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Tourism, Landscapes and Climate Change in Iceland

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1. Introduction

This is the first annual report of the PhD project *Tourism, landscapes and climate change in Iceland* partly funded by the Icelandic Tourism Research Centre (*Rannsóknamiðstöð ferðamála*, RMF). The purpose of this report is to inform about the practical progress and conceptual developments of the project. The report summarises the project's research design, goals and deliverables and provides a detailed description of the project's activities, achieved products and continuing matters of concern during the period September 2012 – September 2013.

As stated the project is part of the PhD thesis of the author who already holds an MA degree in Social and Political Science and an MSc degree in Environment and Natural Resource Management. The author has since 2008 conducted several research projects in cooperation with and for the Hornafjörður Regional Research Centre, operated by the University of Iceland. These projects included research on the socio-economic effects of the Vatnajökull National Park (VNP) on surrounding communities, and a sustainability assessment of local food and tourism networks in the Hornafjörður area. The obtained knowledge, data and contacts during those studies are important to this project.

This report is organized into four sections. The first section introduces the theme of the research project and its inspiration. A literature review section follows, describing the interrelationship between tourism and climate change. The third section of the report outlines the conceptual framework and research design of the project. The last section describes the work plan and milestones achieved in this first project year.

2. Project introduction

Glaciers provide some of the most dramatic scenery to attract tourists worldwide (table 1). Glaciers and their adjacent landforms make up landscapes that are among the most popular tourism sites in Iceland. These glacial landscapes constitute the basis for a diverse array of tourism activities and services, from sight-seeing and ice-climbing to snowmobile driving and helicopter trips, circling Iceland's largest glaciers and icecaps. In Iceland, the Vatnajökull ice cap, the largest in Europe and central icon of the Vatnajökull National Park (VNP), with its several outlet glaciers constitutes an important tourist destination for many glacier based tourism activities and attracts thousands of visitors each year.

Table 1: Glacial destinations worldwide and annual visitor numbers.
Source: Guðmundsson, 2013; Scott et al., 2008, p. 73.

Place	Number of visitors per year
Franz Josef Glacier, New Zealand	250,000
Columbia Ice Fields, Banff National Park, Canada	600,000
Los Glaciares National Park, Argentina	167,000
Vatnajökull National Park, Iceland	343.000

However, glacial landscapes are extremely dynamic and sensitive to climate change and variability (WGMS, 2012). Climate-induced environmental change has been documented in several mountain regions of the world that are also key tourism destinations (e.g. in sites in the European Alps, the Rockies, the Andes mountains, and the Himalayas). An estimated 7,000km^2 of ice cover has been lost from glaciers in these mountain regions in the last 40 years. In the European Alps alone glacier extent has decreased by 30–40% during the 20th century and a similar decrease of 25% has been recorded in the Canadian Rockies over the same period (Haeberli and Beniston, 1998; Luckman and Kavanagh, 2000). Glacier National Park in the US has lost 115 of its 150 glaciers over the past century and scientists estimate that the remaining 35 glaciers will disappear over the next 30 years (Hall and Farge, 2003). Climate change induced alterations of glacial landscapes (e.g. glacier recession and fragmentation, increase in supra-glacial debris coverage and enlargement of pro-glacial areas) effect tourism through changes in hazard and risk scenarios, degradation in panoramic scenery, and accessibility towards and within glacier landscapes (Beniston, 2003; Garavaglia et al., 2012; Ritter, Fiebig and Muhar, 2012).

Till today, only a handful of studies have been carried out thoroughly researching climate induced environmental impacts on glacier based tourism, and none of these relates to tourism in Iceland. The aim of this PhD research project is to investigate the complex and dynamic relationship between glacial landscapes and tourism in Iceland and to analyse how these landscapes and their related tourism development and visitation might alter under future climate change scenarios. The focus during the research will be on identifying suitable measures to adapt tourism development to these dynamics and develop an effective strategy for glacier tourism in Iceland to cope with the impact of climate change. The VNP will be used in the research project as central case-study.

3. Climate change and glacier tourism

Changes in the global climate can have varying effects on the development of tourism in most regions of the world. This is especially true for nature based tourism destinations. Nature based tourism destinations such as mountains and glacial landscapes are especially vulnerable to temperature and precipitation changes. Figure 1 elaborates on the interrelationship between global climate, (nature based) tourism and glacial landscapes that constitute the resources that make up a tourism destination in the context of this study. Each of the relations depicted will be detailed in the following sections of this chapter.

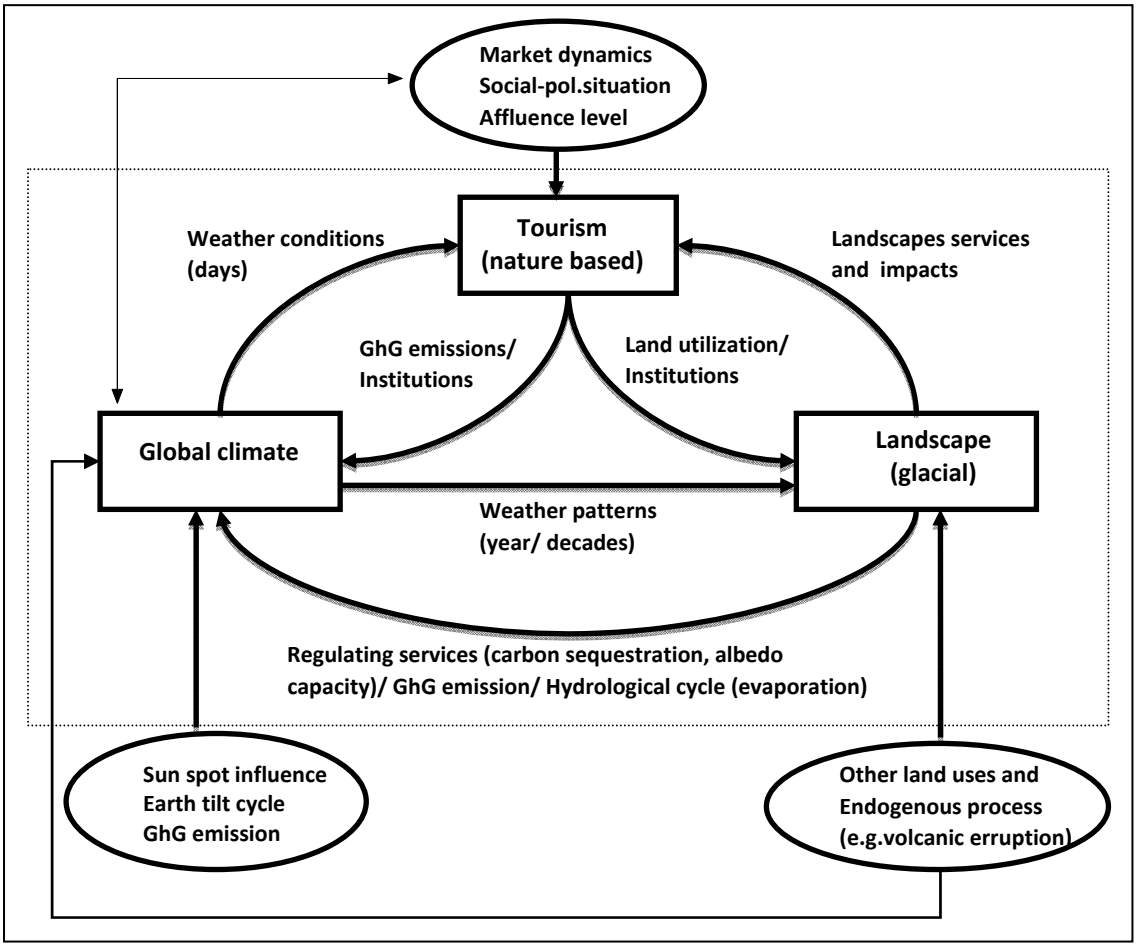

Figure 1: Overview interrelationship between tourism, landscape and global climate.

3.1 Direct impacts - weather conditions

In general, global climate influences tourism directly by determining weather conditions at a tourist destination and their place of origin. Important constituents of weather conditions such as temperature, wind, precipitation and sunshine constitute significant determinants

for tourist well-being at a destination or in their choice of a destination from their place of origin (Hamilton and Lau, 2005; Bigano, Hamilton and Tol, 2006). In addition, weather also affects key aspects of tourism operations, including activity programming and infrastructure (Scott, Jones and Konopek, 2007). As the ideal weather conditions differ depending on tourist activity and personal preferences, changes and variation in global climate can favour some activities at one destination (for example with increasing temperature sightseeing possibilities open up at destinations at higher latitudes) while reducing the attractiveness of other activities at other destinations.

In the case of Iceland, the average temperature will probably continue to rise in the coming years by approximately 0,2°C per decade. Storms will most likely stay at a similar frequency and magnitude or decrease but precipitations is expected to increase by about 0,4% to 0,8% per decade resulting in milder winters with less snow and warmer summers (Björnsson et al., 2008). Local differences in temperature and precipitation are considerable in Iceland (fig.2). How these general forecasted changes will effects future changes in a regional context remains unexplored, especially from a tourism development perspective and tourist choice assessment (e.g. choice of destination or activity, behaviour at destination).

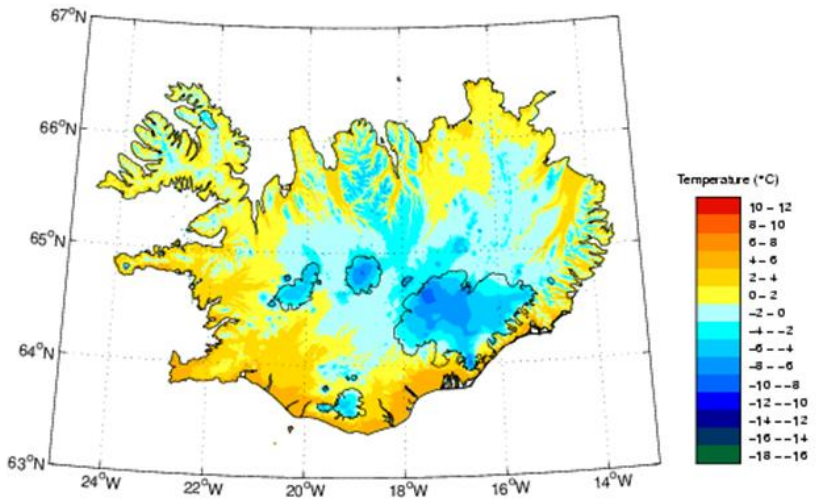

Figure 2: Annual mean temperatures in Iceland (1961-1990).
Source: Björnsson, 2003

3.2 Greenhouse gasses (GhG) emissions

Tourism influences the global climate system mainly through the emission of Greenhouse Gasses (GhG). These can be emitted directly as a consequence of for example

transportation, and indirectly e.g. through the reclamation of wetlands as recreational areas or the import of supplies for tourism consumption. In the case of Iceland, the emission of GhG induced by the tourism sector has not been measured. The latest National Greenhouse Gasses Inventory Report of Iceland (Environment Agency of Iceland, 2011) presents figures on different activities such as land-use, land-use change, food and beverages and transportation (which accounts for 20% of all GhG emission in Iceland). These are aggregated numbers of all economic sectors in Iceland and thus cannot be attributed to individual sectors such as tourism. The total emissions of greenhouse gases in Iceland increased by 35% in a period of 19 years from 3.415 Gg of CO_2- equivalents 1990 to 4.618 Gg CO_2-equivalents in 2009 (Environment Agency of Iceland, 2011).

3.3 Indirect impacts - weather patterns

Global climate indirectly affects nature based tourism by impacting the physical resources that define the nature and quality of natural landscapes on which nature based tourism depends (Scott, Jones and Konopek, 2007). The majority of studies that have examined climate-induced environmental changes have focused on such effects, for example reef degradation and loss of dive tourism destinations (e.g. Gössling et al., 2007; Roman, Dearden and Rollins, 2007; Kragt, Roebeling, & Ruijs, 2009; Zeppel, 2011), coastal area erosion and extreme events and their impacts on beach tourism (e.g. Ruosteenoja et al., 2003; Uyarra et al., 2005) and snow pack reduction in mountain areas leading to decreasing wintersport possibilities (e.g. Elsasser and Bürki, 2002; Moen and Fredman, 2007; Scott et al., 2008; Tervo, 2008; Uhlmann, Goyette and Beniston, 2009).

Mountain and glacial areas are among the most vulnerable natural landscapes to be effected by climate change and variability (Beniston, 2003; IPPC, 2007; Simpson et al., 2008; WGMS, 2012). Several studies have examined how long-term weather patterns shape these landscapes by changing flora, fauna and a-biotic elements such as rock formations, land forms and snow and ice covers (e.g. Gray, 2004; Zwolinski, 2004; Reynard and Coratza, 2007; Kunzler et al., 2010; Garavaglia et al., 2012). New landscapes take shape in such areas due to climate change, constituting both new opportunities and threats for tourism at different spatial and temporal scales (Cannone et al., 2008; Salinger et al., 2008). Glacial landscapes in particular are highly vulnerable to climate change and several studies concerning the effect

of global climate change on alpine mountain and glacier landscapes forecast substantive changes of the characteristics and functions of these landscapes (e.g. Haeberli and Hohmann, 2008; Nesje et al., 2008; WGMS, 2012). According to these studies, global climate change accelerates the retreat and disappearance of glaciers worldwide, reduces ice mass balances, accelerates the degradation of permafrost areas, alters regional water cycles, gives rise to the formation glacier lakes and opens the way for new flora and fauna to invade and colonize such areas. A study by the UNESCO World Heritage Centre (2007) analyzed some glacier World Heritage sites (i.e. Jungfrau-Aletsch-Bietschhorn in Switzerland, Kilimanjaro in Tanzania and Illulissat Icefjord in Greenland) to estimate the consequences of glacier recession on the environment, the landscape and humans. The melting of glaciers will not only have adverse consequences for the cultural and aesthetic values of these sites in the context of World Heritage, but it will also impact surrounding ecosystems through modifying hydrological cycles, related watersheds and change risk scenarios associated with the sites (UNESCO–World Heritage Convention, 2007).

Research on Icelandic glaciers forecasts significant change for the coming 50 years (Björnsson, Pálsson og Haraldsson, 2002; Jóhannesson et al., 2006; Björnsson and Pálsson, 2008; Björnsson, Jóhannesson og Snorrason, 2011). With a reduction of approximately half of the total volume of the current ice caps and disappearance of various glacier tongues in less than a half century, Icelandic landscapes will change dramatically. The research data available concerning the effects of climate change on glaciers in Iceland (e.g. glacier physical flow dynamics and mass-balance models), diverse climate scenario-based glacier models (Magnússon et al., 2005; Jóhannesson et al., 2006), together with world leading monitoring facilities (Björnsson and Pálsson, 2008) make Iceland an ideal case-study for analysing future implications of climate change on glacier tourism demand, supply and management.

3.5 Landscape functions and services

Global climate change, through altering glacial landscapes has indirect effects on tourism. The visitors of the landscape, the service providers, the infrastructure, regulating institutions and marketing actors, all need to adapt to changes in the glacial landscapes being promoted and visited by tourists. Tourism and landscapes are thus related by means of objective activities or entities (e.g. ice climbing or hiking trails) as well by subjective imaging and

experiences and other intangible features (e.g. scenic beauty or territorial embeddedness) at different temporal and spatial scales. In Iceland, glacial landscapes are an important contributor to the growing popularity of the country as a tourism destination. The appeal of glaciers and their adjacent landforms to tourists and Icelandic recreationists alike is largely based on the aesthetic value of the experience of the landscape and the opportunity to encounter rare sublime and challenging natural phenomena (Jóhannesdóttir, 2010; Olafsdóttir, 2013).

A relatively recent approach to connect landscapes properties to the well-being of its users is the concept of landscape or ecosystem services and functions. Landscape services are the *benefits* people obtain from ecosystems within a landscape while a landscape function is the *capacity* of a landscape to provide goods and services to people (MEA, 2005; Willemen et al., 2008; Haines-Young and Potschin, 2009). Capacity and benefit represent the two poles that classify landscape services (e.g. Costanza et al., 1997; de Groot et al., 2002; Costanza, 2008; Fisher, Turner and Morling, 2009). However, one of the most used frameworks is the classification of the Millennium Ecosystem Assessment (MEA, 2005) dividing services into four distinct categories:

- Supporting services: ecosystem services that are necessary for the production of all other ecosystem services, such as nutrient cycle and primary production
- Provisioning services: the products obtained from ecosystems, including: foods and fibre, fuel, fresh water, biochemical and genetic resources.
- Regulating services: the benefits obtained from the regulation of ecosystem processes, including: climate and water regulation, erosion control, pollination and storm protection.
- Cultural services: nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences.

Although the number of studies concerning classification, mapping, modelling, assessing and interpreting landscape and ecosystem services and functions grew after the publication of the MEA in 2005, the application of this approach to tourism is still in its infancy (see Cost project, 2013). Despite this lack of attention tourism constitutes a key factor of human well-being and provides a crucial interface between the different dimensions of ecosystem

services, i.e. tangible bio-physical services (e.g. provisioning services) and the intangible cultural services. Table 2 presents an unexhausted list of glacial landscape components. These are related to glacial landscape functions and services (partly overlapping) and their different spatial implications for a range of tourism beneficiaries.

Table 2: Scheme of glacier based landscape functions and services related to tourism.

Landscape components	Functions	Services/products	Spatial scale	Tourism beneficiaries
Glacier, Ice cap	Surface formation	Foundation for outdoor activity	In situ	Ice climbing, skiing, snowmobile, dogsled
Glacial river, lakes	Water regulation	Transportation measure	Directional flow related	Rafting and boat tourism
Glacial river, lakes, sub glacial areas	Habitat function	Maintenance Game and fish	In situ	Fishing, hunting, bird watching tourism and photographing
Glacier, ice cap	Climate regulation	Maintenance. Favourable climate	Non-proximal	Tourism in general
Total landscape	Aesthetic inspiration	Enjoyment of scenery	Omni directional	Sight-seeing, photographing tourism
Total landscape	Recreation	Possibilities. Travel through nature, outdoor sports	User movement related	Hikers, mountaineering ice climbing, camping
Total landscape	Cultural and artistic inspiration	Use of landscape in branding and advertisement	Non-proximal	Tourism organizations
Total landscape	Education	Use landscape for education purposes	Non-proximal	Exhibition, tourist centres and its visitors
Total landscape	Experience significance	Provision of wilderness, solitude and naturalness	User movement related	Hikers, camping tourism

3.6 Landscape impacts

Landscape dynamism and changes can provide benefits to tourism, but also effect tourism development and demand in negative ways. Different studies on glacial landscapes in Norway, the Alps and the Andes have stressed how the dynamism of these landscapes can lead to e.g. natural hazards (e.g. Nesje et al., 2008; Haeberli and Hohmann, 2008; Chevalier et al., 2011). Changing snow conditions and increasing temperatures can accelerate unpredictable snow and ice-water run-off and avalanches. Further, global warming can increase the instability of ice and avalanches of seracs (free standing blocks or columns of ice formed by intersecting crevasses on a glacier) and glacier retreat can give rice to major rock slides, but both are able to provoke glacier lake outburst floods. In addition, debris flow,

landslides and rock fall can lead to the damage or destruction of trail infrastructure and constitute a direct threat to hikers and mountaineers (Ritter, Fiebig and Muhar, 2012). Finally, the recession of glaciers modifies accessibility to and from the glaciers, e.g. making the glacier margin too steep to attend (Furunes and Mykletun, 2012). Similar to the direct effects of climate change on tourism in Iceland, the indirect or landscape induced effects on tourism are a sparsely researched topic.

3.7 Landscape utilization

The provision of landscape and ecosystem services can only benefit tourism actors by means of physical and/or mental engagement with the landscape (Braat and de Groot, 2012). This engagement includes discovery, management, perceptions, experiences or exploitation. Tourism activities or events that take place in a glacial landscape involve glacier sightseeing, mountaineering, skiing, hiking, trekking, flying, driving, cruising, photographing, exploring, dogsled riding, surveying with scientific research, environmental education and more. All these activities are accommodated with specific local or national organizations and companies, facilities and supplies (e.g. food, beverages, souvenirs) constituting networks and cooperative arrangements. In Iceland, several glacial landscapes or sites are among the most visited places for hikes and sightseeing in the country, such Skaftafell, Snæfellsnes National Park and Jökulsárlón (Icelandic Tourist Board, 2012). In addition, adventure tourism with activities such as ice-climbing, glacier hiking and snowmobile driving that take place on glaciers and ice caps is a fast growing business in Iceland (table 3).

Table 3: Purchased recreation activities by foreign visitors in Iceland (2009 and 2012)
Source: Icelandic Tourist Board, 2010 and 2013

Purchased recreational activities	2009	2012
Swimming/ warm spring baths	65%	70,5%
Museums/ exhibitions	32%	46,2%
Fishing	19%	1,5%
Golf	12%	0,6%
Guided site-seeing tours	6%	35,5%
Guided hike/ mountain climb	6%	14,5%
Horse riding tours	4%	17,3%
Whale watching	3%	34%
Glacier/ snowmobile trips	1%	15,2%

Despite the extensive literature on glacier geology and geography there are relatively few studies that focus on glacier tourism. Glacier tourism is an activity or event where glaciers and/or glacier relics serve as the main attractions through a host of activities already recounted (Wang, He and Song, 2010). Studies that have examined glacier tourism however have focused on their preconditions (Furunes and Mykletun, 2012) and characteristics (Liu, Yang and Xie, 2006) or researched glacier tourist behaviour in different case-studies (Scott, Jones and Konopek, 2007; Nyaupane and Chhetre, 2009).

3.8 Institutions

Another important response from tourism actors towards environmental impacts and landscape dynamism is through networks of existing and possibly new institutions. Institutions are formal (rules, laws, constitutions, organizational entities) and informal (behavioural norms, conventions, codes of conduct) practices that structure human interaction with their environment (Armitage, Plummer and Berkes, 2009). Chapin III et al. (2006) identified four types of institutions that human actors (both individual and groups) use to respond to social, ecological and environmental impacts which can applied to responses of tourism to climate change induced impacts in the context of glacial landscapes (table 4). Most of the institutional responses to changes in landscape impacts and service provision take just one variable into account (e.g. maximal sustained yield of game or acceptable level of visitors). The dominant response thinking is based on linear causal relationships with less attention to tangent linkages to e.g. supporting services (nutrient cycle, seed dispersal or soil formation) that govern long-term trends or unexpected changes in the social and environmental context (Chapin III et al., 2006). New and more cohesive policy strategies are emerging from the science of sustainability that can better address dynamism, surprise and non-linear cause and effect relationships which come along with climate change issues. One of them is human adaptability, the capacity of actors in a system to respond to, shape and create variability in the state of the system (Berkes, Colding and Folke, 2003). So called Adaptive Management (AM) approaches attend to this and are based on continuous learning and innovation that acknowledge uncertainties, and allow for timely adjustment of planning and management strategies (Holling, 1978). An explanatory framework for AM in a protected area management context was developed by the author in an assignment paper of a PhD course and appended to this report (appendix II).

Table 4: Institutions and examples in tourism-glacial landscape context
Source: Chapin III et al., 2006

Types of Institution	***Examples in glacial landscape context***
1) Resource-harvest institution that govern choices people make to manage the supply and appropriation of landscape good and services. Resource harvest institutions include choices made in wildlife, forestry, wilderness management, and water management.	Infrastructure (roads, trails, marked paths) to gain access to panoramic sceneries of glacier sites.
2) Resource-conservation institutions govern choices to conserve and protect ecosystem services, especially regulating and cultural services. They include habitat and cultural protection measures and ecosystem conservation traditions and programs.	The establishment of national parks such as VNP or Snæfellsness NP.
3) Hazard reduction institutions that govern choices that reduce the societal impacts of natural hazards such as floods, avalanches and wildfire. They seek cost-effective protection or coping strategies, based on experiences of hazard occurrence.	Regulating regimes such as the closing of mountain roads or glacier crossings for certain types of vehicles and during a certain period.
4) Ecological externality-producing institutions are a heterogeneous set of rules that influence social and economic goals that have an indirect impact on landscapes and ecosystems. These institutions include policies effecting national and global trade, extraction of non-renewable resources or industrial activities.	Governmental or corporate mitigation policies, emission schemes, guidelines for use of low-emission fuels on motorized tourism activities (e.g. super-jeeps or snowmobiles).

Adaptability strategies to counter or take advantage of the effect of climate change on tourism are a topic of growing importance among tourism scientist (for review see Gössling, 2012). Adaptability strategies in the context of glacial landscape tourism are still sparsely examined. A case-study of the Baishui Glacier No. 1 in China (Shiing, Yuanqing and Xiaodong, 2010) is one of the few examples that outline the possible impacts of climate warming on glacier tourism and put forward adaptive measures and strategies aligned with global climate change. A study on adaptation strategies to climate change in Iceland by the Icelandic Institute of Sustainability Studies (Jónsdóttir, 2011) identified low strategic importance on direct climate adaption and emphasized the need for increased knowledge on different aspects on climate change adaptation and the development of tools (maps and databases). Hence, it is of significant importance to examine in depth the potential impacts of climate change on glacier tourism and to prepare adaptation options. Neither the National Greenhouse Gasses Inventory Report of Iceland (Environment Agency of Iceland, 2011) nor the Climate Change Strategy of Iceland (Ministry of Environment, 2007) mention tourism as an economic sector or as a social activity, subject to or contributing to climate

change. However, important aspects of tourism such as transportation, cultural heritage and invasive species are touched upon. The 2007 Climate Change Strategy sets forth a long-term vision for the reduction of net emissions of greenhouse gases by 50-75% until the year 2050, using 1990 emissions figures as a baseline (Ministry of Environment, 2007). The defined main objectives are the reduction of fossil fuels use in favour of renewable energy sources and climate-friendly fuels, the increase of carbon sequestration through afforestation, re-vegetation, wetland reclamation, and changed land use; the support of research and innovation in fields related to climate change affairs and preparation for adaptation to climate change (Ministry of Environment, 2007).

Emerging from this strategy is another institutional response to climate change impacts on tourism and landscapes, i.e. climate change mitigation. Climate change mitigation includes technological, economic and social changes and substitutions that can help to achieve reductions in greenhouse gas emissions (Simpson et al., 2008). Different mitigation measures in the tourism industry, such as usage of renewable energy sources or the increased use of local supplies, are being applied, both from a marketing and cost-reduction consideration, and even more idealistic sentiments. Despite, these initiatives the growing tourism sector and especially, the fast growing air transport sector that contributes significantly to tourism induced GhG emission (Gössling and Upham, 2009) makes it very difficult to reduce the absolute amount of GhG emission from the tourism sector.

3.9 Landscape regulating services

Glacial landscapes influence global climate through the hydrological cycle. Melting ice at the ablation area of glaciers or in glacier lakes evaporates directly or is transported with surface run-off to the sea to evaporate. In addition, glaciers effect global climate through being able to reflect incoming solar energy. The reduction of this albedo effect (reflectivity) will lead to more solar energy absorption by the earth's surface which contributes to increasing global warming. Finally, changing climate condition can increase or decrease the growth of trees and plants that have the capacity to sequester carbon in soil and atmosphere which, in turn, affects the global climate.

3.10 External drivers of change

Besides the mutual impact of global climate, (glacial) landscapes and tourism, they are all affected by external drivers of change. Important driving forces of climate change are the emission of GhG from other economic sectors such as agriculture and heavy industry, but also the changes in the earth's orbit and tilt (Milankovitch cycles), sunspot cycles and other climate oscillation patterns such as El Niño (Cunningham, Cunningham and Saigo, 2005). Landscapes are also susceptible to other influences than climate. Other land-uses such as agriculture, forestry, infrastructure development and rural urbanization have strong influences on natural landscapes. In Iceland, yet other external drivers of change, such as earthquakes and especially volcanic activity have had and still have enormous effects on the landscape. In terms of tourist behaviour important determinants include the economic situation of tourists' household, life style of travellers, social-political situation of the host country and marketing variables (Sirakaya & Woodside, 2005). The implications of national or international climate change policies on tourism operators can also have effects on tourism. These policies are likely to lead to an increase in transport costs and may foster environmental attitudes that lead tourists to change their travel patterns (Simpson et al., 2008).

To summarize, research into tourism and climate change in Iceland is an untouched topic and worldwide the amount of empirical studies that focus on tourism behaviour in mountain or glacial landscapes under impacts of climate change are limited and mostly aimed at the effects of snowpack reduction. In the following chapter the key aims of this PhD project are outlined, but these are meant to address this lack in an Icelandic context.

4. Research design

4.1 Goals and objectives

The central goals of this study are to explore the current and future implications of climate change on glacial tourism in Iceland and develop effective adaptation strategies for this tourism sector. These goals are divided into three main objectives:

1. To gain a profound understanding of the reciprocal relationship between tourism and glacial landscapes by analysing tourism actors' (tourists, operators and managers) behaviour, attitudes and preferences regarding glacial landscapes and assess the diversity of services and products these landscapes provide to tourism at different spatial and temporal scales.
2. To assess the climate change implications for glacier tourism in Iceland by developing explanatory future scenarios that integrate knowledge on climate change and variability, landscape ecology/glaciology and tourism preferences and behaviour patterns.
3. To develop an effective strategy for glacier tourism in Iceland to cope with the impact of climate change by identifying and selecting sound adaptation and mitigation measures based on the defined future scenarios.

4.2 Research framework

The conceptual framework for this project is shown in figure 3. It is based on the Drivers Pressure State Impact Response (DPSIR) framework, an interdisciplinary tool for environmental analysis developed by the European Environment Agency (EEA, 1995). The DPSIR framework explains how drivers, such as natural forces and human activities produce certain positive or negative pressures that induce impacts on different environments or systems (e.g. biophysical and socio-economic). These pressures change the quality and quantity of the natural resources base of air, water, soil, flora and fauna, and non-renewable resources. Based on the impacts generated by these pressures, society reacts by developing policies and programmes to prevent, reduce, or mitigate not only the impact (outputs) but also the pressure generated (inputs).

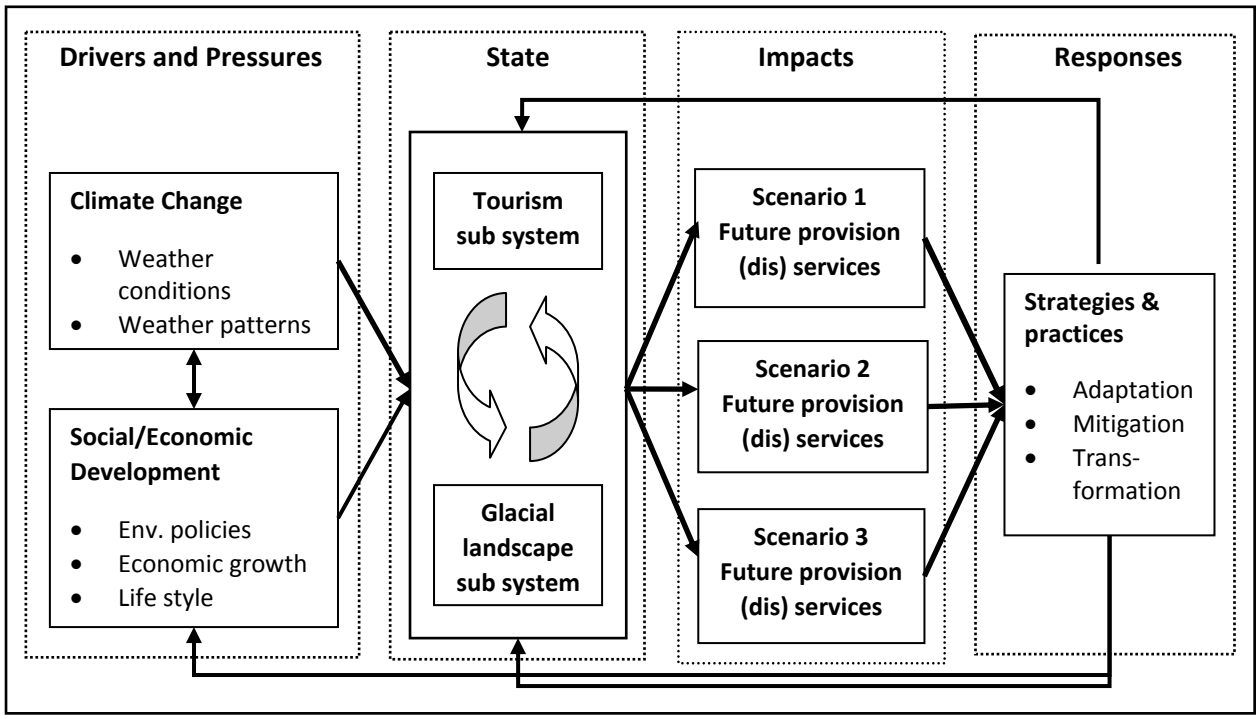

Figure 3: Conceptual framework for the research project.

An important strength of the DPSIR approach is that it emphasizes the role of humans-in-nature (Berkes and Folke, 1998) by representing a system that includes societal-human (tourism) and ecological-biophysical (glacial areas) subsystems in mutual interaction. In order to address this interaction the project builds on the study of complex systems which has created new tools for modelling interactions between anthropogenic and natural systems (Costanza et al., 1997). Complex systems thinking is being used extensively to analyse linked systems of humans and nature, i.e. social-ecological systems (SESs), at various scales and as a means to bridge social and biophysical sciences (Berkes, Colding and Folke, 2003; Liu, Yang and Xie, 2007). In addition, complex systems thinking provides the opportunity to consider and include uncertainty in managing tourism destinations (Strickland-Munro, Allison and Moore, 2010). Complex systems thinking, along with ecosystems research and issues of sustainability has been receiving interest by a growing number of tourism scholars (e.g. Farrell & Twining-Ward, 2005; Schianetz and Kavanagh, 2008, Strickland-Munro, Allison and Moore, 2010). These study tourism development in their complex and dynamic natural context and describe nature not as predictable and balanced, but emphasize its complexity, with multiple states and non-linear behaviour. These research fields use a “whole system perspective” to examine phenomena and focus

on the interrelations between components rather than the individual components themselves. In this sense, the whole is more than the sum-up of its parts.

The research framework employed in this project (fig. 3) applies a DPSIR to investigate the complex dynamics of environmental change that influence the state of social-ecological systems (i.e. glacier tourism system) and their origins. The framework will assess the consequences of climatologically induced impacts and find the most efficient response measures. Drawing on Rounsevell, Dawson and Harrison (2010) the project will modify the DPSIR framework to investigate the complex dynamics of environmental change that influence ecosystem services and societal responses to better manage and protect them. Through their amendments three key components of figure 3 are highlighted:

- *Drivers* are the underlying causes of social-ecological system change that are exogenous to the system or region in question, e.g. climate change, national and international social and economic development.
- *Pressures* are the endogenous variables that quantify the effect of drivers within a system or region, e.g. weather in form of temperature and precipitation, infrastructure, financial resources or property rights.
- *State* variables represent the sensitivity of the system/sector to the pressure variables. This involves the definition and quantification of all those elements relevant to the supply of ecosystem services by biological organisms and a-biotic elements; and the demand for ecosystem services from tourism actors.

The overview in the previous chapter shows that landscape or ecosystem services not only link glacial landscapes with tourism in a beneficial way, but can also create disservices in the form of hazard or disamenities. Further, the flow of services is only possible with some human input in form of utilizations of the landscape mostly governed by means of institutions.

Thus, the state component in figure 3 is made up of variables that describe the whole of the social-ecological system, including the attributes of the providers of landscape (dis)services and the attributes of the beneficiaries of landscape (dis)services. A coherent understanding of the temporal and spatial dynamism of landscape and ecosystem services should include

both the capacity of landscape to deliver services to tourism actors and the social demand for using a particular landscape service in a particular area (de Groot et al., 2010; Haines-Young and Potschin, 2010). The *impacts* shown in figure 3 constitute a measure of whether the changes in the state variables have a negative or positive effect on provision of landscape services and dis-services to tourism actors. Finally, *responses* in figure 3 through planned policy and management, aim to minimise negative impacts (or maximise positive impacts/benefits), by acting on the socio-economic pressure variables or directly on the state variables. The amended DPSIR framework constitutes the conceptual framework that will guide the achievements of the central goal and main objectives of this project and underpins the different studies that comprise this Ph.D research project, described through individual work packages in the next chapter of this report.

5 Work plan

5.1 Work packages: aims, tasks and methods

The design of this research project is illustrated in figure 4 below. It consists of seven different work packages (A till G) including aims, tasks and used methods. Each work package relates with one or more elements of the conceptual framework (figure 3) described in the previous chapter. Table 5 in the following outlines milestones and deliverables and table 6 the work plan according to time slots.

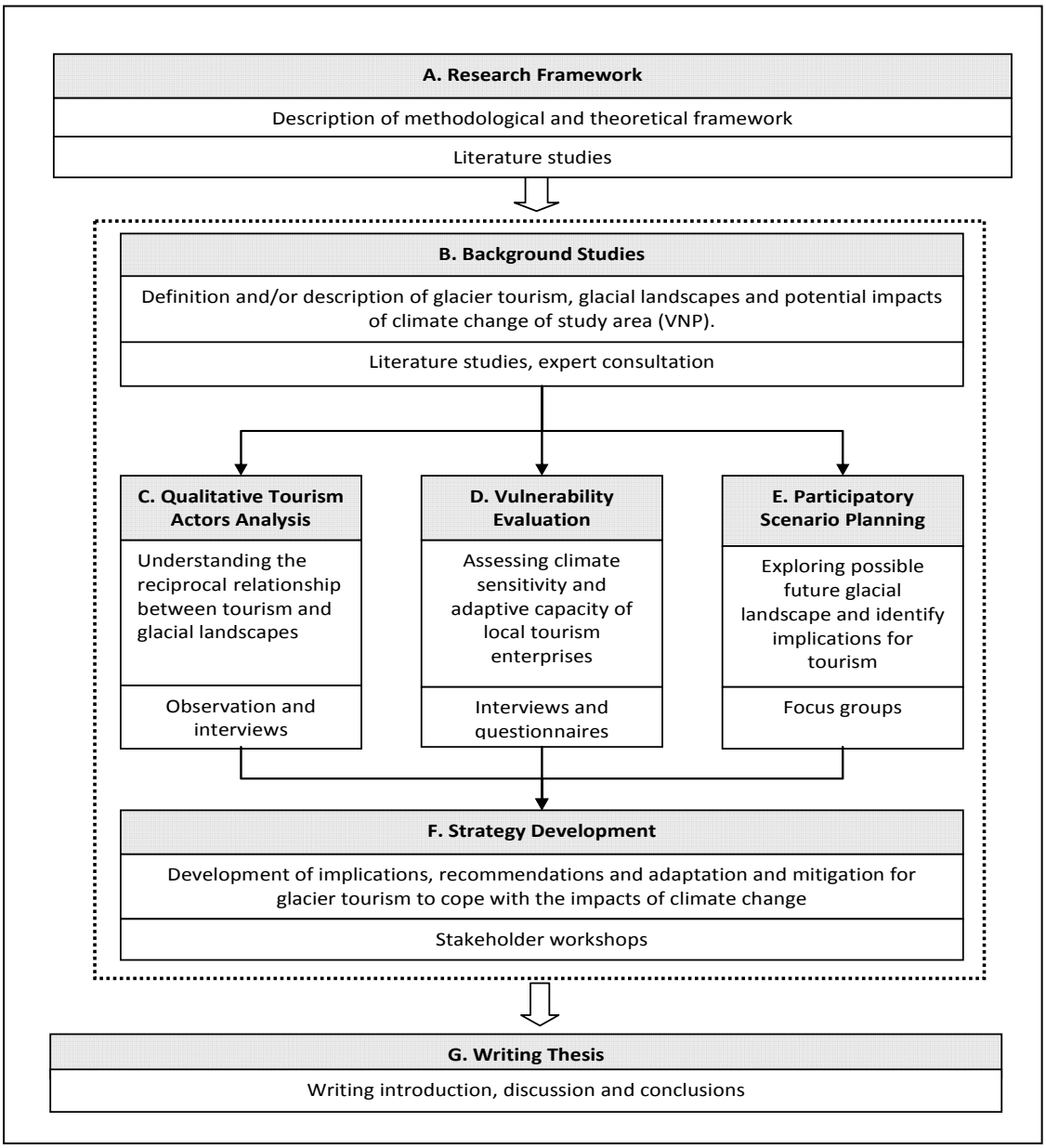

Figure 4: Research project design.

- Work package A relates to the ambitions of this report and deals with the development of a conceptual framework that constitutes the theoretical and methodological underpinnings of the studies in subsequent tasks.
- Work package B constitutes a background study that aims to outline the current understanding of climate change and its potential to impact glacial landscape structures, functions and tourists' behaviour. This task entails an extensive literature survey on the impacts of climate change on glacial landscapes and glacier tourism development in Iceland and the gathering of contextual quantitative data on glacier tourism in Iceland (such as number, location and type of activities, number of customers, etc.) by means of literature surveys (statistics, promotion material and policy-papers) and supplemented with data from stakeholders.
- Work package C aims to gain a profound understanding of the reciprocal relationship between tourism and glacial landscapes by analysing tourism actors' (tourists, operators and managers) behaviour, attitudes and preferences regarding the glacial landscapes and assess the diversity of services and products those landscapes provide to tourism at different spatial and temporal scales. The work package involves an intensive qualitative research approach, using participant observation and in-depth interviews as primary methods. The qualitative research involves a preliminary descriptive examination of behavioural patterns, perceptions, and experiences of tourists visiting glacier sites on the one hand, and an analysis of the attitudes and values of tourism entrepreneurs and management operating in glacier areas on the other.
- Work package D aims to evaluate the climate sensitivity and adaptive capacity of the tourism enterprises that offer activities in VNP in regards to impacts of climate change. This task will employ a community-based vulnerability assessment of local tourism entrepreneurs operating in the VNP to examine their exposure-sensitivity towards climate induced changes of the biophysical environment and their ability to adapt to these changing circumstances. The vulnerability assessment involves a series of semi-structured interviews with tourism entrepreneurs to collect exploratory results and an e-mail survey among tourism entrepreneurs that offer commercial activities in the VNP based on the interview findings to generalize those results on broader scale.
- Work package E aims to assess current and future climate change implications for glacier tourism in Iceland by developing explanatory future scenarios that integrate knowledge

on climate change and variability, landscape ecology/glaciology and tourism preferences and behaviour patterns. The VNP will be used as a case-study. The future scenarios will be developed in a participatory manner. The participatory scenario development will be conducted during a set of expert and stakeholder focus groups. Each participatory session will provide a range of different future developments, involving the provision of glacial landscape services and impacts to tourism actors (work package C) and the capacity of those actors to adapt to or withstand climate change induces pressures (work package D) supplemented with experts and stakeholders' views and knowledge. The scenario development involves the use of *soft system methodology* to describe and model the main elements (drivers, actors, resources and services), interactions and feedbacks of a conceptual tourism-glacial landscape system. Soft system methodology is based on system dynamics, the study of the dynamic behaviour of a variety of complex systems (Checkland, 1988). A common tool for facilitating systems thinking is the causal or influence diagram (figure 5). According to Coyle (2000) influence diagrams can assist systems thinking by summarising complex problems, identifying the relationships and feedback loops which may help to explain behaviour or generate insights, identifying wider contexts of a modelling task and finally providing the basis for a quantified model where appropriate. Typically, influence diagrams use nodes and directed arrows to achieve this and are sometimes referred to as feedback loops or causal loop diagrams.

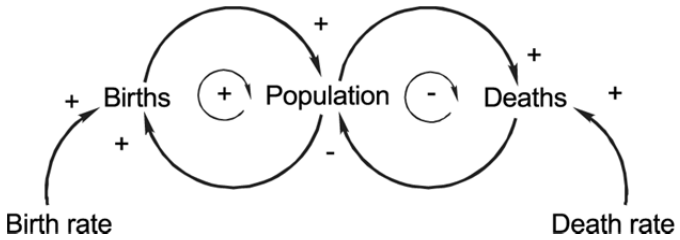

Figure 5: Example of causal loop diagram of population development
Source: Haraldsson, 2000

These causal loop diagrams will be applied to build-up exploratory landscape scenarios represented in narrative and visual forms. On the basis of these scenarios, potential climate induced impacts on glacier tourism will be identified and evaluated.

- Work package F synthesizes the results of previous work packages and aims to develop an effective strategy for glacier tourism in Iceland to cope with the impact of climate change by identifying and selecting sound adaptation and mitigation measures based on the future scenarios. This task will use stakeholders' focus groups to identify feasible adaptation and mitigation measures on the basis of the scenarios developed in task E and the results from the other tasks. A *multi-criteria analysis* will be employed to evaluate the adaptation options on the basis of a set of criteria such as effectiveness, efficiency and feasibility. The focus groups will involve a mix of participants from e.g. park management, tourism companies and local municipalities, and will thus also contribute to increased mutual understanding and problem-solving capacity amongst local stakeholder groups.
- Work package G synthesizes the studies in the different work packages into a PhD thesis.

5.2 Milestones and deliverables

The research project has the following milestones and deliverables per work packages, represented in table 5.

Table 5: Overview of milestones and deliverables per work package.

Work package A *Develop research framework*	
Milestones	*Deliverables*
• Description of theoretical and methodological framework, work-packages, deliverables and planning	• Accepted PhD project proposal • PhD project application Rannís • Assignment PhD course
Work package B *Background studies*	
Milestones	*Deliverables*
• Collection and analysis of relevant literature • Overview of potential climate change impacts on tourism destinations in Iceland	• Development of an updated knowledge base on relationship between tourism, glacial landscapes and climate change • Define a set of knowledge gaps • A conference presentation and paper
Work package C *Glacier tourism actors analysis*	
Milestones	*Deliverables*
• Fieldwork and interview research design • Conducted interviews and observations • Processed and analysed all data	• Grounded theoretical conceptions on relations of glacial landscapes& tourism • One peer-reviewed article + conference paper
Work package D *Vulnerability evaluation*	
Milestones	*Deliverables*
• Survey and interview design • Collecting and review policy papers • Conducting interviews	• Set of best adaptation practices to address impacts of climate change in glacier tourism • Set of supporting and constraining factors

• Transcription and analysis of all data	for development, implementation and effectiveness of adaptation • One peer-reviewed article + conference paper
Work package E *Participatory scenario planning*	
Milestones	*Deliverables*
• Creation of expert/ stakeholder group • Design of conceptual and parameterized model • Scenario simulation • Processed and analysed all data	• Conceptual dynamic system model of glacial tourism landscape site in Vatnajökull NP • A set of future scenarios of glacier tourism in VNP • One peer-reviewed article + conference paper
Work package F *Strategy development*	
Milestones	*Deliverables*
• Creation of expert/ stakeholders group • Development of evaluation criteria • Conduct analysis and process data	• A climate change adaptation strategy proposal for Vatnajökull NP • A set of climate change response measures • One peer-reviewed article + conference paper
Work package G *Finalization the project*	
Milestones	*Deliverables*
• Synthesis results work packages • Writing down results, conclusions	• PhD dissertation completed • Agenda for future research

5.3 Achievement of project year 1

The main achievements (activities and products) of the first research year from September 2012 – September 2013 were six in all.

The first and second ITRC research seminar

The outline of the total project was presented at the first research seminar of the Icelandic Tourism Research Centre (ITRC) at Höfn on 20th and 21st September 2012. The goal of the research seminar was to find synergies between the different projects that are sponsored by the ITRC and to design an overall project time planning (Appendix I). In the second research seminar that was held in Húsavík 9th to 11th of October 2013 the achievements, issues and future development of the project were presented and discussed in group sessions.

PhD course Advances in Tourism related resources

From 8th till 12th November 2012 the author participated in the PhD course 'Advances in Tourism related resources' at Mid Sweden University in Östersund, Sweden. The central focus of this course was on the planning, development, and management of natural as well as the human-built tourism resources. Specific attention was paid to:

(a) how tourism uses such resources and,
(b) the economic, socio-cultural and environmental impacts of tourism-related activities on these resources and the destinations overall.

Central topic of the course was the impact of climate change on tourism. The examination of the course (worth 7,5 ECTS credits) entailed the participation in seminars/in-class discussions and an individual written assignment (Appendix II) including a paper presentation delivered to a panel of opponents.

PhD research proposal for Háskóli Íslands

One of the main activities of this first research year was to write a PhD research proposal for the PhD programme of Tourism Studies at the faculty of Life and Environmental Science of the University of Iceland. The proposal described an overview of the state of the art of knowledge and research concerning the reciprocal relationship between climate change and tourism and focused on current understandings about climate induced impacts on glacier tourism. The proposal attended to the conceptual framework further developed in this report for analysing the implications of climate change on glacier tourism in Iceland. Further, the proposal outlined the main goals and objectives, research design and work plan, which have been advanced in this report.

Rannís Grant application

For additional funding of this PhD project (50% of the project is funded by the ITRC) an application to the Icelandic Research Fund (Rannís) was written and sent in. This application extended the literature review on climate change and tourism and fine-tuned the conceptual and methodological framework of the research project here further elaborated upon.

Literature study, knowledge gap identification and research agenda

A literature study was conducted that outlines the current understanding of climate change and its potential to impact both glacial landscape structures and functions and tourists' behaviour, and identifies the main scientific gaps and issues for a future research agenda. The results of the study are integrated in this report.

Conference presentation and lecture

Findings from the literature study were presented to master students of the University of British Columbia at Höfn in May 2013, and at the Þjóðarspegillinn 2013 annual social sciences conference at the University of Iceland in October 2013.

5.4 On-going activities

In the autumn of 2013 a set of observations and interview sessions with tourists at different glacier sites in Iceland started and will continue until the summer of 2014. Between 10-15 observation and interview sessions will be performed with tourists taking part in various glacier based activities (e.g. ice-climbing or super jeep tours). The focus is upon analysing the reciprocal relationship between glacier tourism and glacial landscape in Iceland. The results of this study constitute the main input of a peer reviewed article and conference paper.

5.5 Work plan scheme

Future developments of the research project are presented in the work plan hereunder (table 6). The light shaded cells in the table indicate currently conducted or achieved developments.

Table 6: Work plan scheme.

	2012		**2013**				**2014**				**2015**			
Main developments	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Work package A														
• Design project proposal														
• PhD course														
Work package B														
• Literature study														
• Write and present conference paper														
Work package C														
• Observation and interview design														
• Conducting observation/ interviews														
• Processing and analysing data														
• Write paper + conference proceeding														
Work package D														

• Interview and survey design														
• Conducting interviews and surveys														
• Processing and analysing data														
• Write paper + conference proceeding														
Work package E														
• Creating stakeholder/ expert group														
• Design and parameterize model														
• Scenario simulation sessions														
• Write paper + conference proceeding														
Work package F														
• Creating stakeholder/ expert group														
• Develop evaluation criteria														
• Workshop sessions														
• Write paper + conference proceeding														
Work package G														
• Write thesis														

6. Conclusions

Tourism is considered a highly climate-sensitive economic sector. As a result climate change constitutes one of the greatest challenges to tourism development in the future. Changes in global and regional climate effects tourism in multiple ways. In the case of Iceland where natural and glacial landscapes constitute the main tourism attraction, environmental induced impacts of climate change form a profound challenge for future tourism development. Despite several future projections that show dramatic changes in the glacial landscapes worldwide including all Icelandic icecaps, research into tourism and climate change in Iceland is an untouched topic. Worldwide the amount of empirical studies that focus on tourism behaviour in mountain or glacial landscapes under impacts of climate change are limited and mostly aimed at the effects of snowpack reduction. The interrelationship between tourism and landscape is complex and dynamic. It involves multiple linkages between actors and entities at different spatial and temporal scales. This research project will look critically and holistically on how this interrelationship might change under defined scenarios of future climate change. The research uses an amended DPSIR framework to analyse the complex dynamics of environmental and societal drivers of change that effect the state of a glacier based tourism system. The research employs a mixture of intensive qualitative research methods (observation and interview sessions with tourists, operators and managers) with participatory modelling and scenario planning techniques with stakeholders to explore the current and future implications of climate change on glacier based tourism in Iceland and develop effective adaptation and/or mitigation strategies for this tourism sector.

This report has provided the conceptual platform and work plan from which this project will be developed. The next steps include the collection and analysis of data from different tourism actors (tourists, operators and managers) concerning their attitudes towards and behaviour in glacial landscapes, the identification of the main landscape services and impacts glacial landscapes have on tourism actors and the assessment of their vulnerability to climate change induced impacts on glacial landscapes in Iceland. The results of these studies will be the main input for the next report in 2014.

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Appendix I – Overall Product planning – First Research Seminar RMF, Höfn October 2012

	Framvinda ársins 2012				Verkefni:								
Verkþáttur (setja x í viku reit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.	Fjöldi vikna
Phase A: Develop research framework (methodologies & theoritical conceptualizations)													0
Initial project activities (compilation project group, detailed project work plan with planning)													4
Project group meetings													2
PhD seminar in Sweden													2
Research seminar													1
Literature survey													15
Development conceptual framework													2
Writing results, conclusions and discussion													0
												Samtals vikur	26

Vörður (skýra og setja x í mánaðar reit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.
Project plan												
PhD seminar Sweden												
PhD seminar paper												
RMF report summary delivery												
Research seminar RMF												

Fjármögnun (setja upphæð í mánaðarreit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.	Samtals	%
RMF													**0 kr.**	####
													0 kr.	####
													0 kr.	####
													0 kr.	####
Samtals	0	0	0	0	0	0	0	0	0	0	0	0	0	

	Framvinda ársins 2013				Verkefni:	0							
Verkþáttur (setja x í viku reit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.	Fjöldi vikna
Phase A: Development of research framework													
Literature analysis													15
Project group meetings													3
Development research framework													3
Phase B: Background Studies													
Project group meetings													1
Literature review													17
Data collection & analysis													8
Writing down results, conclusion and discussion													4
Phase C: Qualitative glacier tourism actor analysis													0
Initial project activities (workplan, acquirement permissions, equipment)													4
Data gathering and processing													5
Data analysis													4
Writing down results, adjustments and implementation													3
												Samtals vikur í verkefni	67
						Launakostnaður pr. viku	x					Heildar launakostnaður	#VALUE!

Vörður (skýra og setja x í mánaðar reit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.
Research proposal Rannís Phase A												
Research proposal HÍ Phase A												
Research proposal Vinir Vatnajökuls												
Conference presentation												
Research seminar RMF												
RMF progress report												
Data base glacier tourism in Iceland												
Paper Phase B												
Research design Phase C												

Fjármögnun (setja upphæð í mánaðarreit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.	Samtals	%
RMF													**0 kr.**	####
													0 kr.	####
													0 kr.	####
													0 kr.	####
Samtals	0	0	0	0	0	0	0	0	0	0	0	0	0	

	Framvinda ársins 2014				Verkefni:		0						
Verkþáttur (setja x í viku reit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.	Fjöldi vikna
Phase C: Glacier tourism actor analysis													
Project group meetings													3
Initial project activities (survey preparations)													3
Data gathering and processing													9
Data analysis													9
Writing down results, adjustments and implementation													13
Phase D: Vulnerability Assessment													
Literature analysis													4
Indicator development													2
Interview and survey preparation													
Data gathering, processing and analysis													8
Writing down results, adjustments and implementation													7
Project group meetings													3
Phase E: Participatory scenario planning													
Project group meetings													4
Stakeholder group preparation (workplan, stakeholder selection, accomodation, etc.)													5
Participative modelling and scenario development sessions													2
Result evaluation													3
Writing down results, conclusion and discussion													6
												Samtals vikur í verkefni	81
						Launakostnaður pr. viku	x					Heildar launakostnaður	#VALUE!

Vörður (skýra og setja x í mánaðar reit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.
Conference proceeding Phase C												
Paper Phase C												
Workplan Phase D												
Conference proceeding Phase D												
Paper Phase D												
Workplan Phase E												
Stakeholder platform												
Set of future scenarios												
Conference proceeding Phase E												
Research seminar RMF												
RMF progress report												

Fjármögnun (setja upphæð í mánaðarreit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.	Samtals	%
RMF													**0 kr.**	####
													0 kr.	####
													0 kr.	####
													0 kr.	####
Samtals	0	0	0	0	0	0	0	0	0	0	0	0	0	

	Framvinda ársins 2015				Verkefni:		0						
Verkþáttur (setja x í viku reit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.	Fjöldi vikna
Phase E: Participatory scenario planning													0
Writing down results, conclusion and discussion													2
Phase F: Climate change strategy development													
Stakeholder group preparation (workplan, stakeholder selection, accomodation, etc.)													
Focus group session													
Writing down results, conclusion and discussion													
Project group meetings													
Phase G: Writing thesis													
Project group meetings													3
Writing thesis introduction and conclusion													19
Finalising thesis													4
												Samtals vikur í verkefni	28
						Launakostnaður pr. viku	x					Heildar launakostnaður	#VALUE!

Vörður (skýra og setja x í mánaðar reit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.
Paper Phase E												
Workplan Phase F												
Focus group meeting												
ReportPhase F												
Paper Phase F												
Thesis												

Fjármögnun (setja upphæð í mánaðarreit)	jan.	feb.	mars	apríl	maí	júní	júlí	ágúst	sept.	okt.	nóv.	des.	Samtals	%
RMF													**0 kr.**	####
													0 kr.	####
													0 kr.	####
													0 kr.	####
Samtals	0	0	0	0	0	0	0	0	0	0	0	0	0	

Appendix II – Assignment Ph.D. Course Advances in Tourism-Related Resources, Mid Sweden University, Östersund Sweden, November 2012

Navigating Tourism towards Sustainability in Protected Areas:
Exploring Adaptive Co-Management as a tourism management approach

PhD. Course: Advances in Tourism-Related Resources
PhD. Student: Hans Welling
November 2012

Abstract
The continuously growing protected area tourism sector in the most fragile and pristine natural areas of the world needs effective tourism planning and managing into sustainable directions. However, transitions towards sustainable tourism development face many challenges, in particular due to the high degree of complexity and uncertainty of protected landscapes and ecosystems, the need to consider the various perspectives and attributes of different stakeholders and the often insufficient management approaches to address these challenges. Such 'messy' situations necessitate new orientation in managing tourism. Recent studies reconceptualise protected area tourism as complex adaptive system and promote new management approaches based on learning and collaboration. The concept of Adaptive Co-Management (ACM) as a model for managing park tourism towards sustainable development is arguably well suited for fulfilling these requirements. This paper proposes an explanatory framework of the concept of ACM which can be used for the practical implementation of the concept to navigate tourism towards sustainability in protected areas.

Keywords: protected area tourism, adaptive co-management, complex adaptive tourism systems, explanatory framework

Introduction

The demand for nature-based tourism has sharply increased over the past decade and is expected to continue to grow in the next decade as well (UNWTO, 2010). National parks constitute a major host for nature-based tourism, which enables them to benefit from potential growth through the appropriation of additional visitor revenues and/or increased opportunities for local development, education and research. Besides nature-based tourism, protected areas constitute a popular destination of other forms of tourism such as wildlife tourism and adventure tourism. However, the growth of such PA tourism also brings costs and threats to the natural capital of protected areas, thereby undermining the long-term benefits of their protection and management. Given this situation, there is a growing recognition of the need to plan and manage tourism development of protected areas into sustainable trajectories. However, transitions towards sustainable tourism development face many challenges, in particular due to the high degree of complexity and uncertainty of protected landscapes and ecosystems, the need to consider the various perspectives and attributes of experts, decision-makers, resource-users and other stakeholders, and the often insufficient management systems available to address these challenges (McCool and Patterson, 2000; Prato, 2005).

According to McCool (2009) protected area tourism takes place in an environment characterized by complexity, change and uncertainty - where these issues can turn easily into 'messy' problems without effective management that address such challenges. Several factors contribute to this environment. First, the rapid increase in PA travel both accelerates the diversity of tourism styles within a protected area (e.g. adventure tourism, wild-life tourism or eco-tourism) and broadens the diversity of expectations about the service and functions that protected areas are expected to provide (e.g. support local economic development, alleviate poverty or serve as gene banks). Furthermore, the double mandate protected areas have concerning biodiversity/ecosystem conservation on the one hand and recreation on the other (Eagles *et al*., 2002) and finally the multiple forms of PA governance resulting in diverse and often unpredictable institutional arrangements (Strickland-Munro *et al.,* 2010). Another complicating factor is the highly dynamic, unpredictable and adaptive properties of ecosystems (Hollings and Meffe, 1996) that protected areas are conserving. Due to these natural uncertainties, protected area management cannot accurately determine the state of the ecosystems and are unable to precisely predict the outcomes of their management actions.

The dominant management and planning processes of protected areas are almost exclusively based on goal-orientated 'command-and-control' modes that assume a static model of the environment (e.g. Rammel *et al*., 2007; Plummer and Fennel, 2009; Prato, 2005). This model focuses "principally on identifying goals, searching for alternatives, evaluating them and choosing the technically most preferred alternative" (McCool and Patterson, 2000, p.111). This expert-driven model is not suited, when used alone, for engaging public interest, addressing adequately the complexity and multi-dimensionality of protected area, and incorporating abrupt changes, discontinuities and uncertainty into decision-making (Walker et al., 2002). In addition, command-and-control based management can make a system more vulnerable in the long term by masking critical system properties that may go unnoticed until it is too late (Holling and Meffe, 1996; Anderies *et al*., 2006). This situation calls for new management approaches that can address uncertainty and

complexity among tourism development in protected areas, and are based on paradigms that move beyond the positivistic ideas that the world is completely understandable by applying reductionist methods and approaches.

The concept of Adaptive Co-Management as a model for planning and managing park tourism towards sustainable development is arguably well suited for fulfilling the aforementioned requirements. Adaptive Co-Management (ACM) is a relatively recently developed approach to natural resource management which addresses uncertainty and complexity through a systematic process of integrating social learning with close collaboration of stakeholders (Ruitenbeek & Cartier, 2001). ACM thus aims to solve resource problems through a collaborative process which fosters ecologically sustainable livelihoods (Folke *et al.*, 2005)

Given the situation described above, the central question that guides this paper is to explore how tourism management in protected areas has to be organized and practiced in order to promote sustainable tourism in their complex and dynamic environment. This paper proposes an explanatory framework of ACM in the context of protected area tourism that touches on the main constituents, processes and outcomes in order to contribute to the applicability of the concept in the context of sustainable national park tourism management.

Literature

Although sustainable development is embraced by today's tourism academic and professional world, the transition from a conceptual idea to practical implementations runs into various difficulties. Most of these problems are related to the perspective many scientists and professionals have of sustainable development as taking the form of a fixed project with static goals that can be achieved as long as we do the 'right' things. But sustainable development is primarily an issue of working with dynamic and complex systems where knowledge is incomplete and uncertainty is paramount. In this context, classic science that solves problems by breaking it down into parts to study them individually run short because they assume that problems are limited, well defined and completely understandable (Hjorth and Bagheri, 2006). Sustainable development in complex and dynamic settings such as tourism in protected areas must, therefore, be seen as an unending process or transition defined not by fixed objectives or specific means to achieve them, but as a systematic approach to create change and improvements through continuous learning, adaption and innovation (Mog, 2004). This revised and more dynamic, process-orientated perspective of sustainable development requires a shift from a fragmentized science approach to more holistic and multidisciplinary research. New approaches and methods that address non-linear and organic thinking are needed to supplement, or in some situations substitute, conventional linear and reductionist methodologies and approaches. Although these latter tools and approaches may provide valuable results within a short time span, in the context of long-term sustainability they are often inadequate, particular in the case of unexpected events and processes (Farrell and Twining-Ward, 2004).

Recently, increasing numbers of tourism scholars (e.g. Farrel & Twining-Ward, 2005; Schianetz and Kavanagh, 2008, Strickland-Munro *et al*, 2010) have begun to use new knowledge from different academic disciplines such as ecosystem research, complexity

theory and sustainability science, to study tourism management towards sustainable development in their complex and dynamic context. The research orientations from these scientific fields describe nature not as predictable and balanced, but emphasize its complexity, with multiple states and non-linear behaviour. These research fields use a "whole system perspective" to examine phenomena and focus on the interrelations between components rather than the individual components part themselves, because, in this sense, the whole is more that the sum-up of its parts. This system thinking approach is also helpful in bridging the social and biophysical science, advancing how human and ecological systems are understood and reframe sustainability as a continuous process, as opposed to the rationally planned end-state perspective (Plummer and Fennell, 2009). In addition, systems thinking provide the opportunity to consider and include uncertainty in managing protected area tourism (Strickland-Munro *et al*, 2010).

Deduced from the aforementioned, park tourism systems are complex adaptive systems that can neither be controlled nor predicted as a whole. Nevertheless, the management of such systems can still foster transitions towards sustainability by apply and enhancing its capacity to learn from experiences (individual and collective) and collective action (Folke et al., 2005). New understandings and solutions can arise when cooperation with different stakeholders and social learning practices are integrated in the daily management and planning processes of park tourism systems. This means that the management organization, its institutions (formal and informal rules and norms) and practices need to be flexible and attentive enough to adapt to slow and rapid changes (e.g. Climate Change, outburst of diseases or natural disasters) by means of learning by doing or adaptive management. Adaptive management (AM) approaches are based on continuous and collective learning concepts that acknowledge uncertainties, and allow for timely adjustment of planning and management strategies (Holling, 1978). Therefore, for sustainable tourism advancement, approaches are needed that promote stakeholder collaboration and learning to ensure that sustainable development is incorporated into the planning and management of tourism in the destination (Schianetz *et al*., 2008).

Plummer and Fennel (2009) argue that new approaches in planning and managing protected areas for sustainable tourism should anticipate system dynamism and transformative changes, build up adaptive capacity to withstand disturbances and address multiple interests and values of various stakeholders. A management approach that is well suited to fulfil these requirements is Adaptive Co-Management (ACM). This management approach combines dynamic knowledge-building through a continual and structural process of analysis that involves modelling, experimenting, testing hypothesis, monitoring, and social learning (Holling, 1978; Walters, 1986), with the linkage characteristic of cooperative management of a network of stakeholders that are tailored to specific places and situations (Olson *et al.,* 2004) and can constitute a sufficient institutional embedding for planning and managing tourism development, especially development that crosses park boundaries. ACM stems from the concepts of adaptive management and co-management that have been evolving towards each other because "adaptive management without collaboration lacks legitimacy, and co-management without learning-by-doing does not develop the ability to address emerging problems" (Berkes, 2009, p 1698). Proponents of ACM emphasize the importance of organizational learning, joint decision making and multi-stakeholder participation in clarifying sustainable development, and identifying the interrelations needed between

stakeholders to ensure more sustainable outcomes over longer time-scales (Dietz *et al*., 2003; Folke *et al*., 2005). The application of different forms of adaptive co-management is addressed in a couple studies concerning tourism development and conservation sites by different scholars, such as Reed (1999), Armitage (2005), Xu *et al.*, (2005) and Clark and Clarke (2011). Plummer and Fennell (2009) assessed the potential of ACM to manage protected areas for sustainable tourism. Their study used a policy appraisal framework to assess the soundness, integrity and practicability of the concept and found salient prospects for ACM as an alternative approach to protected areas management. By re-conceptualizing tourism as a complex system, ACM provides a sound theoretical approach to address intangible and stubborn challenges facing sustainable protected areas tourism such as complexity, conflict and uncertainty (Plummer and Fennell, 2009).

Despite the aforementioned researches there is a lack of an integrated framework that brings together important constituents and processes of ACM and their linkages with sustainability (Plummer, 2009), both in general and specifically in the context of tourism. The proposed framework in this paper is therefore just an effort to represent an explanatory holistic composition of the current understanding of the concept without examining the components in detail.

Conceptual framework

According to Plummer (2009) and Fisher *et al.* (2007), an adaptive co-management approach cannot be captured in a prescription or series of steps. There is also no blueprint of ACM because this governance system has to be tailored to the specific situation in which it is embedded. However, general constituents and processes of ACM and its interrelationships can be described in a conceptual explanatory framework. The cogency and relevancy of such a framework depends on the extent to which is identifies relevant components and constructs coherent combinations of those constituents (Holland, 1998). The components described hereunder are based of relevant literature of ACM from the last 5 years (Plummer and Armitage, 2007a; Fisher *et al*., 2007; Pahl-Wostl *et al.*, 2006) and structures them into a constellation, leading to the development of a conceptual framework (fig.1). The framework consists of a situation-related context and four distinguished building components: a structure, communicative action, processes and outcomes.

Context

The context of an ACM approach includes the natural environment in and adjacent to a protected area and the prevailing property rights regimes: bureaucracy based, community-based, market based governance structure or a combination of these. The context components have considerable influence on the nature of the structure and processes of an ACM.

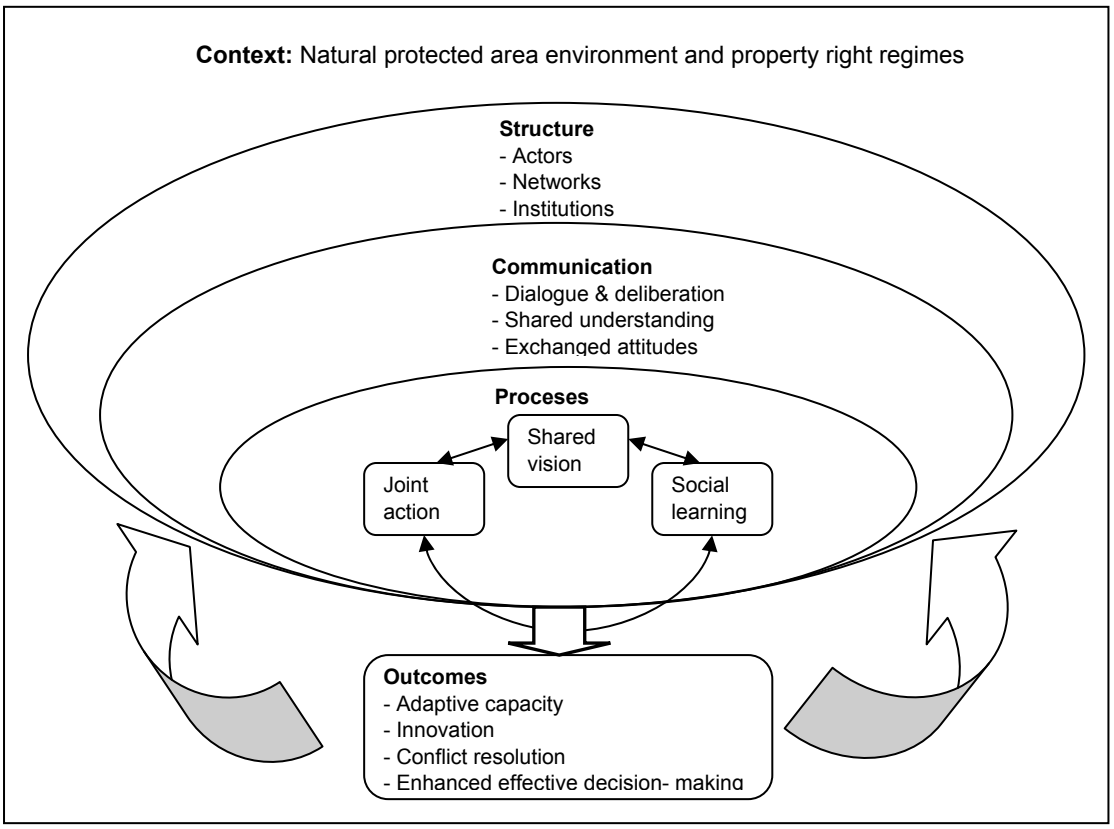

Fig. 1: Conceptual framework of ACM

Structure

The foundation of every ACM approach constitutes a constellation of cross-scale and multi-level linkages of nested actors and organizations, often in networks, from local users, to municipalities, to regional and national organizations. These social, institutional, or economic connections among individuals or organizations may be horizontal (e.g. across geographical space) or vertical (e.g. different levels of organization), forming networks of reciprocity and exchange that enable people to act collectively. In the context of park tourism, the actors could e.g. be park authorities, local resource user groups (e.g. farmer and hunters), tourism enterprises and non-profit environmental organizations. According to Young (2002) effective linkages will establish the basis for regularized flows of information, shared understanding and problem articulation, and will move governance beyond a simple network of perspectives. New structures of governance will be developed that include the legal and organizational framework as well as the formal and informal institutions that structure human interaction.

Communication

Communication activities function as the 'blood circulation system' of the structure of ACM. Communication, commonly understood as the process of transferring information between actors, has in this framework a more action and goal-oriented understanding. Communication here is based on Habermas's (1981) concept of *communicative rationality* where people seek to reach shared understanding and cooperate to solve a common problem on basis of discussion and consensus, as opposed to instrumental rationality where the goal is to take control of changing reality (Reed et al., 2009). The communication activities in an ACM approach focus on clarifying and bridging stakeholder's perspectives and

ideas, and promoting collaboration and self-reflection. Communication can have the form of a dialogue or deliberation among the different actors at multiple scales, resulting in exploration and reflection of existing attitudes and values of stakeholders, bring together fragmented knowledge and discussing its values for obtaining goals (Fisher et al., 2007). Effective communication activities enable and mobilize the three key processes of ACM: a) collaborative visioning, b) social learning and c) shared action and decision-making.

Processes

Walters (1986) suggests that the essence of managing adaptively is to have an explicit vision of the system one it trying to guide. In ACM, the vision is not a static goal to be achieved, rather, the vision serves as a reference point for actors in protected area tourism systems as they navigate their way through decision making and action in management. Faulkner (2003), in a comprehensive discussion of the application of visioning principles to a tourism destination context, identifies a number of contributions vision can make to the process of shaping a destination's future. The first of these is that a vision provides a framework for choosing appropriate responses and for cooperative action. Furthermore, without a vision, the tourism destination will become locked into the past. That is, an incremental approach where decision-makers focus on responding to immediate circumstances in a piecemeal fashion, preventing the destination to come to solutions for coping such with its situation on longer-term bases. Finally, a well-articulated vision that has been constructed in a manner that ensures it represents a consensus among primary stakeholders provides a focus for the strategic planning and managing process and a vehicle for mobilizing cooperative action (Faulkner, 2003). Navigating tourism towards sustainable trajectories requires a change in the belief systems of actors and organizations which can be established by constructing a clear vision of desired goals, shared by the stakeholders. An ACM approach accommodates and mobilizes such a visioning process which develops out of a long-term focus on sustainability goals and simultaneously facilitates stakeholder collaboration and initiates collective learning processes.

A second key process of ACM is learning through complexity. In ACM, learning is a systemic process that is institutionalized in the governance system. Learning is assumed to be an exploratory, stepwise search process where actors experiment with innovation until they meet constraints and new boundaries (Pahl-Wostl, 2009). This means that stakeholders need to seek and apply knowledge actively and deliberately. They create social learning by bringing together their different knowledge, experiences, perspectives and values for addressing shared challenges and potential activities. Armitage *et al*. (2008) consider three forms of learning as relevant to an ongoing learning process: First, experiential learning, a process of creating knowledge through the transformation of experience, and learning-by-doing. Second, transformative learning, a reflective process that enables an individual's perceptions and consciousness to be altered. This type of process helps stakeholders to critically analyze their daily experience so that they can collectively act to change their situation or practice (Fisher *et al.*, 2007). Third, social learning is a process of iterative reflection that occurs when experiences and ideas are shared with others (Keen et al., 2005). Social learning evolves as a transformative process following a spiral of action, observing and reflection leading to revised action. The ACM approach encourages learning at different levels as addressed in the concept of triple loop learning (Hargrove, 2002). According to this concept, effective learning takes place through a sequence of three learning cycles: using

information for incremental improvement of established routines (single-loop learning), making strategic adjustments and changes in reference frames (double-loop learning) and improving the learning processes themselves (triple-loop learning) (Guijt, 2007). Learning processes enable stakeholders to bring up new knowledge that can shape and improve collective visioning and to create networks practice where stakeholders undertake collective action by means of learning-as-participation (Berkes, 2007).

ACM involves joint action in form of participatory planning and shared decision-making that is agreed upon and supported by multiple stakeholders. This trans-active decision making is employed as a basis for achieving decisions whereby multiple sources of knowledge, issues of concern and different attitudes and understanding are acknowledged (Fisher *et al*., 2007). The decisions are reached through dialogue with diverse inputs (e.g. knowledge, visions) in an equitable manner where multiple types of information from multiple sources (e.g. local, traditional, scientific or expert) are accepted (Plummer and Armitage, 2007a). The emergence of these networks of practice enhance mutual trust building and power sharing, and stimulate knowledge creation which in turn stir new learning and shared visioning processes.

Outcomes

ACM is instrumental in nature which means that it produces some type of outcome. An extended inquiry by Plummer et al. (2012) based on a detailed analyses of 108 scientific documents on ACM revealed a broad set of different outcomes. Although the outcomes are not always straightforward there are some clear and frequently mentioned outcomes: a) the resolution of conflicts or disputes among stakeholders, b) increased equity, efficiency and effectiveness in decision-making, c) inciting of innovative ideas for problem solving and d), most importantly for transition towards sustainability, the enhancement of local level adaptive capacity: learning to live with uncertainty and change and create opportunities for self-organization towards social-ecological sustainability that is in accordance with ecosystem and governance scales and anticipates external disturbances (Plummer and Armitage, 2007a). All of the outcomes provide feedback loops to the structure.

Although the framework just touches on several concepts and its mutual linkages, it can contribute to the practical implementation of ACM as a new type of governance of social-ecological phenomena. Placed in the context of a protected area tourism system, as has been assessed by Plummer and Fennel (2009), ACM can function as promising management approaches that is able to navigate park tourism towards sustainable trajectories.

Methods

ACM is a relatively new approach that has so far only rarely been utilized in the context of protected area tourism management. To assess critically the utility of the model described above necessitates a specific action to introduce and facilitate local implementation of the process, *because the proof of the pudding is in the eating*. The methodology has to include action, observation and analysis of processes and outcomes. An appropriate method for this is Action Research (AR), a methodology in which the researcher engages with participants in cycles of planning, action, reflection and fact-finding about the results of the action (Botterill

and Platernkamp, 2012). Another suitable research method is Participatory Action Research (PAR), a process through which members of stakeholder groups or a community identify a problem, collect and analyze information, and act upon the problem in order to find solutions and to promote social or political transformation (Cupain *et al.,* 2003). This method can be utilized to engage stakeholders groups into certain aspects of ACM, such as improving collective visioning or joint monitoring approaches.

Criteria to evaluate the success of the implementation of the framework can be adopted from a Delphi study administered with an expert panel of 30 specialists (Plummer and Armitage, 2007b). The study addressed the following criteria for successful ACM: 1) robustness to overcome/solve challenges; 2) evaluation/monitoring of management actions through reflection aimed at learning and adaptation; 3) conservation/ sustainable resource use and ecosystem health; 4) processes in which stakeholders and government develop, implement, learn, and make adjustments in pursuit of a more resilient socio-ecological system; 5) empowering the actors involved, fostering ecological and social justice, and achieving credible sustainability objectives, e.g. poverty alleviation, future options; and 6) inclusion and effective participation in the process (Plummer and Armitage, 2007b).

ACM is an evolving concept that is not possible to catch in a static framework. The proposed framework constitute a 'snapshot' of the current understandings around the concept mostly deduced from research in natural resources (e.g. water management, fisheries and forestry), and needs to be revised and adapted constantly. There are several variables not included in the framework that can play an important role in a particular setting. Application of the framework in a protected area case-study will not only provide new insights and knowledge of the feasibility and practical implementation of ACM as model for park management but will also contribute to the general understanding of the concept as an approach towards sustainability.

Reflections and Conclusion

The classic trade-off that protected areas, especially National Parks, are facing between the conservation of natural/cultural heritage and the providing of access for visitors seems to be a stubborn challenge for the management of these areas. The centralized and expert driven command-control management approaches that dominate protected areas do not offer a sufficient framework to 'solve' multi-stakeholder conflict or address the complex and dynamic character of many protected area destinations. Approaches which promote sustainable tourism that are based on the same mechanistic paradigm do not offer a structural solution and can even have counterproductive effects in the long-term. Therefore, shifts in orientation how social issues should be address and how our social and ecological world is understood based on complexity theory and ecosystem ecology is a valuable contribution to approaches to manage protected areas for sustainable tourism. Cooperative management approaches that include broad stakeholder participation and power sharing build up new participatory management models for park tourism. ACM is 'grading up' these approaches by including structural experimental and experiential learning processes in the daily management cycles which provide the capability to address more effectively conflict situation or unexpected disturbances. Further, the ACM model provides a theoretical foundation that is in accordance with the transition in management orientations towards

governance and complex system thinking. The ACM approach re-conceptualizes protected area and tourism from ordinary tourism destination and economic sectors to an integrated complex adaptive system.

New tourism research has shown a transition from the reductionist and disciplinary thinking to interdisciplinary system thinking. However, these new conceptual understandings are not being translated into practice yet. Further research is necessary to acquire better understanding of the factors and conditions influencing collaboration and learning processes in protected area tourism management. The proposed framework offers a basis for further elaboration in empirical studies. Such studies should focus on the applicability of ACM in the tourism domain and establish generalizable patterns how the components of the framework related to management goals and social-ecological impacts.

The explanatory framework of ACM in this paper constitutes a conceptual basis for my PhD project in which I have to find a specific venue to concentrate on. New approaches to manage sustainable resource use of protected area that go beyond the current frameworks are necessary in the face of the constantly growing tourism sector in protected areas. Acknowledging that sustainability have to be conceived as a transition and learning process and tourism, also nature based tourism, is an 'inherently non-linear, complex and dynamic system" (McKercher, 1999) that have to be manage adaptively is a crucial step in sustainable tourism management and a basis for further research.

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