



Prosper or perish? The development of Icelandic fishing villages after the privatisation of fishing rights

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Abstract

Icelandic fish stocks underwent privatisation in 1990, when existing fishing quotas were made fully transferable. The country's system of individual transferable quotas has since been held up as a paragon of virtue for sustainable fisheries. This might be valid for ecological and most economic concerns, but for a truly sustainable fisheries management system the question of social impacts has to be addressed as well. This paper evaluates the performance of Icelandic fisheries management from a spatial and social point of view. The theoretical framing stems from the concepts of resilience and vulnerability. Through cluster and correlation analyses, different development trajectories of Icelandic fishing communities since 1990 are revealed. The results are presented on maps. Even though it is no longer the country's largest economic sector, the livelihood of many small and remote settlements is strongly connected to the fisheries. Consolidation has taken place in the fisheries and rural-to-urban migration has continued. The majority of coastal communities can be classified as vulnerable, regarding the status of the local fishing industry in 2014. Regarding demographic development, the number of vulnerable communities was significantly higher in 2014 than it was at the early 1990s.

Keywords Fisheries management · Sustainability · Resilience · Vulnerability · ITQ · Iceland · Fishing communities

Introduction

Natural resource management is a complex endeavour, as it involves stakeholder groups with opposing interests. Fisheries management is no exception. In Iceland, the quasi-privatisation of fishing rights through individual transferable quotas (ITQs), that was completed in the early 1990s, did not go uncontested. It left deep social, economic and political rifts (Eythórssón 2003). Antagonistic perceptions can be detected not only among academics who have analysed this, but also within the fisheries sector, where small-scale fishermen demand access to the same resource as large-scale, vertically integrated, companies (Chambers and Carothers 2017, Mariat-Roy 2014). Although the state of the marine resources

was the major justification for introducing ITQs (Matthiasson 2003), economic goals were no less central, driven by overarching objectives of efficiency and centralisation (Árnason 1998, 2012, Eythórssón 2000). Those are substantial arguments, and arguably the system in use before was unsustainable in every aspect (Haraldsson and Carey 2011). But thorny socio-political issues remain unresolved. According to the first article of the Fisheries Management Act, “the exploitable marine stocks of the Icelandic fishing banks are the common property of the Icelandic nation. The objective of this Act is to promote their conservation and efficient utilisation, thereby *ensuring stable employment and settlement throughout Iceland*” (Icelandic Ministry of Fisheries and Agriculture 2006; italization by authors”).

The experience of Iceland with ITQs has been repeatedly presented as an economic success story (Árnason 2008, Danielsson 1997, Hannesson 2003). Economic concerns, however, are just one aspect of fisheries management. At least two academic strands other than economics demand consideration, namely ecology and social sciences. The input of ecology is manifested in this case through the setting of an annual total allowable catch (TAC), scientific advice and monitoring. Icelandic fisheries perform comparatively well also in

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this regard, and have indeed recovered from severely depleted fish stocks in the 1970s (Haraldsson and Carey 2011, Eythórsson 2000). The third dimension however, that of the social sciences (other than economics), has been rather weakly addressed. Social scientists have struggled to make their voices heard (for an overview of the state of social sciences in Icelandic fisheries see: Chambers and Kokorsch 2017).

Premonitions and critiques regarding negative effects of ITQs for fishing communities have been frequent, accompanied by questions of equity and social responsibility (Karlsdóttir 2008, Pálsson and Helgason 1995, 1996, Eythórsson 1996, 2000, 2003, Holm et al. 2015). Since the “direct subject of fisheries management is not fish, but people who are embedded in existing social, political and economic institutions” (Campling et al., 2012, 181), a more thorough investigation of the human perspective in fisheries management is necessary.

Several coastal communities in Iceland have found themselves in demographic and socio-economic difficulties, which is a blot on a supposedly sustainable management scheme: “Sustainable development is a three legged stool embodying environmental, economic and social sustainability; dangers arise when one of these legs is weakened by neglect” (Symes and Phillipson 2009, 1). But to what extent can the fisheries sector in general, and transferable quotas in particular, be held responsible for local development trajectories? Almost three decades after the implementation of ITQs, a comprehensive analysis appears well overdue: how have Icelandic fishing communities fared during the time since the regime was introduced? Or more specifically: is there a connection between the development of the fisheries sector and socio-economic and demographic developments at the local level? This, in a nutshell, is the focus of this article.

In dynamic and complex socio-ecological systems, such as fisheries, usually more than just one decisive causal variable can be detected (Folke 2006, Johnsen 2017, Ostrom 2009). The questions above can therefore only be partially answered here. In vulnerable systems, however, “even small disturbances may cause dramatic social consequences” (Folke 2006, 253). Thus the assumption that the ongoing process of centralisation in the fisheries sector has had tremendous impacts on the local level might be warranted (Agnarsson et al., 2016, Eythórsson 2000). In the paper, socio-economic, demographic and fisheries data from three different points in time will be evaluated through cluster analysis. In a second step, correlation analysis is used to reveal possible connections between fisheries, demographic development and the socio-economic performance at the local community scale. This analysis provides a retrospective evaluation of the social and regional impacts that have evolved after the policy change.

The results are important for two main reasons. First, they provide an empirically backed-up warning about negative social impacts of ITQs, which should be of value for international

and domestic policy makers. Second, the results shed light on the heated debate about to what extent transferable quotas have resulted in a truly sustainable fisheries management system.

Resilience and vulnerability

The theoretical framework for this study stems from the concept of resilience, which has become pervasive in natural resource management and social sciences during the past decade (Clay and Olson 2008, Lorenz 2013, Nelson et al., 2007, Benson and Garmestani 2011, Welsh 2014). This includes also discussions on appropriate fisheries management (Olson 2011, White 2015, Symes et al., 2015, Pauwelussen 2016).

In a general sense, resilience centres on potential responses to a sudden shock or disturbance, in terms of renewal, regeneration, or reorganisation (Folke 2006). This includes the capacity, potential and ability of ecological, social and/or economic systems to adapt and manage changes in both reactive and proactive ways. Social resilience is defined as “the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change” (Speranza et al., 2014, 110).

Vulnerability is often understood as the opposite of resilience (Obrist et al., 2010, Scoones 1998, Turner 2014, Adger 2000). For Adger (2006, 269), vulnerability determines the “degree to which a system is susceptible to and is unable to cope with adverse effects”. Blount et al. (2015, 2) define vulnerability as “the lack of an ability to withstand destabilizing changes”. Building on this, the key parameters of vulnerability are the stress to which a system is exposed, its sensitivity, and its adaptive capacity (Carpenter and Brock 2008, Folke et al. 2002). In addition, ‘buffer capacity’ marks the thin line between a resilient and a vulnerable system. It can be defined as the “amount of change (disturbance) a system can undergo (absorb) and still retain the same structure, function, identity and feedbacks on function and structure” (Speranza et al., 2014, 112). Buffer capacity is directly influenced by endowments and entitlements. Endowments determine the resources owned by an actor, while entitlements refer to an actor’s access to resources (Speranza et al., 2014, Ozkan and Schott 2013). Hence, buffer capacity, endowments and entitlements are important aspects for local resilience, particularly for communities with limited economic resources that are dependent on individual decisions regarding the trading of such entitlements (Dale and Newman 2006).

Endowments and entitlements are subject to the underlying management regime and changes can have profound effects at the local scale. The loss of entitlements to a resource, for example through privatisation and changing ownership structures, affects the socio-economic capacity and control over local resources (Ozkan and Schott 2013). The result of such changes can be disenfranchised communities with limited capabilities for continued existence.

Icelandic fisheries management and fishing communities

A brief outline of major events and general periods of growth, stagnation and decline in the national fisheries since 1900 (Fig. 1) is appropriate for recapitulating the turbulent history and to understand the reasons that eventually led to the introduction of an ITQ system.

Fisheries were a key industry in Iceland throughout the twentieth century and they still have a central role, even though tourism and heavy industries now compete for the leading position in the country's economy (Jóhannesson 2016). Several communities owe their emergence to their proximity to rich fishing grounds and some towns were not even 'on the map' before fisheries became economically significant in the early twentieth century. Fisheries were an attractive pull-factor and people relocated from scattered farmsteads and temporary settlements to the shore (Valsson et al., 2013). Another economic boom came with the herring fisheries. The era from 1930 to 1968 is presented in the nation's history books as the 'herring adventure' (Icel. *sildarævintýrið*) (Hamilton et al. 2004). The ups and downs – not only for the national economy, but also many settlements in Northern Iceland – were bound to this species. Overfishing put a sudden end to this adventure.

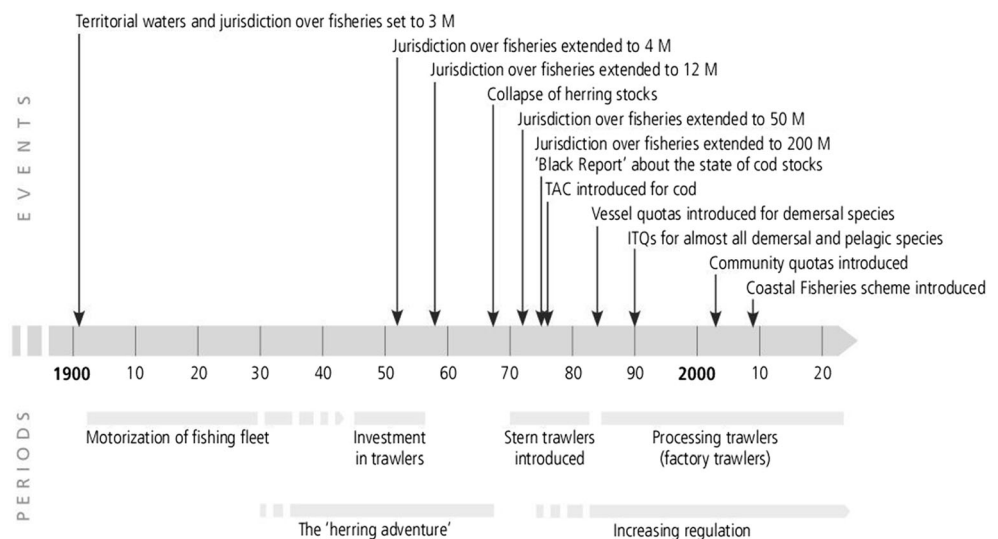
Diversification of target species and improvements of the fishing fleet led to a rapid recovery and 'one-company-villages' were still common (Eythórssón 1996, Matthiasson 2003, cf. Halseth and Sullivan 2004). Reliance on one economic sector left most communities vulnerable to structural and technological changes that set in after the 1970s.

History repeats itself. Overfishing became a serious threat again in the 1980s. The central government had to intervene and initiated quota management for all species in 1984. Then, in 1990, the quotas were made fully transferable. While ITQs

have contributed to increased economic efficiency and centralisation, quota sales have left numerous coastal communities in trouble (Gunnlaugsson and Saevaldsson 2016). Unsurprisingly, critiques of ITQ management have centred on social/regional aspects (see below) and questions of justice and equity (Soliman 2014, Holm et al. 2015, McCay 1995, Olson 2011, Benediktsson and Karlsdóttir 2011). Previously locally-embedded companies changed ownership and the fisheries gradually became a 'footloose industry', where location did not matter much anymore (Eythórssón 2000). The enclosure of the sea and new ownership structures invited comparisons to feudalism (Pálsson 1998). Research has revealed general discontent among stakeholder groups regarding social responsibility and regional development (Kokorsch et al., 2015, Chambers and Carothers 2017). The effects of quota sales at the local scale have been researched by several authors (Chambers 2016, Kokorsch 2017). Even though connections between fisheries, socio-economic and demographic performance have been traced for several communities, no universal conclusion has been possible yet.

That negative local and regional consequences are recognised by policy makers can be seen in the few amendments that have been made to the Fisheries Management Act. Community quotas and a coastal fisheries scheme have been introduced (see Fig. 1) (for an overview over the schemes see: Chambers and Carothers 2017, Þórðarson and Viðarsson 2014). Community quotas are of particular interest here. According to article 10 in the Icelandic Fisheries Management Act, up to 12,000 t (ungutted weight) of demersal fish can be allocated to communities that are facing difficulties due to downturns in fisheries and which are dependent upon demersal fishing or processing [and/or] to communities which have suffered unexpected cutbacks in the total catch quotas of fishing vessels operating from and landing their catch in the communities in question, which has had a substantial impact on

Fig. 1 Major events and general periods of growth, stagnation and decline in the Icelandic fisheries since 1900



the employment situation in these communities (Icelandic Ministry of Fisheries and Agriculture 2006).

The success of these instruments can be debated (Chambers 2016, Kokorsch 2017). Employment in fisheries, including jobs in both the primary and secondary sectors (fishing and fish processing), has been declining despite those modifications. Since 1990 some 5100 jobs (or 36%) were lost from the sectors (Statistics Iceland 2015a, b). The numbers are more drastic for rural Iceland (38%) than for the capital region (27%). Jobs in processing have been decreasing faster than those in the harvesting sector (41% versus 29% decrease).

Methodology

Defining fishing communities

Defining a ‘fishing village’ or ‘fishing community’ is a difficult task (for an extensive discussion on this terminology see Clay and Olson 2008). It is defined here simply as a spatial unit demarcated by geographical and/or administrative boundaries, where fishing and/or fish processing takes place. Four steps were used to identify fishing communities, building on comparable studies in the US fisheries (Jacob and Jepson 2000, Colburn and Jepson 2012, Jepson and Colburn 2013). The data were provided by the Directorate of Fisheries and Statistics Iceland and the key variables used were *harbour*, *quota*, *fishing activity* and *fisheries dependency*.

Places with a designated *harbour* were selected in the first round. In a second step, it was examined whether or not *quotas* were allocated to boats registered at those harbours. Even though quotas are allotted to boat owners and not the harbour itself, this is a first indication. Quotas, due to their transferability, can be classified as a ‘footloose’ commodity. Accordingly, the absence of quotas does not necessarily result in the absence of fishing activities. *Fishing activity* indicates the presence of harvesting, processing and fisheries-related industries. In case of little activity, or low fisheries dependency, the harbour and its attached community were not considered for further examination. The procedure to define *dependency* follows the analytical framework provided by Colburn and Jepson (2012), who measured landing per capita. According to these criteria, 57 communities were identified for the fishing year 1991/92 (see Fig. 2). These were analysed further. The number decreased to 53 in 2002 and 51 in 2014.

Data collection

As the spatial, temporal and economic dimensions cannot be assessed in isolation in a resilience framework, all three dimensions are considered (Adger 2000, Clay and Olson 2008, Obrist et al., 2010, Turner et al. 2003). Regarding data compilation, several aspects need to be considered: neither should

the number of variables be too high, as this might lead to confusion, nor should the assumption of mono-causality be suggested by choosing too few variables (Holling 2001). Furthermore, the analysis follows the rationale to reduce complex data into a workable amount of information and proxy measures (Nyman Larsen et al., 2010).

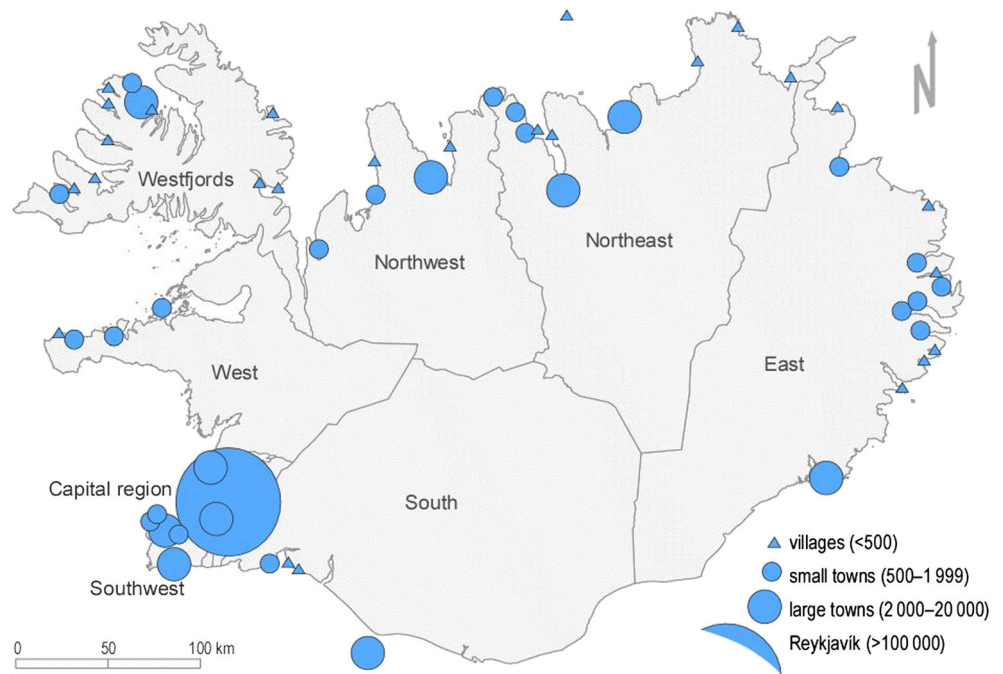
Several theoretical and methodological discussions for the comprehensive assessment of ecological, economic and social goals at the local scale are at hand (Cox and Hamlen 2015, Reed et al., 2006). Regarding the choice of variables for the community level, Cutter et al. (2008) recommend six dimensions, of which three are included in this Iceland-specific analysis (ecological, economic and social), while the other three (institutional, infrastructure and community competence) are not quantifiable at the local scale in Iceland with official data. Lee (2014) suggest ‘integrated factors of social vulnerability’ of which the demographic and socio-economic characteristics find entrance here. These authors discuss how to interpret the either positive or negative effects of each variable on the resilience-building process. In addition, the ‘Arctic Social Indicators’ serve as a reference for assessing different development paths in places located in the arctic region (Nyman Larsen et al., 2010).

Regarding fishing communities in particular, comparable studies on fisheries dependency and the political framing as well as the interplay of natural and human factors (Nayak et al., 2014, Morzaria-Luna et al., 2014) were considered in the data compilation. Most important were the ‘Fishery Performance Indicator’, developed by Anderson et al. (2014) and the ‘social indicators’ for an analysis of resilience and vulnerability in fishing communities of the USA (Colburn and Jepson 2012, Jepson and Colburn 2013, Blount et al. 2015).

The fishing year 1991/92 serves as the starting point or reference year. This was the first year after the fishing quotas had been made fully transferable and also the first for which an extensive amount of digital data is available. The fishing year 2001/02 was chosen as a milestone for the analysis due to two aspects. Before community quotas were introduced in 2003, no major changes had been made to the Fisheries Management Act. Thus 2002 is the last year of a more or less unaltered regulatory system. Besides, the first decade of ITQs has been labelled as a ‘consolidation phase’ and it is appropriate to analyse the consolidation effects at the local level (Eythórsson 2000, Gunnlaugsson and Saevaldsson 2016). That the fishing year 2013/14 serves as endpoint and not a more recent one has two main reasons: the compilation of the data set and its analysis took more time than anticipated, and some data were not available until 2016.

The variables that were eventually chosen for the data set are listed below (Table 1). Several other variables were considered, but the data were not accessible (see below). The number of variables has increased over the years due to two reasons. First, not only were numbers of the chosen years

Fig. 2 Fishing communities in Iceland in the fishing year 1991/92



processed, but also changes between years were calculated. This makes the data more robust, as it is less likely that chance, for example unusually good or bad fishing years, influences the results. Second, the amount of available data has increased since 1992.

Conducting quantitative research at the local scale over a time-span of 25 years is not an uncomplicated endeavour in Iceland. In particular, municipality amalgamations have made it difficult to assemble a coherent database of socio-economic variables. Most variables were calculated per capita. Due to a range from around 24 inhabitants in the smallest community to well over 120,000 in the largest one, outliers were to be expected. Since the capital, Reykjavík, is by far the largest community and thus in a class of its own, it was considered to not include it in the analysis. One could also argue of course that Reykjavík does not represent a typical fishing community, especially in terms of employment and dependency. However, it matches the set criteria explained above and leaving the locality, which ranks amongst the highest in terms of absolute quota allocations, processing and landings, out of such an analysis seemed odd.

While numbers for fisheries-related employment in the primary and secondary sector were available at the local level, figures for the tertiary sector were not. Apart from this, figures regarding the economic performance of the fishing industry, revenues and tax payments of fishing companies, were not made accessible by the relevant institutions. Following the examples from the aforementioned studies, data on the educational level in the communities were requested from the responsible institution. Considering the small size of some villages this was not possible, however, due to privacy

considerations. The tracing of return migrants to the communities was not possible either.

Cluster and correlation analyses

Different tools for processing and evaluating the collected data were considered. *Factor analysis* and *cluster analysis* are arguably the most suitable choices for an assessment of the sort that this study aimed for (Finch 2005, Murtagh and Contreras 2012). Cluster analysis has been applied recently in comparable research in the US (Pollnac et al. 2015) and was eventually chosen for a number of reasons: the number of communities under study is very small ($n = 57$) and especially in comparison to the large number of variables, factor analysis was not feasible. In addition, cluster analysis is more reliable regarding the identification of patterns of similarity or dissimilarity (Powell and Barrientos 2004, Pollnac et al. 2015). Another reason is the aim of finding mutually exclusive groups in a way which maximised differences between groups that were themselves as homogenous as possible (Fonseca 2013). Besides, cluster analysis offers different subcategories to tailor it to a specific case. The method used here is hierarchical agglomerative clustering and centroid measurement (Karypis et al., 1999, Bouguettaya et al. 2015). Some alternatives, such as the Ward method, were also tested. All methods came up with similar results, but the centroid method is in general less sensitive to outliers (Berkhin 2006).

The collected data were assigned to one of the three main dimensions – fisheries, socio-economics or demographics. After that, cluster analysis was conducted twice: First, an analysis of each of the single variables was run, to allow for a

Table 1 Variables included in the analysis

Variable	Unit/ explanation	Sources ^c
Demographic dimension		
Average age		SI
- young population	share of population aged 0–15	oc
- pensioners	share of population older than 65	oc
Gender	Percentage of male/female population	SI
- Gender migration	Outmigration of male/female	oc
- Population development ^a	Relative population development	oc
Socio-economic dimension		
Debts	Debts per capita	SI
Innovation ^a	New registered companies per capita	SI
Long-term unemployment	Unemployment rate over six month	DL
Municipality tax	Municipality tax per capita	DIR
Net income	Net income per capita	DIR
Property tax	Property tax per capita	DIR
Property value ^b	Index for property value	RI, pc
Salaries	Salaries per capita	DIR
Short-term unemployment ^a	Unemployment rate under six month	DL
Social payments	Social benefits paid per capita	DIR
Unemployment	Unemployment rate	DL, pc
Unemployed fish worker ^a	Share of unemployed fish worker	DL
Fisheries dimension		
Allocated Quota	Quotas per capita	DF
Community Quotas ^b	Community quotas per capita	DF
Fleet	Number of boats registered	DF, SI
Fleet diversity	Composition of fleet	oc
Homeport landings	Ratio of fish landed by local/outside fleet	oc
Landings	Landed fish per capita	DF, SI
Landed Value	Value of landed fish per capita	DF, SI
Landed processed	Value of fish landed processed per capita	DF, SI
Landed for processing	Value of fish for local processing per capita	DF, SI
Large vessel share	Share of large vessels (over 100GT)	DF, SI
Licensed companies	Companies with processing license	IFVA, IRDI, pc
Processing	Processed fish per capita	DF, SI
Processed Value	Value of processed fish per capita	DF, SI
Quota/ boat size	Division of quota between boat sizes	DF, SI
Small scale ratio	Share of small scale fisheries	DF, SI
Share CFE	Share per capita based on Cod Fish Equivalent	DF
Total Catch	Total catch per capita	DF, SI
Additional data		
Distance to capital	Distance by road kilometres to Reykjavik	IRCA
Community size	Absolute population	SI
Trawler	Trawler part of community	DF, SI

^a Data for 2002 and 2014

^b Data only for 2014

^c Abbreviations of sources: *SI* Statistics Iceland, *DL* Directorate of Labour, *DIR* Directorate of Internal Revenue, *RI* Registers Iceland, *DF* Directorate of Fisheries, *IFVA* Icelandic Food and Veterinary Authority, *oc* own calculation, *pc* personal communication/requested data, *IRDI* Icelandic Regional Development Institute, *IRCA* Icelandic Road and Coastal Administration

subsequent analysis of individual variables, and then for each of the three dimensions. The number of clusters was set to five for all years, in order to facilitate the temporal analysis. In a given year, every community was identified as belonging to one of these five clusters, which spanned the range from ‘very vulnerable’ to ‘very stable’. Different trajectories of communities through time could thus be identified.

This was followed by an analysis of correlation between the three main dimensions, using the Pearson correlation coefficient. In addition, the associations of single variables with each other were tested. The rationale for this is that even though correlations between three main dimensions might not be detected, it is still possible that single variables show correlations.

Results

Cluster analysis

As stated before, 57 places matched the ‘fishing community’ definition in 1992. That fewer communities are identified in later years is a first result and indication of the development in itself. Considering the ongoing centralisation and closure of processing sites, it does not come as a surprise. Communities which had to be taken out were within the vulnerable fisheries cluster in 1992.

Figure 3 visualises the number of communities in the vulnerable (red) and stable (green) clusters, as well as the movement of fishing communities between the clusters from the beginning to the end of the study period. For an easier comparison, the two vulnerable clusters and the two stable clusters have been combined, whereas the ‘in-between’ category is omitted in the figure. Regarding fisheries, the number of communities in the vulnerable cluster is much higher than that in the stable one. Out of 31 fishing communities that were vulnerable in 1992, only three can be classified as stable in 2014. Another six – indicated by the dashed arrow in Fig. 3 – had moved in an opposite direction and did not even match the criteria of a fishing village after 1992. Some 58% remained vulnerable. In addition, the economic and ecological conditions need to be considered: while the TAC in 2013/14 was much lower than it had been in the fishing years 1991/1992 and 2001/2002, the net profits in the fisheries had increased from the early 1990s to 2014 (Statistics Iceland 2016, Directorate of Fisheries 2015). In other terms: While less fish was caught, the profits increased, albeit not in every community.

Regarding demographics, the number of communities in the stable segment decreased, while the number of vulnerable communities increased by one third (see Fig. 3). Just one town made it over to the stable category over time while seven fell from that category to the vulnerable one. For both fisheries

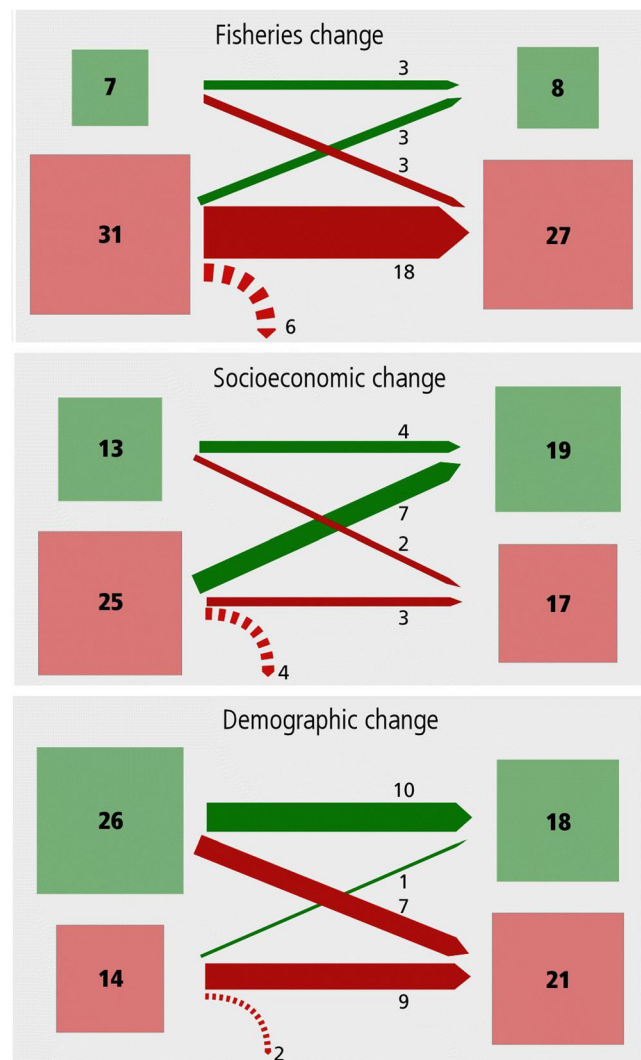


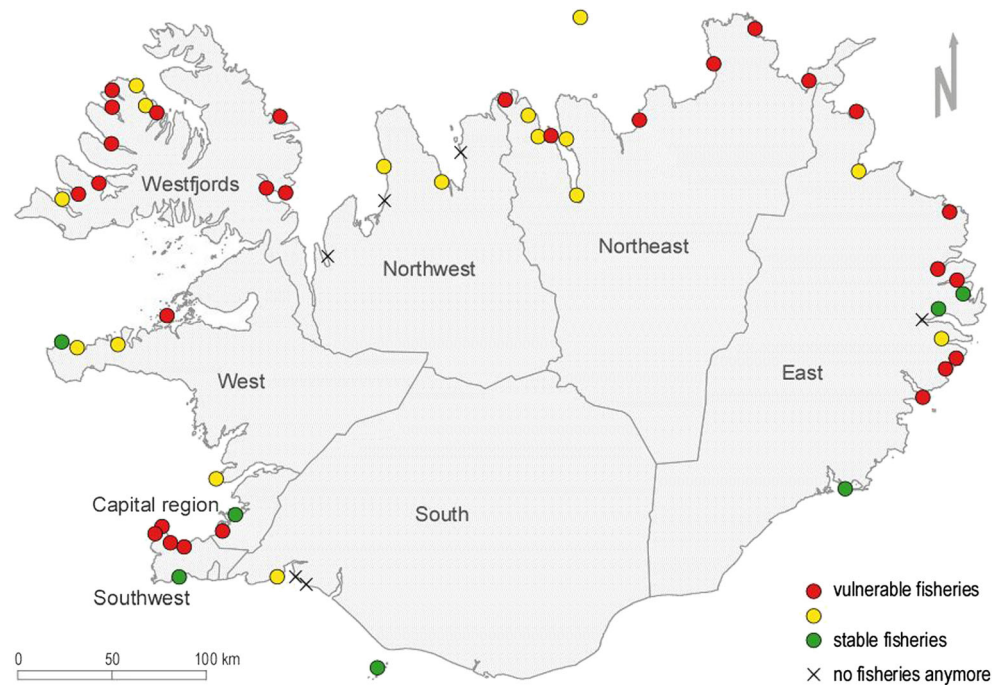
Fig. 3 Distribution of villages in the vulnerable and stable clusters. Absolute numbers of communities in the fishing year 1991/92 (left) and 2013/14 (right). The movement of communities between the clusters is indicated with arrows. The dashed arrows show the number of villages that did not match the definition of a ‘fishing village’ in 2014

and demographics, the way down – from a well-performing to a vulnerable community – is a more likely development path than the other way round. Some kind of an upward-moving barrier was thus detected.

While the development in fisheries and demographics is quite alarming, the overall socio-economic performance looks slightly better, even though some 17 communities were still classified as vulnerable in 2014. One reason for the comparable better development could be municipality reforms including amalgamations of towns, particularly after 2005; some economic burden was thus taken away from heavily indebted localities (Eythórrsson et al., 2014, Kokorsch 2017).

The map (Fig. 4) shows the spatial distribution of the cluster analysis for 2013/14 regarding the performance in fisheries. Considering the population size and location, some striking observations can be made. None of the communities in the

Fig. 4 Spatial distribution of clusters in the fisheries dimension, 2014



Westfjords, Northwest and Northeast ends up in the stable category. Three out of four communities in the Westfjords are in the vulnerable cluster and the situation in the Northeast (seven out of twelve) is not much better. On the other hand, the majority of communities in the positive category can be found in the South/Southwest, including the capital, Reykjavík.

Dependence on a single company or quota holder and an undiversified fleet leaves some seemingly well performing communities ending up in the vulnerable category. The sheer number of boats and quantity of landed fish is not an identifier of a resilient fishing community. Examples have indeed shown that the sudden loss of a trawler or processing facility can have tremendous effects, not only for the fishing industry but the entire community (Kokorsch 2017, Eythórssón 1996).

Remoteness, here measured in road distance to the capital, is not an explanation for this development. Some remote communities have been performing well due to the vicinity to fishing grounds and strategic decisions by the quota-holding companies: most of the bigger vertically integrated companies have been running processing plants in different regions of the country. However, recent examples have shown that local decision makers and fish workers cannot count on a footloose fishing industry. Several communities face difficulties regarding their economic foundation and employment opportunities due to decisions made by quota holders, that value the advantages of centralisation in the southwestern corner of Iceland higher than running a fish factory in remote localities.

Figure 5 shows the results of the demographic performance in 2014. While some results were as expected, particularly in the Southwest, others might be surprising at first sight, but

again it is more than the sheer number of people that counts: gender balance and average age have also been included in the assessment.

The East is a very problematic region, with some eight communities being severely threatened in demographic terms. In general, remoteness is a significant variable for the demographic development (see correlations below).

In Fig. 6 the socio-economic performance of each village is presented. The picture is very mixed. A firm pattern is not observable, neither in terms of regions nor according to community size.

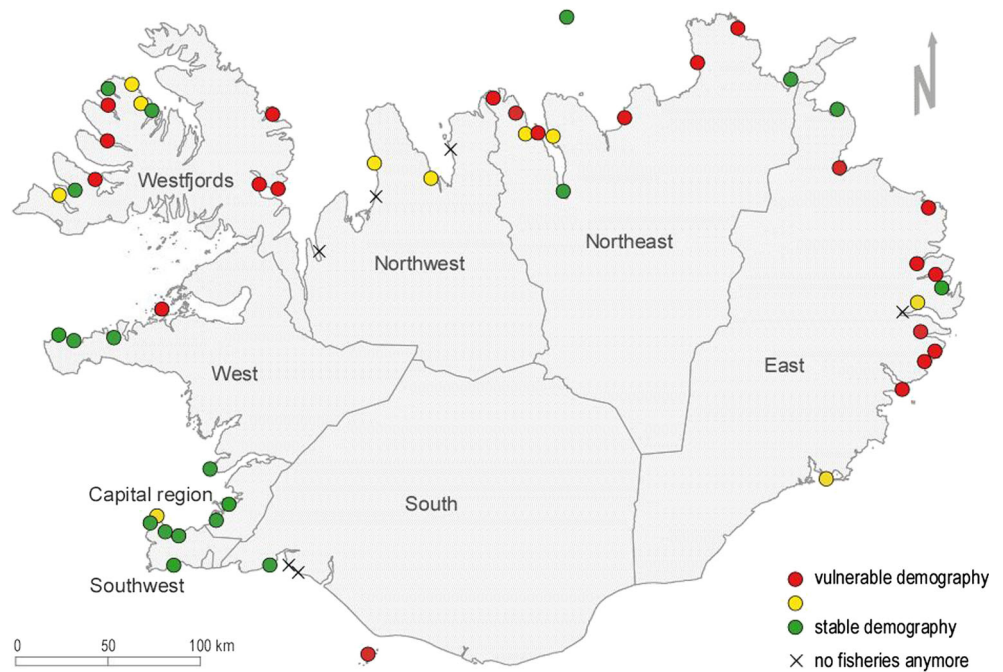
Correlation analysis

The correlations of the three main fields reveal some trends. Figure 7 shows the correlations between the three dimensions at different points in time. While positive correlations between all three main fields were found in 1992 and 2002, only one – between fisheries and socio-economics – remained in 2014.

Table 2 shows the strongest correlations between the three main fields and single variables in other fields over the years. Some negative correlations can be identified, but the one between fisheries and community debts in 1992 and 2002 is particularly noteworthy: has the aforementioned ‘consolidation phase’ in terms of quotas lead to some indebted communities? Indeed, some municipalities took on a heavy financial burden to keep quotas and processing locally (Eythórssón 1996, Willson and Gunnlaugsdóttir 2015, cf. Maguire 2015, cf. Pinkerton 2015).

Quotas (still) matter for local economies: the more fishing quota per capita, the stronger the socio-economic performance

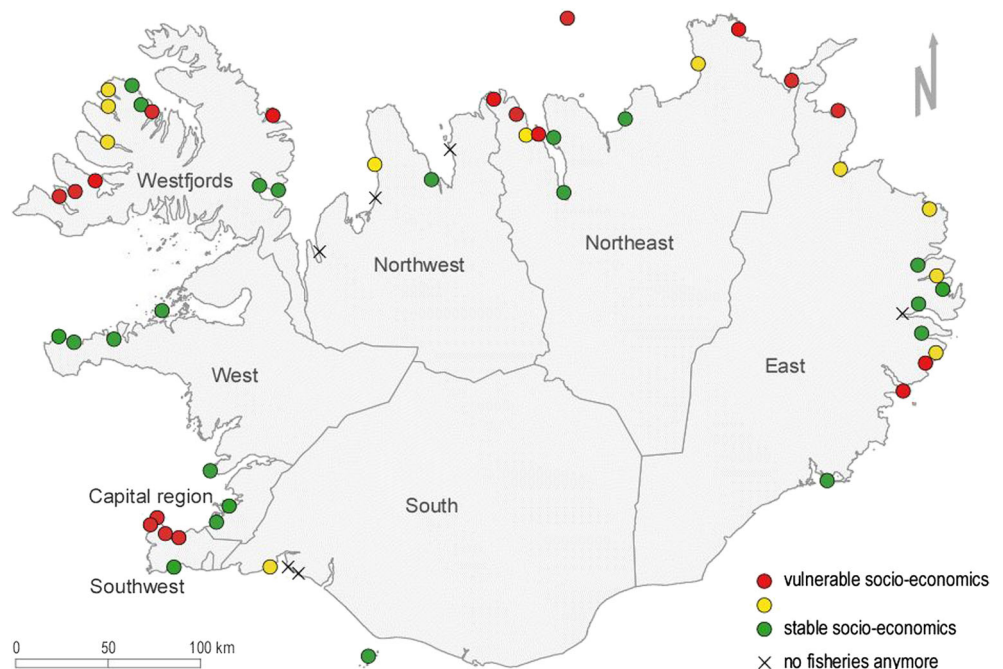
Fig. 5 Spatial distribution of clusters in the demographic dimension, 2014



of the community. They also correlated positively with demographics in 2002 and 2014. In addition, the overall socio-economic performance correlated with the total catch per capita in all 3 years. Apart from quotas, the quantity and the value of landings per capita also correlate with socio-economics in 2002 and 2014. Furthermore, the number of processing companies in the community correlated with the overall socio-economics in 2014 and with the demographic performance in 2014.

Indirectly connected with quotas is the question of scale, here indicated by the relative importance of the small- and large-scale fleets. The large-scale sector shows strong correlations with some economic variables, such as municipality taxes and general income levels in 2002 and 2014. This is particularly interesting when the size of community is considered: while four communities with less than 300 inhabitants had a trawler in their fleet in 2002, none did in 2014. Apart from that, it can be stated for all 3 years that the stronger the

Fig. 6 Spatial distribution of clusters in the socio-economic dimension, 2014



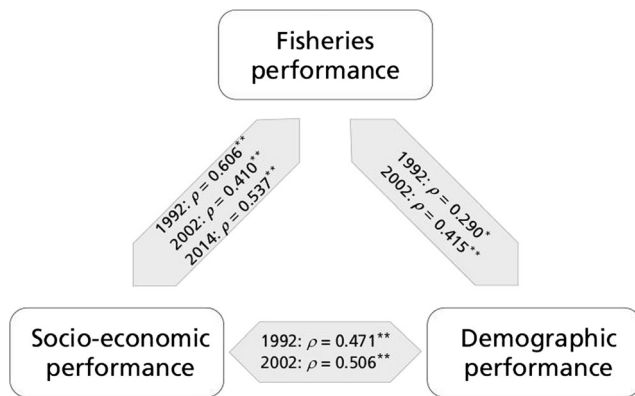


Fig. 7 Correlations between the three dimensions in different time periods

fisheries sector was in a community, the higher were the average salaries.

The aforementioned observations regarding community size and distance were also reflected in the correlation analysis. While the road distance to the capital correlates with demographics only ($\rho = 0.458^{**}$), community size correlates with all three fields in 2014. The strongest correlation can be

Table 2 Correlations of three main dimensions with individual variables

Dimension	Correlations with	Pearson's <i>r</i>		
		1992	2002	2014
Fisheries (F)	Debts (S)	-.458**	-.422**	
	Income (S)	.569**		
	Municipality tax (S)	.445**	.505**	.432**
	Profits (S)		.436**	
	Property value (S)		.588**	.511**
	Salaries (S)	.611**	.418**	.422**
Socio-economics (S)	Landed value (F)		.457**	.498**
	Landed quantity (F)			.530
	Processing plants (F)			.343*
	Processed value (F)	.448**	.339**	
	Quota (F)			.582**
	Share CFE (F)	.449**		
	Total Catch (F)	.416**	.373**	.362*
Demographics (D)	Debts (S)	-.415**		
	Fleet diversity (F)		.358**	
	Income (S)	.569**		
	Municipality tax (S)	.565**		
	Processing plants (F)		.383**	.473**
	Processed value (F)		.339*	
	Property value (S)		.452**	.481**
	Quota (F)		.295*	.298*
	Salaries (S)	.543**	.560**	

Significance of *r*: * $p < 0.05$; ** $p < 0.01$

found with fisheries ($\rho = 0.592^{**}$), followed by socio-economics ($\rho = 0.500^{**}$) and demographics ($\rho = 0.406^{**}$).

Discussion and conclusion

Changes in communities and settlement patterns are inevitable. They can disrupt the existing order, at best leading to a 'creative destruction' (Kivimaa and Kern 2016, Chaffin and Gunderson 2016, Fainstein 2015). Changes become worrisome when they occur too rapidly for the community to adjust to them, particularly when they hit already vulnerable systems. They become a political and social issue when they are foreseeable and avoidable.

Icelandic fishing communities have gone through substantial demographic and socio-economic changes, not least during the period that has been examined in this analysis. The loss of a main industry, such as fisheries, is a change that has far-reaching consequences for undiversified local economies. While the ending of open access halted overfishing, fisheries-dependent localities had to face immediate challenges regarding their future viability. Not all communities have been able to adjust to the new circumstances, either because of economic constraints or the shortage of entrepreneurial people with fresh ideas. Small and remote settlements have been particularly strongly affected. Most 'one company' villages were trapped between two hard choices: either to use municipal funds to invest in quotas, with the threat of being saddled with debt, or risk the selling out of quotas and remaining in comparatively stable economic waters.

To what extent demographic and socio-economic changes since 1991/92 have paralleled the development in the fisheries sector was one of the main questions in this paper. To start with, the general importance of fisheries for the majority of villages and towns has been decreasing. Yet there are still numerous individual communities where a negative development of the local fishing industry is mirrored by adverse demographic and socio-economic trajectories. This counts particularly for small communities that are distant from Reykjavík. Remoteness and size are two barriers that cannot be overcome easily.

Barriers can also be detected on another level: Carothers and Chambers (2012, 49) state that "the changing nature of fishing relationships in many ITQ fisheries has substantially decreased upward labour mobility, often creating impassable class divisions". Labour mobility is one issue that can be linked to the problem of finding new entrants to the industry. The quota issue is still pointed out by stakeholders in fisheries as the main reason for the lack of recruitment (Kokorsch et al., 2015). It is difficult for potential newcomers to establish a business, and high quota leasing prices are a hindrance (Chambers and Carothers 2017). One cannot judge how many people would potentially like to work in this industry these

days, however. Nonetheless, correlations were found between demographics and the overall fisheries in 1992, which is not surprising considering the rather undiversified economic structure of rural Iceland at this point in time. Employment opportunities and educational possibilities have changed considerably since then.

Demographic challenges and changes cannot be explained solely by quota loss. The question of keeping processing companies and landings in a community or not is at least of equal importance. Indirectly this is very much affected by quotas, due to the vertical integration of companies (Benediktsson and Karlsdóttir 2011, Carothers and Chambers 2012, Eythórsson 2000). Communities that experienced quota loss through sales to companies from outside the community are disenfranchised and dependent on the new quota holders. It is no longer up to those communities whether or not their harbour and existing processing facilities are used for processing and landing. That only a few companies can decide where to land and process fish is an alarming development that should raise concern among policy makers and regional developers. Recent examples have confronted local and national policy makers with this inconvenient fact (RUV 2014, Stundin 2017, Hólmkelsdóttir and Hilmarsdóttir 2017).

The success of community quotas as a long-term support scheme for suffering communities can be questioned. The numbers here do not warrant a positive evaluation, especially with respect to the increase of communities in the vulnerable fisheries segment since 2002. With 27 communities in this state, it is questionable whether a small amount of quota can make much of a difference. That almost all of the fishing communities listed here receive quotas from that scheme suggests that these quotas are not only too thinly spread, but also end up in communities where the need is not that great; several communities that host large fishing companies are included. Some community quotas even end up on large factory trawlers. This is somewhat odd and contradictory, as the scheme was meant to support suffering communities. If such an instrument is expected to be successful, it should run on a long-term basis, with a few dedicated communities which can build on a reliable amount and at best enable new entrants to the industry. This seems difficult, as any increase in the community quota allocation meets with disapproval from the large-scale industry and their political allies. Besides, all communities will demand quotas from such a scheme, which makes clear and unambiguous criteria for the allocation of community quotas necessary.

Dependency in terms of employment should be one criterion for such a transitional community quota scheme, which is meant to aid communities undergoing rapid change. The number of fisheries-related jobs on shore has been decreasing steadily. Tailoring regional and community development to a future without fisheries in the primary and secondary sector thus seems more advisable. But as long as humans are part of the fishing industry, and processing and landings are essential

for local economies, they need strong consideration in a truly sustainable fisheries management.

Fisheries-related jobs, particularly in processing, have lost attractiveness for young adolescents, many of whom intend to leave smaller settlements (Bjarnason 2014a, Bjarnason and Thorlindsson 2006, Þorgrímsdóttir et al., 2015). Mobility and highly individualised life scripts are common, not only in Iceland. A downward spiral caused by the loss of youngsters can be set in motion, which in return can negatively affect the social fabric and social cohesion of a community (Dale and Newman 2006, Duhaim et al. 2004, Ozkan and Schott 2013, Chan et al., 2006, Adger 2000). For Hovgaard et al. (2004), one of the reasons for extended outmigration in Nordic villages is changing social values. For Iceland this is of relevance, since most fishing villages have been characterised by kinship and a close-knit society (Skaptadóttir 2003, 1996). The demographic situation in some communities would look a lot worse without the influx of a migrant workforce that works in processing sites (Skaptadóttir, 1996, 2003, 2004, Skaptadóttir and Wojtynska 2008, Júlíusdóttir et al., 2013).

Some communities have lost almost half their population since the early 1990s, resulting in a generation gap: the number of 20–39 year olds has decreased by up to 40% (Þorgrímsdóttir et al., 2015). One of the key findings here is that in the small places, whose livelihood depends on fisheries, the loss of both people and fish is felt more acutely. The number of vulnerable demographic communities has increased over time. Communities with fewer than 1000 inhabitants face major demographic challenges and those with less than 300 are severely threatened.

Whether or not regional policies and changes to the fisheries management are successful, some communities will most likely lose out as the inhabitants continue ‘voting with their feet’. Some might face abandonment eventually. Depopulation, occasionally resulting in abandoned places, has not been uncommon in Iceland (Bjarnason 2014b, Thorarinnsson 1961, Huijbens 2012, Valsson et al., 2013). To what extent fisheries management can be made responsible for demographic development cannot be answered; yet it has been discussed frequently (Carothers and Chambers 2012). One could also consider the abandonment of places as part of a broader evolutionary trend, with small settlements being a ‘collateral damage’ of urbanisation.

Whether or not demographic difficulties were triggered by the fisheries management, the era of ‘one-company villages’ is arguably over. However, the diversification of local economies and their labour markets can hardly take place without innovative capacity and economic capital. Communities with quota holders and a solid fishing industry thus have a considerable advantage. Previous work has discussed the significance of different boat and quota classes extensively (Chambers and Carothers 2017, Mariat-Roy 2014). The results here show that the presence of the large-scale sector,

and particularly a trawler, makes a substantial difference for local economies.

As resilience analysis should always come up with some dynamic and prescriptive solution (Holling 2001), a first step to make up for the adverse effects of privatised profits and socialised follow-up costs could be a redistribution of the generated wealth (Olson 2011, Pinkerton and Edwards 2009). This will not be easy under fully privatised fisheries, yet not impossible. It seems odd at least that the state does not take more note of its own clear assertion of the importance of the social aspect of fisheries management, found in Article 1 of the Fisheries Management Act that was quoted at the beginning of this paper.

Transferable quotas are entitlements that deliberately enabled and created a footloose industry – but one that certainly leaves a ‘footprint’ wherever it has tread. Stable employment and settlement, which are presented as sort of ultimate aim in the Fisheries Management Act, can barely be reached with a fully market based solution. Ostensibly designed to avoid an Icelandic version of the ‘tragedy of the commons’ (Árnason 2012, Benediktsson 2014, Carothers and Chambers 2012), the ITQ regime has generated the prosperity of a few and largely ignored social aspects. To compensate for the social costs and adverse effects, redistribution of revenues, for example through a solidarity fund, seems to be more plausible than waiting for the realisation of the mirage of trickle-down effects. Such a redistribution could be used to spur innovative regional development and improve the conditions for realising the aspiration of stability. Almost three decades after ‘quota kings’ (Pálsson & Helgason, 1996) started to reign and economists claimed that ‘new wealth’ had somehow been created (Árnason 2008) flexible tailor-made solutions, based on general rules, fair principles and the ideal of social justice – for both fisheries and regional development – would be more appropriate for a truly sustainable and comprehensive fisheries management than dogmatic market-based solutions.

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References

- Adger, W.N. 2000. Social and ecological resilience: Are they related? *Progress in Human Geography* 24 (3): 347–364.
- Adger, W.N. 2006. Vulnerability. *Global Environmental Change* 16 (3): 268–281.
- Agnarsson, S., T. Matthiasson, and F. Giry. 2016. Consolidation and distribution of quota holdings in the Icelandic fisheries. *Marine Policy* 72: 263–270.
- Anderson, J.L., C.M. Anderson, J. Chu, J. Meredith, F. Asche, G. Sylvia, M.D. Smith, D. Anggraeni, R. Arthur, and A. Guttormsen. 2014. The fishery performance indicators: A management tool for triple bottom line outcomes. *PLoS One* 10 (5): e0122809–e0122809.
- Árnason, R. 1998. Ecological fisheries management using individual transferable share quotas. *Ecological Applications* 8 (1): 151–159.
- Árnason, R. 2008. Iceland’s ITQ system creates new wealth. *The Electronic Journal of Sustainable Development* 1 (2): 35–41.
- Árnason, R. 2012. Property rights in fisheries: How much can individual transferable quotas accomplish? *Review of Environmental Economics and Policy* 6 (2): 217–236.
- Benediktsson, K. 2014. Nature in the ‘neoliberal laboratory’. *Dialogues in Human Geography* 4 (2): 141–146.
- Benediktsson, K., and A. Karlsdóttir. 2011. Iceland crisis and regional development—thanks for all the fish? *European Urban and Regional Studies* 18 (2): 228–235.
- Benson, M.H., and A.S. Garmestani. 2011. Can we manage for resilience? The integration of resilience thinking into natural resource management in the United States. *Environmental Management* 48 (3): 392–399.
- Berkhin, P. 2006. A survey of clustering data mining techniques. In *Grouping multidimensional data*, ed. J. Kogan, C. Nicholas and M. Teboulle, 25–71. Berlin-Heidelberg: Springer.
- Bjarnason, T. 2014a. Adolescent migration intentions and population change: A 20-year follow-up of Icelandic communities. *Sociologia Ruralis* 54 (4): 500–515.
- Bjarnason, T. 2014b. The effects of road infrastructure improvement on work travel in northern Iceland. *Journal of Transport Geography* 41: 229–238.
- Bjarnason, T., and T. Thorlindsson. 2006. Should I stay or should I go? Migration expectations among youth in Icelandic fishing and farming communities. *Journal of Rural Studies* 22 (3): 290–300.
- Blount, Benjamin, Steven Jacob, Priscilla Weeks, and Michael Jepson. 2015. Testing cognitive ethnography: Mixed-methods in developing indicators of well-being in fishing communities. *Human Organization* 74 (1): 1–15.
- Bouguettaya, Athman, Qi Yu, Xumin Liu, Xiangmin Zhou, and Andy Song. 2015. Efficient agglomerative hierarchical clustering. *Expert Systems with Applications* 42 (5): 2785–2797.
- Campling, Liam, Elizabeth Havice, and Howard Penny McCall. 2012. The political economy and ecology of capture fisheries: Market dynamics, resource access and relations of exploitation and resistance. *Journal of Agrarian Change* 12 (2–3): 177–203.
- Carothers, C., and C. Chambers. 2012. Fisheries privatization and the remaking of fishery systems. *Environment and Society: Advances in Research* 3 (1): 39–59.

- Carpenter, S., and W. Brock. 2008. Adaptive capacity and traps. *Ecology and Society* 13 (2): 40.
- Chaffin, B.C., and L.H. Gunderson. 2016. Emergence, institutionalization and renewal: Rhythms of adaptive governance in complex social-ecological systems. *Journal of Environmental Management* 165: 81–87.
- Chambers, C. 2016. Fisheries management and fisheries livelihoods in Iceland.
- Chambers, C., and C. Carothers. 2017. Thirty years after privatization: A survey of Icelandic small-boat fishermen. *Marine Policy* 80: 69–80.
- Chambers, C., and M. Kokorsch. 2017. The social dimension in Icelandic fisheries governance. *Coastal Management* 45 (4): 330–337.
- Chan, Joseph, Ho-Pong To, and Elaine Chan. 2006. Reconsidering social cohesion: Developing a definition and analytical framework for empirical research. *Social Indicators Research* 75 (2): 273–302.
- Clay, P.M., and J. Olson. 2008. Defining “fishing communities”: Vulnerability and the Magnuson-Stevens fishery conservation and management act. *Human Ecology Review* 15 (2): 143.
- Colburn, L., and M. Jepson. 2012. Social indicators of gentrification pressure in fishing communities: A context for social impact assessment. *Coastal Management* 40 (3): 289–300.
- Cox, R.S., and M. Hamlen. 2015. Community disaster resilience and the rural resilience index. *American Behavioral Scientist* 59 (2): 220–237.
- Cutter, Susan L., Lindsey Barnes, Melissa Berry, Christopher Burton, Elijah Evans, Eric Tate, and Jennifer Webb. 2008. A place-based model for understanding community resilience to natural disasters. *Global Environmental Change* 18 (4): 598–606.
- Dale, Ann, and Lenore Newman. 2006. Sustainable community development, networks and resilience. *Environments* 34 (2).
- Danielsson, A. 1997. Fisheries management in Iceland. *Ocean & Coastal Management* 35 (2): 121–135.
- Directorate of Fisheries. Úthlutun aflamarks e. heimahöfnum 1991/1991–2014/2015 2015 [cited 01.05.2017]. Available from <http://www.fiskistofa.is/aflamarkheimildir/uthlutadaflamark/fyrriar/>.
- Duhaime, Gérard, Edmund Searles, Peter J. Usher, Heather Myers, and Pierre Fréchette. 2004. Social cohesion and living conditions in the Canadian Arctic: From theory to measurement. *Social Indicators Research* 66 (3): 295–318.
- Eythórssón, E. 1996. Theory and practice of ITQs in Iceland. Privatization of common fishing rights. *Marine Policy* 20 (3): 269–281.
- Eythórssón, E. 2000. A decade of ITQ-management in Icelandic fisheries: Consolidation without consensus. *Marine Policy* 24 (6): 483–492.
- Eythórssón, E. 2003. Stakeholders, courts, and communities: Individual transferable quotas in Icelandic fisheries, 1991–2001. In *The commons in the new millennium: challenges and adaptations*, ed. N. Dolšák and E. Ostrom, 129–167. Cambridge: MIT Press.
- Eythórssón, Grétar Thór, Erik Gløersen, and Vífill Karlsson. 2014. West Nordic municipal structure challenges to local democracy, efficient service provision and adaptive capacity.
- Fainstein, Susan. 2015. Resilience and justice. *International Journal of Urban and Regional Research* 39 (1): 157–167.
- Finch, Holmes. 2005. Comparison of distance measures in cluster analysis with dichotomous data. *Journal of Data Science* 3 (1): 85–100.
- Folke, C. 2006. Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change* 16 (3): 253–267.
- Folke, C., S. Carpenter, T. Elmqvist, L.H. Gunderson, C.S. Holling, and B. Walker. 2002. Resilience and sustainable development: Building adaptive capacity in a world of transformations. *AMBIO* 31 (5): 437–440.
- Fonseca, Jaime R.S. 2013. Clustering in the field of social sciences: That is your choice. *International Journal of Social Research Methodology* 16 (5): 403–428.
- Gunnlaugsson, Stefan B., and Hordur Saevaldsson. 2016. The Icelandic fishing industry: Its development and financial performance under a uniform individual quota system. *Marine Policy* 71: 73–81.
- Halseth, Greg, and Lana Sullivan. 2004. From Kitimat to tumbler ridge: A crucial lesson not learned in resource-town planning. *Western Geography* 13 (14): 132–160.
- Hamilton, Lawrence C., Steingrímur Jónsson, Helga Ögmundardóttir, and Igor M. Belkin. 2004. Sea changes ashore: The ocean and Iceland's herring capital. *Arctic*: 325–335.
- Hannesson, R. 2003. The Icelandic fisheries and the future of the Icelandic economy. Paper read at Competitiveness within the global fisheries, at Akureyri, Iceland.
- Haraldsson, G., and D. Carey. 2011. Ensuring a sustainable and efficient fishery in Iceland. In *OECD economics department working papers*. Paris: OECD Publishing.
- Holling, C.S. 2001. Understanding the complexity of economic, ecological, and social systems. *Ecosystems* 4 (5): 390–405.
- Holm, P., J. Raakjær, R.B. Jacobsen, and E. Henriksen. 2015. Contesting the social contracts underpinning fisheries—Lessons from Norway, Iceland and Greenland. *Marine Policy* 55: 64–72.
- Hólmkelsdóttir, H, and SK Hilmarsdóttir. 86 starfsmönnum HB Granda á Akranesi sagt upp. *Visir* 2017 [cited 11.05.2017]. Available from <http://www.visir.is/g/2017170519712>.
- Hovgaard, Gestur, Grétar Thór Eythórssón, and Katarina Fellman. 2004. *Future challenges to small municipalities: The cases of Iceland. Faroe Islands and Åland Islands*: Nordregio, Nordic Centre for Spatial Development.
- Huijbens, E.H. 2012. Sustaining a village's social fabric? *Sociologia Ruralis* 52 (3): 332–352.
- Icelandic Ministry of Fisheries and Agriculture. The fisheries management act 2006. Available from <https://eng.atvinnuvegaraduneyti.is/media/acts/Act-no-116-2006-on-Fisheirs-Management.pdf>.
- Jacob, S., and M. Jepson. 2000. Defining and identifying fishing-dependent communities in Florida. *Urban Anthropology and Studies of Cultural Systems and World Economic Development*: 221–253.
- Jepson, M, and L Colburn. 2013. Development of social indicators of fishing community vulnerability and resilience in the US southeast and northeast regions. *NOAA technical memorandum NMFS-F/SPO-129 (US dept commerce, 2013)*.
- Jóhannesson, G.T. 2016. *A fish called tourism: Emergent realities of tourism policy in Iceland, Tourism encounters and controversies: Ontological politics of tourism development*, 181.
- Johnsen, J.P. 2017. Creating political spaces at sea—governmentalisation and governability in Norwegian fisheries. *Maritime Studies* 16 (1): 18.
- Júlíusdóttir, M., U.D. Skaptadóttir, and A. Karlsdóttir. 2013. Gendered migration in turbulent times in Iceland. *Norsk Geografisk Tidsskrift-Norwegian Journal of Geography* 67 (5): 266–275.
- Karlsdóttir, A. 2008. Not sure about the shore! Transformation effects of individual transferable quotas on Iceland's fishing economy and communities. In *Enclosing the fisheries: People, places and power*, ed. M.E. Lowe and C. Carothers, 99–107. Bethesda: American Fisheries Society.
- Karypis, George, Eui-Hong Han, and Vipin Kumar. 1999. Chameleon: Hierarchical clustering using dynamic modeling. *Computer* 32 (8): 68–75.
- Kivimaa, Paula, and Florian Kern. 2016. Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. *Research Policy* 45 (1): 205–217.
- Kokorsch, M. 2017. The tides they are a changin’: Resources, regulation, and resilience in an Icelandic coastal community. *Journal of Rural and Community Development*.
- Kokorsch, M., A. Karlsdóttir, and K. Benediktsson. 2015. Improving or overturning the ITQ system? Views of stakeholders in Icelandic fisheries. *Maritime Studies* 14 (1): 1–22.

- Lee, Yung-Jaan. 2014. Social vulnerability indicators as a sustainable planning tool. *Environmental Impact Assessment Review* 44: 31–42.
- Lorenz, D.F. 2013. The diversity of resilience: Contributions from a social science perspective. *Natural Hazards* 67 (1): 7–24.
- Maguire, J. 2015. Virtual fish stink, too. In *Gambling debt: Iceland's rise and fall in the global economy*, ed. EP. Durrenberger and G. Pálsson, 121–135. Boulder: University Press of Colorado.
- Mariat-Roy, Emilie. 2014. When fishing means resilience: The evolution of small boat fishing practices in Iceland since 1990 and the new development of longline fishing. *Polar Record* 50 (04): 421–429.
- Matthiasson, T. 2003. Closing the open sea: Development of fishery management in four Icelandic fisheries. *Natural Resources Forum* 27 (1): 1–18.
- McCay, B.J. 1995. Social and ecological implications of ITQs: An overview. *Ocean & Coastal Management* 28 (1): 3–22.
- Morzaria-Luna, Hem Nalini, Peggy Turk-Boyer, and Marcia Moreno-Baez. 2014. Social indicators of vulnerability for fishing communities in the northern gulf of California, Mexico: Implications for climate change. *Marine Policy* 45: 182–193.
- Murtagh, Fionn, and Pedro Contreras. 2012. Algorithms for hierarchical clustering: An overview. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery* 2 (1): 86–97.
- Nayak, P.K., L.E. Oliveira, and F. Berkes. 2014. Resource degradation, marginalization, and poverty in small-scale fisheries: Threats to social-ecological resilience in India and Brazil. *Ecology and Society* 19 (2): 73.
- Nelson, D.R., W.N. Adger, and K. Brown. 2007. Adaptation to environmental change: Contributions of a resilience framework. *Annual Review of Environment and Resources* 32: 395–419.
- Nyman Larsen Joan, Gail Fondahl, and Peter Schweitzer. 2010. Arctic social indicators: A follow-up to the Arctic human development report.
- Obrist, B., C. Pfeiffer, and R. Henley. 2010. Multi-layered social resilience a new approach in mitigation research. *Progress in Development Studies* 10 (4): 283–293.
- Olson, J. 2011. Understanding and contextualizing social impacts from the privatization of fisheries: An overview. *Ocean & Coastal Management* 54 (5): 353–363.
- Ostrom, E. 2009. A general framework for analyzing sustainability of social-ecological systems. *Science* 325 (5939): 419–422.
- Ozkan, Umut Riza, and Stephan Schott. 2013. Sustainable development and capabilities for the polar region. *Social Indicators Research* 114 (3): 1259–1283.
- Pálsson, G. 1998. The virtual aquarium: Commodity fiction and cod fishing. *Ecological Economics* 24 (2): 275–288.
- Pálsson, G., and A. Helgason. 1995. Figuring fish and measuring men: The individual transferable quota system in the Icelandic cod fishery. *Ocean & Coastal Management* 28 (1): 117–146.
- Pálsson, G., and A. Helgason. 1996. The politics of production: Enclosure, equity and efficiency. In *Images of contemporary Iceland: Everyday lives and global contexts*, ed. E.P. Durrenberger and G. Pálsson, 60–68.
- Pauwelussen, Annet. 2016. Community as network: Exploring a relational approach to social resilience in coastal Indonesia. *Maritime Studies* 15 (1): 2.
- Pinkerton, E. 2015. Groundtruthing individual transferable quotas. In *Gambling debt: Iceland's rise and fall in the global economy*, ed. EP. Durrenberger and G. Pálsson, 109–119. Boulder: University Press of Colorado.
- Pinkerton, E., and D.N. Edwards. 2009. The elephant in the room: The hidden costs of leasing individual transferable fishing quotas. *Marine Policy* 33 (4): 707–713.
- Pollnac, R.B., T. Seara, L.L. Colburn, and M. Jepson. 2015. Taxonomy of USA east coast fishing communities in terms of social vulnerability and resilience. *Environmental Impact Assessment Review* 55: 136–143.
- Powell, Martin, and Armando Barrientos. 2004. Welfare regimes and the welfare mix. *European Journal of Political Research* 43 (1): 83–105.
- Reed, M.S., E. Fraser, and A.J. Dougill. 2006. An adaptive learning process for developing and applying sustainability indicators with local communities. *Ecological Economics* 59 (4): 406–418.
- RUV. Kjaftshögg fyrir byggðarlagið 2014 [cited 20.06.2017]. Available from <http://www.ruv.is/frett/kjaftshogg-fyrir-byggdarlagid>.
- Scoones, Ian. 1998. Sustainable rural livelihoods: A framework for analysis..
- Skaptadóttir, U.D. 1996. Gender construction and diversity in Icelandic fishing communities. *Anthropologica* 38 (2): 271–287.
- Skaptadóttir, U.D. 2003. Women coping with change in an Icelandic fishing community: A case study. *Women's Studies International Forum* 23 (3): 311–321.
- Skaptadóttir, U.D. 2004. Responses to global transformations: Gender and ethnicity in resource-based localities in Iceland. *Polar Record* 40 (214): 261–267.
- Skaptadóttir, U.D., and A. Wojtyńska. 2008. Labour migrants negotiating places and engagements. In *Mobility and place: Enacting northern European peripheries*, ed. Jørgen Ole Bærenholdt and B. Granas, 115. Aldershot: Ashgate Publishing.
- Soliman, A. 2014. Using individual transferable quotas (ITQs) to achieve social policy objectives: A proposed intervention. *Marine Policy* 45: 76–81.
- Speranza, Chinwe Ifejika, Urs Wiesmann, and Stephan Rist. 2014. An indicator framework for assessing livelihood resilience in the context of social–ecological dynamics. *Global Environmental Change* 28: 109–119.
- Statistics Iceland. Employed persons by economic activity, sex and regions 1991–2008 2015a [cited 01.05.2017]. Available from http://px.hagstofa.is/pxen/pxweb/en/Samfelag/Samfelag_vinumarkadur_3_arstolur/VIN01102.px.
- Statistics Iceland. Employed persons by economic activity, sex and regions 2008–2014 (NACE REV 2.) 2015b [cited 01.05.2017]. Available from http://px.hagstofa.is/pxen/pxweb/en/Samfelag/Samfelag_vinumarkadur_3_arstolur/VIN01105.px.
- Statistics Iceland. Net profit in fishing and fish processing, using annuity approach (imputed cost of capital) and 6% rate of return 1993–2015 2016 [cited 01.05.2017]. Available from http://px.hagstofa.is/pxen/pxweb/en/Atvinnuvegir/Atvinnuvegir_sjavarutvegur_afkomasja/SJA08107.px.
- Stundin. Græða fimmtán milljarða - segja upp 86 í lágláunastörfum 2017 [cited 11.05.2017]. Available from <http://stundin.is/frett/graeda-fimmtan-milljarða-segja-upp-86-i-laglaunastorfum/>.
- Symes, D., and J. Phillipson. 2009. Whatever became of social objectives in fisheries policy? *Fisheries Research* 95 (1): 1–5.
- Symes, D., J. Phillipson, and P. Salmi. 2015. Europe's coastal fisheries: Instability and the impacts of fisheries policy. *Sociologia Ruralis* 55 (3): 245–257.
- Thorarinsson, Sigurdur. 1961. Population changes in Iceland. *Geographical Review* 51 (4): 519–533.
- G. Þórðarson and JR. Viðarsson. 2014. *Coastal fisheries in Iceland*. Reykjavík: Mátis.
- Þórgrímsdóttir, Sigríður K., Elin Gróa Karlsdóttir, Sigríður E Þórðardóttir, and Sigrður Árnason. 2015. Community, economy and population trends in regions with long-term decline in population. Icelandic regional development institute 2012 [cited 18.05. 2015]. Available from www.byggdastofnun.is/static/files/Skyslur/Byggdarlog/English_summary.pdf.
- Turner, B., R. Kasperson, P. Matson, J. McCarthy, R. Corell, L. Christensen, N. Eckley, J. Kasperson, A. Luers, and M. Martello. 2003. A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences* 100 (14): 8074–8079.

- Turner, M. 2014. Political ecology I: An alliance with resilience? *Progress in Human Geography* 38 (4): 616–623.
- Valsson, Trausti, Gudmundur F. Ulfarsson, and Sigurdur M. Gardarsson. 2013. A theory of the evolution of settlement structures based on identification and use of patterns: Iceland as a case study. *Futures* 54: 19–32.
- Welsh, Marc. 2014. Resilience and responsibility: Governing uncertainty in a complex world. *The Geographical Journal* 180 (1): 15–26.
- White, Carole. 2015. *Social resilience, place and identity in the small-scale North Norfolk “Cromer crab” fishery*. UK: University of East Anglia.
- Willson, M., and Gunnlaugsdóttir, B. 2015. The resilience of rural Iceland. In *Gambling debt: Iceland's rise and fall in the global economy*, ed. EP. Durrenberger and G. Pálsson. 137–149. Boulder: University Press of Colorado.