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Stakeholder Participation in Developing Sustainability Indicators for a European Northern Periphery Tourism System

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Abstract

Many European northern periphery (NP) communities are likely to experience increased and complex environmental, social and economic impacts of tourism in the near future. Therefore, approaches that see tourism as included in complex socio-ecological systems are critical for identifying and assessing sustainability indicators in the NP specifically. This study aims to develop and assess systemic sustainability indicators for tourism in Vatnajökull National Park (VNP), Iceland, and adjacent communities, based on public participation, and to discuss the usefulness of the approach in NP tourism. Interviews with tourism stakeholders in VNP identified eighteen sustainability indicators for VNP. The interconnectedness of these indicators and their role within the system were analyzed by applying a systemic indicator method. The results show five indicators that are currently most influential for the tourism system in VNP and to be the major driving forces for local tourism development: ‘destination attractiveness’, ‘economic seasonality’, ‘social carrying capacity’, ‘societal seasonality’ and ‘local economy’. The smallest change in any of these indicators has major effects on other indicators. Moreover, these five indicators are more important for the sustainability of the community than any external factors. This study concludes that a systemic approach to sustainability indicators can help identify important sustainability issues and is thus especially useful in NP communities where tourism is not a prioritized development path in policies, despite being identified as economically significant.

Keywords: sustainability indicator, tourism, systems analysis, northern periphery, stakeholder involvement, public participation.

1.0 Introduction

In past decades, tourism has become more and more important for new development paths in the northern periphery (NP) of Europe, where communities are likely to experience increased environmental, social and economic impacts of tourism in the near future (e.g. Hall, Müller & Saarinen, 2009; Ólafsdóttir, & Runnström, 2011). These communities are among those where tourism is often praised as economically significant. However, planning and infrastructure that benefits the local tourism development as well as the local tourism stakeholders are often not prioritized (Kristjánsdóttir, 2014; Miller & Twining-Ward, 2005). These impacts are likely to contribute to already complex and dynamic socio-ecological systems (SES) where sparsely populated communities are marginalized in planning and decision-making processes (e.g. Hall et al., 2009; Kristjánsdóttir, 2014; Mikkola, 2014; Vik, Benjaminsen & Daugstad, 2010). Therefore, it is of vital importance that a holistic assessment of sustainability which includes public participation becomes an integral part of decision-making processes in these regions.

The last decades have seen several studies emphasizing that the complexity of SESs and the view of sustainability as a dynamic process rather than end result, should be integrated in all tourism development (e.g. Briassoulis, 2002; Buckley, 2012; Farrell & Twining-Ward, 2004; McDonald, 2009; Miller & Twining-Ward, 2005; Saarinen, 2014; Valentin & Spangenberg, 2000). These studies also call for methodological developments to involve complex SESs, or complex adaptive systems, in order to better understand the relationships between tourism, nature, society and economy within the same system. Sustainability indicators for tourism are most often defined according to the World Tourism Organization as “the set of measures that provide the necessary information to better understand the links between the impact of tourism on the cultural and natural setting in which this takes place and on which it is strongly dependent.” (1996, p. 6). Therefore, this paper focuses on integrated sustainability indicators for tourism (as emphasized by Kristjánsdóttir, Ólafsdóttir, Ragnarsdóttir, 2017), in press), those that both: (a) analyze tourism as part of complex socio-ecological systems (SESs) and thereby aim to monitor environmental, economic and social conditions of the surrounding SES equally (Gibson, 2015; Grace & Pope, 2015; Miller & Twining-Ward, 2005) and; (b) aim to be an integrated part of overall policymaking and planning, not solely within tourism management (Budruk & Phillips, 2011; Pope & Grace, 2006; Valentin & Spangenberg, 2000). Along these lines, several scholars have recently engaged in developing sustainability indicators for tourism which may be considered alternative, namely, those that emphasize qualitative data, public participation and geographic or systems analysis of indicator interconnectedness (Aminu et al., 2013; Aminu, Matori, Wan Yusof & Zainol, 2014; Barzekar, Aziz, Mariapan, Ismail & Hosseni, 2011; Buckley, 2012; Schianetz & Kavanagh, 2008; Sedarati, 2015; Torres-Delgado, Palomeque, 2014; Tsaur & Wang, 2007). There are, however, to the best of our knowledge, no precedent studies on sustainability indicators for tourism in NP areas with an integrated or systemic approach.

This study aims to develop, assess and discuss systemic sustainability indicators for tourism in Vatnajökull National Park (VNP), Iceland, and adjacent communities, based on public participation. The specific aims are to:

1. Identify sustainability indicators for the VNP tourism system through analysis of interviews with local tourism stakeholders.

2. Assess the interconnectedness of these indicators with use of the systemic indicator approach and to identify the most critical indicators for the VNP tourism system.
3. Discuss the usefulness of the systemic indicator approach to developing sustainability indicators for NP areas.

2.0 Background

2.1 Sustainability and Tourism in the Northern Periphery

The northern periphery of Europe usually refers to all the Nordic countries, Iceland, Greenland, Faroe Islands, Norway, Sweden and Finland as well as Scotland and Northern Ireland (The Northern Periphery Programme, 2016). Common challenges for sustainability assessment and tourism management in NP areas stem from the very fact that these areas are, as a rule, geographically peripheral, vast territories of especially fragile ecosystems, with limited infrastructure, low and declining population densities and few economically feasible industries (e.g. Kristjánsdóttir, 2014; Mikkola, 2014; Ólafsdóttir & Runnström, 2009; Snyder, 2007). These factors contribute to making tourism an increasingly important industry in the NP, from an economic and social point of view (Kettunen et al., 2012). Nevertheless, as natural areas are gradually increasing in popularity as tourist destinations, NP regions are expected to experience increased environmental, economic and social impacts of tourism over the coming years (Hall et al., 2009; Newsome, Moore, & Dowling, 2013; Ólafsdóttir & Runnström, 2013).

Mikkola (2014) points out that some of the main sustainability challenges of NP regions are indeed the lengthy channels of communication between peripheral regions and decision-making hubs, for instance on matters of tourism marketing and promotion. This is supported by Hall (2000) who demonstrates that local councils, through public participation, are far better equipped to make decisions regarding their position in the tourism market, product development, infrastructure development, development constraints, preferred futures, local needs and the indicators by which success will be measured. There are, to date, no sustainability indicators that have been developed for tourism in the NP context specifically. Generally, only two sets of sustainability indicators have been developed for NP areas. These are the Arctic Social Indicators developed by the Nordic Council; and the Nordic Sustainable Development Indicators developed by the Nordic Co-operation.

2.2 Sustainability and Tourism in Iceland

Because of the described common characteristics and challenges that sustainable tourism development in the NP is faced with, it is important to share lessons learned between NP areas. Tourism in Iceland has been experiencing a steep increase in foreign visitors over the past few years. In 2016 the total number of visitors reached almost 1,800,000, more than five times the Icelandic population (Icelandic Tourist Board, 2017a, 2017b; Statistics Iceland, 2017). This was an increase from half a million in 2010. Between the years 2015–2016 the increase was 39%, a historic high (Icelandic Tourist Board, 2017a). In contrast, the average increase in tourism in the other NP countries were between 1–10% (Statistics Denmark, 2017; Statistics Finland, 2017; Statistics Faroe Islands, 2017; Statistics Greenland, 2017; Statistics Norway, 2017; Swedish Agency for

Economic and Regional Growth, 2017; Visit Scotland, 2017; Northern Ireland Statistics and Research Agency, 2017). Notwithstanding this big difference in tourism increase, the other NP countries could benefit from lessons learned in Iceland.

Sustainable development has long been the focus of Icelandic authorities' tourism strategies. However, the objectives of the resolution on a tourism strategy for 2011–2020, passed by the Icelandic parliament, focus largely on the sustainability of the economic sector, aiming specifically to: (a) increase the profitability of the sector; (b) systematically develop tourist destinations and product promotion, with the aim of decreasing seasonality and overcrowding of destinations; (c) enhance professionalism, quality, safety and environmental awareness in the tourism sector; and (d) define and maintain Iceland's uniqueness as a tourist destination (Althingi, 2011; Icelandic Tourist Board, 2017c).

This focus on the economic dimension of tourism is also visible in research on tourism in Iceland. Studies of the social dimension of tourism are rare, as is true about sustainability assessments in general (Gibson, 2015; Kristjánsdóttir, Ólafsdóttir & Ragnarsdóttir, in press; Sinclair, Diduck & Vespa, 2015). There exist, however, many important studies analyzing the economic impact of tourism in Iceland, mostly focusing on specific tourism activities (e.g. Helgadóttir & Sigurðardóttir, 2008; Huijbens, & Gunnarsson, 2014; Matilainen & Keskinarkaus, 2010) and potentials for increasing the profitability of the sector (e.g. Frent, 2014a, 2014b; Metrass-Mendes, 2014; Reynisdóttir, Song & Agrusa, 2008). Nonetheless, research shows (i.e. Jóhannesson & Huijbens, 2010; Rögnvaldsdóttir, 2015) that more comprehensive analyses of economic and quantitative data are needed, in order to rationalize decision-making.

A large majority of tourists in Iceland claim that the main reason for their visit is to enjoy the natural landscape (Icelandic Tourist Board, 2017a). However, Iceland's ecosystems and vegetation cover are especially fragile, due to its young geological origins and geographical location in the middle of the Atlantic Ocean. Short summers are the reason for both short growing seasons and intense seasonal tourist trampling (Ólafsdóttir & Runnström, 2013). Most studies that focus on the environmental dimension of tourism in Iceland stress the need for a holistic view of tourism in relation to planning and management (e.g. Ólafsdóttir & Runnström, 2011; 2013; Sæþórsdóttir, 2013; Sæþórsdóttir & Saarinen, 2016). Furthermore, Jóhannesson, Huijbens and Sharpley (2010) point out that this lack of a holistic view underpins a lack of measures that effectively integrate research that identifies the current absence of sustainability considerations in Icelandic tourism into decision-making processes.

Despite these observations, only three studies still exist that focus on analyzing Icelandic tourism as a part of complex SESs. Results of a recent systems analysis of the environmental impact of tourism in Iceland (Ólafsdóttir & Haraldsson, 2015) indicates that 'number of visitors' is not a suitable indicator for assessing the evolution of a tourist destination. The authors reveal that 'number of visitors' as a variable occurs too late in the causal chain. 'Attractiveness of a tourist destination', on the other hand, combines several impact factors and captures the dynamic evolution of the system and its sensitivity more clearly. Using 'attractiveness' as a basis for destination planning and management can, in this way, prevent environmental damage and help avoid a situation where all tourist destinations evolve in the same direction. Similarly, a systems analysis of the causal relation between ecosystems and the tourism system in Þingvellir National Park in Iceland concluded that 'positive visitor experiences', 'tourism infrastructure' and 'landscape' were key variables for the future management of

environmental tourism impact (Van Houtte, 2015). Finally, in an assessment of the value and overall benefits of ecosystem services for well-being and economic prosperity carried out in Heiðmörk Nature Reserve, Davíðsdóttir (2010) concludes that Icelandic tourism is dependent on both well-being and economic prosperity, and is therefore indirectly dependent on ecosystem services. Because of this indirect relationship, the tourism industry is considered unstable by decision-makers, in contrast to other industries that are directly dependent on ecosystem services. This is an attitude which is also experienced by tourist hosts in Northern Sweden, who experience difficulties in making investments in the industry for this reason (Kristjánsdóttir, 2014).

2.3 Systems Analysis in Sustainability Indicators

The most widely applied and discussed approaches to developing indicators employ quantitative methods of index formation, normalization, weighting and/or aggregation as well as a presentation of a list of thematically categorized indicators (Böhringer & Jochem, 2007; Ness, Urbel-Piirsalu, Anderberg & Olsson, 2007). Gustavson, Lonergan & Ruitenbeek (1999) emphasize that a long list of unrelated indicators can be difficult to implement. Furthermore, Miller and Twining-Ward (2005) point out that although indicators that are analyzed with a thematic approach may reinforce the idea that economy, environment and society are of similar importance to sustainable tourism development, this approach also implies that these themes are self-contained. Böhringer and Jochem (2007) assessed the satisfaction of fundamental scientific requirements in quantitative methods and found that normalization and weighting of indicators are methods generally associated with subjective judgments and reveal a high degree of arbitrariness, typically failing to mention or systematically assess critical assumptions. They also underline that, consequently, indices of sustainable development employed in policy practice are doomed to be useless, if not misleading, with respect to concrete policy advice.

Methods of developing sustainability indicators can be divided into two main groups: (a) qualitative subjective approaches based on stakeholders' perceptions and experiences; and (b) quantitative objective approaches based on measurable and observable data (Pissourios, 2013). The latter is less time-consuming, widely applied and regarded as efficient in providing measurable and comparative data. Nevertheless, Pissourios (2013) points out that even the establishment of objective indicators cannot easily be carried out without a line of subjective value judgments. "[E]ven when there is an agreement on the social indicators that will be studied, and agreement about what should be counted, there may still be a debate on the values of the indicators that represent something 'good' or something 'bad' for the society" (Pissourios, 2013, p. 421).

Thus, as supported by Miller and Twining-Ward (2005), it remains to develop qualitative, integrative sustainability indicator frameworks that can compare to the more traditionally established quantitative measures, so that the important issues are not missed. Indeed, as an example, Grace and Pope (2015) and Pope & Grace (2006) emphasize that sustainability assessment should: (a) identify the consequences of particular policies for the trajectory of the focal SES and reflect on the fact that the SES resides within a larger system; (b) include a continuation of business-as-usual as a benchmark policy, as well as potential policy alternatives; (c) determine whether these trajectories are consistent with the SES's potential transition over time, as well as its sustainability goals; and (d) be guided by a collaboratively developed sustainability decision-making protocol that reflects governmental policies and the sustainability vision of the

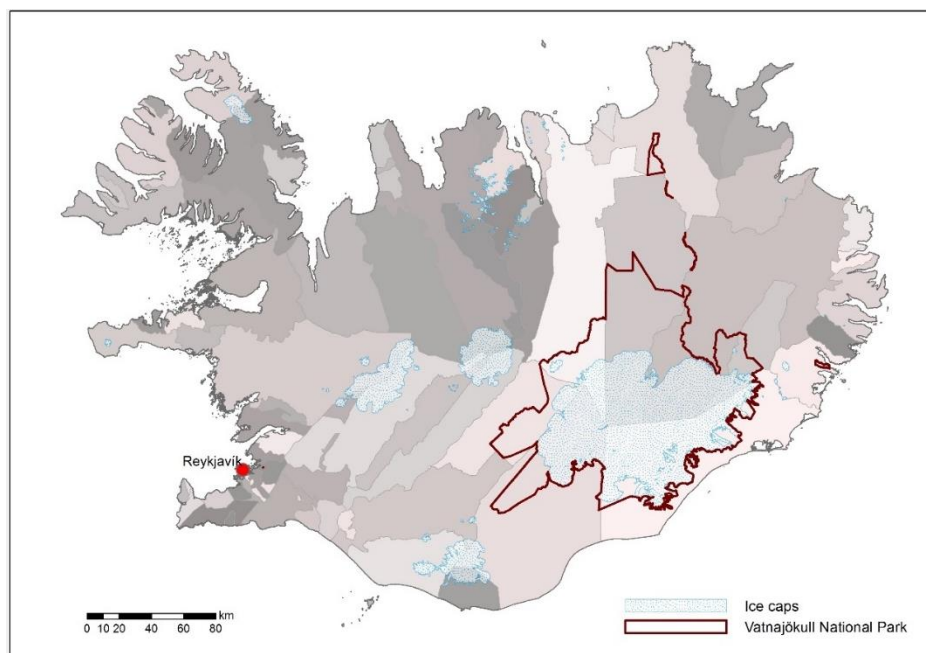
SES members. Seen in this light, it is understandable that sustainability assessment can appear very time-consuming, complicated and expensive. However, this does not mean that it should not be attempted.

Numerous scholars have contributed to the literature on why public participation and tourism stakeholder involvement should play a central role in sustainability assessment, in order to contribute to policy- and decision-making (Byrd, Cárdenas & Greenwood, 2008; Dabpet, Scott & Ruhanen, 2012; Haukeland, 2011; Pepperdine & Ewing, 2001). This is summarized in one sentence by Miller & Twining-Ward (2005), “At a very simplified level, the role of government is to enable its citizens to enhance the quality of their lives” (p. 79) Systemic approaches to sustainability indicators therefore provide an opportunity to develop comprehensive decision-making tools based on holistic assessments of SESs on public participation.

3.0 Study Area

The present study focuses on tourism in Vatnajökull National Park (VNP) and adjacent communities. VNP was established in 2008, and is the second largest national park in Europe. The park surface area is 13,952 km², of which 8,000 km² make up the Vatnajökull glacier, and covers almost 14% of the entire surface of Iceland (see Figure 1). The park stretches into eight different municipalities, all of which have planning authority within the park (Vatnajökull National Park, 2017). The area was selected for this study as it is a northern periphery community that has long faced a migration of residents to the country’s capital area. During the past decade, tourism has gradually increased and is now seen as an effective catalyst for cultural, economic and social re-development of the municipalities surrounding VNP. With tourists, tourist hosts and guides as ‘new users’ of the area, it is more important than ever to empower local knowledge of this dynamic environment.

Figure 1. The Area of Vatnajökull National Park in Iceland, and the Country’s Division into Municipalities.

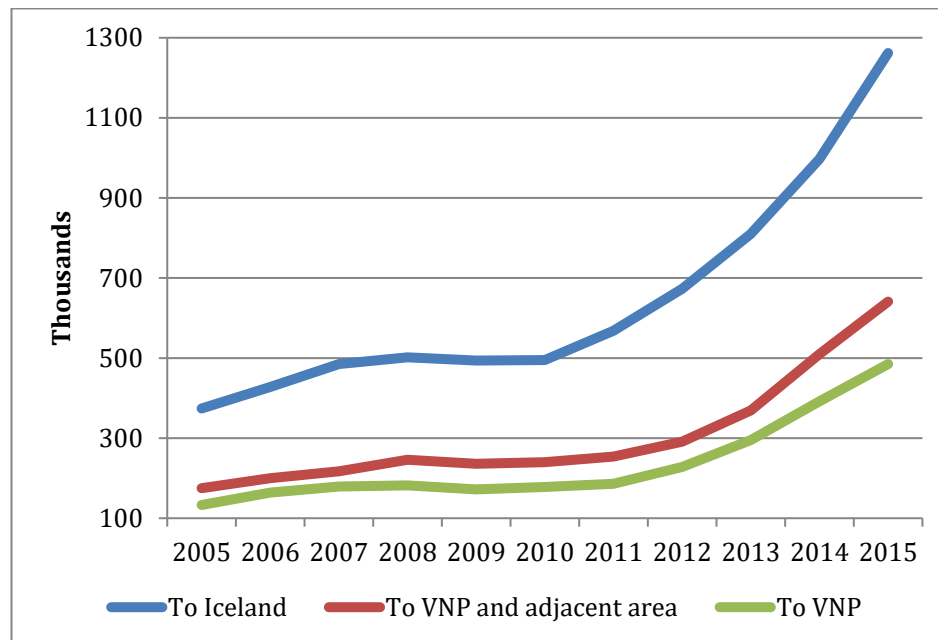


Source: Environmental Agency of Iceland, 2017; National Land Survey of Iceland, n.d.

The study area is characterized by a unique variety of landscape features, created by the combined forces of glacial ice, rivers, as well as volcanic and associated geothermal activity. Additionally, the thousand-year history of human life and culture at the foot of the glacier is unparalleled. The communities adjacent to the glacier are rich in knowledge about co-habiting with natural disasters, volcanic eruptions and associated ash fall, glacier movements and glacial outbursts (i.e. floods caused by glacial melting due to volcanic activity under the glacier) which have many times destroyed vegetated land but also enriched the area with ecosystem services (Vatnajökull National Park, 2017).

However, this heritage is still relevant to people's livelihoods in the area and also to the many who travel through the area. The park and adjacent communities encompass many of Iceland's most popular tourist destinations. The rate of visitor increase to VNP is exponential and in line with the overall increase of visitors to Iceland (Guðmundsson, 2016; Icelandic Tourist Board, 2017a) (see Figure 2). The presumption in this study is that tourism will continue to grow. Tourism as a new development path in this area has led to a change in land use. The glaciers and lagoons which were of no interest in previous forms of land use are now considered valuable. This has resulted in ownership debates between municipalities, national park authorities and private landowners. Parallel to this is an ongoing debate between stakeholders of nature conservation and stakeholders of hydroelectric power plants and heavy industries (Sæþórsdóttir & Saarinen, 2016). VNP, therefore, is a complex system of economic activities, environmental management, social change and political structures typical for the northern periphery.

Figure 2. Number of Tourist Arrivals to Iceland and to Vatnajökull National Park, 2005–2015.



Source: Icelandic Tourist Board, 2017 b; Guðmundsson, 2016.

4.0 Methods

4.1 Data Collection

To develop and assess systemic sustainability indicators for tourism in VNP and its adjacent communities, interviews were carried out with 48 tourism

stakeholders in its Northern and Western territories (see Figure 1) in October 2012. Of the 48 participants, 28 were tourist hosts, 14 were government employees involved in local decision-making processes concerning tourism, and 6 were national park employees and rangers. 75% of the participants were also residents of the area. The participants were selected with a snowball approach where individuals within these groups were contacted and interested parties were subsequently interviewed either on site in their home or workplace, or by telephone or Skype. The interviews included open questions about the participants' views on local tourism development, sustainable development, nature conservation, the social and the economic impact of tourism and environmental impact and management. The participants were not explicitly asked about which issues should be addressed when developing sustainability indicators.

4.2 Data Analysis

The methodological origin of the systemic indicator method applied in this research is in the Sensitivity Model developed by Vester and Hessler (1982), a working tool model intended to describe, interpret and assess interconnectedness in complex SESs (Vester, 2012). This research further develops methods introduced by Schianetz and Kavanagh (2008) who adopted three tools from the Sensitivity Model and combined them with Bossel's (1999; 2001) system-determined orientors for sustainability indicator selection. Bossel's (1999; 2001) orientors are derived from the fields of thermodynamics, ecology, psychology and sociology with the ambition of not only choosing the more visible and easily measurable indicators, but to give equal weight to social, environmental and economic indicators in order to obtain a holistic understanding of the system. Schianetz and Kavanagh (2008) furthermore formulated specific criteria for the application of these to a tourism system. The application of the systemic indicator method in this study consisted of four steps (see Figure 3): (a) identification of sustainability indicator variables for VNP, based on tourism stakeholder perceptions in the interviews; (b) an assessment of the extent to which the indicator variables are relevant to VNP as a tourism system; (c) an assessment of the extent to which the indicators influence each other, and their degree of interconnectedness; and (d) an effect analysis of each of the indicators within the system.

Firstly, to create a set of indicator variables, sustainability themes were derived from the interview results. This was done by grouping the issues that were mentioned most frequently by stakeholders into themes. Secondly, in order to apply an objective assessment to a subjective selection of the sustainability themes, eighteen criteria adapted from Schianetz and Kavanagh (2008) were used to assess the relevance of each indicator variable to a tourism system (see Table 1). The assessment was made by the authors with the following approach: If a given variable was dependent on all or almost all keywords listed for each criterion, the relationship obtained the value 1. If the variable was dependent on half of the keywords it obtained the value 0.5. If the variable was dependent on one or none of the keywords it obtained the value 0. Accordingly, vertical sums of a pair-wise comparison for each criterion revealed whether there was a relationship between the indicator variables and the criteria. As proved by Chan and Huang (2004), the vertical sums should not show an uneven distribution across the criteria, as this would mean that important system components might be missing and that a revision of the indicator variables would be needed.

Thirdly, in order to assess the effect of each variable on another, and on the system, a pair-wise comparison was made by assigning a score from 0–3 that

represents the relationship between each two indicator variables. The assessment was made solely according to stakeholder perceptions in the interviews, in order to avoid subjectivity and value-judgments in the assessment. Accordingly, it was decided to adopt the comparison approach from Schianetz and Kavanagh (2008) in which No relation (0) means that a change in indicator A causes no or very little change in indicator B, or only causes change after a significant time delay; Weak relation (1) means that major change in indicator A causes minor change in indicator B; Proportionate relation (2) means that change in indicator A results in similar change in indicator B and; Disproportionately high relation (3) means that a minor change in indicator A causes major change in indicator B.

Lastly, a pair-wise comparison of the scores generated four main impact sums, which helped to identify the systemic roles of the indicator variables. These are: (a) Active Sum (AS)—The sum score of the effect that each indicator has on the other indicators; (b) Passive Sum (PS)—The sum score of the effect that the other indicators have on each indicator; (c) Product (P)—The combined sums of AS and PS, identifies a variable as either buffering within the system (low values) or of critical importance to the system (high values); and (d) Quotient (Q)— $AS/PS \times 100$, which identifies if a variable is reactive (low values) or active (high values) within the system.

Figure 3. Flowchart Illustrating the Data Analysis Process of the Systemic Indicator Method in This Research.

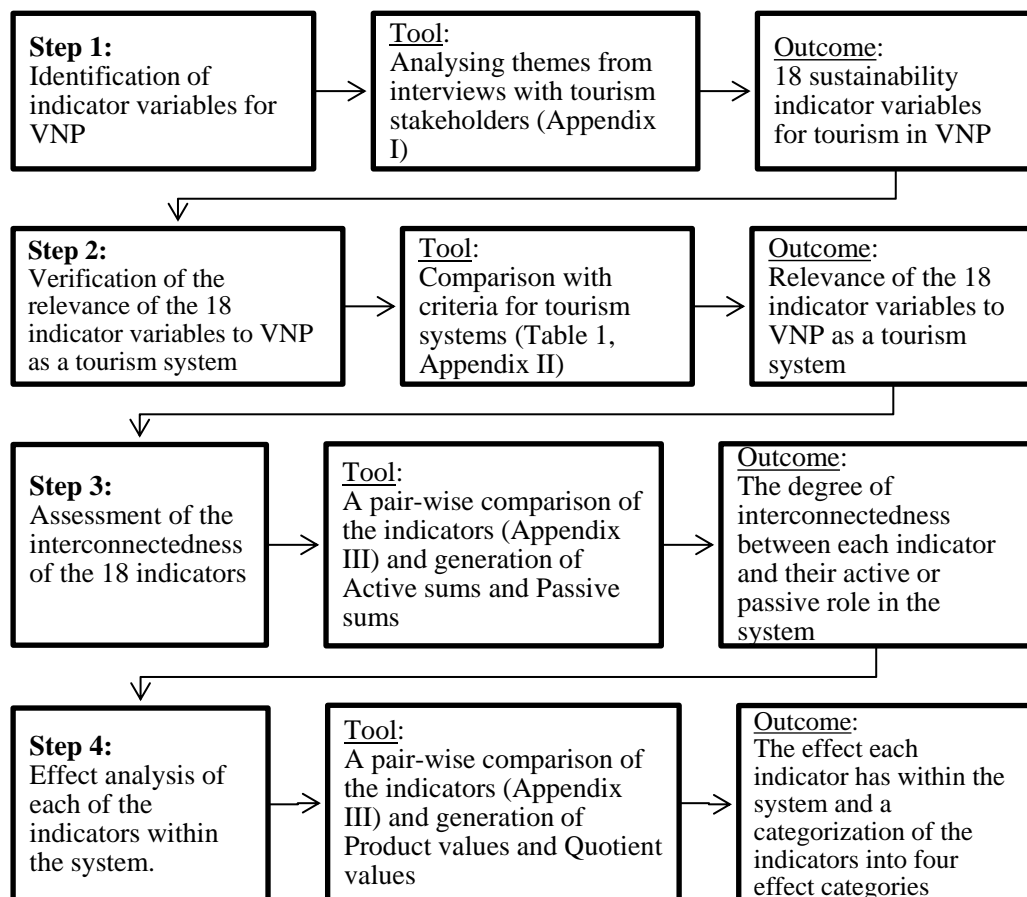


Table 1: *Criteria Used for Verifying the Relevance of the Indicator Variables to a Tourism System*

	Criterion	Definition	Examples for Tourism Destinations
<i>Sectors of Life Criteria</i>			
1	Stakeholders	Who is involved and affected?	Tourists, residents, employees, developers, planners, businesses, ecologists
2	Stakeholder activities	What are they doing?	Tourism activities, economic activities, employment, turnover, services, sales, production, investment
3	Area	Where does it happen?	Land use, population density, size, location and use of buildings, distances
4	Stakeholder feelings	How do they feel?	Motivation, competition, creativity, quality of life, security, education, health
5	Interaction with nature	How do the stakeholders affect the natural resources?	Ecosystem, natural balance, resource use, waste generation, environmental impacts
6	Interconnections	How do the stakeholders connect and communicate?	Transport, infrastructure, accessibility, communication, information, supply, marketing strategies, cooperation projects, permits
7	Organization	How is the resort organized?	Community, legislation, management, taxes, procedures, cultural behavior codes
<i>Physical Criteria</i>			
8	Material/Matter	Predominantly constituted of material or used to transport or transform matter	Accommodation, businesses, means of transport, raw materials, waste, people, flora, fauna, funds, infrastructure, traffic
9	Energy	Energy resources or generators that transform or consume energy	Energy consumption, energy resources, finances, employment, funds, infrastructure
10	Information	Responsible for the flow of information and for communication	Media, decisions, information centers, procedures, requirements, attractiveness, education, finances, recreation facilities

Table 1 continued:

<i>Dynamic Criteria</i>			
11	Flow determinant	Flow of matter, energy, and information within a system	Traffic, energy–water consumption, raw material use, waste generation, finances, visitors
12	Structural determinant	Structure of the system	Infrastructure, recreation facilities, accommodation, population, local businesses, politics
13	Temporal dynamics	Location-specific items that change with time	Tourist seasons, climate, employment, traffic, finances, recreational quality, quality of life
14	Spatial dynamics	Items that change with location	Wastewater, traffic, disturbances, land use, conservation zone, infrastructure
<i>System Relations Criteria</i>			
15	System input	Variables that open the system to input	Access routes, tourists, public transport, water/energy supply
16	System output	Variables that open the system to output	Quality of life, attractiveness, ecological value, recreational facilities
17	Endogenous	Variables that can be influenced or controlled by internal processes or actions	Cultural activities, politics, recreational quality, water pollution, energy/water consumption, waste generation, tourism infrastructure, local security, supply
18	Exogenous	Variables that are influenced or controlled by external processes or actions	Competition, tourists, accessibility, demand, attractiveness of region, politics

Source: adapted from Schianetz & Kavanagh (2008).

5.0 Results

5.1 Sustainability Indicator Variables for the VNP Tourism System

A total of twenty-one sustainability themes relevant to the tourism system in Vatnajökull National Park (VNP) were derived from interviews with 48 tourism stakeholders. The themes and related causes and effects are elaborated in a table in appendix I. A compilation of these themes resulted in eighteen indicator variables:

- Capacity to accommodate tourists
- Community learning
- Destination attractiveness
- Ecological carrying capacity
- Economic seasonality

- Employment
- Environmental management performance
- Implementation of policies and cooperative projects
- Integration of sustainability goals
- Local economy
- Long-term perspective in policies, projects and marketing
- Population decline
- Seasonal pressure on physical environment
- Service and information for tourists
- Social carrying capacity
- Societal seasonality
- Stakeholder involvement
- Trail conditions

The results of a pair-wise comparison between these eighteen indicator variables and criteria of relevance to a tourism system (see Table 1) reveal that the indicator variables represent all the tourism system aspects, including its *System Relations Criteria*, *Sectors of Life Criteria*, *Physical Criteria* and *Dynamic Criteria* (cf. full pair-wise comparison in Appendix II). The *Systems Relations Criteria* describe the behavior of the system as a whole where the vertical sum for each criterion shows how many indicator variables it is related to, between 0–18. The vertical sums of the criteria ‘Endogenous’ (sum=18) and ‘Exogenous’ (sum=5.5) mean that all 18 indicator variables are influenced by actions taken within the system, while only a few are influenced by actions taken outside the system.

The criteria ‘System output’ (sum=17) and ‘System input’ (sum=14.5) describe the extent to which variables open the system to output—quality of life, attractiveness, ecological value, recreational facilities—and input—access routes, tourists, public transport, water–energy supply. The results indicate that almost all of the selected variables contribute to opening the system to output and are thus important, in order to increase the attractiveness of the area and safeguard a long-term continuation of tourism in VNP. The variables do, to a lesser extent, open the system to input, for example, the opening of access routes to the area. Overall, the vertical sums in the remaining three criteria categories are evenly distributed across the criteria, ranging from 9.5–16.5, and the average vertical sums for each category fall between 12.7 and 13.1. According to Chan and Huang (2004), as explained above, this confirms that the indicator variables are relevant to assessing VNP as a tourism system.

Within the *Sectors of Life Criteria*, the indicator variables are mostly reliant on the criteria ‘Stakeholder activities’ (sum=16.5) and ‘Interconnections’ (sum=16). Stakeholders are naturally highly represented, as most issues affect more than one group of stakeholders and as their actions and feelings are crucial for tourism development. However, these results also show that the most important elements are the specific activities of stakeholders, such as services,

production, investment and employment. Moreover, it is the interconnections between stakeholders that verify these activities that are highly represented (i.e. infrastructure, accessibility, communication, information, supply, marketing strategies, cooperation projects and permits).

Among the *Physical Criteria*, 'Information' (sum=16) has a higher sum than 'Matter' (sum=12) and Energy (sum=10), suggesting that these indicators are more dependent on the way in which information is communicated, for example, through media, marketing, education or information centers and facilities, rather than the physical features of the tourist destination itself. Among the *Dynamic Criteria*, none of the criteria have a vertical sum that is important within the system. 'Structural determinant' has the sum of 14.5, as it is clear that most indicator variables are dependent on infrastructure, facilities, local businesses and other population structures. 'Temporal dynamics' has the rather high sum 13 because many sustainability indicator variables are dependent on seasonality.

5.2 Indicator Interconnectedness and Effects Within the System

The sustainability indicators for the VNP tourism system are highly interconnected. The result of the pair-wise assessment of the effect each indicator has within the system reveals five indicators that are the most critical to the VNP tourism system and should be seen as key sustainability indicators for this system (*cf.* full pair-wise assessment in Appendix III; P=Product value, Q=Quotient value). These are: 'Destination attractiveness' (P=1147), 'Economic seasonality' (P=1036), 'Social carrying capacity' (P=1024), 'Societal seasonality' (P=1008) and 'Local economy' (P=992). These indicators have the highest P-values, and are therefore the most influential on other indicators within the system. Nevertheless, they have different functions within the system. The indicators with the highest passive sums (PS), 'Destination attractiveness' (PS-37), 'Social carrying capacity' (PS-32) and 'Local economy' (PS-32), are easily affected by any change in the other indicators. This confirms that destination attractiveness is crucial to the system because it is the most vulnerable indicator to changes in the other indicators. The three indicators with the highest active sums (AS) are 'Societal seasonality' (AS-36), 'Economic seasonality' (AS-37) and 'Employment' (AS-39). These are the indicators that have the most influence on each of the other indicators, and thus on the system as a whole. As employment is highly related to societal and economic seasonality, a small change in tourism seasonality alone will strongly contribute to or reduce the sustainability of the VNP tourism system. Seasonality, economic and societal, are the only two indicators that are both critical and active (exhibiting both high P-values and Q-values), which confirms that seasonality has a very dominant effect on the system.

All three indicators representing the physical environment scored low passive sums. 'Seasonal environmental pressure' (PS-21), 'Ecological carrying capacity' (PS-19) and 'Trail condition' (PS-20) will change little or lagging, even with significant change in other indicators. Consequently, as there is disparity between social, economic and environmental indicators, 'Integration of sustainability goals' (AS-14) has to become significant in order to have any effect on this system. This indicator has a low passive sum value (PS-21) and will therefore change very little, even with large changes in other indicators. This results in both a reactive quotient value and a buffering product value, which means that integration of sustainability goals will influence the system slowly but with lagging effect.

In summary, the effect analysis resulted in four categories (see Table 2): *Effect Category 1*—indicators in this category are currently most influential for the

system and are major driving forces for tourism development. The smallest change in either of these indicators will have major effects on other indicators. Indicators 2, 17 and 18 are already central to decision-making processes, but indicators 1 and 14 are not. *Effect Category 2*—indicators in this category are more influential than sensitive. These are already actively integrated in decision-making processes. Their importance is clear, but their voice is weak. *Effect Category 3*—these indicators are close to neutral in the system, with medium values in all impact indices. All of them have the potential to be more effective within the system. *Effect Category 4*—indicators that have limited interconnectedness with other indicators and therefore have lagging effects on the system and are not sensitive to change. Indicators 7 and 11 should be made more active, in order to increase sustainability of the system.

Table 2: *The Results of the Effect Analysis of Sustainability Indicators for the Tourism System in Vatnajökull National Park.*

Indicator	P	AS	PS	Q	Effect Category
Capacity to accommodate tourists	Medium	Influential	Medium	Active	2
Community learning	Medium	Medium	Low	Medium	3
Destination attractiveness	Critical	Medium	Sensitive	Medium	
Ecological carrying capacity	Buffering	Low	Low	Medium	3
Economic seasonality	Critical	Influential	Medium	Active	
Employment	Medium	Influential	Low	Active	2
Environmental management performance	Buffering	Low	Medium	Reactive	3
Implementations of policies and cooperative projects	Buffering	Low	Medium	Reactive	3
Integration of sustainability goals	Buffering	Low	Low	Reactive	4
Local economy	Critical	Medium	Sensitive	Medium	
Long-term perspective in policies, projects and marketing	Buffering	Low	Low	Reactive	4
Population decline	Medium	Influential	Low	Active	2
Seasonal pressure on physical environment	Medium	Medium	Low	Active	2
Service and information for tourists	Medium	Medium	Sensitive	Medium	2
Social carrying capacity	Critical	Influential	Sensitive	Medium	
Societal seasonality	Critical	Influential	Medium	Active	
Stakeholder involvement	Medium	Low	Medium	Reactive	3
Trail condition	Buffering	Low	Low	Reactive	4

See text section '4.2 Data Analysis' for definition of P, AS, PS and Q.

6.0 Discussion

Looking back at the main objectives of the Icelandic tourism strategy for 2011–2020, mentioned in the background section, the results of this study indicate that decision-makers and tourism stakeholders in VNP might be on the same page regarding some of the current sustainability challenges for tourism development and the important indicator variables to include in a sustainability assessment. However, it can be argued that the systemic indicator method does dig deeper into the relationships between the indicators and some adjustments can be suggested in light of this study. Local economy and economic seasonality are critical sustainability indicators in the VNP system and very present in existing data for measuring tourism sustainability on a national level, which is also reflected in the tourism strategy. Therefore, an increased focus on other areas of sustainability than the economic are vital in order to gain a more holistic view. Similarly, seasonality is also a dominant and active indicator in the VNP system, and the tourism strategy, while at the same time being the main theme in numerous cooperative projects, policies and strategies for tourism development, and closely monitored through statistics on numbers of tourists in Iceland.

Despite these efforts, the current use of existing data is not contributing significantly to sustainability in tourism development. The tourism strategy aims to enhance quality in the tourism industry. The indicator ‘Capacity to accommodate tourists’ is in this study assessed as active and influential within the VNP system, but its voice is weak. It would therefore contribute greatly to the sustainability of tourism if actions and strategies regarding capacity to accommodate and quality could be made more explicit and effective. Finally, the tourism strategy aims to define and maintain tourist destinations. The indicator ‘Attractiveness’ is the most critical within the VNP system, as it is closely interconnected with other indicators and very sensitive to any change within the system. These results, which show ‘Capacity to accommodate’ and ‘Attractiveness’ as important themes support the results of research on Icelandic SES’s by Davíðsdóttir (2010), Ólafsdóttir & Haraldsson (2015) and Van Houtte (2015), as they also emphasize the importance of attractiveness, positive visitor experiences, quality, infrastructure and information.

Seen in this way, a systemic approach to sustainability indicators provides relevant background data to traditional measurements included in sustainability assessments, as called for by the World Tourism Organization (1996) in their definition of sustainability indicators. The systemic approach also stimulates learning about environmental and social issues among various stakeholders and helps in identifying which sustainability issues are related to the local context or local management, and which are dependent on external systems. This information is relevant to any tourism system in any context but could be especially useful in NP communities where tourism is still not a prioritized development path in overall policies, despite being praised as economically significant (Hall et al., 2009; Kristjánsdóttir, 2014; Mikkola, 2014; Vik, Benjaminsen & Daugstad, 2010). Moreover, research on stakeholders’ views on sustainable tourism development in specific NP communities is limited, and tourism stakeholders have few resources with which to engage in public participation (Ólafsdóttir, Kristjánsdóttir, Bjarnadóttir, & Bragason, 2009; Ólafsdóttir & Runnstrom, 2011; Sæþórsdóttir, 2013).

This study is the first attempt to apply systemic indicator approach to the NP context and Icelandic context, and therefore serves as an important baseline for further studies on sustainability indicators in the NP. It is thus recommended that the method be carried out again, including more existing data, such as sustainability goals defined on a municipal or national level, combined with

more recent empirical, qualitative data. On the other hand, the primary advantage of this method is that it can be applied with limited data. As Schianetz and Kavanagh (2008) point out, the method can be applied (a) in early design and construct phases of sustainability indicators; (b) when quantitative data is still limited; (c) without available time series data; and (d) even without extensive qualitative, empirical data. More importantly, it constitutes a promising starting point for constructing sustainability indicators for tourism. As it provides results that can be acted on almost immediately without an extensive development phase before implementation, making the method cost-effective and realistic for regular application. It is furthermore confirmed in the development of the Arctic Social Indicators that realistic approaches to indicators are important in NP regions.

The results of this research identify sustainability indicators for the VNP tourism system in relation to how stakeholders assessed the situation in 2012. Since then, as the trend in numbers of visitors indicate, conditions have changed, even though the priorities stated in the Icelandic tourism strategy are valid for three more years. Stakeholders would thus most likely emphasize these issues and themes differently if the interviews were undertaken today. The interviewees in this study represent several stakeholder views, namely the private sector, the National Park and local decision makers, while most of them are also residents of the area. Together these provide a holistic view of the situation in their community. Also, the results support that the indicator variables derived from the interviews are relevant to assessing a tourism system. Nevertheless, a continuous reevaluation of indicators would be beneficial in order to include current stakeholder perceptions so that best assessment and decision-making can be ensured. This is a crucial component in development of sustainability indicators for tourism in the NP especially because rapid growth in visitor numbers together with ecosystems and communities that are sensitive to tourism impact call for active monitoring and continuation of assessment methods.

7.0 Conclusion

The results of this study suggest that the systemic indicator approach can be used to identify sustainability indicators relevant for taking out the details of complex SESs without losing sight of broader sustainability aspects. The results reveal that it is not the physical matter of tourism or the stakeholders themselves, which are most crucial to the VNP tourism system, but rather the communication between stakeholders about the physical features, attractiveness and structure of the system. At the same time, attractiveness is both the most critical and the most vulnerable indicator in the system. This indicates that the attractiveness of the area is most efficiently maintained through clear communication and interactions regarding recreation facilities, education, services and infrastructure. In addition, all indicators are influenced by actions taken within the system, while only a few are influenced by actions taken outside the system. This means that the system is more reliant on domestic efforts to make tourism development more sustainable than it is on external factors, such as competition, demand and accessibility to the country. Moreover, the results verify that the indicators are more important for the overall attractiveness of the region to visitors than are external factors or input into the area. This study therefore concludes that not tourism demand, but rather stakeholder knowledge and actions, and infrastructure that improves destination attractiveness should play a key role in the assessment of sustainability in the tourism system in Vatnajökull National Park and adjacent communities.

References

- Althingi. (2011). *Pingskjal 1657. Tillaga til þingsályktunar um ferðamálaáætlun 2011–2020*. [Parliamentary resolution on tourism policy 2011–2020]. Þskj. 1657–467. mál. Reykjavík.
- Aminu, M., Ludin, A. N. B. M., Matori, A.-N., Wan Yusof, K., Dano, L. U., & Chandio, I. A. (2013). A spatial decision support system (SDSS) for sustainable tourism planning in Johor Ramsar sites, Malaysia. *Environmental Earth Sciences*, 70(3), 1113–1124.
- Aminu, M., Matori, A. N., Wan Yusof, K., & Zainol, R. B. (2014). Application of geographic information system (GIS) and analytic network process (ANP) for sustainable tourism planning in Cameron Highlands, Malaysia. *Applied Mechanics and Materials*, 567, 769–774.
- Barzekar, G., Aziz, A., Mariapan, M., Ismail, M. H., & Hosseini, S. M. (2011). Using analytical hierarchy process (AHP) for prioritizing and ranking of ecological indicators for monitoring sustainability of ecotourism in Northern Forest, Iran. *Ecologia Balkanica*, 3(1), 59–67.
- Bossel, H. (1999). *Indicators for sustainable development: Theory, method, applications* (A report to the Balaton Group). Winnipeg, Manitoba, Canada: International Institute for Sustainable Development. <http://www.ulb.ac.be/ceese/STAFF/Tom/bossel.pdf>
- Bossel, H. (2001). Assessing viability and sustainability: A system-based approach for deriving comprehensive indicator sets. *Conservation Ecology*, 5(2).
- Böhringer, C., & Jochem, P. E. P. (2007). Measuring the immeasurable—A survey of sustainability indices. *Ecological Economics*, 63(1), 1–8.
- Briassoulis, H. (2002). Sustainable tourism and the question of the commons. *Annals of Tourism Research*, 29(4), 1065–1085.
- Buckley, R. (2012). Sustainable tourism: Research and reality. *Annals of Tourism Research*, 39(2), 528–546.
- Budruk, M., & Phillips, R. G. (Eds.) (2011). *Social indicators research series: Quality-of-life community indicators for parks, recreation and tourism management*. New York, NY: Springer.
- Byrd, E. T., Cárdenas, C. A., & Greenwood, J. B. (2008). Factors of stakeholder understanding of tourism: The case of Eastern North Carolina. *Tourism and Hospitality Research*, 8(3), 192–204.
- Chan, S.-L., & Huang, S.-L. (2004). A systems approach for the development of a sustainable community - the application of the sensitivity model (SM). *Journal of Environmental Management*, 72(3), 133–147.
- Dabpet, S., Scott, N., & Ruhanen, L. (2012). Applying diffusion theory to destination stakeholder understanding of sustainable tourism development: A case from Thailand. *Journal of Sustainable Tourism*, 20(8), 1107–1124.
- Davíðsdóttir, B. (2010). *Ecosystem services and human-wellbeing Valuing ecosystem services*. In D. M. Kristófersson (Ed.), *Rannsóknir í Félagsvísindum XI* (pp. 16–24). Reykjavík: The social science research institute.

- Environmental Agency of Iceland. (2017). *Landupplýsingar* [Geoinformation]. Retrieved June 1, 2017 from <http://ust.is/atvinnulif/sveitarfelog/landupplýsingar/>
- Farrell, B., & Twining-Ward, L. (2004). Seven steps towards sustainability: Tourism in the context of new knowledge. *Journal of Sustainable Tourism*, 13(2), 109–122.
- Frent, C. (2014a). *The economic benefits of tourism in Iceland: New developments for the Icelandic Tourism Satellite Account: Tourism gross fixed capital formation and tourism collective consumption*. The Icelandic Tourism Research Centre.
- Frent, C. (2014b). *The economic benefits of tourism in Iceland: Boosting the Icelandic tourism satellite account development—Icelandic Tourism Satellite Account (TSA) – A conformity assessment with United Nations standards for TSA – Part II*. The Icelandic Tourism Research Centre.
- Gibson, R. B. (with Hassan, S., Holtz, S., Tansey, J., & Whitelaw, G.), (2005). *Sustainability assessment: Criteria and processes*. Abingdon, United Kingdom: Earthscan.
- Grace, W., & Pope, J. (2015). A systems approach to sustainability assessment. In A. Morrison-Saunders, J. Pope & A. Bond (Eds.), *Handbook of sustainability assessment* (pp. 285–320). Cheltenham, United Kingdom: Edward Elgar.
- Guðmundsson, R. (2016). *Vatnajökulsþjóðgarður ferðamenn 2005–2015. Samantekt unnin fyrir Vatnajökulsþjóðgarð*. □Vatnajökull national park tourists 2005–2015. Made for Vatnajökull national park □ Iceland: Rannsóknir og ráðgjöf ferðaþjónustunnar.
- Gustavson, K. R., Lonergan, S. C., & Ruitenbeek, H. J. (1999). Selection and modeling of sustainable development indicators: A case study of the Fraser River Basin, British Columbia. *Ecological Economics*, 28(1), 117–132.
- Hall, C. M., Müller, D. K., & Saarinen, J. (2009). *Nordic tourism: Issues and cases*. Bristol, United Kingdom: Channel view publications.
- Hall, C. M. (2000). *Tourism Planning: Policies, processes and relationships*. Harlow, United Kingdom: Prentice Hall.
- Haukeland, J. V. (2011). Tourism stakeholders' perceptions of national park management in Norway. *Journal of Sustainable Tourism*, 19(2), 133–153.
- Helgadóttir, G., & Sigurðardóttir, I. (2008). Horse-based tourism: Community, quality and disinterest in economic value. *Scandinavian Journal of Hospitality and Tourism*, 8(2), 105–121.
- Huijbens, E. H., & Gunnarsson, K. B. (2014). *Skemmtiferðaskip við Ísland. Úttekt á áhrifum*. The Icelandic Tourism Research Centre.
- Icelandic Tourist Board (2017 a). *Tourism in Iceland in figures. June 2017*. Reykjavík: Icelandic Tourist Board.
- Icelandic Tourist Board (2017 b). *Number of foreign visitors to Iceland 2003–2016*. Retrieved July 15, 2017 from <http://www.ferdamalastofa.is/en/research-and-statistics/numbers-of-foreign-visitors>

- Icelandic Tourist Board. (2017 c). *Tourism Strategy 2011-2020*. Retrieved September 25, 2017 from <https://www.ferdamalastofa.is/en/about-us/tourism-strategy-2011-2020>
- Jóhannesson, G. T., & Huijbens, E. H. (2010). Tourism in times of crisis: Exploring the discourse of tourism development in Iceland. *Current Issues in Tourism*, 13(5), 419–434.
- Jóhannesson, G. T., Huijbens, E. H., & Sharpley, R. (2010). Icelandic tourism: Past directions—future challenges. *Tourism Geographies*, 12(2), 278–301.
- Kettunen, M., Vihervaara, P., Kinnunen, S., D’Amato, D., Badura, T., Argimon, M., & Ten Brink, P. (2012). *Socio-economic importance of ecosystem services in the Nordic Countries. Synthesis in the context of The Economics of Ecosystems and Biodiversity (TEEB)*. Copenhagen, Denmark: Nordic Council of Ministers.
- Kristjánsdóttir, K.R. (2014). Work creates community: The role of tourism in sustainable development of a European arctic community. *Arctic Yearbook 2014*.
http://www.arcticyearbook.com/images/Arcticles_2014/Kristjansdottir_AY_2014_FINAL.pdf
- Kristjánsdóttir, K. R., Ólafsdóttir, R., & Ragnarsdóttir, K.V. (in press). Reviewing integrative sustainability indicators for tourism. *Journal of Sustainable Tourism*. Retrieved from <http://www.tandfonline.com/doi/full/10.1080/09669582.2017.1364741>
- Kristjánsdóttir, K. R., Ólafsdóttir, R., & Ragnarsdóttir, K. V. (2017). Reviewing integrated sustainability indicators for tourism. *Journal of Sustainable Tourism*, 1–17.
- Matilainen, A., & Keskinarkaus, S. (2010). *The economic role of hunting tourism—Examples from northern areas* (Reports 64). University of Helsinki, Ruralia Institute.
- McDonald, J. R. (2009). Complexity science: An alternative world view for understanding sustainable tourism development. *Journal of Sustainable Tourism*, 17(4), 455–471.
- Mettrass–Mendes, A. (2014). *Icelandic tourism profitability and sustainability strategies: The facilitating role of aviation* (Final Project Report). Akureyri, Iceland: The Icelandic Tourism Research Centre.
- Mikkola, P. (2014). *NPP 2020—the gateway to the Arctic? Arctic dimension in the Northern periphery cooperation, preparatory project* (Final content report). Regional Council of Lapland, Northern Periphery Programme 2007–2013 & the European Union—European Regional Development Fund.
- Miller, G., & Twining-Ward, L. (2005). *Monitoring for a sustainable tourism transition. The challenge of developing and using indicators*. Wallingford, United Kingdom: CABI.
- National Land Survey of Iceland (n.d.) (2017), IS50V database. Retrieved June 1, 2017 from <http://www.lmi.is/en/stafraen-gogn/is-50v-nytt/>
- Ness, B. Urbel–Piirsalu, E., Anderberg, S., & Olsson, L. (2007). Categorizing tools for sustainability assessment. *Ecological Economics*, 60(3), 498–508.

- Newsome, D., Moore, S. A., & Dowling, R. K. (2013). *Natural area tourism: Ecology, impacts and management* (2nd Ed.). Bristol, United Kingdom: Channel View Publications.
- Northern Ireland Statistics and Research Agency. (2017). *Northern Ireland Annual Tourism Statistics 2016*. Retrieved July 14, 2017 from https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/2016-Annual-Publication_0.pdf
- Northern Periphery Programme, The (2016). *Northern periphery and Arctic programme 2014–2020*. Retrieved January 9, 2016 from <http://www.interreg-npa.eu/>.
- Ólafsdóttir, R., Kristjánsdóttir, K. R., Bjarnadóttir H. J. & Bragason, Á. (2009). *Umhverfisvitund og umhverfisstjórnun í íslenskri ferðaþjónustu. Viðhorf ferðaþjónustuaðila og ferðamanna til umhverfisstjórnunar og vistvænnar vottunar í og við Vatnajökulsþjóðgarð*. Environmental management in Icelandic tourism industry. The Icelandic Tourism Research Center. http://media.wix.com/ugd/49a74b_69c29abc17634c4a8ec6776f43bf4a82.pdf
- Ólafsdóttir, R., & Runnström, M. C. (2009). A GIS approach to evaluating ecological sensitivity for tourism development in fragile environments. A case study from SE Iceland. *Scandinavian Journal of Hospitality and Tourism*, 9(1), 22–38.
- Ólafsdóttir, R., & Runnström, M. C. (2011). How wild is Iceland? Assessing wilderness quality with respect to nature based tourism. *Tourism Geographies*, 13(2), 280–298.
- Ólafsdóttir, R., & Runnström, M. C. (2013). Assessing hiking trails condition in two popular tourist destinations in the Icelandic highlands. *Journal of Outdoor Recreation and Tourism*, 3-4, 57–67.
- Ólafsdóttir, R., & Haraldsson, H. V. (2015). *A systemic approach to assessing the environmental impacts of tourism and the attractiveness of tourist destinations*. University of Iceland & The Icelandic Tourist Board.
- Pepperdine, S., & Ewing, S. (2001). Integrating social sustainability considerations into natural resource management. In G. Lawrence, V. Higgins, S. Lockie (Eds.), *Environment, Society and natural resource management: Theoretical perspectives from Australasia and the Americas* (pp. 70-83). Northampton, MA: Edward Elgar.
- Pissourios, I. A. (2013). An interdisciplinary study on indicators: A comparative review of quality-of-life, macroeconomic, environmental, welfare and sustainability indicators. *Ecological Indicators*, 34, 420–427.
- Pope, J., & Grace, W. (2006). Sustainability assessment in context: Issues of process, policy and governance. *Journal of Environmental Assessment Policy and Management*, 8(3), 373–398.
- Reynisdóttir, M., Song, H., & Agrusa, J. (2008). Willingness to pay entrance fees to natural attractions: An Icelandic case study. *Tourism Management*, 29(6), 1076–1083.
- Rögvaldsdóttir, L. B. (2015). *Tourism data collection. An analysis at subnational level in Iceland*. Icelandic Tourism Research Centre.
- Saarinen, J. (2014). Critical sustainability: Setting the limits to growth and responsibility in tourism. *Sustainability*, 6, 1–17.

- Sedarati, P. (2015). *System dynamics in tourism: A systematic literature review* (Unpublished master's thesis). University of Algarve, Faro, Portugal.
- Schianetz, K., & Kavanagh, L. (2008). Sustainability indicators for tourism destinations: A complex adaptive systems approach using systemic indicator system. *Journal of Sustainable Tourism*, 16(6), 601–628.
- Sinclair, A. J, Diduck, A. P., & Vespa, M. (2015). Public participation in sustainability assessment: essential elements, practical challenges and emerging directions. In A. Morrison-Saunders, J. Pope, & A. Bond (Eds.), *Handbook of Sustainability Assessment* (pp. 349–374). Cheltenham, United Kingdom: Edward Elgar.
- Snyder, J.M. (2007). The economic role of Arctic tourism. In J. M. Snyder, & B. Stonehouse (Eds.), *Prospects for polar tourism* (pp.102–122). Wallingford, United Kingdom: CABI.
- Solstrand, M.-V. (2013). Marine angling tourism in Norway and Iceland: Finding balance in management policy for sustainability. *Natural Resources Forum*, 37(2), 113–126.
- Statistics Denmark, (2017). *Overnight stay by period, nationality of the guest, region, type of overnight accommodations and time*. Retrieved July 14, 2017 from <https://www.statbank.dk/statbank5a/default.asp?w=1280>
- Statistics Finland (2017). Nights spent in all establishments in 2016. Retrieved July 14, 2017 from http://www.stat.fi/til/matk/2016/matk_2016_2017-04-27_tau_002_en.html
- Statistics Faroe Islands (2017). Passenger transport to and from the Faroe Islands, by air and sea. Retrieved July 14, 2017 from http://statbank.hagstova.fo/pxweb/en/H2/H2_SS_SS01/ferd_sjoloft.px/table/tableViewLayout1/?rxid=43e562a7-ccd6-48da-84f1-10842a58017a
- Statistics Greenland (2017). Overnight stays by unit and time. Retrieved July 14, 2017 from <http://www.stat.gl/dialog/topmain.asp?lang=en&subject=Tourism&sc=TU>
- Statistics Iceland (2017). *Population development 2016*. Retrieved July 14, 2017 from <https://statice.is/publications/publication-detail?id=58377>
- Statistics Norway (2017). Accommodation establishments total. Guest nights, by country of residence, time and contents. Retrieved July 14, 2017 from <https://www.ssb.no/statistikkbanken/selectvarval/saveselections.asp>
- Swedish Agency for Economic and Regional Growth (2017). Statistik Turism. Retrieved July 14, 2017 from <https://tillvaxtverket.se/statistik/vara-undersokningar/resultat-fran-turismundersokningar/2017-02-08-dampad-okning-av-turismen-2016.html>
- Sæþórsdóttir, A. D. (2013). Managing popularity: Changes in tourist attitudes in a wilderness destination. *Tourism Management Perspectives*, 7, 47–58.
- Sæþórsdóttir, A. D., & Saarinen, J. (2016). Challenges due to changing ideas of natural resources: Tourism and power plant development in the Icelandic wilderness. *Polar Record*, 52(1), 82–91.
- Torres-Delgado, A., & Polomeque, F. L. (2014). Measuring sustainable tourism at the municipal level. *Annals of Tourism Research*, 49, 122–137.

- Tsaur, S.-H., & Wang, C.-H. (2007). The evaluation of sustainable tourism development by analytic hierarchy process and fuzzy set theory: An empirical study on the Green Island in Taiwan. *Asia Pacific Journal of Tourism Research*, 12(2), 127–145.
- Valentin, A., & Spangenberg, J. H. (2000). A guide to community sustainability indicators. *Environmental Impact Assessment Review*, 20(3), 381–392.
- Van Houtte, M. (2015). *Sustainable tourism management in protected areas using a systemic approach, A case study from Þingvellir National Park, Iceland* (Master's thesis). Retrieved from Skemman.is (<http://hdl.handle.net/1946/21992>).
- Vatnajökull national park (2016). *Education and interpretation. About Vatnajökull National Park*. Retrieved February 3, 2016 from <http://www.vatnajokulsthjodgardur.is/english/education/>
- Vatnajökull National Park (2017). *Um Vatnajökulshjóðgarð. Sérstaða þjóðgarðsins. [About Vatnajökull National Park. The characteristics of the national park]*. Retrieved September 26, 2017 from <https://www.vatnajokulsthjodgardur.is/is/thjonusta/um-vatnajokulsthjodgard/serstada-thjodgardsins>
- Vester, F. (2012). *The art of interconnected thinking. Tools and concepts for a new approach to tackling complexity* (2nd revised impression). Munich, Germany: MCB Publishing House.
- Vester, F., & Hessler, A. (1982). Sensitivity model. Frankfurt, Germany: Umlandverband Frankfurt.
- Vik, M. L., Benjaminsen, T. A., & Daugstad, K. (2010). Synergy or marginalization? Narratives of farming and tourism in Geiranger, western Norway. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography*, 64(1), 36–47.
- Visit Scotland (2017). *Insight Department. Scotland's tourism performance summary report*. Retrieved July 14, 2017 from <http://www.visitscotland.org/pdf/2016%20Stats%20Summary.pdf>
- World Tourism Organization (1996). *What tourism managers need to know: A practical guide to the development and use of indicators of sustainable tourism*. Madrid, Spain: World Tourism Organization.

Appendix I: Sustainability themes expressed by tourism stakeholders in Vatnajökull National Park, 2012

Theme	Cause and effect
Some communities experience reaching social carrying capacity	<i>Small communities not ready to share services with increased population during tourist seasons</i>
Seasonality	<i>In some areas, contrast between overcrowding in high-season and 'emptiness' in off-season; Lack of full-time employment</i>
Inadequate tourist service and tourist information	<i>Low prioritization of sector; Lack of people who want to work in sector and lack of full-time employment in sector; Seasonality</i>
Stakeholder involvement, public participation and communication between stakeholder groups in decision-making processes	<i>Low prioritization of sector; Seasonality</i>
Lack of people who want to work in sector and lack of full-time employment in sector	<i>Seasonality</i>
Population decline in many communities	<i>Seasonality</i>
Lack of long-term perspectives in and continuation of cooperative projects and marketing	<i>Low prioritization of sector</i>
Lack of implementation of lessons learned from other countries with similar challenges	<i>Low prioritization of sector</i>
Lack of consistency between marketing and the capacity to welcome more tourists in each area	<i>Low prioritization of sector</i>
Many stakeholders do not understand what sustainable tourism is and how it is relevant to their own work	<i>Low prioritization of sector; Lack of implementations from lessons learned from other countries with similar challenges; Lack of long-term perspectives in and continuation of projects</i>
Lack of integration of sustainability goals in tourism development	<i>Low prioritization of sector; Lack of implementations from lessons learned from other countries with similar challenges; Lack of long-term perspectives in and continuation of projects</i>
Soil erosion on hiking trails in nature-based destinations	<i>Inadequate infrastructure for protecting against erosion</i>
Uneven pressure on nature-based destinations—some areas have reached ecological carrying capacity	<i>Lack of planning, management, limiting access to most popular-sensitive areas and directing visitors across a larger area</i>
Overall neutral or negative impact on nature-based experiences	<i>Tourism management is not consistent with increased pressure</i>
Ecolabels—Environmental management schemes have not proved successful tools for encouraging green tourism	<i>Too expensive for tourist hosts; Insufficient incentives, information, support; Lack of incentives for long-term commitment</i>
Seasonality	<i>Lack of coordination and cooperation in marketing and tourist information</i>
Economic feedback in some communities neutral—the revenue of tourism does not stay in community	<i>Low prioritization of sector</i>
Seasonality	<i>Inadequate infrastructure to develop tourism on a year-round basis and on a countrywide basis</i>
Population decline in many communities	<i>Seasonality</i>
Low prioritization of the tourism industry compared to other industries	<i>Investments considered unstable</i>
Lack of consistency between marketing and the capacity to welcome more tourists in each area	<i>Low prioritization of sector</i>

Appendix II: Pair-wise comparison between these eighteen indicator variables and the criteria of relevance to a tourism system

Indicator variables	Criteria																	
	Sector of life						Physical criteria			Dynamic criteria				System relations				
	Stakeholders	Stakeholders activities	Area	Stakeholders feelings	Interaction with nature	Interconnections	Organizational structure	Material–Matter	Energy	Information	Flow determinant	Structural determinant	Temporal dynamics	Spatial dynamics	Opens system to input	Opens system to output	Endogenous	Exogenous
1. Social carrying capacity	1	1	0,5	1	-	1	1	0,5	-	0,5	0,5	1	1	-	0,5	1	1	-
2. Societal seasonality	-	1	1	1	-	1	-	1	0,5	0,5	0,5	1	1	0,5	-	1	1	-
3. Service and information for tourists	-	1	0,5	1	1	1	0,5	1	0,5	1	0,5	0,5	1	0,5	1	0,5	1	1
4. Stakeholder involvement	1	1	-	1	1	1	1	0,5	0,5	1	0,5	1	-	-	0,5	0,5	1	-
5. Employment	1	1	0,5	0,5	-	0,5	1	1	0,5	1	0,5	1	1	-	1	1	1	0,5
6. Population decline	-	1	1	1	-	1	1	-	0,5	0,5	-	0,5	0,5	0,5	-	1	1	-
7. Long-term perspective in policies, projects and marketing	1	1	-	1	1	1	0,5	-	0,5	1	0,5	0,5	1	1	1	1	1	0,5
8. Implementations of policies and cooperation projects	1	1	-	1	1	1	-	-	0,5	1	1	1	1	0,5	1	1	1	-
9. Capacity to accommodate tourists	1	1	1	1	-	1	1	1	0,5	1	-	1	1	-	1	0,5	1	-

Indicator variables	Criteria																	
	Sector of life							Physical criteria			Dynamic criteria				System relations			
	Stakeholders	Stakeholders activities	Area	Stakeholders feelings	Interaction with nature	Interconnections	Organizational structure	Material-Matter	Energy	Information	Flow determinant	Structural determinant	Temporal dynamics	Spatial dynamics	Opens system to input	Opens system to output	Endogenous	Exogenous
10. Community learning	1	1	-	1	1	1	1	-	-	1	-	-	-	0,5	1	1	1	0,5
11. Integration of sustainability goals	-	-	0,5	-	1	1	1	-	0,5	1	0,5	0,5	1	1	0,5	0,5	1	-
12. Trail condition	1	1	1	-	1	1	0,5	1	-	1	0,5	1	1	1	1	1	1	-
13. Ecological carrying capacity	1	1	1	-	1	1	0,5	1	1	1	1	0,5	1	1	1	1	1	1
14. Destination attractiveness	1	1	1	1	1	1	0,5	1	0,5	1	-	1	0,5	1	1	1	1	-
15. Environmental management performance	-	0,5	-	1	1	0,5	0,5	1	1	1	1	1	-	-	-	1	1	-
16. Seasonal environmental pressure	1	1	1	-	1	0,5	-	1	1	1	0,5	1	1	1	1	1	1	-
17. Local economy	1	1	1	1	-	0,5	0,5	1	1	1	1	1	-	1	1	1	1	1
18. Seasonality on local businesses	1	1	1	1	-	1	0,5	1	1	0,5	1	1	1	1	1	1	1	1
Total	13	16,5	11	13,5	11	16	11	12	10	16	9,5	14,5	13	10,5	13,5	16	18	5,5

Appendix III: Pair-wise assessment of the effect each indicator variable has within the system

Effects of a change in □ on □	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Active sum (AS)	P (AS x PS)
1 Social carrying capacity		2	3	2	2	2	2	3	3	2	2	0	0	3	0	1	3	2	32	1024
2 Societal seasonality	3		3	2	2	2	2	2	3	2	2	1	1	3	1	1	3	3	36	1008
3 Service and information for tourists	2	2		0	3	2	0	0	3	1	1	2	1	3	1	2	3	3	29	870
4 Stakeholder involvement	2	1	2		1	1	1	1	1	2	1	0	0	1	2	1	1	1	19	494
5 Employment	3	3	3	2		3	2	2	3	2	1	1	1	3	3	1	3	3	39	819
6 Population decline	3	3	3	2	3		3	3	3	0	1	0	0	3	1	0	3	3	34	714
7 Long-term perspective	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	17	374
8 Implementation	1	1	1	1	0	0	2		1	2	1	1	1	2	2	1	1	1	19	475
9 Capacity to accommodate tourists	3	3	3	2	3	3	0	1		1	1	1	1	3	2	1	3	3	34	918
10 Community learning	3	1	1	2	0	0	1	1	2		1	1	1	1	2	1	2	0	20	480
11 Integration of sustainability goals	0	0	0	1	0	0	1	1	0	2		1	1	1	2	2	1	1	14	294
12 Trail condition	0	0	0	1	0	0	0	1	0	0	1		3	2	2	3	0	0	13	260
13 Ecological carrying capacity	1	0	0	1	0	0	1	1	0	2	1	3		3	2	3	0	0	18	342
14 Destination attractiveness	3	3	2	2	0	1	1	1	1	1	1	2	2		2	3	3	3	31	1147
15 Environmental management performance	0	0	1	0	0	0	0	1	0	2	2	2	2	1		0	1	0	12	336
16 Seasonal environmental pressure	1	3	1	2	0	0	1	1	0	2	2	3	3	3	2		1	2	27	567
17 Local economy	3	2	3	2	3	3	2	2	3	2	1	1	1	1	0	0		2	31	992
18 Economic seasonality	3	3	3	3	3	3	3	3	3	0	1	0	0	3	3	0	3		37	1036
Passive sum (PS)	32	28	30	26	21	21	22	25	27	24	21	20	19	37	28	21	32	28		
Q (AS / PS x 100)	100	129	97	73	186	162	77	76	126	83	67	65	95	84	43	129	97	132		