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# Inherent resilience, major marine environmental change and revitalisation of coastal communities in Soma, Fukushima Prefecture, Japan.

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2020

# Inherent resilience, major marine environmental change and revitalisation of coastal communities in Soma, Fukushima Prefecture, Japan

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Abstract: The Fukushima Dai'ichi nuclear accident presents challenging circumstances for disaster recovery in coastal communities, as ongoing uncertainties around the nuclear plant's decommissioning may create new risks in the future. Within disaster risk studies, inherent resilience – informal practices of resilience sustained through social memory and everyday actions – is seen as important for longer-term recovery. Yet whilst inherent resilience has been studied for acute disasters like earthquakes and hurricanes, less is known about inherent resilience under major and long-term environmental change of the kind seen in Fukushima. Through interview-based research in the Soma area of Fukushima Prefecture, Japan, this paper thus evaluates the potential for inherent resilience practices to support recovery when communities may have to respond multiple times as new setbacks emerge. We show that despite the challenging situation in Soma, inherent resilience practices have helped recovery on the coast by re-establishing a sense of identity and purpose for fishing communities in particular. Equally, however, we also find that ongoing uncertainty about the nuclear plant and emerging pressures linked to climate change make the full re-establishment of some cultural practices associated with inherent resilience difficult. Our findings contribute to existing research by showing that although inherent resilience may well help communities maintain core functions in a way formal institutional support cannot, changes to the physical environment of the kind seen in Fukushima may affect daily living and social relations in a way that makes it difficult to undertake practices necessary to sustain social memory and community relations.

Keywords: fisheries; Fukushima; post-disaster recovery; resilience; Soma.

## 1. Introduction

Resilience has become an organising concept for disaster recovery under a context of environmental shocks and stresses of ever-increasing frequency, magnitude and uncertainty (e.g. Adamson, Hannaford, & Rohland, 2018; Cutter, Ash, & Emrich, 2014). Yet whilst there is a strong body of knowledge around the role of resilience in recovery following acute disasters such as earthquakes, tsunamis and hurricanes, understanding of how communities respond to major environmental changes where new risks and hazards emerge over several years is more limited. This paper contributes to this gap by evaluating the revitalisation of fishing and coastal communities in the Soma district of Fukushima Prefecture, Japan, following the 2011 nuclear accident. Although a nuclear accident of this size and scale is a rare and unique event, the Fukushima Dai'ichi accident is an example of large-scale shock to the marine and coastal environment, the consequences of which are much more diluted in time than an acute disaster. An event of this nature has ramifications for the concept of resilience, as communities might not have to 'bounce forwards' or 'build back' once, but rather respond several times and continuously as new risks and hazards emerge such as the discharge of contaminated waters. Through interviews with fishers and coastal residents in Soma, we assess the implications of the nuclear accident on daily living in Fukushima nearly a decade after the March 2011 earthquake and tsunami, and evaluate their relation to practices of resilience within the community. We find that everyday relations and practices have an important role in motivating the coastal fishing community in Soma to continually adapt to a changing environment, but that the sheer magnitude of environmental change faced makes it impossible to sustain some practices previously associated with resilience in the community. These findings contribute to existing international literature by problematising the potential for 'building back better' when the source of the original shock continues to affect the environment; and questioning the extent to which the effects of a natural hazard event can be separated from the impacts of intensifying climate change and socio-demographic transformation.

## 2. Conceptual background

## 2.1. Inherent resilience

Whilst a number of definitions of resilience exist, Walker (2020: 1) believes "(t)he simplest definition of resilience is the ability to cope with shocks and to keep functioning in much the same kind of way." In a disaster context, key characteristics of resilience include: ability to 'bounce forwards' or 'move on' following a shock or disturbance (Manyena *et al.*, 2011); potential to 'build back better' (Wisner, 2017); and capacity to plan and prepare for, and successfully adapt to, adverse events in a way that restores and improves basic functions (Cutter, Ash and Emrich, 2014). Notable in these definitions is the recognition that a return to functioning in the 'same kind of way' may not be possible or desirable in some cases, and that communities may adopt different forms of organisation and operation to restore or retain resilience (e.g. Mannakkara, Wilkinson and Potangaroa, 2014).

Resilience is argued to be especially important in a coastal setting, where proximity to the sea increases exposure to risks such as storm surges, coastal flooding, rising sea levels, and seismic hazards (McGranahan, Balk and Anderson, 2007; Chang *et al.*, 2015). From a societal perspective, reliance on the seas for livelihoods, income and sense of identity and belonging (Bennett, 2019) and external pressures such as physical remoteness and economic marginality (Vlachopoulou and Mizuta, 2018) add complexity to a society's response to disturbance compared to inland. Indeed, international fora such as Sustainable Development Goal 14 (United Nations, 2020) and Future Earth Coasts (Future Earth Coasts, 2020) refer to marine and coastal resilience in their visons and objectives; and the Sendai Framework for Disaster Risk Reduction (UNISDR, 2015) explicitly mentions coastlines as disaster-prone areas.

The resilience of a community depends not only on financial resources, but also on the presence of social networks and connections (Aldrich, 2019). Yet Aldrich & Meyer (2015) argue these social networks and connections remain underutilised in disaster planning and management practice. Gómez-Baggethun, Reyes-García, Olsson, & Montes (2012) call in particular for research into how local knowledge, practices and institutions are able to address disturbances, and into the role of socio-ecological memories embedded in local cultures. To build on this emerging research area, we work with the concept of 'inherent resilience', defined by Cutter et al. (2014: 66) as the "qualities of a community, stemming from everyday processes, that might enhance or detract from its ability to prepare for, respond to, recover from and mitigate environmental hazard events". Examples of such everyday community processes include membership of religious or civil organisations, volunteer work, and involvement in disaster preparation and training events (Cutter, Ash and Emrich, 2014); participation in religious or spiritual activities (Gómez-Baggethun *et al.*, 2012; Jigyasu, 2014); and informal interaction during day-to-day working practices (Mabon & Kawabe, 2015). Simms (2017) adds that inherent resilience is linked to sense of place, identity, culturally meaningful practices and social interactions.

Inherent resilience is different from 'formal resilience' (Colten, Grimsmore and Simms, 2015), which refers to top-down plans, protocols and funding to anticipate and respond to disasters. Inherent resilience is also closely linked to 'community resilience', defined as "the collective ability of a neighbourhood or geographically defined area to deal with stressors and efficiently resume the rhythms of daily life through cooperation following shocks" (Aldrich & Meyer, 2015: 255). Whilst acknowledging that the two ideas are closely linked and that both are useful to understand the social dynamics of resilience, we see inherent resilience as distinct from community resilience through its more explicit focus on informal everyday practices and also memory. Colten, Hay, & Giancarlo (2012: 1) hold that the basic ingredients for inherent resilience come through social memory, defined by Adger, Hughes, Folke, Carpenter, & Rockström (2005) as reservoirs of practices, knowledge, values and worldviews held by diverse individuals and institutions. Social memory and by extension inherent resilience, Colten et al argue, is sustained through social networks and tradition rather than formal policies and plans.

In sum, it is well understood that inherent resilience is an important component of post-disaster recovery alongside state-led policies and plans and formal and structured initiatives at the local level. There is a burgeoning body of work into how social memory and local networks foster resilient responses to acute disturbances such as hurricanes (Simms, 2017), droughts (Gómez-Baggethun *et al.*, 2012), and earthquakes (Wilson, 2015). Yet there is less engagement with how inherent resilience may function in a situation where the consequences are spread out over a long period of time (i.e. years), and where the community may need to respond or 'bounce forwards' multiple times as new risks and stresses unfold. Given the potential for climate change to lead to more of such 'slow onset' or 'slow burning' hazards as well as extreme events (Staupe-Delgado, 2019) and calls for more attention to how disaster risk reduction research can deal with climate change (Kelman, 2015), this is a notable gap in the literature. Moreover, whilst inherent resilience characteristics are assumed to be in place pre-disaster if they are to support recovery (Cutter, Ash and Emrich, 2014; Cradock-Henry, Fountain and Buelow, 2018), one may question how effective social memories and inherent resilience practices developed in the past can be if the physical and social environment has suffered profound, overwhelming and potentially permanent change (after Laska, 2012). Assessing the dynamics of inherent resilience practices may hence yield insight for broader calls to enhance adaptive capacity in coastal communities (e.g. Cinner et al., 2018) in response to threats associated with global environmental change. Our paper therefore contributes to existing literature on inherent resilience – and resilience thinking more generally – by evaluating the role of inherent resilience in helping communities to respond to multiple long-term stresses associated with the same hazard, under a profoundly changed environment.

### 2.2. Social dimensions of disaster recovery in the marine and coastal environment

To structure our enquiry into inherent resilience under longer-lasting hazards, we identify five characteristics of long-term recovery from major environmental shocks, particularly in the marine and coastal environment, which arise in scholarly literature (Table 1). In Sections 5 (Findings) and 6 (Discussion), we use these characteristics as a framework to structure our assessment of how inherent resilience has supported recovery from the long-term effects of the nuclear accident on the Soma coast. We focus primarily on marine environmental pollution events given our focus on the coastal and marine implications of the Fukushima nuclear accident, but also draw in literature from other radioactive contamination events and coastal hazards where appropriate. It is worth reiterating that disaster risks may become more pronounced in coastal regions due to higher exposure to the effects of natural hazards (Chang *et al.*, 2015); livelihood reliance on the sea as well as the land (Bennett, 2019); and additional difficulty in assessing risks due to logistical and cost limitations on scientific monitoring of the marine environment (Wright *et al.*, 2016).

Table 1: characteristics of recovery from major environmental shocks with long-term effects in the marine and coastal environment and/or stemming from nuclear accidents

| Characteristic of long-term recovery | Key components | Indicative references and cases |
| --- | --- | --- |
| Living in a constantly changing environment, in which new risks and hazards emerge over time. | Scale of disruption may be harder for communities to adapt to and prepare for than extreme weather events;<br>Uncertainties over closure of fishing grounds, health effects, and impacts on marine life;<br>Need to make multiple decisions about management and remediation over time, each with complex technical and ethical considerations;<br>Management and remediation options may involve contamination of previously uncontaminated environments or food. | Colten, Grimsmore, & Simms (2015) – historical oil spills (Louisiana, USA);<br>Oughton (2011) – Chernobyl (Ukraine/Europe-wide effects) and Fukushima (Japan). |
| Formal (i.e. state) vs informal support in responding to the social and cultural impacts of uncertainty | Structured recovery programmes may struggle to compensate non-monetary losses;<br>Complexity of marine pollution may exceed remits or capabilities of government agencies;<br>Complex and bureaucratic nature of state funders means non-state actors may offer more agile support;<br>Lack of trust in governmental officials from 'outside' community. | Beaudreau et al. (2019) – Exxon Valdez oil spill (Alaska, USA);<br>Colten et al. (2015); Laska (2012) – Deepwater Horizon oil spill (USA);<br>Dunning (2020) – Hurricane Harvey recovery (Texas, USA);<br>McKechnie (1996) – radioactive pollution in Irish Sea from Sellafield nuclear plant (UK). |

| | | |
|---|---|---|
| Potential for existing social structures and relations to facilitate, and also in cases inhibit, recovery | Deliberative interactions between coastal stakeholders (especially fishers) and scientists a means of understanding long-term knowledge and recovery priorities; Tightly-knit social networks can, at times, lead to increased psychological distress among fishers, as threats to fisheries from shocks intensify strain on support network; Litigation processes to redress damages can have long-term negative effects on individuals and communities, contributing to 'corrosive communities' through their length, complexity, and raising of unpleasant memories; Gender inequality and cultural roles can mean women less prepared and less able to participate in recovery activities. | Sullivan et al. (2019) - Deepwater Horizon oil spill, (USA); Parks et al. (2019) – Deepwater Horizon oil spill (USA); Fadigas (2017) - Prestige oil spill (Galician Coast, Spain); Picou et al. (2004) - Exxon Valdez oil spill (Alaska, USA). |
| Participation in culturally meaningful activities as facilitators of resilience | Social and psychological impact of losing access to places of community or historical value; Allowing culturally meaningful activities to restart may be more beneficial to community than enforcing excessively precautionary regulation. | Hayano et al. (2017) – Sami and reindeer consumption in Norway after Chernobyl nuclear accident; Oughton (2011) – Chernobyl (Ukraine/Europe-wide effects) and Fukushima (Japan). |
| Pragmatic short-term 'quick wins' in recovery vs longer | Local fishers and communities can in cases benefit financially from | Beaudreau et al. (2019) – Exxon Valdez oil spill, Alaska, USA; |

| | | |
|---|---|---|
| socio-cultural implications | supporting clean-up activities and siting clean-up infrastructure; Potential tensions between residents and in-coming clean-up and decontamination workers; Differential experiences of recovery in longer-term once initial phase of support and connectedness passes. | Jobin (2017) – decommissioning work at Fukushima Dai'ichi (Japan); Gerster (2019) – north-east Japan following 2011 triple disaster. |

The social and cultural aspects of post-disaster recovery have already received attention for north-east Japan more broadly. Aldrich (2019) holds that areas which have recovered faster from the 2011 earthquake and tsunami are characterised by stronger networks and better local governance. Citizen participation in NGO-led activities has been seen as valuable for resilience in aquaculture activities, with the caution that such participation must be meaningful in terms of being able to drive policy and influence outcomes (Vlachopoulou and Mizuta, 2018). Yet not all residents may feel engaged in or supported by these social networks and ties (Gerster, 2019), and barriers to participation in recovery may reflect conditions and issues in localities prior to the 2011 disasters (Cheek, 2020). More specific to coastal Fukushima where the effects of radioactive contamination are added to the earthquake and tsunami damage, social ties – not only neighbours but also participation in activities and culturally-meaningful events – have been reported as reducing anxiety and building resilience (Iwasaki, Sawada and Aldrich, 2017). The significance of restarting culturally-meaningful activities, especially those linked to the natural coastal environment, has been identified as a component of communities' own revitalisation strategies in Fukushima (Mabon, 2019). Moreover, whilst most research into the community dimensions of resilience to major environmental pollution outlined above comes from a US or European context (see Table 1); the majority of work on resilience in coastal north-east Japan has focused on the effects of the tsunami or land-based radiation, rather than contamination of the marine environment.

## 3. Background to the case study

Soma is located in the north of Fukushima Prefecture, on the north-east coast of Japan (Figure 1). We focus on the area covered by the Soma-Futaba Fisheries Cooperative

Association, which includes the municipalities of Soma City and Minamisoma City, as well as fishing ports in the townships of Shinchi to the north and Namie (Ukedo Port) and Tomioka (Tomikuma Port) to the south. The Soma area (see Figure 2) suffered significant damage in the earthquake and tsunami of 11 March 2011. Tsunami waves reached approximately 3 kilometres inland, destroying homes, infrastructure, and port facilities. In Soma City and Minamisoma City, 1,094 people were killed as a direct result (Soma City Government, 2016; Minamisoma City Government, 2019). The earthquake and tsunami also disabled cooling facilities at the Fukushima Dai'ichi Nuclear Power Plant (FDNPP), triggering hydrogen explosions and releases of radioactive material into the land and sea of coastal Fukushima Prefecture.

The nuclear accident forced evacuations of residents in Minamisoma City. As decontamination work progressed and more became known about the extent of contamination, evacuation orders were gradually lifted and citizens able to return home from April 2012 through to July 2016. Odaka District – one focus of this paper – was among the last to be released due to its proximity to FDNPP. Fisheries from all ports in Fukushima Prefecture were voluntarily suspended by the Fukushima Federation of Fisheries Cooperative Associations almost immediately after the disaster, due to the physical damage to fishing infrastructure and also uncertainty over the effects of radiation on fish stocks. After a period of monitoring of fish stocks led by Fukushima Prefecture with the support of fishers, trial fishing operations in the Soma-Futaba fishing district commenced in September 2012 on species in which radioactive caesium exceeding the regulatory threshold of 50 Becquerels per kilogram had not been recently detected, with further species released incrementally based on monitoring results. The aim of these trial fisheries is to support the revitalisation of coastal fisheries in Fukushima Prefecture, through sale of marine products landed in trial fishing to markets and on to the general public. In the Soma-Futaba fisheries area, all ports have now re-opened, and the fish market at Ukedo Fishing Port in Namie to the south of Soma resumed operations in April 2020 (Soma-Futaba Fisheries Cooperative, 2020b). However, trial operations continue to operate at less than one-fifth of pre-disaster levels (Soma-Futaba Fisheries Cooperative Association, 2018; Yagi, 2019).

Concerns continue over marine radiation from FDNPP. Owing to a lack of storage space on the FDNPP site, operator Tokyo Electric Power Company (TEPCO) plans to release water previously used to keep the damaged reactors cool – and containing tritium – into the Pacific

Ocean (Buesseler, 2020; TEPCO, 2020). Whilst TEPCO claims the concentrations of tritium mean that the water will not be harmful to humans or the marine environment if discharged into the sea, decisions are informed by consultation with an expert panel and with local fishers. Regardless of the risk to human health posed by tritiated water, fisheries cooperatives in Fukushima have expressed concern about the reputational damage that would be caused by any released of water perceived as 'contaminated' (Fukushima Minyu, 2019).

Figure 1: Location of Fukushima Prefecture and Soma within Japan (source: adapted from Geospatial Information Authority of Japan, 2019)

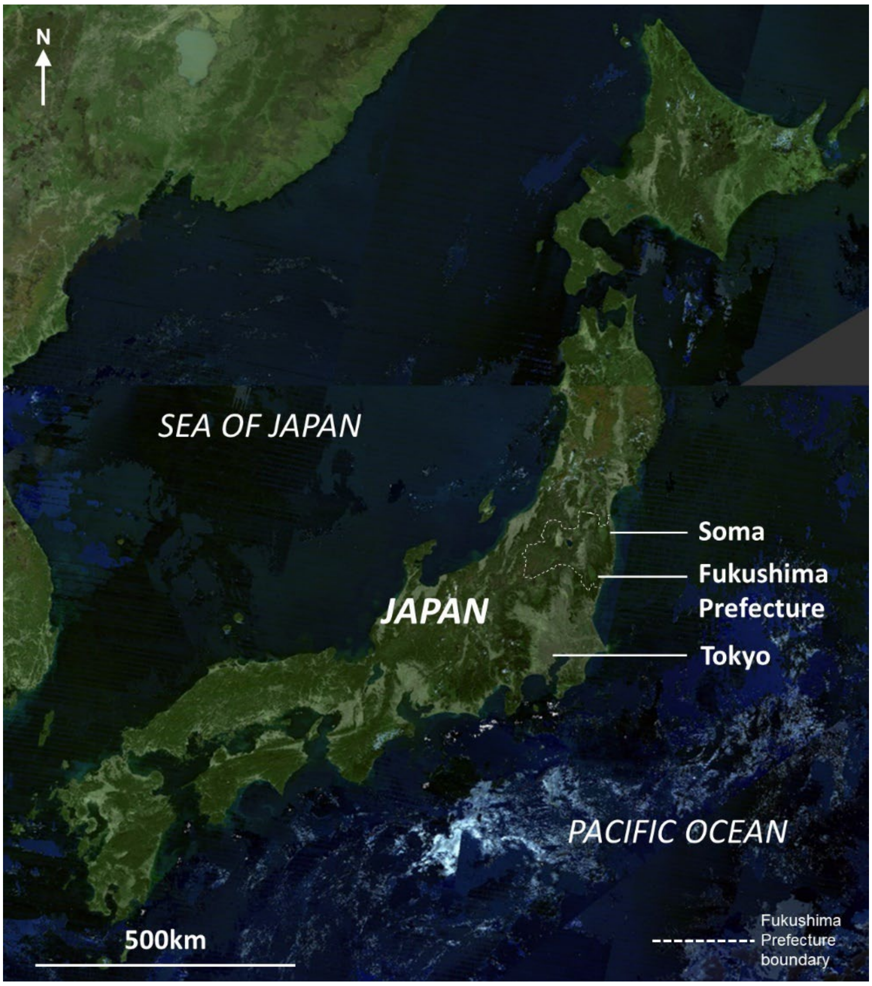
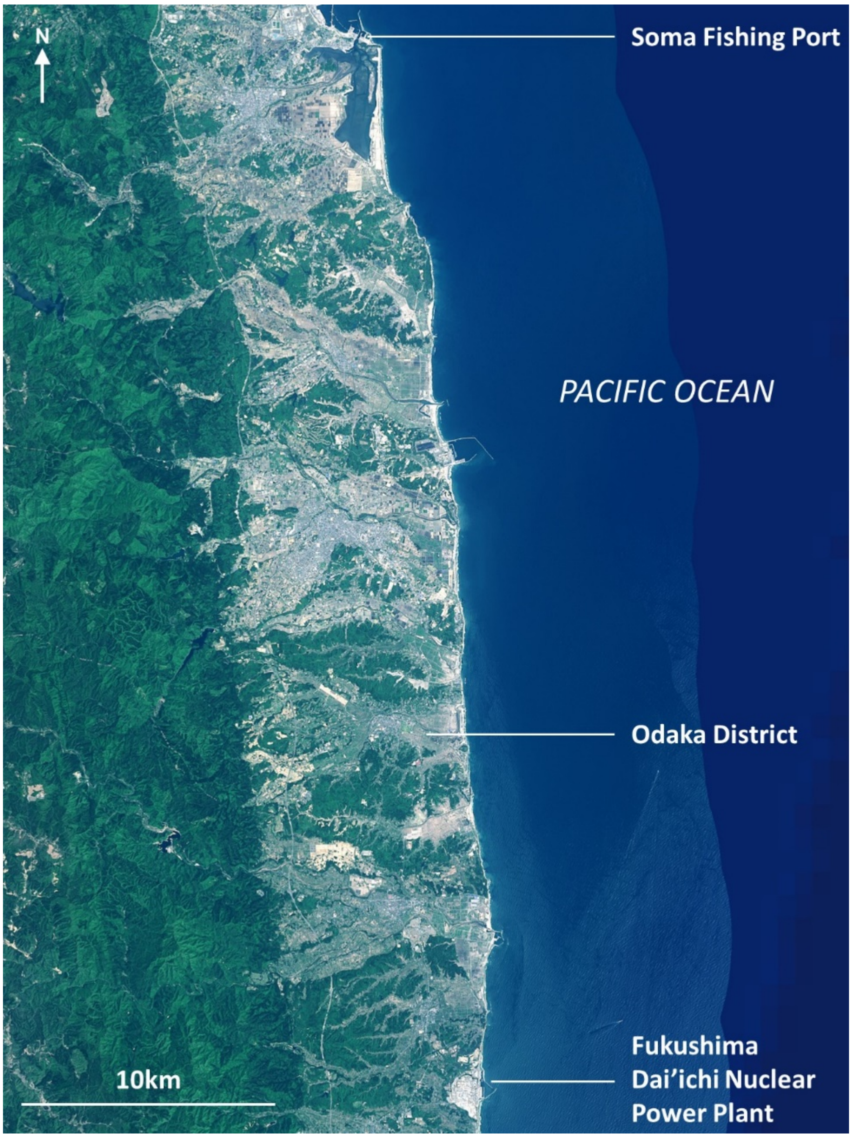



Figure 2: Soma Fishing Port and key locations mentioned in paper (source: adapted from Geospatial Information Authority of Japan, 2019)




It is important to contextualise the extent to which fisheries and coastal communities in Soma can be considered 'resilient' in terms of either 'bouncing forwards' or restoring core functions post-disaster. Whilst the weight of fish landed and the number of recognised post-disaster is broadly comparable to wider Fukushima Prefecture, the value of fish landed in Soma as a proportion of pre-disaster levels is higher than for Fukushima Prefecture as a whole (Table 2). The Soma-Futaba fishing district is also the focal point for recovery targets set by the Fukushima Prefecture Federation of Fisheries Cooperative Associations, to increase trawler hauls to 61% of pre-disaster levels by 2024 (Mainichi Shimbun, 2019). At base, this indicates Soma's recovery has exceeded or kept pace with the Fukushima coast. Qualitatively too, activity on the coast in Soma is drawn on as an exemplar of recovery, with videos and texts on Fukushima fisheries recovery produced by both Tokyo Metropolitan Government (2018) and Fukushima Prefecture (2019) showing the revitalisation of Soma fisheries to represent Fukushima Prefecture overall. Initiatives and people in Soma are also included regularly in Western media (McCurry, 2019), again to represent the recovery and situation on the Fukushima coast. There is hence both qualitative and quantitative evidence to suggest the Soma district has in some ways been able to recover post-disaster, which we evaluate in Sections 5 and 6.

Table 2: Fisheries recovery statistics for Soma district compared to Fukushima Prefecture as a whole (source: Fukushima Prefecture Fisheries Handbook (2018); Soma-Futaba Fisheries Cooperative Association (2019))

| | Fukushima Prefecture (2010) | Fukushima Prefecture (2018) | %age recovery | Soma Cooperative (2010) | Soma Cooperative (2018) | %age recovery |
|---|---|---|---|---|---|---|
| Weight of fish landed (tonnes) | 38,657 | 5,889 | 15% | 18,615 | 3,073 | 10% |
| Value of fish landed (‘000 Yen) | 10,959 | 796 | 7% | 6,546,383 | 1,693,825 | 26% |
| Number of fishers | 1,311 | 1,151 (2017) | 88% | 930 | 805 (2019) | 87% |

4. Method

In-depth interviews were conducted with Soma fishers, and with residents living in Odaka, one coastal district of Soma. Selection and recruitment was focused on fishers given the centrality of fishing activity to the culture and identity of the Soma coast. Nonetheless, bearing in mind the potential for different experiences of recovery across different sections of a locality (Gerster, 2019; Parks *et al.*, 2019), stakeholders in Odaka with an interest in the revitalisation of the area more widely were also interviewed to gain a broader understanding of how a different part of Soma society may view recovery on the coast. Odaka interviews sought to understand how the rehabilitation of the coastal environment and Soma fisheries, as a core component of Soma identity, related to broader recovery activities such as tourism, community revitalisation, social enterprise, and communication around the radiation situation.

In total 14 people were interviewed across 7 interviews; producing a sample size comparable to other research into post-disaster resilience for coastal communities after marine pollution events (e.g. Fadigas, 2017). Interviews were semi-structured, with flexibility to ask follow-up questions within five open-ended areas: (a) what daily life is like in Soma in 2019; (b) how the sea and coastal environment in Soma has changed in the last few years; (c) how daily working practices have changed in recent years; (d) what respondents felt they needed to know about fishing, the environment and recovery, and who they went to for information; and (e) what the positive aspects are of living in Soma. A semi-structured approach ensured the different interviews covered comparable topics, but allowed space within this for respondents to steer the conversation and raise issues they themselves deemed to be of importance.

Fishers were recruited to reflect three sub-groups engaged in the recovery of Soma fisheries: trawler captains (4 participants), who have a role in setting the strategy and direction of trial fisheries as boat owners; members of the youth division of the Soma-Futaba Fisheries Cooperative Association representing the future of local fisheries (3 participants); and gillnet fishers pro-actively setting new marketing and branding strategies for Soma marine produce (3 participants). Given the reluctance of fishers to engage with 'outsiders' – especially in light of the heightened tensions around possible releases of water containing tritium from FDNPP – extension officers from Fukushima Prefecture's Fisheries Section (themselves part of the research team) facilitated the interview discussions with fishers, to encourage the fishers to speak openly and freely. Contrary to the strained relations between fishers and government/TEPCO 'officials' (Fukushima Minyu, 2019, 2020), previous research by the first and second authors (e.g. Mabon & Kawabe, 2015) indicates fishers in Fukushima generally have a trusting and positive relationship with the prefecture's fisheries extension officers as individuals, due to regular informal and face-to-face interaction stretching back to before the 2011 disasters. As such, fishers would be more likely to speak openly if the interviews were led by trusted and familiar contacts. Fishers were interviewed in small groups rather than individually, again to create a more informal atmosphere for discussion by allowing them to discuss responses among themselves. All interviews were conducted in Japanese, and were led by 1-2 extension officers with support from 1-2 academic members of the research team.

Odaka respondents were recruited to provide a cross-section of organisations involved in wider revitalisation on the Soma coast, and were interviewed individually, with questions from the first and second authors in Japanese. Odaka was selected as a community on the Soma coast which had suffered significant effects from the nuclear accident (having been evacuated until 2015), but also as a community appearing frequently as an example of successful recovery activities. Moreover, through their activities in tourism, support for community-level revitalisation, and dialogue facilitation around the future of FDNPP, the Odaka respondents have a stake and interest in seeing the revitalisation of Soma fisheries as part of a vibrant local society, economy and culture. The Odaka data therefore provides an additional perspective on how recovery – and by extension inherent resilience – has progressed on the Soma coast, to supplement the accounts of fishers.

A grounded-type approach was taken to analysis, whereby the research team worked together to group insights from the interviews into overarching themes before considering these themes in relation to outcomes from existing research. Similar to other studies into coastal management and resilience (e.g. Biagini, Bierbaum, Stults, Dobardzic, & McNeeley, 2014; Hopkins, Bailey, & Potts, 2016) we call this a ‘grounded-type’ approach because we use the grounded theory principles of iteratively identifying themes from the data mainly as an analytical tool for drawing insights from our data in order to nuance and refine an existing body of theory, rather than forming new theories per se. Whereas a stricter grounded theory approach might propose new theories through the findings and discussion (Strauss and Corbin, 1994), we structure our findings and discussion around five characteristics of coastal resilience under major environmental change identified in extant research and outlined in Section 2 (see Table 1). These characteristics were identified following data collection and used to structure the paper. As such, although our data analysis initially followed a more inductive approach, we ultimately use the themes identified to refine or challenge existing conceptual understandings of coastal resilience. Whilst analytical techniques rooted in grounded theory are therefore useful as a means of identifying new insights from the data which can be explored further in the findings and discussion, we hence stop short of calling this a fully ‘grounded’ approach to analysis.

We also note Pauwelussen (2016) and the value of description in resilience studies as a means of allowing respondents' own understandings of what resilience means to them to stand on their own, without forcing an *a priori* interpretation of resilience onto the data. Accordingly, the findings in Section 5 are by necessity descriptive. It is also worth noting that whilst cognisance was paid to the gender balance of the sample, the focus on fishers in Soma means the sample is inevitably biased towards men, which we reflect on in Section 6.2.

Table 3: summary of interviewees

| Interview Number | Interviewee | Gender | Age group | Location |
|---|---|---|---|---|
| 1 | Member of young fishers' division (group interview 1) | Male | Late 20s-early 40s | Soma Fishing Port |
| 1 | Member of young fishers' division (group interview 1) | Male | Late 20s-early 40s | Soma Fishing Port |
| 1 | Member of young fishers' division (group interview 1) | Male | Late 20s-early 40s | Soma Fishing Port |
| 2 | Gillnet fisher (group interview 2) | Male | 40s/50s | Soma Fishing Port |
| 2 | Gillnet fisher (group interview 2) | Male | 40s/50s | Soma Fishing Port |
| 2 | Gillnet fisher (group interview 2) | Male | 40s/50s | Soma Fishing Port |
| 3 | Trawler captain (group interview 3) | Male | 50s/60s | Soma Fishing Port |
| 3 | Trawler captain (group interview 3) | Male | 50s/60s | Soma Fishing Port |
| 3 | Trawler captain (group interview 3) | Male | 50s/60s | Soma Fishing Port |
| 3 | Trawler captain (group interview 3) | Male | 50s/60s | Soma Fishing Port |
| 4 | Innkeeper | Female | 60s | Odaka |
| 5 | Innkeeper | Female | 30s | Odaka |

| | | | | |
|---|---|---|---|---|
| 6 | Social entrepreneur/café owner | Male | 30s | Odaka |
| 7 | Local NGO leader/former nuclear plant worker focused on facilitating dialogue and improving understanding about the FDNPP situation | Male | 40s | Odaka |

## 5. Findings

### 5.1. Living with continuous environmental change and risk

Our first area of findings relates to living in a constantly changing environment after an initial shock, one in which new risks and hazards emerge over time. Interviews pointed to a certain degree of inherent resilience within Soma around being prepared for extreme events linked to the marine environment. Fishers described local shrines with names reflecting earthquakes and inundations, indicating a cultural memory of seismic risk in the locality and of constant potential for new risks to emerge in future (interview 1, young fishers); whereas trawler captains explained knowledge of how to fish in storms was a unique characteristic of Soma fishers across generations (interview 3, captains). However, two, longer-term and unfolding pressures in the marine environment challenge the ability to recover from the 2011 disasters: releases of water containing tritium; and broader climatic changes.

Whilst FDNPP is unlikely to experience further catastrophic failures, its decommissioning is far from over. The controversy over releasing tritiated water into the sea (see Buesseler, 2020) is a specific example of how the FDNPP site is still viewed as posing a risk to the environment and people. Younger fishers felt the nuclear plant remained a concern as one could not know what would happen next, and hence believed a feeling of uncertainty would continue until the plant was completely removed (interview 1, young fishers). It was also noted that it was hard to get information about the situation on the coast from elsewhere in Japan (interview 4, innkeeper). One effect of this lack of widely available information, and the threat of additional environmental pressures through water releases, is the possibility of further reputational damage to Fukushima's fisheries (interview 1, young fishers). Indeed, in June 2020, the Vice-Director of the Iwaki City Fisheries Cooperative stated his opposition to the water releases, arguing that releasing contaminated water into the sea would reset the fishers' post-disaster trust-building efforts to zero (Fukushima Minyu, 2020).

Fishers also discussed at length how the fish they caught were changing, possibly due to climate change. Since resuming fishing post-disaster, fishers reported changes in their by-catch, including declines in starfish, sardines and prawns (interview 1, young fishers; interview 3, captains), with a shift from cold-water species to warm-water species (interview 2, gillnet fishers). More 'southern' fish such as octopus and swimming crab were entering nets (interview 1, young fishers; interview 3, captains). A decline in whale and dolphin sightings in 30-50km offshore waters post-disaster was also raised (interview 1, young fishers). Interviewed fishers reported they could 'feel' seawater changes (interview 3, captains); with the fishing grounds moving further north due to water temperature increase (interview 1, young fishers; interview 3 captains). Data would appear to support these intuitions. From an average of 14.9°C over the period 1985-2019, the average water temperature recorded in Matsukawaura, Soma, was 15.0°C, 16.0°C and 15.4°C in 2017, 2018 and 2019 respectively; compared to 14.2°C, 13.6°C and 14.4°C over 1985, 1986 and 1987. (Fukushima Prefecture, 2019b).

Fishers and coastal citizens in Soma may therefore have a certain degree of inherent resilience to extreme events in the sea, conveyed through shrines and through intergenerational fishing practice. However, after the tsunami and initial nuclear accident, the continued presence of harmful radioactive material on-site at FDNPP means the potential for new risks and hazards to emerge will remain until the plant is completely decommissioned over several decades. The potential effect of tritiated water releases on the reputation (and by extension marketability) of Fukushima fish shows how local fisheries may have to 'bounce forwards' or 'build back' several times, or may indeed not be able to fully recover whilst risks remain. Furthermore, fishers' discussions of the effects of environmental change remind us that any recovery from an environmental shock is likely to have to take place against a backdrop of ongoing and intensifying climate change. We now explore further how this environmental context may test the capacity of inherent resilience within the community.

### 5.2. Strengths and limitations of formal support initiatives

Our second area of findings considers the strengths and limitations of formal government and institutional support initiatives, and their relation to inherent resilience. On one hand, there has arguably been a degree of 'formal resilience' – i.e. institutional support at local and regional if not national levels – towards longer-term recovery in Soma. Respondents talked positively about the post-disaster period as an opportunity to try new ideas or do things differently (e.g. interview 5, innkeeper; interview 6, social entrepreneur), with financial, infrastructure and logistical support from municipal and regional governments to do so. Similarly, fishers receive financial compensation from TEPCO, with significant investment in reconstruction of port and coastal infrastructure. The prefectural fisheries office and their extension officers, plus the fisheries cooperatives, have helped fishers to 'bounce forwards' through training in new techniques and approaches to fishing post-disaster. Specific examples of adaptation include the Young Fishers' Division of the Soma-Futaba Fisheries Cooperative Association learning new techniques for fishing post-disaster (interview 1, young fishers); and gillnet fishers diversifying the kinds of fish caught and techniques according to the season, to broaden their fishing activity (interview 2, gillnet fishers).

Such investments may not, however, compensate for the effects of the disaster on people's identity, sense of purpose, or community relations. Fishers described how post-disaster, practices, rhythms, and even their own bodies had changed. Whereas pre-disaster fishing started at 2am and continued all day or even overnight (interview 3, captains), trial fisheries take place once or twice a week, and only in good weather (interview 2, gillnet fishers). Decreased fishing hours meant more time at home with family, which in cases caused tensions (interview 3, captains). Fishers also complained of gaining weight due to reduced physical activity with less time at sea, comments which, whilst made humorously, nonetheless conveyed an underlying frustration at the effects limited fishing time was having on the fishers' daily lives (interview 1, young fishers; interview 3, captains). Indeed, interviewees explained they had wanted to work again after the disaster, even when receiving livelihood support (interview 2, gillnet fishers; interview 4, innkeeper). One gillnet fisher in particular had tried a different job for a while, but came to realise fishing was 'his work' and returned to participate in the trial fisheries. To compensate for a lack of time at sea, younger fishers adopted strategies such as helping out on other boats when they themselves were not sailing (interview 1, young fishers).

These changes have implications for inherent resilience if alterations to rhythms and practices remove people from the working and living contexts which facilitate the meaningful interpersonal interaction. An interviewed innkeeper highlighted the lack of a sense of community when she initially returned post-evacuation, describing Odaka being in complete darkness at night due to the lack of people (interview 4, innkeeper); whereas other fishers felt the constrained conditions of post-disaster fisheries (i.e. fishing only several times a week in good weather) restricted opportunities for young fishers to learn their craft (interview 3, captains). Changes in practice can thus disrupt social networks and relationships in a way that weakens opportunities for sustaining inherent resilience.

As such, whilst it is possible to financially compensate residents for the contamination of the sea and coast of Soma, and to facilitate initiatives to enhance residents' and fishers' adaptive capabilities, such measures will not necessarily replace a sense of belonging, identity or, indeed, community. This becomes a matter for inherent resilience if alternative working and living arrangements that are required to 'build back' into a still-disrupted environment remove people from the practices and interactions which are necessary to maintain inherent resilience. We now assess more precisely how the disaster has affected social relations on the Soma coast.

### 5.3. Social relations as a facilitator and inhibitor of recovery

Our third area of findings concerns the role of social relations to both support inherent resilience, yet also inhibit recovery. In-keeping with the resilience literature in Section 2, social relations were generally viewed as a positive force contributing to the recovery of life on the coast. The warm personalities and personal qualities of the people of Soma – in comparison to people in larger cities - were cited as contributing to recovery (interview 2, gillnet fishers; interview 3, captains); with these support networks giving space to try new initiatives and make mistakes in response to post-disaster challenges (interview 6, social entrepreneur).

Community relations, inherent resilience, and the ability to respond to multiple shocks and stresses over a prolonged period of time perhaps come together most clearly for the issue of trust. As per Section 3, the radiation situation on the Fukushima coast is not static, with new information and updated assessments of risk emerging as knowledge of the environment improves and the situation at FDNPP evolves. When asked who they turned to for information on radiation and revitalisation, fishers unanimously agreed that the officers from the Fukushima Prefecture fisheries section would be their first point of contact (interview 2, gillnet fishers; interview 3, captains). The reason for this is that prefectural officers came to visit them in the fish markets before the disaster too, and have continued to see the fishers nearly every day as trial operations progress (interview 1, young fishers). Social relations and experience of collaborative working between fishers and local government officials that were in place pre-disaster have hence created the conditions for fishers to have a trustworthy contact they can turn to for information to support complex decisions on how to manage marine radiation risks. Notably, fishers' positive assessments of prefectural extension officers stands in contrast to the anger fishers have directed towards other state actors (e.g. TEPCO and the national government) over their handling of the tritium water releases (Fukushima Minyu, 2019, 2020).

Equally, though, it was recognised that these relations of trust, and the subsequent benefits they bring for 'bouncing forwards', did not encompass everyone in the local community when it came to the long-term radiation situation. Fishers admitted that provision of 'true' or accurate information would not necessarily lead to trust among citizens and consumers (interview 1, young fishers). Gaps in relationships were identified between people who worked at FDNPP versus those who lived nearby; and between people who had in-depth technical knowledge of the environmental situation versus those who did not (interview 7, local NGO). Differences in perception between FDNPP operator TEPCO as a company (who were viewed negatively), versus perception of the individuals working for TEPCO (who tended to be viewed more positively), were also noted (interview 5, innkeeper).

By and large, social relations were viewed as a force for good in supporting recovery on the Soma coast. As for how this relates to inherent resilience, the personalities of Soma residents and the relations of trust which existed between fisheries extension officers and fishers were both factors, which existed pre-disaster, that arose organically within the community and became a source of strength in dealing with the multiple shocks and stresses post-disaster. Nevertheless, the findings also show that not all members of local society feel included within these resilience-facilitating social relations.

5.4. Participation and culturally meaningful practices

The fourth area of findings concerns participation and culturally meaningful practices. There are here strong links to social relations (Section 5.3.) and to formal versus informal support (Section 5.2.), however here we focus more on practices themselves.

Fishers saw participation in fishing as a culturally meaningful practice as well as an economic activity. This was especially evident in the training of younger fishers by their seniors. The ability to fish in stormy weather was regarded as a key characteristic and source of pride for Soma fishers. However, with trial fishing only taking place in good weather, trawler captains regretted that they were unable to teach younger generations (especially their own sons) to fish in storms (interview 3, captains). Despite its limitations, the restart of trial fisheries was discussed positively, in that it allowed fishers to reconnect with their friends when fishing, and when buying materials and making fishing gear together. Indeed, Soma fishers also prided themselves on their ability to make the majority of their equipment together from scratch (interview 2, gillnet fishers). As well as showing the socio-cultural significance of fishing, these insights are a clear example of how meaningful practices – especially different generations fishing together - become a means of passing on knowledge, maintaining interpersonal relations, and hence sustaining inherent resilience.

Rehabilitation of the coastal landscape to the extent that people were able to once again consume or enjoy aspects of the natural environment was similarly considered an important component of recovery (interview 6, social entrepreneur). Although the consumption of seafood was part of daily living (interview 1, young fishers), during the suspension of Fukushima fisheries, fishers were forced to eat fish from elsewhere and felt the quality was not as high as Fukushima fish (interview 2, gillnet fishers). Being able to once again consume fish landed in Soma hence came to represent the recovery of fishing as a key component of Soma identity and culture. The re-starting of culturally significant activities associated with the coastal zone likewise came to signify steps towards the locality ‘building back’ – specifically, residents of Minamisoma being allowed brief returns home during the evacuation period to stage the annual Soma Noamoi festival[1] (interview 4, innkeeper).

[1] An annual festival whereby horses are paraded and raced by riders wearing traditional Samurai armour. The Soma Nomaoi was suspended due to the 2011 disasters, but re-started in 2012. A similar nomaoi event was re-started in Namie Town, to the south of Odaka, in 2018.

The above insights show how participation in cultural practices are considered an important marker of Soma 'bouncing forwards' after the initial disaster in 2011. From a resilience point of view, it is interesting to note that cultural practice encompasses not only festivals such as the Nomaoi, but also everyday actions of consuming local food and making fishing equipment. Yet the lingering effects of radioactive contamination on sea and land prevent these activities restarting immediately to their full extent. The issue of short- and long-term recovery is our final area of findings.

### 5.5. Pragmatic short-term 'quick wins' in recovery vs longer-term resilience implications

Our final area of findings concerns the balancing of pragmatic 'quick-wins' in recovery, versus the longer-term implications of living in a constantly changing environment. The 2011 disaster and the subsequent revitalisation of Fukushima's coasts and seas presented new short-term opportunities for fishers. These include joining prefectural marine radiation monitoring efforts in the years immediately following the accident, and more recently the chance to support survey work for installation of offshore wind turbines (METI, 2018). Due to the suspension of fisheries, fish were able to grow to bigger sizes, the result being that fishers landed larger fish (interview 2, gill net fishers) and noticed a generally larger fish population (interview 3, captains). Fishers could catch fish they had not caught previously and eat their own catch, even high-value products (interview 1, young fishers). Fishers' efforts have been supported by enthusiastic marketing, led by the fisheries cooperatives and municipal governments in Iwaki and Soma, to encourage consumption of Fukushima fish as a means of cheering on the locality's recovery (Iwaki City Fisheries Section, 2020; Soma-Futaba Fisheries Cooperative, 2020a).

Yet longer-term challenges to recovery have emerged, largely linked to the continuing radiation situation and the emerging threat of climate change discussed in Section 5.1. Once trial operations restarted, the fish population started to decline again and species that had reappeared, such as prawns and sand eels, began to decrease (interview 2, gillnet fishers; interview 3, captains). These visible differences in the size and abundance of fish alerted the young fishers (interview 1) to the effects of over-fishing on the marine environment. Indeed, 2019 recorded the first annual decrease in landed fish since the start of trial fisheries in 2012, with a 10.6% decrease in weight landed compared to 2018. Within this, no Pacific sand eels were landed (Kahoku Shinpo, 2020). There is also a difficult question of how to expand fisheries beyond trial operations. Younger fishers admitted that people who do not want to eat local fish will not do so regardless of the provision of more or better information (interview 1, young fishers). A local NGO representative similarly argued that suspicion would remain no matter how clean the water and fish were, a situation exacerbated by controversial issues such as the releases of tritiated water (interview 7, local NGO).

Another issue raised in interviews about longer-term recovery relates to young people. Young fishers in their late 20s, 30s and early 40s (interview 1) saw themselves as being in the most difficult situation for fisheries revitalisation. The reason for this is that fishers in this age group had started learning to fish before the disasters, but had to pause for several years due to the voluntary suspension of fishing and then re-learn new techniques for the kind of fishing undertaken in trial fisheries, with the skills and techniques they had started to learn pre-disaster not being applicable to post-disaster fisheries. Older fishers, by contrast, had a much broader set of skills and experiences to draw on to help them adapt, whereas younger fishers (i.e those in their early 20s) only knew post-disaster fisheries and hence had learned to fish solely for post-disaster conditions (interview 1, young fishers). Moreover, as in Section 5.4., the limited nature of trial fisheries constrained the opportunities for youth fishers to develop fishing skills (interview 3, captains). In Odaka too, the question arose of what young people can do, and what can attract young people to remain in the locality (or move in from elsewhere in Japan as was the case with at least 2 of the interviewees) and contribute to re-making the town (interview 6, social entrepreneur).

These points link back to inherent resilience in two ways. First, whilst strong social relations and the reestablishment of meaningful practices have helped short-term revitalisation of the Soma coast in the short term, the ability of these community relations and practices to help the Soma coast stand up to the longer-term effects of radiation and a changing environment remain open to question. Second, the ongoing disruptions to daily life mean that youth – who will at some point become the bearers of social memory and inherent resilience practices - may not have had the opportunity to fully engage with the social memories and oral histories which make up inherent resilience compared to their elders, yet equally may not have the protection of their parents which children and teenagers have.

## 6. Discussion

6.1. Contributions to existing research

We reflect on the implications of our findings in relation to each of the social dimensions of major marine environmental pollution which structured the results, and draw links back to the literature on inherent resilience.

First is living within a constantly changing environment, in which new risks and hazards emerge over time. Unlike oil spills (Colten, Grimsmore and Simms, 2015) or acute events such as hurricanes (Dunning, 2020), in Fukushima one cause of the original shock (FDNPP) remains *in situ*, and has the potential to cause further new stresses through planned releases of radioactive material in the ocean or future unexpected events. As interviewed fishers reported, this means that 'recovery' arguably cannot fully happen until the source of pollution has been completely removed. Moreover, our findings also raise a bigger question about how to separate the effects on society and culture caused by a major marine pollution event, from increasingly prominent localised effects of climate change. As in Section 5.1., when probed on changes in their practices post-disaster, fishers spoke extensively about differences in currents, types of species caught, water temperatures, and location of fishing grounds; over and above the types of fish which had been released for trial operations. Although it is not possible from the data we have to *prove* that these differences are due to climate change, fishers indicated that warming waters and shifting currents were likely related to global warming.

The continued threat of further contamination thus questions whether communities like those in Soma can ever fully 'build back' (Wisner, 2017) or 'function in the same way' (Walker, 2020) in line with more conventional understandings of resilience in the face of environmental shocks. The extent of disruption to daily living brought about by the disaster, and the ways in which the marine environment has changed while fishing has been suspended, has had a limiting effect on the everyday processes (Cutter, Ash and Emrich, 2014) and social networking for sharing memories (Colten, Grimsmore and Simms, 2015) which are fundamental to inherent resilience. Under major changes to the environment happening over longer timeframes, resilience might look different, have different characteristics and require different actions to sustain in comparison to more acute shocks and stresses. Indeed, the adoption of new fishing strategies and economic activities on the Soma coast suggest that the community has in some ways had no choice but to try to reestablish and maintain resilience by ‘moving on’ to a new and different form post-disaster, one that introduces different social relations and practices.

Second is the limitation of formal institutional initiatives in responding to the social and cultural impacts of uncertainty (Laska, 2012; Colten, Grimsmore and Simms, 2015). In Soma, recovery and revitalisation efforts led by the central government, such as compensation and infrastructure provision, were generally discussed positively by respondents. However, similar to Beaudreau et al. (2019) on the Exxon Valdez oil spill, it was apparent that these initiatives are not entirely successful in replacing the non-economic benefits of fishing, and by extension the practices and relationships which may help to sustain social memory and practices of inherent resilience. Fishers complained of too much free time, a desire to be back out doing ‘their’ work, and even the loss of opportunities to pass on skills of fishing in stormy weather to younger generations. Nonetheless, trial fishing operations are themselves driven by the regional fisheries cooperative and supported by regional- and national-level governments, and are evaluated positively by fishers (albeit with the caveats above) due to the opportunities afforded for interaction with their peers and for re-establishing pride in Soma marine produce. Under conditions of major environmental change, what has perhaps made the Soma trial fishing operations at least partially successful in helping to restore and improve core functions on the coast is the role of the extension officers of Fukushima Prefecture’s Fisheries Section. As per the interview findings, extension officers help to get fishers’ buy-in for trial fishing operations through face-to-face explanation of the underpinning science and visibility at fish markets during the landing of trial fisheries catches. There are parallels here to Sullivan et al. (2019) on the value of deliberative instances between fishers and scientists in charting pathways to recovery and Dunning (2020) on the ability of smaller spatial scales of government to provide a more flexible and agile response. Formal government initiatives may stand a greater chance of addressing non-economic losses and maintaining inherent resilience if they can be put into practice by people working at the regional or municipal level with good understanding of the local context and the ability to get buy-in from citizens and stakeholders through pre-existing relations of trust.

Third is the potential for existing social structures and relations to not only facilitate, but in cases inhibit, recovery. Social networks have been discussed extensively for sustaining the inherent resilience practices that will allow a community to ‘bounce forwards’ or improve core functions after a shock (Marín *et al.*, 2015; Cradock-Henry, Fountain and Buelow, 2018;

Aldrich, 2019). Such social networks were evident in Soma too, both for mutual support and encouragement among fishers and also for creating a new focal point for the community in Odaka. Yet reflecting more critical takes on social networks as a potential barrier to recovery for some people (Fadigas, 2017; Parks *et al.*, 2019), not everyone in a community may feel the same about the social capital of the locality. For instance, whereas fishers felt their positive relations with prefectural staff meant the regional government could be trusted for knowledge on the marine radiation situation, interview responses also suggest that not everyone on the Fukushima coast has a positive or trusting view of the authorities' communication efforts. In Odaka too, respondents were reflexive about the need to extend existing networks established by 'newcomers' to elderly people who had a longer relationship with the locality and had returned post-evacuation. The polarisation identified within the locality between citizens who are prepared to eat fish and those who are not, and those who engage with knowledge relating to FDNPP and those who do not, indicates that the strength of interpersonal relations within Soma are not uniform. Reflecting Marín et al's (2015) conceptual insight and Cheek's (2020) empirical observations on participation in post-tsunami recovery in north-east Japan, our findings show that ideas such as social capital can be a force for good in supporting recovery, but may also reinforce or repeat existing gaps within communities. In keeping with more critical takes on resilience (Matin, Forrester and Ensor, 2018), studies of coastal resilience in post-disaster settings would do well to keep in mind questions of who has the power to define 'inherent resilience' and decide if a community has remained resilient after major environmental change.

Fourth is attention to participation and to culturally meaningful activities as facilitators of resilience post-disaster. The contribution of sense of place and cultural activities to resilience comes across strongly in our data, reflecting what has been observed previously in Fukushima (Iwasaki, Sawada and Aldrich, 2017) and on the Gulf Coast (Simms, 2017). Particularly significant in Soma is the restart of activities in the coastal landscape which are closely linked to a sense of 'Soma' identity, such as the Soma Nomaoi festival and the landing of high-value fish catches by Soma fishers. However, the nature of the Fukushima nuclear accident and the long-term environmental damage means that the restart of such culturally meaningful activities must be traded off against what is safe to humans. Whilst it has been demonstrated that cultural practices associated with ecosystems can provide coping mechanisms after a disaster has struck (Oughton, 2011; Jigyasu, 2014; Sandholz, 2016), radioactive contamination meant the Nomaoi at first had to be restricted, and that fisheries remain limited. Whilst the Soma case does illustrate the value of culturally meaningful activities to resilience, it therefore also demonstrates the potential of major and large-scale environmental change to remove or constrain culturally meaningful practices which people have previously relied on as a source of resilience.

Fifth and final is the balancing of short-term 'quick wins' in recovery against longer-term challenges. Despite the ongoing uncertainty over the future marine radiation situation, our findings and the underpinning data suggest that fisheries were able in the short term to 'bounce forwards', aided by an initial increase in fish stocks and enthusiastic marketing of Fukushima marine produce at the local and regional level. Yet in Fukushima Prefecture, disruptions to livelihood have magnified trends, such as population ageing and decline, that existed pre disaster (Yamakawa and Yamamoto, 2017). It hence follows that groups who were already marginalised pre-disaster may disproportionately struggle post-disaster. In our data, notable was that youth emerged as a group in a challenging position, due not only to the limited resources post-disaster but also the fact they had more limited social and human capital to draw on before the disaster happened. It is of course true that major marine pollution events have always to an extent happened against a backdrop of wider social and environmental change (Simms, 2017; Parks *et al.*, 2019). Yet reflecting existing critical takes on resilience in the social sciences (Matin, Forrester and Ensor, 2018; Borie *et al.*, 2019), the situation faced by youth in Soma is a reminder of the need to ensure that the burden of becoming 'resilient', and of sustaining community and inherent resilience outside of institutional support, does not fall on those who may already be disempowered or disenfranchised.

### 6.2. Limitations

One critical limitation of this study concerns gender. The positive social relations in Soma discussed by fishers in this paper are largely relations between men. Yet research elsewhere in Fukushima has shown that men and women have experienced and responded to the disasters differently (Kimura, 2017). Whilst we did seek to engage with women's experiences of post-disaster live in Soma more broadly as part of the interviews in Odaka, further research may wish to consider more explicitly whether men and women view inherent resilience in post-disaster Soma differently. It may be especially valuable to seek the perspectives of women more directly engaged in fisheries, such as female fishers, fish market staff, administrative workers and indeed members of fishing families.

A second limitation relates to sample size and recruitment. The ongoing situation on the Fukushima coast, especially the continued sensitivities around the management of marine radiation, makes engagement with fishers difficult. Accordingly, working with trusted intermediaries, in this case research team members/extension officers from the Fukushima Prefecture Fisheries Section and the leaders of the Soma-Futaba Fisheries Cooperative, was vital to get participation from fishers, and even then this resulted in a small if focused sample. As per Section 4, we believe that extension officers play an important and positive role in connecting fishers with external researchers. Nonetheless, it is worth acknowledging that this approach, whilst giving a pathway to valuable insights, does inevitably lead to a smaller and self-selecting sample of participants.

Finally, whilst we see the unique nature of the disaster in Soma as a chance to evaluate the role of inherent resilience in a situation where the consequences are diluted over time and where new shocks and stresses may emerge during the recovery period, this uniqueness might also hinder the generalisability of the findings to other contexts. However, given calls for more understanding of what slower-onset and longer-term hazards linked to climate change mean for disaster risk reduction and resilience (Kelman, 2015; Cinner *et al.*, 2018; Staupe-Delgado, 2019), we would hope that our case-specific findings here offer insights into the limitations of inherent resilience in relation to longer-term environmental changes.

## 7. Conclusion

This paper set out to understand how communities respond to major environmental changes where new risks and hazards emerge over several years. We had a particular interest in understanding how inherent resilience may support recovery in a situation where communities may need to 'build back' or 'bounce forwards' several times, in comparison to the greater focus on acute disasters in the literature to date. Through interview-based research in the Soma area of Fukushima Prefecture, Japan, we found that the reestablishment of practices such as fishing are vital to create opportunities for social interaction necessary for recovery, and also carried cultural significance linked to local identity. Equally, however, uncertainty over future activities at FDNPP and continued restrictions on fisheries limits the ability of fishers and coastal residents to engage with resilience-building practices supporting recovery. Building on existing international research, our results indicate that whilst practices related to inherent resilience can indeed help communities to maintain core functions in a way that formal institutional support cannot, longer-term changes to the environment may have consequences for daily living and social relations that restrict potential for communities to carry out practices necessary to sustain social memory and maintain pre-existing community relations.

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## REFERENCES


Adamson, G. C. D., Hannaford, M. J. and Rohland, E. J. (2018) 'Re-thinking the present: The role of a historical focus in climate change adaptation research', *Global Environmental Change*. Elsevier Ltd, 48, pp. 195–205. doi: 10.1016/j.gloenvcha.2017.12.003.

Adger, W. N. *et al.* (2005) 'Social-ecological resilience to coastal disasters', *Science*. American Association for the Advancement of Science, pp. 1036–1039. doi: 10.1126/science.1112122.

Aldrich, D. P. (2019) *Black wave : how networks and governance shaped Japan's 3/11 disasters*. Chicago: University of Chicago Press.

Aldrich, D. P. and Meyer, M. A. (2015) 'Social Capital and Community Resilience', *American Behavioral Scientist*. SAGE Publications Inc., 59(2), pp. 254–269. doi: 10.1177/0002764214550299.

Beaudreau, A. H. *et al.* (2019) 'Thirty years of change and the future of Alaskan fisheries: Shifts in fishing participation and diversification in response to environmental, regulatory and economic pressures', *Fish and Fisheries*. Blackwell Publishing Ltd, 20(4), pp. 601–619. doi: 10.1111/faf.12364.

Bennett, N. J. (2019) 'Marine Social Science for the Peopled Seas', *Coastal Management*. Taylor & Francis, 47(2), pp. 244–252. doi: 10.1080/08920753.2019.1564958.

Biagini, B. *et al.* (2014) 'A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility', *Global Environmental Change*. Pergamon, 25, pp. 97–108. doi: 10.1016/J.GLOENVCHA.2014.01.003.

Borie, M. *et al.* (2019) 'Mapping narratives of urban resilience in the global south', *Global Environmental Change*. Elsevier Ltd, 54(August 2018), pp. 203–213. doi: 10.1016/j.gloenvcha.2019.01.001.

Buesseler, K. O. (2020) 'Opening the floodgates at Fukushima', *Science*. American Association for the Advancement of Science, 369(6504), pp. 621 LP – 622. doi: 10.1126/science.abc1507.

Chang, S. E. *et al.* (2015) 'Using vulnerability indicators to develop resilience networks: a similarity approach', *Natural Hazards*. Springer Netherlands, 78(3), pp. 1827–1841. doi: 10.1007/s11069-015-1803-x.

Cheek, W. (2020) 'The paradox of community involvement: rebuilding Minamisanriku', *Disaster Prevention and Management: An International Journal*. Emerald Group Publishing Ltd. doi: 10.1108/DPM-12-2019-0374.

Cinner, J. E. *et al.* (2018) 'Building adaptive capacity to climate change in tropical coastal communities', *Nature Climate Change*. Nature Publishing Group, pp. 117–123. doi: 10.1038/s41558-017-0065-x.

Colten, C. E., Grimsmore, A. A. and Simms, J. R. Z. (2015) 'Oil Spills and Community Resilience: Uneven Impacts and Protection in Historical Perspective', *Geographical Review*. Wiley-Blackwell, 105(4), pp. 391–407. doi: 10.1111/j.1931-0846.2015.12085.x.

Colten, C. E., Hay, J. and Giancarlo, A. (2012) 'Community resilience and oil spills in coastal Louisiana', *Ecology and Society*. Resilience Alliance, 17(3). doi: 10.5751/ES-05047-170305.

Cradock-Henry, N. A., Fountain, J. and Buelow, F. (2018) 'Transformations for resilient rural futures: The case of Kaikōura, Aotearoa-New Zealand', *Sustainability (Switzerland)*. MDPI AG, 10(6). doi: 10.3390/su10061952.

Cutter, S. L., Ash, K. D. and Emrich, C. T. (2014) 'The geographies of community disaster resilience', *Global Environmental Change*. Elsevier Ltd, 29, pp. 65–77. doi: 10.1016/j.gloenvcha.2014.08.005.

Dunning, K. H. (2020) 'Building resilience to natural hazards through coastal governance: a case study of Hurricane Harvey recovery in Gulf of Mexico communities', *Ecological Economics*. Elsevier B.V., 176, p. 106759. doi: 10.1016/j.ecolecon.2020.106759.

Fadigas, A. B. M. (2017) 'Vulnerability factors of shellfisherwomen in the face of oil spill events: An analysis of the Prestige case', *International Journal of Disaster Risk Reduction*. Elsevier Ltd, 24, pp. 560–567. doi: 10.1016/j.ijdrr.2017.07.010.

Fukushima Minyu (2019) 'Future of fisheries "unclear": concerns over handling of treated water containing tritium (in Japanese)', *Fukushima Minyu Online Edition*, 7 March. Available at: https://www.minyu-net.com/news/sinsai/serial/08/06/FM20190307-357798.php (Accessed: 6

November 2019).

Fukushima Minyu (2020) '"Depth of rumours, fate of treated water" Release of treated water...fishers bear the risk (in Japanese)', *Fukushima Minyu*, 28 June. Available at: https://www.minyu-net.com/news/sinsai/fuhyo-deep/FM20200628-511438.php (Accessed: 2 July 2020).

Fukushima Prefecture (2019a) *The Sea of Fukushima Will Not Give In*. Available at: https://www.pref.fukushima.lg.jp/site/movie-now-english/ch-e-makenai-umi.html (Accessed: 17 November 2019).

Fukushima Prefecture (2019b) *Water temperature at Matsukawaura (in Japanese)*. Fukushima. Available at: https://www.pref.fukushima.lg.jp/uploaded/attachment/363616.pdf.

Future Earth Coasts (2020) *Our Vision - Future Earth Coasts*. Available at: https://www.futureearthcoasts.org/our-vision/ (Accessed: 14 July 2020).

Gerster, J. (2019) 'Hierarchies of affectedness: Kizuna, perceptions of loss, and social dynamics in post-3.11 Japan', *International Journal of Disaster Risk Reduction*. Elsevier Ltd, 41, p. 101304. doi: 10.1016/j.ijdrr.2019.101304.

Gómez-Baggethun, E. *et al.* (2012) 'Traditional ecological knowledge and community resilience to environmental extremes: A case study in Doñana, SW Spain', *Global Environmental Change*, 22(3), pp. 640–650. doi: 10.1016/j.gloenvcha.2012.02.005.

Hayano, R. *et al.* (2017) *Overview of session and situation in Fukushima. Stakeholder Involvement and the CRPPH: A Learning Process - From Chernobyl to Fukushima. Public dialogue and policy making: The UK's Science-wise programme. Post-Chernobyl experience: Sami reindeer herders in Norway. JAEC's initiative to encourage public understanding in Japan*, *NEA Workshop on Stakeholder Involvement in Nuclear Decision Making*. Vienna. Available at: https://inis.iaea.org/search/searchsinglerecord.aspx?recordsFor=SingleRecord&RN=48099087 (Accessed: 1 July 2020).

Hopkins, C. R., Bailey, D. M. and Potts, T. (2016) 'Perceptions of practitioners: Managing marine protected areas for climate change resilience', *Ocean & Coastal Management*. Elsevier, 128, pp. 18–28. doi: 10.1016/J.OCECOAMAN.2016.04.014.

Iwaki City Fisheries Section (2020) *Iwaki Joban-Mono*. Available at: http://joban-mono.jp/ (Accessed: 10 July 2020).

Iwasaki, K., Sawada, Y. and Aldrich, D. P. (2017) 'Social capital as a shield against anxiety among displaced residents from Fukushima', *Natural Hazards*. Springer Netherlands, 89(1), pp. 405–421. doi: 10.1007/s11069-017-2971-7.

Jigyasu, R. (2014) 'Fostering resilience: towards reducing disaster risks to World Heritage', *World Heritage*, 74, pp. 4–13.

Jobin, P. (2017) '"Nuclear Gypsies" in Fukushima Before and After 3.11', in MacDowell, L. (ed.) *Nuclear Portraits: People, Communities and the Environment*. Toronto: University of Toronto Press, pp. 274–311.

Kahoku Shinpo (2020) 'Trial fisheries' first year-on-year decrease - no sand lance harvest - 10% reduction in 2019 - Fukushima (in Japanese)', *Kahoku Shinpo (Online Edition)*, 24 January. Available at: https://www.kahoku.co.jp/tohokunews/202001/20200124_62021.html (Accessed: 5 July 2020).

Kelman, I. (2015) 'Climate Change and the Sendai Framework for Disaster Risk Reduction', *International Journal of Disaster Risk Science*. Beijing Normal University Press, 6(2), pp. 117–127. doi: 10.1007/s13753-015-0046-5.

Kimura, A. H. (2017) 'Citizen Science in Post-Fukushima Japan: The Gendered Scientization of Radiation Measurement', *Science as Culture*, 18 July, pp. 1–24. doi: 10.1080/09505431.2017.1347154.

Laska, S. (2012) *Dimensions of resiliency: essential resiliency, exceptional recovery and scale*, *Int. J. Critical Infrastructures*.

Mabon, L. (2019) 'Enhancing post-disaster resilience by "building back greener": Evaluating the contribution of nature-based solutions to recovery planning in Futaba County, Fukushima Prefecture, Japan', *Landscape and Urban Planning*. Elsevier B.V., 187, pp. 105–118. doi: 10.1016/j.landurbplan.2019.03.013.

Mabon, L. and Kawabe, M. (2015) 'Fisheries in Iwaki after the Fukushima Dai'ichi Nuclear Accident: Lessons for Coastal Management under Conditions of High Uncertainty?', *Coastal Management*, 43(5). doi: 10.1080/08920753.2015.1051425.

Mainichi Shimbun (2019) ‘Fukushima fishing coop sets haul target for 1st time since 2011 disaster’, *Mainichi Shimbun (Online Edition)*, 11 September. Available at: https://mainichi.jp/english/articles/20190911/p2a/00m/0na/016000c.

Mannakkara, S., Wilkinson, S. and Potangaroa, R. (2014) ‘Build back better: implementation in Victorian bushfire reconstruction’, *Disasters*. Blackwell Publishing Ltd, 38(2), pp. 267–290. doi: 10.1111/disa.12041.

Manyena, B. *et al.* (2011) ‘Disaster resilience: a bounce back or bounce forward ability?’, *Local Environment*. Routledge, 16(5), pp. 417–424. doi: 10.1080/13549839.2011.583049.

Marín, A. *et al.* (2015) ‘Social capital in post-disaster recovery trajectories: Insights from a longitudinal study of tsunami-impacted small-scale fisher organizations in Chile’, *Global Environmental Change*. Elsevier Ltd, 35, pp. 450–462. doi: 10.1016/j.gloenvcha.2015.09.020.

Matin, N., Forrester, J. and Ensor, J. (2018) ‘What is equitable resilience?’, *World Development*. doi: 10.1016/j.worlddev.2018.04.020.

McCurry, J. (2019) ‘Eight years after Fukushima, what has made evacuees come home?’, *Guardian (Online Edition)*, 10 March. Available at: https://www.theguardian.com/world/2019/mar/10/fukushima-eight-years-on-evacuees-come-home (Accessed: 17 November 2019).

McGranahan, G., Balk, D. and Anderson, B. (2007) ‘The rising tide: Assessing the risks of climate change and human settlements in low elevation coastal zones’, *Environment and Urbanization*, 19(1), pp. 17–37. doi: 10.1177/0956247807076960.

McKechnie, R. (1996) ‘Insiders and outsiders? Identifying experts on home ground’, in Irwin, A. and Wynne, B. (eds) *Misunderstanding Science?: The Public Reconstruction of Science and Technology*. Cambridge: Cambridge University Press, pp. 126–151.

Minamisoma City Government (2019) *Situation in Minamisoma City and Activities Towards Development*. Minamisoma City.

Ministry of Economy Trade and Industry (2018) *Demonstration project for floating offshore wind power system on the Fukushima coast: report of general committee (second part) (in Japanese)*. Tokyo.

Oughton, D. H. (2011) ‘Social and ethical issues in environmental risk management’, *Integrated Environmental Assessment and Management*, 7(3), pp. 404–405. doi: 10.1002/ieam.226.

Parks, V. *et al.* (2019) ‘Fishing Households, Social Support, and Depression after the Deepwater Horizon Oil Spill’, *Rural Sociology*. Wiley. doi: 10.1111/ruso.12297.

Pauwelussen, A. (2016) ‘Community as network: exploring a relational approach to social resilience in coastal Indonesia’, *Maritime Studies*. Springer Verlag, 15(1), pp. 1–19. doi: 10.1186/s40152-016-0041-5.

Picou, J. S., Marshall, B. K. and Gill, D. A. (2004) ‘Disaster, Litigation, and the Corrosive Community’, *Social Forces*. Oxford University Press, 82(4), pp. 1493–1522. Available at: http://www.jstor.org/stable/3598443.

Sandholz, S. (2016) ‘Potential for Ecosystem-Based Disaster Risk Reduction and Climate Change Adaptation in the Urban Landscape of Kathmandu Valley, Nepal’, in Renaud, F. et al. (eds) *Ecosystem-Based Disaster Risk Reduction and Adaptation in Practice*. New York: Springer, pp. 335–360.

Simms, J. R. Z. (2017) ‘“Why Would I Live Anyplace Else?”: Resilience, Sense of Place, and Possibilities of Migration in Coastal Louisiana’, *Journal of Coastal Research*. Coastal Education and Research Foundation, 332, pp. 408–420. doi: 10.2112/jcoastres-d-15-00193.1.

Soma-Futaba Fisheries Cooperative (2020a) *Soma-Futaba Fisheries Cooperative*. Available at: https://www.soso-gyokyo.jp/ (Accessed: 10 July 2020).

Soma-Futaba Fisheries Cooperative (2020b) *Ukedo Fishing Port: Notification of Reopening (in Japanese)*. Available at: https://soso-gyokyo.jp/news/827 (Accessed: 14 July 2020).

Soma-Futaba Fisheries Cooperative Association (2018) *The Current Situation of the Soma-Futaba Fisheries Cooperative Association*. Soma City.

Soma City Government (2016) *Soma City Five-Year Record (Digest of Interim Report)*. Soma City. Available at: https://www.city.soma.fukushima.jp/material/files/group/7/64314766.pdf.

Staupe-Delgado, R. (2019) ‘Progress, traditions and future directions in research on disasters involving slow-onset hazards’, *Disaster Prevention and Management: An International Journal*.

Emerald Group Publishing Ltd., pp. 623–635. doi: 10.1108/DPM-11-2018-0358.
Strauss, A. and Corbin, J. (1994) ‘Grounded theory methodology: an overview’, in Denzin, N. K. and Lincoln, Y. S. (eds) *Handbook of qualitative research*. Thousand Oaks, CA: SAGE Publications, pp. 273–285.
Sullivan, J. *et al.* (2019) ‘Implications of the GC-HARMS Fishermen’s Citizen Science Network: Issues Raised, Lessons Learned, and Next Steps for the Network and Citizen Science’, *New Solutions*. SAGE Publications Ltd, 28(4), pp. 570–598. doi: 10.1177/1048291118810871.
Tokyo Electric Power Company (2020) *TEPCO Draft Study Responding to the Subcommittee Report on Handling ALPS Treated Water*. Tokyo.
Tokyo Metropolitan Government (2018) *[Stories of FUKUSHIMA] Independence and Rebirth | Never forget you*. Available at: http://www.soumu.metro.tokyo.jp/17hisaichi/hp/douga/fukushima02.html (Accessed: 17 November 2019).
UNISDR (2015) *Sendai Framework for Disaster Risk Reduction 2015 - 2030*. Geneva.
United Nations (2020) *Oceans – United Nations Sustainable Development*. Available at: https://www.un.org/sustainabledevelopment/oceans/ (Accessed: 14 July 2020).
Vlachopoulou, E. I. and Mizuta, D. D. (2018) ‘Shellfish aquaculture and resilience: Leadership experiences from Kesennuma Bay, Japan’, *Marine Policy*. Elsevier Ltd, 92, pp. 111–119. doi: 10.1016/j.marpol.2018.02.025.
Walker, B. H. (2020) ‘Resilience: what it is and is not’, *Ecology and Society*. Resilience Alliance, pp. 1–3. doi: 10.5751/ES-11647-250211.
Wilson, G. A. (2015) ‘Community resilience and social memory’, *Environmental Values*. White Horse Press, 24(2), pp. 227–257. doi: 10.3197/096327114X13947900182157.
Wisner, B. (2017) ‘“Build back better”? The challenge of Goma and beyond’, *International Journal of Disaster Risk Reduction*. Elsevier Ltd, 26, pp. 101–105. doi: 10.1016/j.ijdrr.2017.09.027.
Wright, G. *et al.* (2016) ‘Establishing a legal research agenda for ocean energy’, *Marine Policy*. Elsevier Ltd, 63, pp. 126–134. doi: 10.1016/j.marpol.2015.09.030.
Yagi, N. (2019) ‘The State of Fisheries and Marine Species in Fukushima: Six Years After the 2011 Disaster’, in *Agricultural Implications of the Fukushima Nuclear Accident (III)*. Springer Singapore, pp. 211–220. doi: 10.1007/978-981-13-3218-0_18.
Yamakawa, M. and Yamamoto, D. (2017) *Rebuilding Fukushima*, *Rebuilding Fukushima*. Edited by M. Yamakawa and D. Yamamoto. London: Routledge.