

## Industries tackling the impacts of climate change: scenarios for regions

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#### REGKLAM

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## ANALYSIS

### **Industries tackling the impacts of climate change: scenarios for regions**

#### **Abstract**

Analyzing statistical data shows evidence that the climate is changing. We analyze how one of the industries relying most on climate conditions, the tourism industry, meets the challenges of climate change by developing scenarios for regions. Our research focuses on the question, whether and how scenarios are used to develop visions, identify potentials and finally derive and implement adaptation strategies for regions. For this paper we did a double-stage literature review according to Littell and Fink. The literature studies in the first step showed that in the industries water- and energy management, agriculture, insurance, and tourism, scenario analysis methods are used. A closer look into the sources relating to the tourism sector showed that only 7 of the 64 identified studies applied a scenario analysis according to our understanding. These seven studies we analyzed with a screening raster derived from the theory, which can be easily transferred to other industries. The studies published between 2004 and 2009 for regions in Europe and the Great Barrier Reef in Australia use different amounts and types of steering parameters such as common economic steering parameters, e.g. turnovers, and also tourism specific steering parameters, e.g. expenditures for accommodation. Moreover, there are differences in the used key factors or in the number of chosen scenarios.

The findings in the scope of the literature review represent the theoretical basis for the practical conduction of a scenario analysis in the tourism sector as well as in other sectors such as water management in the interdisciplinary research project “Development and Testing of an Integrated Regional Climate Change Adaptation Program for the Model Region of Dresden” (REGKLAM).

**Keywords:**

Scenario planning, climate change, industry, tourism

## 1. Introduction

Scientists expect an impact of climate change on mankind (Rahmstorf and Schellnhuber 2007). A quote by (Yeoman and McMahon-Beattie 2006) “Climate change impacts upon everyone and no one can escape.” confirms the statement of Rahmstorf & Schellnhuber and comprises that organizations and markets are affected as well (Yeoman and McMahon-Beattie 2006, p. 372). Sir Nicholas Stern calculated the economic costs that climate change would cause (Stern 2006). According to the German Institute for Economic Research, an increase in the mean temperature by 3.5 degrees Celsius by the year 2100 would probably cause economic losses of 150 trillion US \$ (Kemfert 2005, Rahmstorf and Schellnhuber 2007).

In the past the research has focused on mitigation strategies of organizations, i.e. on the question how to limit human causes of climate change. However the climate will still change for decades and will cause unfortunate climate change impacts even if all anthropogenic CO<sub>2</sub> emissions end at once. Adaptation measures and strategies can vary the magnitude of climate change impacts (Paavola and Adger 2006) and are becoming necessary in short term, medium term and long term (Watkiss et al. 2005). To develop adaptation strategies the consequences of future climate change have to be assessed. (Smith 1997, Yeoman and McMahon-Beattie 2006) argue that adaptation measures should be deliberate decisions to prepare for potential effects of climate change. Thus, in order to realize anticipatory adaptation foresight and planning are required (Fankhauser et al. 1999). To realize this shortcoming scenario planning can be applied. It provides an opportunity to envision plausible future states and helps to generate strategies to exhaust future opportunities and reduce risks (Miller and Waller 2003). And the climate change even allow organizations to gain competitive advantages or create new business segments or markets (Ott and Richter 2008).

For this article we focus on the regional level, as the impacts of climate change vary due to geographical conditions, prevailing industries and governments in power.

Moreover, we concentrated on industries that are most affected by climate change. In order to identify these vulnerable industries we used four indicators: gross value added, employed people, water intensity, and energy intensity. The tourism industry is one of the sectors that is largely affected by climate.

The function of this paper is two-fold: First, we analyzed how scenario analyses are applied in different industries on the organizational level to get an overview in which industries the method is used and how it is applied. Secondly, we analyzed the studies for the tourism sector in depth to derive a method applicable on the regional level. Therefore we conducted a systematic literature review.

In the following section the state of the art of scenario planning is explained, followed by the methodology regarding the choice of the tourism sector and the systematic literature review. In the fourth chapter we present and discuss the results. A short summary is given in the last section.

## **2. State of the art in scenario planning**

In general a scenario is a “... coherent, internally consistent, and plausible description of a possible future state...” (Carter et al. 2007, p. 145), that reflect different perspectives on the past, the present and the future (van der Heijden et al. 2002). But a scenario describes not only a possible future situation, but also the paths of development which may lead to that prospective situation (Kosow and Gaßner 2008).

The entire process of developing scenarios can describe as scenario planning. Current research papers use different terms relating to scenario planning: scenario analysis, scenario development, scenario method, scenario building and scenario writing. According to (Bishop et al. 2007) “Scenario planning has to do more with a complete foresight study, where scenario development is concerned specifically with creating actual stories about the future. Scenario planning is a far more comprehensive activity, of which scenario development is one aspect.” (Bishop et al. 2007, p. 6). In (Lindgren and Bandhold 2003) words: it is an strategic planning tool for medium to long term planning under uncertain conditions. With this method organizations should enable to integrate discussion of the medium and long-term futures with short to medium term strategic planning.

(Börjeson et al. 2006) subdivide scenario studies into predictive projects (What will happen?), explorative projects (What can happen?) and normative scenario projects (How can a specific target be reached?). In this context, predictive scenarios try to predict future events and make use of probability. These scenarios can help to evaluate the fulfilment of a probability and they can provide the opportunity to adapt to expected future developments. Typical predictive projects look only at the impact of a small number of trends which are assessed by probability. In contrast, explorative scenarios, which are more long-term oriented, explore future events and ask for possible pictures of the future. The analysis mostly begins in the future and can show consequences for current behavior. Furthermore, the priority of the analysis is set on the last part focussing on the consequences. Normative scenarios deal with a certain objective that should be achieved.

Within scenario analysis different instruments and techniques can be applied. Scenario analyses can be divided into eight categories: “judgment”, “baseline”, “elaboration of fixed

scenarios”, “modelling”, “event sequences”, “backcasting”, “dimension of uncertainty” and “cross-impact analysis” (Bishop et al. 2007). Within the literature screening some of these instruments and techniques are relevant and therefore “judgment”, “elaboration of fixed scenarios” and “modelling”. Judgment techniques describe informal methods and make it possible to get an intuitive image of the future. This image is mostly based on the judgements of persons or groups who pay attention to future developments. To describe the future you can make use of visualization techniques in combination with mediation and relaxation techniques or role playing. The technique elaboration of fixed scenarios should help scenario planners to avoid future uncertainties. A small number of scenarios are constructed, for instance a green future or a high tech scenario. Afterwards the logic of the scenarios and the possible impacts on specific domains, such as the legislation or the politics, is discussed. In comparison, modelling is working with mathematical models or equations. One scenario consists of a set of specific assumption of the model. At the end of the analysis, the results of target variables are calculated in time development and portrayed in graphics. Generally, this technique mostly develops baseline scenarios. (Bishop et al. 2007)

An important part of scenario planning is the scenario approach, e.g. the number of steps undertaken within a scenario analysis project. According to (Bishop et al. 2007), a scenario approach consists ”... of an ordered series of steps to accomplish the objectives of the project” (Bishop et al. 2007, p. 6). There are different scenario approaches – some approaches consist of four steps, some of them are composed of ten steps. Ten different approaches are listed in Table 1 (Phelps et al. 2001, Dießl 2006, Kosow and Gaßner 2008, Bishop et al. 2007, van der Heijden et al. 2002, Schwartz 1998 and Ringland 2006, Steinmüller 2003, Geschka and Hammer 1997, MacNulty 1977, Linnemann and Kennell 1977).

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Insert Table 1 about here

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Based on this multitude of different scenario approaches we have generated a six-stage-scenario approach which shall be used for our analysis (figure 1) .

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Insert Figure 1 about here

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In general, the developed approach consists of three parts. The first part, “Scenario development”, encompasses three steps (goal-setting, environmental analysis, scenario building) as does the second part, “Scenario transfer”, (development of visions, options for action, realization). Part three, “Feedback and Feedforward”, takes place at any time.

Goal-setting involves the definition of the theme, the description of the environment as well as the purpose, objective and reason for the analysis (Bishop et al. 2007). To identify the steering parameters is vital because forecasts for possible developments are based on them. The parameters should encompass key performance figures of the organization in achieving its business-related objectives and describe the operating functions of the organization (MacNulty 1977). In this paper we focus on steering parameters which could be affected by climate change, e.g. the turnover of an organization or industry.

In order to conduct the environmental analysis the composition as well as the history of the investigated environment should research (Bishop et al. 2007). Thereby key factors have to identify which on the one hand could impact the organization and its objectives and on the other hand which could perhaps be affected by the organization (MacNulty 1977). The key factors, also called descriptors are generated by empirical and theoretical analysis, workshops or rounds

of surveys (Kosow and Gaßner 2008). Here we only examine key factors that are associated with climate change, such as altered precipitation amounts or temperatures.

“Scenario building”, encompasses the development of the descriptors in the future. For this purpose it is helpful to ask experts, use Delphi-methods or apply available forecasts. In some cases, explicit trends become apparent, in other cases, very different possible developments will emerge (Zürni 2004). In the last case, assumptions about possible future values need to be determined (Kosow and Gaßner 2008). To revise the values consistency analysis helps in order to determine which values are compatible and do not eliminate each other. In a next step the consistent values of the key factors are combined with each other and scenarios are composed. In many cases a multitude of scenarios are created so that it is necessary to choose between them. (Kosow and Gaßner 2008) It is recommended to elect at most four to five relevant scenarios (Kosow and Gaßner 2008). This selection is based on the personal value systems of the decision-makers.

Further, the selected scenarios are the basis for the second part, “Scenario transfer”. With this part the understandings of “Scenario development” are put into practice of an organisation. For developing visions the desired paths are deducted from the chosen scenarios. The decision-maker have to envisioned the favourable outcome and set goals for the preferred future. (Kosow and Gaßner 2008)

Afterwards, adaptation measures are planned and evaluated as well as specific strategies, options and plans are developed. In step 6 the adaptation strategies have to communicated to and implemented by organizations such as with the help of action agendas and intelligence systems (Kosow and Gaßner 2008).

Applying a scenario analysis can support a decision maker in various ways. (Berkhout and Hertin 2002) have derived a framework for analyzing adaptation to climate change from the organizational adaptation literature. For a smooth adaptation to the direct and indirect climate risks they underline the importance of mainly four mechanisms<sup>1</sup>: 1.) A company has to recognize and interpret the external signal that something is changing and adaptation might be necessary. 2.) After adaptation is considered as necessary, adaptation options might be found by experimentation or by explicit search. 3.) In the next step, the “knowledge articulation and codification”, the company has to choose amongst different adaptation options. 4.) In “feedback and iteration” the company has to assure that the adaption was successful or if an iteration of the process might be necessary.

### **3. Methodology**

According to (Littell 2008) a systematic review is “The application of strategies that limit bias in the assembly, critical appraisal, and synthesis of all relevant studies on a specific topic.” (Littell 2008, p. ). (Fink 2005) proposes four steps for a systematic review, which we have taken as a basis for this review. In the first step, Fink suggests selecting the research questions, the bibliographic article databases and websites, as well as the appropriate search terms. Then he recommends applying practical screening criteria for the inclusion of relevant literature and the exclusion of irrelevant literature. In the third step, methodological screening criteria should be deduced for analyzing the studies. Finally, the findings have to be synthesized.

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<sup>1</sup> These functions are derived from (Schwartz 1998, van der Heijden et al. 2002, Dießl 2006).

Of particular importance is that we conducted a double-stage literature review. After focusing on industry sectors in general we concentrated on the tourism sector. Thus, we specified the search terms and repeated the literature search.

We have chosen the tourism sector because of three reasons. First, the tourism sector and climate change are closely related because currently the impacts of climate change, e.g. less snowfall as well as longer and warmer summers, are already perceived, as opposed to other sectors.

Secondly, in the scope of the research project “Development and Testing of an Integrated Regional Climate Change Adaptation Program for the Model Region of Dresden” (REGKLAM) we have identified for one region that the tourism sector is one industry, that is affected by climate change particularly. To determine concernment, four statistical data points of economic activities were analyzed: gross value added, employed people, water intensity, and energy intensity (see figure 2). Gross value added is the value of output less the value of intermediate consumption and it is the source from which the primary incomes of the System National Accounts (SNA) are generated (Organisation for Economic Cooperation and Development (OECD) 2007). Employed persons “... comprise all persons above a specified age who during a specified period, either one week or one day, were in ...” a paid employment or self-employed (Organisation for Economic Cooperation and Development (OECD) 2007, p. ). For both parameters we analyzed the statistical data from 2000 to 2005 over 23 economic sectors for Germany and one region in Germany. Energy intensity is the ratio of previous achievement energy (fossil raw materials, electricity and heat) and the value of output. The ratio of previous achievement water and the value of output is the water intensity. Both parameters are derived

from the national input-output-statistics 2005 for about 23 economic sectors. (Sächsisches Staatsministerium für Wirtschaft und Arbeit 2007, Statistisches Bundesamt 2009)

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Insert Figure 2 about here

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For this exemplary region the statistical analysis showed that the tourism industry is not economically relevant, but climate sensitive because of a high water intensity in “hotels and restaurants” and a higher energy intensity in “transport, storage and communication”.<sup>2,3</sup>

Thirdly, only a few studies are preoccupied with the influence of climate change on economic effects of the tourism industry (Hamilton and Tol 2004), but the number of studies is increasing (Hoegh-Guldberg 2008). According to (Nydegger 2005) the scenario analysis method is used very seldom in the tourism sector, but he thinks that this method is an appropriate method for the forecasting of future developments in this industry. (Page et al. 2009) estimate that the scenario analysis method is applied, but the results, because of concealment, are often not published.

For our literature research we predominantly chose the electronic professional databases of EBSCO with priority to economic adjustment (BUSINESS SOURCE COMPLETE, ACADEMIC SEARCH COMPLETE, ECONLIT WITH FULL TEXT, RISK MANAGEMENT REFERENCE CENTER UND TOC PREMIER). At the search in EBSCO we did not imposed a restriction to the year of publication.

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<sup>2</sup> In the investigated region the following industries are identified to be economically relevant: Real estate, renting and business activities; Manufacturing of electrical and optical equipment; Manufacturing of basic metals and fabricated metal products; Wholesale and retail trade, repair of motor vehicles, motorcycles as well as personal and household goods; Public administration and defense; Compulsory social security; Health and social work; and Education.

<sup>3</sup> Climate sensitive due to significant energy intensity and/or water intensity are the economic activities listed hereafter: Agriculture, hunting, forestry, and fishing; Manufacturing of food products, beverages and tobacco; Manufacturing of other non-metallic mineral products; Manufacturing of chemicals, chemical products and man-made fibres; Manufacturing of basic metals and fabricated metal products; Transport, storage and communication; Hotels & Restaurant; Electricity, gas and water supply; Public administration and defense; Compulsory social security; Health and social work; and Education.

Moreover, we gathered and combined certain search terms to find information on the databases. A combination of search items composed of three parts is what we considered appropriate. The first part is meant to describe the area of *scenario*; the other two parts cover the fields of *economy* and *climate* or *climate change*. Not only do we look up these search keys in dictionaries of synonyms, we also checked their practical relevance in the respective literature. The relevant search keys are shown in Figure 3.

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Insert Figure 3 about here

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Using EBSCO, we added “NOT mitigation” to the search keys to exclude those sources which focus on strategies to mitigate climate change, which is not an object of our analysis.<sup>4</sup> For a closer literature review in the tourism sector, we did a further search in Google Scholar with the following combination of search terms “region AND scenario AND study AND “tourism industry” AND “climate change” AND adaptation” in the area “business, administration, finance, and economics” as well as “social sciences, arts, and humanities”.

According to (Fink 2005) we developed a methodological screening raster for analyzing the studies, which is represented in figure 4. We investigated the following aspects in order to conduct a systematic review:

- Author
- Year of publication
- Source/ ranking value
- Investigated region

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<sup>4</sup> We analyzed the title as well as the abstract. If the title and the abstract seemed to be appropriate, i.e. the study addresses scenario analysis on the organizational level and the full text of the source was available, then the whole text was analyzed. After removing the double represented sources, the pool of relevant sources encompasses 221.

- Problem statement of the investigation
- Used method among scenario analysis

(Van Notten, Philip W. F. et al. 2003) recommend analyzing the object of the scenario analysis project, the used instruments/ techniques, and the content.

- Objective of the scenario analysis project: predictive scenarios or explorative scenarios<sup>5</sup>
- Used instruments/ techniques: the typology of (Bishop et al. 2007) is used: “judgement techniques”, “baseline”, “elaboration of fixed scenarios”, “modelling”, “event sequences”, “backcasting”, “dimension of uncertainty”, and “cross-impact analysis”
- Content of the scenario analysis project: for the investigation of the content-applied issues we concentrated on the used steering parameters and number of steps of scenario method as well as on five further characteristics which are deduced from (Zürni 2004).
  - Key factors: Number of key factors: low amount ( $\leq 10$ ), medium ( $10 < x \leq 20$ ), and large ( $> 20$ ); type of key factors; this paper focuses on climate related key factors
  - Type of the chosen parameters: distinction into quantified value, non-quantified values, or quantified and non-quantified values
  - Focus of the future projection: distinction into extreme projection, trend projection, as well as extreme and trend projection. Extreme projections describe extreme future developments and also extreme

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<sup>5</sup> Normative scenario objectives do not find consideration by reason that this scenario goal can be found in both explorative and predictive objectives.

scenarios. By contrast, trend projections reflect plausible future visions.

- Time dimension: short-term, middle-term, or long-term forecasting
- Number of chosen scenarios

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Insert Figure 4 about here

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#### **4. Synthesis of the results**

Our first screening of the selected literature focused on the line of businesses. At all we researched 221 relevant resources. Figure 5 illustrates that the relevant studies mainly focus on water management, energy management, agriculture, insurance, and tourism. For the tourism sector we counted 25 literature sources in detail. Our secondary search in Google Scholar resulted in 655 hits. For our analysis we chose 41 of them focusing on adaptation to climate change in tourism and using scenario analysis method. Two of them we had covered in the first literature research in EBSCO, so that we had 64 in summary.

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Insert Figure 5 about here

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The majority of the found sources are published in scientific journals, but we also included in our screening sources such as reports, congress proceedings and books. Some found articles are published in journals that are assessed by Handelsblatt ranking of business studies

(“HB BWL 09”)<sup>6</sup>. This ranked journals are “Journal of Travel Research”, “Futures”, “Land Economics” and “Tourism Management”.

The oldest source is published in 1992, and the most recent is from 2009. More than two-third of the sources were published in 2005 or later, indicating increase relevance.

By analyzing the investigated region it is shown that some studies prefer a smaller region within one nation, some address a whole nation and only a few examine continents. It has become apparent that most sources focus on areas in the European territory. The main emphasis is on Mediterranean areas of Europe, as well as areas in Switzerland, Scotland, and Austria. There were also a few studies concerning England and Sweden. 17 studies address North America, whereby seven of them focus only on the USA, six especially on Canada and the residual four studies pay attention to this both regions of North America. Seven studies investigate Africa, five sources Australia, two sources Asia and one study the Antarctic. Moreover, it must be pointed out that for South America no study was found. The following figure illustrates the connection between the analyzed region and the year of publication our searched sources.

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Insert Figure 6 about here

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Furthermore, we want to highlight that many studies are specialized in winter tourism and thus in skiing areas. Further studies address coastal areas, national parks and mountainous regions.

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<sup>6</sup> The Handelsblatt Ranking of business studies 2009 is based on three established journal rankings, the scientific journal list of Erasmus Research Institut of Management (EJL), the scientific journal ranking of “Verbandes der Hochschullehrer für Betriebswirtschaft” (VHB-JOURQUAL 2, JQ2) and the business literature from Social Science Citation Index ([SSCI](#)) and Science Citation Index ([SCI](#)). The Handelsblatt Ranking allocates counts to scientific journals with a maximum value of 1,0 and a minimum value of 0,1. (Verlagsgruppe Handelsblatt GmbH (ed.) 2010)

The used scenario methods applied in the studies are very different. This result verifies the findings of (Hamilton and Tol 2004) who stresses that for the tourism sector very different methods are used. Moreover, we noticed that the scenario analysis method is used not very often as (Nydegger 2005) and (Page et al. 2009) carried out in their papers. In all, only seven of the 64 studies conduct a scenario analysis as it is defined and described above (six-stage-scenario analysis). The remaining studies do not develop alternative scenarios or they name the used method in another manner. However, a few of the studies use scenarios in their analysis, for example the “climate change scenarios” of the International Panel on Climate Change (IPCC). The method scenario analysis itself is not applied systematically. In most cases, a temperature parameter is used to determine an economic or a natural scientific parameter. Thereby, no combination of key factors is conducted, as is also explained above. We point out that the authors of the studies do not belong to economic or social science disciplines. On the contrary, the developed six-stage-scenario analysis method is based on the considerations of scientists from the economics and social sciences. Further used methods are the “pooled travel cost method”, regression analysis, and the Tourism Climate Index. Some studies only summarized other studies. Studies that investigate the climate change impacts on economic values are under-represented.

As mentioned above, seven studies conduct a scenario analysis similar to our definition and understanding. These seven studies, whereas two of them observed the same scenario analysis project and therefore they are described together, are analyzed in more detail in the following. (Study A: Grêt-Regamey et al. 2008; study B: Hoegh-Guldberg and Hoegh-Guldberg 2004; study C: Kok et al. 2006; study D: Müller and Weber 2008; study E: Nydegger 2005;

study F: Glaesser 2006 and Page et al. 2009) Table 2 gives a detailed overview over these remaining six studies.

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Insert Table 2 about here

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Five of these six studies investigated in depth focus on regions in Europe and three of them are concentrated on Switzerland. The other two studies observe the northern Mediterranean area and Scotland. The non-European study gives attention to the Great Barrier Reef in Australia. The studies were published between 2004 and 2009. Study A applies, along with the scenario analysis method, other methods. Four studies are targeted on predictive scenarios and two of them on explorative scenarios. Most of the studies use more than one scenario technique: primarily judgment-technique, in the second instance elaboration of fixed scenarios, and finally modelling.

Between the studies the amount and the type of steering parameters differ very highly: study E names no specific economic steering parameters and study F uses nine economic steering parameters for example. Steering parameters are on the one hand typical economic values such as Turnovers, Gross Domestic Product, Gross Value Added, employment and on the other hand measures which are very typical in the tourism sector industry such as public earnings, expenditures for day excursions and expenditures for accommodation. Moreover, in one study two parameters are used which directly relates to climate change: investment costs relating to climate change adaptation and revenue change in consequence of adaptation.

Similar to the steering parameters there are also differences in the used key factors. Some studies describe the key factors very superficially in terms of “climate change”. However, others list a multitude of factors, for instance study D, which uses temperature, precipitation, snow

reliability, permafrost, receding glaciers, changing landscapes, changing vegetation, natural hazards (mass movement), water balance and fog).

The time dimensions diverge widely: the shortest observed periods range from seven to ten years, two studies developed scenarios for the year 2030, and two studies focus on longer periods (around 45 years).

Differences in results also indicated the number of chosen scenarios: three studies have chosen two scenarios, two studies decided for four scenarios, and one study struck the balance with three scenarios.

By analyzing the scenario analysis approach it became apparent that three studies do not declare the separate steps of the applied scenario analysis approach. Thus, we tried to assign the described scenario analysis project to our developed six-step-approach. Our allocation showed that two of these three studies pass through steps one to five and the remaining study steps one to four. The outcome is that they do not deal partly with options of possible adaptation measures and complete with realization of adaptation strategies. On the contrary, the other three studies specify different steps which we also assign to our approach. This allocation resulted in one four-step-approach, one five-step-approach and in one six-step-approach with regard to our developed scenario analysis approach. One may assume that the third part of our approach “Feedback & Feedforward” is not part of any conducted scenario analysis within these studies.

The investigated studies work mainly with qualitative parameters like the schism in society between the connected and the unconnected people with information and communication technology. While only some use quantitative parameter like the revenues in CHF (Swiss Franc), others used qualitative and quantitative parameters.

The applied future projections are, in two cases, trend projections and twice extreme projections. Two studies used trend projection as well as extreme projection.

Moreover, it becomes clear that several studies used workshops for the generation of the scenarios.

In summary this systematic literature review offered that the industries water and energy management as well as agriculture, insurance and tourism are mainly examined in literature to climate change adaptation. A closer look to studies concerning tourism industry showed that those papers focus basically on areas in Europe and North America. Additionally, the method of scenario planning is not applied very widely in this sector regarding adaptation to climate change impacts. Furthermore it is shown that no standardized scenario approach is used and that the most scenario analysis projects focus on the scenario development but not on the transfer, especially on the formulation of adaptation strategies and their realization. We gained insights about which steering instruments could be interesting for all industries in general and for the tourism sector especially. In addition, we have disclosed new key factors. Moreover, based on these investigated studies it makes sense to use two time dimensions: first, up to the year 2025 and second, up to the 2050.

## **5. Summary**

To minimize the impacts of climate change, appropriate adaptation strategies are essential. One possibility for forecasting changes is to conduct scenario analysis.

In order to identify the most vulnerable industries we suggest four indicators: gross value added, employed people, water intensity, and energy intensity. As the tourism industry is one of the sectors largely affected by climate change we analyzed it in depth. For our analysis we

conducted a systematic literature review according to Fink. In a first step we searched for studies in all industries and could identified the sectors water and energy management as well as agriculture, insurance and tourism as mainly examined industries in literature to climate change adaptation. In a second step we focused specially on the tourism sector. The screening raster derived from the theory encompasses the criteria: author, year of publication, investigated region, problem statement of the investigation, used method among scenario analysis, objective of the scenario analysis project, used instruments/techniques, steering parameters, key factors, type of chosen parameters, focus of the forecasting, time dimension, number of chosen scenarios, and number of steps of scenario method.

In all, we found 64 sources which focus on climate change adaptation in tourism and use scenario analysis method. The sources were published from 1992 to 2009 and address different regions in the world, mainly Europe. It becomes apparent that only 7 of the 64 studies conduct a scenario analysis according to the derived six-stage-scenario analysis approach, all the others reflect only part of the whole picture. The seven studies are published between 2004 and 2009 for regions in Europe and the Great Barrier Reef in Australia. Between the studies the amount and the type of steering parameters differ very highly as well as the key factors. Differences in results also showed the number of chosen scenarios: 3 studies have chosen two scenarios, 2 studies decided for four scenarios and one study stroke the balances with 3 scenarios. By analyzing the scenario approach it becomes apparent that 3 studies do not declare the separate steps of the applied scenario analysis approach and that the studies mainly focus on the scenario development and not on the scenario transfer.

This systematic literature review showed that the scenario analysis method is not applied widely and not yet in depth in the tourism sector regarding climate change adaptation. Further research is desirable to develop a comprehensive and broadly accepted approach.

**Table 1**  
Different scenario approaches in overview

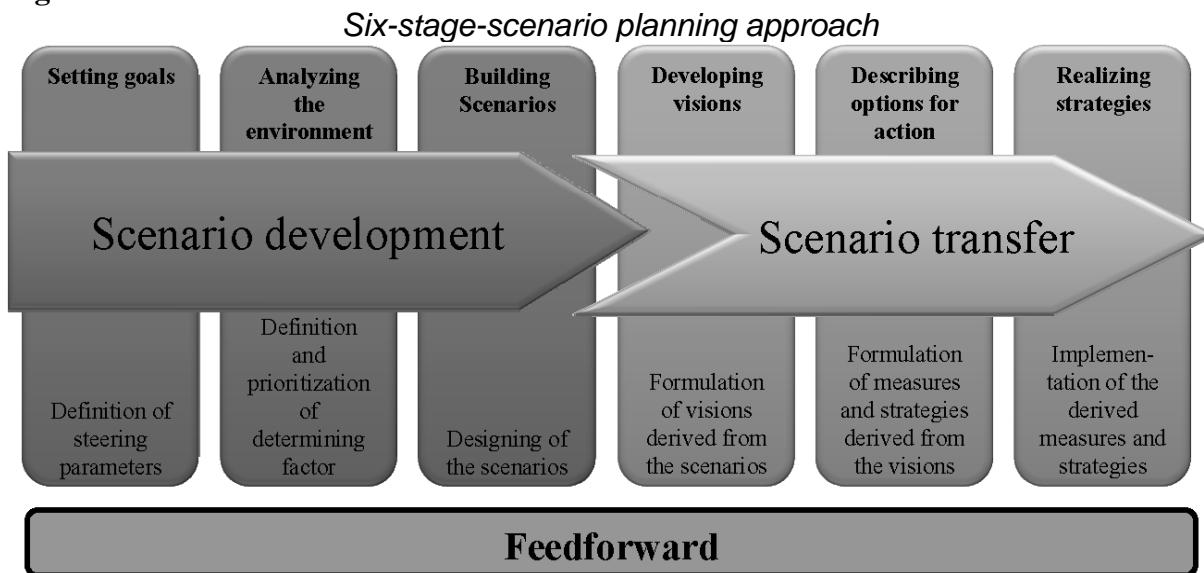
Step	Phelps, Chan, & Kapsalis, 2001	Dießl, 2006, translated	Kosow & Gaßner, 2008	Bishop, Hines, & Collins, 2007	Van der Heijden, Bradfield, Burt, Cairns, & Wright, 2002	Schwartz, 1998; Ringland, 2006	Steinmüller, 2008, translated	Geschka & Hammer, 1997, translated	Macnulty, 1997	Linnemann & Kennell, 1977
1	defining scope	monitoring	defining scope	framing	structuring the scenario process	identify focal issue or decision	problem analysis	structuring and defining the scope	development of databases	identification and formulation of the company's mission, objectives and policies
2	database construction	analysis	identification of key factors	scanning	exploring the scenario context	key forces in the local environment	defining the scope	identification and structuring of drivers	selection of the organization's objective	determination of planning horizon
3	building scenarios	protection	analysis of key factors	forecasting	developing the scenario	driving forces	projections	evaluation of trends and critical descriptors	evaluation of organizational variables	identification of the company's leverage and vulnerability
4	choosing strategic options	transformation	building scenarios	visioning	stakeholder analysis	rank by importance and uncertainty	consistency check	bundling assumptions to consistent sets	evaluation of environmental variables	determination of factors with almost complete certainty
5		scenario transfer	planning	systems check	selecting the scenario logics	building scenarios	derivation of scenarios	scenario selection	identification of trends with make or break consequences	
6			acting	impacting organizational thinking and acting	fleshing out the scenarios	analysis of disturbances	analysis of disturbances	development or construction of scenarios	assignment of reasonable values to each key variable	
7					implications		effect analysis	consequences for the scope	analysis of the implication of the scenarios	development of scenarios
8					selection of leading indicators and signposts		scenario-transfer	derivation of measures	implementation	development of strategy in each scenario
9										testing the flexibility of each strategy in each scenario
10										selection or development of the optimal response strategy

**Table 2**  
Overview over the investigated tourism studies

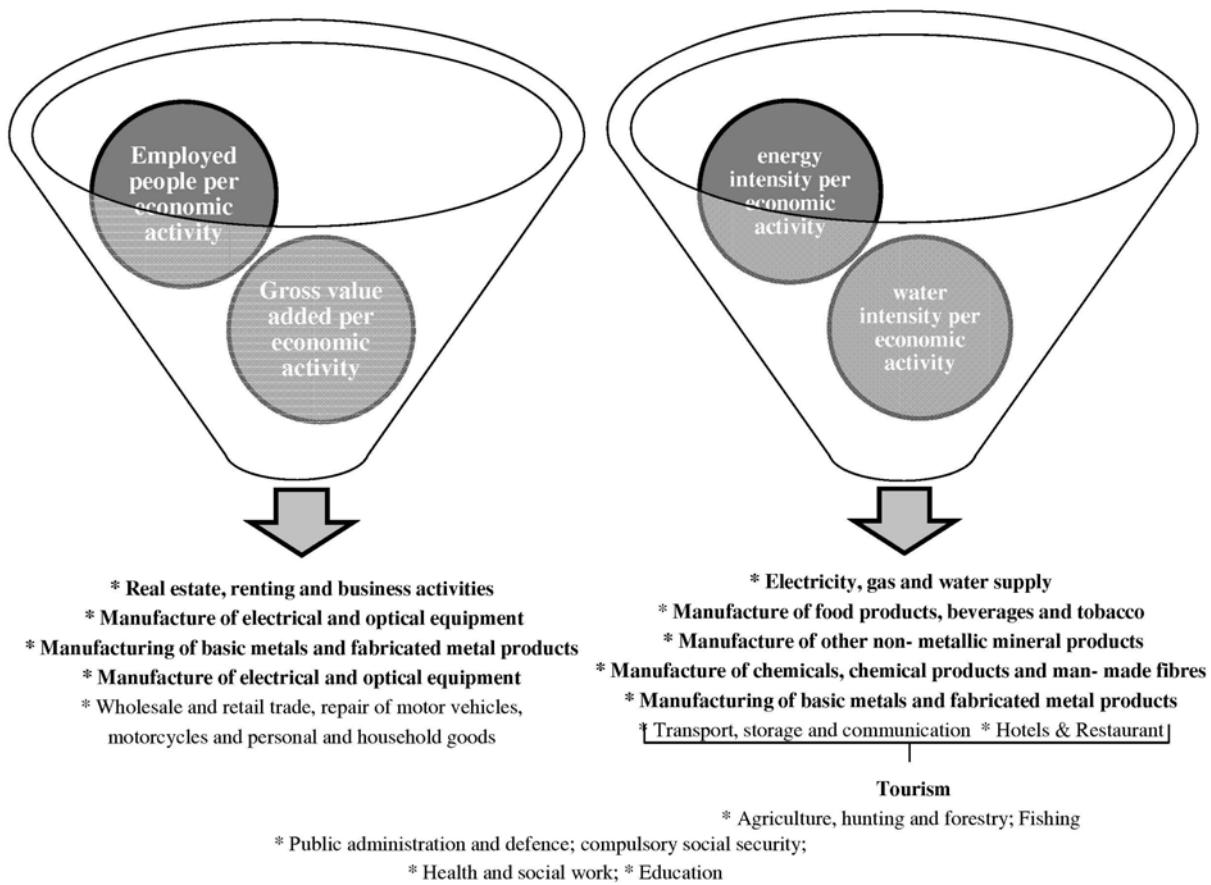
Study	A	B	C	D	E	F
Author:	Grêt-Regamey, A. et al.	Hoegh-Guldberg, H. Hoegh-Guldberg, O.	Kok, K.; Rothmanc, D. S.; Patel, M.	Müller, H.; Weber, F.	Nydegger, M.	Page, S.; Yeoman, I.; Greenwood, C. AND Glaesser, D.
Year of publishing:	2008	2004	2006	2008	2008	2009 AND 2006
Source/ ranking value:	Journal of Environmental Management/ no count	Working Paper	Futures/ count: 0,1	Book	Journal "Jahrbuch schweizerische Tourismuswirtschaft"/ no count	Book AND book
Investigated region:	Territory "Davos" (eastern part of Swiss Alps)	Great Barrier Reef, Australia	Europe, northern Mediterranean area	Berner Oberland, Switzerland	Swiss winter tourism areas	Scotland
Problem statement/ objective of the study:	the Alps strongly depends on tourism, the sector is influenced negatively through changes in land use, land use changes can impact key ecosystem services and weaken the economy, the authors developed a semi-automatic procedure to value ecosystem goods and services	scenarios are developed for fishing and tourism industry in Australian Great Barrier Reef region, the impact of future developments on the economic situation is presented	a lot of ecological, socio-cultural and economic drivers influence the growth in Northern Mediterranean region, with scenarios the development is tried to predict for next years with mainly regard to desertification, the authors analysed a number of sectors like tourism industry	susceptibility of tourism industry to climate change is high - because of economic importance in mountain region and exposed conditions of this sector, the authors wanted to show possible consequences of climate change for tourism in region Berner Oberland and presented some adaptation and mitigation strategies	Swiss tourism is under pressure (consumer behavior and policy is changing, etc.), the author asks for future development of this sector and searches for preparation strategies, method of scenario planning is used for Swiss winter tourism	process of scenario planning - conducted by leading organisation for Scottish tourism - is highlighted, the organization try to understand future issues - mainly the future interaction between tourism and transport - and would like to increase the value of Scottish tourism by 50 % by 2015
Method:	3 methods are used: Scenario planning, „Process-Modeling“ and „Economic Valuation“	Scenario planning	Scenario planning	Scenario planning	Scenario planning; but no information about economic values	Scenario planning; but climate change is not a direct determining factor
Objective of the scenario analysis project:	Predictive scenarios	Explorative scenarios	Explorative scenarios	Predictive scenarios	Predictive scenarios	Predictive scenarios
Used instruments/ techniques:	Modelling, Judgment-technique	Judgment-technique, Elaboration of fixed scenarios	Elaboration of fixed scenarios	Judgment-technique, Elaboration of fixed scenarios	Judgment-technique	Modelling, Judgment-technique
Steering parameters:	Value [CHF]of four ecosystem services	tourism GRP (Gross Regional Product);	Tourism (number) (Arrivals)	Revenue; investment costs relating to	no information about economic values	Gross Domestic Product, Gross Value

	(avalanche protection, timber production, scenic beauty, habitat suitability (they priced the service of habitats for plants and animals)); they estimated people's preferences , results of a willingness-to-pay survey are used conducted with tourists	full-time-equivalent tourism employment; Gross Value Added and employment	(million)/receipts (million \$))	climate change; revenue change in consequence of adaptation strategies	Added, welfare, employment, public earnings, expenditures for day excursions, expenditures for accommodation, tourism expenditures in general in Scotland, tourism expenditures in general in Great Britain (except Scotland), international tourism expenditures
Key factors:	average temperature, land-use, climate change	Weather parameters, climate parameters, sea temperatures and carbonate alkalinities, coral bleaching, CO <sub>2</sub> levels; (further factors: economic values, demographic development)	Climate change influences water availability	temperature, precipitation, snow reliability, permafrost, receding glaciers, changing landscapes, changing vegetation, natural hazards (mass movement), water balance (fog)	Climate change (no closer description); other factors such as social changes
quantitative/ non-quantitative parameters: Focus of the future projection:	Quantitative Trend projections	Qualitative Trend projections	Qualitative Trend- and Extreme projections	Qualitative und quantitative Extreme projections	Qualitative Qualitative and quantitative Trend- and Extreme projections
Time dimension:	Up to 2050; assumption: 42-45 years	2001-2020 and 2020-2050; 49 years	Up to 2030; assumption: 25 years	Up to 2030; assumption: 22 years	From 2005 to 2012-2015; 7-10 years Up to 2025; 20 years
Number of chosen scenarios:	2	4	3	Per tourism area: 2 scenarios (tourism areas: Mountain railways/ Ski school, Accommodation/ Hotel business, Outdoor-Organizer/ Mountain guide/ Tourism organization/ Local Authority)	4 2

Number of steps:	No declaration, probably step 1-5	No declaration, allocation to step 1-5 of the defined scenario approach	No declaration allocation to step 1-5 of the defined scenario approach; focus on step 4	4 steps are indicated; which correlate to step 1-6 of our defined scenario approach	9 steps are indicated; which correlate to step 1-4 of our defined scenario approach	9 steps are indicated; which correlate to step 1-5 of our defined scenario approach
Explanatory note:	Workshops are used; scenario planning method is only a smaller part of the whole analysis	Scenarios of the IPCC are the basis for the scenario development; 3 „scenario planning“-Workshops were conducted	-	Workshops are used	Workshops and Interviews were used	Within the scenario planning the Moffat Model is used (= „a single country static computable general equilibrium model“)

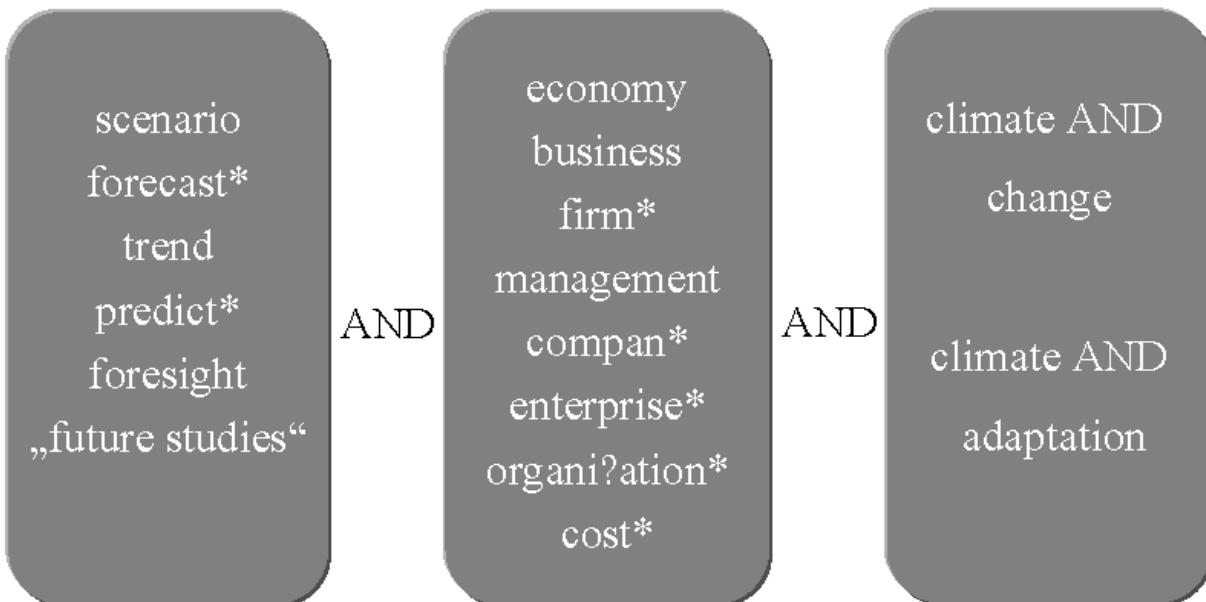
**Fig. 1**

**Fig. 2**  
Sample of industrial sectors



**Fig. 3**

Search terms for the database EBSCO

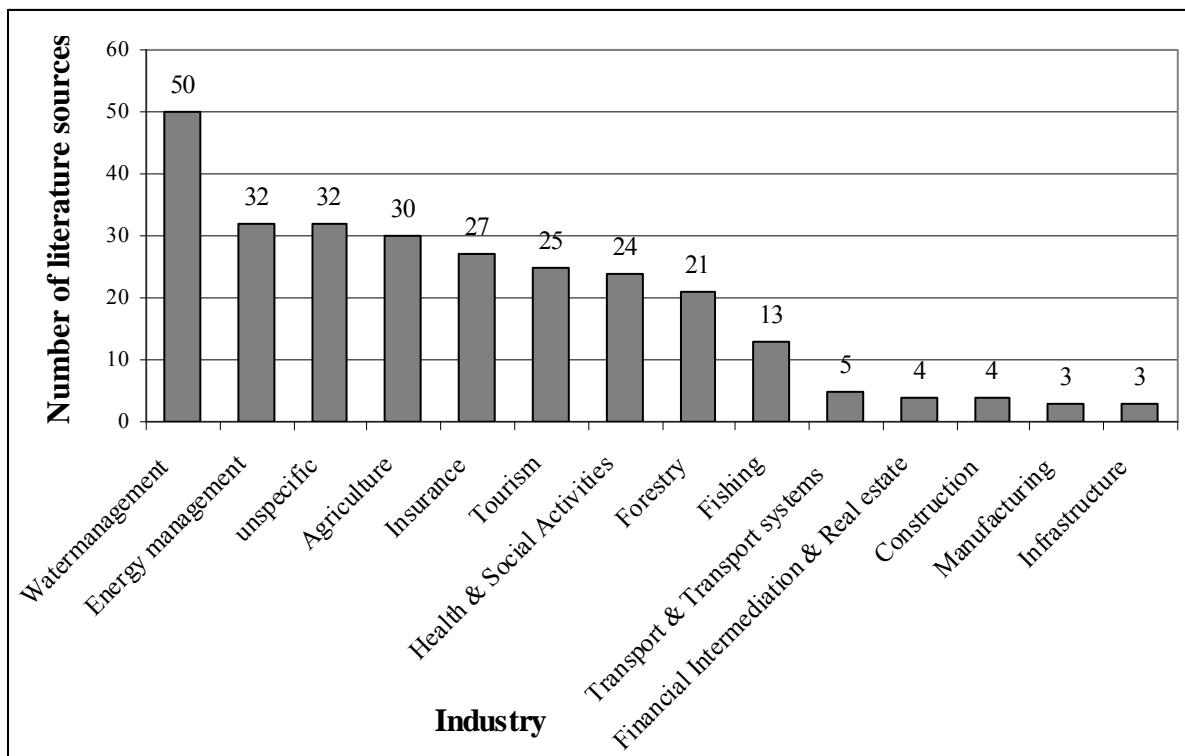


**Fig. 4**  
Screening raster<sup>a</sup>

<b>Author:</b>	
<b>Year of publication:</b>	
<b>Source/ ranking value:</b>	
<b>Investigated region:</b>	
<b>Problem statement/ objective of the study:</b>	
<b>Method:</b>	
Objective of the scenario analysis:	
Used instruments/ techniques:	
<b>Content of the scenario analysis project:</b>	Steering parameters:
	Key factors:
	Quantitative/ non-quantitative parameters:
	Focus of the future projection:
	Time dimension:
	Number of chosen scenarios:
	Number of steps:
	Explanatory note:

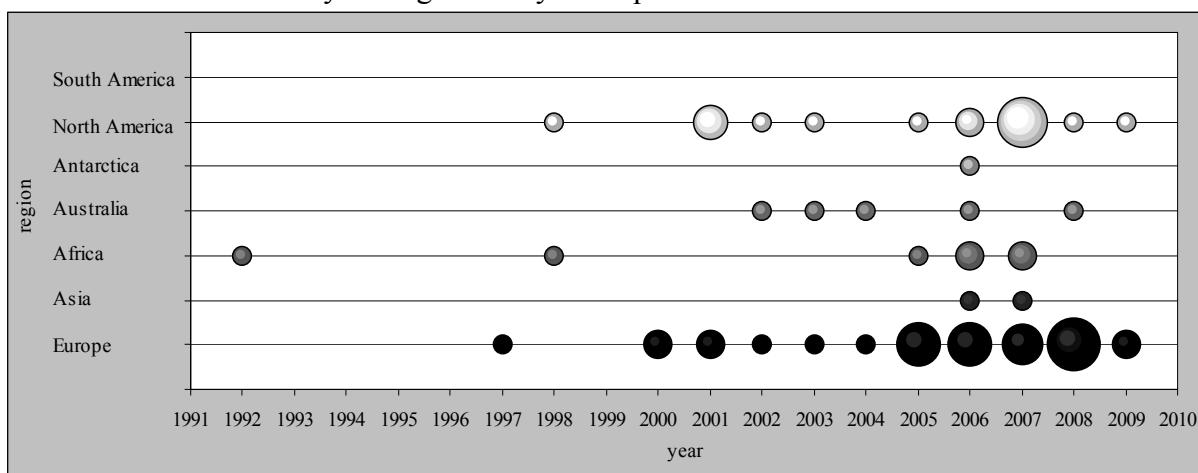
<sup>a</sup> Bold highlighted: investigated over all 64 tourism studies; not bar highlighted: investigated over 7 tourism studies which have used scenario analysis method in detail

**Fig. 5:**  
Literature sources sorted by industry



**Fig. 6:**

Connection between analyzed region and year of publication



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