<thead>
<tr>
<th></th>
<th>Bavaria</th>
<th>Tyrol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Today</td>
<td>24%</td>
<td>19%</td>
</tr>
<tr>
<td>2050 (2 K)</td>
<td>27%</td>
<td>74%</td>
</tr>
<tr>
<td></td>
<td>49%</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>97.5%</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>54%</td>
<td>8%</td>
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</tbody>
</table>
Ski resorts and snow reliability - today

Snow reliability
- not snow-reliable
- limited snow reliability
- snow-reliable

Lift capacity (persons per hour)
- 100,000
- 50,000
- 20,000
- 10,000
- 5,000
What about Snowmaking?
Technical snow reliability - Methodology (1)

Ablation

Necessary snow-making days

0

Accumulation

Potential snow-making days

Degree-day model

Diurnal average temperatures

Snow making capacity

Days with T<0°C /-2°C
Technical snow-reliability – Methodology (2)

Required days for snow-making =

\[\frac{((\text{degree-days} / \text{month}) \times \text{factor}) \times 1.91}{0.025}\]

Ablation

Snow-making capacity
Technical snow reliability – Results

Natural snow reliability 2050 (>1800m)

Technical snow reliability 2050 (>1500m)

Natural snow reliability today (>1200m)

Technical snow reliability today (all elevations)

Kitzbühel, 16.04.2005

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Ski resorts and technical snow reliability - 2050
Ski resorts and technical snow reliability - 2050

Snow reliability
- red: not snow-reliable
- yellow: limited snow reliability
- green: snow-reliable

Lift capacity (persons per hour)
- 100,000
- 50,000
- 20,000
- 10,000
- 5,000
# Reduction of snow reliable skiing area

<table>
<thead>
<tr>
<th>Percentage</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>1</td>
<td>4</td>
<td>7</td>
<td>10</td>
<td>13</td>
<td>16</td>
<td>19</td>
<td>22</td>
<td>25</td>
<td>28</td>
<td>31</td>
</tr>
</tbody>
</table>

- Reduction of snow reliable skiing area over time, showing the percentage of reduction from 0% to 100% for different years (1 to 88).
Future (of) snow-making?

Snow-making will still possible even below 1500m with

- an increased snow production capacity (less than 5 days for 20 cm)
- temperature independent snow making facilities

But this means:

- massive future investments
- rising operating costs
Cost of future snow-making

- Potential snow-making days: -40% to -20%
- Rising demand for artificial snow: +70% to +200%
- Snow-making cost rise by: +200% to +280%

Mölltaler Gletscher, 22.12.2006
Alternatives
Vulnerability and adaptation of winter tourism in Tyrol and Bavaria

Robert Steiger – Institute for Geography, Innsbruck

Wengen Workshop 2006

04.10.2006
<table>
<thead>
<tr>
<th></th>
<th>Bavaria (n=41)</th>
<th>Tyrol (n=213)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow reliable</td>
<td>24 % (10 resorts)</td>
<td>68 % (145 resorts)</td>
</tr>
<tr>
<td>Limited snow-reliability</td>
<td>49 % (20 resorts)</td>
<td>23 % (48 resorts)</td>
</tr>
<tr>
<td>Not snow reliable</td>
<td>27 % (11 resorts)</td>
<td>9 % (20 resorts)</td>
</tr>
</tbody>
</table>
Inhaltsfolie

• Inhaltsfolie
Inhaltsfolie

• Technical snow-reliability – Methodology 1
Technical snow-reliability –
Methodology 1

Ablation
- Average diurnal temperature
- Degree-day-model (degree day factor 2 mm/3 mm)

Snow making capacity
- Number of days per month < 0°C/-2°C
- 5 days = 20 cm cover of groomed artificial snow
Climatic trends – Accumulated fresh snow

- **Hopfgarten (1966/67 - 2000/01)**
  - 600 m
  - Disposable: Summe der Neuschneehöhen (cm) / Trend-/Regressionslinie

- **Kitzbühel (1950/51 - 2000/01)**
  - 763 m
  - Disposable: Summe der Neuschneehöhen (cm) / Trend-/Regressionslinie

- **St. Anton (1950/51 - 2000/01)**
  - 1298 m
  - Disposable: Summe der Neuschneehöhen (cm) / Trend-/Regressionslinie

- **Galtür (1950/51 - 2000/01)**
  - 1587 m
  - Disposable: Summe der Neuschneehöhen (cm) / Trend-/Regressionslinie

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