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ABSTRACT

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Coastal communities 'living at the edge' face intensification and acceleration of coastal hazard risk in the face of climate change. Communities will need to be adaptive in reducing these risks now and over long timeframes. Developing coastal hazard adaptation pathways requires co-production of interdisciplinary knowledge between scientists, policy makers and communities. However, there remains little guidance and limited dialogue about the research practices and frameworks that underpin co-created research. In a first for New Zealand, a co-created research programme is underway titled 'Living at the Edge' that aims to improve the resilience of coastal communities to coastal hazards. This paper provides novel insights into the complexities underpinning the formative stages of co-created research, drawing on practical experience from the Living at the Edge project. We explore the enablers and shapers that led to co-created shifts in the research project objectives and framework. Notions of integration, trust, and flexibility are three fundamental aspects that influenced the early stages of co-creation. The importance of bridging interactions with actors early on in co-created projects is exemplified.

ADDITIONAL INDEX WORDS: *Coastal hazard resilience, co-creation, stakeholder engagement, interdisciplinary research*

INTRODUCTION

Complex socio-environmental issues, such as natural hazard risk and climate change adaptation, comprise multiple interacting dynamics, involving numerous stakeholders, variable impacts and a range of uncertainties. Disentangling such complexities requires integration of science, policy and practice with community, using novel interdisciplinary research approaches. Notions of co-creation (also termed co-production or interdisciplinarity) have been increasingly used in environmental management and climate change research over the past two decades as a novel approach to exploring complex issues (Bremer and Meisch, 2017; Klenk *et al.*, 2015; Thompson *et al.*, 2017). Co-created research is jointly developed and produced amongst actors that have variable knowledge bases, including researchers across academic disciplines, decision-makers, community members and other stakeholders (Mauser *et al.*, 2013). The benefits of co-creation are well-recognized and include an improved understanding of the values and priorities of participants, greater social accountability and improved connections between research and practice (DeLorme *et al.*, 2016; Fazey *et al.*, 2014).

Despite the value of co-creation, funding opportunities for large-scale co-created research projects remain scarce compared to funding for traditional academic research, with evidence of lower success rates for funding of such projects (Bromham, Dinnage and Hua, 2016). However, increasing government investment has been observed, supporting the conditions for co-created research projects in recognition of the wider societal benefits of such approaches and to redress historical funding patterns (Lyall and Fletcher, 2013; Trussell *et al.*, 2017). The projects funded by the New Zealand government as part of the programme of National Science Challenges (MBIE, 2017), which address complex science issues of societal relevance, are illustrative of such commitments, enabling a more conducive environment for co-creation.

While the growth in co-created projects is evident, there remains 'uneven guidance' on approach (Lyall and Fletcher, 2013) and limited dialogue about the research practices and frameworks that underpin co-created research (Thompson *et al.*, 2017). To fill these spaces in practice, an emergent collection of researcher commentaries reflect on project experiences (Bark, Kragt and Robson, 2016; DeLorme, Stephens and Hagen, 2017). More than a record of 'how to', these works contribute a reflective and often personal discussion of the negotiated spaces that

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characterize such projects (Binder, Absenger-Helmli and Schilling, 2015; Trussell *et al.*, 2017). Additional contributions inform practitioner understanding of the complexities of co-created projects, including the characterizations of project stages and processes (Edelenbos, Bressers and Vandenbussche, 2017; Thompson *et al.*, 2017).

It has been argued that integrated co-created research approaches would be valuable for addressing coastal hazard resilience in New Zealand (Bremer and Glavovic, 2013). Traditional coastal risk management approaches in New Zealand are science-driven, protection-focused (Rouse *et al.*, 2016), that use static planning and practice instruments (Lawrence *et al.*, 2015). Such an approach restricts future flexibility under an uncertain climate and rate of sea-level rise (Haasnoot *et al.*, 2013; Lawrence *et al.*, 2014) and ultimately may lock communities into unsustainable pathways that undermine community resilience. Consequently, it has been proposed that a shift is necessary towards an integrated, co-created coastal management approach (Bremer and Glavovic, 2013) in order to overcome existing and entrenched paradigms and appropriately engage local communities in decision-making (Manning *et al.*, 2015; Rouse and Blackett, 2011). However, to date, very few examples of successful community-driven co-created coastal hazard management processes exist in New Zealand (Rouse *et al.*, 2016).

Here, we discuss the formative experiences of a co-created research project in New Zealand that seeks to enhance the resilience of coastal communities to coastal hazards. The research project, titled 'Living at the Edge' (hereafter referred to as the Edge), is the first interdisciplinary research programme in New Zealand to explore flexible, adaptive pathways for building resilience to coastal hazards. This paper aims to provide novel insights into the complexities underpinning the early stages of co-created research, drawing on embedded researcher experience in a real life decision-making process. Specifically, we explore the enablers and shapers that led to co-created shifts in the research project objectives and framework. We then provide a reflective discussion on the notions of integration, trust, and flexibility that emerged as three fundamental aspects underpinning the early stages of co-creation.

BACKGROUND

The Edge research project contributes to a New Zealand government-funded ten-year research initiative, titled Resilience to Nature's Challenges – *Kia manawaroa – Ngā Ākina o Te Ao Tūroa* (RNC). The RNC mission is to enhance New Zealand's resilience to natural hazards through multiple research programmes that explore different domains of natural hazards, including in rural, Māori, urban and coastal (the Edge project) settings (RNC, 2017). Co-created research forms the premise of the RNC (Thompson *et al.*, 2017) and the Edge project, whereby multiple actors (academics, stakeholders and practitioners) are engaged in all stages of the research.

The Edge project was designed in late 2014 through collaborative science-writing workshops involving researchers across two national scientific research institutions and four New Zealand universities. The initial research proposal comprised clear research aims, milestones and attainable and meaningful outcomes; thus successfully meeting traditional research funder requirements. However, the proposal also had an open framework with co-creation embedded in some of the research themes, in order to meet the research team's expectations that the co-created nature of the project could ultimately result in shifts to the detailed research programme with the inclusion of a wider set of stakeholder voices. Such an approach, to allow flexibility, was endorsed by the funding agency to ensure the research could incorporate uncertainties in the co-created research process.

In the formative stages of proposal development the research team engaged with local government stakeholders to explore possible case study regions. As an outcome of this process the case study location (Hawke's Bay) for the Edge programme was identified. Hawke's Bay is located on the east coast of the central North Island, in New Zealand. Hawke's Bay is a national "hot spot" of long-standing community tensions around coastal hazard management, resulting from conflicting perspectives about the active management of coastal erosion between local communities and regulatory authorities (Komar, 2007).

Funding for the research was received from the Ministry of Business, Innovation and Employment (MBIE) in June 2016. This was shortly followed by a seven-month start-up phase (June to December 2016, inclusive) that was central to co-creating the Edge research programme.

To ensure the Edge research was co-created amongst actors, key stakeholders in Hawke's Bay were identified using pre-existing researcher networks and snowball sampling (Sarantakos, 2005). The identified stakeholders were invited to participate in initial discussions about the research project. Initial contact with stakeholders was made through email, preceding face-to-face meetings and subsequent interviews in Hawke's Bay at a time and location convenient to the stakeholder. Interviews were held with a range of coastal communities, local regulatory authorities, and wider stakeholders from key infrastructure and interest groups.

METHODS

To explore how the co-creation process influenced the formative Edge research practices and framework, we completed a document analysis of recorded meeting minutes, project outlines and other internal project documents to trace shifts in both the original research objectives and processes, similar to approaches used by DeLorme *et al.* (2016) and Trussell *et al.* (2017). Furthermore, a comparison of the research project outline before and after the co-created process began was undertaken to document how co-creation transformed the research plan.

RESULTS

A seven-month co-created start up phase characterized the Edge project, which led to the decision to align the Edge project with a pre-existing coastal hazard management initiative in Hawke's Bay. This resulted in shifts in the Edge objective focus and timing of delivery, which furthermore transformed the nature of the Edge research framework.

Negotiating the spaces of engagement

To support the co-created development of the research objectives, the seven-month start up phase of the Edge project was largely characterized by a staged and contingent process of stakeholder engagement. A total of eighteen face to face meetings and eleven interviews were held with key stakeholders in Hawke's Bay between May 24th and December 5th 2016. These

stakeholders included local regulatory agencies, practitioners, local business representatives, community representatives, utility operators, and environmental consultants involved in coastal management in the Hawke's Bay region. Meetings were roughly fortnightly in frequency and typically involved 2–4 researchers and 1–5 stakeholder representatives. Discussions in initial meetings centred around: the aims of the Edge project; the scope of the funded research proposal and room for flexibility within this proposal; the Edge research team capabilities; the most pressing coastal management issues in Hawke's Bay from the stakeholders' perspective; and identification of other important stakeholders. Follow-up meetings with the same stakeholders included discussions around how the Edge project could add value and contribute to existing coastal hazard management initiatives in Hawke's Bay and how potential barriers and problems could be overcome.

These early engagements led to the opportunity and joint decision (between researchers, stakeholders and council consultants) to align the Edge project with a coastal hazards management initiative that was already underway in June 2016: The Clifton to Tangoio Coastal Hazards Strategy 2120 (the Strategy). The Strategy is an initiative designed to address management of long-term (100-year) and evolving coastal hazard risk and is jointly led by Hawke's Bay Regional Council, Hastings District Council and Napier City Council, together with Māori and local community representatives (HBRC, 2017). In a first for New Zealand, the Strategy development is using a novel approach to considering adaptation to the effects of sea-level rise and their influence on coastal hazards, through a cross-council, collaborative process that involves the community in the assessment of adaptation options as part of the decision-making process.

The decision to explore the opportunity for alignment of the two initiatives (the Edge project and the Strategy) was made in late July 2016 for three main reasons. First, the aims of the Strategy and the Edge project were complementary. Second, alignment of the Strategy and Edge project would ensure no unnecessary duplication of coastal hazard work and resources in the Hawke's Bay region. Third, embedding a coastal hazard research project in a practical decision-making process that involves communities would provide a novel case study to explore co-created research practices in a coastal mangement context in New Zealand. Following the decision to align the two initiatives, the stakeholder meetings between August and December 2016 were focused on determining how best to integrate the Edge project with the Strategy, together with the consultants already engaged and underway, who were also part of the co-creation process.

Several key mechanisms were used to formalize relationships with stakeholders in Hawke's Bay. Initially, trust and familiarity were developed through repeated face to face meetings with stakeholders and a core group of four researchers. One of these researchers was identified as a key contact and core facilitator for dialogues between stakeholders and the research group. This process of establishing a dialogue provided opportunities for ideas to be raised and critiqued and a greater shared understanding of the priorities and opportunities emerged. Furthermore, guidelines for engagement and support were negotiated through the development of a memorandum of understanding (MOU) between the Edge research team and the three partner councils involved in the Strategy.

Shifts in the research

As a result of early co-creation and alignment of the Edge with the Strategy (including the consultants), several major changes were made to the initial research proposal regarding the research objectives, timeline and framework (Figure 1).

Research Objectives

The overall intent of the Edge project did not change as a result of stakeholder engagement. The total number of research objectives underlying this broad aim also remained the same pre- and post-engagement. However, the Edge project objectives were re-framed during the start-up engagement phase to ensure the needs of the local community (as defined by the stakeholders) were considered and accommodated. The objectives shifted in their focus and timing of delivery (Figure 1) to embrace stakeholder needs and the tight timeframes for the Strategy process that was already underway. This ensured seamless merging of the Edge project and the Strategy, whilst continuing to address gaps in current knowledge and address the overarching aim of the Edge project. For example, the Edge research team pulled back on determining the existing hazard- and risk-scape as there was already an existing and agreed set of hazard knowledge underpinning the Strategy. Thus, efforts were re-invested to focus on co-creating new coastal science projects to support understanding.

Research Activities and Timeline

The timing of research objective delivery in relation to the broader research project also shifted as a result of co-creation. In the original research proposal, objective delivery was evenly distributed across the research project timeline (Figure 1). The re-developed research timeline reveals that objective delivery became condensed and focused in the earlier stages of the research project (Figure 1).

Three overarching changes to the research framework were identified as a result of co-creating the research (Figure 1). Firstly, phase 1 in the re-developed framework was characterised as 'a co-created start up' and reflects a distinctive phase dedicated to stakeholder engagement and re-designing the research. Secondly, phase 2 in the re-developed framework was re-modelled to represent a combination of phases 1 and 3 in the originally proposed framework. The collective re-development of phase 2 resulted in the research activities that were originally proposed as part of phase 3, to be brought forward in time by 12–18 months, while other research activites were made redundant. These shifts led to the third major change in the research framework, whereby phase 3 in the re-developed framework was created as a novel addition to the research project. Throughout this process of change, new research activities have been shaped to support the refined objectives.

DISCUSSION

Co-created research has the potential to bridge the gap between science, policy, practice and community in building resilience to complex socio-economic issues such as coastal hazard risk (Bremer and Glavovic, 2013; Mauser *et al.*, 2013). Insights from

the formative stages of the interdisciplinary Edge project add to the growing body of knowledge about the practices and frameworks underpinning co-created research based on practical experience. The alignment of the Edge project with the Strategy represents a novel approach to coastal hazard resilience research in New Zealand. Realignment of the Edge research objectives and framework, to fit the compressed Strategy timeframes, not only allowed integration of research and practice efforts in the coastal resilience space in Hawke's Bay, but also provided opportunity and experience to critically explore the practices and frameworks of co-created research in practice. Furthermore, alignment allowed more research emphasis to be placed on engagement and support in developing flexible adaptation pathways under an uncertain future, which has previously been under-represented in such coastal hazard planning.

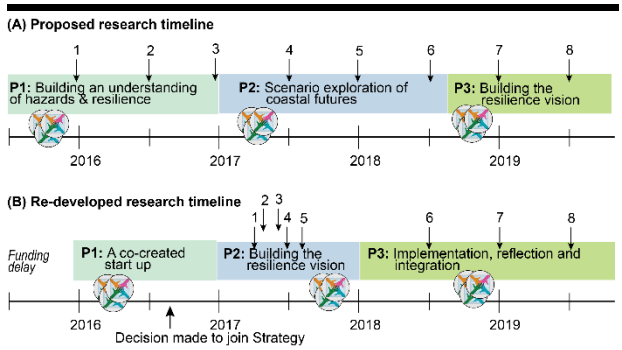

Figure 1 (A) A summary of the initial conceptual Living at the Edge research timeline and framework, which was funded in 2016; (B) A summary of the re-developed Living at the Edge research framework. The new framework in (B) was co-created with stakeholders during Phase 1 (P1). The arrows in (A) and (B) indicate the timing that each numbered research objective commenced.

Building trust with stakeholders and funders

Thompson *et al.* (2017) reveal that from a stakeholder's perspective, effective co-created research should build on existing networks that are often well-established and align with ongoing practical efforts and initiatives. The findings of Thompson *et al.* (2017) are reinforced in practice through the Edge project. Apparent early on was the value of building key contacts and trust relationships between key individuals in the research and stakeholder team, rather than overwhelming the meeting processes with a changing cast of actors. The process of constructing an MOU offered an opportunity to formalize these trust relationships and the interchange of perspectives, to set boundaries, and to test the expectations and understandings of different actors.

Trust equally plays a role between hierarchical networks in the project process. By adopting a research funding model that creates space for co-created research, national funding agencies need to be able to also allow space for these projects to evolve organically and to enable reflexivity between disciplines that enables the knowledge building to be co-created. Such perspectives may be challenging to the current contractual paradigm that places priorities on the achievement of milestones in a time-bounded manner.We argue that the expectation of good governance that is central to a contracting culture is not at odds with the more dynamic nature of co-created research. The essence of risk management, accountability and compliance are arguably strengthened in these projects that engender significant team commitment to the development of trust within networks and accountability to deliver mutually agreed outcomes. As Lyall et al. (2013: 66) reflect, the lifecycle of such projects is non-linear and value emerges from 'tailored catalytic' activities through the life of the project. Such 'catalytic' activities are observable in the progression of the Edge project, including the development of a citizen science project with a local high school.

Building trust within the research team

Edelenbos, Bressers and Vandenbussche (2017) reinforce the importance of frequent and personal interaction to facilitate information exchange across traditional structural boundaries (organizational and disciplinary). The value of face to face communication and the development of personal understandings between Edge team members became important in the start-up phase. Whilst spatially dispersed throughout New Zealand, team members sought to maintain regular video-conferencing updates and face to face meetings within the primary research team and among the wider stakeholder and consultant team.

Flexibility and adaptability

Similarly, notions of flexibility and adaptability were also characteristic of the co-creation experiences in the formative phase of the Edge project. The non-prescriptive nature of the original research proposal was flexible enough to allow for co-creation and adaptation, as evident in the shifts in the research objectives, framework and timeline that resulted from early engagement and dialogues (Figure 1). Indeed, this required flexibility in the researchers themselves in terms of time, availability and methodologies used. This need for flexibility manifested in different practices. For instance, researchers needed to accelerate their thinking around their research questions in order to mesh with the timelines of the Strategy that was already underway. In addition, throughout the co-creation stage, the research team were constantly reflecting on their research practices and what could be changed as the Strategy evolved. Research in action requires flexibility from everyone, including the Strategy stakeholders and consultants.

CONCLUSIONS

Co-created (interdisciplinary) research is a valuable approach to dealing with complex socio-environmental issues, including coastal hazards and risk. Clarity of process that builds trust, reflexivity and commitment can lead to resilient outcomes. This paper presents novel insights from practical experience in a co-created interdisciplinary research project (the Edge) in New Zealand. Befitting the co-created nature of the Edge project, a seven-month start-up phase of stakeholder engagement resulted in alignment of the Edge project with a regional coastal Strategy process (a pre-existing and ongoing collaborative initiative led by local regulatory authorities in Hawke's Bay). The two initiatives seek to build community resilience to coastal hazards and risk, adopting a novel approach to coastal management in New Zealand around community engagement throughout the decision-making process. Embedding the Edge project in the Strategy

resulted in shifts in the Edge research objectives and framework. The notions of trust and flexibility are highlighted as key to integrating co-created research and practice in the context of coastal hazard risk management.

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