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Empowering community voices in land use planning and decision-making using PPGIS - A case study from the Westfjords, Iceland

Rannveig Ólafsdóttir[a], Michaël Bishop[a], Anna Guðrún Edvardsdóttir[b], Johannes Welling[a] and Seija Tuulentie[c]

[a]Department of Geography and Tourism Studies, Institute of Life and Environmental Sciences, University of Iceland, Reykjavík, Iceland; [b]Department of Aquaculture and Fish Biology, Hólar University, Hólar, Iceland; [c]Bioeconomy and environment, Natural Resources Institute Finland, Rovaniemi, Finland

ABSTRACT

This paper explores how public participation in land-use planning contributes to community well-being and evaluates the effectiveness of PPGIS combined with focus group discussions for assessing residents' land-use preferences and concerns. An online PPGIS survey was conducted in a rural community in the Westfjords of Iceland, followed by on-site focus groups to obtain a deeper understanding of residents' attitudes towards aquaculture and tourism and their associated economic, social, and environmental impacts. The results reveal a strong willingness among residents to be actively involved in land-use planning and decision-making. While aquaculture and tourism are perceived as important economic opportunities, they are also seen as insufficient to sustain the community's social and environmental structure. This emphasizes the need to integrate socio-ecological considerations into land-use planning, and highlights the importance of inclusive, collaborative decision-making approaches that prioritize community well-being and environmental stewardship amid the Arctic's rapid environmental and economic changes.

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Land-use conflicts; rural development; public participation; community well-being; tourism; aquaculture

1. Introduction

Arctic communities are confronted with increasing challenges owing to their remoteness, sparse population, fragile ecosystems, and growing global interest in their natural resources. Reconciling the growing influx of new global industries with traditional livelihoods and the well-being of local communities is essential, as the relationships between the two are often conflictual. Thus, land-use conflicts emerge as a critical issue in the Arctic region.

Land-use conflicts have long been a common challenge in rural development, occurring when different stakeholders have competing interests and priorities for the use of land (Mayer & Turner, 1994). These conflicts can arise for various reasons, including land-use change, contested land ownership, differences in socio-cultural values, environmental concerns, or opposing views on the exploitation of natural resources (e.g. Foley et al., 2005; Mayer & Turner, 1994). Conflicting views over land-use can thus lead to tensions between different stakeholder groups, which in many Arctic rural settings include indigenous communities, farmers, fishermen, residents, tourists, industry representatives and local authorities, creating divisions that can be difficult to overcome (Fienitz & Siebert, 2022; Peltonen & Sairinen, 2010). Effective land-use planning therefore requires a holistic understanding of stakeholder dynamics and of the interconnectedness of economic, social, cultural, and environmental dimensions at the local level. This includes identifying areas where potential land-use conflicts may arise, which requires active collaboration between residents, decision-makers, and related stakeholders. Local residents are in this respect key sources of information and knowledge (Kopáček, 2021). Numerous studies (e.g. Edvardsdóttir et al., 2023; McDonagh, 2020; Ólafsdóttir, 2021; Ólafsdóttir & Júlíusson, 2000; Ólafsdóttir et al., 2024; Turunen et al., 2024; Welling et al., 2019) emphasize that

CONTACT Rannveig Ólafsdó ranny@hi.is Department of Geography and Tourism Studies, Institute of Life and Environmental Sciences, University of Iceland, Reykjavík, Iceland

engaging local voices in the planning and management of land-use can help build consensus and reduce conflicts. Empowering local voices in land-use planning and decision-making is even more crucial today than ever before, given the growing interest in Arctic natural resources and the region's strategic importance (Bruun & Medby, 2014; Medby, 2023), as reflected by the gradual increase of foreign investments in the region's natural resources (Suopajärvi et al., 2024). While development prospects are often welcomed by local authorities, expecting them to counteract depopulation and increase community well-being (Edvardsdóttir et al., 2023), underlying land-use conflicts can emerge and undermine the social cohesion of local communities.

Many researchers (i.e. Bishop et al., 2022; Gebeyehu et al., 2023; Hansen et al., 2021; Ólafsdóttir, 2021; Sæþórsdóttir & Tverijonaite, 2024; Welling et al., 2019) emphasize that public involvement in land-use planning is essential to identify values associated with specific areas, such as sites with spiritual, historical or recreational significance for local communities. Public involvement thus provides valuable information about the local environment, cultural practices, and social dynamics, including aspects such as power relations, social norms, and conflicts between different groups. Understanding these site-specific values can help identify potential conflicts and develop strategies to address them (Brown & Raymond, 2014; Mayer & Turner, 1996). Consequently, public participation can enhance the quality and efficiency of decision-making, considering that expert-driven planning may overlook crucial factors (Kopáček, 2021).

Despite the wide recognition of the importance of public involvement in land-use planning, public participation in decision-making remains limited (e.g. Häkli et al., 2019). A possible reason could be that decision-makers have in general no legal obligation to consider the interests of those affected by land-use changes, and participation is thus mostly stipulated through mandatory disclosures before final approval (e.g. Nared et al., 2015; Zaleczna, 2018). Therefore, the success of public participation in land-use planning seems to hinge on the willingness of groups to collaborate and compromise (Redpath et al., 2013; Zaleczna, 2018). Another reason might be that there is still a lack of simple and cost-effective solutions to implement the participation of local residents in the planning process. However, the last decades have seen great progress in the development of web-based public participatory geographic information systems (PPGIS), such as map-based questionnaires and apps (e.g. Brown et al., 2012, Jankowski et al., 2019; Kyttä et al., 2023). Such tools greatly facilitate public involvement in land-use planning and decision-making processes (Hugo & Viertel, 2024; Kahila-Tani et al., 2019; Kantola et al., 2023; Nikula et al., 2020; Ólafsdóttir et al., 2020; Penny et al., 2022; Pocewicz et al., 2012; Zolkafli et al., 2017). Accordingly, using PPGIS can contribute to more inclusive decision-making practices, allowing for better integration of location-based social values and traditional knowledge into planning.

This paper aims to better understand how public participation in land-use planning contributes to community well-being, by assessing residents' attitudes toward changes in land-use, and land-use conflicts, and towards their involvement in land-use planning and decision-making processes. Furthermore, to highlight the strengths and weaknesses related to the use of PPGIS and focus group discussions as a tool for collecting and communicating land-use preferences and concerns for incorporation into decision-making. The study focuses on the Southern Westfjords of Iceland, and particular attention is given to recent developments in the region's fastest-growing industries as key drivers of land-use changes (i.e. aquaculture and tourism), and to residents' perceptions of their impact on the local communities, livelihoods, and quality of life.

2. Study area

2.1. Physical settings and population trends

This study focuses on Vesturbyggð municipality, located in the southern part of the Westfjords region in Iceland (Figure 1). The study area is characterized by mountainous terrain, featuring deep narrow fjords, steep slopes, and few lowlands (NLSI, n.d.). Its sparse vegetation cover is dominated by grass, heath, and scrublands, whereas moss-heaths and unvegetated habitats prevail at higher elevations (Icelandic Institute of Natural History, 2024).

Vesturbyggð municipality is sparsely populated, with a total of 1356 residents as of 1 January 2024, accounting for approximately 0.4% of Iceland's total population (Statistics Iceland, n.d.). The municipality

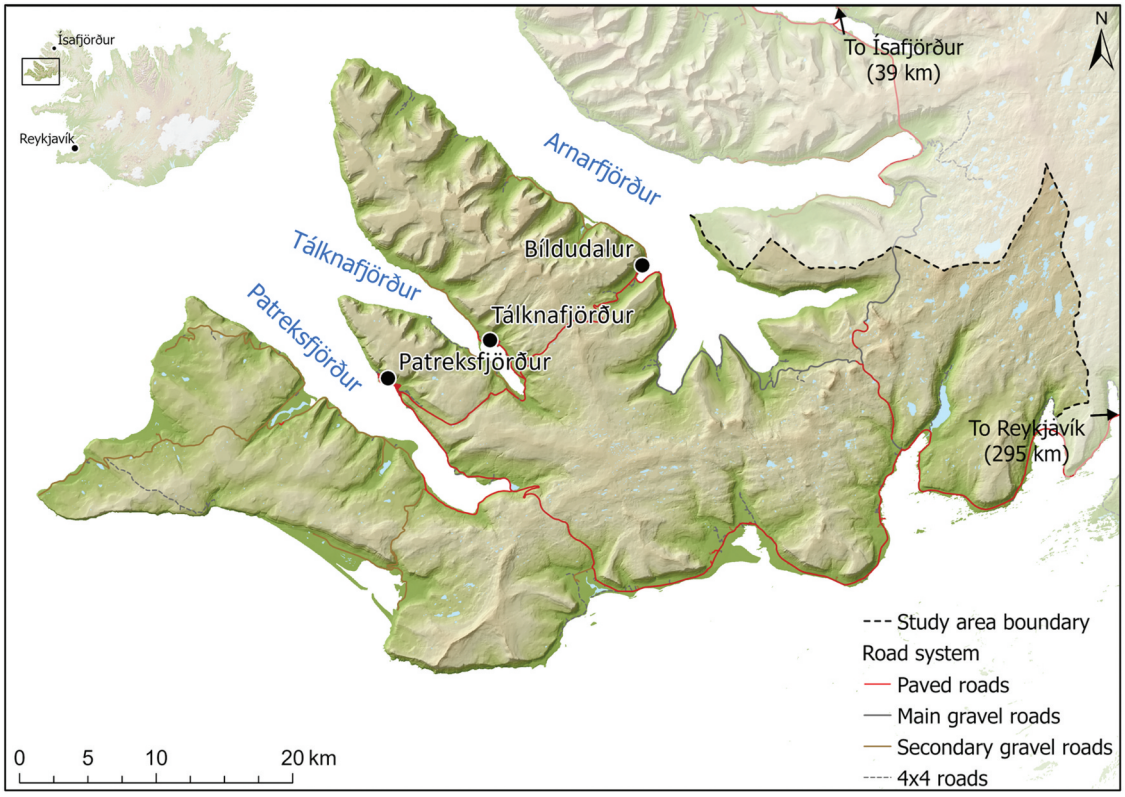

Figure 1. The location of the study area, Vesturbyggð municipality, in the southern Westfjords of Iceland, and its three townships.

experienced a gradual population decline from 1990 until 2011, when it somewhat stabilized. Since 2016, it has been slowly increasing, largely owing to the emergence of aquaculture in the area. Over the past decades, the proportion of men in the population has been rising, reaching over 55% compared to 45% of women in 2024 (Statistics Iceland, n.d.). Residents of foreign origin accounted for 27% of the population in 2024, compared to 15% in 2010, and to the country-wide averages of 16,6% in 2024, and 6,8% in 2010 (IRDI, 2024. This demographic shift reflects changes in the labour market and implies a rapid evolution of societal patterns in the study area.

2.2. Land-use history

In the early 20th century, the rise of fisheries transformed the study area's land-use, triggering the abandonment of numerous sheep farms, and fuelling the growth of the area's three current townships: Patreksfjörður, Tálknafjörður, and Bíldudalur (*cf*. Figure 1). In 1984, the Icelandic fishing industry transformed dramatically with legislation allocating fishing quotas to individual vessels. In 1991, these quotas were made transferable, allowing their sale, resulting in the Westfjords quota being largely sold off, with major impacts on the regional and rural development (Edvardsdóttir, 2016). Since the turn of this century, new industries, essentially aquaculture, mining of calcareous algae, and tourism, have grown and are now viewed as positive counteractions to out-migration and depopulation in many municipalities in the Westfjords (e.g. Edvardsdóttir, 2016). Initially driven by Icelandic investors, the aquaculture industry is now under the majority ownership of foreign investors (Arctic Fish, 2023; Arnarlax, n.d.). The same applies to the supply chain extracting calcareous algae (Icelandic Calcareous Society, n.d.). The rise in foreign ownership of companies in the area highlights the influence of global drivers on local communities (e.g. Nygaard et al., 2024; Suopajärvi et al., 2024). In contrast, the tourism industry in the area is still largely characterized by small- and medium-sized locally owned businesses. Of the total number of foreign tourists visiting Iceland, only 13% went to the Westfjords in 2023 (ITB, 2024). Factors such as the distance from the capital area and the region's peripheral configuration compared to the country's popular ring road (highway #1) are likely to

be significant contributors to this fact (Bishop et al., 2024). However, in recent years, the area has been receiving increasing attention in international travel media (e.g. Gollan, 2019; Lafferty, 2021). Substantial marketing efforts have been deployed to promote the area and the so-called 'Westfjords Way' itinerary, connecting many of the region's key landmarks (https://www.vestfjardaleidin.is/en). Nature-based tourism is by far the largest type of tourism in the study area. While driving rental vehicles seems to be the main travel mode, activities such as hiking, biking, horseback riding, and birdwatching are also pursued, as well as a variety of adventure tourism options. Over the past few years, cruise ship tourism has rapidly grown in the Westfjords and is emerging in the study area where smaller vessels can operate during the summer season (Ólafsdóttir et al., 2024).

The development of these industries has substantial implications for spatial planning. Municipalities are legally responsible for land-use planning within their boundaries (Icelandic Act no.138/2011), while planning of Icelandic waters falls under the national government (Icelandic Act no. 88/2018). Throughout the planning process, citizen involvement is largely limited to public meetings and consultations, which tend to occur late in the process, mostly through the submission of comments on draft plans. However, large-scale projects must undertake an environmental impact assessment (Icelandic Act no. 111,2021), which requires further consultation of key institutions and organizations, and is open to the public. This is the case for obtaining operating licenses for aquaculture in open-sea cages. Yet, public comments rarely impact decisions beyond slight adjustments or phrasing, and environmental impact assessments are not legally binding. Thus, public participation often remains limited to information sharing and comment submission rather than active involvement in decision-making. Tourism developments, still largely carried out by small and medium-sized enterprises, are rarely subjected to laws on environmental impact assessments.

3. Data and methods

To assess the attitudes of local residents towards land-use changes and related impacts on local communities, livelihoods and quality of life, as well as towards potential land-use conflicts, a mixed methods approach was used, comprising both quantitative and qualitative data collection through an online PPGIS survey and on-site focus groups to further discuss the results of the survey and collect more in-depth knowledge. A mixed methods research design was chosen to integrate both quantitative and qualitative data in a single study, showing that there is more than one way of knowing and expressing that knowledge (Almeida, 2018).

3.1. PPGIS survey

An online PPGIS survey was designed using Maptionnaire, which integrates an interactive mapping interface that allows respondents to pinpoint locations and areas on a map. The survey was semi-structured, using both open-ended and structured questions. The latter included multiple-choice items, 5-point opinion scales ranging from 'strongly disagree' to 'strongly agree', and slider items ranging from 'positive' (+5) to 'negative' (−5). Additionally, the participants were asked to pinpoint locations and draw areas on a map. In total, 16 questions across four major categories were used. (1) The first dealt with participants' relationship to the study area as well as their perception of recent land-use changes. (2) In the second category, participants were asked to express their opinions and preferences towards tourism and aquaculture development and to identify locations and areas considered as the most and least suitable for further development of these sectors. (3) The third category dealt with participants' assessment of the economic, social, and environmental impacts of these two industries on several aspects, including local jobs, investments, population growth, local culture and tradition, wildlife, and pollution. (4) The fourth and final category dealt with participants' awareness and level of concern regarding the long-term land-use impacts with respect to climate change in relation to their livelihoods and the resilience of the area. The survey was available in Icelandic, English, and Polish, as 10% of the target population is of Polish origin (Statistics Iceland, n.d.).

The link to the PPGIS survey was shared with participants through the municipality's website and social media pages. To maximize public outreach, the survey was also posted in social media groups for residents and sent by email to all non-governmental organizations registered in the area, inviting all members to participate. Data collection was conducted between June 11th and 8 July 2021. In total, 225 responses were

Table 1. Targeted focus groups participating in the study.

	Focus group (FG)	Date of meeting	*n*	Age range	Duration of residency (years)
FG1	Diverse cross-section of residents	Sep. 2022	12	25–70	5–70
FG2	Young residents (high school students)	Sep. 2022	8	16–19	8–19
FG3	Residents of foreign origin	Nov. 2023	6	30–45	4–25

collected and included in the results of this study. However, only 73 (32%) fully completed questionnaires were submitted. Many respondents dropped out following the first mapping questions, possibly due to unfamiliarity with map-based tasks or challenges in using the interface. The vast majority of respondents were aged 26–65 (84%), and more than half had lived in the area for more than 25 years (52%). Only 2% of the respondents were non-Icelandic citizens. The gender distribution was 63% men, 35% women, and 2% of other gender.

Data analysis primarily consisted of producing frequency tables and computing univariate descriptive statistics for the survey items related to respondents' attitudes. Maps were produced to visualize the PPGIS geodata using kernel density tools with a consistent display and scale to aggregate data points and transparency to visualize polygon overlaps. Bivariate analysis was further used to compare the perceived local impacts of tourism and aquaculture on various items. Two-tailed independent t-tests were used to account for the uneven response patterns among respondents.

3.2. Focus group discussions

To gain a more comprehensive understanding of residents' attitudes, focus group meetings were held in the municipality to introduce and discuss the results of the PPGIS survey. This method aims to capture participants' diverse experiences, beliefs, perceptions, and attitudes through guided and moderated interactions (Hayward et al., 2004; Morgan, 1996). Three focus groups were organized (Table 1) for the study. The aim of the *first* focus group meeting was to bring together a demographically diverse cross-section of residents, along with stakeholders from the tourism and aquaculture industries. Two residents were selected from each of the following groups: young residents (under 25 years old), senior residents (over 65 years old), middle-/working-age residents (25–65 years old), residents of foreign origin, and residents involved in the tourism and aquaculture sectors, resulting in a total of 12 participants with equal gender distribution. The aim of the *second* focus group meeting was to reach out to the younger residents (under 20), which proved difficult to engage in the PPGIS survey. The meeting was organized in collaboration with the local high school, from which eight students of equal gender distribution actively participated in the discussion. Engagement of foreign residents in the PPGIS survey was likewise very limited; therefore, a *third* focus group meeting was organized with six Polish residents living in the area, including four male and two female participants.

All three meetings used an open discussion format. Each began with an introduction to the project and the online PPGIS survey, followed by a presentation and an interpretative discussion of the results. Emphasis was placed on ensuring that all participants had the opportunity to express their thoughts and viewpoints, resulting in dynamic and engaging discussions supervised and moderated by the authors, spanning a duration of 2–3 hours for each focus group meeting.

4. Results

4.1. Local values and land-use change

The first PPGIS component in the survey sought to identify areas of personal significance or importance for respondents, with further inquiry into their related values. The spatial analysis of the answers reveals that the largest clusters of areas of personal significance align with the local towns, namely, Patreksfjörður, Bíldudalur, and Tálknafjörður, while other sites are scattered across the municipality's coastal areas. Most supported their choice by a personal connection to the area, such as a current or former place of residence or family home. Others highlighted its natural (e.g. natural beauty) or cultural value (e.g. historic sites) and how they enjoy it (e.g. outdoor recreation).

Other uses were occasionally mentioned, such as 'diverse economy', 'forestry area', or 'good power plant option'. Participants from focus group 1 (FG1) considered that these results align well with the areas that they also find important in the municipality. Most participants from focus group 2 (FG2) expressed a strong attachment to a natural geothermal bath, which is in their mind a perfect relaxation area. None of the participants of focus group 3 (FG3) could identify a particular site which stands out compared to the others.

The survey participants were then asked to identify the most significant land-use change in recent years. A large majority of respondents consider the development of the aquaculture industry to be the most important change in land-use in the area. Far fewer mentioned tourism, forestry, or the decrease in traditional farming and fisheries. The FG1 participants supported these results, considering that they describe the situation well and align with their own experiences. Overall, participants from all three focus groups seemed optimistic about the recent development of aquaculture and tourism.

4.2. Attitudes towards emerging industries land-uses and land-use conflicts

The survey participants were asked to indicate their level of agreement or disagreement with various statements concerning the development of aquaculture and tourism in the study area.

4.2.1. Attitudes towards aquaculture

The survey results indicate strong local support for aquaculture development, with 69% in favor and 20% opposed (Figure 2). A large majority of respondents (85%) agree that there is a need for further processing of aquaculture products within the region. There is also strong support (84%) for long-term planning in aquaculture development, along with an increased emphasis on better planning for the utilization of marine resources in the fjords. More than 75% of the survey respondents feel the need for increased consultation with local communities regarding aquaculture development, and a similar proportion agree on the need for more sustainable fish farming practices. While 57% support the expansion of offshore fish farming (compared to 24% who oppose it), land-based fish farming receives less support (44% in favor and 27% opposed).

The FG1 participants agreed with these results but also highlighted that the residents had no say in whether they wanted aquaculture or how it should be developed: *'We've never been asked anything about it.' . . . 'It is the government that decides on this.'* Public involvement in such decisions is seen as limited to the delegation of decision-making power to elected officials: *'Our local authorities did, however, provide a favorable review, and they are comprised of elected representatives.'* The FG3 participants, most of whom work in aquaculture, were notably surprised to see that 20%-27% of the survey respondents opposed aquaculture developments in various forms. They were well aware that aquaculture is a debated topic at the national level but did not expect such a large proportion of the local community to hold such views. Further, they expressed the desire to see aquaculture companies operating in the area contribute more to local infrastructure development.

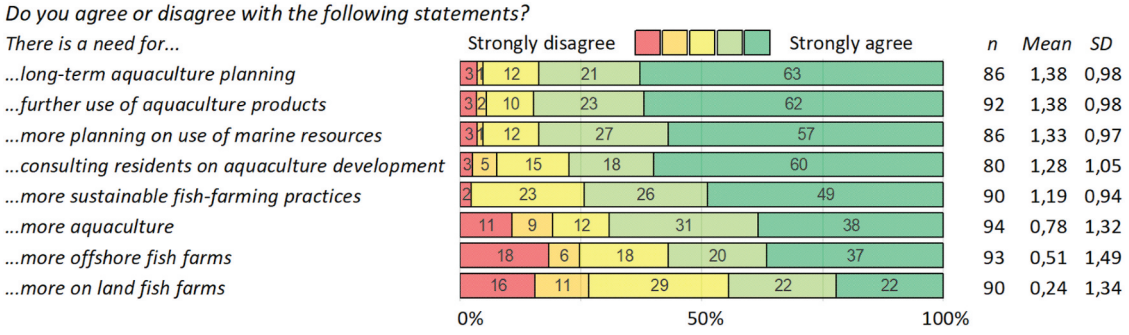

Figure 2. Survey respondents' views of the development of aquaculture in the study area. *(Strongly disagree = -2; Strongly agree = +2).*

4.2.2. Participatory mapping of aquaculture development preferences

The participatory mapping of areas perceived as suitable for aquaculture development and those where it should be restricted reveals some overlap. Most survey respondents identify the most suitable areas to be in the study area's three largest fjords, namely, Patreksfjörður, Tálknafjörður, and Arnarfjörður, which largely correspond with the current areas used for aquaculture (Figure 3(a)). However, a notable proportion consider that aquaculture should not be allowed in Tálknafjörður (Figure 3(b)). Patreksfjörður received the most data points for suitable locations, but the most mapped areas are located towards the outer part of the fjords. Further analysis of the comments attached to the survey participants' 71 data points and areas shows that the array of reasons for suitability encompasses factors such as the best location in terms of land transport, sheltered settings, and favorable conditions regarding rapid sea water changes and robust ocean currents. Some expressed their preference for locating aquaculture at a reasonable distance from the villages, while others simply stated *'as far away as possible.'*

Participants across all three focus groups found the mapping results to be in line with their expectations. One mentioned that this consistency among answers could be due to a carrying capacity assessment previously conducted for the fjords as part of the permit allocation process, which was introduced to the residents. Another noted that a utilization plan for Arnarfjörður was conducted 10 years prior, and that ongoing work directed towards a coastal plan for the Westfjords region might have influenced the perceptions of respondents. However, some found it noteworthy that Patreksfjörður is perceived as more suitable for aquaculture than Arnarfjörður, despite the latter's higher calculated capacity in the utilization plan. This was deeply discussed, and participants wondered whether respondents' residency played a role, each protecting areas near where they live from aquaculture development. Some also pointed to a potential link between areas that the survey respondents considered should be safeguarded from aquaculture development and known natural attractions as well as popular sites for outdoor recreation.

4.2.3. Attitudes towards tourism

Three-quarters of the survey respondents perceive further development of tourism as necessary, with particular emphasis on domestic tourism (81%) and sustainable tourism (74%). Less than half of the respondents (47%) view cruise ship tourism as a priority, compared to 30% who disagree (Figure 4). In terms of tourism planning and management, the vast majority (74%) agree on the need for long-term planning. Nearly half (48%) believe that certain areas should be preserved from tourism development, while 18% disagree. Regarding the development of tourism accommodation types, 64% of the respondents agree that there is a need for more summer houses for rent. Approximately half of the respondents consider the same for guesthouses and hotels (49% agree, 16% disagree), as well as for camping grounds (48% agree, 23% disagree), and luxury hotels (43% agree, 26% disagree).

The participants from FG1 found these findings informative and supported the need for long-term planning regarding tourism development, along with efforts to attract more domestic tourists. When

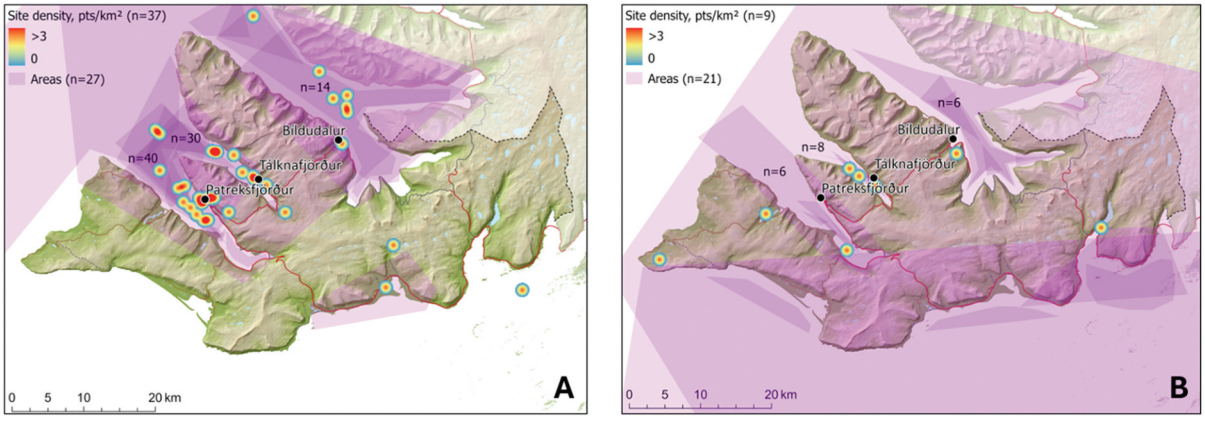

Figure 3. A) sites and areas perceived by survey respondents as suitable for further development of aquaculture; B) sites and areas where no aquaculture development should take place according to respondents. (heatmaps based on kernel density using a cell value of 0.001 and search radius value of 1000).

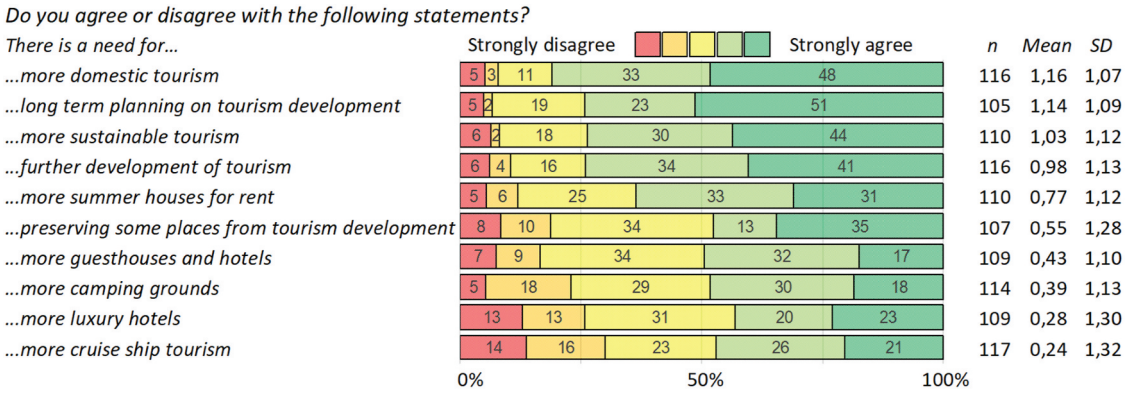

Figure 4. Survey respondents' views of the development of tourism in the study area. *(Strongly disagree = -2; Strongly agree = +2).*

discussing visitors' behavior, expenditure comparisons were made between domestic and foreign visitors. One mentioned that *'the Icelanders make better visitors, because they do well in food and drink, whereas the foreign visitors buy one sausage for four.'* Domestic visitors were, however, considered less inclined to participate in offered trips, and it was further mentioned that foreign visitors are preferable guests in hotels due to their early departures, allowing for easier cleaning, whereas the natives tend to sleep in until noon while on vacation. The FG1 participants also unanimously agreed that there is no need to attract additional cruise ships, noting that their opinion was inconsistent with the ambitions of the local authorities, who in their opinion, seem to consistently target the cruise ship market. The FG3 participants also stressed negative views towards cruise tourism *'because the cruise ships do not leave money for us, everything stays on board of the cruise ships.'* Further discussions arose regarding potential conflicts between residents and the tourism industry. Participants across all three focus groups deliberated on the suitable level of tourism development, where the difference of opinion revolved around where the value lies, that is, in maintaining the area's current state or enhancing accessibility and tourism infrastructure.

4.2.4. Participatory mapping of tourism development preferences

Similar to aquaculture, participatory mapping of areas perceived as suitable for tourism development and those where no tourism development should take place reveals some overlap. The most suitable locations identified for tourism expansion largely align with destinations which are already popular among visitors, while also including secondary sites of interest and places where infrastructure development could take place (Figure 5(a)). Analysis of the comments attached to the survey participants' 125 data points and areas

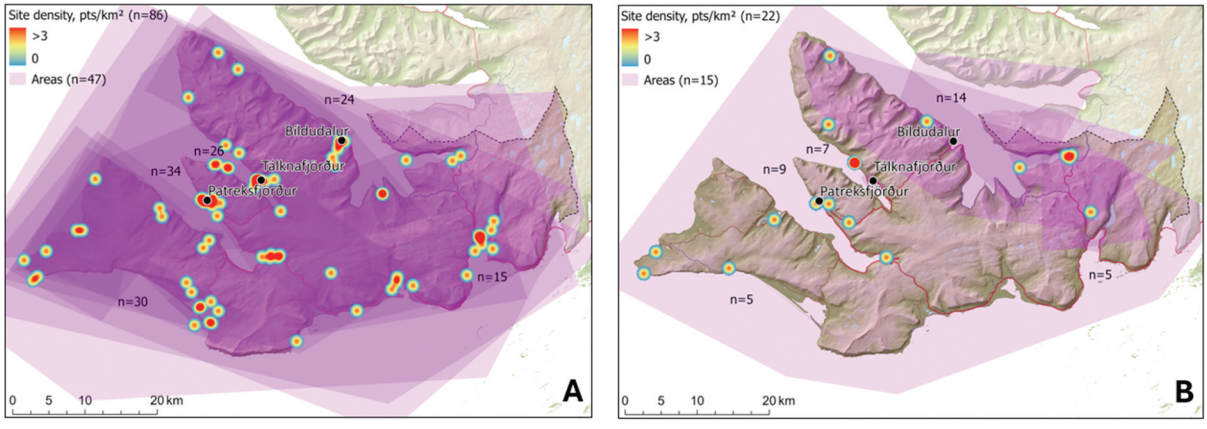

Figure 5. A) sites and areas perceived by survey respondents as suitable for further tourism development; B) sites and areas where no tourism development should take place according to respondents. (heatmaps based on kernel density using a cell value of 0.001 and search radius value of 1000).

reveals that in terms of suitability, natural beauty, nature experiences, wildlife, and enjoying tranquility and quietude were the main factors for selecting these locations. Some also highlighted the potential for promoting heritage tourism based on the area's rich history. Many respondents added information as to which type of development they envision, mentioning hiking trails, visitor centers, increased accommodation, transportation on sea, dining options for visitors, and opportunities to use geothermal waters.

Locations mapped by the survey respondents as needing to be safeguarded from tourism development, although much fewer, largely overlap with sites that are also viewed as suitable for tourism development (Figure 5(b)). This indicates the presence of diverging views on tourism development among local residents. While some respondents highlighted large areas, others were more precise. Among the comments related to these 33 sites and areas, pristine nature and tranquility were key themes referred to by some respondents.

This was discussed in all the focus groups. Some participants found it paradoxical that some of the sites where tourism development is opposed already have tourism infrastructure in place, highlighting in their mind the controversy surrounding tourism activities. One example was raised concerning the Látrabjarg bird cliff, where a few landowners who do not want more tourism development have obstructed the local authority's efforts to improve the road. An example of a conflicting area from the mapping results was also discussed, taking the remote fjord Geirþjófsfjörður, where opinions within FG1 diverged around the possibility of developing tourism services without overly increasing its accessibility: '*. . . it would be feasible to establish tourism services without the necessity of constructing a road down there, ensuring accessibility for tourists while preventing mass tourism.*' FG2 participants expressed their attachment to a small geothermal bath, believing it should remain untouched by tourism and be preserved for locals.

4.3. Economical, societal and environmental impacts

The survey participants were asked to evaluate the impact of aquaculture and tourism development on 26 items related to the local economy, society, and environment, using a slider scale ranging from −5 (very negative impact) to + 5 (very positive impact). In general, both industries are seen as having a very positive impact on their communities (Table 2). In both cases, the highest positive impact is on local jobs, local income, investments, helping people to stay in their home area, livelihood/vibrant community, diversity in the job market for men, immigration in the area, population growth, collaboration with other industries,

Table 2. Impact scores.

	Tourism			Aquaculture			p-val	
Category	*n*	Mean	*SD*	*n*	Mean	*SD*		
*Local jobs**	72	2.47	1.79	54	3.20	1.87	0.0289	−0.73
*Local income**	69	2.28	1.80	53	3.13	1.85	0.0120	−0.86
Investments	69	2.29	1.97	55	2.96	2.23	0.0795	−0.67
*Helps people to stay in their home area***	47	1.87	2.68	45	3.20	1.78	0.0071	−1.33
Livelihood/vibrant community	46	2.11	2.13	43	2.88	1.93	0.0795	−0.78
*Diversity in the job market for men***	54	1.85	2.32	48	3.04	2.13	0.0091	−1.19
*Immigration in the area***	48	1.77	2.35	42	3.05	1.45	0.0033	−1.28
*Population growth****	52	1.65	2.57	46	3.15	1.55	0.0010	−1.50
*Collaboration with other industries**	36	1.69	2.40	39	2.95	1.84	0.0141	−1.25
Availability of services	50	1.80	2.46	41	2.66	1.88	0.0725	−0.86
Diversity in the job market for women	62	1.69	2.41	45	2.51	2.14	0.0751	−0.82
Infrastructure	46	1.61	2.51	38	2.37	2.46	0.1724	−0.76
Accessibility to area and within it	37	2.03	2.15	32	1.94	2.65	0.8790	0.09
Networking and social interaction	30	1.90	2.36	31	1.74	3.05	0.8248	0.16
Local culture and tradition	32	0.94	2.44	24	1.50	2.96	0.4473	−0.56
Peacefulness in wild areas	43	0.47	3.09	28	0.96	3.25	0.5225	−0.50
*Prices of goods and services (e.g. cost of living)**	45	−0.11	2.76	40	1.45	2.83	0.0128	−1.56
Peacefulness in residential areas	31	0.74	2.94	28	0.46	3.30	0.7382	0.28
Hygiene and sanitation	37	−0.08	2.71	28	0.93	2.98	0.1650	−1.01
Effect for wildlife (birds/seals/whales, . . .)	29	0.24	2.49	27	−0.26	3.36	0.5346	0.50
Effect on soil and vegetation	29	−0.24	2.60	19	0.05	2.98	0.7250	−0.29
Safety and security (incl. accidents, crime)	33	−0.39	2.84	29	0.00	3.13	0.6111	−0.39
Visual impacts from infrastructures	31	0.13	2.34	34	−0.85	2.87	0.1439	0.98
Emigration in the area	37	−0.92	2.55	29	−0.24	2.80	0.3162	−0.68
Pollution and other environmental impacts	31	−1.03	1.98	35	−1.23	2.71	0.7441	0.20
Carbon footprint	29	−1.17	2.00	28	−1.21	2.57	0.9464	0.04

*$p < 0,05$; **$p < 0,01$; ***$p < 001$ (independent t-test to compare the means between tourism and aquaculture).

availability of services, diversity in the job market for women, and infrastructure. Additionally, both industries are seen to contribute positively to accessibility to the area and within it, networking and social interaction, and local culture and tradition. Slight positive impacts are noted in terms of peacefulness in wilderness and residential areas, while mixed to positive impacts are noted on prices of goods and services, hygiene and sanitation. Mixed impacts are noted for the effects on wildlife, soil and vegetation. On the other hand, mixed to negative impacts are perceived on safety and security, visual impacts from infrastructure, and emigration in the area. Negative impacts are noted on pollution and other environmental impacts, and in terms of carbon footprint. The comparison of means reveals significantly higher scores for aquaculture than for tourism in terms of impact on local jobs, local income, helping people to stay in their home area, diversity in the job market for men, immigration in the area, population growth, collaboration with other industries, and price of goods and services.

The participants in FG1 agreed with these survey results, yet they also stressed their concerns regarding the growing gender gap among residents. This sparked discussions about the responsibility of aquaculture companies in community development, such as their contribution to the development of services and infrastructure: *'If we had been asked, we would have wanted to set some conditions for their development [. . .], such as demands on the companies to help us building a sustainable society and addressing population development concerns.'* The group also highlighted a concern that increased requirements in environmental matters might hinder community development: *'. . . in industries like aquaculture and natural resource exploitation in general, there could be more restrictions, and it may hinder development in our society, as it is now, because we rely on few and large employers.'* The group then discussed the need for a more diverse economy, arguing that having *'all eggs in the same basket was not an ideal situation.'* Participants in FG3 further added that the lack of local services (e.g. restaurants, discount grocery stores) and poor infrastructure (e.g. transportation, schools) affected their quality of life in the area. Some felt marginalized by governmental plans, particularly in relation to transportation: *'I feel like we are the last in line as regards road construction, tunnels, infrastructure; we are the last.'* Participants in FG2 did not comment specifically on the economic or societal issues as they plan to leave to continue their education elsewhere, yet they acknowledge the qualities inherent to their community in terms of friendliness, mutual support, safety, and the deep sense of community belonging among residents: *'The people are the best here'*; *'What characterizes the community here is how everyone helps each other if there is a problem.'* However, they expect little change in their communities in 10 years with respect to increased services and infrastructure.

4.4. Perceptions of long-term land-use impacts from climate change

In the fourth and final part of the survey, participants were asked about their perceptions of the long-term impacts of climate change on the area's land-use and, consequently, their livelihood. Most consider that climate change will have a positive impact on forestry (average impact score of +1.8 on a scale of −5 to +5), mixed to positive impacts on tourism (+0.7) and agriculture (+0.3), mixed to negative impact on aquaculture (−0.4), societies (−0.6), and shipping (−0.7), and negative impact on fisheries (−1.1), wildlife (−1.2), the environment (−1.2), and natural hazards (−1.9). Among the listed potential climate change impacts, respondents consider that extremes weather and ocean acidification to be most concerning (selected by 71% and 69% respectively), followed by warmer oceans (59%), changes in ocean currents (51%), and rising sea levels (47%). Other impacts were less of a concern among respondents, such as a warmer climate (37%), natural hazards (37%), geopolitical tensions (35%), and invasive species (16%).

The FG1 participants agreed with these findings. They specifically discussed extremes in weather, warmer oceans, and rising sea levels. However, they found the increased tension in international politics in relation to land-use more concerning and raised the possibility of climate refugees fleeing droughts and floods, which could strain intergovernmental relations. Concerns about new invasive species were also raised, prompting a discussion about the Alaskan lupine, a debated invasive species introduced for land reclamation in Iceland. Participants in FG2 expressed mixed views, including some concern due to its significant global impact, and the belief that Iceland might be affected: *'I'm ready to take part in changing the environment, but I don't get so stressed.'* Independently from their attitudes, all acknowledged future impacts on their communities, particularly affecting nature, people, and fishing industries, for example, through potential flooding,

environmental degradation, or changes in air quality. Some participants in FG3 expressed more skepticism towards climate change than others: *'[My old boss] told me he had heard about climate change for 50 years and saw no difference. People are always saying that the climate is changing, but every year it is the same as it was 50 years ago.'*

5. Discussion

5.1. PPGIS as a tool for capturing and communicating land-use preferences

Land-use changes can have substantial impacts on communities´ well-being, but are also often a central cause of land-use conflicts (Foley et al., 2005). Such conflicts can, in turn, have long-lasting impacts on the social cohesion of local communities, while constituting an economic risk for entrepreneurs, investors, and other legally bounded parties such as public authorities (e.g. Živojinović et al., 2024). In Iceland, one of the most influential conflicts in recent times affecting land-use change and consequently rural development is related to the adoption of fishing quotas in the 1980s, subsequently leading to the privatization and consolidation of natural resource use permissions to a few companies. This has greatly accelerated outmigration from the country's rural coastal communities (Edvardsdóttir, 2016; Edvardsdóttir et al., 2023; Kokorsch & Benediktsson, 2018). As a result, any prospects of economic opportunities have been eagerly welcomed to revive these communities, such as through the recent development of aquaculture and tourism in the southern Westfjords. However, concerns over their social and environmental impacts seem to be growing (e.g. Ćirić, 2023). The findings of this research provide valuable insights into the opinions and attitudes of local residents towards the development of these new and emerging industries and their associated economic, social and environmental impacts. While they generally support further development, variations are observed depending on the level and type of development considered, with a preference for more sustainable practices and long-term planning. They furthermore desire to be actively involved in decision-making regarding the development of these industries and related land-uses. Despite strong support for these sectors, a substantial proportion of the local community expressed some negative views towards further development, pointing to potentially emerging land-use conflicts. Participatory planning tools, such as PPGIS, therefore seem particularly useful to refine public preferences beyond the approval or rejection of development projects and look into specific options or locations (Brown et al., 2018), as community members are likely to hold more nuanced opinions than one might expect. The findings further stress that introducing public opinion data to focus group participants provides them with a broader perspective and enables more fruitful and constructive discussions with respect to land-uses. Hence, this process enables sharing opinions that are not necessarily expressed openly in remote rural communities where maintaining social cohesion is important (Zhu et al., 2025). This is particularly crucial for issues such as aquaculture and cruise ship tourism, which can be prone to land-use conflicts and undermine the social cohesion of local communities (e.g. Foley et al., 2005). Despite the challenges inherent to the use of a PPGIS interface, participatory mapping of land-use preferences adds yet another layer of nuance and detail to the opinions that can be expressed, providing a comprehensive overview of where different perspectives and priorities align or diverge, highlighting sources of conflict and synergies. This is supported by many researchers (e.g. Buckley et al., 2017; Metze, 2020) emphasizing that the value of PPGIS lies in visualizing the different stakeholders land-use preferences, augmenting public discussion, and facilitating engagement. Kantola et al. (2023) further adds that PPGIS surveys are most effective when conducted during the early stages of the planning process. It is well known that once the zoning of resource utilization has been drafted, it is challenging to remove these areas from planning documents (Tiller et al., 2015). Therefore, engaging citizens in land-use planning from the onset with an opportunity to express their spatial preferences through PPGIS will facilitate more inclusive and informed decision-making, which can reduce the occurrence of land-use conflicts. The findings of this study additionally show that using PPGIS mapping results as a foundation for focus group discussions yields a more comprehensive and nuanced understanding of residents' attitudes. Focus group discussions encourage sharing information, building on comments, and fostering robust conversations, as every participant has a voice that must be heard (Gearin & Hurt, 2024). In such discussions, differences between groups can also come to light.

5.2. Towards more resilient rural communities

Following changes in natural resource use and subsequent population changes, the resilience of many rural Arctic communities has been challenged (e.g. Kokorsch & Benediktsson, 2018; Suopajärvi et al., 2024). Changes related to the growth of new industries in rural Iceland, such as aquaculture, seem to counterbalance the depopulation trend, making these areas more attractive to new residents. However, this demographic recovery also coincides with a widening gender gap in the study area (Icelandic, 2024), likely due to the number of migrant male workers who typically constitute the bulk of the workforce in such resource extraction industries (Edvardsdóttir, 2016, 2021; Edvardsdóttir et al., 2023). This development is seen in many gender studies, emphasizing that in the rural Arctic, women are less involved in the blue economy than men (Karlsdóttir & Guðmundsdóttir, 2024; Ounanian, 2019). The findings of this research support this view, demonstrating residents' concerns that aquaculture generates more job opportunities for men than for women, a pattern that has intensified discussions regarding the widening gender imbalance. In contrast, the gender gap in tourism jobs is seen as less important, and reluctance related to its development seems to relate to visitor flow and impacts on sites of interest, which are also enjoyed by residents. Overall, support for tourism or aquaculture development seems to relate to their expected economic benefits, providing local jobs and investments, thus helping people to stay in their home area and attracting new residents, contributing in turn to a better community infrastructure, services, social life, and networking. Yet, these benefits have been limited in the southern Westfjords, leading to disappointment and frustration among residents, especially younger residents, who see limited prospects in the region. Hence, while these industries are seen as economically viable, their social contributions to the local community seem insufficient from the perspective of residents. Likewise, both sectors are seen as negative for the environment, which calls for more ambitious efforts from these industries to reduce their environmental impact and increase their contributions to the community. The integration of such socio-ecological dimensions carried by residents´ values in participatory approaches demonstrates the importance of citizen engagement in decision-making to better support host communities and foster more sustainable development and community resilience.

5.3. The role of citizen engagement in community well-being

To create a sustainable community that enhances residents' quality of life and well-being, citizen involvement in decision-making and land-use planning seems essential. A community is first and foremost a place where people live, relate to, and engage with each other (e.g. Edvardsdóttir et al., 2023; Stevenson, 2002). This research highlights that public participation can foster a strong sense of community and that residents are generally eager to engage in land-use decisions related to their local development and thus contribute to community well-being. This demonstrates the crucial role of people in shaping communities (Edvardsdóttir, 2013; Karlsdóttir et al., 2023). Focus group meetings and PPGIS surveys are tools that allow for different formats for participation with their respective audiences and space, providing a non-threatening context where shared solutions are sought (Gutiérrez et al., 2016). Aside from fostering better civic engagement of communities and creating a more transparent and democratic process, better decisions are likely to result from such a process, more adapted to the local context through the integration of local knowledge, as well as more aligned with expectations, while offering opportunities for stakeholders to work together or anticipate negative outcomes (Reed, 2008). This highlights the importance of understanding the complex interplay between the economic, social, cultural, environmental, and political conditions in local communities, as demonstrated by many researchers (e.g. Atkinson et al., 2017; Wiseman & Brasher, 2008). Participatory mapping of collective values and areas of personal significance in this study emphasizes the importance of place attachment, landscape aesthetics, natural and cultural heritage, as well as the recreational importance and usage of an area. Integrating these ecosystem services in land-use planning seems essential to foster community well-being (Williams & Ólafsdóttir, 2022), for example, through conservation projects or community incentives.

Community well-being and quality of life involve a complex interplay of many factors which must be considered to increase community attractiveness for new residents and appeal to young people. Integrating the perspectives of these specific groups in land-use decisions seems crucial to ensure

that communities retain their appeal to future generations and new or returning residents. Residents' early engagement in the decision-making process fosters a sense of belonging and social cohesion, where individuals feel connected to their place and to one another, thus actively contributing to the collective welfare and well-being of their community. From a land-use policy perspective, community well-being should be a strategic goal to increase the attractiveness of rural communities in the Arctic.

6. Conclusions

The recent development of the aquaculture and tourism sectors in the southern part of the Westfjords in Iceland has bolstered the area's livelihood, attracted new residents, and is thus positively perceived by the local residents. As in other Arctic regions, economic benefits are well recognized, while perceived social contributions remain limited and negative environmental impacts are acknowledged (e.g. Bjørkan & Eilertsen, 2020; Ólafsdóttir et al., 2024). While tourism development is still in its early stages, aquaculture has become well established, and local demographics reflect a high proportion of male migrant workers, resulting in societal challenges for the local community, which still lacks social infrastructure to appeal to the younger generation. According to local residents, diversification of the local economy with increased value creation on-site and community-controlled development of new industries could contribute to increasing the quality of life and community well-being.

Whether future tourism growth can attract complementary demographic segments and evolve within the range of desirability of residents remains unclear. Yet, this provides an opportunity for the expressed preferences to be incorporated into planning documents. The use of PPGIS and focus group discussions to collect and map the preferences of residents in terms of land-use planning enables the identification of conflictual and more consensual development or protection areas, pointing to a delicate balance in terms of use types and intensities as well as geographic locations. Balancing economic development with social and environmental concerns is crucial for community well-being. National and local decision-makers, who play key roles in this process, should therefore actively involve local residents and employ more adequate tools to facilitate this engagement. By fostering inclusive decision-making processes that integrate local knowledge, cultural values, and democratic rights, different stakeholders can work collaboratively to address the complex issues that communities across the Arctic region are currently facing and build more resilient and prosperous societies for future generations. This requires a high-quality process, well-informed participants with framed expectations, and a clear goal so that they can place their trust in the process and take ownership of its outcome. The aim should always be to create sustainable and resilient communities that foster the quality of life and well-being of their people.

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Author contributions

CRediT: **Rannveig Ólafsdóttir:** Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing; **Michaël Bishop:** Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing; **Anna Guðrún Edvardsdóttir:** Investigation, Validation, Writing – original draft, Writing – review & editing; **Johannes Welling:** Writing – original draft; **Seija Tuulentie:** Writing – original draft.

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