Geoheritage (2014) 6:71–87
DOI 10.1007/s12371-013-0095-3

ORIGINAL ARTICLE

Geotourism and Geoparks—A Tool for Geoconservation and Rural Development in Vulnerable Environments: A Case Study from Iceland

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Received: 16 December 2012 / Accepted: 20 November 2013 / Published online: 7 December 2013

Abstract Iceland has a unique geology and a dynamic natural landscape which has long attracted a large number of tourists to the island. Owing to the dynamic geological processes which are still shaping the Icelandic landscape, combined with the country's raw nature, Iceland is often referred to as an open laboratory in geosciences. Geotourism and geoparks are relatively new concepts within tourism. However, both have grown rapidly over the past decade. Geotourism has evolved partially in response to the need to minimize the negative impacts of mass tourism in geologically and geographically situated tourist environments, whilst at the same time providing a catalyst for sustainable rural development. This paper attempts to assess the compatibility of geoconservation and rural development within geotourism by exploring the challenges and potential outcomes of the geotourism development in Iceland; by identifying and analysing the various potential outcomes of geopark development; and by proposing a strategic planning approach for sustainable geotourism planning and management in vulnerable environments. The results indicate nine distinctive sites for geopark development, each of which presents the major challenge of using geological heritage as a basis for informing the area's 'ABC' components such that both visitors and locals are given a holistic appreciation of the area based on an understanding of its geology. The results further emphasize the importance of sustainable management in geotourism development. Only when managed in a sustainable manner is geotourism likely to provide long-term improvements for developments in rural areas.

Keywords Geotourism · Geoparks · Geoconservation · Rural development · Sustainable tourism · Iceland

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Introduction

Within the field of tourism, geotourism and geoparks are two of the most recent concepts. According to Newsome and Dowling (2010) geotourism has developed to address the need to minimize the negative impacts of mass tourism at tourist sites based around geological and geomorphological attractions. They stress that its central goal is an emphasis on sustainable tourism development in primarily rural and natural environments. A geopark on the other hand is a tool for sustainable development as well as a global marketing concept. It is defined by UNESCO (2006) as a nationally protected area that contains a number of geological heritage sites of particular importance, rarity or aesthetic appeal, and is one element in an integrated concept of protection, education and sustainable development. For this reason, both geotourism and geopark may be seen as attractive tools for rural development in many peripheral areas facing emigration.

Iceland has a unique geology and a dynamic natural landscape which has long attracted international tourists to the island. Owing to the dynamic processes still shaping the Icelandic landscape, combined with the country's raw natural environment, Iceland is often referred to as an open laboratory in geosciences. The uniqueness of Iceland's geology lies in the fact that the country is part of the ocean rift system which is normally a suboceanic feature. It is a rare exception for the oceanic rift system to be above sea level, the prime cause being a hot spot or a plume of upwelling from deep within the mantle and associated high volcanic production (Steinþórsson

1986). Being a part of the ocean floor, the Icelandic bedrock is mainly of basaltic origin, something that is very rare in other countries, and being part of the mid-Atlantic ocean rift zone results in greater volcanic activity in Iceland than elsewhere. The country's location close to the Arctic Circle also makes glacial activities and formations very common. This combination of 'fire' and 'ice' has long been used as one of the major slogans in Icelandic tourism. As such, the whole country could easily be defined as a geopark. However, geotourism and geoparks are more of a regional development phenomenon and to date no country has been established as a geopark, in its entirety.

In recent decades, many peripheral regions have been subject to migration phenomena, losing their rural residents to urbanized areas. In Iceland, the rural areas now regard tourism as a viable way of reinforcing their economic development (e.g. PMO 2011). Over the course of the past decades, tourism has grown rapidly in Iceland from around 4,000 foreign visitors in 1950 up to 672,000 in 2012 (ITB 2013), which is more than double the country's population (Fig. 1). It is expected that the number of foreign visitors will reach one million in the near future (ITB 2012). With respect to this, it has been pointed out by Ólafsdóttir and Runnström (2009; 2013) that in fragile geo- and ecosystems such as those which characterise Iceland, the impact of a high volume of tourism can easily cause severe damage if it is not properly managed. Subsequently, this adverse impact can bring about a decrease in visitor satisfaction leading to a decline in the number of visitors to a given area. This paper attempts to assess the compatibility of geoconservation and rural development in geotourism development firstly by exploring the challenges and potential outcomes of geotourism development in Iceland; secondly by identifying different possibilities for geopark development in Iceland; and thirdly by proposing a strategic planning approach for sustainable geotourism planning and management in vulnerable environments.

Concepts and Definitions

Geotourism

Geotourism and geoparks are among the newest concepts within tourism. However, both concepts have developed rapidly over the past decade and become widely known (Dowling 2010, 2011). One of the most recent definitions is given by Newsome and Dowling (2010, 3) defining geotourism as "a form of natural area tourism that specifically focuses on landscape and geology. It promotes tourism to geosites and the conservation of geodiversity and understanding of Earth sciences through appreciation and learning. This is achieved through independent visits to geological features, use of geotrails and viewpoints, guided tours, geo-activities and patronage of geosite visitor centres". According to Dowling (2009; 2011) geotourism can occur in a range of environments, from natural and wild to constructed and planned and comprise both independent travellers and tourist parties. Such tourism is simply based upon geoheritage conservation through appropriate sustainability measures. Dowling (2009) stresses that the key aspect of geotourism is that it involves all of the wider aspects of tourism activity such as transport, access, accommodation, services, planning and management. Thus, geotourism makes a positive contribution to rural development while simultaneously expanding the tourism sector as a whole. Geotourism is, above all, a sustainable form of

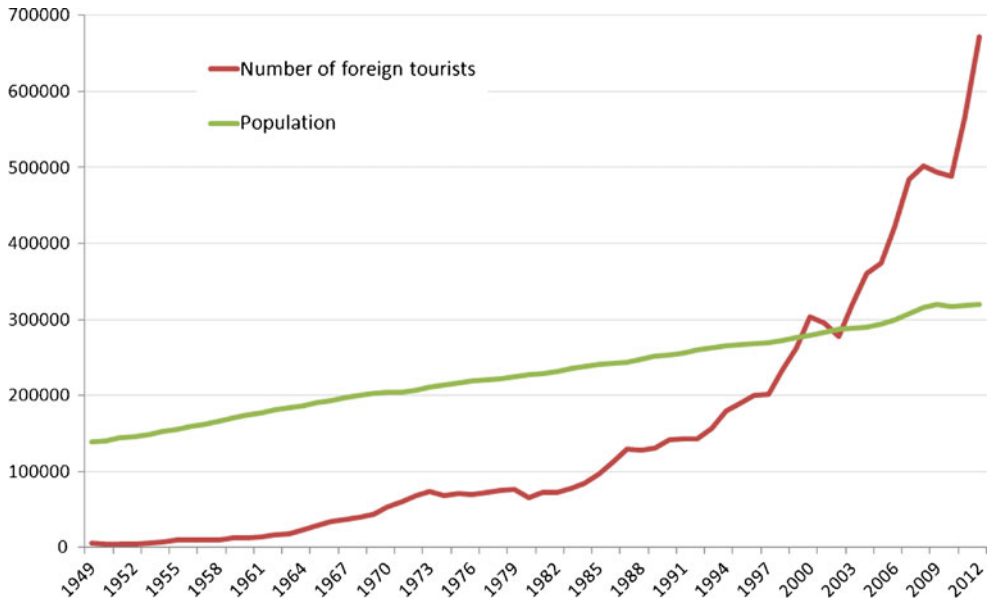

Fig. 1 Foreign tourists to Iceland 1949–2012 and Icelandic population respectively (source: Statistic Iceland 2013; Icelandic Tourist Board, 2013)

tourism and has the potential to contribute economic benefits for local communities (Dowling and Newsome 2006).

Geoparks

A geopark is a territory with a particular heritage of international significance, not only from a geological standpoint; it may also be significant for archaeological, ecological, economical, historical and cultural reasons. In a geopark, all of these aspects should be linked in a sustainable territorial development strategy (e.g. McKeever et al. 2010; Cimermanova 2010). Geoparks are usually established by local communities who want to develop sustainable tourism in their region allied to a global marketing concept or brand. Once an administrative group is set up, it then begins to establish a geopark which is recognised by UNESCO as an 'Aspiring' Geopark (Table 1). Such parks are then reviewed by the National Geopark Committee of that country, an autonomous body representing all of the geoparks situated within it. A number of countries are currently in the process of establishing, or have already established, national facilities (e.g. Brazil, Canada, Chile, China, Italy, Germany, Iceland) indispensable for the coordination of geoparks at national level and the submission of candidates for the Global Geoparks Network (www.unesco.org). The members of the National Geopark Committee represent:

- Governmental bodies dealing with sustainable development, geological heritage, tourism, environmental and cultural protection
- Global Geopark Network (GGN) members
- National geoparks
- Earth scientists with an interest in geoheritage
- Tourism and development experts

Aspiring geoparks usually seek to become recognised as one of the national geoparks of that country. National geoparks are endorsed by a country's National Geoparks Committee. Usually, the National Geoparks Committee will then work with individual geoparks to apply for global status. When this happens, the geopark in question is assessed by UNESCO. The GGN Secretariat at UNESCO Headquarters coordinates the candidatures and is ready to provide advice (www.unesco.org). Before submitting a dossier for membership of the GGN, the candidate must first have made contact with the GGN Secretariat to express interest. Before the submission of any dossier, there needs to be evidence of a de facto existing geopark. It is not possible to accept candidates on the basis of mere plans for the development of a geopark, which only exist on paper. Furthermore, the aspiring geopark must ensure that the relevant national bodies have been informed (e.g. the National Geopark Committee, relevant governing bodies) and that their application for membership of the GGN is in accordance with national regulations.

Table 1 Levels of geoparks

No	Level	Icelandic example
1	Aspiring	Reykjanes Geopark
2	National	Katla Geopark
3	Regional, e.g. European	Katla Geopark
4	Global	Katla Geopark

The terms used in the Levels of Geoparks are from the Global Geopark Network. The Iceland examples include Reykjanes, an aspiring Geopark, and Katla, Iceland's first Geopark which is now part of the European Geoparks Network [EGN] and was admitted as a member of the Global Geopark Network [GGN] in 2011

A Global Geopark is a unified area with geological heritage of international significance and where that heritage is being used to promote sustainable development of the local communities who live there (UNESCO 2012a). The Global Geopark brand is a non-statutory label denoting quality, and while it is not a legislative designation, the key heritage sites within a geopark are protected under local, regional or national legislation as appropriate. The GGN was established by UNESCO in 2004, and by 2012, the network consisted of 90 members in 26 countries (UNESCO 2012a). The GGN is an international, non-governmental, non-profit and voluntary network with a mission to influence, encourage and assist local communities worldwide to conserve the integrity and diversity of abiotic and biotic nature. It also ensures the sustainable use of natural resources as well as the support of economic and cultural development for local communities. The GGN seeks to enhance the value of territories designated as geoparks and at the same time create employment and promote regional and local economic development (Global Geoparks 2012).

The promotion of sustainable development is thus a central aim of the geopark ideology. According to McKeever et al. (2010), a geopark must have clearly defined boundaries and be of a sufficient size to allow for true territorial economic development, primarily through tourism. This is highlighted by Dowling (2008), who stresses that geoparks are primarily established to create enhanced employment opportunities for the people who live there as well as fostering economic benefits for them. Geoparks must furthermore be of international importance in terms of their scientific quality, rarity, aesthetic appeal and educational value. A geopark achieves its goal through a four-pronged approach: conservation, education, tourism and research. Through conservation, a geopark seeks to conserve significant geological features, and explore and demonstrate methods for excellence in conservation. Through education, a geopark organizes activities and provides logistical support to communicate geoscientific knowledge and environmental concepts to the public, through various means. As regards tourism, geoparks stimulate economic

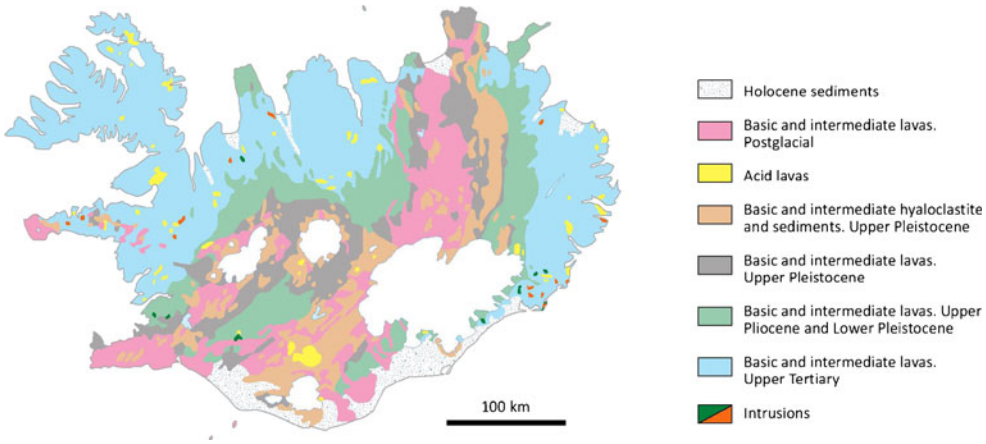

Fig. 2 Geological map of Iceland (obtained from the National Land Survey of Iceland)

activity and sustainable development through geotourism. Most importantly, they encourage the participation of local communities in the creation of enterprises and cottage industries involved in geotourism and geoproducts through tourism planning, development and management. Lastly, research is essential in order to correctly preserve and/or transmit the main geological features in a sustainable manner.

Geoconservation and Geodiversity

According to the GeoConservation Commission of the Geological Society of London (www.geoconservation.com), the term 'geoconservation' is a recent one, generally accepted post-2000 as an alternative to the term 'geological and geomorphological conservation', which was used previously. The Commission points out that conservation consists of the informed use and management of a resource and the term geoconservation therefore refers to active management of geological features and processes. Geoconservation aims to preserve the natural diversity of the abiotic environment, i.e. our geodiversity. Gray (2004: 8) defines geodiversity as "the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (land form, physical processes) and soil features. It includes their assemblages, relationships, properties, interpretations and systems". According to Gray (2004; 2005) the term was first used in the mid-1990s and has since grown in popularity. He observes that using the terms biodiversity and geodiversity in tandem emphasizes that nature comprises two equal components, i.e. biotic and abiotic, and when taken together, these linked concepts help to promote a more holistic approach to nature conservation than the traditional biocentric focus.

Geodiversity is in many places as fragile as biodiversity. For example, many of the post-glacial lava formations in Iceland can easily be destroyed by inappropriate or unsustainable use. Geodiversity is therefore a vital part of nature conservation. Geoconservation is furthermore a critical element in bioconservation, since geodiversity ensures the variety and integrity of environments which are directly conducive to biodiversity.

Iceland—Environmental Characteristics

Geology and Geomorphology

Iceland has a land area of c. 103,000 km^2, extending approximately from latitude 63°23′ to 66°32′N and longitude 13°30′ to 24°32′W. The island's location surrounded by the North Atlantic Ocean gives rise to a cold temperate humid maritime climate. Elevation ranges from sea level to 2,110 m. More than one third of the country's area lies above 600 m, and only about a quarter below the 200 m contour line. Currently, glaciers cover 10 % of the land surface (NLSI 2011). In geological terms Iceland is a dynamic hotspot situated on the Mid-Atlantic Ridge where the edges of the American and Eurasian tectonic plates are constantly moving apart. The country is characterised by its Tertiary and Quaternary volcanic origins, with the oldest known geological formation no more than 15 million years old (e.g. Albertsson et al. 1982). The age decreases towards the centre of the country where the active volcanic zone bisects the island from southwest to north (Fig. 2). About 90 % of the land mass is made up of volcanic rocks, mainly basalts, the remainder being covered by aeolian, fluvial and glacial deposits (Jóhannesson and Sæmundsson 2009).

Iceland is one of the most volcanically active countries in the world. During historical times volcanic eruptions have been numerous, averaging 20 per century (Þórðarson and Höskuldsson 2008; Þórarinsson 1981). However, it is not only Iceland's tectonic situation which makes its geology remarkable; its northerly location further leads to a strong exogenic influence on the endogenic processes through loading and unloading of ice as well as by dynamic erosion and deposition

(e.g. Jacoby and Gudmundsson 2007; Ólafsdóttir and Guðmundsson 2002). Jacoby and Guðmundsson (2007) point out that when the characteristics of volcanism in Iceland are considered, this interplay of external and internal forces is exceptional, such as the magma–water interaction when eruptions occur under ice cover. The volcanic zones are characterised by dynamic landscapes formed mainly during fissure eruptions under glaciers that have led to the formation of steep-sided hyaloclastite ridges (Jóhannesson and Sæmundsson 2009). Hyaloclastite is very rare outside of Iceland. The low-lying areas in between the hyaloclastite ridges are filled up by subaerially formed lava fields piled up during interglacial periods. Due to the country's active volcanology, geothermal heat is abundant all over the country, but its temperature rises especially towards the volcanic zone (e.g. Arnórsson et al. 2008).

Iceland is thus exceptionally rich in geological and geomorphological phenomena encompassing both internal and external processes and the interplay of the two. Additionally, several geological features are globally very rare, such as the subglacially formed hyaloclastite mountains as well as the widespread basaltic glacial fluvial plains.

Population and Land Use

Iceland is sparsely populated, with just around 320,000 inhabitants who are located more or less along the country's coastline (Statistics 2013), leaving the interior highlands an uninhabited wilderness, the largest remaining wilderness in Europe (Ólafsdóttir and Runnström 2011). The average population density today is 3.1/km^2, but almost all inhabited areas are to be found below 200 m (Statistics 2012a).

The history of human inhabitation in Iceland only stretches back about 1,000 years. It is generally believed that the beginning of the Norse settlement in Iceland took place around the year 874 (Old Icelandic literature 1968). Most of the settlers were farmers intent on making a new life in virgin territory. These early settlers brought with them livestock, mainly cattle, sheep, pigs and horses, which became the main source of livelihood in Iceland until the early twentieth century. Grazing has consequently been the major land use strategy since the earliest settlement (Ólafsdóttir and Júlíusson 2000). Yet, less than 2 % of the lowlands are cultivated, mainly for hay production (Arnalds 2011). The highlands were previously mostly used as pasture for sheep and horses. Over the course of the past decades they have, however, been growing in importance as a resource for more diverse land use. From the early 1970s onwards, changes towards multiple uses have gradually taken place. Vehicles have taken over the role traditionally played by horses in the rounding up of the sheep in autumn, numerous hydro-electric power stations have been constructed and tourism has expanded rapidly (e.g. Ólafsdóttir and Runnström 2011; Sæþórsdóttir and Ólafsson 2010). Consequently, the intensified use of the ecologically vulnerable highlands and subsequent increased anthropogenic impact has gradually increased the risk of biodiversity loss and severe land degradation. During the twentieth century, the fishing industry grew gradually and became dominant in the Icelandic economy. Over recent decades, its share of GDP has however gradually decreased (Statistics 2012b; Daníelsson 2004), while conversely in the same period both the aluminium and tourism industries have progressively grown in economic importance. Concurrent with advances in technology and subsequently the development towards less labour-intensive industries, Icelandic society has changed, greatly affecting rural development. Since the latter half of the twentieth century Iceland's rural landscape has faced intensive migration towards the country's metropolitan area, with approximately 64 % of the population now living in and around the capital (Statistics 2012a).

Nature Conservation

Iceland obtained its first Act on nature conservation in 1956 (Icelandic Act no. 48/1956), which was renewed in 1971, in 1996 and in 1999 (Icelandic Act nos. 47/1971, 93/1996, 44/1999). Recently, a new Act on nature conservation (Icelandic Act no. 60/2013) has been announced by the Icelandic parliament, which will come into effect in April 2014. The number and areal coverage of protected areas have increased considerably during the past decades (Fig. 3); at present, protected areas cover about 16.5 % of Iceland's land area (The Environment Agency of Iceland 2012a). There are currently three national parks: Þingvellir National Park, Snæfellsjökull National Park

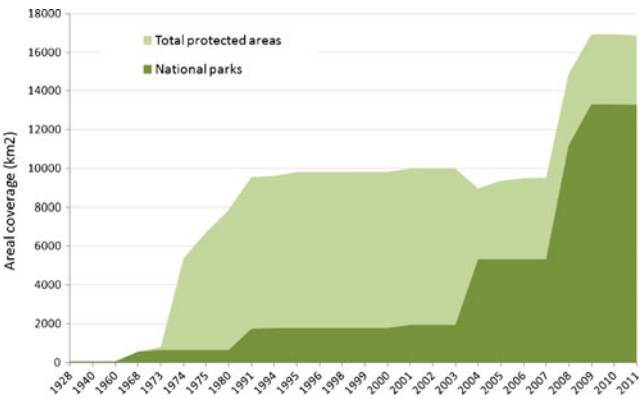

Fig. 3 Areal coverage of protected areas in Iceland 1900–2011 (data obtained from The Environment Agency of Iceland)

and Vatnajökull National Park (Table 2); all are popular tourist destinations presenting a magnificent spectrum of the very best the Icelandic natural landscape has to offer.

The country's most recently established national park is Vatnajökull National Park, which was established in 2008 (Icelandic regulation no. 608/2008), and has the honour of being Europe's largest national park. It is dominated by Vatnajökull glacier, which covers nearly 60 % of the park's areal cover. Since the end of the Little Ice Age in Iceland around 1920, the glacier has been retreating rapidly leaving behind a very dynamic landscape containing exceptional examples of the impact of climate change on both nature and man (McKinzey et al. 2005). Snæfellsjökull National Park was established in 2001 (The Environment Agency of Iceland 2012b), and represents a unique geology with the ice-capped volcano Snæfellsjökull towering over the area. Þingvellir National Park is Iceland's oldest national park, established in 1930 in connection with the millenial anniversary of the Icelandic parliament (Icelandic Act no 59/1928). The Icelandic parliament was founded at Þingvellir in the year 930 and is at present the world's oldest parliament still in existence (Björnsson 1994). Many of the most significant events in Icelandic history have furthermore taken place at Þingvellir, such as the unique Christianisation of the entire nation in the year 1000 and the proclamation of the country's independence in 1944. Owing to its long and rich cultural history, Þingvellir was the first Icelandic site to be included on the World Heritage List, accepted onto the list in 2004 as a world cultural heritage site (UNESCO 2012b) (Table 3). As regards tourism, Þingvellir's geological value is no less than its cultural value. Geologically speaking, the area is very diverse and one of the world's best examples of divergent plate tectonics. The second Icelandic site to be included on the World Heritage List is Surtsey, accepted onto the list in 2008 as a world natural heritage site (UNESCO 2012b) (Table 3). Surtsey is a recently formed volcanic island, formed in 1963. Since its earliest existence, access has been prohibited, except for scientists studying the colonisation process of new land by plant and animal life (e.g. Steinþórsson 1998). Despite prohibited access, simply being on the World Heritage List stimulates tourists' awareness of and interest in the site, and visitors are now able to appreciate its qualities both from the air and the sea.

Tourism and Rural Development

Foreign visitors were a rare presence within the Icelandic landscape before 1960. In 2012, 672,000 foreign visitors came to Iceland (cf. Fig. 1). The number itself might not seem so high compared to many other countries, however when compared to the sparse population of Iceland it is indeed high. Most indications show that the number of tourists will grow significantly in the very near future (ITB 2010; 2012). Iceland is included as a top destination for 2012 in all of the major global travel media, such as National Geographic, Lonely Planet, and The Sunday Times Travel Magazine (National Geographic 2012; Lonely Planet 2012; The Sunday Times Travel Magazine 2012).

Tourism currently accounts for nearly 20 % of Iceland's export revenue (Statistics 2012c). The importance of tourism as an economic sector has been progressively increasing over the course of the past decades, and following the economic crises faced by Iceland in 2008 the Icelandic government has put in a significant effort to promote the tourism sector. Consequently, most of the rural regions of Iceland now regard tourism as a viable means of reinforcing their economic development. Tourism is likely to yield an economic boost to Iceland's peripheral regions. Nonetheless, it has been emphasized in numerous pieces of research (e.g. Ólafsdóttir and Runnström 2009; Ólafsdóttir and Runnström 2013; Wall and Mathieson 2006; Buckley 2000) that if tourism is not properly planned and managed, the impact of relatively intensive tourism may damage fragile ecotourism sites, and subsequently bring about a decrease in visitor satisfaction resulting in declining numbers of visitors to a given area. Still, Iceland's unique natural landscape is by far the most major factor attracting tourists to the country (e.g. Sæþórsdóttir 2010). Icelandic ecosystems are however very vulnerable to external impact, a circumstance which underlines the necessity for tourism in these areas to be planned and managed with a view to sustainability. Geotourism emphasizes sustainability in its

Table 2 Icelandic national parks (in 2012)

National park	Year of designation	Areal size[a] (km^2)	Area significance
Þingvellir National Park	1930	228	Natural and cultural
Snæfellsjökull National Park	2001	167	Natural
Vatnajökull National Park[b]	2008	13304	Natural and cultural

[a] The Environment Agency of Iceland (2012a)

[b] The former Skaftafell National Park (designated 1967) and Jökulsárgljúfur National Park (designated 1973) became a part of Vatnajökull National Park in 2008

Table 3 UNESCO sites in Iceland (in 2012)

UNESCO site	Year of designation	Area significance	UNESCO homepage
Þingvellir National Park	2004	Cultural heritage	http://whc.unesco.org/en/list/1152
Surtsey	2008	Natural heritage	http://whc.unesco.org/en/list/1267

development, and therefore provides an ideal development opportunity in vulnerable Sub-Arctic environments such as Iceland.

Possibilities for Geotourism and Geopark Development in Iceland

Katla Geopark—Iceland's First Step

Iceland's first, and to date its sole, geopark is Katla Geopark (Fig. 4). It was accepted into the European Geoparks Network (EGN) and jointly into the GGN in September 2011. It covers 9,542 km^2, or about 9.3 % of the total land area of Iceland. It is made up of three municipalities with a total population of around 2,700. The area found itself under a global spotlight when the stratovolcano Eyjafjallajökull erupted in 2010 causing exceptional disruption to all air traffic in northern Europe, the first ever eruption to do so. Eyjafjallajökull is one of many active volcanoes within Katla Geopark. The eruption in 2010 started on the 20th of March as a small, spectacular effusive flank eruption at Fimmvörðuháls east of the volcano's main summit, attracting numerous domestic and international tourists. After 3 weeks, the effusive eruption ended and a day later, on the 14th of April 2010, an explosive summit eruption started that lasted over a month and was a major catastrophic event (Sigmundsson et al. 2010). However, within Iceland it was limited to only the southern part of the country. No lives were lost and the rest of Iceland was unaffected, with the only major damage on land being the ash fall which still remains in the area. In the long run, this event has turned out to be a major tourist attraction for this part of Iceland, and a boost for Katla Geopark.

Fig. 4 Location of Katla Geopark (Source: www.katlageopark.is/)

The work of Katla Geopark has provided a wealth of experience for other municipalities in Iceland draw upon when taking the step forward into the geopark development process. The focus of the development in Icelandic tourism in general reflects the country's geological importance for tourism. There are numerous examples of geotourism developments around the country including Iceland's most popular tourist attraction, the Blue Lagoon, which was recently nominated by National Geographic as one of the top 25 wonders of the world. The Golden Circle has for a long time been Iceland's most popular tourist route (ITB 2012), located at a convenient distance from Reykjavík and taking in Þingvellir National Park, Gullfoss (the Golden Waterfall), and Geysir (a geothermally active area with spouting hot springs). Visitors' centres demonstrating the respective areas' geological processes and history have been constructed both at Geysir and Gullfoss. The visitors' centres within the three national parks also serve to educate visitors regarding geological and geomorphological processes. Dowling (2010) points out numerous other examples that may count as geotourism developments in Iceland, such as the Bridge between the Continents in the Reykjanes peninsula and Eldheimar—the Pompeii of the North in Vestmannaeyjar.

Geotourism and Geoparks Inventories

The Icelandic landscape is exceptional in its geology. The whole country could easily be classified as one large geopark. Both internal and external geological processes are extremely dynamic as a consequence of the country's location right on top of the Atlantic Ocean Ridge where the tectonic plates are constantly spreading apart. The landscape is further shaped by the island's northerly location in the middle of the North Atlantic Ocean where active ocean and air currents are constantly at work shaping the landscape. The whole country is thus a unique site for studying geological and geomorphological processes and at present, most importantly, the impact of climate change. In Iceland, geotourism has the potential to utilize these exceptional geological circumstances to strengthen all dimensions of local sustainability, economic, social and environmental. As such, Iceland is a perfect example of how

geotourism has the potential to strengthen a country's rural development.

As the final part of a field course on geotourism held by the University of Iceland in August 2011, students were given the task of analysing and mapping the diverse possibilities for geopark development in Iceland. Their overall aim was to identify and classify each area's unique qualities as regards geology, tourist attractions, sustainability and rural development. The results of this project formed the basis for the subsequent analysis presented here. The results indicate a total of nine potential geoparks distributed equally across Iceland (Fig. 5). A key motivating factor for rural communities contemplating participation in a geopark project is branding. A particular focus is therefore placed upon deciding the name of the geopark. In order to be a valuable branding tool a fundamental factor is that the name reflects the geological uniqueness of the area and at the same time piques interest and curiosity among potential visitors.

Potential future geoparks in Iceland include:

1. **Torfajökull Caldera Geopark**. The Torfajökull caldera is located in the southern Icelandic highlands within the active volcanic zone. The area is the largest silicic centre in Iceland, with a 12-km-diameter caldera and an outstanding high-temperature geothermal field (Soosalu and White 2006). The landscape within the caldera is characterised by its light rhyolite appearance which stands in stark contrast to the otherwise black basaltic appearance of the Icelandic landscape. There have been two eruptions in the Torfajökull area since the settlement of Iceland, the most recent at the end of the fifteenth century (Soosalu and White 2006). The Torfajökull area is the largest geothermal area in Iceland and occupies a unique position among Iceland's volcanoes both as regards type of volcanism and structure. Its geothermal potential is estimated in the range of 1,000 MW (Sæmundsson 2009). The largest part of the caldera belongs to Fjallabak nature reserve, a popular tourist resort. The most popular tourist destination within the Icelandic highlands, Landmannalaugar, is also located within this area (ITB 2012). A geopark is likely to strengthen sustainable tourism development in the nature reserve. Being a part of the Icelandic southern highlands it is also important that the geopark supports rural development in the adjacent lowland areas. As Torfajökull Caldera Geopark is situated on the northern edge of Katla Geopark both geoparks should be able to benefit from mutual planning and management, the remit of Caldera Geopark being geothermal geomorphology and education both in situ as well as in the lowland rural areas.
2. **Eastfjords Geopark**. The oldest geological formations in Iceland are found in the country's western and eastern fjords. For instance the bedrock of the East Fjords belongs to the Tertiary formation (Jóhannesson and Sæmundsson 2009). The landscape is characterised by valleys and fjords that present a unique showcase for all forms of glacial erosion, such as ideal U-formed valleys and hanging valleys. Glacial erosion is an immense cause of change in our landscape and thus one of the main forces of nature. The area is exceptionally rich in precious stones, especially zeolites, which may be viewed at an exceptional genuine mineral museum at Stöðvafjörður, Petra's Stone and Mineral Collection, which is currently

Fig. 5 Potentials for geoparks development in Iceland in relation to rural development (Base map obtained from the National Land Survey of Iceland)

the world's largest privately owned mineral museum (http://www.steinapetra.is/). Perhaps the most famous mineral found here is the Iceland spar, which is a transparent variety of calcite long used to demonstrate the polarization of light. According to Kristjánsson (2001), Iceland spar was the first crystal whose elastic and inelastic deformation was studied in any detail. Recently a geological centre dedicated to the geologist Georg P. L. Walker and his work in Iceland was opened at Breiðdalsvík in the East Fjords. Walker, who is renowned as the father of modern quantitative volcanology and one of the foremost volcanologists of the twentieth century made his first major marks on geology and volcanology in the East Fjords (Thordarson et al. 2009), and he claims that Iceland taught him geology (Morgunblaðið 1988).

Fisheries have long shaped the employment history of the local communities in the East Fjords of Iceland. Around 1800, the waters of the East Fjords became popular with thousands of French fishermen, who in 1903 built their own hospital in the area, known as the French hospital (e.g. Jónsson 2013). The building is now under reconstruction by the Icelandic heritage protection association, and is planned to be opened in 2014 as a hotel and a museum of the French fishermen (The Municipality of Fjarðarbyggð 2013). This unique history of the area's French colonial period plays a central role in the its history and its attractiveness for visitors. The Eastfjords Geopark will thus present a unique example of man and nature in a glacially eroded landscape.

3. **Mývatn Geopark**. Lake Mývatn is located in the northern part of the active volcanic zone. Mývatn and its hinterland are widely known for their natural beauty and Mývatn has for a long time been the foremost tourist attraction in northern Iceland (e.g. Ólafsdóttir and Jóhannsdóttir 2009). The area represents a geological diversity that is scarcely seen elsewhere, both as regards forms, colours and texture as well as geological formation. The landscape has acquired its particular character as a result of tectonic movements attributable to the slow drifting apart of the two continents and the consequent splitting apart of Iceland, at a rate of about two centimetres a year (e.g. Sturkell et al. 2008). The stress that gradually builds up when the plates spread apart is largely released during rifting episodes. The last such episode took place north of Lake Mývatn in 1975–1984 after a 250-year interval from the previous period episode, which took place in 1724–1729. During these episodes, gradual subsidence of the landmass occurs resulting in numerous fresh faults punctuating the landscape (e.g. Sturkell et al. 2008; Guðmundsson 1995). Lake Mývatn was formerly better known for its rich birdlife, and ornithologists from all over the globe still visit its shores to study the remarkable variety of birds found there. Recently, so called “lake balls”, a very rare form of green algae (*Cladophorales*), are receiving increased interest among visitors. These lake balls cover a large part of Mývatn's lake floor. Such colonies of *Cladophorales* have only been observed in one other lake in the world, Lake Akan on the island of Hokkaido in Japan (Einarsson et al. 2004). In 1977, Lake Mývatn and its surrounding area was designated a Ramsar site, the first of six Ramsar sites in Iceland (http://www.ramsar.org/pdf/sitelist.pdf).

The local economy around Lake Mývatn is characterised by sheep farming. Several attempts have been made to build up industry in the area, mainly including sulphur mining, and later extracting and processing diatomite from the bottom of Lake Mývatn. For that purpose a factory was constructed at Reykjahlíð on the north-eastern side of the lake in 1967, and subsequently a small community developed close to the factory. The diatom factory closed down in 2004 after years of debate about the influence of the mining on the lake's rich wildlife. Mývatn's geological history as well as the history of man's interaction with nature in this area is thus exceptional both in an Icelandic and a global context.

4. **Tjörnes Fossil Geopark**. The Tjörnes peninsula north of Húsavík is made up of sedimentary rocks that are, while relatively commonplace on the world's continents, very rare in Iceland. Only about 5 % of the Icelandic bedrock is sedimentary, and the large majority of that is found in the Tjörnes peninsula (Jóhannesson and Sæmundsson 2009). The Tjörnes deposits are made up of layers of organic deposits that date back to the Pliocene era (Símonarson and Eiríksson 2012) and have for a long time been among the best known geological localities in Iceland owing to the rich and spectacular marine fossil layers they include, which document huge environmental changes in the Earth's environmental history. According to Eiríksson (1981), the Tjörnes sequence is unique in the North Atlantic area in its lithological character and long Quaternary record. The Tjörnes sequence combines lithological and palaeontological evidence about prehistoric temperature conditions and climate. The most striking environmental change that may be seen in the Tjörnes strata occurred around 3 million years ago, indicating the beginning of the Ice Age in Iceland. The deposits moreover reveal a unique Quaternary record of repeated glaciations and at least ten differently extended warm periods in between with subsequent changes in sea levels (Símonarson and Eiríksson 2012).

One town, Húsavík with 2,228 inhabitants on the 1st of January 2013 (Statistics 2013), is located on the western part of the peninsula. Otherwise, sparsely distributed farms characterise the peninsula's settlement pattern. Soil erosion has long been a major factor making the

agricultural and grazing land here of poor quality (Arnalds et al. 2001). Over the course of the past decades, Húsavík has grown to be one of Iceland's most popular spots for whale watching, and whale watching has gradually come to dominate the area's image as regards tourism. In 1997, the country's only whale museum opened at Húsavík (cf. www.sjominjar.is/syningar-og-setur/husavik/). Tjörnes Fossil Geopark is likely to enrich the local identity of the area and thus strengthen its rural development.

5. **Trolls Geopark**. The mountainous peninsula in northern Iceland between Eyjafjörður in the east and Skagafjörður in the west bears the name Troll Peninsula (Icel. Tröllaskagi). As part of the ancient heritage of Scandinavian mythology, Icelandic folktales are brimming with elves and trolls alike. The Icelandic trolls live in mountains, caves and cliffs, and in this mountainous region tales of trolls are even more abundant than elsewhere in the country. The peninsula contains many of Iceland's highest mountains and is the part of the country with the highest elevation outside the central highlands. Several of the small rock glaciers decorating the central part of the peninsula have shown rapid responses to climate change (e.g. Caseldine and Stötter 1993; Farbrot et al. 2007), and have thus significantly contributed to a better understanding of the impact of climate change as well as the geomorphological history of the area. The mountainous landscape of the peninsula provides a paradise for all kinds of hiking and riding activities and in the wintertime the great variety of mountains and slopes are increasing popular skiing destinations. In 2010, a new two-road tunnel was opened connecting the area's two largest townships, Siglufjörður and Ólafsfjörður (Icelandic Road 2010), significantly increasing accessibility to these towns and their environs.
6. **Europe**'s **Westend Geopark**. Over the course of the past decades, the Westfjords peninsula has been facing greater population decline than any other region in Iceland. The number of residents continues to fall in all of the peninsula's municipalities (Statistics 2012d). The peninsula's westernmost part, Látrabjarg, marks the westernmost point of Iceland. Látrabjarg is Iceland's largest sea cliff, with a total stretch of unbroken sea cliffs of 14 km, and contains one of the world's most densely populated seabird colonies (e.g. Garðarsson 1995). The world's largest population of *Alca torda* is located in Látrabjarg, with 40 % of the total world population (Garðarsson 1995). Sea cliffs also provide an ideal cross section of the country's geological history. Tourism is slowly growing in the area, and the fact that one can get very close to the sea birds, especially puffins that mainly sit on the top of cliffs, is a major draw for tourists. Close to Látrabjarg is Rauðasandur, a golden red sand beach in a spectacular remote area. The large sand beach is formed from shells drifting ashore with the ocean currents, and the light golden colour of the sand contrasts with the otherwise black basaltic landscape.

   In earlier times, the area was dotted throughout with sheep farms despite harsh conditions, but now only a few sparsely distributed farms remain. At one time, the bird cliffs were a major source of food for the locals by means of abseiling down the cliffsides to collect eggs and catch birds, which resulted in numerous deaths down through the ages (Gestsson 1971). Throughout the centuries, ferocious storms caused many ships to be run aground against the cliffs, the most famous incident being the beaching of the British trawler Dhoon in December 1947 and the rescue of its crew by local farmers who placed themselves in great danger as the terrain was both slippery and hazardous (e.g. Lúðvíksson 1971). Drawing upon this rich geological and cultural history, Europe's Westend Geopark will be able to present unique stories of human life in these inhospitable natural surroundings alongside exceptional examples of dynamic coastal erosion and natural birdlife habitats.
7. **Snæfellsnes Geopark**. The Snæfellsnes peninsula has for a long time been a popular destination for tourists visiting Iceland due to its vast geological diversity and dynamic landscape, including formations from almost every era of Iceland's geological history. During the late Tertiary period, the two tectonic plates forming the Mid-Atlantic Ridge are believed to have met along the Snæfellsnes peninsula (e.g. Steinþórsson 1986). Throughout Iceland's short geological history, the Ridge has been drifting westward relative to the mantle plume located beneath the central part of the country, and periodically it has jumped to the east towards the mantle plume (e.g. Steinþórsson 1986; Hardarson et al. 1997). According to Hardarson et al. (1997), the most recent jump occurred at ~7 Ma when the Ridge left the Snæfellsnes rift and jumped 100–200 km eastwards to its present location. The area is however still active and numerous eruptions here have been dated to the Holocene period. Several large and unique post-glacial lava fields characterise the peninsula, many with passable hiking paths. The peninsula's largest and most famous volcano is Snæfellsjökull, a snow-capped stratovolcano that last erupted around 1,800 years ago (Jóhannesson 1982). Snæfellsjökull is located on the westernmost part of the peninsula. In 2001, the area surrounding Snæfellsjökull was designated a national park, and is the smallest of the country's three national parks (cf. Table 1). In 2008, all of the five municipalities in the Snæfellsnes peninsula together with the national park were the first in the northern hemisphere to obtain a joint Green Globe certification for communities (Green Globe International 2008), that in 2010 changed to Earth Check (cf. http://nesvottun.is/english-2/). Such

certification emphasizes the communities' efforts towards sustainable development, a critical platform for a geopark development.

8. **Reykjanes Lava Geopark.** The peninsula stretching west from the metropolitan area is called Reykjanes. The Reykjanes peninsula is part of the active volcanic zone and presents an exceptionally dynamic geology dominated by vast basaltic lava fields with numerous cinder craters, as well as subglacially formed mountains and geothermal areas that have for a long time attracted tourists in this area. The peninsula has on the whole a barren appearance and has hitherto been more of a drive-thru destination for tourists. However, with the excellent accessibility from the capital area and the country's only international airport, the peninsula is a perfect candidate for geotourism development. Iceland's currently most popular tourist attraction, the Blue Lagoon, is a man-made geothermally heated lagoon located in the middle of a vast lava field. It was formed following the construction of facilities by a regional heating corporation around 1976 which make use of geothermal steam from drilling holes to warm heat cold water, which is then pumped to the surrounded villages. After steam has been used in this way, it is cooled and the water siphoned out onto the lava field. Due to the high content of silica precipitating from the water, it does not flow through the lava as was initially expected; instead the silica filtered the lava, thereby forming a lagoon. Shortly after the formation of the lagoon, it started to become a popular spot for bathing among Icelanders, and is now recognized worldwide for its healing qualities (e.g. Olafsson et al. 1996; Grether-Beck et al. 2008). Last summer (2012), efforts were made to open up one of the peninsula's largest lava caves to tourists. This cave is believed to be the world's deepest lava cave. There is still work to be done to improve accessibility to the site and the design of its infrastructure and construction work as regards environmental impact assessment (VSÓ 2012). Due to its extensive lava fields, the peninsula has never been good farming land, meaning the inhabitants are more dependent on fisheries than most other parts of Iceland. In recent times, the most significant influence on the peninsula's settlement pattern is most likely the United States Naval Air Station located close to Keflavík in the northwestern part of the peninsula, as well as Keflavík international airport, which was constructed by American forces during World War II and opened in 1943 for military purposes (e.g. Brynjólfsson 1984). This provided numerous jobs for local people, in turn bringing about an expansion of the communities close to the naval base. In 2006, the American navy left the area after more than 50 years of occupation (Vísir 2006).

   Recently, the municipalities in the Reykjanes peninsula set in motion the process of having the peninsula recognized as an international geopark (Eggert S. Jónsson, project manager at the Reykjanes Regional Development Agency; personal communication). The area is thus now an aspiring geopark.

9. **Vestmannaeyjar Volcano Geopark**. The Westman Islands archipelago is a group of 18 islands located just off the Iceland's south coast. The largest island, Heimaey, is the only inhabited island in the archipelago, with a population of 4,194 on the 1st of January 2012 (Statistics 2012d). The whole archipelago is an outstanding example of the interaction of internal and external forces in the Earth's geological history, with submarine eruptions and oceanic erosion shaping the formation of the landscape after each island was born. The Westman Islands archipelago makes up a special volcanic system that forms the southern extremity of the propagating Eastern Volcanic Zone (EVZ) and according to Mattsson and Höskuldsson (2003) thus represents the initial activity at the tip of the rift. The most recent volcanic activities in the archipelago are the eruptions of Surtsey in 1963 and on Heimaey in 1973, the latter being the only eruption in Iceland's history to take place in a populated area. The island of Surtsey was formed in a single eruption in 1963 and is thus the youngest island in the archipelago. Since its birth, the island has been protected and closed to the public, but continuous geological and biological research has been conducted on the island providing valuable knowledge on the formation of hyaloclastite (e.g. Sigurðsson and Jakobsson 2009) as well as how life originates on a new land. For that reason Surtsey was designated a World Heritage Site in 2008. The eruption on Heimaey in 1973 lasted for 3 months, from January to March of that year, during which time a large part of the only local town was covered by lava. Remnants of some of the houses can still be seen in the lava, and have now been made accessible to the public as tourist attractions. Since the eruption, the lava's high temperature has been utilized for heating the houses on Heimaey. Currently, a total of 4,219 inhabitants live on Heimaey, which is a little less than lived there prior to the eruption (Statistics 2013). Life on the island has always been closely linked with fisheries.

Whilst tourism is already undertaken in all of the nine geopark areas listed above, the presence of any real geological interpretation or tourist activities (such as geological interpretive centres and geotrails) is still limited. Based on the circumstances set out above, these areas' significance in terms of geological heritage and consequent potential for geotourism is illustrated in Table 4. The key point of geotourism is that the Abiotic [A]=geology (together with an area's climate), influences the area's Biotic [B]=fauna (animals) and (flora) plants, all of which combine to influence the Culture [C]=how people live in an area (past and present). Thus the major task of

geopark development is to use geological knowledge as a basis for informing our understanding of the 'ABC' components of an area. In this way visitors as well as locals will gain a holistic appreciation of the region based on an understanding of its geology.

Discussion and Conclusions

Management Implications for Icelandic Geotourism

Tourism is a young industry in Iceland. It has grown rapidly during the past two decades without any clear planning and management structure. Research and data on Icelandic tourism are furthermore very limited. Sustainability is a central goal in geotourism and for tourism to be sustainable it needs to be carefully planned and managed. One regional planning and development approach which has an ideal application for rural and regional geotourism development is the Regional Ecotourism Development Planning Approach (REDPA) developed by Dowling (1993). It is modified here for sustainable geotourism development planning (Fig. 6). This approach identifies opportunities for tourism developments in natural areas through the identification of significant features, critical areas and compatible activities. Significant features are either environmental (e.g. geological) attributes which are valued according to their level of diversity, uniqueness or representativeness, or tourism features valued for their resource value. Critical areas are those in which environmental and tourism features are in competition and possible conflict. Compatible activities are outdoor tourism recreational activities which are considered to be both environmentally and socially compatible. The essential elements of the REDPA model include its grounding in the sustainable development approach, which is based upon environmental protection, community well-being, tourist satisfaction and economic integration in order to achieve environment: tourism compatibility. Other essential elements include its being strategic and iterative, regionally based, incorporating land use zoning, and environmentally educative, that is, fostering the environmental ethic.

REDPA is a strategic planning approach to environment: tourism planning in five stages. It includes: Stage (A) a statement of objectives, (B) survey and assessment, (C) evaluation, (D) synthesis, and (E) proposals. The five stages can be expanded into ten processes (cf. Fig. 6). The direction of development is determined by the objectives or planning goals which have emerged from the environment: tourism relationship review. From there, a number of planning zones are defined which are designed to protect conservation values while fostering tourism developments and activities. These zones are identified and described based on an approach where the land and water areas of a region are classified according to their need for protection and their compatibility with tourism. The following general zones and their primary functions are proposed for geotourism development:

- Sanctuary zones—areas requiring special preservation
- Geoconservation zones—areas sustaining a combination of protection and use but with emphasis on the former
- Geotourism development zones—small, concentrated areas of tourist attractions
- Outdoor recreation zones—natural areas that can accommodate compatible outdoor recreation activities

This provides a guide for future environmental (including geoconservation) planning, tourism (including geotourism) planning and regional development planning. Environmental protection and the conservation of environmental values underpins the approach in any regional as well as rural application not only for the sake of these areas' intrinsic values, but also because the natural and social environments form the basis for the sustainable development, including tourism development of the region. The principal aim of geotourism development within REDPA is to promote environmentally compatible geotourism developments and associated recreational activities.

Geotourism strategies comprise the following elements: environmental protection, product development, marketing and promotion, infrastructure development and industry assistance. REDPA has been successfully applied in a number of regions in Australia including the Gascoyne Region (Dowling 1993), the South West Region (Dowling and James 1996) and the North West Cape Region (Dowling 1999). In addition, it has been profiled by the European Union (Dowling 1994) and formed the basis of the first Queensland Ecotourism Plan (Queensland Government 1997).

Stakeholder Engagement

Participation by local residents in geotourism planning is fundamental to the sustainability of the process, so stakeholders have a buy-in and a degree of empowerment in the process of geotourism development. Appropriate ecoethics for resident and tourist participation in the planning process include the need for developers to take account of local community attitudes and feelings, including the way in which a local unaltered environment contributes to a community's sense of place. Any geotourism development should not lessen the enjoyment of the local environment by the local community and where practicable, should enhance it. Thus geotourism development at the regional level must be developed within the context of sustainable local, national and international tourism development. The three main principles of sustainable development which can also be applied to regional geotourism development planning are its concentration on geological, social and economic issues.

Table 4 The significance of Iceland's geological heritage as regards its potential of geotourism

	Geopark	Geological specialities	Potential for geotourism
1	Torfajökull Caldera Geopark	Geothermal landscape; geothermal activity; central volcano; caldera	Caldera trail: Interpretative geotrail around the caldera edges Wilderness experience
2	Eastfjord Geopark	Glacially eroded landscapes and geomorphology; tertiary stratigraphy; intrusions, minerals and stones	Visitor centre focussing on past and present glacial landscapes, landforms and processes Mineral museum
3	Mývatns Geopark	Tectonic movements; mud pools, sulphur and other geothermal depositions and transformations	Visitor centre focussing on the geology of the North American—Eurasian plate boundary and its movement Geotrail system (many connected hiking trails) with interpretive signs
4	Tjörnes Fossil Geopark	Tertiary and Quaternary chronological history of past climate change; marine fossils	Interpretative profile of the Tjörnes sequence 'in situ' Include the areas chronological history for example in the Whale watching tours
5	Trolls Geopark	Glacial geomorphology; landslides, mass movements	An Interpretive Centre focussing on Iceland's geology and cultural history
6	Europe's Westend Geopark	Massive sea cliffs; coastal erosion; shell drifted sand beaches	Visitor Centre and interpretive walk along Europe's largest seacliff A Western Fjords visitor centre
7	Snæfellnes Geopark	Iceland's complex geology in a nutshell	A geological interpretation centre based around the theme of 'Lava and Ice' Volcano museum in Stykkishólmur
8	Reykjanes Lava Geopark	Basaltic lava fields with numerous lava types, e.g. aa, pahoehoe, pillow, basaltic columns, lava tubes and caves, subglacially formed hyaloclastite mountains	100 Crater Park Walk Geotrail focussing on different lava types Blue Lagoon geothermal area Bridge between the continents Geothermal interpretation centre at Krísuvík
9	Vestmannaeyjar Volcano Geopark	Living Volcanoes; submarine eruptions, hyaloclastite; coastal erosion	Eldfell Volcano interpretive trail The World of Fire (Pompei of the North) buried village site Surtsey World Heritage Visitor Center Volcano exhibition centre

Central to geotourism development are the inclusion of a range of stakeholders. Each group makes a contribution towards changing the nature of tourism and their own success is dependent upon the contribution of others. Tourism development, including geotourism development, involves multiple stakeholders including business and government as well as community and environmental groups. An introductory definition of 'stakeholder' is any person, group or organisation that is affected by the causes or consequences of an issue (e.g. Bryson and Crosby 1992). Although it is often difficult and time-consuming to involve a range of stakeholders in the planning process, it has been shown (i.e. Medeiros de Araujo and Bramwell 2000) that their involvement can have significant benefits for sustainability including environmental, social, cultural, economic and political sustainability.

A central task in stakeholder development is to establish who the stakeholders actually are and whether or not they adequately represent the affected stakeholders. This can be done by identification, self-nomination or referral. Once identified, stakeholders can be positioned on a map according to these relationships in order to determine their power to influence the relationships between themselves and other stakeholders, their perceived legitimacy and the urgency of their claims (Newsome et al. 2005). These three relationships are central to how stakeholder groups become involved in an issue. Another important consideration is to limit the number of stakeholders in collaborative planning to a manageable size in order to build trust and consensus and increase the likelihood of achieving a mutually acceptable outcome. One aspect of stakeholders' interests in tourism development is the involvement of the local or host community (Richards and Hall 2000; Scheyvens 2002; Singh et al. 2003). When referring to natural areas, the use of the term 'community' is sometimes based on an incorrect assumption that it comprises a single homogenous unit; however, social stratification is a common phenomenon in almost every community and different groups within it often have differing interests or stakes in the natural resource (Ashley and Roe 1998). Thus, with respect to

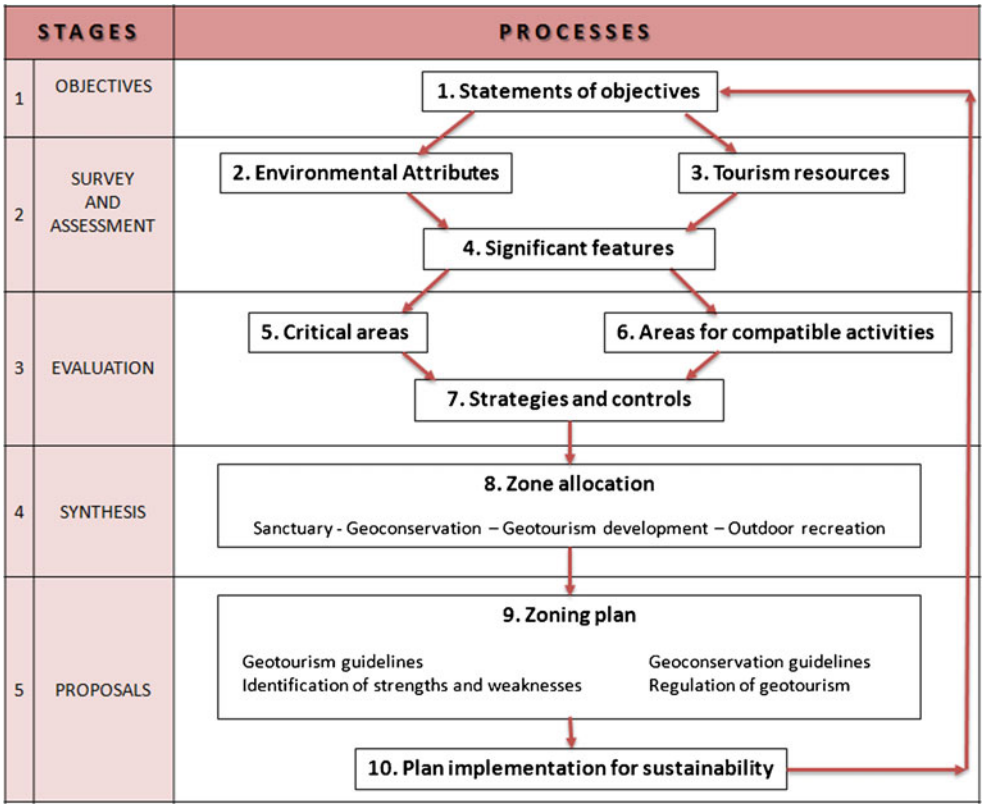

Fig. 6 Regional Ecotourism Development Planning Approach (REDPA) modified from Dowling (1993) for sustainable geotourism planning

geotourism in natural areas, a community may not work together for its development in a harmonious way. Therefore, a more appropriate approach is to expand the definition of the host community to the wider community, in this instance a set of people with a mutually recognised interest in the resources of a particular area rather than as people living in that area (Gilmore and Fisher 1992). The community thus represents users of a resource rather than a homogenous resident unit.

Geotourism and Geoparks—A Tool for Geoconservation and Rural Development?

The Icelandic landscape attracts increasing numbers of tourists annually. In geological terms, Icelandic nature is, as stated by Thórhallsdóttir (2008), a living laboratory demonstrating all the major processes of nature in action, water, ice, volcanism and wind. Icelandic geology and geomorphology is moreover a showcase for understanding how these shape the surface of the Earth.

This paper has examined the geological features of Iceland in order to make the case that there are a number of areas in the country which could form the basis of a collection of geoparks. The essence of a geopark is that it is a unified area with a geological heritage of international significance. However, the concept of geoparks is that they are not set up solely to protect, conserve or interpret geological heritage, but in addition 'the purpose of a geopark is to explore, develop and celebrate the links between that geological heritage and all other aspects of the area's natural, cultural and intangible heritages' (www.unesco.org). Thus, the establishment of geoparks presents a sound opportunity for Iceland to achieve geoconservation of its resources whilst fostering sustainable development of its regional areas, as the country's natural features are very vulnerable and sustainable use is the only option if this resource is to be conserved and utilized in the long term. Geoconservation is therefore a fundamental element in geotourism development in naturally vulnerable areas like Iceland. This conclusion is supported by Ólafsdóttir

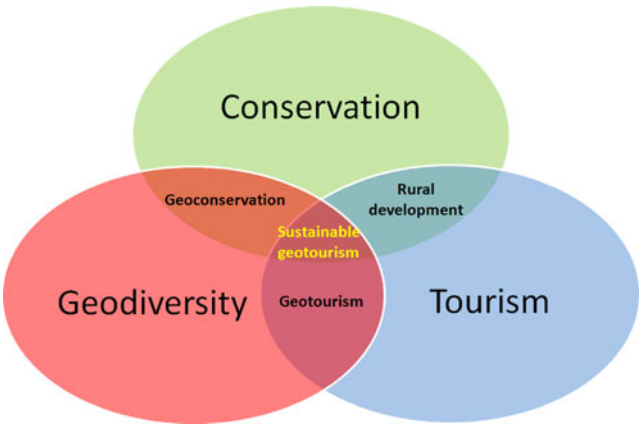

Fig. 7 The interrelationship between geodiversity, conservation and tourism

and Runnström (2009), who stress that in order to achieve sustainability in tourism development in such fragile environments as Iceland, tourism must be maintained in such a way as not to cause negative disturbance to nature, culture, society and economy. Thus, when managed in a sustainable manner, geotourism is likely to provide long-term improvement in rural development. However, fundamental to the management of sustainable geotourism is an understanding of the interrelationship between geodiversity, conservation and tourism development (Fig. 7), emphasizing the critical importance of research in order to find the ideal balance between these three central components. Achieving sustainability will indubitably increase the quality of life and experience both for the local community and for the tourists, and thereby strengthen rural development.

Acknowledgments We are very grateful to the University of Iceland and the South Iceland University Centre for their financial contribution to the geotourism course in August 2011. We would like to acknowledge Sigurður Sigursveinsson and Hrafnkell Guðnason for their help in organizing the field course. We would also like to thank our students Anna Jónsdóttir, Erla Dóra Vogler, Ingunn Hjaltalín Ingólfsdóttir, Kolbrún Reynisdóttir, Lilja Bjargey Pétursdóttir and Ragnhildur Sveinbjarndardóttir for their contribution to this work. Special thanks are further given to Dr. Gísli Már Gíslason as well as to our anonymous reviewers for valuable comments and suggestions which have led to significant improvements to this paper. Additional thanks are given to Dr. Hugh Atkinson for language correction.

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