THE IMPACTS OF CLIMATE CHANGE ON SKI TOURISM

Assessing the vulnerability of ski tourism and adaptation strategies in the region Oberstdorf-Kleinwalsertal

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PREFACE

Dear reader,

You are about to read my bachelor thesis that I wrote to obtain my bachelor's degree of the programme Geography, Planning and Environment (GPE) at Radboud University. This thesis was written over the course of five months, although the idea for the subject of the impact of climate change on ski tourism originated almost a year before, when I was sitting in the back seat of the car driving home after a skiing vacation in Oberstdorf-Kleinwalsertal. Climate change is a subject I am very interested in and combining it with the Alps and skiing seemed like a perfect match. Therefore, I really enjoyed the overall process of working on this thesis (although it could be quite stressful at times) and I am proud of the end result.

Firstly, I would like to thank my supervisor Cebuan Bliss for her time, advise, and support during the entire process. I would also like to thank Sebastian Gries and Simon Steuer for their time and allowing me to interview them and providing me with the needed information. Furthermore, I want to thank all of the respondents that filled in the survey, and sent kind emails with additional information.

I hope you enjoy reading my thesis!

Julia Kosters

Best, 13th of August 2021

SUMMARY

One of the biggest challenges society faces today is climate change. Climate change will affect society and the surrounding environment in different ways. One of the branches of society that will be affected is the tourism industry (IPCC, 2007a). Climate is an important factor in the tourism industry, since the climate can play a major role in attracting tourists and can determine what types of activities can be done (Hall & Hingham, 2005; Moreno, 2010). One branch of the tourism industry can be particularly affected by climate change: ski tourism. For ski tourism sufficient snowfall is necessary, so it can be problematic when snowfall decreases due to climate change. The ski industry has a large international market of between 300 and 350 million skier visits globally every year, and therefore climate change can have drastic consequences for ski tourism-dependent communities when the number of annual tourists decreases (Steiger, Scott, Abegg, Pons & All, 2019). Climate adaptation may therefore be necessary (Moser & Baulcomb, 2020).

The existing studies on the impact of climate change and the vulnerability of ski tourism often take a quantitative approach and only consider climatic conditions. This research takes a more qualitative approach and includes the economic- and social vulnerability as well. Furthermore, the ski industry is dependent on local climatic conditions, which makes it hard to generalize findings (Steiger et al., 2019). Since there has not been any research on the region Oberstdorf-Kleinwalsertal, this research will contribute to our knowledge of climate vulnerability and adaptation in the region. This research is also relevant for the local government in Oberstdorf-Kleinwalsertal, since ski tourism is a major contributor for the local economy and approximately 95% of all income in the municipality of Oberstdorf is generated through tourism, which is good for an estimated revenue of 200 million Euro (Markt Oberstdorf, 2019). This research could also be relevant for stakeholders in the ski tourism industry in the region, since it could give them insight into how their business might be affected by climate change.

The aim of this research is to explain the economic, social, and environmental impacts of climate change on ski tourism in Oberstdorf-Kleinwalsertal and to assess what climate adaptation strategies there are. The main research question to reach this aim is: *How does climate change affect ski tourism in the ski region Oberstdorf-Kleinwalsertal and how is the region adapting to climate change?* The sub-questions to answer the main research question are: *How is ski tourism vulnerable to climate change in terms of economic, social, and environmental factors?* and *What types of climate adaptation strategies are there for ski tourism?*

Defining the risks of climate change and assessing the vulnerability to climate change of a certain region can be important and help identify measures to adapt to climate change. Vulnerability can be defined as “the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes.” (McCarthy et al, 2001 p. 6). The IPCC (2007b) recognizes three components of climate change vulnerability: exposure, sensitivity, and adaptive capacity.

The impacts of and vulnerability to climate change can vary between different systems, for example social, economic, and natural (Satapathy et al., 2007). There are several existing conceptual frameworks that distinguish different types of vulnerability. In general, the different types of vulnerability that are mentioned are economic vulnerability, social vulnerability, and environmental

vulnerability.

Climate change is potentially challenging for tourism, in particular ski tourism since it is reliant on snowfall, which is climate dependent. This is why the tourism industry will have to adapt to climate change and implement structural changes. Adaptation can be defined as the "adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects of impacts." (IPCC TAR, 2011). Elsasser and Bürki (2002) distinguish four different types of adaptation strategies for ski tourism: maintaining ski tourism, finding alternatives for ski tourism, the use of subsidies or fatalism (the latter one is not considered as a real strategy).

This research uses a combination of quantitative and qualitative research methods (mixed-methods) to collect data. A cross-sectional survey was sent to accommodation owners, restaurants, and ski schools and/or rentals to determine the economic and social vulnerability of stakeholders, and to investigate if they are adapting to climate change. However, the response rate was low, especially for ski schools and/or rentals, which is why it was decided to review the websites of ski schools and/or rentals to make the results more representative. Furthermore, two online semi-structured interviews were conducted with an employee from Allgäu Klimaschutz and an employee from Tourismusverband Ostallgäu to gain insight into the economic, social, and environmental vulnerability, and to learn more about climate adaptation in the region. In addition, a desk research was carried out to determine the vulnerability (specifically exposure) of the region, and to gain insight into climate adaptation strategies in the region.

The results show that the extent to which the stakeholders of the ski tourism industry are economically vulnerable differs between stakeholders. The results indicate that accommodations are less dependent on ski tourism than, for example, ski schools and/or rentals. An important reason for this is that winter and summer tourism are both of importance for the region, which is beneficial since it indicates that the tourism industry is not only dependent on ski tourism, thus making the tourism industry less vulnerable. Besides this, the region has a strong economic adaptive capacity, which makes the economic vulnerability smaller.

Furthermore, due to an aging population and the cultural importance of ski tourism, the region is more socially vulnerable, although there are support networks between stakeholders, which make the region more resilient to climate change, and thus less vulnerable. The social adaptive capacity seems to be relatively small, which can cause the region to be more socially vulnerable to climate change.

Ski tourism impacts the environment due to the need of water and energy for artificial snowmaking in order to make ski tourism more resilient to climate change. Additionally, the region is also vulnerable to natural hazards. However, the region is taking action to protect the environment, although natural hazards are often not well anticipated, which makes the region more environmentally vulnerable.

Regarding climate adaptation, it can be concluded that the region is in the early stages of developing climate adaptation and that there is no official report on the subject. A reason for this is that there is currently no signal that the region is in need of such a report, because in the short term, climate change is not a major concern for ski tourism. However, the region has taken action to adapt to climate change. This is mainly done by shifting the focus from ski tourism to all-year tourism and creating alternatives to ski tourism. There are also adaptation strategies that are aimed at maintaining ski tourism, although these seem to be less popular than finding alternatives. The least

used adaptation strategy is the use of subsidies since they are not commonly used in the region. There are subsidies for the tourism industry from the Bavarian Government and informal subsidies between stakeholders, but these are not necessarily directed at adapting ski tourism to climate change.

The most important limitation of this research is the lack of collected data since the few survey responses and only two interviews. however, this research uses triangulation, which increases the reliability of this research.

For future research, it could be useful to include the future vulnerability to get a broader view of the vulnerability of the region. Besides this, future research could include a more diverse group of stakeholders to increase the representativity. Additionally, future research could investigate which climate adaptation strategies regarding ski tourism are most suitable for Oberstdorf-Kleinwalsertal and could include a wider range of adaptation strategies, or also include climate mitigation strategies. Lastly, it could be interesting to compare Oberstdorf-Kleinwalsertal to a more ski tourism-dependent region, to get insight into how the region with weaker summer tourism could attract more summer tourists and decrease the vulnerability to climate change.

TABLE OF CONTENTS

List of abbreviations

IPCC	Intergovernmental Panel on Climate Change
UNWTO	United Nations World Tourism Organization
GHG	Greenhouse Gas
SDGs	Sustainable Development Goals
UN	United Nations
AMSL	Above Mean Sea Level
OK-Bergbahnen	Oberstdorf-Kleinwalsertal Bergbahnen
KWh	Kilowatt hours
StMUV	Bayerisches Staatsministerium für Umwelt und Verbraucherschutz

List of figures

List of tables

1. INTRODUCTION

This chapter begins by giving a brief background on climate change and how it can affect the tourism industry and ski tourism industry specifically. After this, the scientific and societal relevance of this research in discussed and the research aim and questions are given. The final paragraph the explains the outline of this research.

1.1 Background

One of the biggest challenges society faces today is climate change. Climate change refers to a change in average weather patterns that persists for decades or longer (Cubasch, 2013). This will affect society and the surrounding environment in different ways. According to the Intergovernmental Panel on Climate Change (IPCC) (2007a), Global warming and climate change causes changes in precipitation, temperature, sea level and concentrations of atmospheric carbon dioxide. The IPCC has predicted that these changes will impact freshwater resources and their management; ecosystems; food, fibre and forest production; coastal systems; industry, settlement and society; and overall human health. Climate change will have different consequences for different places all over the world. In Australia, for example, climate change will cause a loss of biodiversity in ecologically-rich areas including the Great Barrier Reef, while in Europe, mountainous areas will face reduced snow cover and the retreat of glaciers (IPCC, 2007a).

These negative impacts of climate change will present challenges to various economic sectors, including the tourism industry (IPCC, 2007a). Tourism is defined by the United Nations World Tourism Organization (UNWTO) (2010) as a "social, cultural and economic phenomenon which entails the movement of people outside their usual environment for personal or business/professional purposes. These people are called visitors (which may be either tourist or excursionists; residents or non-residents) and tourism has to do with their activities, some of which involve tourism expenditure." It is important to note however, that the tourism industry is also a contributor to climate change due to the greenhouse gas (GHG) emissions it generates (Steiger et al., 2019). This is mostly because of (local) transportation (e.g. aviation), accommodations and other activities (Peeters, 2007). Furthermore, tourism can damage the environment by adding pressure to ecosystems, the construction of resorts and roads that destroy nature, the pressure on land, water and air through pollution, discharge of residuals, erosion and deforestation (United Nations World Tourism Organization, 2010).

Climate is an important factor in the tourism industry, since the climate of a region can play a major role in attracting tourists and can determine what types of recreational activities can be done (Hall & Higham, 2005; Moreno, 2010). For instance, sunny and warm weather is necessary for beach tourism, and snowy conditions are required for ski tourism. As such, climate change can affect the demand for tourism of a certain region (Hall et al., 2005). This makes climate change significant for the tourism industry because of its effect on the economic viability of tourist destinations and activities, tourist behavior and its consequences for the tourism industry (Hall et al., 2015).

One branch of the tourism industry can be particularly affected by climate change: ski tourism. For ski tourism (and other winter activities in general) sufficient snowfall is necessary, and as such, it can be problematic when snowfall decreases due to climate change. Abegg, Bürki and Elsasser (2008) show that when climate change progresses, the number of naturally snow-reliable ski

areas in the European Alps could decline from 666 to 202 with a warming of 4°C. The extent to which ski areas are sensitive to climate change can differ significantly between the Alpine countries (Abegg et al, 2008). For example, Abegg et al. (2008) illustrate how ski areas in the Bavarian Alps in Germany are more sensitive to climate change ski areas in Switzerland, since these ski areas have better natural snow conditions. Due to climate change, Alpine winter tourism could potentially experience economic losses because of warmer and snow deficient winters, specifically in ski areas at a lower altitude (Abegg et al., 2008).

Ski tourism originated in the early twentieth century, but the roots of present-day ski tourism emerged in the 1960s and 1970s, with the increase of international mass tourism and the establishment of new ski areas and the expansion of small ski areas (Steiger, Scott, Abegg, Pons & All, 2019). The ski tourism industry was especially accessible for disadvantaged mountainous regions, since the technology of ski lifts was cheap and simple, and because governments support ski tourism development due to the fact that it can boost the local economy of disadvantaged mountainous regions (Steiger et al., 2019). This increased the demand further and the development of new ski areas continued until the 1980s and 1990s, when the number of visitors slowed and the ski markets reached maturity (Steiger et al., 2019).

Nowadays, the ski industry has a large international market with between 300 and 350 million skier visits globally every year (Steiger et al., 2019). Approximately 44% of the annual global skier visits are captured by the Alps, making it the biggest ski destination in the world (Vanat, 2016). Due to the largeness of the industry, climate change can have drastic consequences for ski tourism-dependent communities when the amount of annual tourists decreases, since alternatives can be limited in the often rural mountainous regions (Steiger et al., 2019). Climate adaptation may therefore be necessary, but this often comes with various sustainability challenges, such as the usage of artificial snow (Moser & Baulcomb, 2020). Artificial snowmaking is the most common adaptation strategy in the ski tourism industry and is used to increase the resiliency to climate variability of ski areas and to lengthen the ski season (Abegg et al., 2008). However, artificial snowmaking can impact the alpine environment by increasing the input of ions and water into ski pistes, which can affect the biodiversity and change the present plant species, as well as the availability of fresh water supply (Rixen, Stoeckli, & Ammann, 2003; Abegg, 2011).

1.2 Relevance

1.2.1 Scientific relevance

In the existing literature about climate change impact and the vulnerability of ski tourism, the focus is mostly on snow cover, artificial snowmaking, and the snow reliability of ski areas in relation to overnight stays (Galloway, 1988; Steiger & Mayer, 2008; Abegg, 1996; Dawson & Scott, 2007; Willibald, 2021). These studies often take a quantitative approach and only take into account climatic conditions and no other characteristics of the market that could influence the tourism industry's vulnerability to climate change, for example, the scale and diversity of the ski business (Steiger et al., 2019). This research can contribute to science as it takes a quantitative, as well as a qualitative approach to the problem and includes the economic- and social vulnerability as well.

Steiger et al. (2019) mention that a major limitation of existing sensitivity and vulnerability research is the exclusion of snowmaking. Artificial snowmaking should be included, since it is often used in the modern ski industry, for example as a climate adaptation strategy, as it reduces the sensitivity to natural snow variability significantly (Steiger et al., 2019). Stakeholders of the ski industry may perceive artificial snowmaking as a technological solution against climate change and

therefore they may consider studies that do not include the artificial snowmaking capacity in a particular region as invalid (Steiger et al., 2019). This research will include the use of artificial snowmaking, thus filling in this gap.

The vulnerability of the ski industry is furthermore dependent on local conditions due to different climatic conditions (e.g. windward versus leeward location) (Steiger et al., 2019). This makes it hard to generalize findings and since there has not been any research on the region of Oberstdorf-Kleinwalsertal, this research will contribute to our knowledge of climate vulnerability and adaptation in the region. In addition, Steiger et al. (2019) also mention that to increase credibility among stakeholders, it is necessary to include the new developments in the ski tourism industry (e.g. artificial snowmaking), since this is not always taken into account.

1.2.2 Societal relevance

As climate change impacts ski tourism which can have consequences for society, this research can be of societal relevance in multiple ways. To begin with, this research could be relevant for the local governments of Oberstdorf-Kleinwalsertal since ski tourism is a major contributor for the local economy and therefore an important activity for the region. Approximately 95% of all income in the municipality of Oberstdorf is generated through tourism, which is good for an estimated annual revenue of 200 million Euro (Markt Oberstdorf, 2019). This research can help to give the local government insight in the vulnerability of ski tourism in the region and outline possible adaptation strategies for the region, which can make tourism more climate resilient and sustainable.

In addition, this research could contribute to achieving the Sustainable Development Goals (SDGs) from the United Nations (UN). The 13th goal '*take urgent action to combat climate change and its impacts'* is applicable to this research, specifically the corresponding target '*improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning'* (United Nations, n.d.). This research assesses the vulnerability of the ski tourism industry and gains insight into what climate adaptation strategies are used, which could help the local government implement suitable climate adaptation strategies for the region in the future, as well as gaining awareness of the need for climate adaptation.

Furthermore, this research can be relevant for stakeholders of the ski tourism industry in the region, for example hotel or apartment owners, owners of restaurants, ski rentals, cable car companies and transport services, since it could give them insight into how their business might be affected by climate change. This could help these businesses to define what adaptation strategies might be beneficial for their businesses regarding climate change.

Additionally, research about the subject of the impacts of climate change on the ski tourism industry may not only lead to more awareness about the subject among policymakers, but also among citizens in the region. If there is an increasing awareness among policymakers, it may give them more drive to implement climate action policies. More awareness of climate change and the impacts on ski tourism among citizens in the region could increase the pressure on policymakers to take action in terms of climate change, which eventually can lead to sustainable and climate resilient tourism.

1.3 Research aim and questions

The aim of this research reads as follows:

> *To explain the economic, social, and environmental impacts of climate change on ski tourism in Oberstdorf-Kleinwalsertal and to assess what climate adaptation strategies there are.*

The main research question for this research is:

> *How does climate change affect ski tourism in the ski region Oberstdorf-Kleinwalsertal and how is the region adapting to climate change?*

The following sub-questions have been drafted to answer the main research question:

1. How is ski tourism vulnerable to climate change in terms of economic, social, and environmental factors?
2. What types of climate adaptation strategies are there for ski tourism?

1.4 Thesis outline

In chapter 2 the theoretical framework is discussed, which explains the theories about climate change vulnerability and climate adaptation, as well as the conceptual model and the concepts this research is based on. Chapter 3 explains the research strategy and the research methods this research uses: surveys, interviews, and desk research. After this, chapter 4 gives the results and analysis of the vulnerability assessment and chapter 5 gives the results and analysis of climate adaptation in the Alps and Oberstdorf-Kleinwalsertal. In chapter 6, the sub-questions and main research question are answered. Finally, chapter 7 gives a critical discussion and reflection on the research process, after which recommendations for future research are given.

2. THEORETICAL FRAMEWORK

This chapter starts off by discussing the theory of climate change vulnerability and climate adaptation. After this, the conceptual model is discussed, in which the concepts of climate change, economic, social, and environmental vulnerability and climate adaptation will be described in terms of how they apply to this research.

2.1 Climate change vulnerability

2.1.1 Definitions and concepts

Climate change can potentially create risks in vulnerable areas, economic sectors, and various social groups. According to Satapathy et al. (2014), defining the risks of climate change and assessing the vulnerability to climate change of a certain region can be important and help identify measures to adapt to climate change. Vulnerabilities to climate change can differ between regions, economic sectors, and social groups (Satapathy et al., 2014). Vulnerability can be defined as "the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity." (McCarthy et al, 2001 p. 6).

The IPCC (2007b) recognizes three components of climate change vulnerability: exposure, sensitivity, and adaptive capacity. Exposure can be defined as "the nature and degree to which a system is exposed to significant climatic variations." (McCarthy et al, 2001, p. 987). Sensitivity refers to "the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. Climate related stimuli encompass all the elements of climate change, including mean climate characteristics, climate variability, and the frequency and magnitude of extremes. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise)" (McCarthy et al, 2001, p. 6). Adaptive capacity can be defined as "the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (McCarthy et al., 2001, p. 6). The adaptive capacity can, according to the IPCC TAR (2001), be determined by the following main features of regions: economic resources, technology, information and skills, infrastructure, institutions, and equity. For a more elaborate description of the features that determine adaptive capacity, see chapter 2.2.2. Allen Consulting (2005) has drafted a model showing the relations between vulnerability and the components it encompasses (Figure 1):

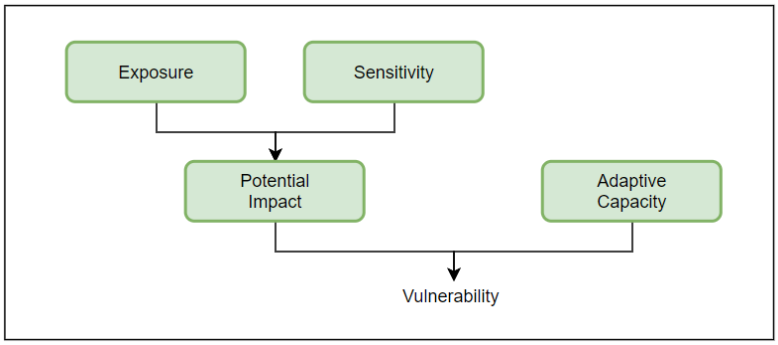

Figure 1: relations between the concepts of vulnerability (source: adapted form Allen Consulting, 2005)

2.1.2 Types of vulnerability

The impacts of and vulnerability to climate change can vary between different types of systems, for example social, economic, and natural systems (Satapathy et al., 2014). There are several existing conceptual frameworks that distinguish different types of vulnerability. The UN (2004) distinguishes between four factors of vulnerability: physical factors, which can be defined as the exposure of vulnerable elements in a certain region; environmental factors, which is the state of the environment in a certain region; economic factors, which is the availability of economic resources of individuals and groups; and social factors, which are the non-economic factors that influence the welfare of individuals and groups.

Moss, Brenkert, & Malone (2001) recognize three different dimensions of climate change vulnerability: the physical-environmental dimension, which refers to the impacts of climate change on the physical environment; the socio-economic dimension, which is the capacity of a region to recover financially from extreme events and adapt to change in the long term; and the availability of external assistance, which is the ability of a region to be assisted in climate change adaptation by (international) allies, trading partners and communities.

Alber et al. (2011) investigate the impact of climate change on tourism by assessing the vulnerability of tourism products in a certain region. Tourism products are the combinations of different aspects (for example characteristics of the place visited, modes of transport, types of accommodation and specific activities at a destination) around a specific center of interest such as beach tourism, sports tourism, and winter tourism (UNWTO, 2010). In the report of Alber et al. (2011) three areas of vulnerability are defined that need to be considered when assessing the vulnerability of a region: economic vulnerability, social vulnerability, and environmental vulnerability. Alber et al. (2011) further divides the types of vulnerability into indicators.

The economic vulnerability includes the economic welfare and the tourism dependency of a region, which can be measured by indicators such as the tourism intensity, which describes the economic importance of tourism in a region, and the job market dependency, which is the importance of tourism regarding the job market. The social vulnerability includes indicators such as the demographic aspects of a region and the community spirit, which describes the support and cooperation of a community. These indicators influence the social vulnerability, since a population can be more socially vulnerable when the population is, for example, aging or when a population lacks support and cooperation. Lastly, the environmental vulnerability includes indicators such as the reliability of natural resources (e.g. ski tourism is dependent on snowfall or water and energy for artificial snowmaking) and the occurrence of natural hazards such as landslides and rock fall.

In the frameworks of the UN (2004), Moss et al. (2001) and Alber et al. (2011) there is a clear division between environmental (or physical) vulnerability, and the social and economic (or socio-economic) vulnerability. However, according to Füssel (2005) there is no set definition of the terms, which means the distinction between the types of vulnerability can differ between conceptual frameworks. For example, according to the conceptual framework of Klein and Nicholls (1999) the natural vulnerability can determine the socioeconomic vulnerability, and according to Brooks (2003) the social vulnerability can determine the biophysical vulnerability. In these conceptual frameworks, there is no clear distinction between the types of vulnerability. However, according to Cutter (1996), the social and biophysical vulnerability are independent from each other.

Füssel (2005) concludes that the different types of vulnerability are incompatible and that integration among the terms is not consistently possible, although Füssel (2005) does note that the

socioeconomic and biophysical vulnerability can overlap on certain occasions. Füssel (2005) further explains that the varying distinctions of the types of vulnerability by the frameworks can be relevant for the systems it aims to assess, which means that the distinctions of the vulnerability types and how they overlap is dependent on the assessed system.

The focus of this research lies on ski tourism, and ski tourism is a socio-economic activity that uses the environment. Therefore, the economic, social, and environmental vulnerability can overlap.

2.2 Climate adaptation

2.2.1 Definitions and concepts

Climate change is potentially challenging for tourism, in particular ski tourism since it is reliant on snowfall, which is climate dependent. Therefore, the tourism industry will have to adapt to climate change and implement structural changes. Adaptation can be defined as the "adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in processes, practices, or structures to moderate or offset potential damages or take advantage of opportunities associated with changes in climate." (IPCC TAR, 2001). Adaptation also takes into account the adjustments that have to be made to reduce the vulnerability of communities, regions and activities (IPCC TAR, 2001). Adaptation is of relevance for climate change because it is related to the assessment of impact and vulnerability (as mentioned in chapter 2.1.1) and it is related to the development of response and evaluation options (IPCC TAR, 2001).

The IPCC TAR (2001) differentiates between two types of adaptation: autonomous and planned adaptation. Autonomous adaptation refers to adaptation that is taken after the initial impacts of climate change. Planned adaptation, on the contrary, is reactive or anticipatory, meaning it is undertaken before the impacts of climate change. There are various reasons why actors either choose to invest in autonomous or planned adaptation. In the case of autonomous adaptation, actors may have faith in market mechanisms and believe in the capacity of human systems to adapt to climate change autonomously (IPCC TAR, 2001). However, autonomous adaption comes with constraints, such as limited information and access to resources, adaptation costs and residual damages, which is why planned (anticipatory) adaptation is needed (IPCC TAR, 2001). Burton (1996) mentions six reasons why it is necessary to adapt to climate change immediately: 1) Climate Change cannot be avoided, 2) anticipatory and precautionary adaptation is more effective and less costly than forced, last-minute, emergency adaptation or retrofitting, 3) climate change may be more rapid and more pronounced than current estimates may suggest, and so unexpected events are possible, 4) immediate benefits can be gained from better adaptation to climate vulnerability and extreme atmospheric events, 5) immediate benefits also can be gained by removing maladaptive policies and practices, and 6) climate change brings opportunities as well as threats, and therefore future benefits can result from climate change.

Adaptation can also be distinguished in various adaptation or response options. Burton (1996) outlines the following classification of adaptation/response options (figure 2):

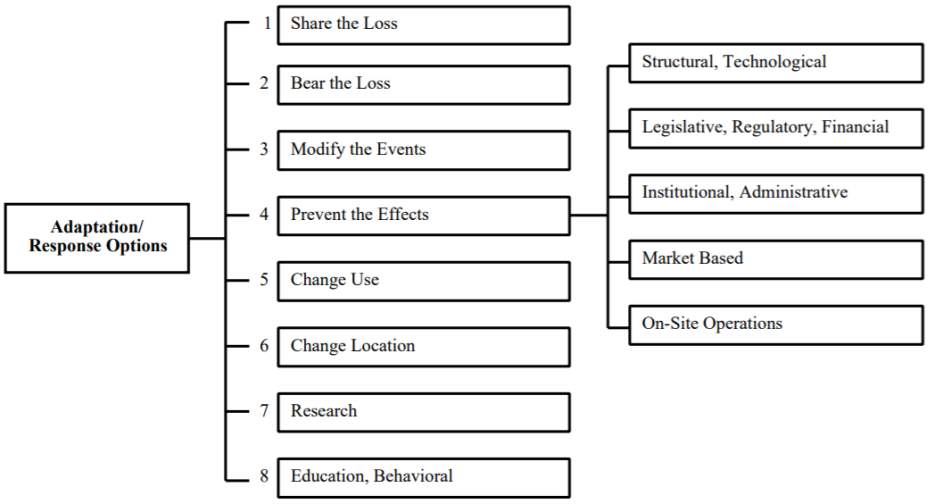

Figure 2: classification of adaptation/response options (source: Burton, 1996)

The figure shows six different adaptation/response options: sharing the loss, bearing the loss, modifying the events, preventing the effects (which can be divided into five sub-categories) changing the location, investing in research, and finally investing in education and behavioral change.

2.2.2 Adaptive capacity

The capacity of a system to adapt to climate change is determined by various social, economic, political, biophysical, and technological aspects of a region (IPCC TAR, 2001). According to the IPCC TAR (2001) there are six main features of regions or communities that determine the adaptive capacity:

1. *Economic resources of a region*. The economic condition of a region can influence the capacity to adapt, since it is known that more wealthy nations are better prepared to support the costs of climate adaptation measures, than nations that know a high level of poverty.
2. *Technology*. A limited access to technology can influence a nations ability to implement climate adaptation strategies. Technology is an important factor in climate adaptation, because most possible strategies include some form of technology (e.g. irrigation, production of artificial snow).
3. *Information and skills*. To implement successful climate adaptation, it is important to understand the necessity to adapt, to have the knowledge needed about the availability of options, and to have the ability to assess and implement adaptation strategies.
4. *Infrastructure*. This refers to the social infrastructure and the availability of and access to resources by decisionmakers, and vulnerable sectors of a population (e.g. how vulnerable is a population when a hazard occurs, are there any backup plans?).
5. *Existing institutions in a region*. Usually, (wealthy) nations with developed institutions are generally thought to have a greater adaptive capacity than developing nations with less effective institutions.
6. *Equity*. This means that when institutions arrange an equal distribution of access to resources for all the population, it can positively influence the adaptive capacity of a community of a country.

2.2.3 Climate adaptation strategies and ski tourism

Climate adaptation will look different for various stakeholders in the ski tourism industry, since, for example, a top ski resort with a diverse range of activities and high snow reliability will have more opportunities for adaptation than smaller ski locations with less offers and less opportunities (Elsasser & Bürki, 2002). Elsasser and Bürki (2002) distinguish four different types of adaptation strategies for ski tourism.

The first strategy is maintaining ski tourism. This includes artificial snowmaking, development of higher terrain, ski slope design and co-operation. The second strategy is aimed at finding alternatives to ski tourism. This consists of developing non-snow related activities in the winter, of focusing on all-year tourism. The third strategy is receiving subsidies form, for example, the government. This can consist of annual contributions or single contributions. The fourth and last adaptation strategy is taking a fatalistic attitude, which means either continuing 'business as usual' or canceling ski tourism altogether. Although it is mentioned by Elsasser & Bürki (2002), taking a fatalistic attitude is not considered a real adaptation strategy since continuing ski tourism without changing anything or cancelling ski tourism is not adapting to climate change. Figure 3 displays the four adaptation strategies of Elsasser & Bürki (2002).

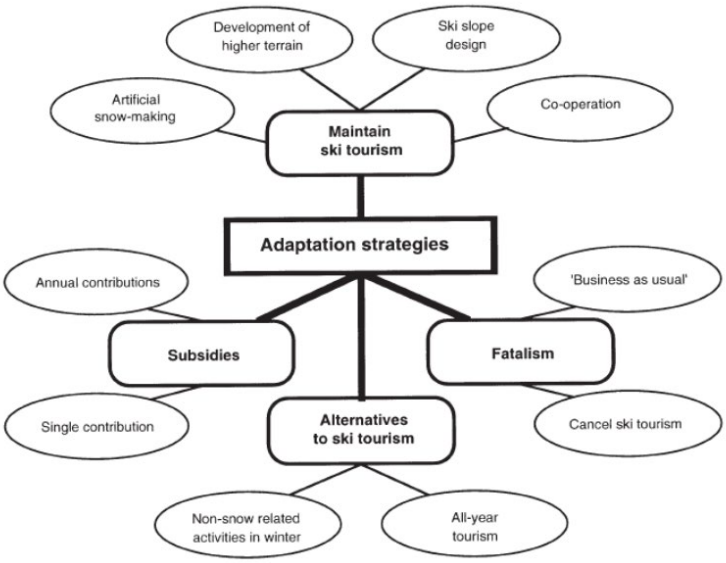

Figure 3: adaptation strategies for ski tourism (source: Elsasser & Bürki, 2002)

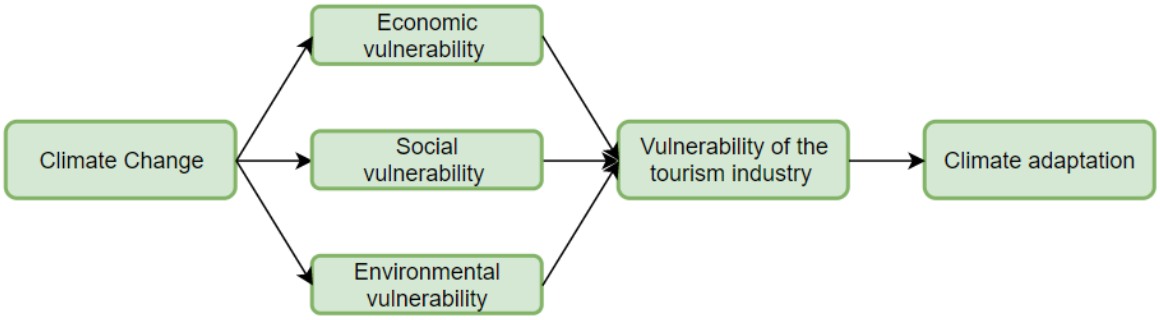

Figure 4: conceptual model

In the model, it is shown how the independent variable *climate change* influences the dependent variables *economic vulnerability*, *social vulnerability*, and *environmental vulnerability*, since climate change can impact economic, social, and environmental systems (Satapathy et al., 2014). The types of vulnerability combined determine the overall *vulnerability of the tourism industry.* Furthermore, the *vulnerability of the tourism industry* influences the dependent variable *climate adaptation* since the extent to which the tourism industry is vulnerable to climate change determines what kind of climate adaptation strategies are needed in a certain region (Satapathy et al., 2014). The variables economic, social, and environmental vulnerability, as well as climate adaptation are further operationalized in Appendix 1.

3. METHODOLOGY

This chapter outlines the methodology of this research. In the first part of the chapter, the used research strategy is explained. After this, the case study this research focusses on is further explained and the three methods used to collect data are discussed: surveys, interviews, and desk research.

3.1 Research strategy

The research strategy encompasses all the decisions that are made about the approach of the research and how the research is executed (Verschuren & Doorewaard, 2007). According to Verschuren & Doorewaard (2007) three core decisions have to be made. The first core decision that has to be made is if the research is either going to be broad or profound. The second core decision is if the research is quantitative or qualitative. The third core decision is if the research is going to be conducted in the field, or if the research is going to be conducted by investigating existing literature.

This research is going to be profound, since it focuses on a spatially specific problem in time, the impact of climate change on ski tourism in Oberstdorf-Kleinwalsertal. Therefore, the approach is conducted on a smaller scale which causes the results to be less generalizable. However, it does enable the research to be more detailed, complex, and less uncertain.

As for the second core decision, the choice has been made to use a combination between quantitative and qualitative research, also known as mixed-methods. Quantitative research is used to gain insight into the vulnerability of the different stakeholders that are involved in the ski tourism industry. Since there are many different stakeholders and businesses, quantitative research can include all these stakeholders and businesses and as a result, give a better overall picture of the vulnerability of the region. Qualitative research is used to gain insight into climate adaptation strategies in the region, since this research is aimed to get an in-depth detailed view of climate adaptation in the specific region. A qualitative approach is therefore more convenient because the interpretation and consideration of the acquired data is of importance, instead of reporting the data in tables or graphs.

Regarding the third core decision, the choice has been made to conduct this research in the field, in the region Oberstdorf-Kleinwalsertal. The choice for the region and general information about the region can be found in chapter 3.2.

Three strategies are used to collect data for this research: cross-sectional survey, semi-structured interview, and desk research in the form of a literature study. By using multiple data recourses, a better insight into the impact of climate change on ski tourism and climate adaptation is gained, which results in a higher reliability of the results and conclusions of this research (Vennix, 2016).

3.1.1 Methodological framework

Satapathy et al. (2014) give a methodological framework that can be used for assessing the vulnerability of a region. In this framework (figure 5), the vulnerability assessment has four stages. In this research, the emphasis is on the first three stages since the aim of this research is to assess the current vulnerability of the region and how the region is currently adapting to climate change. The future vulnerability of the region to climate change will be discussed in chapter 7.

Stages		Steps	
Involvement of relevant stakeholders	1. Defining the purpose of the vulnerability assessment	Formulate **questions** to be answered by the assessment	Iterative Process
	2. Planning the vulnerability assessment	1. Set the **boundaries** of the vulnerability assessment 2. Define the **general approach** of the vulnerability assessment	
	3. Assessing current vulnerability	1. Assess the profile of the system of interest 2. Assess the observed climate **(exposure)** 3. Assess the impacts of climate stimuli on the system of interest **(sensitivity)** 4. Assess the responses to climate variability and extremes **(adaptive capacity)** 5. Assess overall **current vulnerability**	
	4. Assessing future vulnerability	1. Assess the future climate **(future exposure)** 2. Assess the future impacts on the system of interest **(sensitivity)** 3. Assess future socio-economic scenarios **(adaptive capacity)** 4. Assess the overall **future vulnerability**	

Figure 5: framework for climate change vulnerability assessments (source: Satapathy et al., 2014)

This research will take a bottom-up approach by analyzing what causes the region to be vulnerable to natural hazards that can be caused by climate change (Satapathy et al., 2014). A Bottom-up approach fits this research, since it is focused on which specific groups of people are vulnerable and the differences in vulnerability between these groups (Satapathy et al., 2014). Furthermore, the approach is used to assess the vulnerability at a local level and for planning possible adaptation strategies (Satapathy et al., 2014).

3.2 Case study

For this research, a case study is used to get an in-depth and integral view into the subject of climate change and ski tourism (Vennix, 2016). The choice has been made to carry out a single case study (Verschuren & Doorewaard, 2007). The case this research will focus on the region Oberstdorf-Kleinwalsertal. The region is dominated by the Alps and is spread out over two countries: the Bavarian municipality of Oberstdorf, located in Southern Germany, and the Kleinwalsertal valley, located in the state of Vorarlberg, Austria. The towns of Rubi, Reichenbach, Schöllang, Tiefenbach, Kornau, Reute, Jauchen, Spielmannsau, Birgsau, Einödsbach and Rohrmoos are also included in the municipality of Oberstdorf. The municipality is part of Allgäu, a south-German region. The Kleinwalsertal exists of four villages: Riezlern, Hirschegg, Mittelberg and Baad, and is only accessible via Germany. Oberstdorf is located at an elevation of 815 meters AMSL, while the elevated Kleinwalsertal is located at an altitude of 1,100 to 1,250 meters AMSL (Markt Oberstdorf, 2019; Kleinwalsertal, n.d.b). The map below (Figure 6) shows the location of Oberstdorf and Kleinwalsertal.

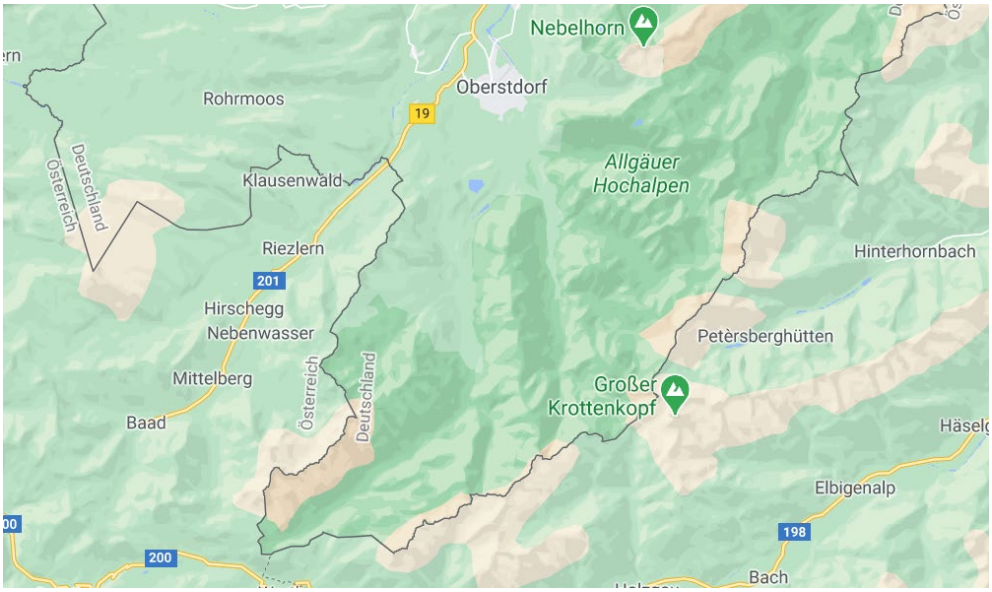

Figure 6: map of Oberstdorf-Kleinwalsertal (Source: Google Maps)

The municipality of Oberstdorf has over 9,600 inhabitants and Kleinwalsertal has approximately 5,000 inhabitants, which means that combined the region has an estimated population of 14,600 (AdminStat, n.d.; Kleinwalsertal, n.d.b).

Oberstdorf-Kleinwalsertal is selected as a case for this research because there is no research about the impact of climate change on ski tourism in the region, and because the region Oberstdorf-Kleinwalsertal is a popular tourist destination in both summer and winter and attracts many tourists every year. In 2019, the region counted almost 4,5 million overnight stays, from which almost 1,9 million overnight stays were the winter season of 2018/2019 (Oberstdorf, n.d.; Amt der Vorarlberger Landesregierung, 2020). Therefore, the economy is dependent on ski tourism, which may be affected by climate change. The region has 130 kilometers of slopes and has a total of 48 lifts that are operated by the organization Oberstdorf-Kleinwalsertal Bergbahnen (OK-Bergbahnen) (Kleinwalsertal, n.d.a). The region is divided into different ski areas: Nebelhorn, Fellhorn, and Söllereck in Germany, and Kanzelwand, Heuberg, Walmerdingerhorn, and Ifen in Austria.

3.3 Surveys

To answer both sub-questions and to gain insight into the economic and social vulnerability of the different stakeholders in the ski tourism industry, and how they might adapt to climate change, a survey was used. Due to the fact that surveys can be distributed more widely and so include more stakeholders, a broader picture of the vulnerability of ski tourism can be gained. This makes it a suitable research method for this research, due to the limited time. According to Verschuren & Doorewaard (2007) there are several variants of surveys. The variant that is used in this research is a cross-sectional survey, because this research is conducted at one moment in time in one group, and because cross-sectional surveys are relatively easy to execute and thus time efficient.

3.3.1 Data collection

To collect the necessary data, a survey was drafted. The wording of the survey however was slightly adapted to fit the context of the stakeholder it concerned: accommodations, restaurants/cafés, and

ski schools and/or rentals. These three groups were chosen since they are all involved in the ski tourism industry. The aim of the surveys is to determine the economic and social vulnerability of stakeholders, and to investigate to what extent they are adapting to climate change. The surveys can be found in Appendix 2. For this research a web survey was chosen because of the distance between The Netherlands and Oberstdorf-Kleinwalsertal, which would make it difficult to do face-to-face surveys, and because of the Coronavirus pandemic. The survey was created using the software program Google Forms, since it enables the transfer of data to Excel efficiently, and the program displays the collected data automatically in graphs. According to Vennix (2016), a web survey has the advantage that results do not have to be manually processed but are automatically saved in a database. Another advantage is that a respondent can fill in the survey at any convenient time. A disadvantage of a web survey is that the representativeness of the survey can be lower, since not all respondents are familiar with online surveys. This can lead to a lower response rate.

The surveys were sent out by email to the different accommodations, restaurants and cafés, and ski schools and/or rentals. In total, approximately 363 surveys were sent out, with additional follow up emails, over the course of a month. The businesses were selected by using either Google Maps, or via the websites of the tourist offices of Oberstdorf and Kleinwalsertal.

3.3.2 Data analysis

The survey that was directed to accommodations in the region got thirteen responses, the survey that was directed to restaurants and cafés got two responses, and the survey that was directed to ski schools and/or rentals got one response. This means that in total, the survey got sixteen responses (response rate: 4,4%). Firstly, the responses were transferred to Excel, to get an overview of the responses. Because of the low response rate, specifically of ski schools and/or rentals, it was decided to review the websites of the ski schools and/or rentals to make the results more representative of the population (Appendix 3). For restaurants and cafés, it was decided to still use the results of the two respondents since it can still be relevant for this research because of the different context of the restaurant and the café: the restaurant in located next to a ski slope in Kleinwalsertal, while the café is located in the centre of Oberstdorf. The amount of respondents that answered a certain question are displayed using 'N=…' in the figures that can be seen in the results (chapter 4).

3.4 Interviews

Two qualitative interviews were conducted to gain insight into climate adaptation, as well as the vulnerability of the region Oberstdorf-Kleinwalsertal. According to Creswell & Poth (2018) the aim of an interview is to understand the world from the point of view of the subject, and to unfold the meaning of their experience. The type of interview that is used for this research is a semi-structured interview. This means that an interview guide is drafted which entails a list of topics that will be touched upon in the interview and the order of these topics and formulation of the questions are determined by the interviewer (Vennix, 2016). This type of interview enables the interviewee to openly talk about the subject, and as a result, give more detailed information (Creswell & Poth, 2018). This is useful to gain a better understanding of the vulnerability in the region, but it is especially useful for answering the second sub-question about climate adaptation, since there are few publications on the subject.

3.4.1 Data collection

Both interviews were held online since it was not possible to do the interviews face-to-face physically due to the Coronavirus pandemic and the international aspect of this research. For the two

interviews, an interview guide was drafted which can be found in Appendix 4. The first interview was with Simon Steuer, an employee from the organization Allgäu Klimaschutz, who coordinates climate protection in the region Oberallgäu. The second interview was with Sebastian Gries, who is manager at Tourismusverband Ostallgäu.

3.4.2 Data analysis

Both interviews were recorded with consent of the respondents, and the relevant information for this research transcribed for analysis. The next step in the process is coding, which is done with the program ATLAS.ti. In the coding process, certain concepts are allocated to the transcript to link the empirical findings with concepts of the theoretical framework (Vennix, 2016). The first step in the coding process was 'open coding'. This means that relevant parts of the transcript were linked to a code. The codebook in appendix 5 gives an overview of the used codes. The second step in the coding process was creating 'code groups'. This means that the used codes were sorted into groups to clarify to what overarching concept the codes belong.

3.5 Desk research

To answer both sub-questions, a desk research was conducted. Desk research is a method where already produced resources from others (e.g. academic literature, policy documents) are used to reflect on and gain insight into the subject that is studied (Verschuren & Doorewaard, 2007). Verschuren & Doorewaard (2007) differentiates between two variants of desk research: the literature study and secondary research. The variant that is chosen for this research is the literature study, since the literature is studied in-depth, often in a qualitative way. This type of a literature study can be characterized as a qualitative content analysis (Verschuren & Doorewaard, 2007).

Using desk research as a research method has, according to Verschuren & Doorewaard (2007) advantages and disadvantages. The biggest advantage is that it is time efficient, since the method makes it possible to acquire a lot of data in a short amount of time. This is convenient for this research due to the limited time frame. A disadvantage is that the used resources are originally intended for other purposes than for this research, which can lead to a one-sided view of the subject. However, since triangulation is used for this research, the subject is explored using different methods, which will lead to a more nuanced view of the subject.

Another consequence of not using self-collected data is the fact that there is a dependency on existing literature and that there is a possibility that not all the needed resources are available. Another disadvantage is that there is no direct contact with the research units. When these research units are people, it can have as a consequence that non-verbal information is missing, and one cannot give an explanation when the material is not understood correctly.

3.5.1 Data collection

For the first sub-question, literature is used for the vulnerability assessment to determine the exposure to climate change of the ski tourism industry of Oberstdorf-Kleinwalsertal. As mentioned in chapter 3.3.2, the websites of ski schools and/or rentals were reviewed to determine to economic vulnerability of ski schools and/or rentals. The websites were found by using the official website of Oberstdorf-Kleinwalsertal Bergbahnen and Google Maps. Additionally, literature and websites from organizations were studied to gain more insight into the environmental vulnerability.

For the second sub-question, various literature sources were used to gain insight into climate adaptation strategies in the region. The used literature for both sub-questions entails (policy) reports

from local governments and a non-governmental international organization, as well as academic research. An overview of all the used literature is shown in table 1.

Literature	Source
Die Winter im Kleinwalsertal und Im Oberallgäu: Eine Analyse amtlicher Temperatur- und Schneemessreihen	Aigner, G. (2020)
Tourismus im Klimawandel: ein hintergrundbericht der CIPRA	Abegg, B. (2011)
Climate Policy Programme Bavaria 2050	Bavarian State Government (2015)
Klima-Report Bayern 2015: klimawandel, auswirkungen, anpassungs- und forschungsaktivitäten	Bayerisches Staatsministerium für Umwelt und Verbraucherschutz (2015)
Ergebnisse der Ideen- und Kooperationsbörse für die Region Allgäu	IKU_Die Dialoggestalter (2017)
Masterplan 100% Klimaschutz im Landkreis Oberallgäu: teil 2	Landkreis Oberallgäu (2017)
Leitbilder und Strategien im und für den Landkreis Oberallgäu	Regionalentwicklung Oberallgäu (2014)
Strategie zur Anpassung an den Klimawandel in Vorarlberg – Ziele, Herausforderungen und Handlungsfelder	Vorarlberger Landesregierung (2015)

Table 1: used literature for the literature study

Furthermore, websites from governments were used to gain information about the environmental vulnerability of the region Oberstdorf-Kleinwalsertal. The used website are displayed in table 2.

Website	Source
https://respektiere-deine-grenzen.at/die-initiative/	Amt der Vorarlberger Landesregierung (n.d.)
https://www.ok-bergbahnen.com/unternehmen/mymountainnature/flora-fauna/tiere.html	Oberstdorf Kleinwalsertal Bergbahnen (n.d.)

Table 2: used websites for the literature study

3.5.2 Data analysis

The data that has been collected for the first sub-question about the exposure of the region, the vulnerability of ski schools and/or rentals, and the environmental vulnerability are not further analyzed using an analysis programme, because the literature was clear and straightforward, and thus it was not necessary to analyze it further. Therefore, the data is directly incorporated in the results (see chapter 4). The useful data of the documents on climate adaptation strategies in Oberstdorf-Kleinwalsertal are summarized and can be found in appendix 6. This summary was analyzed and coded using the programme ATLAS.ti.

4. RESULTS & ANALYSIS: VULNERABILITY ASSESSMENT

In this chapter, the results and analysis of the vulnerability assessment are discussed. The chapter begins by assessing the overall exposure of Oberstdorf-Kleinwalsertal. After this, the economic, social, and environmental vulnerability are assessed, by analyzing the sensitivity and adaptive capacity.

4.1 Exposure

The first concept of vulnerability that is analyzed is exposure. This is firstly done by analyzing long-term changes in temperature, snowfall, and season length of Oberstdorf and Kleinwalsertal.

4.1.1 Temperature, snowfall, and season length

The first indicator of exposure is the winter temperature, which is most relevant for this research because the focus is on ski tourism. Aigner (2020) gives two different figures that are relevant for the winter temperatures in Oberstdorf-Kleinwalsertal. Figure 7 shows the changes in winter temperature between 1781 and 2014 at the weather station in Hohenpreissenberg, which is located 70 km north-east of Oberstdorf at approximately a similar height.

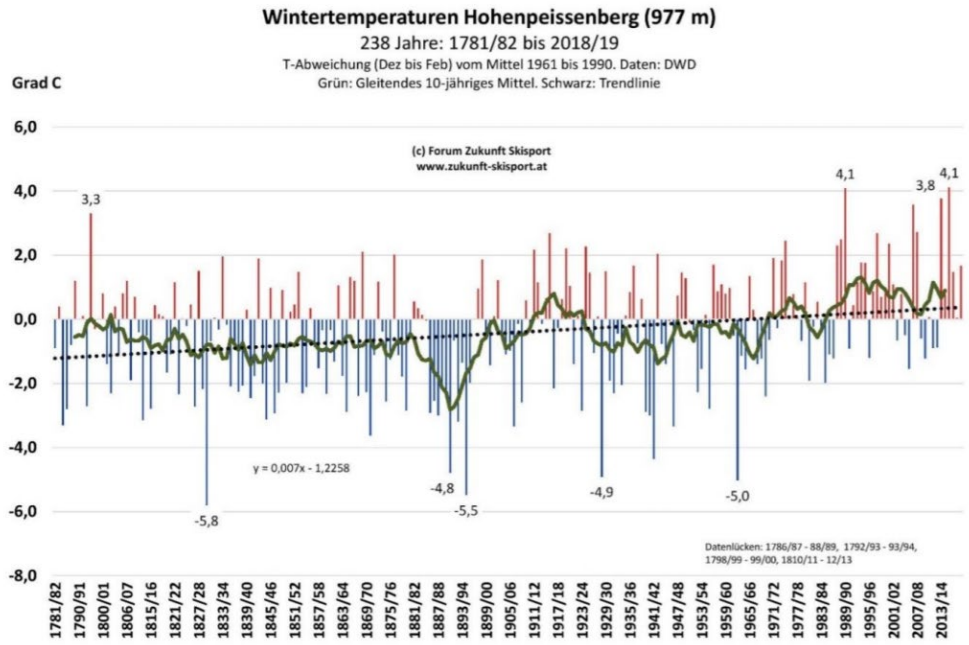

Figure 7: winter temperatures in Hohenpeissenberg (source: Aigner, 2020)

When specifically looking at the green and dotted black line, it can be seen how the winter temperature in Oberstdorf has slightly increased over the years, especially in the period between 1941/42 and 2013/14, since the average winter temperature has increased from -1°C to 1°C, which indicates that there are small climatic variations in terms of winter temperature.

Figure 8 shows the winter temperature in Kleinwalsertal between 1994 and 2020.

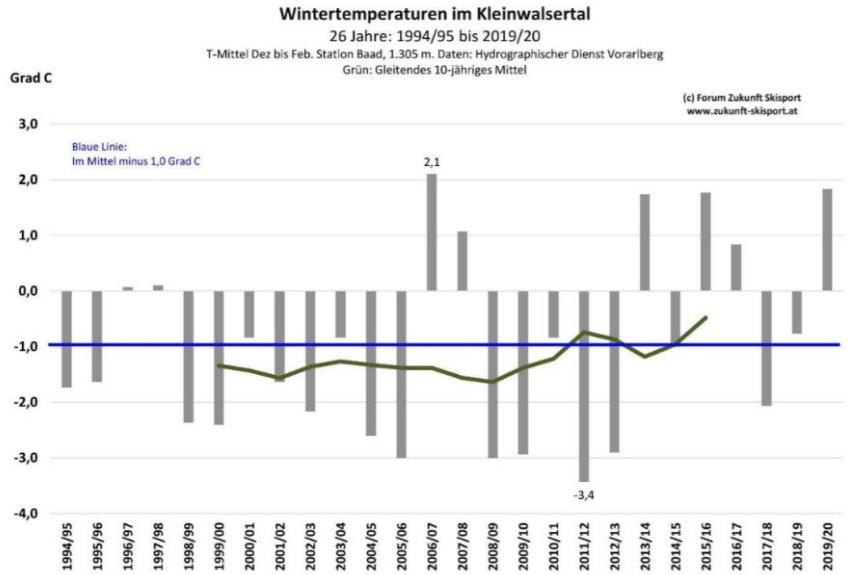

Figure 8: winter temperatures in Kleinwalsertal (source: Aigner, 2020)

The green line in the figure shows how the winter temperature in Kleinwalsertal has also increased between 2008/09 and 2015/16, from -1°C to -0,5°C. This indicates that there are small climatic variations in Kleinwalsertal in terms of winter temperature. Therefore, the two figures both indicate that the winter temperature has increased slightly in both Oberstdorf and Kleinwalsertal. However, the increase in winter temperature is larger in Oberstdorf (2°C) than in Kleinwalsertal (0,5°C). It is important to note that the average temperature in Oberstdorf is above freezing point, while the average temperature in Kleinwalsertal stays under freezing point. This means that the chance of snowfall in Kleinwalsertal is higher, which can be favorable for ski tourism.

The second indicator of exposure is the amount of snowfall in the region. This is measured in the annual amount of fresh snowfall. The figures below (figure 9 and 10) show the annual fresh snowfall in Oberstdorf and Kleinwalsertal.

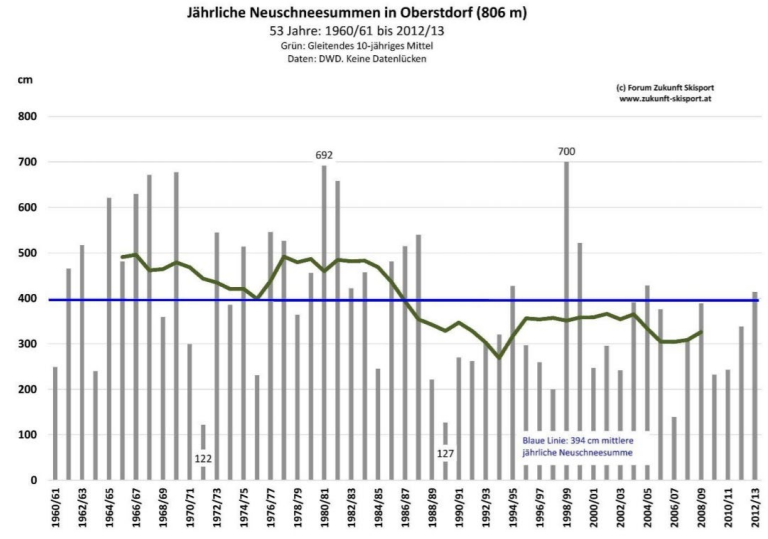

Figure 9: annual fresh snowfall in Oberstdorf (source: Aigner, 2020)

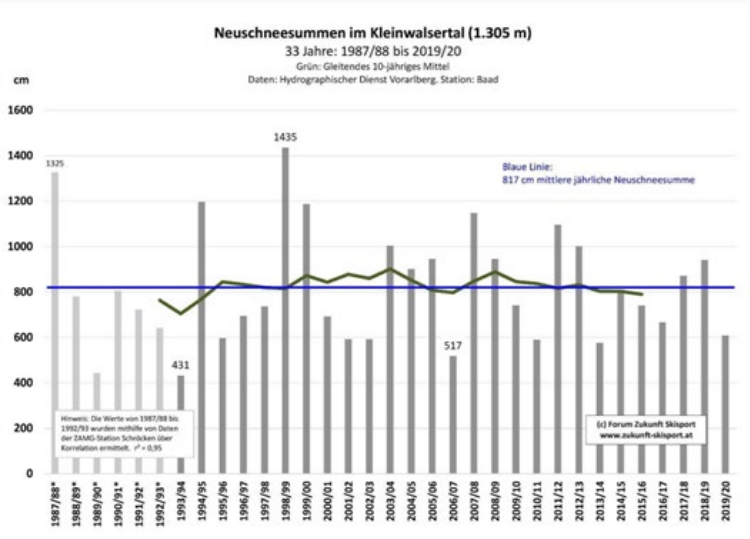

Figure 10: annual fresh snowfall in Kleinwalsertal (source: Aigner, 2020)

The green line figure 9 shows that the annual fresh snowfall in Oberstdorf is decreasing, especially between 1983/84 and 1993/94, since the annual fresh snowfall decreased from 480 cm to 275 cm. This indicates that there are climatic variations in terms of fresh snowfall in Oberstdorf. The green line in Figure 10 shows that the annual fresh snowfall in Kleinwalsertal has remained around 800 cm between the years 1993/94 and 2015/16. It can therefore be said that in terms of fresh snowfall, there are no clear climatic variations in Kleinwalsertal in the years analyzed. The figures about fresh snowfall show a clear difference between Oberstdorf and Kleinwalsertal. This ties in with the winter temperature changes in the region, as average winter temperatures in Oberstdorf are higher than in Kleinwalsertal, which can lead to less fresh snowfall.

The third indicator of exposure is the season length of the winter season. This can be measured by the number of days with snow cover. The figures 11 and 12 show the number of days with snow cover in the winter season in Oberstdorf and Kleinwalsertal.

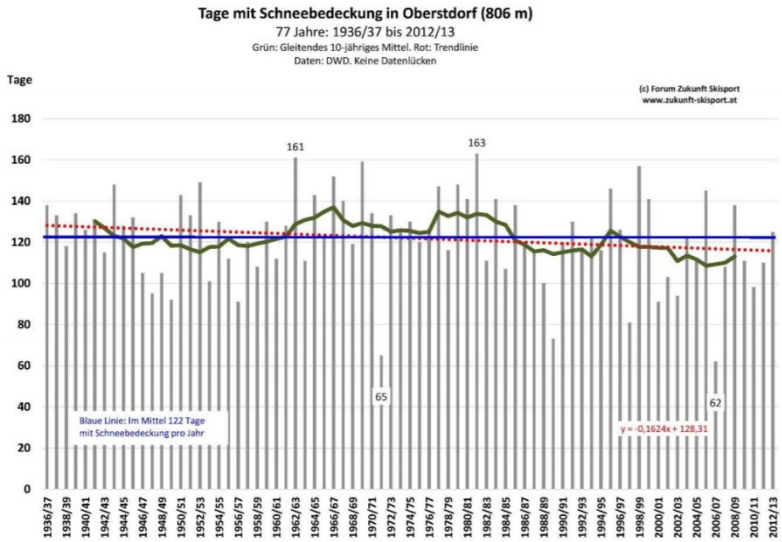

Figure 11: days with snow cover in Oberstdorf (source: Aigner, 2020)

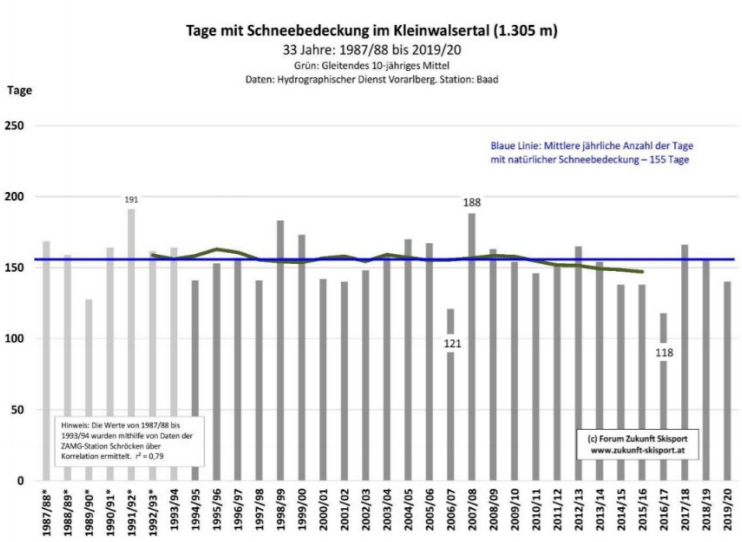

Figure 12: days with snow cover in Kleinwalsertal (source: Aigner, 2020)

The green line in figure 11 shows how the number of days with snow cover has decreased between the years 1981/82 and 2007/08 from 163 days to 110 days. The red trend line also indicates that there is a decrease in days with snow cover. Therefore, there are climatic variations in Oberstdorf in terms of days with snow cover. The green line in figure 12 shows that the number of days with snow cover decreased slightly between the years 2009/10 and 2015/16 from 160 days to 145 days, thus indicating that there are climatic variations in terms of days with snow cover in Kleinwalsertal. Therefore, both figures show that the number of days with snow cover have decreased over the years in both Oberstdorf and Kleinwalsertal, which indicates that the winter season has become slightly shorter over the years. However, the difference in bigger in Oberstdorf (53 days) than in Kleinwalsertal (15 days).

4.1.2 The experience of stakeholders with exposure

Since this research takes a bottom-up approach and takes into account the various stakeholders in the ski tourism industry, one question of the survey was dedicated to investigating how stakeholders in the region experience the exposure (Appendix 2, question 2). The responses are summarized in figure 13.

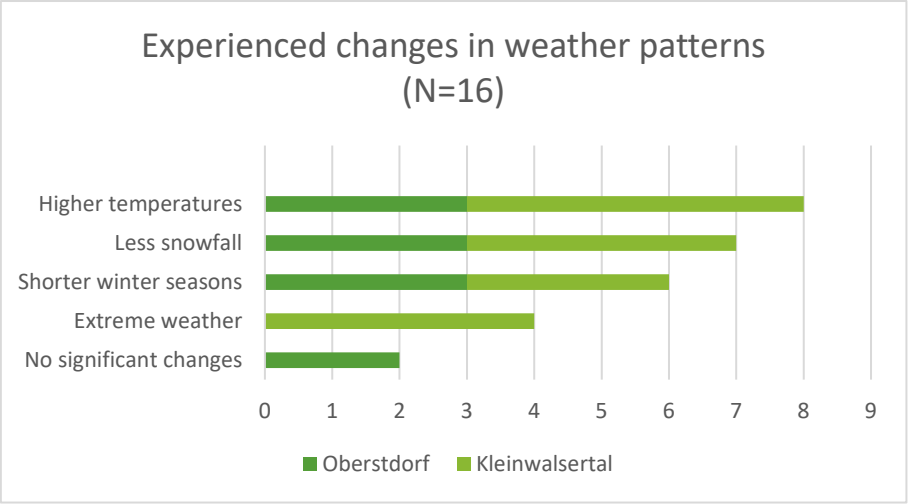

Figure 13: experienced changes in weather patterns

Figure 13 shows the responses to the survey question *"Have you experienced changing weather patterns in recent years that could be due to climate change?"* The category most chosen is *higher temperatures*. The second most chosen category is *less snowfall*. The next category is *shorter winter seasons*. Because multiple respondents mentioned extreme weather in the category *other* in the survey, an extra category was added, *extreme weather*. The final and least chosen category was *no significant changes*.

What is important to note about the graph is that the majority of the respondents do experience changes in weather patterns that could be due to climate change, since only 2 respondents have not experienced any significant changes. Another noteworthy aspect is that the graph does not show a clear difference between Oberstdorf and Kleinwalsertal. Although the study of Aigner (2020) shows that the effects of climate change are slightly stronger in Oberstdorf than in Kleinwalsertal, the respondents of the survey from Oberstdorf are the only ones that chose the category "No significant changes". Therefore, from the perspective of stakeholders, there is no evidence of a clear difference between Oberstdorf and Kleinwalsertal.

4.1.3 The overall exposure

The results show that the winter temperature in both Oberstdorf and Kleinwalsertal have increased over the years, although the increase of temperature is higher in Oberstdorf than in Kleinwalsertal. This indicates that, in terms of winter temperatures, Oberstdorf is more exposed to climate change than Kleinwalsertal. Regarding the annual fresh snowfall, the results show that while Oberstdorf is experiencing a decrease of the annual fresh snowfall, the amount of annual fresh snowfall remains stable in Kleinwalsertal. This means that Oberstdorf is more exposed to climate change in terms of annual fresh snowfall than Kleinwalsertal, since Kleinwalsertal does not experience any climatic variations regarding annual fresh snowfall. Furthermore, the number of days with snow cover have decrease in both Oberstdorf and Kleinwalsertal, indicating that winter seasons have become shorter in the entire region. However, the decrease is stronger in Oberstdorf, which means that regarding the season length, Oberstdorf in more exposed to climate change than Kleinwalsertal.

This suggests that overall Oberstdorf is more exposed to the effects of climate change, which could mean that, regarding ski tourism, Oberstdorf could face more challenges and would possibly need to adapt more to climate change than Kleinwalsertal.

The survey results show that the majority of the respondents notice the effects of climate change through higher temperature, less snowfall, shorter winter seasons and the occurrence of extreme weather. However, the survey results show no clear distinction between Oberstdorf and Kleinwalsertal, while the study by Aigner (2020) clearly does. A reason for this could be that the extent of the effects of climate change could be bigger in Oberstdorf, but the survey does only take into account if respondents experience a change in weather patterns, not the degree of it.

4.2 Economic vulnerability

4.2.1 Sensitivity

The first component of economic vulnerability that is going to be discussed is sensitivity. There are two indicators used to determine the sensitivity of the ski tourism industry to climate change: the income dependency and job dependency on ski tourism.

Accommodations

The first aspect that is considered to determine the sensitivity of ski tourism is if accommodations are busier in the summer or winter season. Figure 14 shows the survey results to the question "*In the past five years, has the winter season been busier, just as busy, or less busy than the summer season for your business?"*

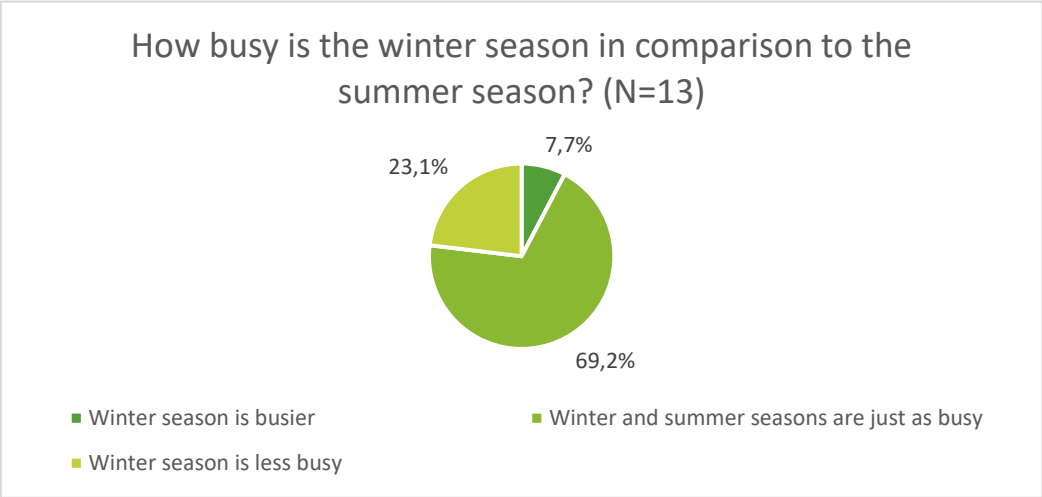

Figure 14: how busy is the winter season in comparison to the summer season?

Figure 14 shows that the majority of the accommodations, 69,2% are equally busy in the summer and winter seasons. 23,1% answered that the winter season in less busy, and 7,7% answered that the winter season is busier. This indicates that incomes and jobs of accommodations in the region are not only dependent on the winter season, and thus ski tourism, but that the summer season also plays a pivotal role. This was also mentioned by Simon Steuer in the interview when asked about the importance of ski tourism in comparison with summer tourism: "*That's quite interesting in die Allgäu, because here, summer tourism is equivalent, or even more important to tourism. And that's an important strength also for the region."* He further mentioned that the availability of jobs is similar all year around for accommodations, which means that the jobs of accommodations are not necessarily only dependent on ski tourism.

To gain further insight in the dependency on ski tourism in the region, a question of the survey was dedicated to investigate the income dependency on ski tourism: "*How much (%) of the annual income of your business is approximately generated through ski tourism?"*

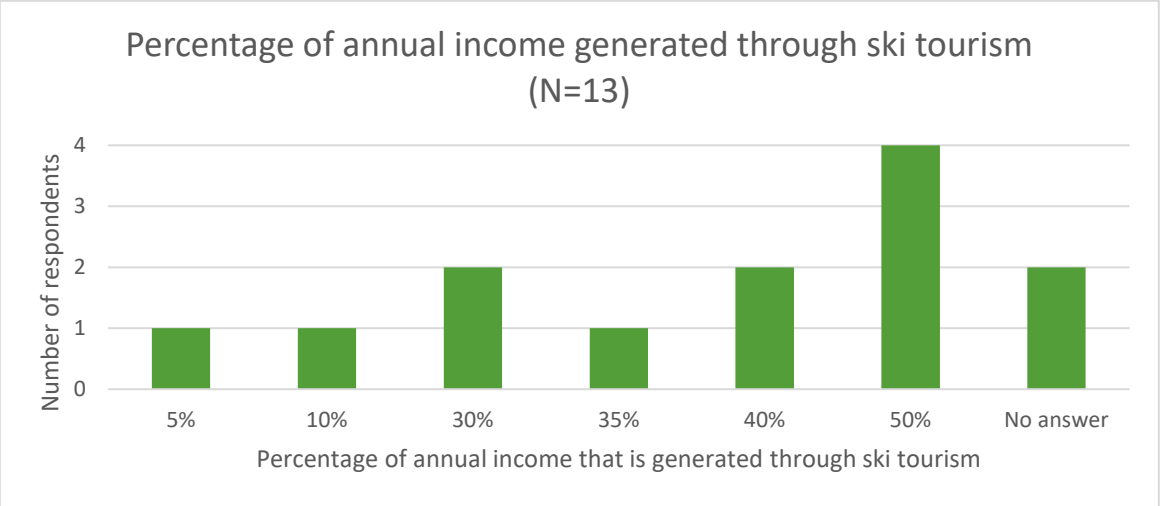

Figure 15: percentage of annual income generated through ski tourism

Figure 15 shows that the most frequently chosen category is 50%, meaning that ski tourism is an equally important source of income for accommodations as summer tourism. Most respondents, however, answered that ski tourism is a less important source of income in comparison with summer tourism. However, for most accommodations, still a significant amount of income is generated through ski tourism. It is also noteworthy that none of the respondents answered above 50%, which indicates that ski tourism is not responsible for the majority income for the accommodations, which means that they are possibly less sensitive to climate change. This was also mentioned in the interview with Simon Steuer. He mentioned that in general, *"hotels generate more income in summer than in winter already."*

In addition, a question in the survey was used to determine if the amount of snow in the region affects the number of visitors to accommodations. The answers can be seen in figure 16.

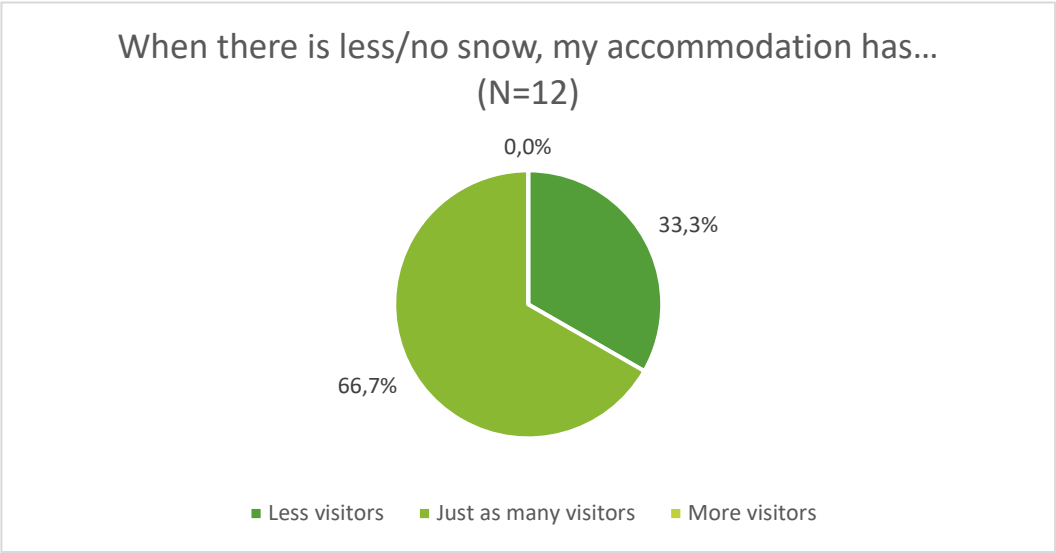

Figure 16: when there is less/no snow, my accommodation has...

The figure shows the majority of accommodations, 66,7%, do not experience a change in the number of visitors when there is less or no snow in the region. 33,3% of the accommodations do experience less visitors when there is less or no snow. The category *more visitors* is not picked by any of the respondents. One of the accommodations in Kleinwalsertal also gave additional information, saying that when there is less snow in Oberstdorf and other lower parts of Germany, they notice an increase in visitors in their accommodation. Therefore, they "highly benefit" from snow deficient winters.

Furthermore, it has been investigated what types of winter activities visitors of accommodations are related to. The results of the question on the survey are displayed in figure 17.

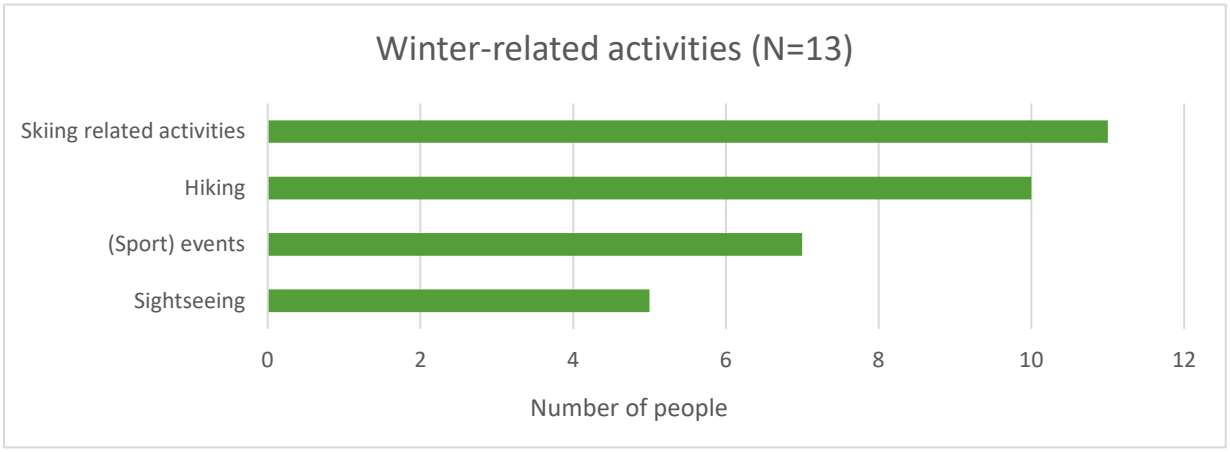

Figure 17: winter related activities visitors of accommodations come for

The figure shows that the majority of visitors of accommodations in the winter season come for skiing related activities (e.g., tour skiing and cross-country skiing). The activity that is almost equally as big as skiing related activities is hiking. The third winter activity visitors come for are (sport) events, and lastly, sightseeing. This indicates that most visitors' motivation to come to the region in the winter are skiing related activities. This highlights the importance of ski tourism for accommodations in terms of attracting visitors in the winter season.

Restaurants and cafés

The first aspect that is investigated to determine the dependency on ski tourism is if the restaurant and cafés are busier in the winter or summer season. The results can be seen in Figure 18.

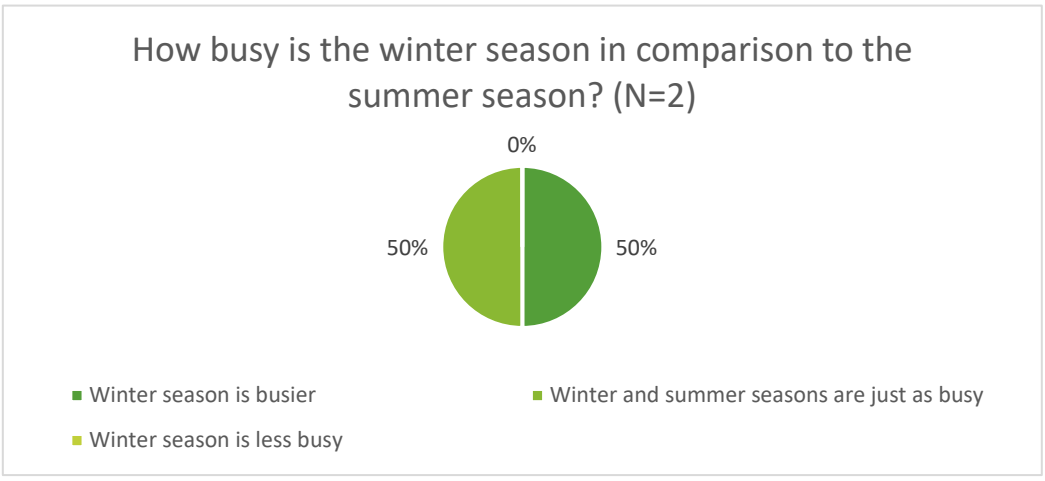

Figure 18: how busy is the winter season in comparison to the summer season?

In the figure, the respondent that answered that the winter season is busier, is the owner of the restaurant in Kleinwalsertal next to the ski slope, while the owner of the café in Oberstdorf answered that the winter and summer seasons are just as busy. This could mean that the restaurant in Kleinwalsertal has a more sensitive position in comparison to the café in Kleinwalsertal, since the restaurant in busier in the winter season. In terms of jobs, Simon Steuer mentioned that for restaurants and cafés in general, the availability of jobs is similar in the winter and summer season, which means that both the summer and winter season are equally important in terms of creating jobs.

Additionally, one question in the survey was aimed to investigate the income dependency on ski tourism of restaurants and cafés. The results are displayed in figure 19.

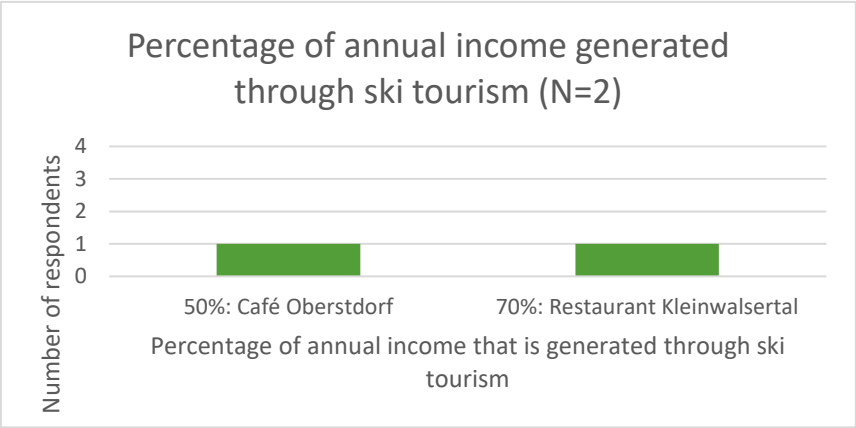

Figure 19: percentage of annual income generated through ski tourism

The figure shows that the café in Oberstdorf generates 50% of the annual income through ski tourism, while the restaurant in Kleinwalsertal generates 70% of the annual income through ski tourism. This indicates that the restaurant in Kleinwalsertal is more income dependent on ski tourism than the café in Oberstdorf. This could be due to the fact that the restaurant in Kleinwalsertal is located next to a ski slope, thus attracting more skiers.

Furthermore, it was investigated if visitors in the winter season are related to skiing related activities or other winter activities. The results are displayed in figure 20.

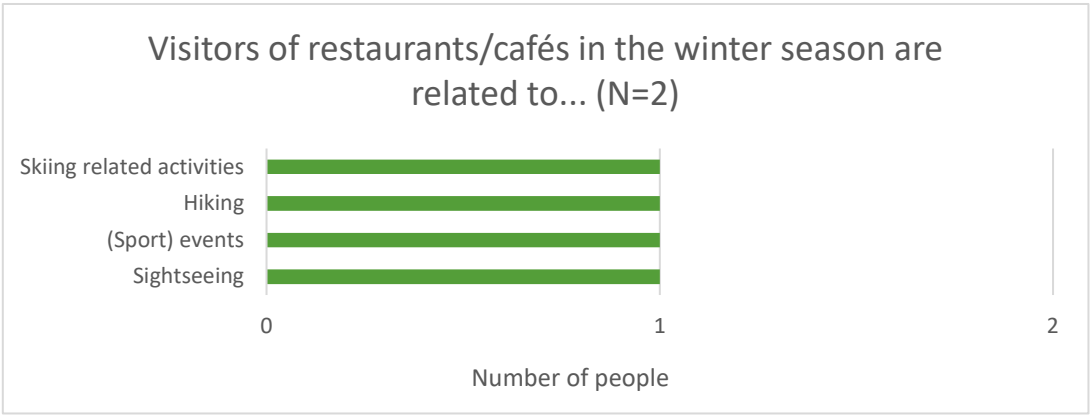

Figure 20: visitors of restaurants/cafés in the winter season are related to...

The figure shows that all activities are equally chosen, however, it is important to know that the restaurant in Kleinwalsertal only answered 'skiing related activities', while the café in Oberstdorf answered that visitors in the winter season are mostly related to hiking, (sport) events and sightseeing. This indicates that the restaurant in Kleinwalsertal is more dependent on ski tourism than the café in Oberstdorf since the visitors in the winter season come for skiing related activities.

Ski schools and/or rentals

It was investigated how dependent ski schools and/or rentals are on ski tourism by looking at the variety of activities they offer in the summer and winter season. Firstly, it was investigated if ski school and/or rentals also offer summer activities besides winter activities. The results are displayed in figure 21.

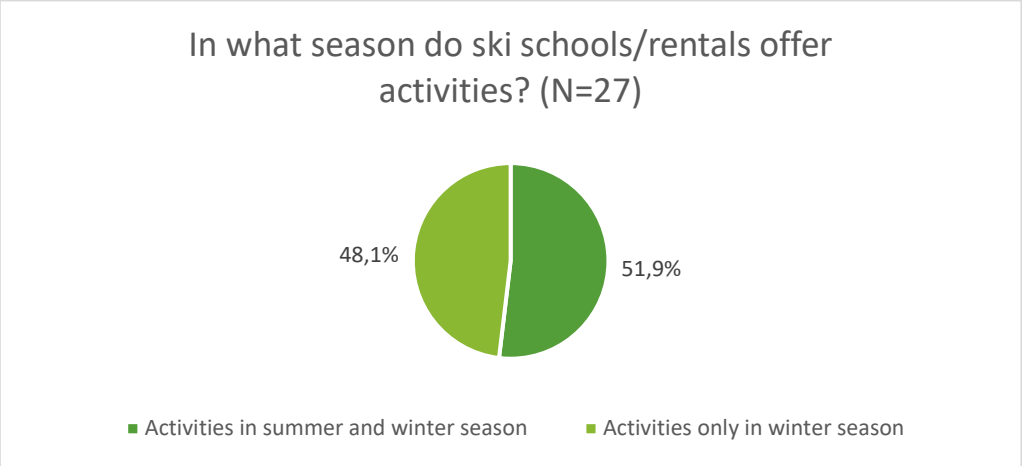

Figure 21: in what season do ski schools/rentals offer activities?

The figure shows that 51,9% of the ski schools and/or rentals offer activities in both the summer and winter season. 48,1% of the ski schools and/or rentals only offer activities in the winter, which means that they are completely dependent on the winter season in terms of income and jobs.

To get a further insight into ski schools and/or rentals that offer activities in the summer and winter season, it was investigated if from this group, more activities are in the winter or summer season. The results can be seen in figure 22.

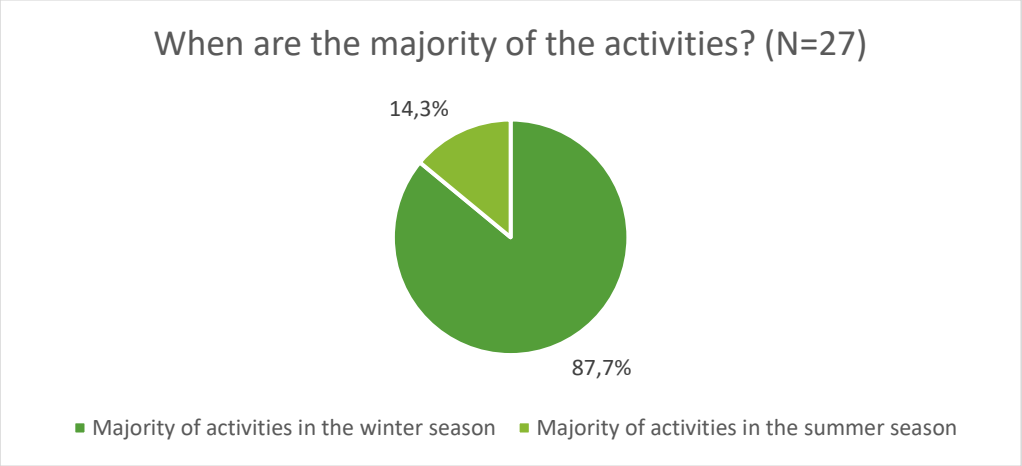

Figure 22: when are the majority of the activities?

The figure shows that, from the ski schools and/or rentals that offer activities in both summer and winter, 87,7% still offer most activities in the winter season. 14,3% offer most activities in the summer season. This indicates that, even if ski schools and/or rentals offer summer activities, the majority is still focused on the winter season, and thus, ski tourism. This means that ski schools and/or rentals are dependent on ski tourism in terms of income and jobs. This was also mentioned in the interview with Simon Steuer. He mentioned how currently in the winter, much more people work in tourism than in the summer season. Often, these people work in ski tourism in the winter and have another job for the summer, like construction work and farming. He also gave the example that especially ski teachers can be in a vulnerable position in the future when it comes to climate change, and that they may have to adapt and find an alternative job.

Oberstdorf-Kleinwalsertal Bergbahnen

The final stakeholder of the ski tourism industry that is going to be discussed is the cable car organization of the region: Oberstdorf-Kleinwalsertal Bergbahnen. In the interview with Simon Steuer, it was mentioned how the summer and winter season are both of importance for the organization, since the winter season alone is not enough income for the organization. However, he also mentioned that the winter season is a lot busier than the summer season since in the summer season visitors only use the lifts once a day, while in the winter season visitors use the lifts continuously. As a result, more income is generated in the winter season. Therefore, ski tourism is an important source of income for OK-Bergbahnen.

Furthermore, he mentioned that more people work in the winter season than in the summer season, which means that also more people work for OK-Bergbahnen (e.g. more lifts are open in the winter season than in the summer season, preparation of ski slopes). This indicates ski tourism creates many additional jobs for people in the region which means that many jobs of OK-Bergbahnen are dependent on ski tourism.

4.2.2 Adaptive capacity

The second component of the economic vulnerability that is going to be discussed is the adaptive capacity. The indicator that is used to measure this are the available economic resources in the region. Sebastian Gries mentioned in the interview that one of the reasons the region can adapt very well is because it is a wealthy region: *"I think the region can adapt really well because on the one hand, there is money, on the other hand, it's a pretty wealthy region as well, because of the economic situation (…)".* This indicates that that region has the capacity, in terms of economic resources, to adapt to climate change.

4.2.3 The overall economic vulnerability

The results show that the economic sensitivity of the ski tourism industry to climate change is dependent on the stakeholder. Generally, for accommodations the winter and summer seasons are equally economically important and for restaurants/cafés the results suggest that the degree to which a restaurant/café is sensitive to climate change is dependent on the location of the restaurant/café. Furthermore, ski schools and/or rentals are more sensitive than the other stakeholders since they are mainly aimed at ski tourism and the winter season which makes them more economically dependent. For Oberstdorf-Kleinwalsertal Bergbahnen, both the summer and winter season are of importance. However, the majority of income and jobs are generated through ski tourism, which indicates that the organization has a sensitive position in the ski tourism industry.

Regarding the adaptive capacity, the results show that the region has the needed economic

resources to adapt to climate change due to the good economic situation of the region, which indicates a strong adaptive capacity.

Taking into account the exposure, sensitivity, and adaptive capacity, it can be said that all of the stakeholders of the ski tourism industry in the region are economically vulnerable to climate change, but the degree to which they are vulnerable differs between stakeholders.

4.3 Social vulnerability

4.3.1 Sensitivity

The first component of the social vulnerability that is going to be discussed is sensitivity. To measure the social sensitivity, three indicators were used: demographics, community spirit, and the cultural aspect of ski tourism.

Demographics

Figure 23 displays the age distribution in Oberallgäu, and figure 24 displays the age distribution in Kleinwalsertal.

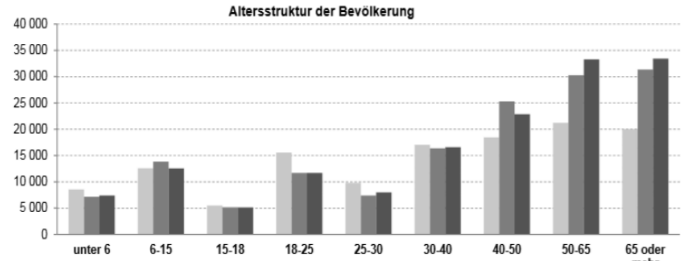

Figure 23: age distribution of Oberallgäu (source: Landkreis Oberallgäu, 2017)

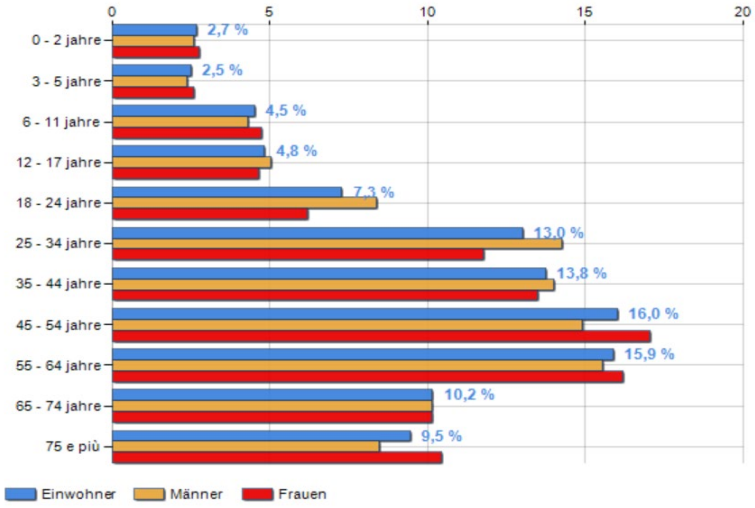

Figure 24: age distribution of the municipality Mittelberg in 2019 (source: AdminStat, n.d.a)

Both figures show that the age group of 50+ has the biggest share of the population, which indicates that Oberallgäu and Kleinwalsertal have to deal with an aging population. Since this is also a visible trend in other parts of Europe, it may cause an increasing demand for less physical activities from the local population, as well as from potential visitors of the region. This means that the demand for skiing related activities could potentially decrease.

Community spirit

This was done by investigating to what extent there is cooperation between the different stakeholders in the ski tourism industry. Figure 25 displays the results of the survey.

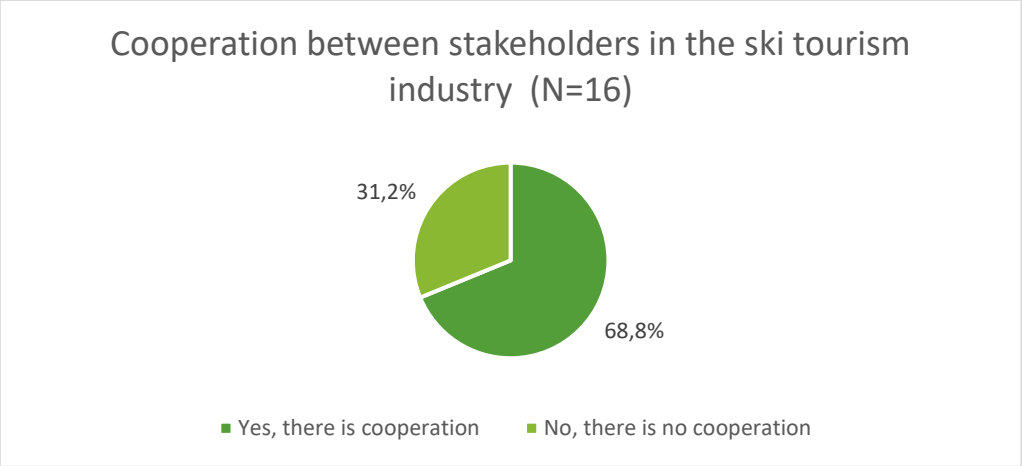

Figure 25: cooperation between stakeholders in the ski tourism industry

The figure shows that 68,8% of the respondents answered that their business does cooperate with other businesses, while 31,2% answered that they do not cooperate with other businesses in the ski tourism industry. In the survey it was also possible to name examples of collaborations. The most frequently named cooperation is with Oberstdorf-Kleinwalsertal Bergbahnen. This is probably due to the fact that most accommodations offer free use of OK-Bergbahnen, which is also mentioned in the interview with Simon Steuer.

He also explained in the interview that there is a shared interest in the lifts by accommodations and municipalities since they depend on the lifts because it attracts visitors. He gave an example of another ski area near Oberstdorf-Kleinwalsertal called Bolsterlang, where the lift needed to be renovated, but because the lift company itself could not afford it, the municipality decided to finance it. This indicates that there is cooperation in the ski tourism industry, and that there are networks of stakeholders that support each other. Other than OK-Bergbahnen, cooperation with the tourism office, sporting events, a fun park for skiing and snowboarding, and an association for private accommodations and a trade association were mentioned in the survey.

The analysis of the ski schools and/or rentals shows that 23 of the 27 (85,2%) analyzed businesses cooperate with other businesses in the ski tourism industry. The most frequently mentioned collaborations are with other ski schools and/or rentals, accommodations, shops, tourist offices, Oberstdorf-Kleinwalsertal Bergbahnen and restaurants. This indicates that there is cooperation between the different ski schools and/or rentals and between ski schools and/or rentals and other businesses of the ski tourism industry and that there are networks between the stakeholders in the ski tourism industry.

The cooperation between the stakeholders could make the region more resilient to climate change, since the stakeholders form a network and are able to support each other when there are, for example, natural hazards.

Cultural aspect of ski tourism

Figure 26 displays the result of the survey.

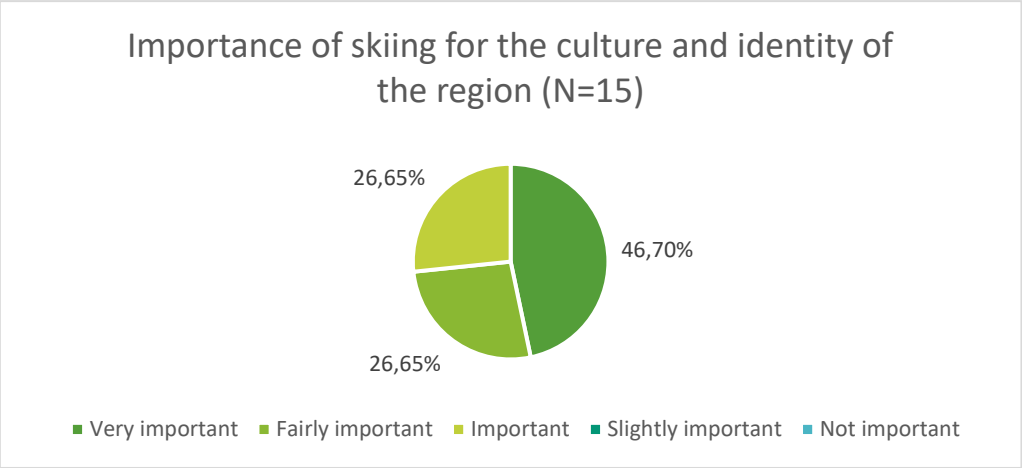

Figure 26: importance of skiing for the culture and identity of the region

The figure shows that 46,7% of the respondents answered that skiing is a very important aspect of the culture and identity of the region, while 26,65% of the respondents answered that it is fairly important and 26,65% that it is important. None of the respondents answered that it is slightly important or not important, which indicates that overall, skiing is seen as an important aspect for the culture and identity of the region.

This means that it could be harder for the region to potentially shift the focus to alternatives to skiing when climate change progresses, because skiing is seen as an important cultural aspect of the region. Sebastian Gries suggested in the interview that because Ostallgäu does not have a strong ski tourism sector, the range of adaptation strategies might be wider than when a region does have strong ski tourism, which is the case in Oberstdorf-Kleinwalsertal. Therefore, adaptation strategies in the region could be more focused on maintaining ski tourism since ski tourism has an important role in society.

4.3.2 Adaptive capacity

The second component of the social vulnerability is the adaptive capacity. Three different indicators are used to assess the adaptive capacity: information and skills, the willingness to adapt, and the social infrastructure.

In both interviews, the need for information and skills of adapting to climate change was mentioned. In the interview with Sebastian Gries from Ostallgäu, he explained that the district already has a climate adaptation report and a climate adaptation manager who oversees climate adaptation in the district. While in the interview with Simon Steuer, it was mentioned that in Oberallgäu, there is no group of people that is actively working on climate adaptation since there appears to be currently no one available to work on the topic of climate adaptation. This indicates that in terms of information and skills, Oberallgäu, and thus Oberstdorf-Kleinwalsertal is lagging behind on Ostallgäu, which can potentially cause the region to struggle more to adapt to climate change when it is needed.

Information and skills also entails understanding the need to adapt. Sebastian Gries from Ostallgäu mentioned in the interview that Ostallgäu started making their climate adaptation report because they wanted to discover what the effects of climate change on the region could be, what

climate adaptation strategies could be useful, and what potential benefits climate change could have. Simon Steuer mentioned in the interview that the necessity for climate adaptation is not seen in the region. A possible reason for this is that climate adaptation is focused on the long-term, and politicians in the region realized that it is not concerning them in the next few years. He also mentioned how he personally thought more pressure would come on the topic because of the climate adaptation report of Ostallgäu, but there is still no signal that Oberstdorf-Kleinwalsertal is in need of a climate adaptation report.

Sebastian Greis also mentioned in the interview that the willingness of the people to adapt is of importance for the adaptive capacity, and that in Ostallgäu, there is willingness to adapt. In Oberallgäu however, it seems as if the willingness is currently limited, which could be due to the fact that climate adaptation is not currently seen as a necessity, as was explained by Simon Steuer.

Furthermore, the social infrastructure of the ski tourism industry is of importance for the adaptive capacity. As mentioned before, there is cooperation between different stakeholders of the ski tourism industry and there are networks of actors. They are also prepared to help each other, as the example of the Bolsterlang ski area illustrates. This indicates that there is a good social infrastructure, which benefits the adaptive capacity.

4.3.3 The overall social vulnerability

The results show that the region is particularly socially sensitive regarding the demographic aspects and the cultural aspect of ski tourism. Oberstdorf-Kleinwalsertal and other European countries have an aging population, which could lead to a decreasing demand for skiing related activities. Additionally, skiing is seen as an important aspect for the culture and identity of the region, which indicates that it could be more difficult to shift to alternative activities to skiing when climate change progresses. However, in terms of the community spirit, the result show that there is cooperation and a network between the majority of the stakeholders in the ski tourism industry, which could make the ski tourism industry more resilient to climate change, and thus less sensitive.

Regarding the adaptive capacity, the results suggest that social adaptive capacity is limited. This is due to the fact that there is a lack of information and skills, and because the necessity to adapt is currently not well understood. Additionally, the willingness to adapt in the region seems to be limited as well. However, the social infrastructure of the region is in good shape, which could make it easier to adapt to climate change.

Taking into account the exposure, sensitivity and adaptive capacity, it can be said that the region is socially vulnerable to climate change, since the region is especially sensitive in terms of demographics and the cultural importance of ski tourism, and because the social adaptive capacity is limited.

4.4 Environmental vulnerability

4.4.1 Sensitivity

The first component of the environmental vulnerability that is going to be discussed is sensitivity. The sensitivity is measured with three different indicators: environmental protection, natural hazards, and the reliability of natural resources.

Environmental protection

In the interview with Simon Steuer, it was mentioned how in Germany, it is not allowed to use chemicals in artificial snow so that the environment is not damaged. There are also certain areas in

the region that are protected. For example, the ski area Fellhorn has wildlife protection areas which are prohibited to enter in winter to protect rare bird species (Oberstdorf Kleinwalsertal Bergbahnen, n.d.). This seems to be successful measure, because the population has risen in 2018 (Oberstdorf Kleinwalsertal Bergbahnen, n.d.). Furthermore, the state of Vorarlberg has launched the initiative "Respektiere deine Grenzen" in 2004 which aims to protect animals and plants by creating protected areas (Amt der Vorarlberger Landesregierung, n.d.). The ski area of Ifen has multiple of these zones that are prohibited to enter in both summer and winter. All of these protected areas are also marked on the slope map of the entire ski region to create awareness and prevent skiers from entering the areas.

These protected areas can make it more difficult to claim more land for ski tourism. For example, Simon Steuer explained in the interview that for artificial snow, pools are needed to store water, which impacts the environment. But since some areas are protected, it can be difficult to get the permission to build another water storage pool. This all indicates that Oberstdorf-Kleinwalsertal is actively taking action to protect the environment from ski tourism.

Natural hazards

Natural hazards such as rock fall, rockslides, landslides, and sinkholes can be especially threatening to life and infrastructure the Alpine region (Bavarian State Government, 2015). These hazards can be hard to predict hazards, since they often occur spontaneously, and therefore there is not enough time to give a warning or take safety measures (Bavarian State Government, 2015). The Bavarian State Government (2015) has taken measures to protect areas in Bavaria from natural hazards with "the geohazard precaution and information programme". This programme entails measures such as the registration of potential sensitive areas to natural hazards, inspections, and reference cards of vulnerable regions in Bavaria, risk dialogue with affected districts, and metrological observations of sensitive mountainous areas.

Environmental protection can also help to decrease the likeliness of landslides, rock fall and avalanches (Amt der Vorarlberger Landesregierung, 2014). This is because when the environment is protected, nature is less damaged and held intact, which reduces the chance on natural hazards. This is beneficial for nature, but also for settlements and ski tourism because the risk of dangerous natural hazards decreases (Amt der Vorarlberger Landesregierung, 2014).

In the interview, Simon Steuer gave the example of the occurrence of a landslide in the Bolsterlang ski area close to Oberstdorf-Kleinwalsertal, which damaged the lift. He characterizes this situation as very vulnerable since it is only in catastrophic situations that people tend to take action to combat a problem like this. He also mentioned that the problem is that natural hazards like landslides, storms, and avalanches are not well anticipated since they can happen to all of the ski infrastructures in the region. Therefore, the region is vulnerable because natural hazards are not well anticipated, even though there are measures from the Bavarian State Government to combat this problem.

Reliability on natural resources

For ski tourism, enough snowfall is necessary, and thus there is a reliability on natural resources. However, the amount of fresh snowfall decreases due to climate change as discussed in chapter 4.1.1, which means artificial snowmaking might become more important. In the interview with Simon Steuer, he explained how artificial snowmaking requires a lot of water, especially since the majority of the slopes are equipped with snow cannons for artificial snowmaking. The amount of water that is used is dependent on the location, weather conditions and the efficiency of the snowmaking systems

(Abegg, 2011). To illustrate, the production of 1 m^3 artificial snow requires approximately 200-500 Liters of water (Abegg, 2011). Furthermore, the example Simon Steuer gave about the plans to build a new water storage pool for artificial snowmaking suggests that there is a need for more water, especially when climate change progresses. This indicates that ski tourism in the region relies on water supply, and therefore relies on natural resources.

Besides using a great amount of water, the artificial snowmaking process also requires a lot of energy. The energy consumption is, as the water use, dependent on the location, weather conditions and the efficiency of snowmaking systems. For example, producing 1 m^3 of artificial snow requires approximately 1,5 - 9 KWh (Abegg, 2011). This number is likely to increase due to climate change and higher temperatures, even if snowmaking systems become more efficient (Abegg, 2011). This means that ski tourism depends on energy and therefore relies on natural resources.

4.4.2 Adaptive capacity

To measure the adaptive capacity of the environment, the indicator technology is used. Simon Steuer mentioned that in Oberstdorf-Kleinwalsertal most of the slopes are all equipped with artificial snowmaking, which means that the region has the needed technology to make ski tourism more climate resilient. He also mentioned that artificial snowmaking potentially could be modernized, for example with systems that have a more efficient water and energy use. This indicates that, if the region has the access to the needed technology, it could potentially have the ability to adapt ski tourism to climate change in a more sustainable way. However, the access to technology is also dependent on the economic resources of the region (economic vulnerability), since investing in (new) technology costs money. But because Oberstdorf-Kleinwalsertal is a wealthy region and thus has enough economic resources, indicates that region has the means to invest in the needed technology.

4.4.3 The overall environmental vulnerability

The results show that the region is mostly environmentally sensitive due to natural hazards and ski tourism's reliability on natural resources. Natural hazards are not well anticipated and can occur at any time in all of the ski areas in the region, which makes ski tourism more sensitive regarding the environment. Furthermore, ski tourism is highly dependent on natural resources due to the need of either fresh snow or water and energy use for artificial snowmaking. This dependency makes ski tourism sensitive, because if fresh snowfall or the availability of water and energy were to decrease due to climate change, the ski tourism industry will be immediately affected. However, the region actively protects the environment from the effects of ski tourism, which could decrease the sensitivity of the environment. This may not be beneficial for ski tourism since it means there is less land available to possibly expand, but it is more sustainable because the interests of ski tourism and the environment are both considered, which could decrease the environmental sensitivity.

Furthermore, the results suggest that the region has a good environmental adaptive capacity, since there is access to the needed technology to make ski tourism more resilient to climate change. Additionally, technology could potentially be modernized to make artificial snowmaking more sustainable and less damaging for the environment, which could also lessen the chances of a natural hazards, since the environment is being protected.

When taking into account the exposure, sensitivity and adaptive capacity, it can be said that the environment is vulnerable to climate change. The results suggest that the environment is sensitive, and that the sensitivity could increase due to climate change. However, the region's adaptive capacity good since there is access to the needed technology.

5. RESULTS & ANALYSIS: CLIMATE ADAPTATION

In this chapter climate adaptation strategies in the Alps and Oberstdorf-Kleinwalsertal are discussed. The chapter begins by looking at how awareness is created for climate adaptation in the region. After this, strategies that are aimed at maintaining ski tourism, creating alternative strategies to ski tourism and the use of subsidies are discussed, based on the framework of Elsasser & Bürki (2002), (Figure 3).

5.1 Creating awareness for climate adaptation

Currently, there is no official report on climate adaptation in Oberstdorf-Kleinwalsertal. However, the conversation about the topic in the region has started. Landkreis Oberallgäu (2017) states in their report on climate protection that citizens of the municipality of Oberstdorf should be informed about possible climate adaptation strategies, and what that could change in the region. The report also mentions that regular initiatives in the future can be useful to create more awareness.

This fits in the classification adaptation/response options from Burton (1996) under the category education/behavioral, since creating awareness of the subject may lead to citizens being more educated on climate adaptation, as well as behavioral change among citizens.

5.2 Maintaining ski tourism

5.2.1 Maintaining ski tourism in the Alps

Abegg (2011) discusses various Alpine adaptation strategies that are aimed at maintaining ski tourism. The first adaptation strategy that is mentioned is artificial snowmaking. The main reasons artificial snowmaking is used is to ensure ski tourism of enough snow, to uphold the duration of the ski season and to soften the natural boundaries of snowfall that are dictated by weather and climatic patterns. According to Abegg (2011), millions of Euros have been invested into artificial snowmaking, and as a result, 47% of the of the ski slopes in the Alps have been equipped with artificial snow.

Other adaptation strategies mentioned by Abegg (2011) to maintain ski tourism include snow farming, landscape interventions and the concentration of ski areas at more suitable locations. Snow farming is managing natural and artificial snow by creating snow depots in ski areas that are located at a high elevation. The snow is covered by foil or sawdust to conserve it and can be used for the next winter season. Although this adaptation strategy saves electricity and fuel, it does negatively impact the landscape. Landscape interventions are aimed at reducing the minimal snow depth by removing obstacle form ski slopes as well as equalizing ski slopes and are often used in conjunction with artificial snowmaking. Due to landscape change, this adaptation strategy can damage the existing vegetation and increase erosion. Concentrating on ski areas at more suitable location entails, for example, concentrating on ski areas that are already located at a high elevation, expanding ski areas to higher undeveloped terrain, and locating ski slopes on south-facing slopes. Although this strategy is often used, it does have its limits. For example, in many ski areas it is not possible to expand to higher elevated terrain. Furthermore, weather tend to be extremer at higher elevations (e.g. wind) and there is an increased risk of avalanches, which can disadvantageous for ski tourism. Additionally, developing high terrain for ski tourism can be very expensive and can contradict with measures that are taken to protect the environment.

5.2.2 Maintaining ski tourism in Oberstdorf-Kleinwalsertal

From the studied literature, only the Vorarlberger Landesregierung (2015) states that they aim to maintain the current good position of winter tourism, but no specific climate adaptation strategies regarding maintaining ski tourism are further mentioned.

The Bayerisches Staatsministerium für Umwelt und Verbraucherschutz (StMUV) (2015) mentions that investments in artificial snowmaking are specifically beneficial for higher elevated ski areas. Furthermore, it is explained that artificial snowmaking to maintain ski tourism could be made more sustainable by generating the necessary energy locally from renwable sources.

However, in both interviews, two strategies were mentioned regarding maintenance of ski tourism. Firstly, are investments in the lift infrastructure. Simon Steuer explained that in Oberstdorf-Kleinwalsertal they are currently investing in the renovation of existing lifts. An advantage of this, as stated by Sebastian Gries, is that the lifts are not weather dependent, and therefore, the summer season also benefits from a better lift infrastructure.

Secondly, in both interviews it was stated how artificial snow is an important strategy when maintaining ski tourism. Simon Steuer explained in the interview that the region already has invested in artificial snowmaking and that most of the slopes are already equipped with snow cannons. Due to this, there are no activities regarding the expansion of artificial snowmaking, and it is expected that the amount of artificial snowmaking will more or less stay the same. This means that to maintain ski tourism, the region tries to modify the events, which in this case means modifying ski tourism to climate change (Burton, 1996). However, it was mentioned in both interviews that artificial snowmaking has many negative impacts. Simon Steuer explained that the local population is against more artificial snowmaking, and that artificial snow has negative environmental impacts due to the large demand for water and electricity. Sebastian Gries also mentioned that artificial snowmaking is not a sustainable solution because of the environmental impacts, but also due to the fact that it creates a situation where the focus lies just on ski tourism, and not on other alternatives to ski tourism.

5.3 Alternatives to ski tourism

5.3.1 Alternatives to ski tourism in the Alps

The first adaptation strategy Abegg (2011) discusses regarding alternatives to ski tourism, is diversification of winter tourism, which means offering other activities than skiing related activities, that are either snow dependent or snow independent. The aim of this adaptation strategy is to reduce the dependency on ski tourism. The benefit of this is that the amount of visitors in the winter rises, because a more diverse group of visitors is targeted. However, most of these alternative activities still tend to be snow dependent, which means these activities are still vulnerable to climate change. Additionally, Abegg (2011) mentions that there is no alternative that is big enough to potentially replace ski tourism. As a result, only focusing on alternatives could mean a decrease of income for stakeholders in the ski tourism industry.

The second adaptation strategy Abegg (2011) discusses in terms of alternatives to ski tourism in focusing on all-year tourism. The aim of this strategy is to decrease the dependency on winter tourism by shifting the focus to strengthening tourism in the other seasons. This can be especially useful for regions located in the Alps, since climate change causes summer temperatures to still be enjoyable, while, for example, summer temperatures in the Mediterranean Sea region become too high to be pleasant. This can cause summer tourism to become more important in Alpine regions.

5.3.2 Alternatives to ski tourism in Oberstdorf-Kleinwalsertal

There are two categories that can be distinguished regarding climate adaptation strategies that are aimed at alternatives to ski tourism. Both categories are focused on modifying (winter) tourism to climate change (Burton, 1996). The first category entails alternative winter activities to ski tourism. In the report of IKU_Die Dialoggestalter (2017) ideas of the local citizens regarding climate adaptation in the Allgäu region are discussed. In terms of winter tourism, it is stated how currently, visitors in the winter season do not primarily come for ski tourism, and therefore it is important that the focus lies on the diversification of winter tourism by developing attractive and sustainable winter tourism, that can be attractive, regardless of the amount of snow. Sebastian Gries explained in the interview that, since the winter season is not mainly focused on ski tourism, there are other winter activities such as winter hiking, sledding, and other activities for families with children. He further mentioned that in Ostallgäu, since they do not have a significant ski tourism industry, the adaptation strategies might be broader because they are more focused on the alternative winter activities: "*We are less talking about more artificial snow, we are more talking about how to get from ski tourism to winter activities. What to do on a rainy day? We less think about how to make snow on a warm day, we more think about what to do on a rainy day."*

The responses to the survey showed that for 61,5% respondents, the winter season is still mainly focused on ski-related activities. However, some responded that they also market other activities, such as (snowshoe) hiking and trail running, and therefore, focus on alternative winter activities.

The second category of climate adaptation strategies aimed at alternatives to ski tourism entails shifting the focus to all-year tourism. In the report of Regionalentwicklung Oberallgäu (2014) it is stated how the region Oberallgäu is mainly investing in tourism activities related to hiking, cycling, and health tourism. Furthermore, the StMUV (2015) mentions that alternative activities should focus more on health, wellness, and culinary tourism. In addition, activities on the mountains (for example around lifts) should be expanded by investing, for example, in building themed huts, viewing platform, adventure trails and hiking trails. The StMUV (2015) also explains that there could be more investments in weather independent indoor activities like swimming and climbing. Besides this, the Vorarlberger Landesregierung (2015) states that they want to strengthen the summer and mid-season by focusing on innovation, quality, regional products, sustainability, and cooperation with other industries to strengthen the competitiveness in Vorarlberg. In both reports, there are no practical climate adaptation strategies mentioned, but the reports do show that there are investments in strengthening all-year tourism.

The focus on all-year tourism was also discussed in both interviews. Simon Steuer explained that summer tourism is equivalent, or even more important for the tourism industry than ski tourism, which is an important strength of the region. Therefore, it might be easier for the region to focus on all-year tourism. He also mentioned how there are investments in the renovation of lifts and recreational areas around the lifts, for example playgrounds, as to also attract visitors to the lifts in the summer season. However, he also illustrated how this can be controversial by giving an example about Grünten, a mountain just outside of the region Oberstdorf-Kleinwalsertal. The new owner wants to invest in summer tourism and make an entire recreational area including a zip line and a brand-new restaurant, but the owner is facing a lot of opposition against the plans. Therefore, it can be difficult to invest more in summer tourism, but it is something they are actively thinking about in the region. Furthermore, Sebastian Gries explained that in Ostallgäu, most investments are to

improve the quality of the existing hiking trails and bike infrastructures, as well as reducing the number of trails, so that the focus really lies on improving the quality. This is especially important because they are located in mountainous areas, and thus are more vulnerable to climate change. Besides this, he mentioned that there are investments in countryside holidays.

The survey responses showed that, regarding attracting summer tourists, accommodations often market activities such as hiking and cycling, and try to show the beauty of the mountains and nature. Furthermore, one of the restaurants mentioned that there are longer opening times in the summer season, which indicates that there are accommodations and restaurants that are trying to focus on all-year tourism.

5.4 Subsidies

5.4.1 Subsidies in the Alps

According to Abegg (2011) the aim of the use of subsidies is to support touristic (skiing- related) activities with public funds. These subsidies can be either be single contributions, or repeated contributions. In addition, the subsidies can be used to mediate loans, which, for example, can be used by cable car organizations. The report further indicates that subsidies are often exclusively aimed at cable car organizations, and not directly extended to other stakeholders in the ski tourism industry. Abegg (2011) explains that the main reason for this is that these cable car organizations are often seen as the backbone of touristic activities and are therefore of great importance for the local economy. Additionally, other stakeholders in the (ski) tourism industry benefit from the cable organizations, which means it is in their interest to have well-operating lifts and ski areas.

5.4.2 Subsidies in Oberstdorf-Kleinwalsertal

In the studied literature there is nothing mentioned about the use of subsidies in ski tourism. Sebastian Gries stated in the interview that the Bavarian Government has announced that, also due to the Corona pandemic, there is a plan to invest more in sustainable tourism, to make tourism more climate resilient, specifically in terms of infrastructure, mobility, and small businesses. This indicates that there are subsidies for the tourism industry, but it is not focused on ski tourism. Simon Steuer stated in the interview that, in general, it is not common for the tourism industry to get a subsidy, even when they have a bad year. However, he did mention that the Bavarian Government co-financed the renovation of certain lifts in Oberstdorf-Kleinwalsertal in the last few years, so there was a subsidy available for the renovation of lifts.

He further explained that there are also informal subsidies that are not obvious. This is illustrated with the example given before about the Bolsterlang ski resort, where the municipality decided to finance the renovation of the lift to support the lift company since they could not finance it themselves.

It is noteworthy that all of these examples are all related to the lifts in the region, and thus are confined to one stakeholder of the ski tourism industry, which is in line with the report of Abegg (2011). Furthermore, these subsidies seem to not be necessarily directed at adapting ski tourism to climate change.

5.5 Relation to climate adaptation literature

The analysis of the different climate adaptation strategies shows that in the Alps and Oberstdorf-Kleinwalsertal adaptation strategies generally fall under the three categories mentioned in the framework by Elsasser & Bürki (2002). However, the framework does not mention creating awareness as an adaptation strategy, while it is mentioned as an aspect of climate adaptation in the report by Landkreis Oberallgäu (2017) and in the framework of Burton (1996). Increasing awareness of the subject could lead to behavioral change and a more educated citizenry, which may mean more support and willingness for adaptation strategies. Support for adaptation strategies is important, because climate adaptation can be controversial, as the examples of artificial snowmaking and Grünten illustrate. Therefore, not only the three general adaptation strategies of maintaining ski tourism, alternatives to ski tourism and the use of subsidies should be considered, but also creating awareness of climate adaptation.

Furthermore, as mentioned in chapter 1.2.1, artificial snowmaking is included as an adaptation strategy in this chapter, as it is a commonly used adaptation strategy in the Alps and the region Oberstdorf-Kleinwalsertal. Additionally, this chapter contributes to the existing climate adaptation literature by analyzing existing literature about ski tourism related climate adaptation in the Alps and in Oberstdorf-Kleinwalsertal, as well as adding information that was gained by the two interviews and surveys about climate adaptation in Oberstdorf-Kleinwalsertal. This means that climate adaptation is not only viewed from the perspective of official reports, but also from the point of view of people living in the region, which gives a broader view of climate adaptation in the region.

6. CONCLUSION

In this chapter, the main research question of this research will be answered based on the analysis of the results. The aim of this research was to explain the economic, social, and environmental impacts of climate change on ski tourism in Oberstdorf-Kleinwalsertal and to assess what climate adaptation strategies there are. Firstly, both sub-questions will be answered in this chapter, after which the main research question will be answered.

6.1 Answering the sub-questions

6.1.1 Economic, social, and environmental vulnerability

The first sub-question that is going to be answered is: *How is ski tourism vulnerable to climate change in terms of economic, social, and environmental factors?* Firstly, it can be concluded that Oberstdorf-Kleinwalsertal currently is exposed to the consequences of climate change. The winter temperatures are rising in both Oberstdorf and Kleinwalsertal, the amount of snowfall is decreasing in Oberstdorf, and the length of the winter season has also slightly decreased in both Oberstdorf and Kleinwalsertal. This indicates that Oberstdorf is more exposed to climate change than Kleinwalsertal. However, the survey responses showed no clear difference between Oberstdorf and Kleinwalsertal in terms of exposure. Therefore, it can be concluded that the region is exposed to climate change and that Oberstdorf is more exposed to climate change than Kleinwalsertal, although the difference is currently not clearly visible for the stakeholders.

In terms of the economic vulnerability, it can be concluded that the most sensitive group of stakeholders are the ski schools and/or rentals, since most of the ski schools and/or rentals are mainly focused on the winter season. This means that income and jobs in this sector are dependent on ski tourism because the majority of people in this sector work in the winter season. The stakeholder that is less sensitive than ski schools and/or rentals is Oberstdorf-Kleinwalsertal Bergbahnen. Oberstdorf-Kleinwalsertal Bergbahnen is more dependent on ski tourism than summer tourism because ski tourism is responsible for the majority of income and creates additional jobs. Regarding restaurants and cafés, the results show that the sensitivity to climate change is dependent on the context of the restaurant or café. Therefore, it can be concluded that restaurants or cafés that are located near a ski slope are more dependent on ski tourism than a restaurant or café that is located in the town centre. The group of stakeholders that is least sensitive to climate change are accommodation owners, since the summer and winter season are either equally busy, or the summer season is busier. In addition, the generated income is often equal in the summer and winter season, or bigger in the summer season. This indicates that accommodations in general are not more dependent on ski tourism than on the summer tourism.

Regarding the economic adaptive capacity, Oberstdorf-Kleinwalsertal has a favorable position. The results show that the region is wealthy, and the state of the economic situation is good as well. Therefore, it can be concluded that the region has enough economic resources and the economic capacity to adapt to climate change.

In conclusion, the results show that, regarding the economic vulnerability, the stakeholders of the ski tourism industry are vulnerable to climate change. However, the extent to which a stakeholder is vulnerable is dependent on the stakeholder.

In terms of the social vulnerability, it can be concluded that Oberstdorf-Kleinwalsertal currently has an aging population, which can lead to a decrease in demand for physical activities such as skiing. This indicated that in terms of demographics, the region is quite sensitive. Furthermore, it can be concluded that Oberstdorf-Kleinwalsertal has a moderate community spirit. There is cooperation between the different stakeholders of the ski tourism industry, but not all of the stakeholders cooperate with other businesses in the ski tourism industry to the same extent. For example, the results show that accommodations primarily have a collaboration with Oberstdorf-Kleinwalsertal Bergbahnen, but that other businesses in the ski tourism industry are often not included. The analysis of the ski schools and or/rentals showed that a large majority cooperates with other businesses in the ski tourism industry. This indicates that there are networks between the different stakeholders to support each other, but these networks can be stronger or weaker, depending on the stakeholder. It can also be concluded that skiing is seen as an important aspect of the culture and identity of the region, which can add to the sensitivity of the region because people might be more resistant to focus on alternatives to ski tourism, which can make the region more vulnerable.

Based on the results, the social adaptive capacity appears to be limited. The willingness to adapt is small, due to the fact that the necessity of climate adaptation is not seen. In addition, no people are actively working on the subject of climate adaptation, which can make the region vulnerable to climate change if something unexpected happens. However, the social infrastructure of the region is good, because there are actor networks and stakeholders are prepared to support each other.

In conclusion, the region is socially vulnerable to climate change, particularly because of the aging population and since ski tourism is of cultural importance for the region. Furthermore, the adaptive capacity is limited which makes it more difficult to adapt to climate change.

The next factor is the environmental vulnerability. The region Oberstdorf-Kleinwalsertal is actively taking measures to protect the environment from the impacts of ski tourism, which can lessen the sensitivity of the environment and thus make the environment less vulnerable. However, natural hazards are not well anticipated in the region and only in catastrophic situations people seem to take action to combat the actual problem. This causes settlements and ski infrastructures in the region to be sensitive to natural hazards and have a vulnerable position. Furthermore, ski tourism is very dependent on the availability of water, especially due to artificial snowmaking. This can make ski tourism more climate resilient, but the environment more sensitive and therefore vulnerable to climate change.

The available technology plays a part in the adaptive capacity of the environmental vulnerability. Since most of the slopes are equipped with artificial snowmaking infrastructure, it can be concluded that the region has the needed technology to make ski tourism more climate resilient. The artificial snowmaking process could also be modernized, which could potentially make it more environmental-friendly, since artificial snowmaking is not considered as sustainable towards the environment.

In conclusion, it can be said that the ski tourism industry in Oberstdorf-Kleinwalsertal is environmentally vulnerable to climate change, since natural hazards form a threat and because of the dependency of ski tourism on natural hazards. However, the region actively protects the environment from ski tourism and the region has a good adaptive capacity, since the needed technology in accessible and could potentially be modernized.

6.1.2 Climate adaptation

The second sub-question that is going to be answered is: *What types of climate adaptation strategies are there for ski tourism?* As of right now, Oberstdorf-Kleinwalsertal does not have an official report yet on climate adaptation. However, the region has taken measures that generally fall into three types of strategies: strategies that aim to maintain ski tourism, strategies of alternatives to ski tourism and the use of subsidies. Besides this, the region seeks to inform citizens about climate adaptation strategies and create awareness on the subject. This might be beneficial for the region, since climate adaptation is currently not seen as a necessity, and more awareness could lead to more willingness to adapt to climate change, thus creating more pressure on the topic.

Based on the results it can be concluded that Oberstdorf-Kleinwalsertal is currently not investing in more artificial snowmaking to maintain ski tourism, since most of the slopes are already equipped for artificial snowmaking and because there is opposition. However, there are currently investments to renovate some of the lifts in Oberstdorf-Kleinwalsertal, which benefits ski tourism as well as summer tourism.

The region focuses the most on strategies that emphasize the alternatives to ski tourism. A reason for this is that an important strength of the region is that summer tourism is equivalent, or even more important than ski tourism. Alternative winter activities that are mentioned mainly consist of (snowshoe) hiking, trial running and sledding. Furthermore, alternative strategies that are concerned with shifting the focus to summer tourism consist of strengthening summer tourism with investments in hiking, cycling and health tourism. In addition, there are investments in recreational areas around the lifts, to attract more visitors to the lifts in the summer season.

The use of subsidies as an adaptation strategy is not common in the region, and therefore not an important adaptation strategy. There are certain subsidies, mainly from the Bavarian Government, to invest in sustainable tourism and the renovation of the lifts in Oberstdorf-Kleinwalsertal. In addition, there are also informal subsidies between stakeholders that are not obvious. However, these subsidies are not necessarily aimed at adapting ski tourism to climate change.

6.2 Answering the main research question

The main research question is *How does climate change affect ski tourism in the ski region Oberstdorf-Kleinwalsertal and how is the region adapting to climate change?* Climate change affects ski tourism through economic, social, and environmental impacts. It can be concluded that the economic effects of climate change differ between stakeholders of the ski tourism industry. For example, accommodations are less dependent on ski tourism than ski schools and/or rentals, which means that they are less vulnerable to climate change than ski schools and/or rentals. An important reason for this is that winter tourism and summer tourism are both of importance for the region, which is an important strength, since it indicates that tourism is not only economically dependent on ski tourism. This makes the tourism industry less vulnerable. Furthermore, the region has a strong economic adaptive capacity, which overall, makes the economic vulnerability smaller.

Climate change also affects the social aspects of ski tourism. This is due to an aging population and because ski tourism is seen as an important part of the culture and identity of the region, which can make the region more socially vulnerable to climate change. However, there are networks and support systems between stakeholders of the ski tourism industry, which make the region more resilient to climate change. The social adaptive capacity of the region seems to be

currently relatively small, which can make the region more socially vulnerable to climate change.

Furthermore, climate change affects ski tourism in terms of the environment. This is due to the fact that ski tourism relies on natural resources like water, which is needed for producing artificial snow and can negatively impact the environment. Furthermore, the region is also vulnerable to natural hazards. One of the reasons for this is that these are not well anticipated. However, the region is taking action to protect the environment from the impacts of ski tourism. In addition, the necessary technology to adapt ski tourism to climate change is available, which on the one hand, makes ski tourism more climate resilient, but on the other hand, is not really sustainable regarding the environment.

The region is in the early stages of developing climate adaptation and there is an absence of an official report and plan for climate adaptation. The main reason for this is that there is no signal that the region is in need of such a report, because in the short-term, climate change is not a major concern regarding ski tourism. Therefore, the willingness to take action and adapt ski tourism to climate change appears to be small. However, the region has undertaken action to adapt to climate change. The climate adaptation strategy that the region is mainly focused on is creating alternatives to ski tourism. This is done by focusing on alternative winter activities, and by shifting the focus from the winter season to the summer season to strengthen summer tourism even more.

Besides this, there are also climate adaptation strategies that are aimed at maintaining ski tourism, although these seem to be less popular than focusing on alternatives to ski tourism. To maintain ski tourism, most of the slopes are equipped with artificial snowmaking which makes ski tourism more resilient to climate change. However, currently there are no investments in that direction anymore. The region is currently investing in the renovation of lifts, which benefits ski tourism as well as summer tourism.

The least used adaptation strategy is the use of subsidies. They are not commonly used in the region, but the Bavarian Government occasionally supports the tourism industry with subsidies, and there are informal subsidies between stakeholders when they need to support each other. However, these subsidies seem to not be directed at adapting ski tourism to climate change.

7. DISCUSSION & REFLECTION

This chapter starts off by discussing the validity and reliability of this research. After this follows the reflection of the process of this research, which entails the limitations and improvements of this research, as well as the relation to the existing literature. Finally, recommendations for future research will be given.

7.1 Validity and reliability

Firstly, the validity of this research will be discussed. The validity explains how accurately the used methods measure the concepts used in this research (Heale & Twycross, 2015). There are two types of validity used to determine the validity of this research. The content validity explains if the results of this research are representative for the variables it seeks to measure (Heale & Twycross, 2015). The fact that the survey got few responses and only two interviews could be conducted, caused that the amount of collected data is rather small. This reduces generalizability to all of the stakeholders of the ski tourism industry in Oberstdorf-Kleinwalsertal. However, because of the use of triangulation it could be examined if the results were in line with each other, which increases the likeliness that the results are representative for the involved stakeholders. Additionally, the construct validity explains whether this research correctly measures the variables it is aimed to measure (Heale & Twycross, 2015). Since this research used triangulation by collecting data through surveys, interviews, and a desk research, the chance of measuring the concepts correctly was increased, which increases the construct validity. Furthermore, all of the steps of this research were consistently followed, which increases the construct validity.

Secondly, the reliability of this research is discussed, which refers to the consistency of the measurements (Heale & Twycross, 2015). Because this research used surveys, interview and a desk research to collect the necessary data, the data can be compared to each other, which means that the chance of measuring the same results when repeating a similar research is increased, which increases the reliability of this research. However, because the research is focused on the current effects of climate change on ski tourism and since this is a situation that could change as climate change progresses, it could be that in the future the results of a similar research would be different.

7.2 Reflection

7.2.1 Limitations & improvements

The biggest limitation of this research is the lack of collected data. The few responses to the survey cause the results to be less representative, thus making more difficult to generalize the results over the whole population. This was solved by using triangulation and by reviewing the websites of ski schools and/or rentals. Furthermore, only two interviews could be conducted, from which both interviewees were from Germany. This means that there is a lack of representation from Austria (Kleinwalsertal) in terms of interviews.

Besides this, another limitation is that the interviewees were both not directly connected to Oberstdorf-Kleinwalsertal, as Sebastian Gries is employed at Tourismusverband Ostallgäu and Simon Steuer works for Allgäu Klimaschutz. A deeper understanding of the region, especially regarding the economic and social vulnerability could have been achieved when there would have been additional interviewees that are directly connected to Oberstdorf-Kleinwalsertal (e.g. tourist offices of

Oberstdorf and Kleinwalsertal, municipalities, Oberstdorf-Kleinwalsertal Bergbahnen). These organizations were contacted but did not respond.

Furthermore, a limitation of this research was the fact that everything had to be done online, because of the Coronavirus pandemic and because the research is international. This can make the communication more challenging. For example, questions and terms in the web survey could be interpreted differently by respondents, such as the term ski tourism. This could be improved by mentioning a clear definition of the used terms at the beginning of the survey. Furthermore, there could be miscommunications in the interviews due to the fact that they were conducted in English, which is not the first language of the interviewees as well as myself.

Additionally, a limitation of this research is that due to the limited time and scale of this research, the number of indicators and actors that are used are limited as well. Another indicator that could have been used to measure the economic vulnerability is, for example, the growth of destination which refers to if, for example, the amount of accommodations are growing and if there is a difference in growth between winter and summer tourism (Alber et al., 2011). An indicator that could have been used to measure the social vulnerability is the unemployment rate, since climate change may cause unemployment in the ski tourism industry, for example ski teachers. Furthermore, another actor that could have been added is the transportation sector in Oberstdorf-Kleinwalsertal, since (ski) tourism causes more traffic and pressure on transportation networks, which generates income for the transportation sector, but it can also impact the environment negatively due to the emission of GHG (Steiger et al., 2019).

7.2.2 Relation to other literature

This research has expanded the existing literature on climate vulnerability and climate adaptation in relation to ski tourism in several ways. To begin with, this research has added to the existing literature because it has investigated the vulnerability of the ski tourism industry in the region Oberstdorf-Kleinwalsertal, as well as what the region has done to adapt ski tourism to climate change, which has not been done before. The focus on one particular region is especially important regarding climate change vulnerability and climate adaptation, since the vulnerability and climate adaptation strategies can differ between regions (Steiger et al., 2019). This also means that results and conclusions of other research cannot be applied to Oberstdorf-Kleinwalsertal but are only suitable for the regions research focusses on.

Additionally, this research has added to the existing literature is by not only taking a quantitative approach, but also taking a qualitative approach, which is an approach not often used in the existing literature (Steiger er al., 2019). Because this research also takes a qualitative approach, the collected data is studied and interpreted in-depth, which means results are not just reported in tables and graphs, which is for example the case in Willibald et al. (2021).

Furthermore, this research has added to existing literature by also including the economic and social vulnerability, instead of just the environmental/biophysical vulnerability, which causes the research to be broader. Including the social and economic vulnerability is also important because it can help to determine suitable climate adaptation strategies for the ski areas and communities in the region (Dawson & Scott, 2007).

The results also show that the economic, social, and environmental vulnerability can overlap, as mentioned by Füssel (2005). For example, the unemployment might rise (social vulnerability) because the number of jobs in the ski tourism industry (e.g. ski teachers) might decrease due to climate change (economic vulnerability). Another example is that because of protected areas, it is

not possible to expand ski tourism to other locations. Furthermore, natural hazards can damage ski tourism related infrastructure such as ski lifts (e.g. Bolsterlang ski area), as well as accommodations and other stakeholders in the ski tourism industry, which can lead to economic losses. This also means that when the environment is less sensitive to natural hazards, stakeholders in the ski tourism industry have a lower risk of damage and economic losses, which can make them less economically vulnerable. This shows how the environmental vulnerability influences the economic vulnerability (Nicholls, 1999).

7.3 Recommendations for future research

Since this research is solely focused on the current vulnerability of Oberstdorf-Kleinwalsertal, it could be useful to also include the future vulnerability in future research to gain a better insight in how the region and stakeholders could be affected by climate change in the future. Including both the current and future vulnerability will give a more thorough picture of the vulnerability of the region.

Furthermore, future research should include more stakeholders, due to the limited representativity of this research. The response rate of the surveys of this research is quite low, therefore, the research could be improved if more stakeholders would be included. Moreover, only two interviews were conducted, both with German interviewees. Future research could also include Austrian interviewees, and interviewees that are directly connected to the region, to give a clearer picture of the Austrian point of view and to gain a broader view of the region.

Additionally, future research could investigate which climate adaptation strategies are most suitable for Oberstdorf-Kleinwalsertal. This could be especially beneficial for the region since climate adaptation regarding ski tourism is currently in the beginning stages. The results of this research suggest that because ski tourism is of social and economic importance for the region, maintaining ski tourism might be a more obvious adaptation strategy. However, because this research is not focused on the suitability of adaptation strategies, this is only discussed limitedly. Therefore, it could be included in future research by, for example, investigating the attitude of stakeholders towards different adaptation strategies.

It could also be useful for future research to include more adaptation strategies. Although this research takes into account most of the commonly used adaptation strategies, there are also other strategies that have not been included, or partially included. For example, the adaptation strategies snow farming, landscape interventions and concentrating ski areas in more suitable locations are only touched upon briefly in chapter 5.2.1 but seem to currently not play a huge role in Oberstdorf-Kleinwalsertal. This, however, could change in the future when climate change progresses. An example of an adaptation strategy that could be included in future research is focusing on sustainable tourism, which aims to develop environmental and climate friendly tourism (Abegg, 2011).

Besides climate adaptation strategies, climate mitigation strategies could also be included, since including both climate adaptation and mitigation draws a broader picture of climate change and ski tourism, especially since tourism is also a driver for climate change (Steiger et al., 2019). Therefore, climate mitigation in the (ski) tourism industry could help combat climate change. Possible mitigation strategies for (ski) tourism could be traffic management and energy management (Abegg, 2011).

Lastly, it could be useful for future research to compare Oberstdorf-Kleinwalsertal, or another similar region with strong winter and summer tourism, with a region that is more focused and dependent on ski tourism and has weaker summer tourism. This could give insight into the

differences between the regions, and how the region with weaker summer tourism could attract more summer tourists, to decrease the vulnerability of tourism in that region to climate change.

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APPENDIX

Appendix 1: Operationalization

The concepts of economic, social, and environmental vulnerability are further operationalized to make them more measurable. Economic, social, and environmental vulnerability consist of three different components, as discussed in chapter 2.1.1: exposure, sensitivity, and the adaptive capacity. These are further operationalized in into various indicators, to make the components of vulnerability measurable.

Economic vulnerability

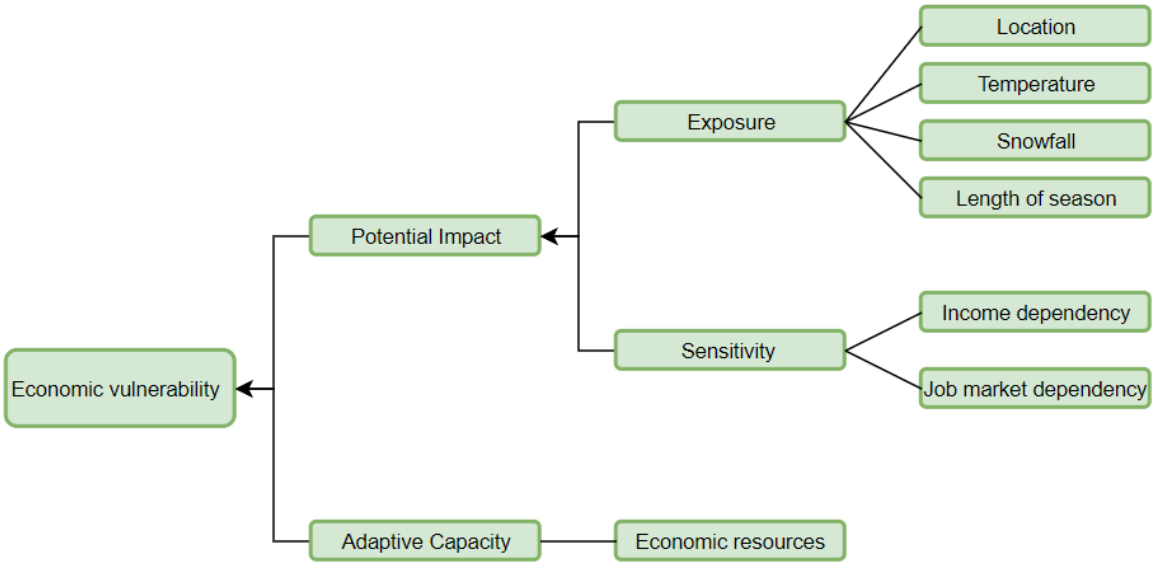

Figure 27: operationalization of the economic vulnerability

Figure 27 shows that the exposure is measured by four indicators: *location*, *temperature*, *snowfall,* and the *length of season*. These indicators can measure to what extent Oberstdorf-Kleinwalsertal is exposed to climate change, and how exposed the ski industry is to climate change. It is important to note, that the exposure is similar for social and environmental vulnerability since the exposure is a general aspect of the region. Furthermore, the sensitivity can be divided into two indicators: *income dependency* and *job market dependency*. These indicators can determine how economically dependent the region is on ski tourism, and thus how sensitive the sector is. The adaptive capacity can be measured by the available *economic resources* in the region.

Social vulnerability

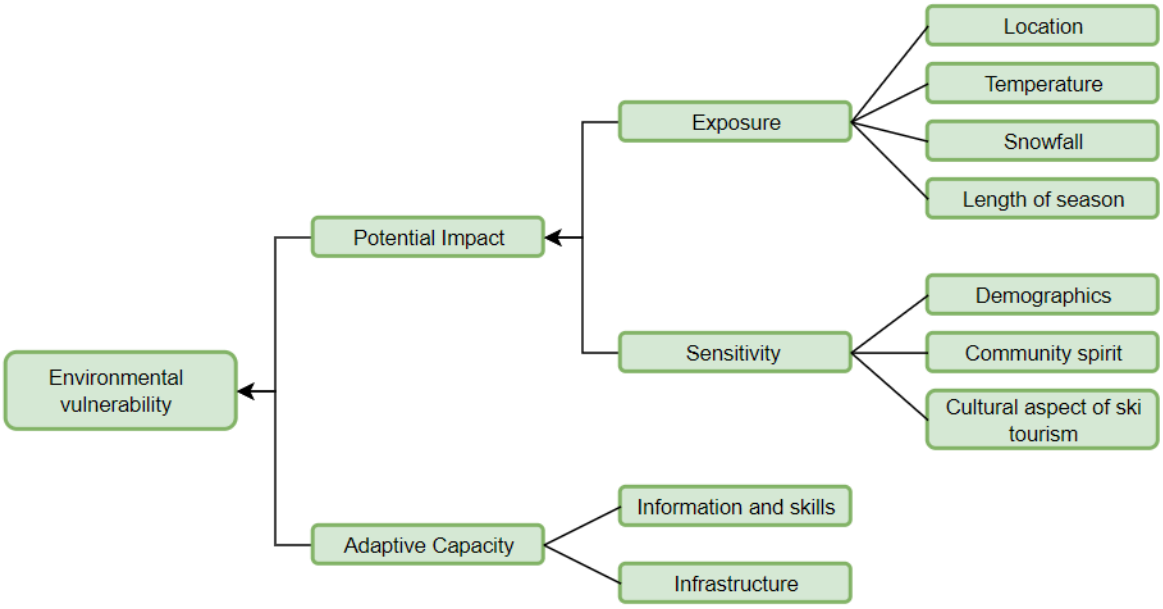

Figure 28: operationalization of the social vulnerability

Figure 28 shows that the exposure is again measured by four indicators: *location*, *temperature*, *snowfall*, and the *length of season*, to measure to what extent Oberstdorf-Kleinwalsertal is exposed to climate change, and how exposed the ski industry is to climate change. The sensitivity is divided into three indicators: *demographics*, *community spirit* and the *cultural aspect of ski tourism*. Furthermore, the adaptive capacity can be divided into 'information and skills' and the (social) *infrastructure*.

Environmental vulnerability

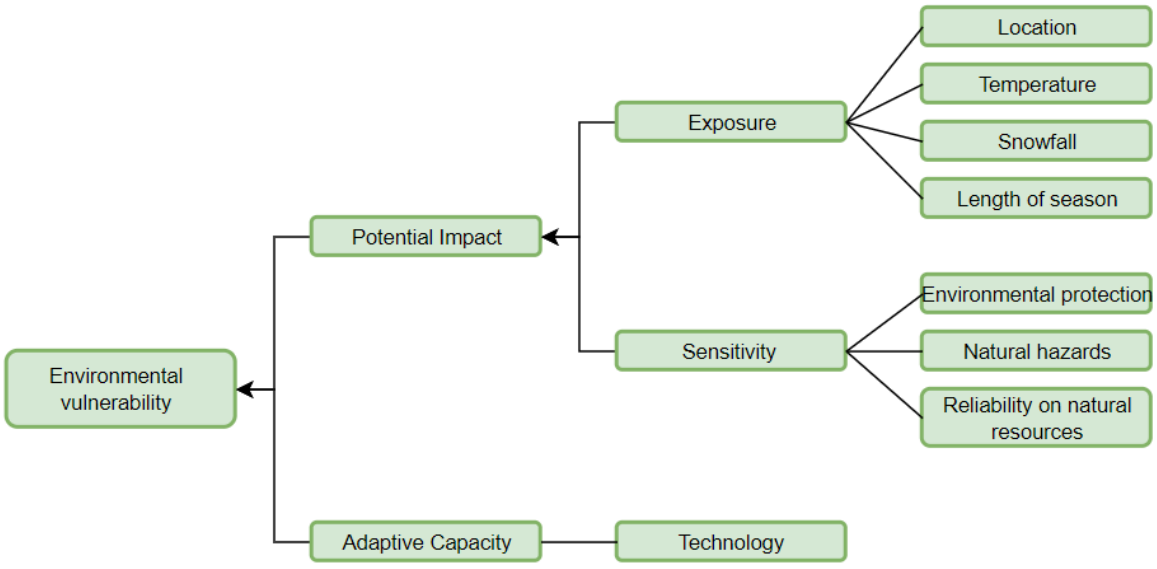

Figure 29: operationalization of the environmental vulnerability

Figure 29 shows that the exposure is again measured by four indicators: *location*, *temperature*, *snowfall*, and the *length of season*, to measure to what extent Oberstdorf-Kleinwalsertal is exposed to climate change, and how exposed the ski industry is to climate change. The sensitivity in divided into three different indicators: *environmental protection*, *natural hazards,* and *reliability on natural* resources. The adaptive capacity has one indicator, *technology*.

Climate adaptation

The concept of climate adaptation is further operationalized based on the framework presented by Elsasser and Bürki (2002), which is displayed in figure 3. The aspects of the framework that are used for the analysis of climate adaptation in the region Oberstdorf-Kleinwalsertal are *maintaining ski tourism*, *alternatives to ski tourism*, and *subsidies*.

Appendix 2: Surveys

Survey accommodations

1. What is the name of your accommodation?

2. Have you experienced changing weather patterns in recent years that could be due to climate change?
- Higher temperatures
- Less snowfall
- Shorter winter season
- No, I have not experienced any significant changes
- Other

3. In the past five years, has the winter season been busier, just as busy, or less busy than the summer season for your business?
- Winter season in busier
- Winter and summer seasons are just as busy
- Summer season in busier

4. How much (%) of the annual income of your business in approximately generated through ski tourism?

5. Do visitors of your accommodation in the winter season come just for skiing related activities, or do they also come for other activities?
- Just for skiing related activities
- Hiking
- Sightseeing
- (sport) events

6. When there is little/no snow in the winter season, my accommodation has
- Less visitors
- Just as many visitors
- More visitors

7. Is there cooperation between accommodations, or/and between accommodations and other businesses in the tourism industry?

8. Would you say that skiing is an important aspect for the culture and identity of the region?
- Very important
- Fairly important
- Important
- Slightly important
- Not important

9. Does your business invest in other winter activities than only activities related to ski tourism? If yes, what kind of activities?

10. Does your business invest in attracting visitors in the summer season? If yes, how do you attract summer tourists?

Survey ski schools and/or rentals

1. What is the name of your ski school/rental?

2. Have you experienced changing weather patterns in recent years that could be due to climate change?
- Higher temperatures
- Less snowfall
- Shorter winter season
- No, I have not experienced any significant changes
- Other

3. In the past five years, has the winter season been busier, just as busy, or less busy than the summer season for your business?
- Winter season in busier
- Winter and summer seasons are just as busy
- Summer season in busier

4. How much (%) of the annual income of your business in approximately generated through ski tourism?

5. Is there cooperation between ski schools/rentals, or/and between ski schools/rentals and other businesses in the tourism industry?

6. Would you say that skiing is an important aspect for the culture and identity of the region?
- Very important
- Fairly important
- Important
- Slightly important
- Not important

7. Does the ski rental also rent/sell other products that are not related to winter sports?

8. Does the ski school also offer other courses than skiing/snowboarding?

Survey restaurants/cafés

1. What is the name of your restaurant/café?

2. Have you experienced changing weather patterns in recent years that could be due to climate change?
- Higher temperatures
- Less snowfall
- Shorter winter season
- No, I have not experienced any significant changes
- Other

3. In the past five years, has the winter season been busier, just as busy, or less busy than the summer season for your business?
- Winter season in busier
- Winter and summer seasons are just as busy
- Summer season in busier

4. How much (%) of the annual income of your business in approximately generated through ski tourism?

5. Do visitors of your restaurant/café in the winter season come for skiing related activities, or other activities?
- Just for skiing related activities
- Hiking
- Sightseeing
- (sport) events
- Other

6. Is there cooperation between restaurants/cafés, or/and between restaurants/cafés and other businesses in the tourism industry?

7. Would you say that skiing is an important aspect for the culture and identity of the region?
- Very important
- Fairly important
- Important
- Slightly important
- Not important

8. Does your business invest in attracting visitors other than skiers in the winter season?

9. Does your business invest in attracting tourists in the summer season? If yes, how do you attract summer tourists?

Appendix 3: Analysis websites of ski schools/rentals in the region Oberstdorf-Kleinwalsertal

To get a better insight into the economic and social vulnerability of ski schools- and rentals in the region Oberstdorf-Kleinwalsertal, various websites businesses in this sector of the ski tourism industry were analyzed. To assess the economic vulnerability, the activities the businesses offer were evaluated (income and job dependency), as well as the cooperation of and between the businesses to assess the social vulnerability (community spirit). The ski schools were selected via Google Maps, and via the official website of Oberstdorf-Kleinwalsertal Bergbahnen.

Ski schools/rentals

1. Alpinschule Oberstdorf, Oberstdorf
Activities: this not really a basic ski school, since there are a lot of activities that are not related to skiing. However, the school does organize ski tours and snowshoe hiking. Most of the activities are related to the summer season.
Cooperation: there is cooperation with certain brands, but nothing is mentioned about cooperation with other businesses in the region.

2. Alpin Skischule, Oberstdorf
Activities: the ski school offers ski/snowboard courses and there is also a rental for ski/snowboard and cross-country skiing equipment. Therefore, all the organized activities are related to ski tourism.
Cooperation: the ski school cooperates with various accommodations in the region.

3. Erste Skischule, Oberstdorf
Activities: the ski school offers ski/snowboard courses, cross-country skiing courses, and the schools also has a rental for all the materials. On the website it is mentioned that it is now also possible to rent snowshoes (new!).
Cooperation: there is cooperation with Oberstdorf Kleinwalsertal Bergbahnen and Tourismus Oberstdorf.

4. Aktiv am Berg, Oberstdorf
Activities: this is not a basic ski school, in the winter diverse ski tours are organized. The school also offers snowshoe hiking and ice waterfall climbing. The most activities take place in the summer season.
Cooperation: there is cooperate with an accommodation in the region.

5. Neue Skischule, Oberstdorf
Activities: the ski school offers ski/snowboard courses, as well as cross-country skiing and snowshoe courses. The ski school also has a rental for skiing/snowboarding, cross-country skiing, Nordic-walking and snowshoes and sleds. They just recently added an E-bike rental and the possibility to buy hiking equipment. Therefore, most activities are related to winter tourism, but there are some new activities that are focused on summer tourism.
Cooperation: cooperation with another ski rental in the region.

6. Alpensport Oberstdorf, Oberstdorf
Activities: this rental is primarily a rental for E-bikes and related equipment in the summer season, and the rental also organizes E-bike tours. In the winter season it is possible to rent ski, snowboard, and cross-country equipment (in cooperation with Neue Skischule Oberstdorf). They also cooperate with Neue Skischule Oberstdorf to offer ski/snowboard/cross-country skiing courses.
Cooperation: cooperation with Neue Skischule Oberstdorf.

7. Out of Bounds, Oberstdorf
Activities: Out of Bounds in a snowboard school and they offer private snowboarding and split boarding courses, as well as snowshoe hiking. They also have a rental where snowboards/split boards/snowshoes can be rented. In the summer season they offer the course 'Into the Wild' a survival course, and they also rent Stand Up Paddling boards and paddles. Therefore, most activities take place in the winter season, but they do have some summer activities.
Cooperation: on the website it is mentioned that they cooperate with professional partners, but it is not mentioned who these are.

8. NTC Sports, Oberstdorf
Activities: NTC Sports has two shops, one is located at the Nebelhornbahn and one at the Fellhornbahn. They offer ski courses, snowboard courses, and cross-country skiing courses. There is also a rental where ski/snowboard/snowshoes equipment can be rented. In the summer season, the shops sell outdoor clothes and equipment. Besides this, it is possible to rent E-bikes, as well as take part in E-bike courses. NTC Sports also host events.
Cooperation: on the website, nothing is mentioned about cooperation with other businesses.

9. Bergsport Ja, Oberstdorf
Activities: the ski school offers ski, cross-country skiing, and snowshoe courses. Besides this, they have a rental where it is possible to rent ski, cross-country skiing, and snowshoe equipment, as well as sleds. In the summer season, it is possible to rent E-bikes and book E-bike tours. Therefore, most activities are in the winter season and are related to skiing, but there are also some activities that can be done in the summer season.
Cooperation: on the website, some accommodations are mentioned and recommended.

10. Skitechnikschule, Oberstdorf
Activities: the ski school offers (private) courses for skiing and cross-country skiing, as well as offering training and ski tours. Furthermore, they have a rental where it is possible to rent cross-country skiing and ski equipment
Cooperation: there is cooperation with a couple of accommodations, sport shops and Oberstdorf Kleinwalsertal Bergbahnen.

11. Intersport Huber, Oberstdorf
Activities: the whole year around Intersport Huber is a (sport) shop, however, in the winter season it is also possible to rent ski, snowboard, cross-country skiing, and snowshoe/sledding equipment. In the summer season it is possible to rent E-bikes.
Cooperation: on the website, nothing is mentioned about cooperation with other businesses. However, since Intersport is part of an international retail chain, there is probably cooperation with other Intersport shops.

12. Wintersportschule Oberstdorf, Oberstdorf
Activities: the ski school offers various ski, snowboard, and cross-country skiing courses.
Cooperation: on the website, nothing is mentioned about cooperation with other businesses.

13. Skischule Riezlern, Kleinwalsertal
Activities: the ski school offers ski, snowboard, cross-country skiing, and snowshoe courses- and tours.
Cooperation: there is cooperation with a couple of sport shops- and rentals, as well as some ski lifts and accommodations.

14. Sport Hilbrand, Kleinwalsertal
Activities: Sport Hilbrand has two shops that are open all year around. In the winter season it is

possible to rent ski and snowboard equipment, and in the summer season it is possible to rent mountain sport and E-bike equipment.
Cooperation: there is cooperation with accommodations, mountain cabins, the region Kleinwalsertal, other ski schools and sport shops, and winter sport platforms.

15. Sport Pauli, Kleinwalsertal
Activities: the sport shop is open all year, and in the winter season it is possible to rent ski and snowboard equipment. In the summer season, it is possible to rent hiking and climbing equipment.
Cooperation: there is cooperation with ski schools and rentals, accommodations and Kleinwalsertal Tourismus.

16. Sport & Mode Kessler, Kleinwalsertal
Activities: the sport shop is open all year for summer and winter clothing. Besides this, it is also possible to rent ski/snowboard/cross-country skiing equipment and it is possible to book ski courses and snow bike courses through the shop, in cooperation with Skischule Seite Egg. In the summer, it is possible to rent E-bikes. They also own the Kessler ski lift, which includes a snow park, and they organize night skiing.
Cooperation: there is cooperation with Skischule Seite Egg, and it is also possible to buy ski passes in the shop (from Oberstdorf Kleinwalsertal-Bergbahnen).

17. Rief Verleih, Kleinwalsertal
Activities: it is possible to rent ski, snowboard, and cross-country skiing equipment.
Cooperation: there is cooperation with multiple ski schools, accommodations, and restaurants.

18. Skischule Seite Egg, Kleinwalsertal
Activities: the ski school organizes ski/snowboard courses, and snowshoe and ski tours.
Cooperation: there is cooperation with Sport & mode Kessler, and one accommodation.

19. Fun Alp Lifestyle & Sport, Kleinwalsertal
Activities: they sell clothes in summer and winter, and there is a rental where it is possible to rent ski and snowboard equipment in the winter season.
Cooperation: nothing about cooperation is mentioned on the website but might work together with Privatskischule Kleinwalsertal.

20. Privatskischule, Kleinwalsertal
Activities: the ski school offers private ski- and snowboard courses.
Cooperation: the ski school might work together with Fun Alp since their logo is pictured on the ski clothing.

21. Ifensport, Kleinwalsertal
Activities: in the winter, it is possible to rent ski, snowboard, cross-country skiing, and snowshoe equipment. In the summer, it is possible to rent E-bikes and hiking equipment. Furthermore, there is a shop for winter and ski related clothing.
Cooperation: there is cooperation with ski school *Die Skischule*

22. Die Skischule, Kleinwalsertal
Activities: the ski school offers ski, snowboard, and cross-country skiing courses.
Cooperation: there is cooperation with Ifensport, Vorarlberger Skischulen, Kleinwalsertal Tourismus, and Oberstdorf-Kleinwalsertal Bergbahnen.

23. Sporthaus Edelweiss, Kleinwalsertal
Activities: it is possible to rent ski, snowboard, cross-country skiing, and sled equipment. Furthermore, there is a sports shop that is open the whole year around.
Cooperation: there is cooperation with various accommodations, Oberstdorf-Kleinwalsertal Bergbahnen, Skischule Hirschegg, and Kleinwalsertal Tourismus.

24. Skischule Hirschegg, Kleinwalsertal
Activities: the ski schools offer ski, snowboard, and cross-country skiing courses.
Cooperation: there is cooperation with Sporthaus Edelweiss. This is not mentioned on the website of the ski school, but on the website of Sporthaus Edelweiss.

25. Austrian Ski & Service Ranch, Kleinwalsertal
Activities: it is possible to rent and buy skis.
Cooperation: there is cooperation with a ski school, accommodations, Kleinwalsertal Tourismus and other shops.

26. Skischule Mittelberg, Kleinwalsertal
Activities: the ski school offers ski, snowboard, cross-country skiing, and snowshoe courses.
Cooperation: there is cooperation with accommodations, restaurants, and ski rentals and shops.

27. Skischule Bödmen Baad, Kleinwalsertal
Activities: the ski school offers ski and snowboard courses.
Cooperation: there is cooperation with Oberstdorf-Kleinwalsertal Bergbahnen and Kleinwalsertal Tourismus.

Analysis
Economic vulnerability - sensitivity
Ski schools/rentals that have activities in summer and winter: 14/27 = 51,9%
So, over a little over half of the businesses invest in winter and summer tourism and are not completely dependent on ski tourism. However, from this group most activities are still related to ski tourism. Therefore, they are probably still more dependent on ski tourism than on summer tourism and thus, more income is generated through ski tourism.
- More activities in the winter season: 12/14 = 85,7 %
- More activities in the summer season: 2/14 = 14,3%

Ski schools- and rentals are not only a source of income for the region, but also create jobs. The ski schools- and rentals that only offer ski related activities in the winter season are more vulnerable to climate change since they do not have any other alternatives. The jobs in these businesses are therefore more dependent on ski tourism, than ski schools- and rentals that also invest in summer tourism. However, the number of jobs in the winter can still be higher, since the winter season is still busier than the summer season in most businesses.

Social vulnerability - sensitivity
23 of the 27 businesses cooperate with other businesses and organizations in the tourism industry, which is 85,2%. The most frequent mentioned partners are:
1. Other ski schools and/or rentals: 15/27 = 55,6%
2. Accommodations: 12/27 = 44,4%
3. Shops: 9/27 = 33,3%
4. Tourist offices of Oberstdorf/Kleinwalsertal: 7/27 = 25,9%
5. Oberstdorf-Kleinwalsertal Bergbahnen: 6/27 = 22,2%
6. Other: 3/27 = 11,1%

7. Restaurants: 2/27 = 7,4%

This shows that there is cooperation between the different ski schools- and rentals and there is cooperation between ski schools- and rentals and other businesses in the (ski) tourism industry. This indicates that the different businesses form a network and are involved with each other.

Appendix 4: Interview guide

Introduction
Good morning, and thank you so much for your time to do this interview. My name is Julia Kosters and I am a Dutch third year Bachelor student Geography, Planning and Environment at Radboud University in The Netherlands. To obtain my Bachelor's degree, I am conducting research about the effect of climate change on ski tourism in the region Oberstdorf-Kleinwalsertal and how the region is adapting to climate change. The interview will take about 15-30 minutes. If you have any questions or remarks, feel free to tell me, and you can also quit the interview at any given time. Do you have any further questions?

In researching the subject of climate adaptation and ski tourism, I came to the conclusion that there are three ways that ski tourism can adapt: maintaining ski tourism, alternatives to ski tourism, and subsidies.

Introductory questions (only used for the interview with Sebastian Gries from Ostallgäu)
1. Ost-Allgäu is the first region of Allgäu to have a climate adaptation report, what is the reason that it was decided to make the report? Why was it necessary for the region (in terms of ski tourism)?
- In relation to ski tourism? Do you notice climate change in ski tourism, especially since the ski areas in Ost Allgäu are lower?

Questions about maintaining ski tourism
1. Are there already things that the region is doing to stimulate/maintain ski tourism? (maybe other regions as an example?)

2. Artificial snowmaking? Do you think it makes to region more climate resilient (since it still needs to be cold for artificial snow) Is it sustainable? Since it also has downsides for nature, and water use?

Questions about alternatives to ski tourism
3. In your experience, is summer tourism just as important as ski tourism? Or is there room for improvement?
- When it comes to income, jobs?

4. How is the region investing is summer tourism? What can the region do to attract more summer tourists?

Subsidies: how to help businesses in the ski tourism industry
5. Are businesses in the tourism industry given any sort on subsidies or financial support?

6. *Adaptive capacity: how well can the region adapt?*
- Economic resources
- Technology
- Information & skills (is there enough knowledge about climate change in the region?)
- (social) Infrastructure
- Institutions
- Equity

Appendix 5: Codebook

Various codes were created in ATLAS.ti which were assigned to part of the transcripts of the interviews and the summary of the desk research about climate adaptation in Oberstdorf-Kleinwalsertal. All of the codes were further divided into code groups. The different codes groups are: economic vulnerability, social vulnerability, environmental vulnerability and climate adaptation. The codes croups and the corresponding codes are shown below:

Economic vulnerability
Income dependency
Job dependency
Economic resources

Social vulnerability
Community spirit
Information and skills
Willingness to adapt

Environmental vulnerability
Environmental protection
Natural hazards
Reliability on natural resources
Technology

Climate adaptation
Creating awareness
Maintaining ski tourism
Alternatives to ski tourism
Subsidies

Appendix 6: Desk research – climate adaptation in the region Oberstdorf-Kleinwalsertal

Landkreis Oberallgäu (2017) mentions in their climate report '*Masterplan 100% Klimaschutz im Landkreis Oberallgäu*' that citizens of the municipality of Oberstdorf should be informed about the expected changes of climate adaptation. This should be done by organizing readings about the subject of climate change and the impacts it can have for the region. The information and data of these readings should be published on the website of the municipality. The report states that further regular initiatives in the future can be useful to create more awareness of the subject.

In 2017, the region of Allgäu organized a meeting in which ideas-and cooperation were exchanged in order to make citizens more aware of the future effects of climate change and to discuss possible adaptation ideas and strategies with citizens in the fields of business, science, and civil society. The outcomes of the meeting are summarized in the report '*Ergebnisse der Ideen- und Kooperationsbörse für die Region Allgäu'* from IKU_Die Dialoggestalter (2017). The report mentions climate adaptation ideas for (winter) tourism, which is mostly focused on diversification of winter tourism. The report states that the snow reliability in Allgäu's skiing areas is declining due to climate change, but that currently the numerous winter tourists that are visiting the region, do not primarily come for alpine skiing. It is therefore important that - in cooperation with municipalities and tourist offices - the region develops attractive and sustainable winter tourism and provides diverse kinds of offers, that can be attractive either with, or without snow.

The regional development plan of Oberallgäu (Regionalentwicklung Oberallgäu, 2014) mentions the tourism strategy of the region in the years 2014-2020. The report states that the core types of tourism are hiking tourism, health tourism, and winter tourism. The leading tourism activities the region is investing in are hiking, cycling and health.

The Bayerisches Staatsministerium für Umwelt und Verbaucherschutz (StMUV) (2015) also mentions possible adaptation strategies for winter tourism in areas such as technical and structural measures, expansion of activities, and marketing and research. The report mentions how the use of artificial snow on ski slopes can be successful in higher elevated ski areas. In addition, the energy that is used for artificial snow could be generated locally from renewable sources, to make artificial snowmaking process more sustainable. Furthermore, the StMUV (2015) explains that the activities should be expanded with an emphasis on health, wellness, and culinary tourism. Besides this, activities on the mountains could be expanded by, for example, building themed huts, viewing platforms, adventure trails and an extensive network of hiking trails that can be used in both the summer and winter season. There could also be more investments in weather independent indoor activities by investing in swimming pools or climbing halls to give visitors more alternatives.

The Vorarlberger Landesregierung (2015) mentions that the tourism strategy of Vorarlberg is aimed at maintaining the current (very good) position of winter tourism and improving both the summer season and mid-season by strengthening all-year tourism. Vorarlberg has taken the following existing measures: early preoccupation with the consequences of climate change and implementation of the tourism strategy. The first existing measure, early preoccupation with the consequences of climate change implies that Vorarlberg Tourismus, Alpenregion Bludenz, Bregenzerwald Tourismus and Lech-

Zürs Tourismus have conducted a scientific study in 2013, supported by Land Vorarlberg, about the consequences of climate change in Vorarlberg to prepare early for the coming changes. The second measure, the implementation of the tourism strategy implies promoting all-year tourism to strengthen the summer- and mid-season. Therefore, the focus lies on innovation, quality, regional products, sustainability and the cooperation with other industries (e.g. crafting, agriculture), to strengthen the competitiveness in the tourism regions of Vorarlberg in the long-term.

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