Impacts of climate change for Swiss winter and summer tourism: a general equilibrium analysis

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Aim: Investigate the international effects of climate change for Swiss winter and summer tourism

Why the tourism industry?

1. Significant share of the economy
2. Highly exposed
3. Strong adaptation capacity
4. Very sensitive to international effects

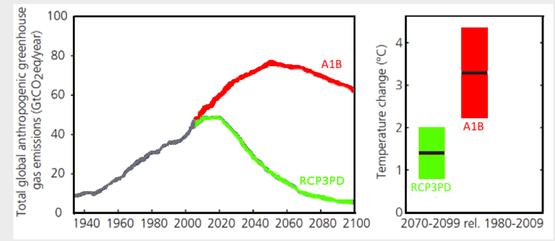
Examples of exposure and adaptation capacity for winter and summer tourism

	Winter tourism	Summer tourism
Exposure	Snowfall decrease Glacier melting	Temperature Precipitation
Adaptation Capacity	Artificial snowmaking Investment in ski run	Longer season New activities

What climate scenarios?

Climate change impacts depend on future GHG emission. We simulate 2 scenarios:

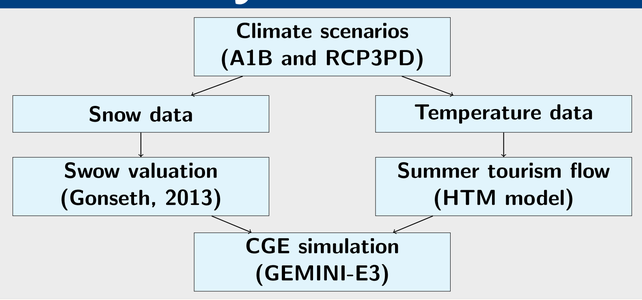
- A1B: non-intervention, high growth
- RCP3PD: ambitious mitigation



From climatic variables to the tourism economy

Winter tourism

- Snowfall change disrupts the ski industry.
- Variation of natural snow calculated using the climate variable "Fractional Snow Cover".
- Snow economic value obtained from Gonseth (2013).



Summer tourism

- Temperature change affects countries' attractiveness, causing a reallocation of tourism flows between countries.
- Simulation of international tourism flows using the HTM model developed by Hamilton et al. (2005).

How to model the tourism industry in a Computable General Equilibrium framework?

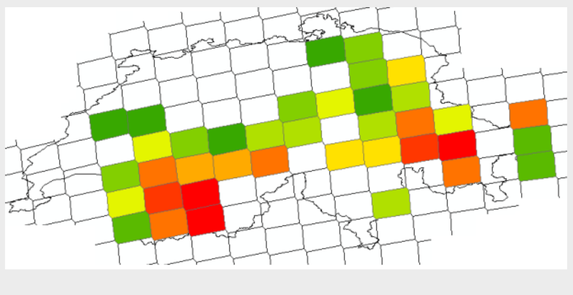
Model GEMINI-E3: a multi-sectoral multi-regional general equilibrium model.

Tourism industry represented by 3 sectors:

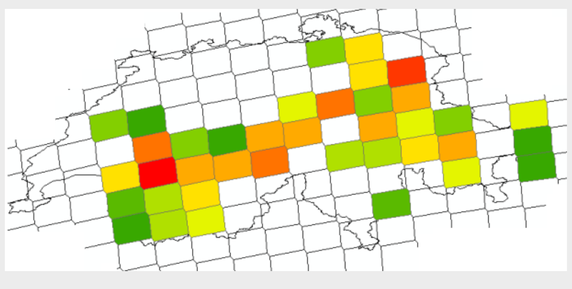
- "winter overnight tourism" (WOT): skiers generating at least one overnight stay.
- "one-day winter tourism" (ODT): excursionist skiers.
- "other forms of tourism" (OFT): mainly summer tourism.

Why two winter tourism sectors?

- WOT skiers go to high-altitude ski areas
- ODT skiers go to low-altitude ski areas, near city centers



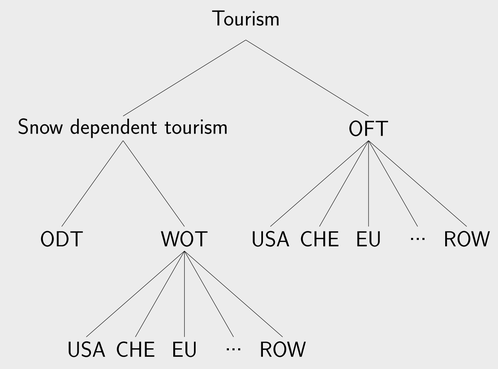
Distribution of overnight skiers visit (WOT)



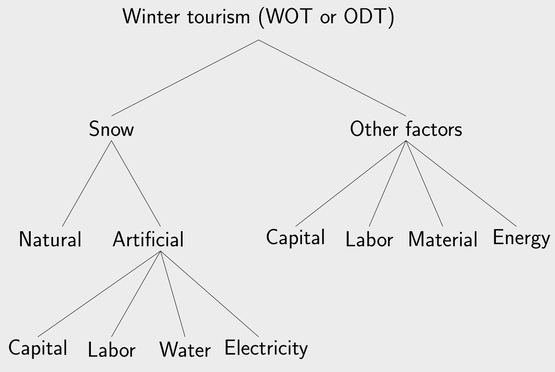
Distribution of excursionist skiers visit (ODT)

- It is more difficult to produce artificial snow at lower altitude because of higher temperatures, so the ODT sector is more vulnerable than the WOT sector.

Consumption of tourism



Production of winter tourism



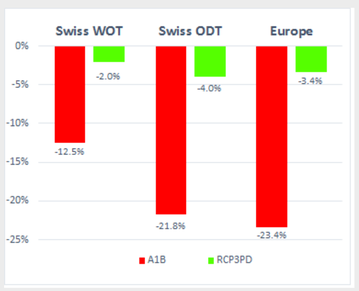
How does a change in snowfall affect winter tourism supply?

- Natural snow introduced in the production function.
- Producers respond to a decrease in natural snow by:
  1. producing more artificial snow.
  2. substituting with other production factors: investments to improve ski runs' preparation and maintenance or to modernize transport facilities.

A limited welfare gain from winter tourism

Results

- Due to the decrease in natural snow, production price increases, leading to a decrease in domestic consumption.
- But WOT benefits from international gains which translates into limited welfare gain for Swiss households, around 0.01%.



Snow cover variation in 2060 w.r.t. 2010

	WOT		ODT	
	RCP3PD	A1B	RCP3PD	A1B
Natural Snow	-2.0%	-12.5%	-4.0%	-21.8%
Artificial Snow	1.4%	10.5%	1.0%	7.2%
Producer Price	0.2%	1.6%	0.7%	5.1%
Consumption	-0.2%	-1.2%	-0.4%	-2.8%
Exports	0.2%	2.3%		
Imports	-0.4%	-3.7%		
Production	0.03%	0.6%	-0.4%	-2.8%

Interpretation

- Swiss WOT resorts are located at higher altitudes than EU resorts. They are less impacted and gain from competitiveness improvements.
- Vulnerability increases since natural snow is substituted with more expensive production factors (e.g. artificial snow or capital).

Limitations

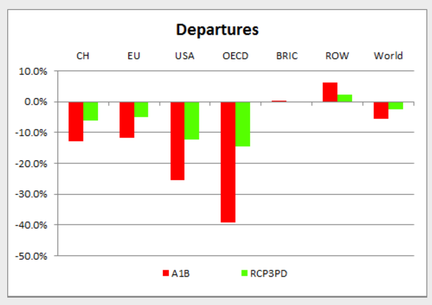
The "Fractional Snow Cover" does not factor in snow quality. In reality:

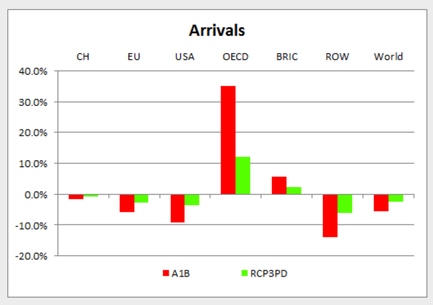
- a decrease in snow quality would increase the cost of ski-slope preparation, which might be impractical in a warmer climate.
- a lower snow quality, the lack of snow in cities or the concentration of skiers in a few resort could decrease people's inclination to ski.

A moderate welfare gain from summer tourism

Results

- Cold countries become more attractive, but total international tourism flows decrease.
- In Switzerland, the increase in domestic tourism more than compensates the decrease in arrivals. The summer tourism production increases, resulting in a moderate welfare gain, between 0.08% and 0.16%.





Change in international tourism flows in 2060 w.r.t. no climate change

	OFT	
	RCP3PD	A1B
Departures	-6.0%	-12.0%
Arrivals	-0.7%	-1.6%
Consumption	0.1%	0.3%
Production	1.4%	3.0%
Welfare	0.08%	0.16%

Interpretation

The results highlights some adaptation possibilities for alpine resorts:

- During heat waves, tourists prefer colder mountain areas to hot cities.
- The summer tourism season could expand to spring and autumn.

Limitations

- We model a representative temperature for each country, and get total impacts for Switzerland. But the situation will be more nuanced at the regional scale.
- Tourists could get used to warmer climate, making summer tourism flows more robust to climate change.

Acknowledgment and bibliography

The research leading to these results has received funding from the Swiss Federal Office for the Environment. Database: `http://swidchi.epfl.ch/`

Gonseth, C. (2013). "Impact of snow variability on the Swiss winter tourism sector: implications in an era of climate change." In: *Climatic Change* 119.2, pp. 307–320.

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