



Living with Natural Hazards on the Icelandic South Coast

Guðríður Ester Geirsdóttir



**Líf- og umhverfisvísindadeild
Háskóli Íslands
Júní 2011**

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30 eininga ritgerð sem er hluti af
Magister Scientiarum gráðu í Umhverfis- og auðlindafræði

Leiðbeinendur
Guðrún Gísladóttir
Ásdís Jónsdóttir

Prófdómari / Fulltrúi deildar
Guðrún Jóhannesdóttir

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Háskóli Íslands
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Sturlugötu 7
101 Reykjavík

Sími: 525 4600

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Útdráttur

Íbúar Stokkseyrar búa við náttúruvá. Þorpið er staðsett á Suðurlandsbrotabeltinu og býr þar af leiðandi við reglubundna skjálftavirkni. Í maí 2008 reið yfir síðasti stóri skjálftinn á svæðinu en hann var 6.3 á Richter skalanum. Sjávarflóð eru tíð á Stokkseyri þar sem þorpið rís ekki hátt yfir sjávarmáli og er opið fyrir úthafinu. Síðasta flóð, svokallað Stormflóð, átti sér stað í janúar 1990 og er talið eitt versta flóð í sögu landsins. Eins og mörg önnur smáþorp á Íslandi hefur Stokkseyri gengið í gegnum ýmsar hagfræðilegar og samfélagslegar breytingar undanfarin 20 ár. Aðalatvinnuvegur íbúanna hefur tekið stakkaskiptum og þjónusta dregið saman. Tilgangur þessarar rannsóknar var að kanna viðhorf íbúa Stokkseyrar hvað varðar tjónnæmi (*vulnerability*), þol (*resilience*) og aðlögun (*adaptation*) gagnvart náttúruvá og áhrif samfélagsbreytinga þar á. Árið 2010 var haldinn rýnihópafundur (*focus group meeting*) þar sem veltiúrtak var notað við val á viðmælendum. Einnig voru tekin opin viðtöl og var hentugleikaúrtak notað við val á viðmælendum. Þátttakendur voru á aldrinum 32-69 ára og höfðu flestir búið á Stokkseyri meirhluta lífs síns. Viðhorf viðmælanda var breytilegt eftir því hvort um var að ræða sjávarflóð eða jarðskjálfta. Flestir töldu sjávarflóðin vera aðalváanna á svæðinu en þrátt fyrir það voru flestir tjónnæmari gagnvart jarðskjálftum. Ástæða þess er annars vegar sú að Veðurstofan og Almannavarnir gefa út öflugar viðvaranir þegar vond veður eru á leiðinni og hins vegar vegna þess að lagt hefur verið í ýmsar aðgerðir til að varna svæðinu fyrir flóðum, en í flestum tilfellum gera jarðskjálftar ekki boð á undan sér. Allir viðmælendur okkar lýstu áhyggjum sínum af þeim miklu breytingum sem samfélagið hefur undirgengist á síðustu 20 árum. Flestir voru sammála um að þær hagfræðilegu og samfélagslegu breytingar sem hafa átt sér stað hafi haft þau áhrif að samfélagskennd sé ekki lengur til staðar. Líklegt er að þessar breytingar hafi haft þau áhrif að samfélagið er ekki eins í vel stakk búið til að takast á við náttúruvá. Niðurstöður þessar gefa til kynna að nauðsynlegt sé að auka samkennd og samheldni íbúanna.

Abstract

Residents in the village of Stokkseyri in southern Iceland live with the threat of natural hazards. The village is located within the South Iceland Seismic Zone and subject to earthquakes that can be > 6.0 on the Richter scale. The latest great earthquake, 6.3 in size, occurred in May of 2008. Stokkseyri is also subject to frequent storm flood surges as it is low-lying and open to the North Atlantic Ocean. The latest coastal flood happened in January 1990 and is considered to be one of the greatest such floods in the history of Iceland. Stokkseyri, as many small villages in Iceland, has experienced extensive socio-economic changes in the past 20 years, manifested in the loss of the economic mainstay and gradual deterioration of local services. The purpose of this paper was to investigate residents' perception of the communities' vulnerability, resilience and adaptation to the recurring natural hazards of the area and the impact of socio-economic changes thereon. In 2010, we held one focus group meeting using a snowball sample technique, and conducted in-depth, face-to-face interviews with local residents using an opportunistic sample technique. All participants were between the age of 32-69 and most of them had been living in Stokkseyri their entire lives. The perception of our respondents varied depending on the natural hazard in question. Most considered the coastal floods to be the main natural hazard in the area, yet the majority of them felt more vulnerable towards the earthquakes. The reason for this is both that effective flood warnings are given by governmental institutions, and because numerous adaptive measures have been taken to mitigate the effects of possible floods, whereas earthquakes usually happen without a warning. All of our respondents voiced their concern regarding the difficult changes that their community has undergone in the last two decades. Most of them concluded that these socio-economic changes have led to loss of sense of community. These changes are likely to have made the community more vulnerable and less resilient to natural hazards. These results indicate that measures aimed at increasing community cohesion and awareness are needed.

*Ég tileinka þessa ritgerð föður mínum
með þökk fyrir óbilandi trú og stuðning*

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Þakkir

Verkefni þetta er tilkomið vegna fjögurra landa samstarfsverkefnis sem heitir: Coast Adapt - the sea as our neighbor og er styrkt af The Northern Periphery Program. Á Íslandi eru það sveitarfélögin Árborg og Vík í Mýrdal sem taka þátt í verkefninu en Stofnun Sæmundar fróða hjá Háskóla Íslands stýrir verkefninu. Ég kynntist Coast Adapt verkefninu sumarið 2010 og varð það m.a. til þess að stefnan sem var tekin í mastersverkefni mínu varð þessi.

Sumarið 2010 fékk ég starf hjá sveitarfélaginu Árborg sem var styrkt af Vinnumálastofnun. Snéri þetta starf að gagnasöfnun vegna náttúruvár og gaf það mér tækifæri til að safna gögnum vegna komandi mastersritgerðar minnar við Háskóla Íslands.

Ég færi leiðbeinendum mínum, Guðrúnu Gísladóttur og Ásdísi Jónsdóttur, kærar þakkir fyrir leiðsögnina.

Ég vil einnig færa Fanney Gísladóttur þakkir fyrir skjót og góð viðbrögð við kortagerð.

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Lífið við ströndina

Guðríður Ester Geirsdóttir

*Umhverfis- og auðlindafræði, Líf- og umhverfisvísindadeild, Háskóla Íslands
Reykjavík, Ísland*

Ritgerð þessi er samsanett úr þessum inngangskafli og grein sem birt er í kafla tvö:

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Inngangur

Við ströndina fögru var Stokkseyri byggð
og stendur frá landnámsins dögum,
frá þegnunum hlýtur hún trúnað og tryggð,
er tignuð í ljóði og sögum.
Þótt brimaldan svarrandi brotni við hlein
og björgunum lyfti úr skorðum,
þá lognaldan hjalar við lábarinn stein
og leikur við börnin sem forðum.

Þú Eyrin mín kæra við úthafsins rönd,
sem alið og fósrað mig hefur,
um fjörur og útsker með blikandi bönd
sig blundandi lognaldan vefur.
Og brimið þar kveður með rymjandi raust,
þær rímur sem geymast í minni,
ég lífsfleyi mínu vil leggja í naust
að lokum, á ströndinni þinni.

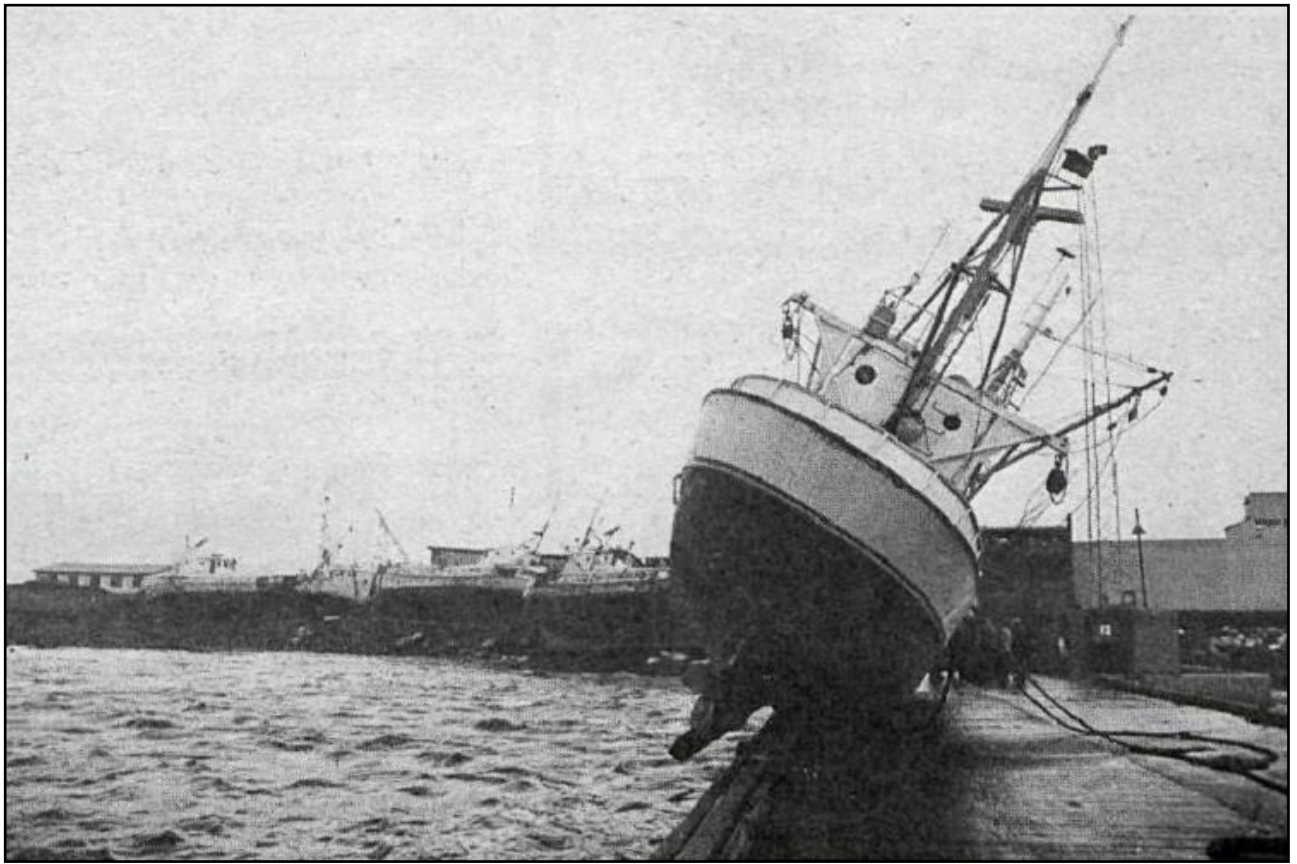
Texti: Stefán A. Jónsson

Lag: Pálmar Þ. Eyjólfsson

Á einstakan hátt tekst textahöfundur að lýsa samfélaginu á Stokkseyri með þessu ljóði. Aldan sem slík er ekki bara í formi hafsins. Hún er tákn mótlætis og meðlætis sem íbúar staðarins búa við. Suma daga skellur aldan harkalega á ströndinni og suma daga líður hún áfram og einungis sléttir fjörusandinn með nærveru sinni.

Frá upphafi byggðar hafa Stokkseyringar þurft að takast á við Ægi. Hann hefur gefið og hann hefur líka tekið. Í langan tíma var hann forsenda byggðar en einnig stærsta ógnin. En ógnirnar eru fleiri. Víða um land hafa atvinnuvegir breyst og er það engin undantekning á Stokkseyri. Lítil, blómlegur fiskibær með þéttan kjarna íbúa hefur á vissan hátt breyst í úthverfi. Flestir íbúar vinna fjarri heimabyggð og eyða litlum tíma saman í þorpinu sínu. Verslun og þjónusta við íbúana er farin á brott og í staðinn hefur tekið við afþreying og þjónusta við ferðamenn. Staðurinn þrífst sem slíkur, peningar streyma inn í hagkerfið, en hvaða áhrif hefur slík þróun á samfélagið, samfélagasandann og íbúana?

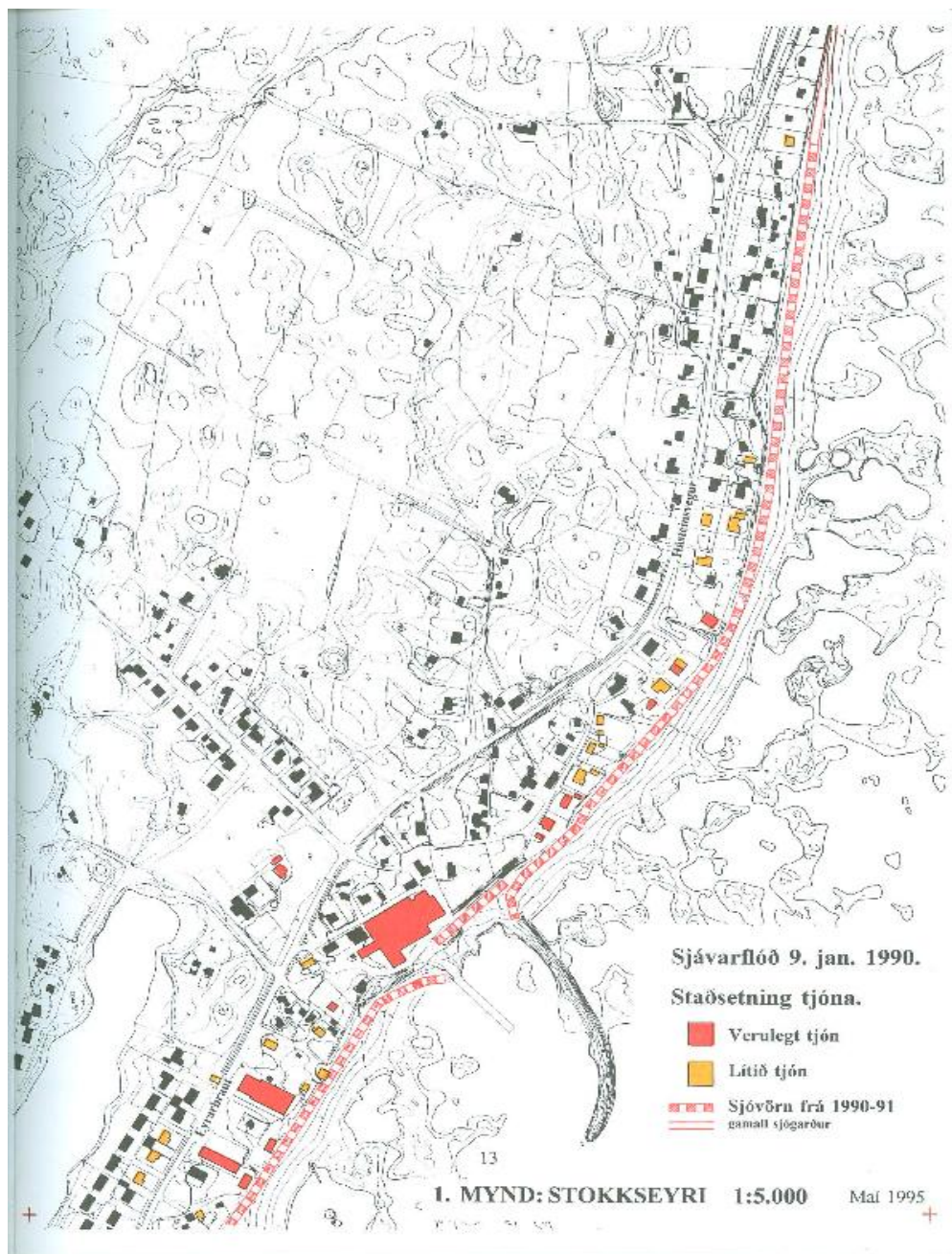
Á tímum hnattrænna loftslagsbreytinga þegar spár um hækkandi sjávarborð og frekari vár vegna hafsins eru ríkjandi er eðlilegt að velta fyrir sér stöðu lítils sjávarþorps sem er einungis um þrjá metra yfir sjávarmáli. Hvaða áhrif kemur þessi breyting til með að hafa á Stokkseyri? Náttúruvá má með ýmsum hætti verjast en það sem gefur hvað mestan styrk til að takast á við vanna er samstaða íbúanna sem einna helst finna má í samfélagskennd þeirra.



Mynd 2 Bryggjan og fjaran á Stokkseyri í desember 1977. Tekið af vef Tímarit.is (Vísir, 1977).

Stokkseyri hefur ekki farið varhluta af sjávarflóðum og var fyrsti sjóvarnargarðurinn byggður af Grími Grímssyni árið 1890 (Hafsteinsson et al., 2010). Sjávarflóð hafa verið tíð og eru þau einkum slæm ef fer saman SSV átt, há sjávarstaða og fullt tungl, en það er einmitt það sem gerðist þann 9. janúar 1990 þegar eitt það stærsta sjávarflóð Íslandssögunnar reið yfir. Íbúar svæðisins hafa lært að lifa með slíkum flóðum og er það einkum vegna þess að viðvaranir frá Almannavörnum og Veðurstofunni hafa komið að góðu gagni, en einnig vegna þess að þorpið er varið með tæplega 5 kílómetra löngum, öflugum sjóvarnargarði sem var reistur í kjölfar flóðsins. Þar sem talið er að sjávarborðshækkun geti orðið 0.6 metrar á þessari öld eru taldar líkur á því að það komi til með að hafa áhrif á tíðni og styrk stormflóða því samhliða (IPCC, 2007; Bjarnadóttir og fl., 2010). Því má leiða líkur að því að Stokkseyri komi til með að verða tjónnæmara (*vulnerable*) gagnvart náttúruvá í formi sjávarflóða í framtíðinni (Blaikie et al, 1994; Buckle, 1999; UNISDR, 2009).

Stokkseyri hefur gengið í gegnum miklar samfélagsbreytingar á undanförunum tveimur áratugum, ekki ósvipað og aðrir smáir staðir á landsbyggðinni. Þjónusta á borð við bankastarfsemi, pósthjónustu, heilsugæslu og verslun er ekki lengur til staðar í þorpinu og stærsta vinnustaðnum, þ.e. frystihúsinu, hefur verið lokað. Ferðamennska hefur í staðinn tekið yfir á undanförunum árum en staðurinn býr yfir fjölbreyttum söfnum, vinsælum veitingastað og ýmis konar afþreyingu. Breytingar þessar hafa hvort tveggja haft áhrif á samfélagið og íbúa þess. Áhyggjuraddir heyrast um það að Stokkseyri verði svefnbær eða sumarbústaðabyggð í framtíðinni og til þess að sporna gegn þeirri þróun þarf að finna leiðir til að styrkja innvið samfélagsins og anda þess.



Mynd 3 Staðsetning tjóna í sjávarflóðinu 1990. Skipulag ríkisins, 1995.

Svo virðist sem sveitarfélagið Árborg, sem Stokkseyri tilheyrir, reyni að stemma stigu gegn frekari fólksfækkun í þorpinu og samkvæmt meginmarkmiðum skipulagsgreinagerðar með aðalskipulagi Árborgar 2005-2025 skal draga fram sérkenni hvers svæðis innan Árborgar fyrir sig og byggja tillögugerð á þeim til hagsbóta heildarinnar og hverju svæði fyrir sig (Sveitarfélagið Árborg, 2005).

Vorið 2010 stóð mér til boða að kynna mér verkefni sem heitir Coast Adapt - the sea as our neighbor og er styrkt af The Northern Periphery Program. Verkefni þetta er fjölþjóðlegt rannsóknarverkefni sem fjallar um það hvernig smá samfélög við strendur Norður

Atlantshafs aðlagast breytingum sem verða vegna hnattrænnar hlýnunar. Sveitarfélögin Árborg og Vík í Mýrdal taka þátt í verkefninu en Stofnun Sæmundar fróða hjá Háskóla Íslands stýrir verkefninu hér á landi. Auk Íslands taka þátt sveitarfélög og rannsóknarstofnanir á Írlandi, í Skotlandi og norður Noregi.

Tekin var sú stefna að ég myndi þróa meistaraverkefni mitt í tengslum við Coast Adapt verkefnið og í kjölfarið fékk ég tækifæri til að taka þátt í rýnihópafundi í Vík í Mýrdal í júlí 2010 með Ásdísi Jónsdóttur annarra leiðbeinanda minna. Tekin var sú ákvörðun að ég myndi undirbúa sambærilega fundi í sjávarþorpum Árborgar, þ.e. Eyrarbakka og Stokkseyri sem voru haldnir í septemberbyrjun 2010.

Í samráði við Guðrúnu Gísladóttur var ákveðið að nota niðurstöður Stokkseyrarhópsins sem og 3 viðtöl sem ég hafði tekið þá um haustið í mastersverkefnið.

Í kafla 2 er gerð grein fyrir niðurstöðum eigindlegrar rannsóknar á tjónnæmi (*vulnerability*), þoli (*resilience*), aðlögunarhæfni (*adaptation*) og samfélagskennd (*sense of community*) Stokkseyrar og íbúa hennar.

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Living with Natural Hazards on the Icelandic South Coast

G.E. Geirsdóttir¹, G. Gísladóttir² and Á. Jónsdóttir³

¹The School of Engineering and Natural Sciences, University of Iceland, Reykjavík, Iceland

²The Department of Geography and Tourism, Faculty of Life and Environmental Sciences, University of Iceland, Reykjavík, Iceland

³ Centre for Technology, Innovation and Culture, University of Oslo.

Abstract

Residents in the village of Stokkseyri in southern Iceland live with the threat of natural hazards. The village is located within the South Iceland Seismic Zone and subject to earthquakes that can be > 6.0 on the Richter scale. The latest great earthquake, 6.3 in size, occurred in May of 2008. Stokkseyri is also subject to frequent storm flood surges as it is low-lying and open to the North Atlantic Ocean. The latest coastal flood happened in January 1990 and is considered to be one of the greatest such floods in the history of Iceland. Stokkseyri, as many small villages in Iceland, has experienced extensive socio-economic changes in the past 20 years, manifested in the loss of the economic mainstay and gradual deterioration of local services. The purpose of this paper was to investigate residents' perception of the communities' vulnerability, resilience and adaptation to the recurring natural hazards of the area and the impact of socio-economic changes thereon. In 2010, we held one focus group meeting using a snowball sample technique, and conducted in-depth, face-to-face interviews with local residents using an opportunistic sample technique. All participants were between the age of 32-69 and most of them had been living in Stokkseyri their entire lives. The perception of our respondents varied depending on the natural hazard in question. Most considered the coastal floods to be the main natural hazard in the area, yet the majority of them felt more vulnerable towards the earthquakes. The reason for this is both that effective flood warnings are given by governmental institutions, and because numerous adaptive measures have been taken to mitigate the effects of possible floods, whereas earthquakes usually happen without a warning. All of our respondents voiced their concern regarding the difficult changes that their community has undergone in the last two decades. Most of them concluded that these socio-economic changes have led to loss of sense of community. These changes are likely to have made the community more vulnerable and less resilient to natural hazards. These results indicate that measures aimed at increasing community cohesion and awareness are needed.

Keywords: Natural hazards; Earthquakes; Coastal floods; Storm surges; Vulnerability; Adaptation; Resilience; Sense of community; Stokkseyri; Iceland

Introduction

The South Iceland coastal village of Stokkseyri is a community of 445 inhabitants (Statistic Iceland, 2011). It belonged to the former district called Stokkseyrarhreppur, which is situated in the most southern part of Árnesýsla, an administrative district in South Iceland (Fig. 2.1). The village is subjected to storm flood surges where it is low-lying and open to the North Atlantic Ocean and experiences floods frequently. In the 20th century, fishing was the economic mainstay of the area, despite the fact that the harbour at Stokkseyri is open to the harsh North Atlantic Ocean and that a number of skerries make the navigation to it difficult.

In Iceland weather related hazards such as storms and floods are regularly monitored by the Icelandic Meteorological Office (IMO). Storm and flood warnings are broadcast on national radio and television as well as online (Almannavarnir.is). Advice is simultaneously given to residents in the areas under risk. Along frequently flooded coasts, like the one in Stokkseyri and the neighboring village of Eyrarbakki, breakwalls have been constructed to protect the communities. The breakwalls protecting the coasts of the two neighboring villages, are currently about 7 km long (Kjartansson and Hergeirsdóttir, 2010) whereas 2.7 km of the coast line is still in a need of a similar breakwall.

Stokkseyri is also subjected to earthquakes, being located within the South Iceland Seismic Zone (SISZ). Due to the large earthquake risk in Iceland the IMO and the Earth Science Institute of the University of Iceland conduct extensive monitoring of seismic activity in Southern Iceland (Stefánsson et al., 2000; Bird et al., 2008; Böðvarsson et al., 1999). As early as 1985, geoscientists predicted an earthquake in the region of the size 6.3-7.5 on the Richter scale within a time span of 25 years (Einarsson, 1985; Stefánsson et al., 2000). Despite the fact that a large earthquake was expected in the region, predictions were not accurate enough to issue emergency warnings prior to the actual earthquake. In June 17th 2000 an earthquake of the size 6.6 on Richter scale struck the southwest Iceland in the very location that scientist had predicted (Stefánsson and Halldórsson, 1988; Stefánsson et al., 2000). Following the damaging earthquake (Stefánsson et al. 2000), the IMO initiated a Web-site for viewing near-real-time earthquake activity using results from the South Iceland Lowland (SIL) national seismic network (Böðvarsson et al. 1996; Bird et al., 2008). Analysis of data after the event indicated that another earthquake was likely to take place in the following days in the western part of the SISZ (Stefánsson et al., 2000). This allowed scientists to warn the Icelandic Civil Protection and Emergency Management of the National Commissioner (ICP) in time before the second earthquake struck on June 21st the same year (Stefánsson et al., 2000). In 2008 an earthquake of the size 6.3 struck the area again following by an immediate aftershock, which was recorded by the SIL seismic network (Decriem et al., 2010). Some mitigation measures are available to minimize economic damage and risk of people's life if an earthquake strikes. In Iceland all buildings in defined earthquake area have to be constructed according to regulations (Act no 73/1997) to endure large earthquakes.

Despite the relatively high risk of coastal flooding and earthquakes, no special mitigation strategies, such as evacuation and emergency plans when facing these particular events are

in place for the area as such (Jóhannesdóttir, personal communication). However, general evacuation and emergency plans are available and during an emergency the ICP takes immediate action according to its legal obligations (Act 82/2008). District police and an emergency management team, including the Red Cross and local rescue teams, lead the work in cooperation with the ICP when disaster strikes in the region. At the time of the earthquakes in 2008 a thorough reaction plan had recently been developed for municipalities in Iceland and was adjusted to Árborg, to which Stokkseyri belongs, and the neighboring municipality of Hveragerði in the days following the disaster (see Þorvaldsdóttir et al., 2008).

Stokkseyri has experienced extensive social changes in the past 20 years. The village has moved away from being a fishing village with its own service providers, such as commercial stores, banks, post office and health care center to becoming dependent on the neighboring town of Selfoss (15 km away) and the capital Reykjavík (65 km away) for both services and employment. Today, tourism, partly benefitting from the proximity to the capital, is becoming increasingly important creating economic flow into the community.

Here we present a study in which we explored views of inhabitants of the coastal village, Stokkseyri, South Iceland, in relation to natural hazards. The purpose of the study was to investigate, in a non-representative qualitative manner, residents' perception of the communities' vulnerability, resilience and adaptation to the recurring natural hazards of the area, and the impact of socio-economic changes thereon.

1 Vulnerability, resilience and adaptation

Within the field of risk analysis and emergency management, numerous authors have identified the importance of these concepts, i.e. of vulnerability, adaptation, resilience and sense of community, when assessing the preparedness and response of communities prone to natural hazards (e.g. Blaikie et al., 1994; Tobin, 1999; King and MacGregor, 2000; Paton and Johnston, 2001; Cutter, 2003; Jóhannesdóttir, 2005; Bird et al., 2009; Jóhannesdóttir and Gísladóttir, 2010; Bird et al., 2011).

Vulnerability generally refers to the characteristics of person or group exposed to hazard, and their susceptibility to disturbances and losses determined by exposure and sensitivity to the damaging effects of a hazard (Blaikie et al, 1994; Buckle, 1999; UNISDR, 2009) that in turn contribute to the elements ability to resist, deal with and recover from the impact of a natural hazard. Vulnerability is an essential concept in hazards research and central to hazard mitigation strategies (Cutter, 1996).

Cutter (1996) suggests that existing research on vulnerability should fall under three main themes, i.e. vulnerability as risk/hazard exposure; vulnerability as social response; and vulnerability of places. The study of vulnerability as risk/hazard exposure is characterized by a focus on the distribution of the hazardous condition where the human occupancy and the degree of loss is associated with the frequency of the particular event of natural hazard. The study of vulnerability that focuses on resilience to hazards and societal resistance examines chronic disturbances such as drought, famine, climate change or environmental change and highlights the social construction of vulnerability. That can be a condition that can be rooted in historical, cultural, social or economical processes, which affect the ability of the individual or the society to cope with disasters and respond to them in a sufficient way. The study of vulnerability of place is conceived as both a biophysical risk and a social response within a specific areal or geographic domain, which can be either geographical space or social space (Cutter, 1996).

Social vulnerability is partially the product of social inequalities and is often described using the individual characteristics of people and communities, in terms of factors such as age, income, employment, political status and social network access and provides information on vulnerability and resilience of communities (Blaikie et al., 1994; Cutter et al., 2003; Paton and Johnston, 2001; Tobin, 1999). It is a measure of how communities are able to resist and recover from the impact of a natural hazard (Armaş, 2008) where these social factors that influence or shape the susceptibility of groups to harm, can also affect their ability to respond (Cutter et al., 2003). Reducing the vulnerability level of communities is the only efficient and accessible way to reduce the pressure of natural risk (Armaş, 2008). This can, for example, be done by increasing the overall ability to quickly recover from a disaster, e.g. with some mitigation measures. Sense of community is a feeling that community members have of belonging; it is a feeling of neighborliness and a shared faith that their needs will be met in cooperation (McMillan and Chavis, 1986). When sense of community is lacking a society can become more vulnerable and less able

to face natural hazard whereas vulnerability can be decreased by raising sense of community (Bird et al., 2011) because *sense of place* is an important factor in community cohesion (King and MacGregor, 2000). Social, economic and cultural differences can influence the vulnerability and resilience of a community as a whole (Tobin, 1999) as well as that of individuals; and particularly of new-comers to a society who may not have experienced or gained knowledge of local hazards (King and MacGregor, 2000).

When exploring vulnerability indicators it is important to keep in mind that some factors can be considered to increase individual's vulnerability at the same time as they increase resilience. For example, old people might be considered vulnerable due to diminishing mobility, but under specific conditions they represent an endurance and resilience due to lived experience and gained knowledge (Paton and Johnston, 2001). King and MacGregor (2000) identified single person households and newcomers to a community likely to be highly vulnerable to hazards whereas experience is the most effective source of awareness when it comes to risk perception (Alexander, 2000; Pagneux et al., 2010). Bird et al., (2011) found similar results when comparing urban and rural resident vulnerability in a community in south Iceland. Their research indicates that the higher percentage of single person households and newcomers in an urban area than in the neighboring farming community led to more community vulnerability when facing risk posed from the volcano Katla. An important factor contributing to this may be the local knowledge and experience that newcomers do not have.

The research of King and MacGregor (2000) also showed that vulnerability cannot be explained by physical data and risk analysis alone. The perceived natural risk in an area is also an important factor of social vulnerability (Armaş and Avram, 2009; Bird et al., 2009; Jóhannesdóttir and Gísladóttir, 2010; Bird et al., 2011). Perception is likely to be time related, as people tend to magnify the importance of events that are close in time and space, and minimize the importance of the distant ones (Alexander, 2000).

Effective mitigation strategies that people exposed to hazard trust, are important and may reduce vulnerability and raise resilience, and increase the likelihood that people respond accordingly in case of increased stress (Paton et al., 2008). To ensure the safety of all concerned close cooperation and adequate communication between the scientific community, governmental and local authorities and the inhabitants is vital (Bird et al., 2008; Jóhannesdóttir and Gísladóttir 2010; Bird et al., 2011).

If communities are both exposed and vulnerable when natural hazard strikes, it can lead to a disaster (Armaş, 2006; Pelling, 2001). That may for example occur when a community already suffering an economical downturn experiences a natural hazard. Contrastingly, communities may experience increased resilience endorsed by societal cohesion, both during and in the aftermath of a natural disaster (Paton and Johnston, 2001), thus reducing community vulnerability.

Thus if community resilience is weak it is essential to increase it, as resilience it is the ability of hazard exposed communities and systems to resist, absorb, accommodate and recover from the effects caused by the hazard UNISDR (2009). And the resilience of a community towards a potential hazard is determined by the degree to which the community has the necessary resources and is capable of organizing itself both prior to and during times of need. Importantly, resilience refers to either the community's or the individual's capacity to cope and adapt when facing an extreme event. Resilient

communities are thus more likely to resist and recover from disaster (Tobin, 1999). The source of resilience can be in tangible factors such as the built environment and on economic wellbeing, or it can be on the ability of the community members to utilize the physical and economic resources available, and hence, minimize disruption and facilitate growth (Paton and Johnston, 2001).

Adaptation involves the adjustment in natural or human systems in response to actual or expected stimuli or their effects (UNISDR, 2009). Adaptation is therefore aimed to moderate harm or exploit beneficial opportunities in numerous ways e.g. with risk reduction measures of an individual or household scale through adaptation of a community to multiple stresses (Smith and Wandel, 2006).

Community adaptation towards natural hazard can be in the form of mitigation programs designed to reduce risk (Tobin, 1999). Flood embankments and breakwalls constructed to protect communities from flooding are one form of mitigation as is heightening the ground floor level in new buildings (Skipulag ríkisins, 1992). Individual preparedness, such as securing ones home and belongings in the event of a storm, also falls under mitigation.

Sense of community, i.e. people's feeling of belonging and being attached to a specific place, can increase community resilience (King and MacGregor, 2000; Jóhannesdóttir 2005; Jóhannesdóttir and Gísladóttir, 2010; Bird 2010; Bird et al., 2011). It can also be an indicator of communities' fragmentation that gives insight into community vulnerability (Paton and Johnston, 2001). There are different ways available to increase sense of community in an attempt to reduce vulnerability and concurrently raise community resilience (Paton and Johnston, 2001), e.g. by strengthening social structure of the community and increase cohesion, which can be implemented through involvement with community and neighbors and family, awareness and preparation training an ability to access warnings, general and local knowledge. Community involvement in the solving of problems often generates a sense of community and hence reduces vulnerability and increases community resilience; especially if a relatively large proportion of the residents are involved (King and MacGregor, 2000; Paton and Johnston, 2001; Jóhannesdóttir and Gísladóttir, 2010; Bird et al., 2011). Sense of community is therefore a vital factor in increasing communities' resilience and adaptation, and decreasing vulnerability. When people sense that they have a common future and the social network is strong, community life is more easily sustained and can lead to greater resilience (Buckle, 1999; Bird et al., 2011; Alexander, 2000). Or, on the contrary, as Alexander (2000) points out; societies that are experiencing serious disequilibrium when disaster strikes are unlikely to bounce back and are therefore not resilient.

It is therefore the purpose of this study to explore the views of inhabitants of the coastal village of Stokkseyri, southern Iceland, in relation to natural hazards, and to investigate, in a non-representative qualitative manner, residents' perception of the communities' vulnerability, resilience and adaptation to the recurring natural hazards of the area, and the impact of socio-economic changes thereon. To provide background to our research, we first describe the temporal socio-economic changes that have occurred in Stokkseyri, and then past and future potential hazards endangering the village and finally the present state of emergency and mitigation plans.

2 The study area

2.1 The Stokkseyri community

Stokkseyri is a coastal village of 445 inhabitants (Statistic Iceland, 2011) located on the southern coast of Iceland and exposed to the North-Atlantic Ocean (Fig. 2.1).

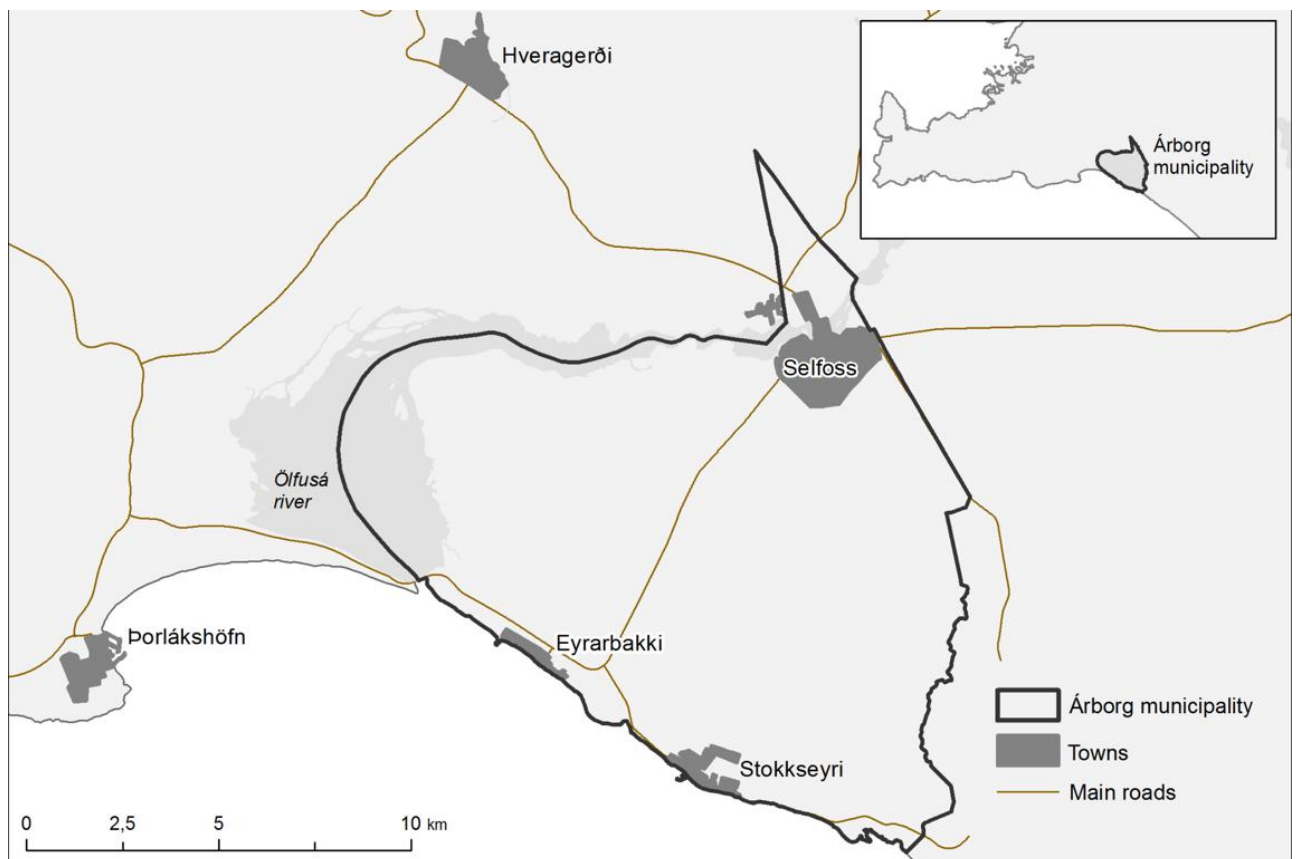


Figure 2-1 A map showing the municipality of Árborg and the nearby towns of Hveragerði and Þorlákshöfn. The position of the municipality within south-west Iceland is shown on the smaller inserted map.

In the late 1800 Stokkseyri was more like a seasonal dwelling place where people stayed during the annual fishing season than an established village. In 1896 the population of Stokkseyri counted mere 55 persons but from then on the population grew until reaching a maximum of 746 inhabitants in 1922 (Fig. 2.2). In 1923 the population started to decline and by 1960 the number had fallen to 370 persons. From 1975 onward the number has been around 450 with a current population of 445 (Statistics Iceland, 2011).

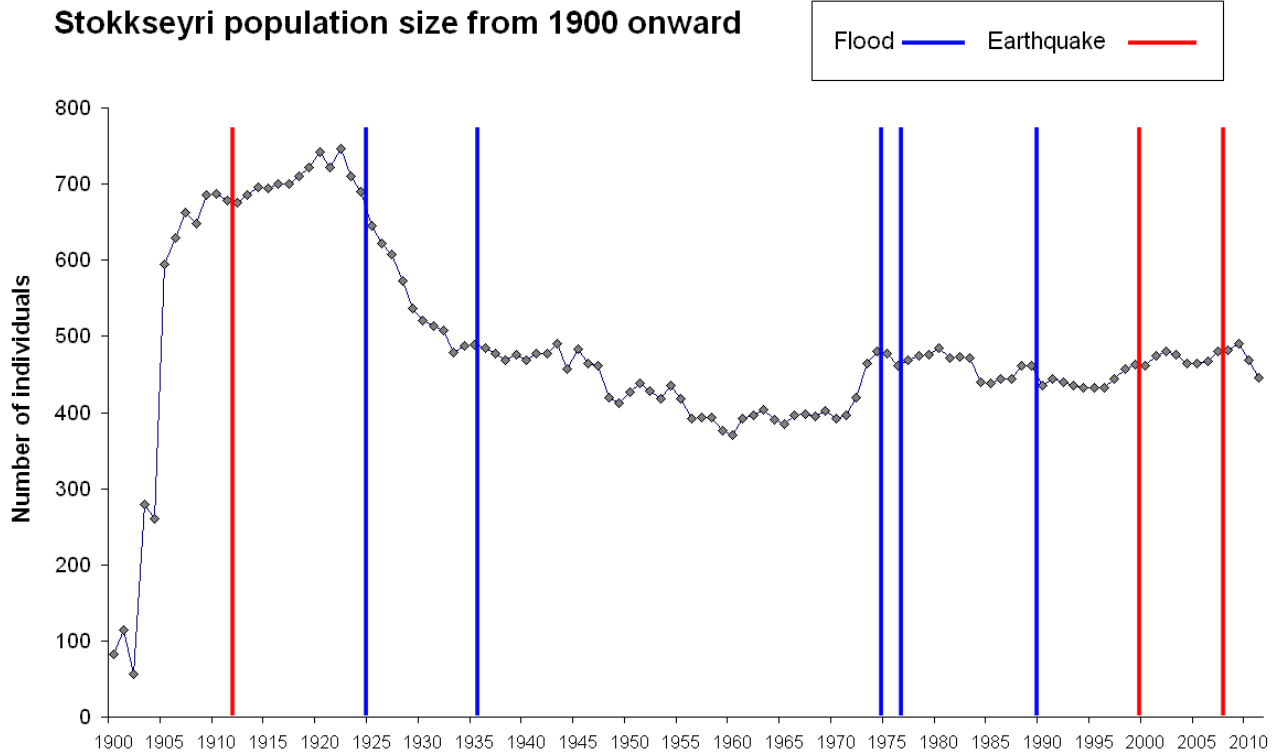


Figure 2-2 Stokkseyri population development in the period 1900-2011. Also depicted are the natural hazards which occurred in the period.

In the 20th century, fishing and fish processing was the economic mainstay of the area, despite the fact that the harbour at Stokkseyri is open to the harsh North Atlantic Ocean and that a number of skerries make the navigation to it difficult. In addition to fishing, farming was also practiced from the first days of settlement. In 1884 Stokkseyri was made a legitimate trading centre and from then on the village began to grow as a trading place (Hafsteinsson et al., 2010). In 1852 an elementary school was established in Stokkseyri.

In the late 1980's a number of circumstances led to a major change in the local economy of Stokkseyri. In 1988 the Ölfusá River (Fig. 2.1) was bridged making it possible for people in Stokkseyri to commute to Þorlákshöfn, a larger nearby town. Instead of maintaining the local harbour, the authorities decided to collaborate with the community of Þorlákshöfn, where the harbour is more accessible (Sveitarfélagið Árborg, 2005). Consequently, the fish processing plant, the largest local enterprise in the village, was closed down. Ten years later, in 1998, Stokkseyri merged with several neighboring municipalities to become a part of the municipality of Árborg (Fig. 2.1). Since then the inhabitants have experienced further socio-economic changes, most notably the erosion of various aspects of the service sector with the closing down of the local health care unit, bank, post office and the villages' only grocery store. Despite these changes, the population of the village has remained stable since 1990 (Figs. 2.3 and 2.4). No information was available on household demography because neither Statistics Iceland nor the central office of Árborg municipality gather this data for the village, only from the municipality as a whole. We tried to receive information on numbers of households with newcomers living at Stokkseyri because they can be more vulnerable when facing natural hazards because of lack of experience (King and MacGregor, 2000; Alexander, 2000). The fact that these information are not available in the municipalities database can be of concern because not

knowing how many newcomers are living in a community, which can be a vulnerable group, can in it self cause community's vulnerability. A loose count of current vacation homes reveals that already today, about 10% of the homes in Stokkseyri are used as seasonal vacation homes (Geirsdóttir, personal knowledge).

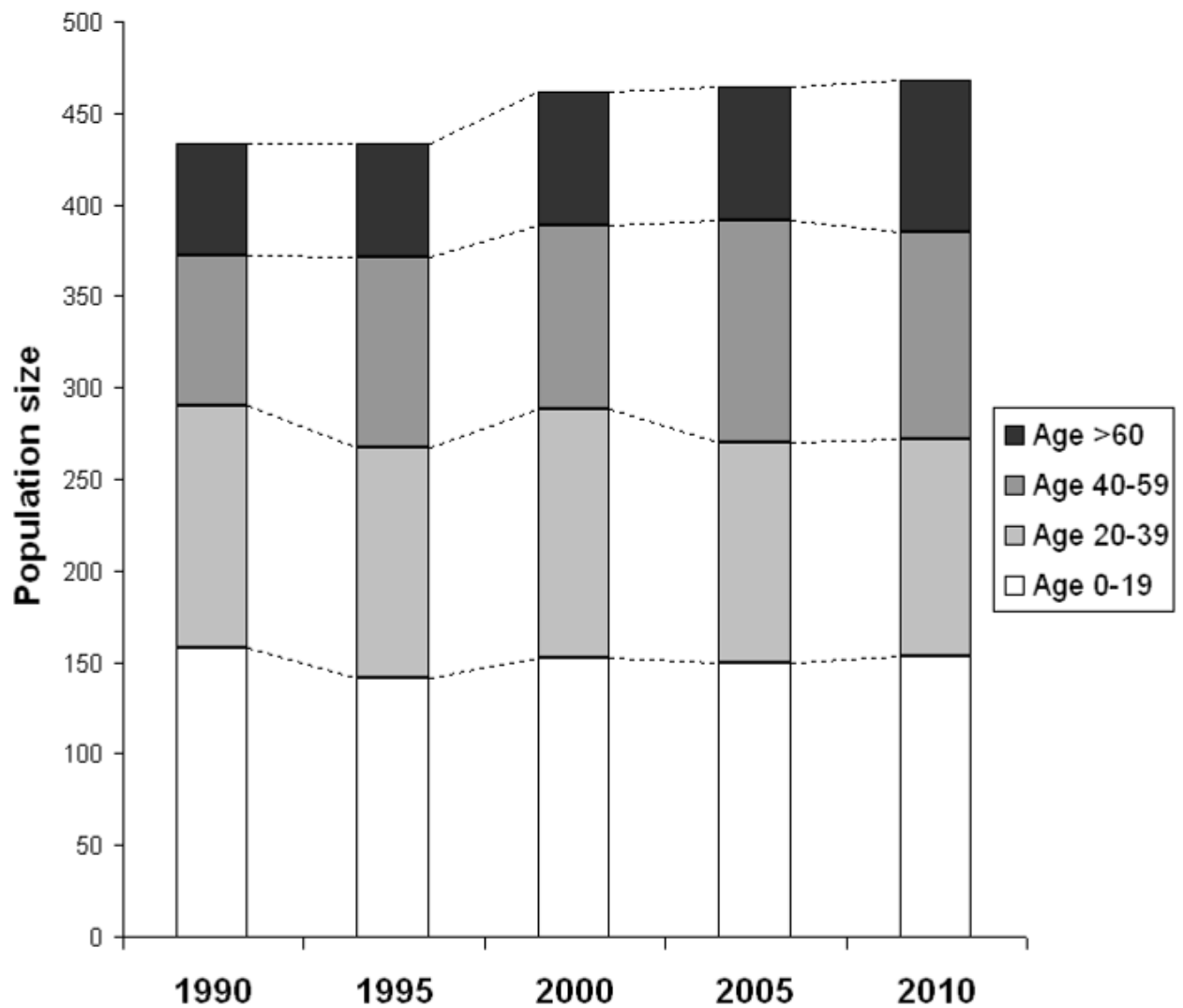


Figure 2-3 Population size and age distribution in the village Stokkseyri from 1990-2010 (Statistic Iceland, 2011).

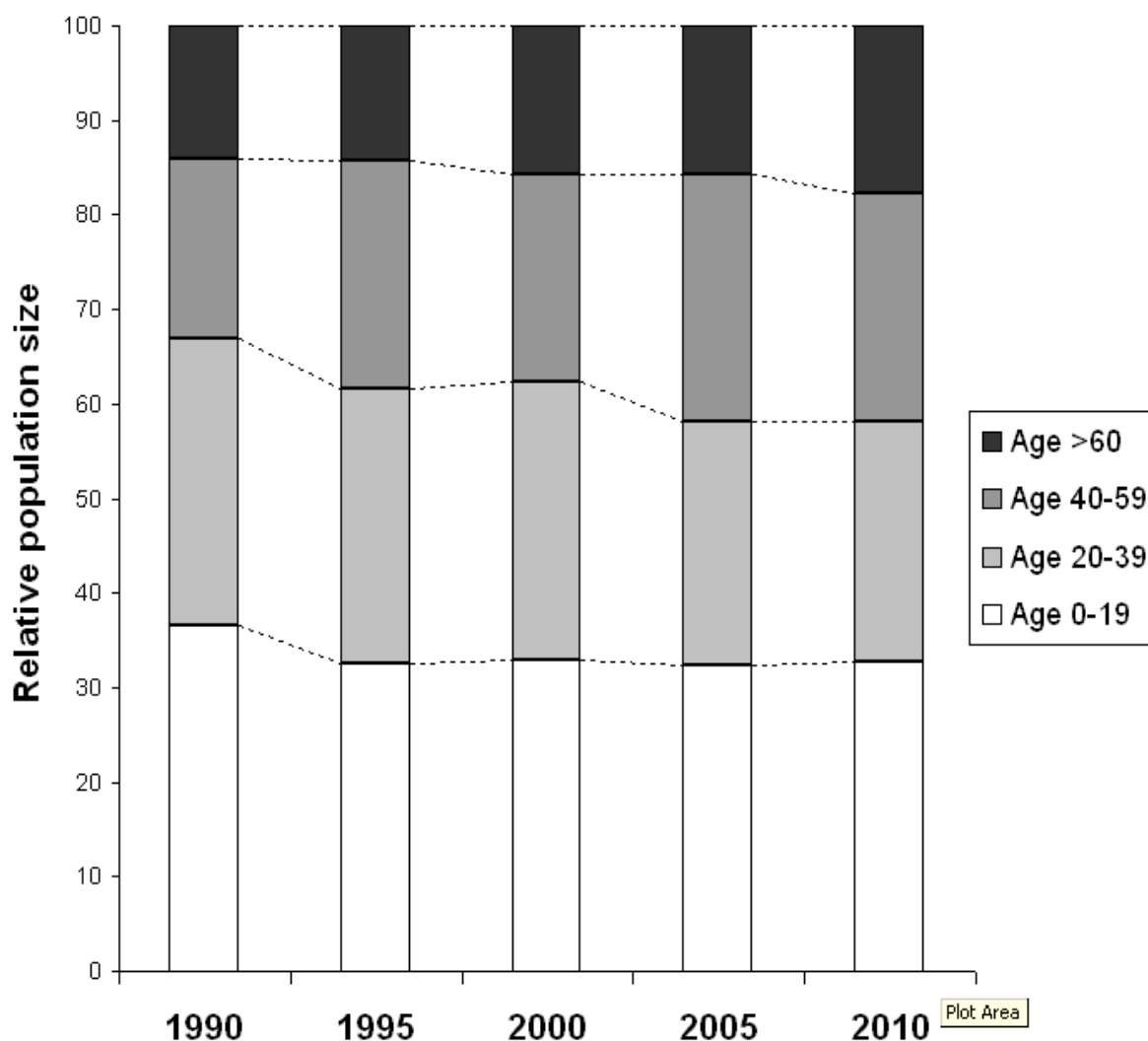


Figure 2-4 Relative population size and age distribution in the village Stokkseyri from 1990-2010 (Statistic Iceland, 2011).

2.1.1 Present day

Today a kindergarten, an elementary school, a nursing home, public library and a public swimming pool are still in operation in Stokkseyri. One of the privately operated banks in Iceland is open for two hours a week in the former office of the rural council. There is one gas station which houses a small store where people can buy some necessities. However, most people seek the necessary services in the neighbouring town of Selfoss (15 km away) or in the capital (65 km away). In the village some small local enterprises are in operation such as a company which produces dried fish and a construction firm that builds windows and doors. The majority of the villagers seek employment outside the village.

In the years following the collapse of the fishing industry in the village, Stokkseyri has observed a steady increase in tourism and currently tourist-oriented activities and services play a large role in the local economy. The services provided in Stokkseyri have changed from being geared towards the inhabitants themselves to being marked to outsiders. Today,

five museums are found in the village. One of the two older museums is the reconstructed fisherman's hut of Þuríður Einarisdóttir (1777-1863) which is a traditional turf-hut (sod-house) rebuilt in 1949. Just outside the village is an old dairy farm which today is a museum and gives an insight into the old ways of making dairy products (erected in 1904). Two of the new museums focus on local heritage in relation to ghost, elves, trolls and northern lights and the remaining one displays stuffed mammals and birds hunted in Africa and Greenland. Stokkseyri is also renowned for its natural surroundings and ample opportunities for kayaking and bird watching and therefore gives great opportunity for nature lovers. A cultural centre is currently operated in the former freezing plant where some local artists' workshops are found. Two local guesthouses and one local restaurant cater to the tourism. Most of the interaction between the inhabitants today is in relation to the kindergarten, the elementary school and the nursing home. These institutions are both the largest working places in the village and also places where people meet when dropping of children to school and visiting old relatives in the nursing home. The gas station is also a kind of meeting place, but no intimate places as café are located in Stokkseyri so people do have limited opportunities to sit down and chat in local areas. The inhabitants of Stokkseyri have a way of dealing with this and that is by doing a lot of visiting. It is very customary to 'drop in' to your relatives and friends on a daily bases for a coffee and preferably a cake.

2.2 Stokkseyri - physical environment

The village sits at the southern end of a lowland plain, on average only 3 meters above sea level (Landmælingar Íslands, 2011). Due to postglacial isostatic adjustment the southwest part of Iceland is subsiding (Imsland and Einarsson, 1991; Árnadóttir, et al., 2008). The frequency of coastal flooding is higher in the southwestern part of Iceland than in other parts of the country (Imsland, 1992) and more than half of the documented floods in Iceland for the period 1199 to 1991 occurred in this region. Of the 54 coastal floods that caused damage in the 20th century in Iceland, 37 took place in the southwest. The reason for this is that most of the floods are connected to storm events where the waves build up far out at the North Atlantic Ocean and when they hit the coast from a southwesterly direction they have increased in size and can be both strong and high. Serious floods occur when these storms coincide with high tide. Moreover, the southern coast is quite flat and unshielded, which, along with the subsiding of the landmass explains the high frequency of damaging floods (Imsland and Einarsson, 1991; Árnadóttir, et al., 2008).

Global climate change is expected to impact Stokkseyri through sea level rise which is predicted to be in the order of 0.2 - 0.6 meters in this century (IPCC, 2007; Björnsson et al., 2008; Church et al., 2008), making the area more vulnerable to storms and flooding (Skipulag ríkisins, 1992; Bjarnadóttir et al., 2010). Measurements in Reykjavík in the years 1956-2007 state that sea-level rise is about 1.5 mm per year, which is in accordance to the world average of 1.8 mm reported from IPCC (Viggósson, 2008). Stokkseyri is located on a gravel bank on top of the approx. 8700 years old Þjórsá lavafield (~950 km²) originating from a volcanic system 140 km north of Stokkseyri (Árni Hjartarson, 1988). The lava forms the village's coast and extends approximately one km into the North Atlantic. One of Iceland's largest wetland areas has formed on the lava and extends from the village towards the west, north and east.

The area is a part of the South Iceland Seismic Zone (SISZ) in which the most severe earthquakes in Iceland occur (Einarsson, 1991; Einarsson, et al., 2008; Stefánsson et al., 2006). Based on historical earthquake records in the SISZ (Table 2.1) and geophysical research, Decriem et al. (2010) have identified a seismic cycle of 130-150 years during which the crustal stress builds up and accumulates until released by earthquakes in the whole zone, occurring in one or more earthquakes or single events. During the 18th-20th century it took in the range of 16-52 years to release the crustal stress that had accumulated in a given cycle. The last two earthquake sequences in the SISZ occurred in 2000 and 2008 and according to scientists there is still a potential for a strength 7 magnitude release as there is still some crustal stress within the system.

Table: 2-1 Documented earthquakes in the SISZ.

Date (yy/mm/dd)	Magnitude	Epicentre	Approximate distance from Stokkseyri in km
1630/02/01	7	Land - Minnivellir	44-47
1633/-/-	-	Ölfus	15-18
1706/04/20	6	Ölfus - Hveragerði	15-18
1732/09/07	6.7	Land - Leirubakki?	50-55
1734/03/21	6.8	Flói - Litlu Reykir?	18-20
1766/09/09	6	Ölfus - Gljúfur Kross	17-19
1784/08/14	7.1	Holt - Gíslholtsvatn	30-33
1784/08/16	6.7	Flói - Laugardælir	11-13
1829/02/21	6	Rangárvellir - Hekla	45-65
1896/08/26	6.9	Skarðsfjall - Fellsmúli	50-53
1896/08/27	6.7	Flagbjarnarholt - Lækjarbotnar	41-43
1896/09/05	6	Selfoss - Ingólfssfjall	11-14
1896/09/05	6.5	Skeið - Arakot - Borgarkot	28-30
1896/09/06	6	Ölfus - Hveragerði	15-18
1912/05/06	7	Selsund - Galtalækur	55-57
2000/06/17	6.6	Holt, Skammbeinsstaðir	36-37
2000/06/21	6.5	Flói, Grímsnes, Hestvatn	22-25
2008/05/29	6.3	Ingólfssfjall, Kross	15-17

Notes: Moderate size ($M > 6$) earthquakes in SISZ since 1896. Modified from Decriem et al., 2010.

2.2.1 Natural hazards and emergency plans

Stokkseyri and the neighbouring village Eyrarbakki (Fig. 2.1) have been exposed to coastal storm floods for centuries. During the last century floods that caused damage occurred in 1925, 1936, 1975, 1977 and 1990 (Kjartansson and Hergeirsdóttir, 2010) (Table 2.2 and Fig. 2.2). Overall there were huge economic losses to both communities in these floods, particularly because of damage to boats and breakwalls. The 1990 flood is one of the greatest in the history of Stokkseyri, which caused huge economic losses. The flood occurred by extreme conditions: an extremely low pressure with SSW winds up to 35 m/s (Imslund and Einarsson, 1991) that coincided with an nearly full moon and an unusually high tide. This resulted in enormous waves. The highest wave measured about 23 m high and is considered to be the most powerful wave measured world wide (Viggósson, 1990). This weather occurred two days prior to full moon and 3-4 days before spring tide. Under these circumstances and when the wind blows from a SSW direction conditions arise for a disastrous event to take place, and that is what happened in the 1990 flood. The day prior to the flood the ICP issued a warning and people had the opportunity to attend to their belongings. Even so buildings, breakwalls and other properties were badly damaged (Imslund and Einarsson, 1991). Two years following the flood new breakwalls were built in at Stokkseyri; this time considerably larger than the former ones and more likely to endure an onslaught by the sea (Fig. 2.5). Some of the larger rocks in the new breakwall are as heavy as 6.0 tons with the medium weight as 3.3 tons. The smaller rocks are 0.3 - 2.0 tons with the medium weight as 0.8 tons (Siglingastofnun, personal communication May 2011).



Figure 2-5 The large 4.7 km long breakwall at Stokkseyri. Photo Alex Máni.

In the period from 1700 to 2008 seventeen large earthquakes occurred in South Iceland (Decriem et al., 2010) (Table 2.1). According to Hafsteinsson et al. (2010) there was major damage in the 1896 earthquake in Stokkseyri and surrounding areas. The earthquake in

1912 did not have any impact on Stokkseyri but in 2000 and 2008 damage were reported to buildings and structures (Table 2.2).

Table: 2-2 Major natural hazards at Stokkseyri in the period 1896-2008.

Year	Hazard	Description
1896	Earthquake	Five strong earthquakes (6.0 - 6.9 on the Richter scale) over a two week period. 1284 out of 1427 buildings were affected and 80 collapsed altogether, in the district of Stokkseyrarhreppur. Many houses collapsed in Stokkseyri.
1912	Earthquake	Earthquake 7,0 on the Richter scale. No impact on Stokkseyri.
1925	Flood	Storm surge. Great damage to breakwalls. A barn was blown away and many inhabitants evacuated their houses during the event.
1936	Flood	Storm surge. Some damage to breakwalls.
1975	Flood	Storm surge. Breakwalls and buildings were damaged. Houses were abandoned.
1977	Flood	Storm surge. Buildings got flooded. Four boats were damaged when they were torn loose and either broke or ended up on the harbour pier.
1990	Flood	Storm surge. Massive damage to constructions and breakwalls which scattered over the village. Houses got flooded and roads got damaged.
2000	Earthquake	Two strong earthquakes over a five day period (6,6 and 6,5 on the Richter scale). Damage reported to interior of buildings.
2008	Earthquake	Two earthquakes strike at the same time (6,3 on the Richter scale). Some damage to buildings and structures.

Despite relatively frequent natural disasters, no risk mitigation strategies, such as evacuation and emergency plans, are available for the Árborg municipality (Jóhannesdóttir personal communication), and no for Stokkseyri specifically. Weather related hazards such as storms and floods are monitored by IMO which is also in charge of broadcasting warnings in the national media and online. Advice is simultaneously given to residents in the areas. In case of emergency the ICP gives a warning and reacts accordingly. Recently, the ICP, in cooperation with Árnessýsla district Civil Protection Board (ACP) and a number of residents, have analyzed the need for mitigation strategies in relation to earthquakes, coastal and river flooding and potential tsunami following an eruption in the volcano Katla. In 2011 natural hazards are to be categorized by most pressing risk and emergency plans developed (Jóhannesdóttir, personal communication) and when completed they will be introduced to the local residents In this work the ICP has

recognized the importance of taking into account potential risk related to global climate change, e.g. sea level rise.

3 Methods

The research is a qualitative study based on a *focus group* and *in-depth interviews* using a snowball sample technique for the focus group and opportunistic sample technique for the in-depth interviews (Taylor and Bogdan, 1998; Ritchie et al., 2003). In the snowballing method one or more participants are selected and then asked to suggest other potential participants. The people we contacted were very willing to point out other possible informants and often initiated contact on their own. This technique is commonly used when studying a certain area or social groups (Taylor and Bogdan, 1998; Jóhannesdóttir and Gísladóttir, 2010) and is therefore suitable for this study which is looking at the vulnerability, resilience and adaptation of the inhabitants of Stokkseyri in relations to natural hazard and community change. When using the opportunistic sampling method the researcher takes advantages of unforeseen opportunities during the course of fieldwork e.g. by using available encounters (Ritchie et al., 2003).

In addition to the focus group and the interviews, climate records for the period 1893 to 1993 were reviewed. This was done both by consulting data records from Jónsson (1993) and by reading Icelandic newspapers and magazines from 1913 onward (Tímarit.is, 2011) to see if storms or floods in Stokkseyri were documented.

3.1 Focus group and in-depth interviews

A focus group meeting can be a very useful approach to explore views, experience and concerns of people (Kitzinger and Barbour, 1999) and for producing insights into a topics that would be difficult to attain without the group dynamic that comes from this kind of an interaction. Focus groups are appropriate methodology when the researcher has specific topics to explore rather than looking at private aspects of people's lives (Taylor and Bogdan, 1998). By opting to use focus group as a method for collecting data we aimed to recruit a group that could be defined in relation to the particular conceptual framework of the study, not to be a representative sample of the population being studied (e.g. Macnaghten and Myers, 2007).

A focus group typically consists of 6 to 10 individuals. In some instances focus group members can be selected because they have something in common, e.g. something that is relevant to the topic being studied and therefore the participants are likely to be more homogeneous than in a group picked with a random method (Hoyle, et al., 2002; Bender, 2003).

The meeting was held in a classroom in the elementary school at Stokkseyri in September 2010. A week before the meeting we phoned all the potential participants and explained the nature of the study and what was required of them as participants. They were informed that data could not be traced to the individual participants through published results. We asked them to bring an object that represented Stokkseyri in their mind, either as society or environment or both if preferred. The purpose was to encourage the participants to reflect

on the topic of the focus group before the meeting and to encourage storytelling as an alternative to the more structured discussions also included in the meeting. Eight persons agreed to attend and two more said that they might be able to come. All in all six people attended; five women and one man. The focus group was recorded.

Certain pre-determined themes were discussed in the focus group but the participants were also encouraged to introduce other topics of concern.

Three in-depth interviews were conducted in September and October 2010. Before the interviews, a normal procedure was applied where I (Geirsdóttir) asked for permission to record the interview and told my respondents that everything said would not be traceable to individuals (Legard et al., 2003). Then I introduced myself, explained what my research was about and said that the interview would not take more time than about an hour. Then I asked a few background questions.

The interviews were semi-structured and questions were asked about the following: the community's past, present and future and the changes that have occurred in the past 25 years; the physical environment and the changes that have occurred in the past 25 years; the local natural hazard and lived experiences of disasters, if any; and global climate change. Despite of the structure of the interviews I gave my respondents the opportunity to evolve the interview according to their emphasis.

3.2 Data processing

The focus group discussions and the interviews were recorded. Written notes were also taken during the meeting. All of the vocal data were transcribed afterwards and an open coding was used where all the data were read line-by-line and ideas and themes were identified and formulated in the process (in accordance with Emerson et al., 1995).

The sample size of the study is not large, but this is not of great concern because the results are not to be generalized for the whole population but rather to get a basic understanding of inhabitants' perception of vulnerability, resilience and adaptation. This is in accordance with non-probability sampling where it is not the aim to be representative and generalizing about the population, but rather to gain deeper understanding. Non-probability sampling is often used when participants have a known common characteristic (Bird, 2009) and therefore this decision was made based on the fact that a small group of people would give us a deeper understanding of the views and experience in an in-depth interview or in a focus group about specific topics. Also it was our intention to obtain some basic understanding of the vulnerability, resilience and adaptation of the inhabitants of the study area, instead of generalized results for the whole population.

The discussions from the focus group meeting and the interviews were analyzed in relation to the following topics:

- The society, past, present and future. The participants were asked about the current status of the society, how it has changed in the past 25 years and how they see it in the future. Are there any opportunities; is there anything to be concerned about? This was done to get an understanding of the social structure and by that we hoped to get an understanding of their resilience, vulnerability and sense of community.

- Natural hazards. The participants were asked what the perceived main source of natural hazard in the area was. Have they, by first hand, experienced a natural disaster or heard about it from others? What was that experience like? What kind of effect did past earthquakes and coastal floods have on the society? This was done to get an understanding of risk perception and by that we hoped to get an understanding of their vulnerability, community mitigation, adaptation and resilience.

- Global climate change. The participants were asked if they had noticed any changes in the physical environment in past years. Has the weather changed? Do people see any opportunities from these changes or are they a threat to the community? This was done to get an understanding of perception of environmental matters and global climate change and by that we hoped to get an understanding regarding their vulnerability, adaptation, resilience and community mitigation.

The sample size consisted of nine participants, both male and female and all adults. In the focus group there were six residents of Stokkseyri, five women and one man; all in the age range of 32 to 59 years old. In the in-depth interviews there were three women aged 34 to 69 years. All of the people have lived in Stokkseyri for nine or more years. Seven of them were born and raised in Stokkseyri; one person moved there as a young woman and one has been living there for nine years. Most of them have a rooted connection to Stokkseyri: two are the first generation living in Stokkseyri; one person is second generation; two are third generation; one is fourth generation; two the 10th generation; and one is the 11th generation living in Stokkseyri.

The focus group meeting lasted for one and a half hour and the interviews lasted up to 60 minutes each.

4 Results

4.1 Natural hazards

The main source of natural hazard

Personal experience of natural hazards often determined their perception on the dominating hazard in Stokkseyri. Four persons stated that the coastal floods were the main source of natural hazard; two said that the earthquakes were the main threat; one woman said that she was mostly afraid of a tsunami hitting the coast if the volcano Katla would erupt and produce a glacial outburst flood (*jökulhlaup*). One woman said that she wasn't able to point out what was the main natural hazard because she hadn't experienced the coastal flood in 1990 and the earthquake in 2000. In addition she had been driving when the earthquakes in 2008 hit and didn't experience them so well because of that. She said *"I feel like I have missed out on things"*.

We could detect from our respondents some mixed feelings about the sea. Most of the people talked about it in a respectful manner and with admiration, even though they thought about it as a threat. For example, one of the women interviewed said that the sea is the main hazard in the area, but even so she considers it beautiful and magnificent. She said that when bad weather is coming she thinks about possible flooding, i.e. if the sea is going to go over the pier and cause damage and then she prepares herself for it by tending to loose things in her garden. This woman has experienced three coastal floods in 1975, 1977 and 1990. She remembered well the damage to the boats in the two first floods and was awake the night when the 1990 flood happened and observed it very closely, so she has close, personal experience when facing coastal floods.

In some other instances only negative feelings towards the sea were dominating. One woman said that she used to live further away from the sea when she was younger and after she moved into her current house, which is close to the sea, she had nightmares about the sea, that it was coming over the breakwall and hitting her house. She said *"it [the sea] was my greatest fear... I felt I was too close to it"*. Today if bad weather is on its way she worries about potential accompanied flood. She said *"... if I'm driving and see the waves splashing then I start to drive a little bit faster because then I get scared about my loved ones ... if they are alone at home and then maybe the sea would come and they all would be gone"*. This woman has experienced the three coastal floods (1975, 1977 and 1990). She remembered well the damages of the floods and when the boats landed on the pier see Table 2.2.

Four out of five of the women in the focus group talked about the possibility of a tsunami hitting the coast in the case of an eruption in volcano Katla. They were concerned about the fact that there is no emergency plan available for the area and that people therefore do not know how to react if a tsunami would hit the coast. One of the women stated that she had heard that if an eruption would take place the people of Stokkseyri would have one

hour to evacuate before the tsunami would hit the area. One of the young women said “.. *what we need is some notification about what we are supposed to do if* [her emphasis] *this would happen. What will then happen? This is something that is never talked about*”. She also stated that for some people warning of a possible tsunami would scare them, but for others it would give a sense of safety. In her mind, not knowing is a threat of its’ own. In a similar vein one of the women interviewed said “*you need to know about these things, if you are supposed to evacuate your house or just sit tight ... you have the right to know it*”. One of the older women in the group said that she had been talking to some people that have some more information about the possible danger and told the group that the experts are now not as concerned about a tsunami as they were before. “*They don’t think that there is great danger of a tsunami*”. All of the people we talked to were convinced that Katla is going to erupt; the only doubt is what the effects are going to be like. From the discussions that emerged in the focus group it is apparent that in the community there is a need for information regarding a possible tsunami and the report from ICP that is going to be issued this year will be of great importance.

The eruption in Eyjafjallajökull was recently over when the focus group meeting was held and it came as no surprise to us that people had been thinking a lot about it. Both because of the effect it had in the vicinity of the eruption but also the possible effect on Stokkseyri and its’ inhabitants. One young woman in the group said that in the time after the eruption she had thought more about natural hazard. After the eruption she used to monitor the IMO homepage, of near real time earthquake information, to look for any possible change in earthquakes occurring in Iceland. She thought about the possibility of an eruption in Katla and paid a lot of attention to this at that time. Nevertheless, after the eruption in Eyjafjallajökull ceased she stopped monitoring the homepage.

The coast/shore

The shore is of great importance to the people we talked to and people have lot of personal experience and memories about the shore and the sea, from different periods in their life. Most of them talked about that it used to be their playground when they were young and that it was often the only place to play. As the man in the focus group said “*there were no playgrounds, you see, so the only place to play was on the shore ... you would build rafts and catch crabs and three-spined stickleback [Gasterosteus aculeatus] and then, later on, the sea would be your workplace*”. Two of the older women said that they used to play on the shore when they were children and run around on the skerries when the tide was low. When people got older and realized that the sea could be threat to lives, the views often changed. When one of the women got older and had children on her own she did not want them to play on the shore. One young woman said that she is afraid of the sea, and that this is probably the reason why she does not go as much to the shore as she did when she was a child. She told us that she is afraid for her son if he goes to the shore and does not allow him to go there on his own, even though she did that herself when she was a child, but against the will of her father. One of the women in the interviews raises her concern about the fact that children today do not know how to play outside as when she was a child. Today everybody is so protective of their children that the children do not know how to play in nature. She said “*kids today do not know how to go to the shore and play, like we used to do in the old days ... now everybody just lies around watching television, preferably one by one in different rooms in the house or play computer games and that kills the spirit of the community*”. She said that she allowed her children to play on the shore but not until she had taught them “*how the sea behaves*” so they would not get into

danger because of changing tides. She said that she is afraid of the sea as a threat to her children but even more so of the breakwall as a barrier and a potentially dangerous construction when climbing on it.

The breakwall

A large breakwall was erected in 1991-1992 as a mitigation measure to protect the village from coastal floods (Fig. 2.5). The breakwall has not yet been put to the test because no coastal flood of the size as the one in 1990 has occurred but most of our respondents talked about the sense of safety that the wall provides. An older woman who has experienced the three floods in 1975, 1977 and 1990 and is very afraid of the sea said *“the wall is big and strong and I am glad it is there to protect me”*. The man in the group stated that he is glad that the breakwall was built because it protects buildings and people, now *“the sea spray goes over your house but it used to be the whole wave”* but he also notes that it destroys the view to the sea and in addition he said that after the breakwall was built the sandy beach is not as wide as it used to be because the breakwall empowers the waves so more sand is eroded and transported out to sea. Sadly he expressed *“nothing is as it was. The beach has changed extremely much, it is just gone”*. He has experienced the three floods earlier mentioned and lives just by the sea in a house that is only about 50 meters from the breakwall. One of the older women in the focus group told us that after the breakwall was erected it bothered her a lot. It robbed her of her view to the sea, but now she has come to terms with it and does not pay as much attention to it as before. She said *“you know, it protects [her emphasis] you or at least is supposed to do that”*.

This led to lengthy discussions where the true protection of the wall was questioned. Before this new breakwall was built it was much easier to go to the shore and you had a much better view to the sea and the shore than now. A younger woman said that the breakwall is *“not pleasing to the eye”* and very ugly even though it protects you. She has not experienced any floods in Stokkseyri as she only moved there nine years ago. One of the older women in the group talked about the ugly breakwall ruining ones view of the ocean, but she also acknowledges that it is there to protect her. In contrast to the potential protection of the wall she also recognized that it might also be a source of danger as she said *“if a rock from the breakwall is tossed by the wave I would not want to be in the way”*. A woman who experienced the 1990 flood and remembered when the rocks from the old breakwall were scattered around the village said *“when another one of these big floods happens here, then I’m not so sure that this breakwall will protect us ... if these serious floods can happen in other countries they can happen here as well and you need some kind of enormous breakwall to stop the sea if it intends to go somewhere”*. It seems that she does not trust the wall to withstand the power of the ocean and that is similar to views expressed by one of the other interviewed woman, which had experienced the three floods in 1975, 1977 and 1990 and who said *“the sea is of course threatening when it behaves badly. It’s like looking at big mountains coming rushing in and nothing can stop it, not even breakwalls ... this breakwall gives more sense of security but if a wave would grab one of these rocks from the breakwall I would not want to be in the way, you see .. nothing [her emphasis] impedes the ocean”*.

Description of natural hazards - Coastal floods

In the group we asked about peoples experiences of coastal floods and specifically asked about the last flood in Stokkseyri that occurred on the 9th of January 1990. All of our respondents were living in Stokkseyri at that time except one. The man in the focus group

experienced it and remembers it vividly. He told us that he had to go to work in the evening of January 9th 1990 when the coastal storm was accumulating. He stated *“I stood outside my house and thought that it was really raining heavily but then I realized that it were the waves that were breaking on the house”*. He told us that for an outsider that did not experience the flood it was probably hard to believe how bad the weather was that night. He told us that not even the local rescue team could cross the intersection that connects Stokkseyri, Eyrarbakki and Selfoss during that night because the road was flooded. Another young woman remembers a panic state in her home, her mother screaming to her and her sister to stay away from the windows because they lived only about 50 meters from the sea and it could easily break the windows in their house.

Despite an issued storm warning (broadcasted by the ICP on the national radio) on January 8th in 1990, some of the residents did not receive the warning. An older woman talked about the flood coming as a bit of a surprise. The weather forecast was bad but people did not expect it to be as bad as it proved to be. She said that she does not remember any warning and that she does not know *“if it was some kind of mess up from the IMO that this weather came as such a surprise as it did ... they did not give any warning or at least I do not remember any such”*. Her house is situated outside the village and in that storm it got flooded but not with water from the coastline but with water that came redirected from inland. The storm surge had entered the inland wetland area and the backwater flowed toward the house from that direction instead of directly from the sea.

Even though this storm came as a surprise to this woman, most of our respondents said that they knew that a very bad weather was on its way so it did not come as a surprise, but even so they did not realize it would be this bad. The oldest woman told us that *“everyone knew that a big flood was coming but no one knew that it was going to be this great”*. The day after the storm a notification from the ICP was published in a newspaper, which stated that because of the warning from the ICP, further damage was avoided because people reacted accordingly and tended to their belongings (Morgunblaðið, 1990). By that it seems that the warning issued from the ICP had good effect, even if not all of the inhabitants noticed it. This woman remembers the flood in 1990 very well. She was awake the whole night and watched the weather steadily get worse. She had heard the warning from the ICP and monitored the change in the weather as the night passed and knew at what time it would be in its highest peak *“I knew that the tide was at its highest at four o'clock and once that time had passed I calmed down because then I knew that we had passed the worst of it and it would soon be over”*. Her basement was filled with seawater and because she and her family were awake during the night they could rescue their belongings from the basement before it got filled with seawater. She remembers seeing fishes in her garden and damage to houses and that the asphalt was torn off the roads. She also witnessed a garage literally getting torn apart by the weather. The same garage got also torn apart in the flood in 1977 (Morgunblaðið, 1990). Another older woman did not experience the coastal flood in 1990 but remembers the bad weather in the 70's when boats ended up on the pier. According to Icelandic newspapers from that time (Tíminn, 1977) a flood warning was broadcasted by the ICP on the national radio before the flood in 1977, though with some uncertainty about the accurate location. Reviewing the newspapers from 1975 no data were found regarding warnings about the flood in that year.

Some of our respondents did not experience the flood in 1990 even though living at Stokkseyri at that time. One woman from the interviews said that she woke up the morning after the flood in 1990 and saw huge rocks in her neighbours' garden. She had slept

through the whole night and did not notice anything until the morning after when she saw the rocks. These were rocks that used to be in the breakwall but during the night they had scattered over the lawn. She also remembered well the floods in 1975 and 1977 when the boats were destroyed and the effect that it had on the community. A young woman talked about the morning after the storm when she went outside to look at all the dead fish in the street. She, as a young girl at that time, remembers looking at a few horses that were kept in a hayfield just behind her house, but the flood waters had trapped them on a small hill that looked like a small island on a lake. Both of these women talked about that they were amazed the morning after, waking up and seeing the effects of the flood all around in the village and having been sleeping through the whole night.

Description of natural hazards - Earthquakes

Only two years had passed since the big earthquake happened on the SISZ and most of our respondents experienced this earthquake. All agreed that this earthquake was much stronger than the earthquakes that happened in 2000 and had more effect in the area. The effects were though more severe in Selfoss and Hveragerði. Most of our respondents talked about that only after seeing the effects that the earthquake caused, especially in the area outside Stokkseyri, they realized how strong and dangerous it had been. Before that, they did not experience fright or danger. One of the young women was at work in Selfoss when the earthquake hit. Everything started to shake and she had to hold on to her desk so she would not fall. At the time she did not realize what was happening and it was not until she and her co-workers looked outside and saw the lamp posts swinging that they realized what was going on. Next they recognized that it was the building that that was swinging and not the lamp posts. She told us that she was not afraid for herself while this was happening but was concerned for tinsmiths that were working on the ground floor because the plates of tin were tossed around and they could have been injured. She told us that after she heard that her sister had to run out of her home with her children while furniture were collapsing around them she got afraid and realized how bad the earthquake had been and her sister and niece and nephew were in real danger.

Many of the people we talked to have the same to say, i.e. not experiencing the earthquake as a hazardous or scary event until seeing the consequences from it. One of the younger woman was at Stokkseyri when the earthquake hit and did not experience getting afraid during the actual event. But when she drove to Selfoss to pick up her daughter she realized how much damage the earthquake had caused. She looked through the windows of a grocery store in Selfoss and everything was upside down inside the store and realized the severity of the event. She also noted that still, after experiencing the earthquake, she is afraid that something even worse might happen e.g. an even stronger earthquake might hit the area and have greater effects. Yet at the same time she was sure that the effects are never going to be as strong in Stokkseyri as in Selfoss because *“there will be some effect reduction because of the wetland area north of Stokkseyri”* and therefore the area is not as vulnerable to earthquakes as Selfoss and Hveragerði.

The circumstances people were in at the time the earthquake happened seem to be important in relation of perceived experience. One of the older women was, for example, driving and only thought she had a flat tire and got out of the car to have a look. She was quite surprised when she realized that it was an earthquake that made her car act this way. She told us that *“the earthquake kind of passed me by”*. Another woman was in another kind of situation where she was sitting in front of the television when the 2008 earthquake

occurred and said that she experienced it like watching a movie. She could observe exactly the effects of the earthquake, how the chandelier was swinging, object falling down and breaking and then seeing everything in the kitchen upside down. During the earthquake she got really scared and her view towards earthquakes changed after this experience. Before she thought them to be exciting but now she is really afraid of them and even has nightmares about gigantic earthquakes. She said *“after this experience I realized that during an earthquake you are extremely vulnerable”*.

When enquired about the aftermath of the earthquake people talked about the rescue teams in a admirable manner. How quick their reaction was and thoroughly organized. The man in the group talked about, how the rescue teams arrived within one hour after the earthquake, visited all the homes in Stokkseyri, Eyrarbakki, Selfoss and Hveragerði, talk to people, assessed the situation and offered fresh water, first aid and crisis counseling.

Comparison of natural hazards

We wanted to know if people could compare the two major natural hazards in the area, i.e. the coastal floods and the earthquakes. By that we were trying to attain information regarding perceived vulnerability towards the hazards. The answers were all similar, i.e. when facing coastal floods you have some control but when facing earthquakes you are extremely vulnerable. You can not escape the earthquakes because they come without a warning, but during coastal floods and storm surges you have the opportunity to escape because of accurate weather forecasts and storm warnings from the IMO and the ICP.

It is obvious that some of our respondents do more than listening to the weather forecast and reacting accordingly to warnings. Based on experience of the serious coastal floods in the past personal preparedness is applied by some of our interviewees. This takes for example the form of monitoring the position of the moon, spring tide and wind direction at a given time. Then you can protect your belongings by e.g. putting them in a safe place so they won't be affected by the weather. People in the focus group said that when these signs match nothing can stop the sea, not even the breakwalls. Based on her experience, the oldest woman who was of the 10th generation living in Stokkseyri said that when these conditions coincide a major flood can happen. The man in the focus group, also the 10th generation living in the village, approved with the woman. They both shared their view with another woman who said *“I'm absolutely sure that another big flood will occur in the near future, at least before I die”*.

Despite having experienced floods in the area some of the people did not necessarily foresee another flood occurring in the near future, whereas most, when discussing the earthquakes, talked about that they had some notion that another large earthquake was bound to happen, which is in accordance to the findings of Decriem et al., 2010 priorly mentioned. An older woman said that she thinks that *“the earthquake isn't quite over because people talk about that there is one more to come”*, but she also thinks that the next coastal flood would not happen in the near future. She was also more concerned about hazards like volcanic eruption similar to the one in 1973 in the Westmann Islands that happened after five thousand years quiescence. Despite having experienced the 1990 flood and being of the third generation living in Stokkseyri one of the younger women shared that thought and thinks that a flood as big as the one in 1990 is unlikely to hit Stokkseyri again.

When comparing coastal floods and earthquakes it seemed that our respondents were more resilient to floods and experienced the earthquakes as situation where more vulnerability was dominant. Some of the people said that the earthquakes “*lasts longer*” i.e. when an earthquake happens there is a lot of uncertainty and lack of control, people do not know how many aftershocks there will be and often wonder if a bigger earthquake is just around the corner so the situation lasts longer. These answers gave us also the expression that the inhabitants of Stokkseyri have maybe adapted to living with the threat of coastal floods in a better way than the earthquakes and show more resilience towards them.

Global climate change

Residents are aware of the link between climate change and flood risk even though they do not perceive it as an immediate threat. Most of the people talked about the changes in the climate being very slow and because of that it did not affect them so much in the present. One older woman said “*earthquakes and floods just happens BOOM ... but this [global climate change] happens so slowly that you feel like you don't have to worry about anything ... you don't pay any attention to it*”. This is similar to what other people talked about, i.e. global climate change happens over hundreds of years and you don't feel the impact as quickly as from a natural hazard.

When asked about the scientists prediction on sea-level rise one of the younger women said that she was of the opinion that the sea would go further inland in the coming years at Stokkseyri. One of the older ones agreed about that there is going to be a sea-level rise and the man in the group pointed out that “*the sea has already got higher*”. The same was stated by two of the older participants in the interviews, as one woman said “*I can see how the sea-level has risen ... the sea is 'bigger' and during high-tide the sea goes higher on shore*”. This woman have been monitoring the sea since she was a child and pays a lot of attention to weather forecasts and looks at the IMO webpage on regular basis to keep an eye on the earthquakes. Both of these persons are the tenth generation living in Stokkseyri. The man also pointed out that when the glaciers melt the sea level will rise and after the breakwall was erected following the flood in 1990 the sandy beach is almost gone.

We asked the informants if they would consider moving away from Stokkseyri if coastal flooding would become more frequent, especially in relation to sea-level rise. One of the young women who had experienced the flood in 1990 and had stated that she was very afraid of the sea said that she would move (she is the eleventh generation continuously living in Stokkseyri). One of the older women said that she would consider moving if floods would happen frequently while at the same time the land would be subsiding as the south-west coast is. The man in the group, on the other hand, did not seem to be afraid about the village getting more vulnerable to coastal floods and said that “*I would not leave because of possible floods in the future; I have already seen so many floods and another one wouldn't make a difference for that matter*”. There were other things of more concern for him, i.e. the possibility of having work or not was a much greater factor in the decision to moving or not. One young women replied “*I think that the really toughest people of Stokkseyri would stay, the other ones would leave*” and by that she was referring to the families that have been living there for generations (she is a first generation inhabitant of Stokkseyri). An older woman said that buildings are being built in Reykjavík in places that will go under water if sea-level rise will take place and that people have not been making wise decisions when planning for the future. Two of the older women said that an unusually long time had now past since the last coastal flood occurred and in the past the

floods used to happen every ten years or so. One of them thought that not many years are going to pass before another flood happens but the other one which had nightmares about the sea was sure that another would not happen until after she will be dead.

Despite that the inhabitants think about how the sea has changed and can be a possibly increased threat in the future and planning should be made with care, climate change was often perceived as a positive change by many of the people we discussed with, because of the warmer summers and milder winters, also with increased opportunity for vegetable and fruit grow. Younger woman said *“today you can walk around with an umbrella in Iceland ... without it being destroyed in the wind”* because the weather is much nicer and not as windy as before. Our informants also talked about that now you can dress lightly in the summertime and that is a great change. An older woman said, *“now you can almost grow everything in Iceland, at least last summer”*. She grew peas outdoor last summer and two apple trees are now growing in her garden, and that that is very unusual in the cold country that Iceland usually is.

4.2 Community

In the beginning of the focus group meeting and the interviews we began our discussions talking about the community of Stokkseyri. We asked our respondents how the community was in the past, how it had changed and how they saw the future of Stokkseyri. Soon we discovered that the hazard that the inhabitants of Stokkseyri are faced with are not only connected with nature.

Everything is gone

In general people were concerned about the degradation of service and employment in Stokkseyri over the last 10-20 years. When the residents were asked about the changes that Stokkseyri has undergone in the past 10-20 years the answers were all quite similar, i.e. that everything is gone and the strength in the community today was not the same as in the past. The man said *“this has become a ghost town ... everything is gone”*. Their consensus was that all the services that used to be there were gone. There was no bank anymore, no store, no post office, no doctor, not even an ATM. One had to go to Selfoss for everything nowadays. There is one small shop where one can buy milk, bread and some canned goods but it is very expensive. One woman from the interviews said *“everything is so expensive that I don’t want to go into that shop”*. When asked about the reason for this change, i.e. the loss of public services, the respondents related it both to the regional merging of municipalities in 1998 (*sameining sveitarfélaganna í Árborg*) (Sveitarfélagið Árborg, 2005) and to the influence of globalization where large chain stores have taken over the commerce and small, local stores can not survive. The formation of the municipality Árborg out of Eyrarbakki, Sandvíkurhreppur, Selfoss and Stokkseyri marked the beginning of the reduction in services. One woman said *“It was all taken away from us. Everything [all service] had to be in Selfoss”*. She said that this was the fault of the regional merging of the municipalities, but at the same time she was well aware that it is difficult for the municipalities to maintain service in the little villages and said *“I know it was expensive for them [the municipality] but [her emphasis] you can always have one store in the village”*. Another woman said that it is obvious that both Eyrarbakki and Stokkseyri aren’t as important parts of the municipality of Árborg as Selfoss is and there is no doubt that it

would have been too expensive to maintain these service sectors in the small villages and therefore the service was moved to Selfoss. A younger woman has another explanation for this, i.e. it was also because people changed their shopping behavior when one of the largest low price chain stores opened at Selfoss. She said *“I think it is also the fault of Bónus [which is one of the largest chain stores in Iceland] everybody went to Selfoss to shop in Bónus and went to the bank at the same time and the post office and naturally they cut down the service instead [in Eyrarbakki and Stokkseyri]”*. She further pointed out that the closing of the bank didn’t have anything to do with the municipality as it wasn’t run by it. This change also led to the closing of the small service units in Stokkseyri.

Before this change occurred there was more neighborliness dominating in the community. People talked about the times when the village was full of life. Times when people worked in the prosperous fishing plants and spent time together and also met in the grocery store and chatted. Nowadays people do not interact as they used to because all of the meeting places are gone. The result of this is that you do not get to know your neighbor and in some instances you don’t even recognize them out on the street when you pass them by like one woman from the interviews said with a surprise in her voice *“I did not know that I had new neighbors, they had been living here for many months and I did not know and there are only 10 steps between our houses”*. The man in the group had the explanation that it was because of better transportation and stated that services had left because of the bridging of river *“everyone wanted the bridge but when it came everything else went away”*.

During this discussion an older woman in the group sadly commented *“there isn’t any community here anymore”* and told us that nowadays you never meet the other people that live in the community. *“You used to meet people in the freezing plant where you worked with 70, 80 up to 100 people which you knew and you met people in the shop and the bank but now all the old meeting places are gone”*. She said *“before people used to experience all kinds of things together. People grieved together and rejoiced together but now this closeness is not there anymore”*. The other people in the focus group agreed with her and talk about that now you do not even know your new neighbor. You know the people that have been living there for years but not the new people. There are so little interactions between the residents that have been living here for a long time and the new one *“you never meet anybody ... now most of the inhabitants go somewhere else to work and there is no store to meet people”*. The oldest woman mentioned that in the little shop in the gas station a small group of men meet on a regular basis but that’s all, for other people there are no local meeting places.

The future

When looking into the future all the informants agreed that tourism is probably going to be the economic mainstay in the village. Currently there are several small businesses that cater to tourism, among them a popular seafood restaurant. The man stated that in 2009 approximately 25 thousand people dined at the restaurant and that is positive for the economy of the community. One of the younger women said that the situation in town used to be worse than it is today. About 10-15 years ago the village was a ghost town and the inhabitants experienced a pessimistic period and little hope for the future. But now tourism is having a good effect. The village is more alive than before. It came as a little surprise to us that despite the restaurants’ popularity all of the respondents stated that they rarely went there, maybe 2-3 times in 10 years. The all agreed that it was a shame not to make more use of it as well as the museums which they also agreed that they did not visit often. They

could not explain why it was like that because it was really nice to go to the restaurant but one woman said that one possible explanation could be that *“maybe it is too close to us”*

Local employment is very important for the society, as was expressed by the people in the focus group who voiced their concern regarding the future of the privately run nursing home, that serves both south Iceland and sometimes people from other parts of the country and is the largest working place in Stokkseyri. About 55 persons work in the nursing home and of that approximately half reside in Stokkseyri. The family who run it is in a retiring age and if no one will replace them a closure of the nursing home will have a huge impact on the village. They considered that as one of the major threat Stokkseyri is facing in the near future where the community is already extremely vulnerable because of lack of local employment opportunities.

One of the older women stated that she thinks that in the future Stokkseyri will mainly be a place where people have summer houses. That is the same as one of the women in the interviews said, who also saw an opportunity for people to live in Stokkseyri but commute to other municipalities every day for work, even to Reykjavík which is a 45-60 minutes drive away *“In the future I can see Stokkseyri either as a town full of summer houses ... or as place where younger people live and travel back and forth to work in another municipality”*. The woman also mentioned that *“Stokkseyri is going to be a younger place [i.e. with younger inhabitants] because old people that can not drive and is in more need for service can not live here anymore”*. One of the younger women talked about how good it is to live in Stokkseyri and raise children there, even though you have to drive 15 kilometers for most kind of service needed. The oldest women interviewed said the same thing *“people want to live here, it’s a nice place ... people build houses here”*.

Personal involvement in creating a viable community is important as one of the younger women said. She said that if Stokkseyri is going to be a blooming and beautiful place in the future the inhabitants need to do something themselves. *“You can’t rely on the municipality to do everything for you, especially when the tendency is to nurture the largest town in the integrated municipality and forget the small ones like Stokkseyri”*. A young woman agreed and said *“we need to make a community by ourselves”*.

Meeting places in the community are extremely important for the people we talked to. When people talked about the small local store in Stokkseyri they always referred to it as a meeting place *“the place where you got all the important information that are circulating in a community”*. No one mentioned the ability to buy commodities in the village as the most important part; everyone emphasized the importance of the shop as the place where you used to meet your neighbor. An older woman said that the shop was the main place where you got news and could gossip, *“it was there where you got information about your neighbor and your community and also shared information”*. A young woman said that one of the major reasons for people not knowing their neighbors today is the fact that there was no large grocery store in the village and that undermines the consistency of the community.

5 Discussion

5.1 Natural hazards and risk perception

The coastal floods

Four out of nine respondents perceived coastal floods as the main source of natural hazard in the area. All of them had personal experience of the floods, as did their forefathers who had lived in Stokkseyri for generations. They told us that they really know how bad these floods have been in the past and therefore they know how bad they can be in the future. It is obvious here that first hand experience is very important in relation to risk perception and local knowledge is important in raising awareness and reducing vulnerability (Morin et al., 2008; Jóhannesdóttir and Gísladóttir, 2010; Bird et al., 2011). Pagneux et al. (2010) found that experience of the past flooding events in the neighboring town of Selfoss was the most effective source of knowledge. Three of these respondents have also adapted knowledge to monitor coastal flooding through concurrent moon phase, spring tide and wind direction, which in turn reduce their vulnerability. Paton et al. (2008) found that residents who had inherited knowledge in relation to volcanic hazard were more likely to adapt personal preparedness measures and adapt accordingly.

One of the four persons perceiving the coastal floods as the main threat, on the other hand, does not think that a coastal flood will happen in the near future. She has experienced three floods in the area and is very afraid of the sea and has nightmares about it, but even so she does not think that a big flood is going to happen in her lifetime. This view can be the result of putting the threat away to be able to live a normal life and this perception can increase her vulnerability and reduce her resilience. Jóhannesdóttir and Gísladóttir (2010) found similar experience in a volcanically threatened area in south Iceland, where a resident put the threat away by normalizing the situation in order to be able to live a normal life.

Lack of experience can, on the contrary, have the effect that people do not perceive the natural hazard that they live by as risk. For example, one woman said that she was not able to point out what was the main natural hazard because she had not experienced the coastal flood in 1990 and the earthquake in 2000. In addition she had been driving when the earthquakes in 2008 hit and did not experience them so well because of that. She said *“I feel like I have missed out on things”*. From her remarks it seems important for her to have personal experience when assessing natural hazards and probably preparing for it.

The regular monitoring and weather forecast by the IMO and their effective storm and flood warnings, in which people trust, has contributed to residents' awareness and increased their resilience, e.g. by giving people the possibility to attend to their belongings before a storm hits the area. Many of our respondents talked about monitoring the IMO webpage, especially in relation to earthquake activity and give special notice to weather forecasts when the position of the moon, spring tide and wind direction were unfavorable

to the area and could increase the effects of coastal storms. All of the respondents concurred that when facing a coastal flood they had the opportunity to actively mitigate the risk, by appropriate response and therefore it was not a major threat. Even though the official mitigation plan for the area is still not in place, the residents' trust in IMO is likely to facilitate personal responsibility for adopting preparedness measures as Bird et al. (2011) found among urban residents who confirmed high degree of trust in information provided from all emergency management agencies, and thus likely to increase their resilience. Based on her previous experience and the increased flood risk because of sea level rise, one of the woman in Stokkseyri said that she was sure that another big flood would threaten the village in the future *"at least before I die"*. She also said *"when bad weather is on its' way and the tide is high then it is just like that. You expect something to happen"*. During the eruption in Eyjafjallajökull this woman monitored the IMO webpage to see if any changes of the earthquakes could be detected or if there *"were some indications that Katla was going to erupt"* because she is afraid that a tsunami could hit the coast of Stokkseyri. She had mentioned earlier that she was concerned that no emergency and evacuation plans were available for Stokkseyri and did not know if she should evacuate if Katla would erupt so her personal monitoring of the IMO webpage is a mitigation way to adapt and increase her resilience and sense of safety. Thus, it is important that that ICP provide correct and up to date hazard information to the residents in Stokkseyri to ensure appropriate understanding of potential hazards and support higher level of disaster awareness (e.g. Bird et al., 2009; Jóhannesdóttir and Gísladóttir, 2010; King and MacGregor, 2000). A great difference has been between warnings of different natural hazards in the area. Coastal floods and storm surges often happen with a precursor warning whereas precursor warnings have been non-existing in relation to earthquakes, with the exception of the latter earthquake in 2000 (Stefánsson et al., 2000). Yet at the same time most of the residents stated that the severity of the flood in 1990 came as a surprise, even though there had been issued a warning the day before. According to newspapers from that time (Morgunblaðið, 1990) the damage caused by the flood wasn't as severe as it could have been because of this warning, even though it was extreme. People had the opportunity to secure their belongings that were situated outside. The reason for the extensive damage, even though mitigation measures were undertaken may lay in the fact that this storm was one of the greatest in Iceland since 1799.

Reviewing of the newspapers gave good information on the impact and frequency of storms and coastal floods at Stokkseyri. Since 1925 five major coastal floods have occurred with the maximum of 23 years between flooding. Today 21 year has passed since the severe flood of 1990 and when we were talking to our respondents it was apparent that they were aware of that and in some instances talked about that another flood 'is on time', even though they were not all that afraid of another flood. That feeling may be induced by the fact that only three years have passed since a strong earthquake hit the area but 21 year has passed since a major coastal flood happened and people tend to diminish the importance of distant events that are not close in mind where scale and the accuracy of perception may depend on the social problems in the community and the extent to which lives and resources are at risk (Alexander, 2000). Jóhannesdóttir and Gísladóttir (2010) found that the local school in their study area could be exposed to a tsunami. The school was built in 1976, and is located in a contemporary defined tsunami risk zone following an eruption in the nearby volcano Katla. Because of the long quiescent, close to 90 years, the planning authorities overlooked the risk that follows the eruption. Pagneux et al. (2010), on the contrary discovered in their study that higher percentage of their informants could

remember a river flood that happened in 1968 than a flood that happened in 2006. Our study show that the threat of a coastal flood is still in the recent memory of the inhabitants of Stokkseyri and the regional planning of the municipality of Árborg have solid regulations regarding building development on the area prone to flooding e.g. the height of ground floor of houses (Sveitarfélagið Árborg, 2005; Skipulag ríkisins 1992).

The sea, the shore and the breakwall

The respondents shared a certain appreciation for the sea and emphasized the importance of its' presence as well as the coast. Most of them have childhood memories about playing in the shore but today, due to the new breakwall, the access to the sea has been diminished, and they all agree that this has lead to the fact that people do not go as much to the seaside. Currently there are only a handful of places along the breakwall in Stokkseyri where people can access the shore without having to clime over the wall' boulders. Children are therefore in danger if they try to climb over the breakwall, which they sometimes choose to do rather than passing around it. Children today do not go as much to the shore as prior to the erection of the breakwall and this can lead to less resilience and more vulnerability in future inhabitants of Stokkseyri due to less association with the sea, also because fishing is now not practiced as before. It can also have negative affect on the vulnerability of the community where the connection people had to the sea is not the same now and people do not 'study' the sea and the weather as before when their livelihood depended upon it. Before the community changed into its current condition people of all generations would often spent a great deal of time together at and around the sea. The sailors were coming home from sea and offloading their catch, people coming to the pier to watch; often older people that shared a common interest of the sea and the children playing in the shore at the same time. This time is over and the family is not as involved in the environment that the sea offers and that can weaken the social bonds in relation to the sea and decrease the resilience. Even so, some of the residents, showed some inherited knowledge of reading the signs of flood risk and the mitigation strategies they adapted accordingly which some were the results from centuries' old adaptation of former generations that offer inherited knowledge about the sea as their neighbor. But will this apply to newcomers in the village? Who is going to teach them about reading the signs of flood if interaction is as little as now? They may not adapt as well to the community and their lack of experience of the natural hazards in the area as well as less possibility to learn and gain inherited knowledge from others, can also make them more vulnerable to the hazards.

Interestingly some of the residents perceived a potential threat from the breakwall during severe coastal floods. They had experienced that rocks from the previous brakewall were scattered around in the village after the 1990 flood. Similarly during a flooding event in 1968 in Ölfusá river following the break-up of ice jams upriver, forced ice blocks that weight up to hundreds of kg on streets of the city Selfoss (Pagneux et al., 2010). The breakwall can also give a false sense of security. It has not yet been put to the test, as no large coastal flood has occurred since it was built, so its' efficiency is not know. There is the question about how safe it is as a structure? Does the breakwall pose a physical threat because of its' nature? The medium size of the largest rocks is 3.3 tons and if these rocks are tossed by the sea they will pose a great threat to the community and its' inhabitants. As one woman said "*this breakwall gives more sense of security but if a wave would grab one of these rocks from it I wouldn't want to be in the way, you see .. **nothing** impedes the ocean*". Will it protect the village from harm? There is also the question if it does decrease safety and increase vulnerability because of its' social effects? It cuts a line through the

village and on the one side there are the people and their community and on the other side there is the sea.

Alarminglly there seem to be a lack of knowledge transfer to some of the youngest generations, demonstrated by the paradox that the adults have consciously restricted their children's play on the shore, and by doing so disentangling their connection with the sea and instead of learning to monitor the sea and be better equipped to respond appropriate it will make them more vulnerable. Disaster preparedness information and training for children is likely to reduce disaster risk (Gustafson, 2009). This view was shared by one of the residents in Stokkseyri who allowed her children to play on the shore, but not until she had taught them about the behavior of the tide and related risk.

We paid a special notice to the fact that when respondents talked about the sea as a threat they always talked about it as they were talking about a person. One woman, for example, said "*how the sea behaves*" and another said "*when he [the sea] behaves badly*". Jóhannesdóttir (2005) and Jóhannesdóttir and Gísladóttir (2010) noticed that when their respondents talked about the volcano Katla they addressed it as a female and said 'she'. When listening to the people talk about the sea it was apparent that people showed a lot of respect for it. They talked about it in a cautious manner as talking about someone they knew. The people we talked to have all experienced coastal flooding except one and know what the consequences of it can be. That knowledge can reduce the vulnerability and increases resilience and adaptation.

Tsunami

Majority of the people attending to the focus group showed great concern about a possible tsunami hitting the coast if the volcano Katla would erupt. They told us that it was a general understanding in the village that there is a possibility of a tsunami hitting the coast, but currently did not have any further information about it. People did not know if they "*only had about an hour to evacuate*" as one woman told us the rumor stated or if there was no threat to them at all. Tobin (1999) points out that lack of knowledge can increase vulnerability. There are no evacuation and reaction plans available for the municipality and our respondents raised their concern about this. If people knew more about the possibility of a tsunami hitting the village and an evacuation plan were available, they would have more sense of safety, making them less vulnerable and more resilient, as well as giving them the opportunity to prepare themselves.

The earthquakes

Most of the people in the study do not see earthquakes as the main source of natural hazard and they were all in agreement that earthquakes do not affect Stokkseyri as severely as the neighboring communities of Selfoss and Hveragerði. Even so there is some indication that our respondents are more vulnerable to earthquakes than coastal floods and show less resilience. When asked to compare the earthquakes and the flooding, all of them, except one woman, talk about the earthquakes lasting longer than the coastal floods. As it is obvious that in real time earthquakes do not last longer than coastal floods, we have to assume that this statement isn't referring to real time. Our respondents said that they felt a lot of uncertainty during the course of an earthquake. The quakes happens without a warning and nobody knows how long the aftershocks will last and if there will be another big one as one woman said "*they talked about that another earthquake was still to come*,

where will it happen?”. There was no way to prepare yourself for earthquake, “*if it happens it will do so without a warning*”. As mentioned before the scientists from the IMO and the Earth Science Institute at the University of Iceland saw from the SIL seismological data acquisition system that another earthquake was expected to happen in a few days time after the former happened. Now the scientist could give a warning to the ICP. Further advantages in the science of seismological data acquisition system can possibly give people some notice regarding earthquakes in the future.

Perceived risk and actual predicted risk

The frequency of major earthquakes affecting Stokkseyri is less than of coastal floods, which often have more environmental, economic and social effect than the earthquakes (Table 1 and Figure 2). Future sea-level rise is predicted to be about 0.6 meters in the next century and will most likely have negative effect on a coastal village that is only 3 m a. s. l. (Landmælingar Íslands, 2011). More frequent storm events can follow sea-level rise (Skipulag ríkisins, 1992; Bjarnadóttir et al., 2010) which is serious in an area that currently experiences more frequent coastal flooding than other parts of the country (Imsland, 1992). Even so, some of our respondents did not show much concern about this threat. This can be an indication of the community’s resilience but at the same time it can represent its’ vulnerability where a lack of risk perception in the face of hazardous event can be alarming. To respond to this, a risk communication between inhabitants and the ICP must be presented as recommended by researchers (Bird et al., 2009; Jóhannesdóttir and Gísladóttir, 2010; Bird et al, 2011; Alexander, 2007). This work is a priority for the Árborg area and is already in process as the ICP is developing an emergency plan for the area (Jóhannesdóttir, personal communication).

Another possible explanation for this can be time related where people tend to magnify the importance of events that are close in time and space whereas diminish the importance of the distant ones (Alexander, 2000). Only three years have passed since the great earthquake happened in 2008 and it is still in peoples’ near memory. In 2010 eruptions happened in both *Fimmvörðuháls* and *Eyjafjallajökull* and that had affect on our respondents which also thought about a possible eruption in the volcano Katla and the affect it could have in the area of Stokkseyri. As Alexander (2000) points out the fading memory lends a distance-decay function to the temporal pattern of disaster. Because 21 year has passed since the coastal flood in 1990 there is the possibility that people don’t experience much threat of another flood in the future.

5.2 Community change

Sense of community and social vulnerability

Sense of community is a vital aspect of community cohesion (King and MacGregor, 2000; Bird et al., 2011) and has great effect on vulnerability and resilience. Our respondents had a lot of concern about how their community had changed in the past 20 years and the sense of community the felt in the past seemed to be gone. One of the interviewed woman said “*I think the social factors are worse [i.e. more threat] than the natural hazard in the community*”. Sense of community can increase resilience and decrease vulnerability of the inhabitants when facing natural hazards whereas lack of it can have the opposite effect. In

our study we could detect some fragmentation of the community which can result in increased vulnerability and decreased resilience. Our respondents talked about not knowing their neighbor that have moved to Stokkseyri in the recent years and one could therefore presume concurrently that in some instances the neighbor does not either know his neighbor. When facing natural hazard, newcomers in a community are vulnerable if they don't know the risk (Alexander, 2000; King and MacGregor, 2000; Pagneux et al., 2010) or not having the experience of natural hazard (Pagneux et al., 2010). In the case of Stokkseyri where little interaction is among inhabitants, newcomers are especially vulnerable. They not only do not have the experience of the present local natural hazard since 21 years have passed since the flooding in 1990 but either do not get the knowledge about the risk at second hand.

Our respondents emphasized the importance of having 'a community' within the society, and having meeting places so people could interact and spend time together. When people talked about the local grocery store that used to be in operation in the village, they always talked about it as 'a meeting place' and not as an important service provider and the closing of the store played a big part in why people do not know their neighbor today "*in the store you got to know what was happening in the community, who was who and get all these important information*". McMillan and Chavis (1986) have proposed a definition of sense of community which is based on four elements. One of the four elements is *shared emotional connection* and refers to the belief that members share a common place, history, similar experiences and time together. Our respondents pointed out that people today do not share a common place where most of the former meeting places (i.e. the store, the bank, the post office etc.) are gone. In addition to that most of the local enterprises are closed and therefore little time is spent together where most of the inhabitants of Stokkseyri work in places outside the village. If people have the opportunity to spend time together and create history together resilience can increase (Paton and Johnston, 2001).

When the structure of the community becomes weaker it can have negative impact on adaptation and resilience and hence increases vulnerability. The fact that Stokkseyri has changed from a lively fishing village into a blooming tourist place where thousands go through every year, has perhaps better effect on the local economy. Tourism, partly benefitting from the proximity to the capital, is becoming increasingly important creating economic flow into the community and this can lead to positive effects for the community, where people learn how to adapt to changed situation, but at the same time it can also be a cause of concern. This change has not necessarily had good effect on the people in the community or changed the fact that the old meeting places the inhabitants used to share, now 'belong' to outsiders, i.e. the tourists. Our respondents told us that they almost never went to the restaurant and the museums and therefore these places did not replace the former locations as meeting places. This new development does not increase the cohesion of the inhabitants but could, on the other hand, increase the social vulnerability of the community as a whole.

Resilience and adaptation

The inhabitants of Stokkseyri did show some resilience in the past when facing natural hazards, but in these times the community was different in many ways. The last natural hazard that affected Stokkseyri in a major way, i.e. the coastal flood in 1990, happened at a time when the community was experiencing change, but all of the services were still in operation and some of the fishing plants still open. The sense of community is likely to

have been greater than today and more existing cohesion within the community. If, or maybe when, another coastal flood happens there is a possibility that it will have more serious effects on the community due to both sea-level rise and increased vulnerability among the residents due to diminished cohesion and sense of community. Newcomers can be more vulnerable (King and Macgregor, 2000; Jóhannesdóttir and Gísladóttir, 2010; Bird et al, 2011) and it is important to give them good information about the threat of a severe flood as happened in 1990 so they can prepare themselves and be more likely to respond correctly to the ICP.

According to UNISDR (2009) adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli and its' aim is to moderate harm. Adapting to change has long been a factor in the life of inhabitants of coastal villages such as Stokkseyri. The natural hazards that have struck the village in the recent century seem not to have affected the population size (Fig. 2.2). People have adapted to changed situations and often because of a disaster. In 1926 a major blaze, where buildings of trade and some homes burned down, changed the economy and daily life of inhabitants of Stokkseyri. After this disaster trading never gained its' former strength and from then on the fishing industry became the mainstay of the community (Hafsteinsson et al., 2010).

Community adaptation towards natural hazard can also be in the form of mitigation programs designed to reduce risk. Flood embankments and breakwalls constructed to protect communities from flooding are one form of mitigation (Tobin, 1999) and the large breakwall in Stokkseyri was built as mitigation to reduce risk from the sea where the old breakwall was not efficient enough. Individual preparedness, i.e. securing ones home and belongings in the event of a storm, also falls under mitigation and adaptation.

The recent development that has lead to the community change that the village has undergone is not a 'natural hazard' or 'disaster' in the common sense. But in the minds of our respondents, it seems to have the same affect. When discussing the future of Stokkseyri during the focus group meeting one woman said "*we need to make a community by ourselves*". This sentence expresses the need for cohesion and sense of community, which would increase the residents' of Stokkseyri resilience and adaptation to potential threats of coastal floods.

In a focus group meeting which we held in Eyrarbakki at same time (Geirsdóttir and Jónsdóttir, unpublished data) people had similar feelings regarding the lack of cohesion and sense of community. One person at that meeting said "*we should revive the old district councils that were operated before the merging into the municipality of Árborg*". Soon after this research was completed a district councils which have the purpose of being a consultation place where representatives of the inhabitants, the municipality, business and NGOs interact and form the design of the future plan of the district were established in the four communities that form Árborg. The councils give the municipality' administration a consulting advice based on the local inhabitants wishes for their community and enhances the social capital of the village.

The results of this study may be used when organizing municipalities' mitigation strategies where the data can be considered as a useful indicator of current vulnerability, resilience and adaptation. It supplies important knowledge to emergency managers as well as the municipalities' leader.

6 Conclusions

The village of Stokkseyri, located on the south coast of Iceland, experiences frequent natural hazards. Through the centuries the inhabitants have adapted to these conditions and often shown remarkable resilience when faced with coastal floods or earthquakes. Some mitigation measures have been taken, e.g. the construction of a large breakwall to protect the community from coastal floods, although such measures might also give a false sense of security and hence, in and of them self, pose another kind of threat to the village and its' inhabitants. Overall, because of pre-warnings from the IMO and the ICP, the inhabitants feel less vulnerable when facing coastal floods as compared to the occurrences of earthquakes.

The results of this study indicate that recent socio-economic changes within the community may have lead to a decreased sense of place by the inhabitants; i.e. loss of neighborliness and diminished cohesion may have reduced the resilience of the residents and therefore made the community more socially vulnerable. And as social vulnerability is a part of the measure of how communities are able to resist and recover from the impact of a natural hazard, there are some indications that the current social conditions at Stokkseyri make the place more vulnerable to face natural hazards. A possible response to this development would be to increase the cohesion of the community through bottom-up approaches put forth by the newly established district council.

What we learned from this study is that sense of community is important for inhabitants of Stokkseyri. The changes that the community has gone through in the past 20 years can pose as much threat to inhabitants as living with the threat of coastal floods and earthquakes, given that the social factor is closely connected to natural hazards. This indicates that when studying vulnerability of communities towards natural hazards it is of importance to place emphasis on the perceptions of the inhabitants; whether it be perception of vulnerability, resilience and adaptation towards the natural hazard itself or towards some other factors of importance.

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