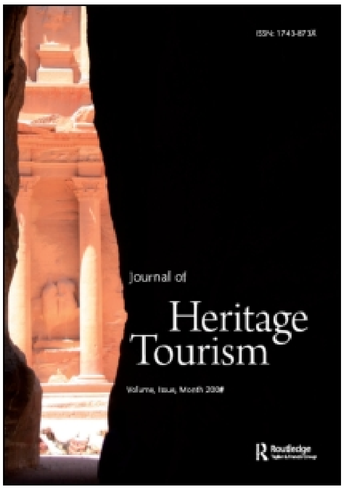

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Nature tourism assessment in the Icelandic Master Plan for geothermal and hydropower development. Part II: assessing the impact of proposed power plants on tourism and recreation

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Nature tourism assessment in the Icelandic Master Plan for geothermal and hydropower development. Part II: assessing the impact of proposed power plants on tourism and recreation

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The Icelandic government is carrying out a project called Master Plan for geothermal and hydropower development where all major potential hydropower and geothermal power plant projects in Iceland are being evaluated and ranked. One part of the project is presented here, the effect of power plants on tourism and recreation. The impact of the proposed power plant is considered to depend on both the present value of the affected region and the impact on the region. To get a single score for the impact that takes into account both these factors, the so-called impact coefficient is defined. It is obtained by multiplying the present value of the tourism region with the impact the power plant has on the region. The impact coefficient for a particular power plant is computed as the sum of the impact coefficients for all regions affected by the plant. The impact coefficient is the highest in valuable tourist areas where the impact is large and where the affected area covers many tourism regions. The results show that wilderness areas are very sensitive to power plant developments and that the largest effects would be in wilderness areas which are already of great importance for tourism and recreation.

Keywords: power plants; impact assessment; nature tourism resources; wilderness; highlands; planning

Introduction

Industry's demand and competition for natural resources, including for nature tourism, is increasing in high-latitude regions (Hall & Saarinen, 2010). Decisions as to how to exploit resources often requires complex economic, environmental, social and political policy-making and their utilization has to be carefully planned for them to be sustainable (Hall, 2008, 2010).

The current mainstays of the Icelandic economy are renewable natural resources: rich fishing grounds, hydro- and geothermal power, pasture land, and nature, on which the Icelandic tourism industry is based. Tourism accounts for 13% of the country's total exports (Statistics Iceland, 2010a), with over 88% of foreign summer visitors coming to experience its natural environment (Rögnvaldur Guðmundsson, 2010).

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An important part of this natural attraction is the interior of Iceland, called the highlands, which covers about 40% of the country. The landscape is very diverse and unusual, with wide open spaces, lava fields, deserts, mountains, ice caps and geothermal areas. The highlands are uninhabited with little visible evidence of human influence except in few areas that have been developed for power production and some jeep tracks and huts for travellers. The area is an important resource for tourism as about 40% of all foreign visitors who come to Iceland in the summer go there (Capacent Gallup, 2008).

Aluminium and some other products of the power-intensive industry are also important for the Icelandic economy, and their share in export has increased from 10% to 24% since 1990, while the share of seafood has declined from 56% to 27% (Statistics Iceland, 2010a). Electrical power produced by hydro- or geothermal power plants accounts for 82% of all energy used in Iceland. About 80% of that is used by heavy industries (Statistics Iceland, 2010b). Worldwide the demand for green energy is steadily increasing and recently international corporations have started investing in the Icelandic power sector, a development encouraged by the previous right wing liberal government, but less favoured by the present left wing coalition. While the emphasis is on traditional users such as aluminium smelters, other uses are being considered and recently the idea of a submarine cable connecting Icelandic to the European energy market has been revisited (Landsvirkjun, 2010). Power plants require land and in recent years as new large power plants have risen, land-use conflicts have increasingly occurred between the interests of power production and nature conservation. This has resulted in public demonstrations, acts of sabotage and court actions which are costly and time-consuming (Benediktsson, 2008; Thórhallsdóttir, 2007a, 2007b).

In 1999, the Icelandic government led by the Ministry of Industry, Energy and Tourism in co-operation with the Ministry for the Environment started a project called 'Master Plan for geothermal and hydropower development' (Rammaáætlun um nýtingu vatnsafls og jarðvarma), where all large potential power plant projects are being evaluated and ranked. Most of the work has been carried out in four workgroups, each considering a specific aspect of the project, one of them evaluating the impact of power plants on tourism and recreation. The group developed a generic methodology to evaluate the value of nature tourist destinations (Sæþórsdóttir & Ólafsson, 2010d). This paper extends that paper and presents the methodology developed to evaluate the impacts of the proposed power plant projects on tourism and recreation, as well as the ranking of the power plant projects according to their impacts.

The Master Plan for geothermal and hydropower development

Approximately, 10% of the hydropower that is technically feasible to harness in Iceland has already been exploited and it is estimated that it is economically feasible to utilize about half of what is left (Steingrímsson, Björnsson, & Adalsteinsson, 2007). All the large hydropower plants are at the edge of the highlands, mostly in the southern part, with one in the northwest and one in the northeast (Figure 1). So far geothermal power plants have only been built in the lowlands, but since some of the most powerful geothermal areas in Iceland are located in the highlands, there are plans for building power plants too (Rammaáætlun, n.d.). Unexploited geothermal energy is considered to be a thousand times more than what is now being utilized (Steingrímsson et al., 2007).

In 1998, the Icelandic government put forward an action plan for sustainable development where one of the goals was to make a long-term plan for the utilization of natural energy resources (Umhverfisráðuneytið, 1997). Following that it was decided by the government to develop a master plan for the utilization of the geothermal and hydropower

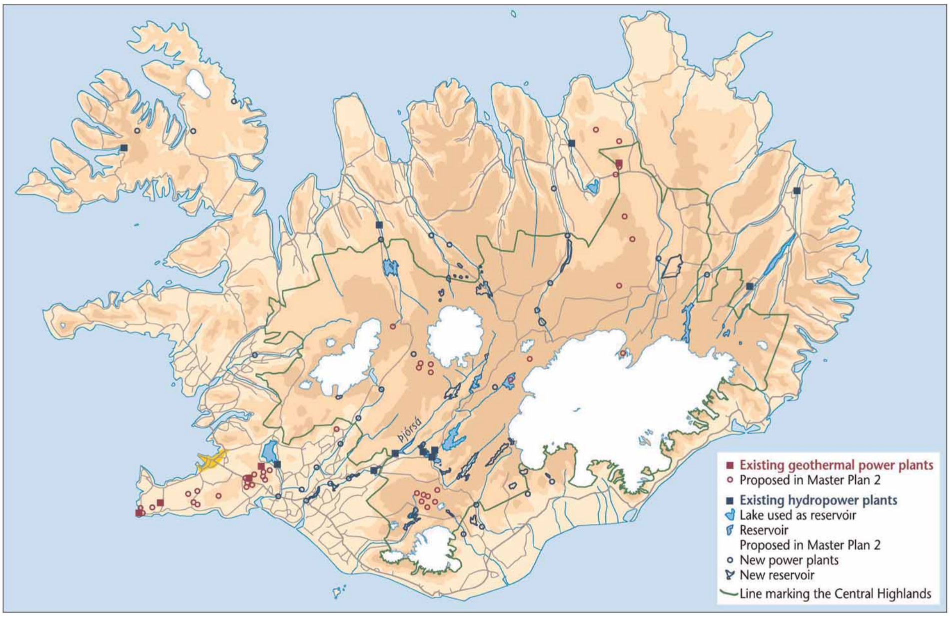

Figure 1. Location of existing and proposed power plants.
Source: Rammaáætlun (n.d.). Previously published in Sæþórsdóttir (2010b) (published with permission).

resources. The objective of the master plan project is to integrate utilization and conservation policies and improve the planning process by identifying weaknesses and deficiencies in decision-making at an early stage in the planning process which should lead to a greater consensus on the harnessing or protection of the natural resources in the country (Rammaáætlun, n.d.).

The Norwegian Master Plan for Water Resources was partly used as a model for the Icelandic Master Plan (Carlsen, Strand, & Wenstöp, 1993; Samlet Plan for Vassdrag, 1984). The Norwegian project was first completed in 1984, but revised since and is one of a few examples of a comprehensive analyses of the impacts of large-scale developments like power plants at a national level (Thórhallsdóttir, 2007a, 2007b).

The master plan in Iceland was jointly initiated by the Ministry of Industry and the Ministry for the Environment and is lead by a special Steering Committee. The project was split into two phases: Phase 1 that ran from 1999 to 2003 (Steingrímsson et al., 2007; Thórhallsdóttir, 2007a, 2007b), and Phase 2 that ran from 2004 to 2010. After Phase 1 was completed, the working methods used were re-evaluated and additional research conducted in fields where the need was felt to be the greatest (Rammaáætlun, n.d.). However, no new research was conducted on tourism and recreation despite the fact that very limited research has been performed in these fields in the regions that are under evaluation in the Master Plan (Sæþórsdóttir & Ólafsson, 2010c).

Most of the work in the Master Plan was carried out in four workgroups that evaluated the effects of the proposed power plants on various subjects and ranked them according to their impact:

- Workgroup 1 evaluated the impact on nature, landscape, geological formations, vegetation, flora, and fauna, as well as on cultural heritage.

- Workgroup 2 evaluated the impact on tourism, outdoor activities, agriculture, fishing, and hunting. (two of its members are the authors of this paper);
- Workgroup 3 evaluated the impact on economic activity, employment, and regional development.
- Workgroup 4 identifies potential power projects, both hydro- and geothermal, and carries out technical and economic evaluations (Rammaáætlun, n.d.).

In this paper, the work of Workgroup 2 on tourism and recreation is presented. How the results were later combined with the impact on agriculture, fishing, and hunting is described in Sæþórsdóttir & Ólafsson (2010c). The findings of all the workgroups will be compiled by the Steering Committee which will rank all the projects on the basis of their overall feasibility. The workgroups finished their job in early 2010 and the final results from the Steering Committee should be available by end of 2010.

In Phase 1 of the Master Plan, tourism and recreation were placed in separate workgroups. Recreation was in Workgroup 2 along with farming, fishing in rivers and lakes, and hunting, but the tourist industry in Workgroup 3 with business and social affairs. This was changed in Phase 2 and the work on tourism and recreation was combined in Workgroup 2. Due to this changed arrangement and the fact that in Phase 1 Workgroup 3 had not accomplished to develop a methodology to evaluate the impacts of power plants on tourism, it was decided in Phase 2 to develop a methodology for evaluating the impact of the proposed power plants on tourism and recreation.

In Phase 1, about 40 projects were evaluated and in Phase 2 over 40 new projects were added to the list, so in Phase 2, a total of 84 proposed power plant projects were evaluated. Of these 44 are geothermal, 20 of them in the highlands, and 40 hydropower, 24 of them in the highlands (Rammaáætlun, n.d.). All places where hydro- and geothermal energy can be found in large enough volume for it to be economically exploitable are under investigation in the Master Plan (Figure 1). This includes all major rivers and geothermal areas, protected areas, and national parks.

Information about the 84 power plant project proposals varied considerably. Some of the plans were new and complete and had even gone through the entire process of environmental impact assessment, while other plans were old with limited information. Due to that, Workgroup 2 did not evaluate all of the proposed power plant projects in Phase 2. In some cases, the location of the proposed plant was unclear. In total, 62 projects were evaluated by Workgroup 2.

Assumptions

As Iceland's main tourist attraction is nature, and as the majority of the proposed power plant projects are in environments with a high degree of naturalness, the development of the methods and evaluation mainly focuses on nature tourism. As over half of the power plant projects are in the highlands of Iceland, in an area where visitors consider unspoilt wilderness to be the most important component of their experience, and where the wilderness and intact nature are most sensitive to construction, the main emphasis when developing the methodology was on including those elements. For a more detailed description of nature tourism in Iceland, see Sæþórsdóttir (2010a). Wilderness tourism and the effects of power plants on visitors' experience is described in Sæþórsdóttir (2010b), and theoretical argumentation on evaluating the value of tourist destinations is to be found in Sæþórsdóttir and Ólafsson (2010d).

Although some broad indications regarding the importance of nature and wilderness for the tourism industry are given in the official Icelandic tourism strategy plan (Alþingistíðindi

2004–2005 A 6, 2005), the tourism industry in Iceland has not put forward any plans or wishes for land use, nor decided which target groups it wants to attract to various areas. The evaluation should have been built on such information, but since it did not exist, the workgroup decided to evaluate the impact of the power plants according to how the plants would affect the current market segment in each region, that is, it assumed similar use as is now the case.

The workgroup also used as guidelines the Central Highlands Regional Plan (Umhverfisráðuneytið & Skipulagstofnun, 1999), where the declared goal is to keep wilderness areas as far as possible free from man-made intrusions and infrastructures. Required infrastructures should as far as possible be built in designated structure belts, so as not to unnecessarily disturb wilderness areas. Other guidelines come from the National Strategy for Sustainable Development (The Ministry for the Environment in Iceland, 2002, p. 40), where one of the objectives regarding wilderness conservation is that 'Large areas of wilderness should remain untouched in Icelandic uninhabited areas. Man-made structures should preferably be built outside of defined wilderness areas'.

The visual impact of hydropower plants is very unlike that of geothermal power plants. Hydropower plants comprise dams, canals, power lines, reservoirs, and large buildings housing the turbines and transformers. They often alter the neighbouring environment and natural heritage values a great deal, as when waterfalls disappear or diminish, rivers and canyons become dry, and vegetation disappears under the reservoirs.

The geothermal power plants require large buildings for turbines and steam separators, the drill holes are noisy and steaming and are connected to the main buildings by pipelines that stretch between the drill holes and the plant. In addition, the geothermal areas, which are characterized by colourful boiling ground and steaming geysers, can be damaged and made less interesting to observe, both when buildings are erected there and when the geothermal activity of the area is altered.

Power plants are accompanied by electrical power lines and their visual impact is massive, especially in wilderness areas, as the land in the highlands is very barren and there are no trees to conceal the masts. The location of power lines needed to connect the plants to the national grid has for most projects not been determined exactly, but rough estimates were provided. This information was not always trustworthy and often it seemed that straight lines had simply been drawn to the nearest existing network point without considering minimizing the effect the lines would have on the environment.

The location, quality, and type of roads required for the building and operation of the power plants were in many cases not clear, so the workgroup had to make realistic assumptions about what would be required of those kinds of infrastructure. Despite the fact that road-making and building of bridges has for a long time been the basis for travels in the highlands, it can no longer be taken for granted that better roads and more bridges in the highlands and other nature destinations are beneficial for tourism and recreation (Sæþórsdóttir, 2004, 2009a). Due to that, the group did not automatically give higher scores for new or better roads in their evaluation (see step 3 in the evaluation process in the next section).

The evaluation process of the impact of potential power plants projects on tourism and recreation

The process of evaluating the effect of a potential power plant project on tourism and recreation was divided into five steps (Figure 2) and is outlined in the following sections.

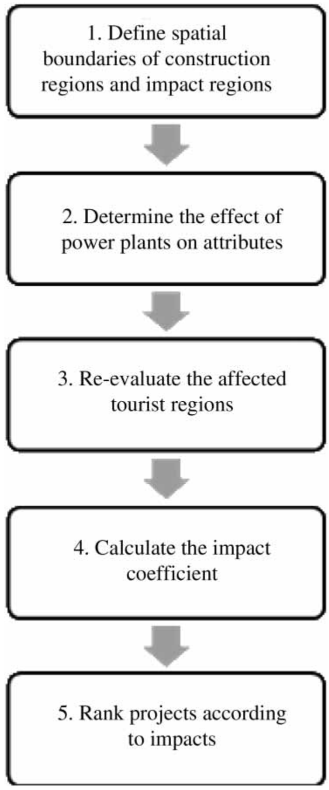

Figure 2. Working process when determining the impact of potential power plants on tourism and recreation.

When the *value* of tourist destinations was evaluated (see Sæþórsdóttir & Ólafsson, 2010d), the first step was to determine the area that would be affected by the proposed power plants and divide it into the so-called tourism regions. Fifty-seven regions were identified covering approximately half the country. Then, a generic methodology was developed to evaluate these regions. This involved systematically evaluating the value of 43 attributes that are important for tourism and recreation. A five-point scale with scores given on the scale: 10, very high value; 6, high value; 3, some value; 1, little value; and 0, no value. In this way, a value was found for each region after which the regions could be ranked (see Sæþórsdóttir & Ólafsson, 2010d).

Step 1. Define spatial boundaries of construction regions and impact regions

The first step in the process of evaluating the *effects* of power plants on tourism and recreation (Figure 2) is to define two kinds of regions: *construction regions* and *impact regions*. The construction region is defined as the area where the various constructions belonging to the power plant would be situated, that is buildings, lagoons, dams, canals, drill holes, platforms, and pipes. A part of the construction area is also the region affected by noise pollution, for example, from drill holes, and the areas affected by the roads required by the construction of the plant, and the high-voltage power lines, which often have to be built over long distances to reach the national distribution network. Because of the barren wilderness landscape in the highlands, the visual impact of constructions can be extensive. Due to its characteristics, tourism will be affected in an area larger than just the construction region. This area is called the *impact region* and its size depends on two factors. First, it depends on the travelling patterns of visitors and the transportation system in the region, as tourist often travel through the construction region of a power plant on their way to other destinations and are then affected by the plant. Second, hydro-power plants often alter the amount of water in rivers, and waterfalls can then be reduced or can even disappear, thereby affecting tourists' experience. The impact region can therefore be considerably more extensive than the construction region.

Steps 2 and 3. Determine the effect of power plants on attributes and re-evaluate the affected tourism regions

When estimating the impact of power stations, the same methodology (attributes, score values, and rating) was used when assessing the present value of the tourism regions (see Sæþórsdóttir & Ólafsson, 2010c, 2010d). All attributes in each tourism region were evaluated in the same way as before except now as *if* the power station had already been built. Generally, the power plant projects affected the attributes connected with wilderness and naturalness but did not necessarily affect other attributes. As an example, the region Hveravellir scored 10 for the attribute *naturalness*. If a geothermal power station would be built, the value of the attribute would fall to 1. The plant would contain large buildings for turbines and steam separators, noisy drill holes and pipelines would stretch between them and the plant. Furthermore, approximately 60 km long power lines would stretch to the north, through the tourism region Auðkúluheiði to the closest existing power line system (Figure 3). The neighbouring tourism regions Hagavatn, Gullfoss, Geysir, Kerlingarfjöll, and Eyvindarstaðarheiði would lie inside the impact region as all those regions are connected by the tourist travelling pattern. In these regions, the value of the attribute *naturalness* also decreases, but less than in Hveravellir.

The impact of developments was considered to be more severe in wilderness areas than in already developed areas. Þórisvatn, where there are already some hydropower plants, scored 3 for the attribute naturalness, but after the addition of one more hydropower plant, which would reduce the flow in a beautiful waterfall and add a new highly visible power line, its score falls to 1, i.e. the proportional deterioration there is considered to be less than in tourism regions in the wilderness undisturbed by power plant developments.

When a development is expected to disturb the homogenous or unique aspect of the region or it is considered probable that it would change the appearance of the landscape, those grades were lowered. Other attributes in the sub-category physical properties and the attributes beauty and magnificence are handled in a similar way.

If the proposed power plant lies within a protected area the value of the attribute falls down to 0 after the energy developments. However, if the power plant is not within the actual protected area, but in the same tourism region as the protected area, the score of the tourism region goes down one category.

The value of the attribute tourism carrying capacity increases if the number of tourists is severely reduced due to the development. This would be the case if, for example, the quality of the attraction in the area is reduced. However, the number of visitors is likely to increase if new roads open up an area while the attraction is more or less intact. In that case, the toll on the environment can be expected to increase and consequently the value of the attribute goes down. If the developments are expected to affect the image of a region, the score of that attribute falls.

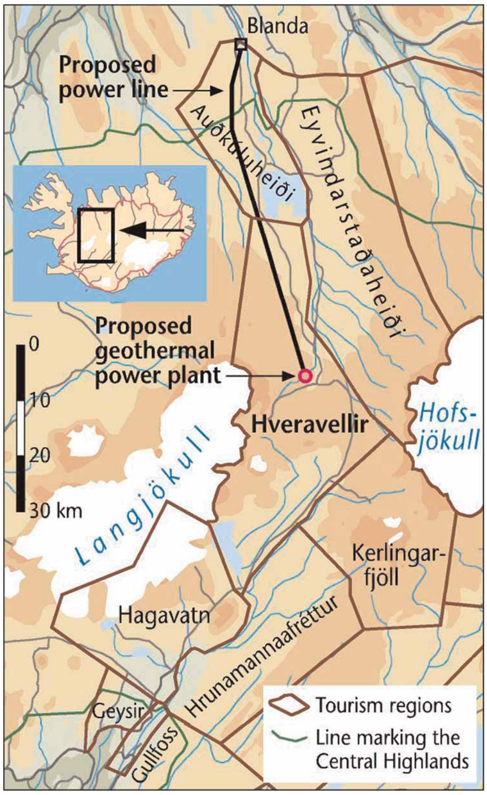

Figure 3. The construction region and the impact region of the proposed geothermal power plant at Hveravellir in the heart of the highlands. The geothermal power plant at Hveravellir would not only affect the tourism regions Hveravellir and Auðkúluheiði (the construction region), but also the regions Hagavatn, Gullfoss, Geysir, Kerlingarfjöll, and Eyvindarstaðarheiði. Together these regions make up the impact region.

The impact on recreational opportunities is evaluated in a similar way. Walking tours often pass through several tourism regions and the effect of development on such tours can be reflected in lower grades for that attribute in many tourism regions within the impact region. The same applies to riding tours, mountain biking and super jeep tours. When the flow of rivers is reduced, the opportunities for river rafting are affected and the score for the attribute is consequently lowered. At many of the existing power plants in Iceland, visitor centres have been built. The workgroup did not consider that more of those kinds of visitor centres would improve or strengthen tourism in Iceland, and as none of the descriptions of the proposed plants mentioned that visitor centres would be built, no scores were given for the attribute visitor centres after the building of a power plant.

Impacts on infrastructure can be of two kinds. Infrastructure can be destroyed, e.g. when a reservoir would cover 4×4 tracks. Although new roads can be made instead on dams or along the reservoirs, they are not considered to substitute the 4×4 tracks. In these cases, scores for 4×4 tracks would go down to 0 (the same holds for recreational driving on 4×4 tracks), but scores for ordinary cars go up to 10. Infrastructure can be improved when new roads are made to an area which until then was not accessible for motorized vehicles. Power plant construction requires the transportation of heavy equipment and as the present 4 × 4 tracks are not sufficient for that kind of traffic better roads have to be built. This leads to the same result, that is, higher scores for the attribute ordinary cars but lower for jeep tracks. Although the description of the developments seldom specified this kind of infrastructure, the group assumed that new or better roads would be built where they would obviously be needed.

Even though increased accessibility usually leads to more visitors, this was not necessary so here. In some cases, the power plant development destroys the principal attraction of a region, and in that case, it is assumed that the number of tourists will decrease. In regions where the development can be expected to reduce the attraction of the region, the score for tourist service was decreased. Developments do not affect distance from the market and therefore the score for that attribute is not altered by power plant developments.

Power plants can affect the travel pattern of visitors as in the case when tracks disappear under reservoirs as mentioned above, or when visitors change their usual travel pattern in order to avoid areas where nature has been damaged. That would, for example, be the case for the proposed power plant Markarfljót B. There an important and popular 4 × 4 track would disappear under the reservoir and it would be difficult or impossible to find an alternative location for the track. The reservoir would also reach up to Iceland's most popular long-distance hiking route, Laugavegur, which would presumably decrease its popularity considerably. Some of the less known walking routes in the area would disappear completely. The same would happen to popular riding routes that pass through the region. The energy developments at Markarfljót would thus change travel patterns extensively and impact and diminish considerably the tourist experience in a vast area in the Torfajökull tourism region, as well as in the neighbouring regions.

Where the power plant developments can be expected to reduce the quality of the attraction to the extent that it would cause people to stay for a shorter time in the region, the score for that attribute was lowered. Similarly, development can cause people to be less likely to return and then the score for that attribute was lowered. The last attribute to be evaluated was future possibilities where the main consideration was whether the power station affects the future possibilities of tourism and recreation. Finally, when all the attributes had been re-evaluated for all tourism regions in the impact region of the proposed plant, the new value of the tourism regions, as it would be after the construction of the proposed plant, was calculated.

Step 4. Calculate the impact coefficient

When the value of the tourism regions after the construction of the proposed plant has been found, the total impact of the plant is computed. The change in the value of the tourism regions due to the development is found by subtracting the original value of each tourism region from the value it is expected to have after the power plant has been built. Damage to valuable regions is considered more serious than to less valuable regions, consequently the impact is considered to depend on both the present value of the affected region and the impact the power plant has on the region. To get a single score for the total impact of a plant that takes into account both these factors, the so-called impact coefficient is defined. It is obtained by multiplying the present value of the tourism region with the impact the power plant has on the region. The impact coefficient for the power plant is then computed as the sum of the impact coefficients for all regions affected by the plant, that is, by the sum of the impact coefficients of all the tourism regions within the impact region of the plant.

Example:

Hagavatn power station.

Its impact region extends over four tourism regions Hagavatn, Hveravellir, Hrunamannaafréttur, and Gullfoss (Figure 3):

Hagavatn: value 7.38. Value after the developments 3.28. The reduction is 4.10. The impact factor is: $7.38 \times 4.10 = 30.26$.

The energy developments also affect:

Hveravellir: value 9.58. Value after the developments 8.60. The reduction is 0.98. The impact factor is: $9.58 \times 0.98 = 9.39$.

Hrunamannaafréttur: value 5.85. Value after the developments 5.61. The reduction is 0.24. The impact factor is: $5.85 \times 0.24 = 1.40$.

Gullfoss: value 9.18. Value after the developments 8.33. The reduction is 0.85. The impact factor is: $9.18 \times 0.85 = 7.80$.

The *impact coefficient* (the total impact of the proposed plant) is accordingly $30.26 + 9.39 + 1.40 + 7.80 = 48.85$.

Rank according to impacts

The impact coefficient is utilized to rank the energy development ideas with regard to their effect on tourism and recreation. The coefficient takes values from 0 up to a couple of hundreds, where the highest number reflects the most damage (Table 1). It is highest in valuable tourist areas, in areas where the proposed power plant projects have a large impact, and where the impact region extends over many tourism regions.

Discussion

Over half of the proposed power plants evaluated in the project are in the highlands. Wilderness quality is based on primitiveness, naturalness, and remoteness (Hall, 1992; Hall & Page, 2006; Lesslie & Taylor, 1983) and the construction of power plants reduces these values. Research among travellers in the Icelandic highlands has shown that power plants have negative effect on their wilderness experience (Sæþórsdóttir, 2009a, 2009b, 2010b). Furthermore, the government has previously recognized wilderness as being of great importance and that 'wilderness should remain untouched in Icelandic uninhabited areas', as well as '…structures should preferably be built outside of defined wilderness areas' (The Ministry for the Environment in Iceland, 2002, p. 40). The workgroup therefore assumed that the largest and most controversial effects of the proposed power plants would be in the highlands and consequently the main emphasis was on capturing the effect on wilderness attributes.

The effects of power plant construction often stretch over large areas but are most serious in the construction region where many of the attributes in the experience category were downgraded when the proposed power plants are considered to affect natural features like waterfalls, or dry up hot springs. In the impact region, but outside the construction region a power plant project usually affects the attributes connected with naturalness and the size of the wilderness, but did not necessarily influence other attributes.

An attempt was made to capture these extended effects in one number so the proposed projects could be ranked as an impact coefficient. The impact coefficient takes into account the present value of all the affected tourist regions, as well as the new value of the regions as

Table 1. The ranking of proposed power plant projects with respect to their effect on tourism and recreation, with the most impacted at the top.

Proposed power plant	Type	Impact coefficient	Proposed power plant	Type	Impact coefficient
Torfajökull	G	211.31	Hagavatnsvirkjun	H	48.89
Markarfljótsvirkjun B	H	188.23	Bjallavirkjun	H	48.55
Markarfljótsvirkjun A	H	149.74	Brennisteinsfjöll	G	48.31
Askja	G	130.04	Grændalur	G	43.24
Hólmsárvirkjun m.miðl. Hólmsárlón	H	128.84	Austurengjar	G	41.50
Skaftárvirkjun	H	120.88	Sveifluháls	G	41.07
Arnardalsvirkjun	H	117.18	Þverárdalur	G	40.05
Bláfells- & Gýgjarfossvirkjun	H	113.37	Bitra	G	38.45
Vonarskarð	G	99.88	Ölfusdalur	G	36.12
Hólmsárvirkjun - án miðlunar	H	97.16	Villinganesvirkjun	G	34.37
Kverkfjöll	G	92.11	Tungnárlón	H	34.30
Helmingsvirkjun	H	86.48	Innstidalur	G	34.23
Fljótshnúksvirkjun	H	83.68	Norðlingaölduveita	H	32.97
Búðartunguvirkjun	H	79.36	Hvalá	H	30.04
Kerlingarfjallavirkjanir	G	78.92	Trölladyngja	G	29.88
Skaftárveita með miðlun í Langasjó	H	77.60	Sandfell	G	25.83
Hrafnabjargavirkjun A	H	76.60	Eldvörp (Svartsengi)	G	23.09
Hrúthálsar	G	75.64	Þeistareykir	G	22.87
Fremrinámar	G	73.34	Stóra Sandvík	G	16.37
Geysir	G	73.32	Hverahlíð	G	15.05
Skatastaðavirkjun B	H	69.08	Hvammsvirkjun	H	14.15
Hveravellir	G	66.31	Bjarnarflag	G	12.76
Gjástykki	G	66.17	Krafla I og II	G	11.93
Skatastaðavirkjun C	H	61.93	Gráuhnúkar	G	11.68
Skaftárveita án miðl. í Langasjó	H	61.13	Meitillinn	G	10.03
Búlandsvirkjun	H	60.79	Urriðafossvirkjun	H	6.13
Skrokkölduvirkjun	H	60.19	Reykjanes	G	3.41
Djúpá	H	59.91	Holtavirkjun	H	2.72
Hverfisfljót	H	57.87	Hellisheiði	G	1.97
Hólmsárvirkjun neðri	H	57.42	Blönduveita	H	0.53
Hágönguvirkjun	H	56.97	Búðarhálsvirkjun	H	0.00

Note: G, geothermal; H, hydropower.

it is assumed to be after the power plant has been built. Such an approach reinforces two of the principles of wilderness management put forward by Hendee, Stankey, and Lucas (1990), that is, the importance of managing wilderness as one extreme on the environmental modification spectrum, and the need to manage wilderness comprehensively, but not as separate parts.

In Iceland, the access roads that accompany new power plants frequently improve or open up access to areas which have until then been inaccessible or completely closed to motorized vehicles. In Iceland, this has hitherto been considered by some as a positive effect and used as an argument for power plants (Ólafsdóttir & Kristjánsdóttir, 2008). In 1968 and 1978, when large hydroelectric plants were built in the southern highlands this was certainly the case. The main roads were improved and asphalted and the tracks along the power lines opened up new areas and became quite popular for 4 × 4 tours. A destination where access increased enormously is Landmannalaugar in the southern highlands. It was remote and with limited access, but with better roads it became the most visited highland destination in Iceland. It is now only a 3 h drive from the capital city of Reykjavik and can be reached in an ordinary passenger car. As a result, the character of tourism there changed and according to a fifth of visitors, important features of the wilderness, as quiet and solitude, are becoming more difficult to find (Sæþórsdóttir, 2007, 2010a). Landmannalaugar was also most commonly mentioned by other highland visitors as the place to avoid due to the extent of tourism (Sæþórsdóttir, 2009a, 2009b). When accessibility suddenly increases, as when roads are built for power plants, previously remote areas can randomly be transformed into tourist destinations (Hall, 2006; Sæþórsdóttir, 2007). This kind of change in land use should not happen arbitrarily. In order to keep that from happening, a tourism land-use plan would be a helpful guide for development.

The roads that are built for the construction of power plants are asphalted, relatively straight, and built up above the landscape and therefore more obtrusive and quite different from the traditional highland tracks that wind through the landscape. The experience they provide is therefore very different and not what the majority of the existing market is looking for (Sæþórsdóttir, 2009a, 2009b). Better access not only leads to increased number of visitors, but it also changes the market group from purists to urbanists (see Sæþórsdóttir, 2004, 2010a). As tourist industry stakeholders rely on different markets and therefore have different interests with respect to access to the highlands and other remote nature areas, this can lead to conflicts. Super jeep safari companies will, for example, loose the foundation of their business if the roads are improved too much, and areas without roads are important for travel companies selling hiking tours.

An argument often heard in Iceland is that it should not be a privilege for owners of 4×4 vehicle to travel in the highlands as is the case now, and therefore good roads should be evaluated positively when assessing the value of regions for tourism. However, this is not in agreement with the principle that wilderness-dependent activities should be favoured in the wilderness (Hendee et al., 1990). In the Icelandic context, this principle would mean that the motorized activity practised in the highlands should be to drive around in a 4×4 vehicle or motor cross, but not drive in an ordinary passenger car, as that can be done everywhere else.

Visitor centres accompany many of the existing power plants in Iceland. Even though many visitors go there, they are not the same kind of attraction as Icelandic nature. None of the descriptions of the proposed power plant projects the workgroup was provided with mentioned visitor centres. Visitor centres in power plants are also a non-wilderness-dependent activity that is already practised in the lowlands. Therefore, the workgroup considered that visitor centres do not add to the attraction of tourism in the highlands and would gradually ruin the wilderness experience.

There are also differences as to what activities should be practised in the highlands, and what kind of facilities should be allowed there. For a tour operator with mass tourists as the main market group, a hotel in the wilderness could be a sellable product, but such a hotel could spoil the wilderness experience for the existing market as a result of the reduction of wilderness qualities (Sæþórsdóttir, 2010b).

The workgroup did not take a position as to whether the goal should be to manage the highlands biocentrically, that is, to emphasize the maintenance of natural systems, even at the expense of tourism if necessary, or anthropocentrically, that is, promoting the development of facilities that would increase aesthetic pleasure and facilitate wilderness use. Instead the workgroup evaluated the impact from the perspective of the existing market.

As in most analyses of tourism systems, it was not easy to define the spatial boundaries of the regions affected by each power plant project. In the highlands, the impact regions often turned out to be vast and stretched over many tourist regions. In order to capture this effect, the so-called impact coefficient was defined. The coefficient of a tourist region is obtained by multiplying the present value of a tourist region with the assumed reduction in value of the region that occurs when the power plant is built. The impact coefficient for a proposed power plant is then found as the sum of the impact coefficients for all tourist regions affected by the plant. Especially in the highlands, it was considered important for mobile features like tourism and recreation, to take into account impacts outside of the actual construction area as 'what goes on outside of, but adjacent to, a wilderness can have substantial impacts inside its boundary' (Hendee et al., 1990, pp. 190–191). Lesslie, Maslen, Canty, Goodwins, and Shields (1991, p. 20) points out that:

> . . .a development in lesser quality wilderness on the margin of an area of higher quality wilderness will reduce wilderness quality within the higher quality area. The lesson to be drawn from this is that areas of lower quality wilderness which fringe areas of high quality are important in maintaining these quality areas. In order to ensure protection of wilderness quality, a wilderness management area therefore must include all marginal areas.

When the proposed power plants were evaluated, the effects of each power plant were assessed separately and as if this plant was the only option going to be exploited. In many areas, this is not a realistic assumption and many of the proposed plants are located in the same area. If one or more of them were to be built, it is likely that the value of the regions remaining intact would increase and the impact of a later plant would therefore be higher than the model assumes. The work group did not try to evaluate the size of this effect but it is, for example, likely to be important in the vicinity of the capital area where many new geothermal power plants are planned. Another aspect of the positioning of power plants is that when a power plant is placed in an area already affected by power development, the impact of the new plant is less than it would have been if the plant had been placed in an undisturbed area. From the perspective of the maintenance of wilderness values, it is therefore better to concentrate developments in certain areas rather than spread them into intact regions.

The model did not manage to completely capture some factors. This became obvious during the last step of the evaluation (see Sæþórsdóttir & Ólafsson, 2010c). After Workgroup 2 had combined the impact on tourism and recreation with the impact on agriculture and hunting, it used the analytic hierarchy process (AHP)-stepwise analysis to compare the computed results with the opinion of the experts in the workgroup. The AHP procedure belongs to a group of methods of operational research that are employed in diverse types of multi-criteria decision analysis when the options have to be arranged concurrently by data and the opinions of the evaluators (Kiker, Bridges, Varghese, Seager, & Linkov, 2005).

The results from the AHP procedure, as well as the comparison with the results from the model computations are thoroughly described in Sæþórsdóttir and Ólafsson (2010c). Here they are only discussed with respect to differences in the results that describe in some way the quality of the model. The proposed power plants were ranked according to their impact both by the model and the AHP process and the ranking compared. Fifty-six per cent of the plants ranked in the same positions by both methods, or moved one to two positions up or down. Approximately a fifth of the plants did however shift three or more positions upwards. Approximately a fourth of the plants shifted downwards. However, those changes in rankings were not as large as the upward ones and were primarily a normal consequence of other plants being transferred upwards. When considering these changes it became obvious that the methodology did not sufficiently cover a few aspects, but after they had been taken into account the workgroup considered that the model and the AHP process basically gave comparable results. For example, the impact of the proposed Geysir geothermal plant was underestimated by Workgroup 2. The AHP-stepwise analysis placed the plant 12 positions higher than the model and in a more realistic position as the Geysir region is one of the most important tourist destinations in Iceland. Geysir is situated in the lowlands and is connected to important lowland tourist regions. Due to the fact that when developing the methodology the main emphasis was on the qualities of intact nature, the properties of lowland tourist regions were underestimated and Geysir would never have been rated as highly as the undisturbed nature regions in the highlands.

Another quality that the model did not reflect was the great value of completely unspoiled wilderness that is roadless areas without any infrastructure whatsoever as in the case of the Djúpá area. These features are extremely important for tourism, recreation, and biodiversity conservation now and in the future. Even though Workgroup 2 assigned high value to those attributes in the methodology, it was not sufficient to reveal the distinctiveness the group considers the Djúpá region to possess. In the AHP analysis, the workgroup was conscious of this uniqueness.

The Skagafjörður region is the Icelandic rafting Mecca, with the very best rafting rivers in Iceland and actually the only place that can offer 3 day rafting tours. The rivers there are therefore very important for tourism in Iceland and even more so for tourism in Skagafjörður municipality which is heavily dependent on the rafting business. One of the power plant proposals in Skagafjörður would make rafting there impossible and the other two would reduce it seriously, as they would make both the 3 day tour and the more demanding tour (grade 4+) impossible, leaving only the grade 2 tour. The model did not capture well enough the great importance of this activity, both regionally and nationally, and the power plant project Skatastaðir B was ranked 6 positions lower by the model than by the AHP process.

The proposed geothermal power plant at Gjástykki was ranked higher in the AHP process because of the region's future potential as a geopark and a very important region for geotourism in Iceland. Nowhere in Iceland can the mechanism of the continental drift be better observed.

These examples demonstrate well how the debate that occurred in the group during the AHP process managed to reveal a few weaknesses in the methodology. The workgroup was of the opinion that if there had been more time to develop the methodology and make more assessment trials, the methodology could have been refined and would then have given comparable results to the experts using the AHP method. However, the methodology has the great advantage that the assessment is built on traceable and objective systematic evaluation rather than just on the opinion of experts.

Conclusions

This paper introduced a method to assess the effect of large developments on natural area tourism and recreation in Iceland, in this case the impact of proposed power plants. It outlined the process of evaluating their effects on tourism and recreation resources. The model gives traceable, numerical results to the impact of each project so they can be ranked according to their impact. The model makes it easier to look at the spatial distribution and significance of tourism resources, looks at the big picture, and sets goals for the utilization of natural resources before projects come too far into the preparation stage. The model and the resulting ranked list of power plant projects should therefore be a very valuable tool for decision-makers, managers, and planners when making decisions regarding these large developments and the allocation of natural resources.

There is no standardized method for evaluating the effects of large developments on natural area tourism and recreation. The method demonstrated in this paper can be further improved, but so far the work shows that even the undertaking of imperfect research is useful when it makes mutual decision-making possible and helps resolving conflicts. Future research in the field should be directed towards developing a tourism land-use plan, where the results from this study are followed up by research on environmental and social tourism carrying capacity issues, visitor surveys, and analyses of present and possible market groups. The big challenge is to utilize the natural resources of the country in a sustainable way so they can support the Icelandic nation as well as the individual regional communities in the future.

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