Stakeholder participation in developing sustainability indicators for a European Northern Periphery tourism system

ABSTRACT

Many European northern periphery (NP) communities are likely to experience increased and complex environmental, social and economic impacts of tourism in the nearest future. Therefore, approaches that see tourism as included in complex socio-ecological systems are useful 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. The results of 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. Five indicators are currently most influential for the tourism system in VNP and are major driving forces for local tourism development: ‘Destination attractiveness’, ‘Economic seasonality’, ‘Social carrying capacity’, ‘Societal seasonality’ and ‘Local economy’. The smallest change in either 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.

INTRODUCTION

Tourism is important, although not prioritized, in 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 nearest 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 sector, tourism development or local tourism stakeholders are often not prioritized (Miller & Twining-Ward, 2005; Kristjánsdóttir, 2014). 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. Valentin & Spangenberg, 2000; Briassoulis, 2002; Farrell & Twining-Ward, 2004; Miller & Twining-Ward, 2005; McDonald, 2009; Buckley, 2012; Saarinen, 2014). These studies also call for methodological developments to involve complex SES’s, 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 (1996:6) 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.”* (p. 4). Therefore, this paper focuses on integrated sustainability indicators for tourism (as emphasized by Kristjánsdóttir, Ólafsdóttir, Ragnarsdóttir, In Press), those that both: i) 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 (Miller & Twining-Ward, 2005; Gibson, Hassan & Tansey, 2015; Grace & Pope, 2015) and; ii) aim to be an integrated part of overall policymaking and planning, not solely within tourism management (Valentin & Spangenberg, 2000; Pope & Grace, 2006; Budruk & Phillips, 2011).Along these lines, several scholars haverecently 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; Schianetz & Kavanagh, 2008; Buckley, 2012; Tsaur & Wang, 2007; Barzekar, Aziz, Mariapan, Ismail & Hosseni, 2011; Torres-Delgado, Palomeque, 2014; Sedarati, 2015). 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.

BACKGROUND

*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, 2014). 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, NPregions are expected to experience the increased environmental, economic and social impacts of tourism over the coming years (Hall et al., 2009; Newsome et al., 2013; Ólafsdóttir & Runnström, 2013).

Mikkola (2014) points out that some of the main sustainability challenges of northern periphery 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. The only sustainability indicators that have been developed for the NP are the Arctic Social Indicators (ASI). These were developed by the Nordic Council in 2006 and revised in 2014, with the objective to devise a limited set of indicators that reflect key aspects of human development, are tractable in terms of measurement, and can be monitored at a reasonable cost (The Nordic Council, 2014).

*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 1,792,201, more than fivetimes the Icelandic population (The Icelandic Tourist Board, 2017a; b; Statistic Iceland, 2017). This was an increase from half a million in 2010. Between the years 2015-2016 the increase was 39%, a historic high (The Icelandic Tourist Board, 2017a). In contrast, the average increase in tourism in the NP countries were between 1-10% (Statistics Denmark, 2017; Statistics Finland, 2017; Statistics Faroe Islands, 2017; Statistics Greenland, 2017; Statistics Norway, 2017; Statistics Sweden, 2017; Visit Scotland, 2017; Northern Ireland Statistics and Research Agency, 2017). Despite of this big difference in tourism increase, the other NP countries could benefit from lessons learned from Iceland.

Sustainable development has long been the main focus of the 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: i) Increase the profitability of the sector; ii) Systematically develop tourist destinations and product promotion, with the aim of decreasing seasonality and overcrowding of destinations; iii) Enhance professionalism, quality and safety in the tourism sector and; iv) Define and maintain Iceland’s uniqueness as a tourist destination (Althingi, 2011).

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 et al., 2015; Sinclair, Diduck & Vespa, 2015; Kristjánsdóttir, Ólafsdóttir & Ragnarsdóttir, in Press). 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, 2014; Metrass-Mendes, 2014; Reynisdottir, 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 the natural landscape (The Icelandic Tourist Board, 2016a). 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 SES’s. 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 because of this reason (Kristjánsdóttir, 2014).

*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 et al., 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: i) qualitative subjective approaches based on stakeholders’ perceptions and experiences and; ii) 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; Pope & Grace, 2006) emphasize that sustainability assessment should: i) 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; ii) Include a continuation of business-as-usual as a benchmark policy, as well as potential policy alternatives; iii) Determine whether these trajectories are consistent with the SES’s potential transition over time, as well as its sustainability goals, and iv) 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 sentenceby Miller & Twining-Ward, 2005:79): *“At a very simplified level, the role of government is to enable its citizens to enhance the quality of their lives”* Systemic approaches to sustainability indicators therefore provide an opportunity to develop comprehensive decision making tools based on holistic assessments of SESs on public participation.

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 (figure 1). The park stretches into eight different municipalities, all of which have planning authority within the park (Vatnajökull National Park, 2016). The area was selected for this study as it is a NP 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.

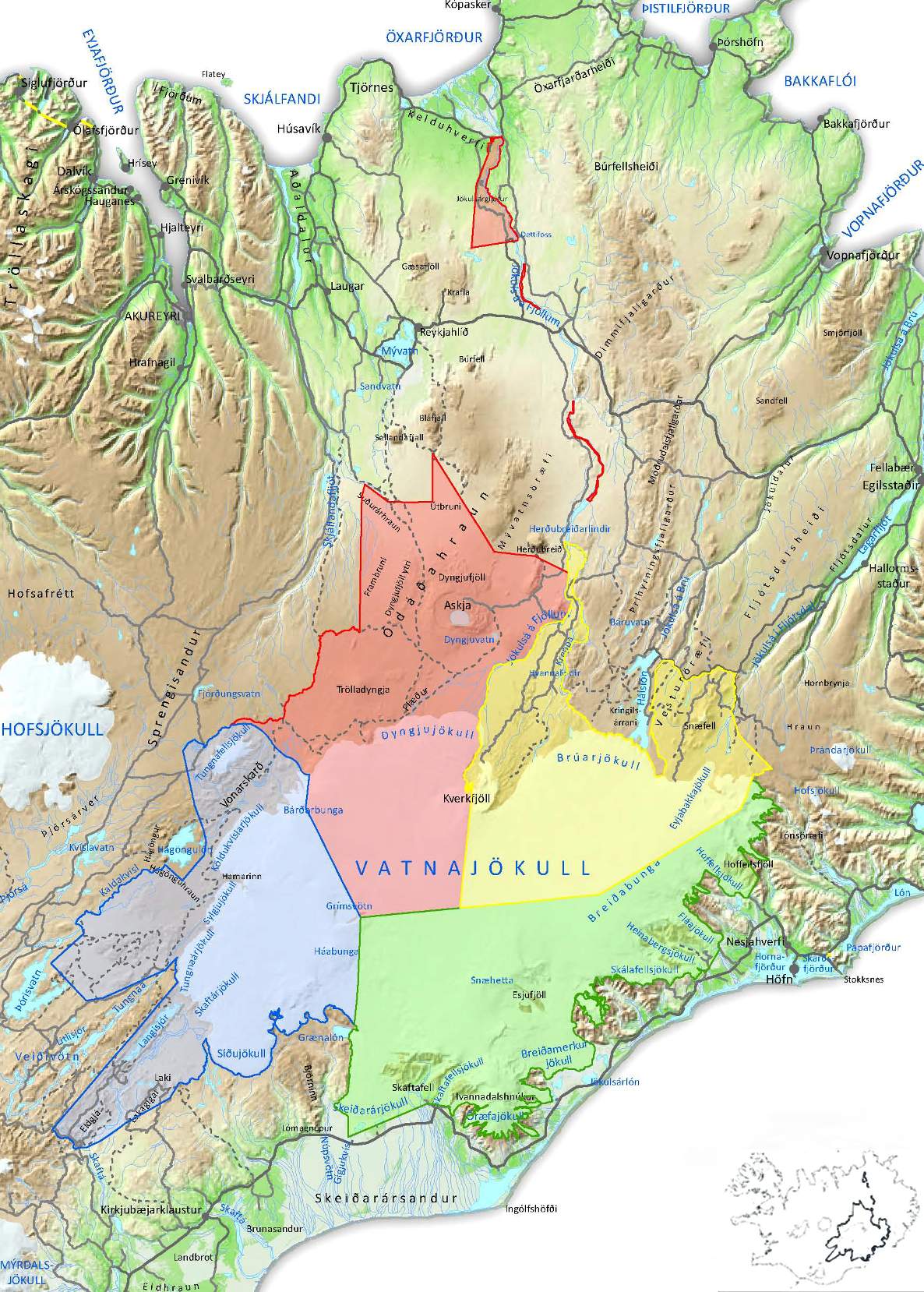
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Figure 1: The area of Vatnajökull National Park in Iceland, and division into its Northern, Western, Southern and Eastern territories. Source: Vatnajökull national park.

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, 2016). 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; The Icelandic Tourist Board, 2017a) (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

METHODS

*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 (*cf.* figure 1) in October 2012. Of the 48 participants, 28 were tourist hosts, 14 government employees involved in local decision-making processes concerning tourism, and 6 were national park employees and rangers. The participants were selected with a snowball approach where individuals within these groups were contacted and interested parties were subsequently interviewed in either their home or workplace, 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.

*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 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 (figure 3): i) Identification of sustainability indicator variables for VNP, based on tourism stakeholder perceptions in the interviews; ii) An assessment of the extent to which the indicator variables are relevant to VNP as a tourism system; iii) An assessment of the extent to which the indicator variables influence each other, and their degree of interconnectedness and iv) An effect analysis of each of the indicators within the system.

Figure 3: Flowchart illustrating the data analysis process of the systemic indicator method in this research

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 (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.

Table 1: Criteria used for verifying the relevance of the indicator variables to a tourism system. Adapted from Schianetz and Kavanagh (2008).

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Criterion** | **Definition** | **Examples for tourism destinations** |
| ***Sectors of life criteria*** | | | |
|  | Stakeholders | Who is involved and affected? | Tourists, residents/natives, employees, developers, planners, businesses, ecologists |
|  | Stakeholder activities | What are they doing? | Tourism activities, economic activities, employment, turnover, services, sales, production, investment |
|  | Area | Where does it happen? | Land use, population density, size, location and use of buildings, distances |
|  | Stakeholder feelings | How do they feel? | Motivation, competition, creativity, quality of life, security, education, health |
|  | Interaction with nature | How do the stakeholders affect the natural resources? | Ecosystem, natural balance, resource use, waste generation, environmental impacts |
|  | Interconnections | How do the stakeholders connect and communicate? | Transport, infrastructure, accessibility, communication, information, supply, marketing strategies, cooperation projects, permits |
|  | Organization | How is the resort organized? | Community, legislation, management, taxes, procedures, cultural behavior codes |
| ***Physical criteria*** | | | |
|  | 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 |
|  | Energy | Energy resources or generators that transform or consume energy | Energy consumption, energy resources, finances, employment, funds, infrastructure |
|  | Information | Responsible for the flow of information and for communication | Media, decisions, information centers, procedures, requirements, attractiveness, education, finances, recreation facilities |
| ***Dynamic criteria*** | | | |
|  | Flow determinant | Flow of matter, energy, and information within a system | Traffic, energy/water consumption, raw material use, waste generation, finances, visitors |
|  | Structural determinant | Structure of the system | Infrastructure, recreation facilities, accommodation, population, local businesses, politics |
|  | Temporal dynamics | Location-specific items that change with time | Tourist seasons, climate, employment, traffic, finances, recreational quality, quality of life |
|  | Spatial dynamics | Items that change with location | Wastewater, traffic, disturbances, land use, conservation zone, infrastructure |
| ***System relations criteria*** | | | |
|  | System input | Variables that open the system to input | Access routes, tourists, public transport, water/energy supply |
|  | System output | Variables that open the system to output | Quality of life, attractiveness, ecological value, recreational facilities |
|  | 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 |
|  | Exogenous | Variables that are influenced or controlled by external processes or actions | Competition, tourists, accessibility, demand, attractiveness of region, politics |

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: i) *Active Sum* (AS): The sum score of the effect that each indicator has on the other indicators; ii) *Passive Sum* (PS): The sum score of the effect that the other indicators have on each indicator; iii) *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; iv) *Quotient* (Q): AS/PS × 100, which identifies if a variable is reactive (low values) or active (high values) within the system.

RESULTS

*Sustainability indicator variables for the VNP tourism system*

A total of twenty-one sustainability themes relevant to the VNP tourism system were derived from interviews with 48 tourism stakeholders (*cf*. appendix I). A compilation of these themes resulted in eighteen indicator variables:

1. Capacity to accommodate tourists
2. Community learning
3. Destination attractiveness
4. Ecological carrying capacity
5. Economic seasonality
6. Employment
7. Environmental management performance
8. Implementation of policies and cooperative projects
9. Integration of sustainability goals
10. Local economy
11. Long-term perspective in policies, projects and marketing
12. Population decline
13. Seasonal pressure on physical environment
14. Service and information for tourists
15. Social carrying capacity
16. Societal seasonality
17. Stakeholder involvement
18. Trail conditions

The results of a pair-wise comparison between these eighteen indicator variables and the criteria of relevance to a tourism system (*cf.* table 1) reveal that 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 criteria 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, e.g. 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, e.g. 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 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.

*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 variable 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 variables 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 (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* c*ategory 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* c*ategory 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* c*ategory 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. See text section Data analysis for definition of P, AS, PS and Q

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 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 | 1 |
| Ecological carrying capacity | Buffering | Low | Low | Medium | 3 |
| Economic seasonality | Critical | Influential | Medium | Active | 1 |
| 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 | 1 |
| 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 | 1 |
| Societal seasonality | Critical | Influential | Medium | Active | 1 |
| Stakeholder involvement | Medium | Low | Medium | Reactive | 3 |
| Trail condition | Buffering | Low | Low | Reactive | 4 |

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 are on the same page regarding some of the current sustainability challenges for tourism development and the important variables. However, it can be argued that the systemic indicator method does dig deeper into the relationships between the variables 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, 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. Seasonality is also a dominant and active indicator in the VNP system, 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 result, 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; Vik, Benjaminsen & Daugstad, 2010; Kristjánsdóttir, 2014; Mikkola, 2014). 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 et al., , 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; i) in early design and construct phases of sustainability indicators; ii) when quantitative data is still limited; iii) without available time series data and; iv) 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.

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 SES’s 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). *Þingskjal 758. Tillaga til þingsályktunar um ferðamálaáætlun 2011–2020*. Þskj. 758–467. mál. [Parliamentary proposal on tourism policy 2011-2020]. Reykjavík

Aminu, M., Ludin, A., Matori, A–N, Wan Yusof, K., Dano, L. & Chandio, I. (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 & Materials 567*: 769–774

Barzekar, G., Aziz, A., Mariapan, M., Ismail, M.H. & Hosseni, 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*. International Institute for Sustainable Development, Winnipeg, Canada. http://iisd.ca/about/prodcat/perfrep.htm#balaton

Bossel, H. (2001). Assessing viability and sustainability: A system-based approach for deriving comprehensive indicator sets. *Conservation Ecology 5*(2): no p

Böhringer, C. & Jochem, P.E.P. (2007). Measuring the immeasurable–A survey of sustainability indices. *Ecological Economics 63*: 1–8

Buckley, R. (2012). Sustainable tourism: Research and reality. *Annals of Tourism Research 39*(2): 528–546

Budruk, M. & Phillips, R.G. (Eds.) (2011). *Quality-of-life community indicators for parks, recreation and tourism management. Social indicators research series*. Springer

Briassoulis, H. (2002). Sustainable tourism and the question of the commons. *Annals of Tourism Research, 29*(4): 1065–1085

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*: 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 Kristófersson, D.M. (2010). Rannsóknir í Félagsvísindum XI. Reykjavík: The social science research institute

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. (2014). *The Economic Benefits of Tourism in Iceland: New Developments for the Icelandic Tourism Satellite Account: Tourism Gross Fixed Capital Formation and Tourism Collective Consumption* and *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 Center

Gibson, B., Hassan, S. & Tansey, J. (2015). *Sustainability Assessment: Criteria and Processes*. Earthscan

Grace, W. & Pope, J. (2015). A systems approach to sustainability assessment. In Angus Morrison-Saunders, Jenny Pope and Alan Bond (Eds.) *Handbook of Sustainability Assessment*. UK, USA: Edward Elgar Publishing

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*: 117–132

Hall, C.M., Müller, D.K. & Saarinen, J. (2009). *Nordic tourism. Issues and cases*. Channel view publications

Hall, C.M. (2000). *Tourism Planning*. UK: Prentice Hall Harlow

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. May 2017*. Reykjavík: Icelandic Tourist Board

Icelandic Tourist Board (2017 b). *Number of foreign visitors to Iceland 2003–2016*. Retrieved 15072017 from http://www.ferdamalastofa.is/en/recearch-and-statistics/numbers-of-foreign-visitors

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).* Nordic Council of Ministers

Kristjánsdóttir, K.R. (2014). Work creates Community: The Role of Tourism in Sustainable Development of a Northern European Periphery Community in Sweden. *Arctic Yearbook 2014, 1*:  
http://www.arcticyearbook.com/images/Arcticles\_2014/Kristjansdottir\_AY2014\_FINAL.pdf

Kristjánsdóttir, K. R., Ólafsdóttir, R. & Ragnarsdóttir, K.V. (In Press). Reviewing integrative sustainability indicators for tourism. *Journal of Sustainable Tourism*. Manuscript accepted for publication.

Matilainen, A. & Keskinarkaus, S. (2010). *The Economic Role of Hunting Tourism – Examples from Northern Areas. Report 64*. The Icelandic Tourism Research Centre and 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

Metrass–Mendes, A. (2014). *Icelandic tourism profitability and sustainability strategies: The facilitating role of aviation - Final Project Report*. 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, EU

Miller, G. & Twining-Ward, L. (2005). *Monitoring for a sustainable tourism transition. The challenge of developing and using indicators*. CAB International

Newsome, D., Moore, S.A., & Dowling, R.K. (2013). Natural Area Tourism. Ecology, Impacts and Management (2nd Ed.). Channel View Publications

The Nordic Council (2014). *TemaNord 2014*:568 http://sdwg.org/wp-content/uploads/2015/02/ASI-II.pdf

The Northern Periphery Programme (2016). Retrieved from http://www.interreg-npa.eu/ 20160109

Ólafsdóttir, R., Kristjánsdóttir, K. R., Bjarnadóttir H. J. & Bragason, Á. (2009). *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): 1–17.

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 Lockie, S., Higgins, V., Lawrence, G. (Eds.), *Environment, Society and natural resource management: Theoretical perspectivesfrom Australasia and the Americas*. Northampton: 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

Reynisdottir, M., Song, H.& Agrusa, J. (2008). Willingness to pay entrance fees to natural attractions: An Icelandic case study. *Tourism Management 29*(6): 1076–1083

Rögnvaldsdóttir, L. B. (2014). *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*. Master thesis University of Algarve, Faculty of Economics

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

Simpson, M.C. (2009). An integrated approach to assess the impacts of tourism on community development and sustainable livelihoods. *Community Development Journal, 44*(2): 186–208

Sinclair, A. J, Diduck, A. P. & Vespa, M. (2015). Public participation in sustainability assessment: essential elements, practical challenges and emerging directions. In Morrison-Saunders, A., Pope, J. & Bond, A. (Eds.) *Handbook of Sustainability Assessment*. UK/USA: Edward Elgar Publishing

Snyder, J.M. (2007). *The economic role of Arctic tourism. In Prospects for Polar Tourism*. In Snyder, J. M. & Stonehouse, B. (Eds.). Channel View Publications

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 Iceland (2014). *Störf í ferðaþjónustu 2000 – 2009*. Employed in tourism 2000–2009. Retrieved 18072014 from www.statice.is

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*: 381–392

Van Houtte, M. (2015). *Sustainable tourism management in protected areas using a systemic approach, A case study from Þingvellir National Park, Iceland*. M.Sc. thesis, Faculty of Life and Environmental Sciences, University of Iceland. Available at http://hdl.handle.net/1946/21992

Vatnajökull national park (2016). *Education and interpretation. About Vatnajökull National Park.* Retrieved 03022016 from http://www.vatnajokulsthjodgardur.is/english/education/

Vester, F. & Hessler, A. (1982). Sensitivity model. Frankfurt Main: Umlandverband Frankfurt

Vester, F. (2012). *The art of interconnected thinking. Tools and concepts for a new approach to tackling complexity*. 2nd Revised Impression. Malik management

Vik, M. L., Benjaminsen, T. A. & Daugstad, K. (2010). Synergy or marginalization? Narratives of farming and tourism in Geiranger, western Norway. *Norsk Geografisk Tidskrift - Norwegian Journal of Geography 64*: 36–47

World Tourism Organization (1996). *What tourism managers need to know: A practical guide to the development and use of indicators of sustainable tourism*. Madrid: WTO

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

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

**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 | - |
| 1. Societal seasonality | - | 1 | 1 | 1 | - | 1 | - | 1 | 0,5 | 0,5 | 0,5 | 1 | 1 | 0,5 | - | 1 | 1 | - |
| 1. 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 |
| 1. Stakeholder involvement | 1 | 1 | - | 1 | 1 | 1 | 1 | 0,5 | 0,5 | 1 | 0,5 | 1 | - | - | 0,5 | 0,5 | 1 | - |
| 1. Employment | 1 | 1 | 0,5 | 0,5 | - | 0,5 | 1 | 1 | 0,5 | 1 | 0,5 | 1 | 1 | - | 1 | 1 | 1 | 0,5 |
| 1. Population decline | - | 1 | 1 | 1 | - | 1 | 1 | - | 0,5 | 0,5 | - | 0,5 | 0,5 | 0,5 | - | 1 | 1 | - |
| 1. 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 |
| 1. Implementations of policies and cooperation projects | 1 | 1 | - | 1 | 1 | 1 | - | - | 0,5 | 1 | 1 | 1 | 1 | 0,5 | 1 | 1 | 1 | - |
| 1. Capacity to accommodate tourists | 1 | 1 | 1 | 1 | - | 1 | 1 | 1 | 0,5 | 1 | - | 1 | 1 | - | 1 | 0,5 | 1 | - |
| 1. Community learning | 1 | 1 | - | 1 | 1 | 1 | 1 | - | - | 1 | - | - | - | 0,5 | 1 | 1 | 1 | 0,5 |
| 1. Integration of sustainability goals | - | - | 0,5 | - | 1 | 1 | 1 | - | 0,5 | 1 | 0,5 | 0,5 | 1 | 1 | 0,5 | 0,5 | 1 | - |
| 1. Trail condition | 1 | 1 | 1 | - | 1 | 1 | 0,5 | 1 | - | 1 | 0,5 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| 1. Ecological carrying capacity | 1 | 1 | 1 | - | 1 | 1 | 0,5 | 1 | 1 | 1 | 1 | 0,5 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1. Destination attractiveness | 1 | 1 | 1 | 1 | 1 | 1 | 0,5 | 1 | 0,5 | 1 | - | 1 | 0,5 | 1 | 1 | 1 | 1 | - |
| 1. Environmental management performance | - | 0,5 | - | 1 | 1 | 0,5 | 0,5 | 1 | 1 | 1 | 1 | 1 | - | - | - | 1 | 1 | - |
| 1. Seasonal environmental pressure | 1 | 1 | 1 | - | 1 | 0,5 | - | 1 | 1 | 1 | 0,5 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| 1. Local economy | 1 | 1 | 1 | 1 | - | 0,5 | 0,5 | 1 | 1 | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 |
| 1. 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 |  |  |