Coastal Change in North Norfolk: The Contribution of Visualizations to Decision-Making

Jacqueline Zavala

November 2019

A thesis submitted for the degree of Doctor of Philosophy to the School of Environmental Sciences of the University of East Anglia

Abstract

In the UK, stretches of coasts are under threat from increased coastal flooding and erosion. As a result, the UK has developed programs and policies that allow local authorities to have more oversight on the management of these coasts. However, it has been argued that more integrated management of coastal areas is needed, balancing present and future needs in relation to current and future change. These processes can be aided by the application and use of different tools, such as visualizations, which may facilitate understanding and learning. However, there is a lack of research on the use of visualizations in decision-making processes over continued periods of time. This thesis addresses this gap, and aims to explore the uses and limitations of visualizations in coastal decision-making.

A longitudinal study was conducted in a village on the North Norfolk coast of the UK, where coastal change has been prominent over past decades. Over a two-year period, throughout diverse phases and modes of engagement, participants' perceptions of the physical and social aspects of the village, as well as views of potential futures, were explored and discussed. Visualizations were used to show future changes that participants suggested, and to elicit discussion of these, to explore how the village might face and deal with future changes.

The findings of this thesis indicate that visualizations are useful tools in participatory processes for communicating future changes, and supports the usefulness of a bottom-up approach to creating visualizations and developing future longitudinal coastal management options. Limitations of the methods utilized in this case study include the implications of external variables on responses given by participants (e.g. storm events, local government actions), and technological limitations. This study reflects on potential implications of integrating visualizations in coastal management, including requirements and constraints.

Acknowledgments

This thesis is possible because of a lot of people. First, a big thank you Dr. Irene Lorenzoni, Dr. Andrew Lovett, and Dr. Katy Appleton for your invaluable guidance, advice, and infinite patience. Irene, I appreciated every bit of feedback and your positive guidance throughout the entire process. Andrew and Katy, thank you for always making time to help me when I needed it. Your support is greatly valued. I would also like to thank the University of East Anglia and the Marshall Aid Commemoration Commission for funding this research, and providing me with the opportunity to have life changing experiences in the U.K. I would also like to thank EnvEast Doctoral Training Programme for providing training opportunities throughout my PhD.

A special thank you to all the participants in my study, and the village of Trimingham as a whole for welcoming me and making me feel like part of your wonderful community. Your contributions have been invaluable and this thesis would not be possible without you.

Next, I have to thank the life-long friends (yes, you're stuck with me) I have made these last few years. Alia, thanks for being my first friend at UEA, and for your k-drama recommendations. Charlotte, thank you for thinking about my health by eating my food for me, and for teaching me the difference between *brioche* and cake. I still don't forgive you and Alia for eating my cake though. Netti, thank you for feeding me amazing food (unlike the other two). Gurpreet, we got through it together. Thank you for being my confidante. Ayman, enjoy the night shift without me. Sarah, you're next girl! Cristina, Becci, and Ulysse, I am sure I have annoyed you the most, but you guys have been such a big part of this whole experience that I can spend my entire acknowledgements trying to say everything. I'll just say that I wouldn't trade a night out at the pub with you guys for the world! Thank you to the Marsh-mallows, and especially the 2015 Marshall cohort for generally just being good people. Thanks to my flatmates for the late-night discussions, and friendship. Alice, Chloe, Carver, Zara, Abi, Briggs, Holly, Em, Hana, and Maddie, you are the starting 10 of my heart (I'm number 11) and MOTM for helping me get through this thesis. Extra big shout out to my A&E crew. Let's never do that again please. Thank you to BIGBANG, Elton, Billy, Selena, Epik High, Queen, Vicente, Lin Manuel, and all the artists and podcasts that got me through my long days of work.

"Last, but not least, I want to thank me. I want to thank me for believing in me. I want to thank me for doing all this hard work." Snoop Dogg (2018)

(see next page)

All joking aside, I would like to sincerely thank my family. Mom, thank you for being my biggest cheerleader and hype-woman. Dad, thank you for showing me the value of hard work and respect. Jenny, you continue to be a role-model to me, especially when it comes to being compassionate. Julie, every step I take is to try to be a better role-model for you, and make the road a bit easier for you to travel after me. To all 50+ of my big, extended Mexican family… I am where I am today because of your influence on my life. You are the foundation and support that I can stand on. *Los quiero mucho!*

In loving memory of Guadalupe Z. Rodriguez

April 28, 1938- November 27, 2017

"I can do all this through him who gives me strength." Philippians 4:13

Table of Contents

List of Figures

List of Tables

List of Acronyms

AONB- Area of Outstanding Natural Beauty

BSCI- Brief Sense of Community Index

C2A- Community Awareness to Action

CATPCA- Categorical Principal Component Analysis

CCC- Committee on Climate Change

CZM- Coastal Zone Management

DEFRA- Department for Environment, Food, and Rural Affairs

DTM- Digital Terrain Model

EA- Environment Agency

EEA- European Environment Agency

GIS- Geographic Information System

ICZM- Integrated Coastal Zone Management

MSW- Making Space for Water

NCERM- National Coastal Erosion Risk Map

NEP- New Environmental Paradigm

NNDC- North Norfolk District Council

OS- Ordnance Survey

PAF- Process of Adaptation Framework

PCA- Principal Component Analysis

PGIS- Participatory Geographic Information System

SMP- Shoreline Management Plan

SOC- Sense of Community

SSSI- Site of Special Scientific Interest

UK- United Kingdom

VNS- Visual Nature Studio

Chapter 1 | Introduction

1.1 Introduction and rationale

It is estimated that 41% of the population in Europe lives in coastal zones (European Environment Agency, 2019). Climate change, growing populations, differing views and values, differing landscapes, and lack of available resources create challenges for managing coasts at European and national levels (Environment Agency, 2018; Kovats *et al.*, 2014; IPCC, 2014a; Schmidt *et al.*, 2013). The European Environment Agency (EEA) and the Intergovernmental Panel on Climate Change (IPCC) state that climate change will likely lead to increased risk to biodiversity and coastal populations in Europe (Reker *et al.*, 2017; Kovats *et al.*, 2014), and that managing changing coasts requires strategies that account for social needs in relation to coastal processes (IPCC, 2014a; IPCC, 2014b). Thus, it has been argued that a more sustainable management of coasts requires the consideration of social, economic and environmental factors. Bringing these together in decision-making, in the context of long-term changes in the climate, makes the management of coasts challenging (Kovats *et al.*, 2014; Milligan *et al.*, 2009; Smit and Pilifosova, 2003). In Europe and the UK, there have been a range of projects and planning attempts to engage and involve publics in decision-making processes around coastal management, in order to enable these processes to at least consider their views and needs, as well as become more responsive to these, and potentially aid in the implementation of solutions to issues that arise during these processes (e.g. Kelly and Kelly, 2019; Schmidt *et al.*, 2013; Few *et al.*, 2007; O'Riordan *et al.*, 1993). For example, Coastal Zone Management (CZM) relates to decision-making processes concerning resources within coastal zones, and has been used in coastal decision-making since the 1970's (Birch and Reyes, 2018). Government in the UK has encouraged the involvement of communities and local authorities in CZM for over two decades (Edwards *et al.*, 1997), resulting in a variety of outcomes, which research has attempted to examine and better understand (Kelly and Kelly, 2019; Flinders *et al.*, 2016). Subsequently there was a shift towards making coastal management more inclusive of public participation (Brown *et al.*, 2006; Fenn *et al.*, 2015, Environment Agency, 2018).

One example of attempting to widen participation in coastal management is the second revision of the Shoreline Management Plans (SMP) around 2010. The SMPs are non-statutory documents, meant to give communities an understanding of how, if, and why different forms of intervention in coastal management may occur over different timescales in the future, and to assist decision-makers to manage coasts in England, and outlines varied,

non-prescriptive, management options (Environment Agency, 2012). However, communities have voiced their concern at being only marginally, or not at all included in discussions around such options, or that the options in the SMPs did not reflect their views and concerns. Several communities did not agree with the forms of management proposed in the SMPs at a variety of geographical levels. Recently there has been an attempt to learn from such experiences by applying a more integrated approach to coastal management, enabling communities to express their views, led by the Environment Agency in reviewing the current SMPs (Environment Agency, 2018). It has been argued that these types of participatory process could make individuals more likely to accept a decision if they have greater input into decision-making processes and these reflect their views (Milligan *et al.*, 2009, Muro, 2012; Blunkell, 2016). It has been acknowledged that aspects which affect, emerge from, and influence involvement in coastal management include individual feelings and perceptions about coastal change, past experiences, place attachment, and knowledge (Kelly and Kelly, 2019). However, there are few examples in the literature of ways to implement successful participatory processes for decision-making around coastal zones (Schmidt *et al.*, 2013). This awareness forms the basis of the ongoing project 'Working Together to Adapt to a Changing Climate: Flood and Coast' (2018-2020) led by various UK agencies to engage communities in climate adaptation planning (Kelly and Kelly, 2019).

By including communities in decision-making processes, local knowledge, as well as values, preferences and views of communities can be considered, if the process is designed and implemented to do so (Few *et al.*, 2007). How people perceive coasts and how they may be supported in making decisions pertaining to their management has evolved recently, and continues to be studied from a variety of perspectives, which are progressively being integrated. For example, the Tyndall Coastal Simulator has been developed to aid management of the coast by improving the understanding of coastal processes in the UK (Dawson *et al.*, 2015; Mokrech *et al.*, 2011). Research has continued to study the uses and implications of the Tyndall Coastal Simulator through the engagement of stakeholders, which contributed to its development. Although studies have highlighted the contribution of engagement to developing tools for improved coastal management in the UK, and the benefits of this engagement (Mokrech *et al.*, 2015; Nichols *et al.*, 2015), Nichols *et al.* (2015) also mention some constraints in using the coastal simulator – similar to those identified by other studies on engaging publics in decision-making in the UK. The acquisition or lack of available resources is commonly cited as a potential constraint to enabling engagement (e.g. Jude *et al.*, 2007; Nichols *et al.*, 2015; Harwood *et al.*, 2015). Management of expectations,

understanding the sensitivities of the context and of those participating in the process, and the utilization of different forms of engagement are considerations discussed in relation to integrated management approaches that could act as a barriers or constraints during the processes (e.g. Milligan *et al.*, 2009; O'Neill and Nicholson-Cole, 2009). Given these challenges and the importance of an integrated approach to coastal management, Schmidt *et al.* (2013) suggests a need for national scale approach to engaging publics with an aim of establishing adaptive approaches to coastal management. However, it has also been recognised that no one process of engagement will be applicable and appropriate in all situations; the literature reflects this through the use of a variety of methods and tools to engage publics in decision-making (e.g. O'Riordan *et al.*, 2014; Moser and Ekstrom, 2010; Schmidt *et al.*, 2013). The literature also identifies the need for further research on specific barriers to adaptation to evolving circumstances, and in light of future change, to better understand local contexts, and how these barriers can change over time (Ekstrom and Moser, 2014).

Addressing the need for approaches that can engage publics has been one of the goals of using visualizations in decision-making. Visualizations have been integrated into decision-making as a tool to aid learning and understanding (O'Riordan *et al.* 1993; Wissen *et al.*, 2008; Lieske *et al.*, 2009; Lewis, 2012). Similarly to the field of management and participation, there have been shifts in the field of landscape visualizations towards including more non-experts in decision-making processes through the use of visualizations (e.g. O'Riordan *et al.*, 2014). The use of visualizations can act as a catalyst for discussions among publics of sensitive changes occurring to landscapes (e.g. Wissen *et al.*, 2008; Bishop *et al.*, 2013; Lewis, 2012).

Recent research in landscape visualizations has utilized a variety of tools to present or enhance user experiences with visualizations (e.g. Wissen *et al.*, 2018 and Orland *et al.*, 2018). Despite the benefits to using visualizations in decision-making processes, there are still considerations when creating visualizations. Similarly to the observation above around participatory processes, a message or visualization will need to be tailored for the specific situation, context, and group it is used with (Appleton *et al.*, 2002; Nicholson-Cole, 2005). Therefore, it has been recommended that visualizations be tailored for a specific audience, with caution to limit potential biases of their creators (Gill *et al.*, 2013; Nicholson-Cole, 2005; Lewis, 2012). This tailoring of visualizations involves considering which type(s) of visualizations (e.g. 2D images, videos, 3D images, etc.) are appropriate to communicate with the desired audience. There are also resource considerations such as the cost of hardware

and software, and data availability to create visualizations. For example, in the UK studies have modelled coastal movement to a certain extent (e.g. Tyndall Coastal Simulator, Jude *et al.*, 2015; Day *et al.*, 2015); however, there are still complications with modelling cliff movement in places in the UK that have complex geology (Lopez De San Roman Blanco *et al.*, 2019). Thus, visualizations may become misleading or data may not be available because of the complexity of modelling certain stretches of coast accurately. In order to try and limit this, individuals can be involved in the co-creation and modification of visualizations in a variety of ways including the use of different platforms and technology, and interviews (e.g. O'Riordan *et al.*, 1993; Lovett *et al.*, 2015). Along with these considerations, the literature has aimed to evaluate the effectiveness of visualizations (e.g. Bishop *et al.*, 2013). However, there has not been an accepted prescribed use of specific criteria for doing so, and the definitions of criteria vary e.g. Knight (2001) and Sheppard (2012). These elements can make the evaluation of criteria less consistent across studies.

Using iterative and longitudinal methodologies can aid in the co-creation of visualizations and the engagement of publics in the process of deciding on future actions taken to change landscapes (Ellis and Dix, 2006; Burgess and Chilvers, 2006; Bishop *et al.*, 2013). Burgess and Chilvers (2006) state that iterative studies are useful in a process that evolves over time. Similarly, Ellis and Dix (2006) also commend the use of an iterative process; however, they caution that this approach requires participants who are willing to take part regularly. Longitudinal studies are uncommon because of time, availability and resource costs associated with engaging with individuals over a long period of time (Bryman, 2016); nonetheless, longitudinal studies have been proposed as opportunities for observing and studying changes over time – for example, perceptions of visualizations (Bishop *et al.*, 2013), social change (Bryman, 2016; Capstick *et al.*, 2015) in relation to changing individual circumstances, and social contexts. Longitudinal studies could allow for barriers to decision-making and future change, as well as the opportunities to overcome these barriers, to be identified through participatory processes (Moser and Ekstrom, 2010). However, there are few such studies, especially including publics and various stakeholders (Ekstrom and Moser, 2014). Despite calls in the engagement and landscape visualization literature (e.g. Burgess and Chilvers, 2006; Bishop *et al.*, 2012; Capstick *et al.*, 2015; Schroth *et al.*, 2015), few studies combine iterative and longitudinal designs for engaging publics in the creation of visualizations for decision-making purposes, e.g. O'Riordan *et al.*, 1993 and Bishop *et al.*, 2013.

1.2 Research aims, objectives and thesis structure

The aim of this thesis is to understand the roles of visualizations in participatory decision-making processes during a longitudinal study. In order to achieve this aim, the main research objectives of this thesis are to:

i. Understand how individuals experience coastal change and how they view the future of where they live and why;
ii. Explore the role of visualizations in decision-making about future physical and social landscapes, using a specific longitudinal case study;
iii. Explore the effects and implications of a longitudinal study;
iv. Understand the lessons and implications of integrating visualizations in decision-making processes.

The first objective aims to address the gap in the literature pertaining to the understanding of how experience with coastal change and other factors contribute to perceptions of the future. The second objective explores the potential of use of visualizations in a participatory longitudinal process which has rarely been attempted before. The third objective examines the potential benefits and constraints – in relation to the literature- of utilizing a longitudinal study. The fourth objective aims to address the limited understanding pertaining to how visualizations can be used in decision-making processes that engage publics from the creation of visualizations through to their evaluation. The structure of this thesis follows the logical order provided by these objectives.

Following this introduction, the second chapter reviews the literature from various fields including landscape visualization, decision-making, and engagement. This literature forms the research background for this thesis, which builds on the literature pertaining to good governance and coastal management, combining it with processes of creating and evaluating visualizations, to understand the role of visualizations in a longitudinal participatory process.

Chapter 3[1] provides detail on the case study site, and discusses the research design. This thesis focuses on the village of Trimingham located on the North Norfolk coast. This chapter

[1]A paper was published based on the methodology and preliminary findings of this research in the *Journal of Digital Landscape Architecture*, 3-2018. Dr. Irene Lorenzoni, Dr. Andrew Lovett, and Dr. Katy Appleton appear as co-authors on this paper through their supervisory support and feedback.
The reference for this paper is: Zavala, J., Lorenzoni, I., Lovett, A., & Appleton, K. (2018). Community-led Coastal Planning: The Contribution of Visualizations to Decision-making. *Journal of Digital Landscape Architecture*, 3-2018, p. 12-22.

delves into the history of erosion in the area and the policies that affect change in the village. In order to explore the research objectives, this research utilizes a mixed methods approach.

Chapter 4 is the first empirical chapter, which analyses the findings relating to the first research objective. In this chapter, the exploratory interviews, focus groups, village questionnaire, and workshops are analysed in order to understand participants' perceptions of their village and future change. Barriers to the decision-making process are identified, analysed, and discussed.

Chapter 5 discusses findings related to the second research objective, i.e. the use of visualizations. This chapter analyses the workshop, exhibition, and final interview responses pertaining to the use of visualizations. This is in order to analyse the effectiveness of visualizations used during this study, suggest improvements to the visualizations, and understand future uses of the co-developed visualizations as suggested by participants.

The final empirical chapter is Chapter 6, which analyses the findings of this study as they relate to the third research objective. This chapter uses the surveys from the workshops and exhibition to create typologies of potential individuals and barriers that those wishing to engage communities may encounter during integrated planning and management processes. The final interviews are analysed in order to understand ways that the research design used in this study can be improved.

Chapter 7 concludes this thesis with a discussion of the main findings and implications of this research, and future work is recommended, addressing the fourth research objective. The findings are related back to the literature and contributions to the wider body of literature are discussed.

Chapter 2 | Public participation in coastal zone management and the contribution of visualizations to decision-making

"No-one knows for sure just what kind of society will be most appropriate for such a [sustainable] future: the bland assumption is that many different features of social organization are called for, so that there can be no single blueprint or template of a sustainable society." (O'Riordan et al., 1993, p. 124)

2.1 Introduction

It is estimated that 206 million people live within Europe's 68,000 km of geologically diverse coastal regions (European Environment Agency, 2019). Coasts are dynamic and have been valued by humans from immemorial times for the access they provide to natural resources, trading, and mobility opportunities (Liquete *et al.*, 2013; Lam *et al.*, 2016). These are likely to be affected in the future by changes to sea levels and storminess as well as human development of coasts (Kovats *et al.*, 2014), with profound implications for the livelihoods and wellbeing of coastal inhabitants and many others. This has been recognised over many decades of attempts at creating improved frameworks, tools and blueprints for coastal management and governance. However, some significant challenges continue to persist due to the mutable features of coasts, their multiple uses and their change over time (Dawson *et al.*, 2015).

As O'Riordan *et al.* (1993) noted over two decades ago, it is difficult to predict the form that future sustainable societies will take because of the varied and changeable contribution and influence of individuals (e.g. level of awareness and understanding, perceptions of futures, priorities etc.) and institutions into their development. The quote at the beginning of this chapter denotes how researchers have sought to understand the process of involving publics in creating a sustainable society using visualizations for over 25 years. O'Riordan *et al.* (1993) describe the implications of visualizations, i.e. drawings and paintings, in decisions about future landscape change. O'Riordan *et al.* (1993) emphasise the importance of coordination among government agencies responsible for management by stating that the "true success" (p.144) of research is measured by the implementation of the ideas of the research by planners and managers, and whether priorities of publics can be linked to the policies delivered. The study showed that participants had an interest in looking at future landscapes and that visualizations could help with stimulating participation. Since then, other bodies of work, visualizing a variety of future landscapes, have continued to explore the

implications of visualizations for the purpose of decision-making and communication. This leads to the question: how much has changed in the last quarter of a century?

This chapter reviews key considerations of coastal governance and management, including engaging stakeholders and publics in decision-making, as well as tools and processes that could contribute to doing so. In reviewing the literature on decision-making and visualizations, this chapter aims to show the complexity of these topics, while also discussing crosscutting concepts and how they have been applied in different contexts. This chapter begins with a review of coastal change and its implications in a UK context. Section 2.3 discusses the barriers that can hinder planning and decision-making processes, and emerging opportunities. Subsequently, Section 2.4 introduces types of visualizations and their purpose, debates on what constitutes an effective visualization, and the limitations of visualizations. Finally, Section 2.5 outlines the goals of this research.

2.2 Management of changing coasts

The diversity of coasts at varying scales creates a complex situation that contributes to difficulties in the implementation of management strategies, and raises concerns around access to resources necessary for adaptation within coastal communities at risk of climate change and extreme weather events in European regions (Kovats *et al.*, 2014; Smit and Pilifosova, 2003). There are an assortment of coastal management strategies that have been implemented or piloted to address the economic, social, and environmental considerations of coastal change, including both government and research led initiatives. This section reviews and examines coastal management strategies, including those implemented in the UK, in order to understand how these management strategies have evolved, which are discussed in greater detail in Section 2.3.

2.2.1 Adaptation as a strategy for coastal management

Coastal managers face the challenge of working with social, ecological, and geological variations and addressing the social, ecological, and economic needs of people in diverse localities. As the quote at the top of the chapter states, "… there can be no single blueprint or template of a sustainable society." (O'Riordan *et al.*, 1993, p. 124). Managing coastal change requires strategies that take into account coastal processes and societal needs; these can include adaptation, mitigation, and no action (Environment Agency, 2012; IPCC, 2014a; IPCC, 2014b). Adaptation has been defined in multiple ways. Nelson *et al.* (2007) define adaptation as "the decision-making process and the set of actions undertaken to maintain the

capacity to deal with current or future predicted change." (p.396) The authors further state that adaptation is a continuous development "…of activities, actions, decisions, and attitudes that inform decisions about all aspects of life and that reflect existing social norms and processes." (p.397). For the purposes of this thesis, adaptation is defined, following the use of the term by Nelson *et al.* (2007) in the context of environmental change, as actions by social actors to modify the social, ecological, and economic spheres in response to actual or expected changes in the environment. This definition encompasses the salient points from different definitions of adaptation in various contexts (e.g. Environment Agency, 2012 and Aytur *et al.*, 2015). Adaptation is complex and involves various different actors and institutions (Adger *et al.*, 2009), which adds to the existing complexity of managing coastal systems and uncertain future changes. The implementation of integrated management approaches has become a recent focus in attempts to manage this complexity of changing coasts (Committee on Climate Change, 2018; DEFRA, 2005; European Environment Agency, 2006).

Among the various approaches to aiming to satisfy the considerations of coastal management is Integrated Coastal Zone Management (ICZM). Drawing upon this ICZM literature, integrated is defined and used in this thesis as the inclusion of publics in research, planning, management, and educational components of decision-making. Furthermore, the literature that reviews ICZM refers to sustainable development and sustainable management as means to achieve sustainability, which this thesis therefore also adopts. Sustainable development is a dynamic process, and the pursuit of sustainable development is sensitive across time and place. It aims to "…reconcile the ecological, economic and social dimensions of life." (Baker, 2016, p. 9) Sorensen (1997) describes pilot studies examining the application of ICZM as a means to achieve successful sustainable development, and how successful ICZM programs could be designed and implemented for various geographic locations. These case studies showed that governments were willing to fund ICZM programs resulting in various ICZM programs across different countries. However, ICZM has come under scrutiny. Although it advocates "adequate and timely participation by local populations and stakeholders" (Haines-Young and Potschin, 2011, p.15), and the reduction of human associated and natural risks to the coastal systems, the processes and outcomes of ICZM have been critiqued. Billè (2008) criticizes the emphasis on consultation and consensus building in ICZM processes, which the author feels the true implications (or lack thereof) are overlooked and whose issues are oversimplified. The author cautions against the illusion of impacts of simply consulting and holding discussions with local communities, i.e. lower

levels of governance, and the importance of a single coastal manager within current ICZM processes (Billè, 2008). However, a lack of good communication continues to be included among the problems with good governance and coastal management (Shipman and Stojanovic, 2007). Milligan *et al.* (2009) and Shipman and Stojanovic (2007) also indicate some scepticism as to the pace at which ICZM can be successfully implemented because of a lack of coordinated governance. Similarly, the European Environment Agency (EEA) refer to the example of the Spanish government utilizing ICZM in their coastal management plans, but mentioned that there was limited applicability because they did not identify an appropriate way for ICZM to be implemented (European Environment Agency, 2006). In the UK, the Committee on Climate Change (CCC) (2018) also stated that "Coastal communities need to be engaged to plan for their future over several decades, but the capacity and political will to do so does not currently exist." (p.9) Some further issues relating to the difficulties in evaluating ICZM include the time it takes for ICZM implementation effects to emerge, assessing the causation of outcomes, and demonstrating behavioural change (Haines-Young and Potschin, 2011; Sorensen, 1997). Longitudinal studies have been suggested as a way to assess and evaluate perceptual and behavioural change during decision-making processes, (Schroth *et al.*, 2015; Bishop *et al.*, 2013), and, particularly, for measuring ICZM progress (Pickaver *et al.*, 2004). However, this is partially disputed as what occurs in actuality by Shipman and Stojanovic (2007) as they discuss the differences in how ICZM is viewed, i.e. a process vs a project, and identified barriers such as funding and limited timeframes. The authors also noted how there was a shift from the European level to encouraging national levels to implement ICZM strategies. Many ICZM success stories can be considered anecdotal, without systems in place for measuring outcomes or changes (Sorensen, 1997). These criticisms indicate that there is still a need for further studies on successful applications of coastal management approaches and their evaluation (Haines-Young and Potschin, 2011).

More recently, adaptive governance has been considered as a more flexible and encompassing approach to coastal management. It builds on ICZM in terms of importance of integrating knowledge about the coast into its management. Although descriptions of adaptive governance vary slightly in the literature, it is generally accepted that adaptive governance is a flexible process of learning, understanding, and reviewing. It is built on the premise of collaboration among government and non-government actors in order to decide and coordinate the management of coastal systems. This also includes the management of risk and uncertainties (Schmidt *et al.*, 2013, Shultz *et al.*, 2015). Adaptive coastal governance

is similar to ICZM because both support the inclusion of the participatory processes, support by governing bodies, and understanding and use of locally-specific information and knowledge (Haines-Young and Potschin, 2011; Schmidt *et al.*, 2013; European Environment Agency, 2006). There is also an understanding within these literatures that there needs be more work done to improve coordination between different stakeholders and organizations, within and between various levels (i.e. national and local) (Schultz *et al.*, 2014; Schmidt *et al.*, 2013). Even so, these two approaches differ in that adaptive coastal governance is a system of governing that puts more of an emphasis in the engagement of multiple stakeholders and publics (Schmidt *et al.*, 2013), while ICZM is a system of management that gives greater importance to the roles of governing bodies, and top-down coordination, in its processes. Schmidt *et al.* (2013) propose that key characteristics of adaptive coastal governance (which can be evaluated) include: credibility of science, improved clarity of policy and creation of strong political will, clear goals, educational programs, and social trust and justice fostered by the adaptive coastal governance process (Schmidt *et al.*, 2013).

Based on these characteristics of adaptive governance, Schmidt *et al.* (2013) argue that the Netherlands' proactive coastal management policy is the most developed attempt to date to manage the coast in a holistic way, i.e. reorganization of planning, compensatory, participatory, and coherent and integrated financing for coastal management. Schmidt *et al.* (2013) refer to the Dutch government's process of scaling management down from a national scale (e.g. giving permissive powers to local governments) and the inclusion of different stakeholders for a more participatory approach as examples of how this approach differs from other European coastal management circumstances. They highlight how the Dutch case study is built on the importance of coordinating national and local governments, and addressing the balance between local needs and national expectations. In contrast, their assessment of Portuguese coastal management indicates difficulties in coordinating national and local efforts with an interest in coastal management, and does not find comparable evidence to the Dutch case study of the inclusion of various stakeholders. O'Riordan *et al.* (2014) found in a comparison of case studies in the UK and Portugal that neither of these countries had met the conditions for successful coastal adaptation governance. Regarding England specifically, O'Riordan *et al.* (2014) maintained that the lack of capacity to model coastal changes and risks were hindering the establishment of trust; that there was a lack of participatory planning, and a disconnect between "policy coordination and delivery." (p. 628). These European case studies highlight differences in respective governments' approaches to management of changing coasts (O' Riordan *et al.*, 2014; Rocle and Salles,

2018). Expanding on this, Schultz *et al.* (2014) conducted case studies outside of the European context and found that coordination of government and non-government actors were a necessary component in successfully implementing adaptive governance, and that cases studies on adaptive governance were generally in high-income democracies that have already shown interest in bottom-up approaches to management.

Therefore, how can adaptive coastal governance be implemented? There are various examples in the literature of approaches and frameworks which focus on enabling involvement of publics in a holistic coastal management approach and in moving towards management solutions (Renn, 2008; Ekstrom and Moser, 2013; Moser and Ekstrom, 2010; Schmidt *et al.*, 2013). Here, three are outlined, which focus on management in three different contexts and have three different aims. These three were chosen as indicators for different management contexts, adaptation processes and risk management, and because they showed similar sequences of facilitating decision-making that could be useful processes in creating an evaluative and longitudinal methodology for this research (see Chapter 3). Firstly, Schmidt *et al.* (2013) note four stages of their "framework for progressive adaptive coastal governance" (p.315), which includes recognition of risk, critical analysis, strategic intervention, and proactive preparedness. This framework primarily focuses on systems of governing and aims to progress the process of adaptive coastal governance. With this framework the authors review and evaluate adaptive governance in the English, Portuguese, and Dutch case studies, described in the previous paragraph, and aided in the identification of barriers to inclusive adaptive governance. The authors found that aspects of strategic intervention, in the English and Dutch case studies, while the Portuguese case study was seen to be disjointed in the stage of strategic intervention. The second management strategy is described by Renn (2008), and aims to avoid, or reduce risk. The general components to risk management include option generation, option assessment, option evaluation and selection, option implementation, and monitoring and feedback (see chapter 3 for an example of how this can be implemented). These components were adapted from the International Risk Governance Council's white paper on risk governance (2005, p. 44). Renn (2008) describes this process of risk management as iterative and nonlinear. The author also suggests that the components may be undertaken in different sequences to suit the situations it is used in. There are indicators for each component that aid in the evaluation of each component as it relates to managing risk (Renn, 2008). There has not been an explicit mention of how these components have been used in the body of literature on risk management. However, the components are based on the basic decision theory model, and,

because of the similarities with the other two examples of management processes used in this section, and because of the context in which this research will take place, was still included in the discussion on management processes. Thirdly, Moser and Ekstrom (2010) developed a diagnostic adaptation process framework in the context of climate change, aimed at identifying opportunities and barriers to adaptation. Nine individual nonlinear sub-processes (Table 2.1) are identified. The authors refer to this framework in various ways across publications, i.e. Moser and Ekstrom (2010), Ekstrom, Moser, and Torn (2011) and Ekstrom and Moser (2014). This thesis will refer to this framework as the Process of Adaptation Framework (PAF), grouped into main phases of Understanding, Planning, and Managing. This framework was used in five case studies in the San Francisco Bay area and consisted of interviews with "key informants" (p. 178), which were primarily composed of individuals within governing institutions (Ekstrom and Moser, 2014). With the use of this framework, the authors were able to identify barriers to adaptation, sources of barriers, and strategies used to overcome these barriers. This framework was shown to be a useful tool in understanding barriers and identifying ways to overcome them (Ekstrom and Moser, 2014).

Although these three processes and frameworks were developed and utilized under different contexts, there are several similarities of the goals of several stages. Table 2.1 shows the stages of the Process of Adaptation Framework (Moser and Ekstrom, 2010), Progressive Adaptive Coastal Governance framework (Schmidt *et al.*, 2013), and the general components of risk management (Renn, 2008) and how the stages of each approach are generally related. All of these approaches to management have sections that include an assessment of the available options and a stage where changes are made to the current system of management, e.g. Implement options, Option implementation, and Proactive preparedness; however, implementation of a specific desired option is not explicitly mentioned for the Progressive Adaptive Coastal Governance framework. The Process of Adaptation Framework and the Progressive Adaptive Coastal Governance framework both include stages that aim to raise awareness of the problem, and gather information about the problem. There are stages that are specific to the individual frameworks, and these discrepancies make it so that these frameworks and processes cannot be directly compared. However, there seems to be components that are generally recommended in a management strategy where options are generated, assessed, selected, and evaluated, regardless of context. The frameworks by Renn (2008) and Moser and Ekstrom (2010) also both include stages where the implemented option would be monitored. These three examples of management processes can be used by coastal managers when attempting more integrated

approaches by allowing facilitators of decision-making processes to understand the components that are cross-cutting, as well as aim to include aspects of one or more of these processes when tailoring the decision-making process to the location and publics which are being managed.

Table 2.1: Stages of frameworks by Moser and Ekstrom (2010), Schmidt *et al.* (2013), and Renn (2008).

Process of Adaptation Framework ***Moser and Ekstrom (2010)***	**General Components of Risk Management** ***Renn (2008)***	**Progressive Adaptive Coastal Governance Framework** ***Schmidt et al. (2013)***
Detect the problem		Recognition of risk
Gather/ Use information		Critical Analysis
Define the problem		Strategic Intervention
Develop options	Option generation	
Assess options	Option assessment	
Select options	Option evaluation and selection	
Implement options	Option implementation	
Monitor option and environment	Monitoring and feedback	Proactive preparedness
Evaluate		

Recent studies and assessments concerning management, such as the ones described by Schmidt *et al.* (2013) and Moser an Ekstrom (2010); as well as, O'Riordan *et al.* (2014), and the European Environment Agency (European Environment Agency, 2006) discussed previously, are indicative of the shift in management practices towards greater inclusivity of stakeholders, i.e. "A person or organization with an interest in, or affected by, the policies produced" (DEFRA, 2005, p. 45), in more localised management and engagement strategies (O' Riordan *et al.*, 2014; Rocle and Salles, 2018; Schmidt *et al.*, 2013). The next subsection discusses management of coastal zones in the UK and England.

2.2.2 Management of changing coasts in the UK and England

For centuries, people have been drawn to living along the coasts of the UK because of the economic, scenic, and health benefits they afford. However, there are also risks associated with living and working on the coast, including flooding in low-lying areas, as well as erosion, with impacts on property, infrastructure, livelihoods and natural habitats (Fontaine, 2015; Committee on Climate Change, 2018). The UK has one of the longest coasts in Europe and around half a million people are employed in maritime activities, including tourism (Lowe *et al.*, 2009). The UK has historically developed policy on coastal management in

response to coastal change. In Victorian times, the UK saw large expansions of seaside resorts (Walton, 2011), resulting later in increased risks to these new settlements, such as Sheringham located on the Norfolk coast. The Coastal Protection Act of 1939 legislated there could be no excavation or removal of material from the seashore. In the same year the UK was thrust into World War 2; public policy on coastal management resumed with the Coastal Protection Act of 1949, where the responsibilities and authority of lower levels of government pertaining to coastal protections were outlined. Prior to this local councils and districts needed permission from Parliament in order to make changes to coastal protection (Coastal Protection Act, 1949; Sheringham Beeston Protection Act, 1898). English law indicates that the responsibility of coastal protection falls on the property owner (POST, 2009). Smaller amendments to the Coastal Protection Act have since followed up until the present day. Figure 2.1 is a timeline containing relevant policies that have had an effect on coastal management in England. The timeline shows how coastal management has changed in recent years to include greater permissive powers to local authorities and government agencies. Coastal management in the UK, and in England specifically, has been revised in response to major events, such as the 1953 storm surge, which resulted in the loss of 307 lives, and more recently the storm surge in 2013. In comparison to the 1953 storm surge, the storm surge in 2013 was not as costly in terms of loss of life (Cawley and Daniel, 2013); early warning systems, coastal protection and improved management practices likely contributed to this (Spencer *et al.*, 2014).

Over the past decade, policy on coastal management in England has increasingly recognised the importance of 'working with nature', that is, enabling natural processes to take place and enhancing the protection they provide over large areas and over time, whilst enabling coastal communities to manage changes that may result from not maintaining hard coastal infrastructure where not economic to do so. For example, models have shown that allowing cliffs to naturally erode, instead of maintaining them, usually leads to sediment deposition downstream, benefitting flood-prone areas down current through risk-reduction (Hall, 2015). However, this has proven controversial with local communities, who have objected – sometimes quite vociferously – to decisions for radical coastal management (see discussion of SMPs below).

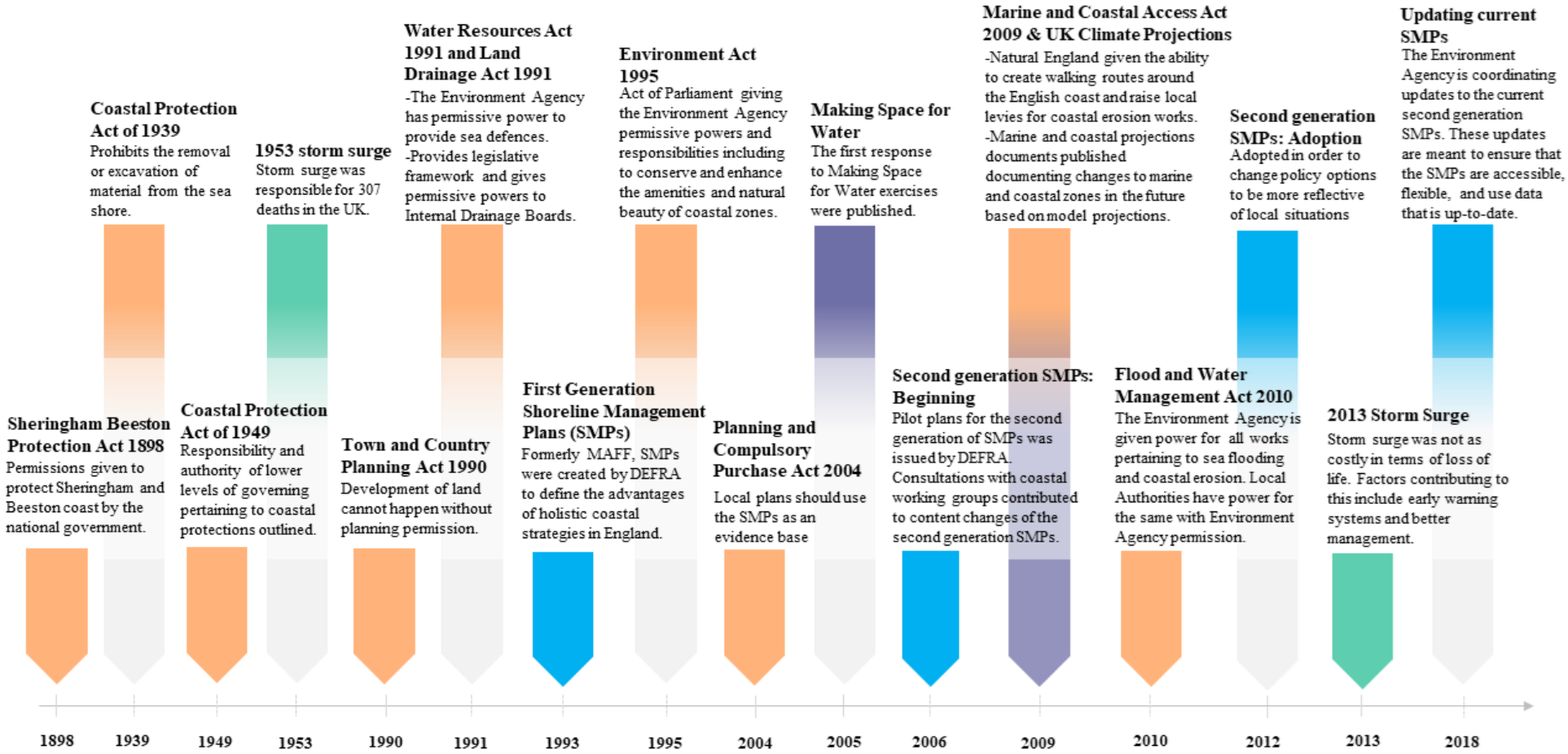


Figure 2.1: Timeline of events and policies that are pertinent to present coastal zone management practices in England. Adapted from Hines, 2010; Sheringham Beeston Protection Act, 1898, Coastal Protection Act, 1949; DEFRA, 2005; SMP, 2012; Milligan and O'Riordan, 2007; Environment Agency, 2018; and Cawley and Daniel, 2013. Orange colouring indicates acts of Parliament, green indicates weather events, blue indicates SMP events, and purple indicates programmes and tools developed by an organization. Timeline is not to scale.

Making Space for Water (MSW) for example was an initiative by the Department for Environment, Food and Rural Affairs (DEFRA), and a current grant option through Natural England aiming to approach the management of coastal erosion and flooding in a holistic way (DEFRA, 2005; Milligan *et al.*, 2009; Natural England, 2018); their goals resonate with the core ideas of ICZM and adaptive coastal management. MSW's adaptation tool kit was used by DEFRA in consultations on enabling local level adaptation (Hines, 2010). Building upon this initiative, and recognising the complexity of coastal management, the Pathfinder project funded by DEFRA aimed to enable local governments to explore creative ways of responding to challenges faced by coastal communities. In 2015, DEFRA evaluated the Pathfinder program to understand if rollback, and buy or lease back are realistic options for local authorities in the North Norfolk region of England, where coastal management options were being revisited (Fenn *et al.*, 2015). Some of the planning issues which would enable more adaptive coastal management, identified through this evaluation were: the need for a more holistic or "whole coast" (p. 75) rollback approach, i.e. relocation or replacement of at-risk properties and infrastructure further inland, multi-level agreement of planning policy, identifying suitable land for rollback, legal issues with demolition of properties, funding, land availability, and the need for a more flexible approach to rollback (Fenn *et al.*, 2015). These elements of the Pathfinder project evaluation (Fenn *et al.*, 2015) mirror the adaptive governance characteristics in the previously discussed Dutch case study i.e. suitable levels of government and local support, and inclusion of stakeholders. The Pathfinder project is further discussed in Section 2.3.2. This reiterates the importance of government organizations and their roles in implementing adaptive management strategies; however, it also highlights the need for coordination among various government and non-government actors and financial, as well as planning opportunities for undertaking change.

In addition to government agencies, there are also several charity and non-profit organizations in the UK that play a role in coastal management. The National Trust, a major charity in England, Wales, and Northern Ireland focuses on conservation of heritage and open spaces, cares for over 775 miles of coast and spends an average of £3,000 per mile of coast per year (National Trust, Accessed: June 29, 2018). They stated in "Shifting Shores" that it is important to rethink the way the coast is protected through the use of long-term planning, government and community co-operation, and innovation, acknowledging that maintaining the current coastal profile may not be possible (National Trust, 2015).

Currently the English coast is divided into sections, each overseen by a Shoreline Management Plan (SMP). SMPs are non-statutory documents developed by the

Environment Agency (EA) and Local Authorities, as part of the Department for Environment, Food, and Rural Affairs' (DEFRA) strategy for flood and coastal defence. The SMPs assess the risks to the coast and provide the basis policy options for the management of different sections of coast (Milligan *et al.*, 2009; Environment Agency, 2012). The SMPs take into account the importance of natural environments and coastal processes, such as sediment transfer, as well as human use of coasts and infrastructure, when proposing options for coastal management (Environment Agency, 2012). A total of 22 SMPs cover the whole of the English and Welsh coasts (Committee on Climate Change, 2018). Four options are available for each sub cell within an SMP: hold the existing defence line, advance the existing defence line, managed realignment, and no active intervention. The SMPs describe "hold the existing defence line" as protection of the coast coastal defences "… by maintaining or changing the standard of protection." (Environment Agency, 2012, p. 9) "Advance the line" means that new defences will be built with the intent to reclaim land (Environment Agency, 2012, p. 9). "Managed realignment" is when the coast is moved inland (Environment Agency, 2012, p. 9). "No active intervention" is where no investment will be made in maintaining the current position of the coast (Environment Agency, 2012, p. 9). These policy options are defined for three time scales: short-term (0-20 years), medium term (20-50 years), and long-term (50-100 years) (Environment Agency, 2012). The non-statutory nature of SMPs means that local councils may choose to manage stretches of their designated coast differently to options laid out in the relevant SMP. Although the Planning and Compulsory Purchase Act 2004, shown in Figure 2.1, suggests that the SMPs should be used as an evidence base for local coastal plans, this seems to not be occurring; and the SMPs themselves are not rigorously analysed (Committee on Climate Change, 2018). Furthermore, the Committee on Climate Action (2018) criticizes the SMPs as an inadequate approach to respond to coastal risk because they are non-statutory, the timescales of the SMPs and local plans do not align, and funding for implementation of many of the policy options is unlikely.

The EA is currently coordinating the refreshing of the SMPs for England, which will be steered by coastal groups including various stakeholders. The goal of refreshing the SMPs is to make the SMPs more accessible, i.e. information available in different forms and using different media, to the public and local planners (Environment Agency, 2018). This allows the SMPs to be reviewed in light of current events, issues, and governance considerations. This is an important acknowledgement of the relevance of local knowledge in participatory processes feeding into policy. In the drafting of the current SMPs, for example, some coastal groups and local authorities refused to accept the content of the SMPs unless social justice

and fairness were also embedded in the options being proposed (Milligan and O'Riordan, 2007). It follows that processes of coastal management matter as much if not more than outcomes; the next section reviews the literature on social aspects of decision-making.

2.3 Needs of good decision-making

There are various considerations when deciding on which coastal management approach to implement in different situations and locations. Section 2.2 introduced examples of integrated approaches to coastal management strategies and specific policies and programmes that affect coastal management in England. Additionally, the previous sections briefly alluded to the importance of building in flexibility and reflection in the decision-making process, and the need to allow for meaningful participation (Milligan *et al.*, 2009). This section examines specific considerations in coastal management from a social perspective, that reflect the interrelatedness of these various elements across the varied literatures on decision-making regarding coastal management, including perceptions of and responses to change. Subsequently Section 2.4 focuses on landscape visualizations.

2.3.1 Barriers to good decision-making

There are a multitude of constraints in managing diverse coasts. These constraints, or barriers, have been studied in different contexts, including the coast. Biesbroek *et al.* (2013) define barriers as impediments that lead to a negative outcome and reduce the chances of success of outputs, e.g. tangible products such as management plans (Milligan, 2009), and argues that barriers emerge from the individuals, the system of concern, or the system of governing. In other words, a barrier is a factor that inhibits or constrains the implementation of measures to deal with change (Leichenko, 2015), and is something that can be overcome; at an individual level, barriers differ (Biesbroek, *et al.* 2013; Eisenack *et al.*, 2014; Moser and Ekstrom, 2010). Moser and Ekstrom (2010) organize barriers based on the phases of their Process of Adaptation Framework, discussed in Section 2.2. These barriers were derived by the authors from a review of adaptation literature and include barriers originating from individuals and institutions. Examples of barriers found in an English context are identified in the Pathfinder project evaluation. This document indicates that the most prevalent challenges in the five sites they looked at were access to available land, funding, and awareness or understanding (Fenn *et al.*, 2015).

Barriers can also be examined on temporal and spatial scales as these may influence the approaches that can be used to overcoming them (Moser and Ekstrom, 2010). Moser and

Ekstrom (2010) describe spatial attributes of barriers as remote and proximal, remote denoting barriers that come from sources outside of a location and proximal barriers originating within a location. The temporal attributes are contemporary and legacy, which refer to barriers that originate in the present and barriers that originated in the past or historically. These differences in scales affect how much control an individual will have on overcoming barriers (Moser and Ekstrom, 2010). A barrier that is proximal and contemporary is more within an actor's control (Moser and Ekstrom, 2010). On the other hand, a legacy and remote type barrier is difficult to overcome. Moser and Ekstrom (2010) give the example of a local official being unable to find information about their community because past government agencies have not conducted the research necessary.

2.3.2 Governance and political institutions

As the previous sections mention, governance and sometimes finances related to governance are common barriers found in the literature on coastal management (Ekstrom and Moser, 2013; Shackleton *et al.*, 2015; Nelson *et al.*, 2007). Similarly, the Committee on Climate Change's 2017 UK Climate Change Risk Assessment states that institutional barriers to a successful adaptation strategy include "… unclear or unmeasurable adaptation policy goals across correlated risks; a large number of partners involved in delivering adaptation activity; the limited alignment between related policy goals (e.g. flood risk management with housing and planning policies); and capacity gaps, including as a result of funding and resource constraints, particularly at the local level." (Committee on Climate Change, 2016, p.76). In three case studies conducted in Portuguese coastal communities concerning perceptions of risk, trust, and participation, Schmidt *et al.* (2014) identify that disconnect between the different levels of the management process leads to distrust, and inhibits communication between local stakeholders and institutional decision-makers. These examples are in line with suggestions to improve integrated coastal management approaches such as ICZM and adaptive coastal governance, see Section 2.1.

Similarly, Ekstrom and Moser (2013) found that the most frequent barriers hindering the adaptation process, using the Process of Adaptation Framework (Table 2.1), from the case studies they conducted in the San Francisco Bay area relate to institutions and governance. They found that institutional barriers were predominant in the early stages of the decision-making process for adaptation and theorize that this could be because of the role of institutions in mobilizing change. The authors also argue that institutions can hinder change because of their roles in regulating social processes. On the other hand, Slovic (2000) states that policies could be a catalyst to thinking of alternative decisions because new policy

constraints make old methods of dealing with change inadequate. An example of a policy suggestion affecting social change is the SMP changing the designation of certain areas from being defended to not being defended, which led to different ways of thinking about managing coasts in the UK. The village of Happisburgh has been affected by projects done (i.e. the Pathfinder Project) after this policy suggestion because the village was designated to not continue to be protected and went through a period of rapid erosion. These two views of policy as a potential barrier to and driver of change are important considerations when deciding which management approach is appropriate for a location, as well as the long-term viability of an approach, e.g. changes after election cycles.

It is suggested that planners and managers should promote good governance by creating effective participatory processes at different scales, where people and other actors engage to contribute their "creativity, energy, and diversity" (Milligan and O'Riordan, 2007, p. 506). Expanding on this literature, Sheng (2009) describes eight characteristics of good governance: participatory, transparent, follows the rule of law, consensus oriented, equitable and inclusive, effective and efficient, and accountable. These are important when considering the approaches to coastal management, discussed in Section 2.2, and how they are affected by the participation of various actors in the decision-making process. Considerations when undertaking participatory processes are discussed in Section 2.3.5.

It has been shown that previous experiences with processes, managers, governing bodies, and / or researchers can affect participants' willingness to continue with a project and the conflicts that may arise if their previous experience was negative (Muro, 2012). Some suggestions on how to improve governance include: understanding past failures, improved participation through understanding of local conditions, better cohesion among management institutions, and improved leadership of projects (Schmidt *et al.*, 2014).

2.3.3 Perceptions of risk and uncertainty, and trust

Similar to the way that experience can affect perceptions and interactions with agencies, organisations and individuals involved in decision-making processes, an individual's perceptions of risks and uncertainties can be influenced by their personal experience as well as cultural and socio-economic factors, and their interpretation of relevant information (McEwen, 2011; Renn, 2008; Moser and Eckstrom, 2010; Biesbroek, 2013). Furthermore, personal perceptions of risk can differ from quantifiable risk, and this has been a concern expressed by risk managers when engaging with publics (McEwen, 2011).

For example, Poumadère *et al.* (2015) conducted case studies in two French locations where stakeholders acted as consultants to make recommendations to government of future scenarios. The stakeholders participated in interviews where they imagined the future impact of marine submersion from storms on their two respective communities in 2030 and more generally on how they thought their community would look like in the future. The authors then used this information to develop two future scenarios for each location that were shown to stakeholders in workshops. Using these, the stakeholders came to different conclusions. In the first workshop, participants' recent experiences with storms and risk made them more willing to accept the option of adaptation to the changing coast. In the second case study, which had a history of protecting the coast and a culture to "fight against the sea", the participants decided that they should protect the coast (Poumadère *et al.*, 2015, p.173). These two cases show that the context of the seasons, weather, and the history and culture of an area influence considerations and decisions on how to manage risks and the degree to which adaptation is acceptable. The study also showed that background, personal and collected experiences of approaches to coastal management affect the decisions that they make individually and as a group. This study also suggests that future scenarios be tailored to the location's needs and priorities. This supports findings that past experiences of different risks and governance will have an effect on decision-making (McEwen, 2011; Renn, 2008; Moser and Eckstrom, 2010; Biesbroek, 2013) and behaviours (Touili *et al.*, 2014). For example, Weber (2010) argues that individuals have a finite pool of worry, thus affecting which actions are taken in relation to that worry. During challenging economic times, individuals may worry less about other things such as climate change, while during extreme weather events, such as long periods of drought, individuals may become more aware of and prioritize climate change more than economic issues (Weber, 2010; Capstick, 2015). It has also been shown that in some circumstances, after individuals have taken action to reduce some risk they "…are much less likely to take additional steps…" that would reduce the risk further or solve the issue at hand (Weber, 2010, p.20).

Furthermore, high trust in processes and actors involved, transparency in decision-making, and effective and trusted communication are important factors that contribute towards increased understanding of changes and participation in decision-making processes such as those advocated by adaptive coastal governance (Muro, 2012; Nicolson-Cole et at., 2015; Sheppard, 2012; Schmidt *et al.*, 2014; Milligan *et al.*, 2009). It has been suggested therefore that coastal managers build trust with project participants (Muro, 2012). The goals, methods, and outcomes of research in which publics have engaged with should be well communicated

in order to avoid losing trust and credibility with publics, and to better manage publics' expectations. Good governance requires that publics be engaged (Sheng, 2009); however, a lack of trust and credibility can develop from multiple circumstances such as a lack of local knowledge (Wissen *et al.*, 2008) and previous negative experiences with planners or managers (Muro, 2012).

2.3.4 Place attachment and Place Identity

Another consideration in management of environmental assets is how attached a person is to a location and what role a place has in shaping a person's identity. Place attachment is the process of becoming attached to a place, and the positive emotional connection with locations (Devine-Wright, 2009), resulting in a sense of self that is gained by a person through their interaction with their surrounding environment (Quinn, 2013). Place attachment takes time to build, and thus cannot be adequately studied in a single instance; instead, it should be studied over time, e.g. through the use of a longitudinal study, which is not a tendency in literature relating to place attachment (O'Neill and Graham, 2016). In a critical analysis of the literature around place attachment and identity, Devine-Wright (2013) argues that rapid changes to the environment can threaten place attachment and identity, and can cause negative social and physiological issues. These arguments suggest that although place attachment takes time to build, rapid change can disrupt attachment to place. Moreover, there can be varying levels of attachment at different spatial scales; however, this is not always the case (e.g. Devine-Wright, 2013). Attachment can be formed at any scale and may not be associated with spatial proximity or distance (O'Neill and Graham, 2016; Devine-Wright, 2013; Scannell and Gifford, 2013). Furthermore, there are both physical and social dimensions to place attachment, which Lewica (2011) argues are distinct from each other. Scannell and Gifford (2010) also state that research on place attachment tends to focus primarily on the social aspect of place as opposed to the physical aspect of a place. The literature indicates that there needs to be further research on how attachment and identity are affected by spatial scales, e.g. attachment to the world, a continent, or a region as opposed to local scales, and how place attachment and identity affect proposals for changes to physical spaces. There are also mixed findings about which attachments, physical or social, play larger roles for individuals' attachment to a place (Lewicka, 2011).

Indicators of place attachment and identity have been developed to examine how these change over spatial and temporal scales, and how they affect decision-making processes (e.g. not accepting change). It has been found that there is not necessarily a direct linear relationship between some indicators and place attachment. For example, length of residence

is used as an indicator for place attachment at the local level (Quinn, 2013; Hernandez *et al.*, 2007). Similarly, O'Riordan *et al.* (1993) found that people who have spent less time in a location have less experience of it and use its resources more passively. These individuals are more likely to change the way they perceive changes about futures of landscapes they have spent less time in, than people who have spent more time at the location and have more experience of its context and issues affecting it (O'Riordan *et al.*, 1993). Furthermore, in a review of literature relating to place attachment, Devine-Wright (2013), summarized that those that travelled more outside their countries, i.e. spent more time in other European countries, and had personal connections in other countries, felt more attachment on a continental level than those who do not travel or had fewer social connections outside of their country. This seems to support that time spent in a location can contribute to feelings of attachment. Even though there is evidence in the literature to support that time spent in a location can affect place attachment, there is still a lack of literature relating to how technology such as virtual reality, Google Maps, and general access to information pertaining to a location can affect attachment, even if an individual never physically visited a place.

Community and place attachment are commonly researched together at local levels (Lewicka, 2011) and sense of community is another indicator for place attachment. Sense of community (SOC) is a contested term; it has been used to denote the collaboration between people built on social norms, networks and trust (Long and Perkins, 2007). Long and Perkins (2007) use a Brief Sense of Community Index (BSCI) to measure SOC in NewYork City. The authors look at individual SOC and SOC as a collective. They found in their study that SOC, measured using BSCI, was positively correlated to efficacy, engagement, neighbouring, and place attachment when looking at the group level, i.e. in a collective of people. Place attachment also positively predicted SOC at the individual level, indicating that the BSCI can be used to identify links to place attachment for individuals (Long and Perkins, 2007). Although the study by Long and Perkins (2007) seems promising for those wishing to use BSCI, there have been few studies that have actually used this index. One study that has used this index, discussed community in the context of mental health. In this study participants felt that SOC was important, even without the presence of actual SOC in their lives (Townley and Kloos, 2011).

Place attachment and identity can affect planning and management processes by influencing willingness to undertake or accept change, or resistance to change. Place attachment does not necessarily lead to engagement, but people who are more attached to a place are more

likely to participate in processes relating to changes to place (Quinn, 2013; Devine-Wright, 2013). ICZM can include the discussions of changes that are sensitive to individuals with varying levels of attachment. In order to understand the decisions individuals make, it is important to better understand the social and physical dimensions of place attachment. This could lead to more effective communications with individuals, while being sensitive to their attachments. In the following section, the benefits and limitations of engagement in decision-making processes is discussed.

2.3.5 Engagement in decision-making processes

Section 2.2 highlighted recent calls for and demonstrable progress towards more honest inclusive participatory approaches in adaptation and decision-making literatures, as well as in policy. This section builds on section 2.2 to consider in more detail engagement of stakeholders and draws on various literature to gain a better understanding on the relationship between engagement, coastal management approaches and coastal governance.

Drawing from the various literature, this thesis defines the engagement of stakeholders as the participation of various groups of stakeholders in decision-making and with subsequent enacted actions (Beierle, 1998; Cornel, 2006; Few *et al.*, 2007; Chilvers and Longhurst, 2016). The degree and way in which different actors are engaged varies, with some authors advocating for high levels of contribution towards decision-making (Few *et al.*, 2007), and others proposing the use of technology, e.g. visualizations, to engage stakeholders (Brown *et al.*, 2006; Bishop *et al.*, 2013) (see Section 2.4).

It has been cautiously argued that in some cases stakeholders may be more willing to implement the decisions from a process that they took part in, even if the outcomes differed from what they desired (Milligan *et al.*, 2009, Muro, 2012; Blunkell, 2016). However, others argue strongly against this because some of these processes, where inclusive participation is only nominal, can result in isolation, frustration and disenfranchisement for stakeholders and communities, as well as the risk of misinterpretation and loss of trust (Beierle, 1998; Few *et al.*, 2007; Muro, 2012). When participatory processes are coined on principles of openness, honesty, trust, transparency and inclusivity, the benefits include participants feeling that their views are valued, an increased understanding in how they and others are affected by an issue, ability and willingness to contribute to discussions, often leading to greater acceptance of resulting decisions and / or outputs (Milligan *et al.*, 2009; Blunkell, 2016); inclusive participatory processes also enable the inclusion of information, knowledge, and expertise of participants (Lieske, 2009). Thus, it is argued that the overall quality of decisions are

improved through participatory processes (Schmidt *et al.*, 2014). Other benefits of involving publics include more personal responsibility over decisions and outcomes, and better understanding of locally specific data (White *et al.*, 2010). Because of these benefits, engaging publics and stakeholders in environmental management has become a feature in improving policymaking (Environment Agency, 2012) and in research pertaining to the management of different landscapes (i.e. Wissen *et al.*, 2008; Milligan *et al.*, 2009; Geaves and Penning-Rowsell, 2016).

Despite the benefits of participatory decision-making and engagement, individuals are cautious about how much influence they actually have on decisions that are made during participatory decision-making processes (O'Riordan *et al.*, 1993; Milligan *et al.*, 2009). Frustration and a lack of trust towards managers and planners could arise when goals and realistic outputs of projects are not clearly defined and managed throughout the decision-making process (Milligan *et al.*, 2009). There is also a need for balancing the different views and interests of participants and avoiding any implicit biases that a manager or planner may have towards certain future scenarios (Few *et al.*, 2007; Milligan *et al.*, 2009; Bishop *et al.*, 2013; Blunkell, 2016). Similarly, Section 2.2 outlines the difficulty of coordination among the various actors, including stakeholders, involved in decision-making, and how this could lead to drawn out processes that may not be within the scope of a project. Although some planners may have reservations about the time it takes to involve publics in the planning process (Brown *et al.*, 2006; Milligan *et al.*, 2009; Blunkell, 2016), engagement should include publics from the beginning, and allow them to have input in a way that is meaningful and impactful to the decision-making process (Muro, 2012; Few *et al.*, 2007). Despite the limitations, there is potential success in developing a "common vision" (Milligan *et al.*, 2009, p.211) by working with publics from the beginning of coastal decision-making processes.

The shift towards more integrated, inclusive and participatory approaches to decision-making has to be balanced against the risks of undertaking processes in ways that may alienate participants. An example of a participatory decision-making process in the UK is a study by Blunkell (2016) – where two communities in England were engaged in decision-making pertaining to coastal adaptation. Although there were similar findings in the study raising awareness and similar interests about loss of homes because of changing coastal policy, one community was found to have elicited a larger and more negative response towards the proposed loss of homes. However, this community was also satisfied with their ability to affect change after discussing with managers and policy makers, and the initial

negative views of drafted proposals for loss of homes could have been due to the lack of transparency and input from the community in their initial development (Blunkell, 2016). Caution is needed to limit participatory processes for the sake of participation, i.e. it is necessary to achieve active engagement in decision-making for true participation (Few *et al.*, 2007). Furthermore, there are a variety of barriers to decision-making processes, see Section 2.3.1. The literature (see section 2.2) points to gaps in participatory decision-making processes applied in the context of coastal zones, and how these processes can be implemented. There are several applied examples of a participatory approach to coastal decision-making in the UK (e.g. O'Riordan *et al.*, 2014; Jude *et al.*, 2007; Milligan *et al.*, 2009). These studies highlight the difficulties of engaging publics in decision-making processes, e.g. balancing various views, interests, and beliefs, as well as costs (i.e. resources). Some of the participatory processes can be lengthy; however, as was previously mentioned in Section 2.2.1, longitudinal studies can be used to gain valuable context to decisions made (Capstick at al., 2015), can measure shifts in perceptions throughout engagement (Hine *et al.*, 2014) and evaluate impacts of tools and varied methodologies of engagement on decision-making (Schroth *et al.*, 2015; Bishop *et al.*, 2013).

2.4 Landscape visualizations and uses in landscape management

Sections 2.2 and 2.3 outlined the importance of communication in coastal management and the various potential barriers to coastal management. In order to move towards a more participatory approach to management there have been calls for innovative uses of visualization technology, e.g. images, videos, and models, in deliberation and decision-making processes (Jude *et al.*, 2007). Data visualizations can be broadly described as any representation of information that is neither written nor verbal (Pettit, 2012; Tversky *et al.*, 2002). Visualizations can be used in various contexts to help overcome some of the limitations with traditional forms of communication and engagement (Bateman *et al.*, 2009; Jude *et al.*, 2015).

There is a long history of using visualizations in the decision-making process. Information and Communication Technologies (ICTs), including Geographic Information Systems (GIS) and similar data visualization technology, have been applied since the 1950s to support spatial decision-making (White *et al.*, 2010). Visualizations have been used specifically in landscape planning to aid and engage individuals in decision-making over several decades (O'Riordan *et al.* 1993; Wissen *et al.*, 2008; Lieske *et al.*, 2009; Lewis, 2012). With the introduction of new technologies, the definitions of visualizations have evolved. A recent

definition for a landscape visualization which incorporates modern technology is "a computer- generated image providing an enhanced visual representation of a physical space or environment, with the intention of facilitating interpretation" (Brown *et al.*, 2006, p. 843). In a similar way, Sheppard (2005) refers to landscape visualization as representations of physical places from a 3D perspective. Visualizations have also been used in the context of visualizing coasts. The Tyndall Coastal Simulator attempted to simulate coastal processes and visualize coastal change data for communication purposes in order to improve coastal management (Jude *et al.*, 2015; Dawson *et al.*, 2015). For the purposes of this thesis, a visualization is defined as a geographic presentation of information used as a tool to engage individuals and facilitate learning and understanding.

This section examines visualizations, primarily focusing on landscape visualizations but also drawing on other literature on data visualization. Section 2.4.1 reviews visualizations as a purposeful tool in facilitating learning and understanding. Section 2.4.2 describes the types of visualizations and how they can represent reality through different forms of media. The subsequent sections review aspects of the creation of visualizations that affect how they are perceived, which are then related to the considerations for good governance and effective coastal management discussed in Section 2.3.

2.4.1 Purpose of visualizations

The literature on visualizations generally describes their use as a tool to help facilitate understanding and learning, in conjunction with other sources of information available to the individual (Nicholson-Cole, 2005; Bishop *et al.*, 2013, Wissen *et al.*, 2008). Pettit (2012) cautions against using visualizations as a substitute for learning about an issue. Rather, a visualization aids in interpretation and thought processes. It has been argued that visualizations can be used to either improve understanding of data or improve individuals' ability to communicate information (Bishop *et al.*, 2013; Lewis, 2012); they can also be used to motivate and focus the individual, to aid in understanding concepts (Wissen *et al.*, 2008; Nicholson-Cole, 2005) and foster learning. Visualizations can improve the accessibility of information and can help with understanding (Lewis, 2012; Nicholson-Cole, 2005; Bishop *et al.*, 2013). Furthermore, visualizations can also enhance the outcomes of coastal management processes by creating higher efficacy, better understanding, more caring, and better recognition. However, there is still a lack of understanding pertaining to the use of visualizations in decision-making processes, and their ability to facilitate communication (Lewis, 2012). The following sections discuss the uses, considerations, and limitations of

using visualizations in decision-making processes. The purpose of the visualizations as it relates to this research is also discussed further in Chapters 5 and 7.

2.4.2 Types of visualization

Different forms and types of visualizations have been used in different contexts and, as mentioned above, there has been a recent move towards visualizations created through the use of computers and other technology (Nicholson-Cole, 2005). Lange (2001) refers to more traditional analogue visualizations which include "plans, sections, sketches, perspective drawings, photomontages, and physical models" (p.164). In addition, other types of visualizations utilize more modern technology such as film, 3D visualizations, virtual reality, and augmented reality (Sheppard, 2012; Lange, 2001).

The literature discusses the advantages to using specific types of visualizations in decision-making. For example, a sketch can be a cost-effective way to induce emotions and make bold interpretations of landscapes (Sheppard, 2012). This type of visualization was used by O'Riordan *et al.* (1993) (see Figure 2.2) to portray the Dales in the UK to engage different groups of stakeholders in imagining future landscapes. Photographs can be useful for before and after comparisons, are cost-effective and can be realistic (Sheppard, 2012). High drama film can be realistic as well and engage audiences through narratives. When done well and used appropriately, sketches, photographs and film are suited for engaging the individuals interacting with the visualizations to make their own inferences and conclusions about what is being visualized (O'Riordan *et al.*, 1993). However, these types of visualizations are subject to biases of the creator of visualizations (Sheppard, 2012; Downes and Lange, 2015).

With increasing accessibility of technology, it is becoming more common for 3D visualizations to be used in research (e.g. Appleton *et al.*, 2002; Jude *et al.*, 2007; Lange and Hehl-Lange, 2010; Lovett *et al.*, 2015). 3D visualizations can include still images (e.g. Lovett *et al.*, 2015; see Figure 2.2), animations, and real-time models. In still images a 3D visualization may be more accurately described as 2.5D visualization because it is presented in a 2D format. With animations and real-time models the landscape can be seen in a 3D manner because of the movement of the environment showing different perspectives. The various types of 3D visualizations will have various purposes and will require different levels of resources (Lovett *et al.*, 2015). Using 3D visualizations that are created with robust scientific data can be interactive, engaging, and lead to greater understanding about an issue (Jude, 2015; Schroth *et al.*, 2015). 3D visualizations are also a useful tool in presenting large and complex data sets to a wide audience through visual cues (Appleton *et al.*, 2002).

Applications of this type of visualization can be very simple with little detail, or realistic. All of these visualizations can be modified to include text in some form; some of them, such as film and 3D visualizations could also include audio (Sheppard, 2012). However, these visualizations should be used only when appropriate to suit the intended purpose of creating visualizations (Hine *et al.*, 2014, Sheppard, 2012; Nicholson-Cole, 2005; Scannell, 2013; Chou *et al.*, 2009). In some cases these types of visualizations may not be as effective as visualizations that do not use computers or internet (Houben *et al.*, 2016; Preece *et al.*, 2013).

Figure 2.2: Examples of different types of visualizations including: sketch (A) from O'Riordan et al. (1993), Scene Express real-time model (B) and 3D image (C) from Lovett et al. (2015)., and a 3D image at ground view (D) from Appleton et al. (2003).

There are limitations to using visualizations that affect the suitability and appropriateness of a visualization. The creation of visualizations should be approached with clear goals. When visualizations are altered from present physical realities they can be considered fake, biased and prompting, and may eventually lead to misinformation, incorrect inferences, and distrust (Sheppard, 2012; Downes and Lange, 2015). Some visualizations such as film and videos may not be interactive and can be costly (Sheppard, 2012). In the case of 3D visualizations, data availability will drive what is possible to visualize. There are other factors such as internet connection and connection speed which can create difficulties with certain methods

of presenting visualizations (Lovett *et al.*, 2015). The availability of technology will affect what can be visualized as well as the visualization itself. For example, sketches, 2D maps, and 3D physical models can be created to be modified without the use of technology, thus making them a useful tool in areas that do not have access to computers or the internet. Visualizations have the ability to cause confusion and create conflict, as well as undermine discussions and negatively affect the professional credibility of the creator (Lewis, 2012) if great care is not taken in creating visualizations that will be used in the management process. Sections 2.4.3, 2.4.4, and 2.4.5 discuss different characteristics of visualizations and how they can be included and used in participatory decision-making in order to be perceived positively and credibly.

2.4.3 Tailoring messages

Visualizations are not a "one size fits all" solution (Appleton *et al.*, 2002). Nicholson-Cole (2005) stated that "…we can never depend on one image appealing to everyone in the same way, let alone presume that a particular message will be delivered" (p.260). While deciding on the type of visualization to use, it is important to consider the aspects of visualizations that will affect how they are perceived, and in the case of landscape visualizations, the existing physical landscape. The way that a visualization is presented also affects its effectiveness as a means of communication. An individual's ability to relate to and connect with a visualization also depends on the individual's prior experiences and perceptions of the issue visualized. The connection with a visualization may also influence an individual's motivation to take action (Nicholson-Cole, 2005) in the same way that experiences will affect individual perceptions of change and actions taken in decision-making processes, see Section 2.3.

Touili *et al.* (2014) argues that the way an issue is framed can also affect the way an issue is perceived. Similarly, Allen (2018) stated that visualizations can affect perceptions through selective framing. It is also important to remember that the creator of visualizations will have their own prior assumptions and views, and will provide a particular visualization which may be framed in a specific way, possibly tailored to the audience (Gill *et al.*, 2013; Nicholson-Cole, 2005; Lewis, 2012).

For those wishing to use landscape visualizations in management processes, there are different forms of media that can be used to present visualizations. The type of visualization needs to be adapted to best meet the needs of those producing and engaging with the visualizations (Hine *et al.*, 2014, Sheppard, 2012; Nicholson-Cole, 2005; Scannell, 2013;

Chou *et al.*, 2009), and take into account the available resources (Nicholson-Cole, 2005). An example of this is a case study conducted by Milligan *et al.* (2009) where participants were asked to annotate a map. All of the participants found this task difficult; however, there were no suggestions by the author as to how this task could be made easier for participants. At this point, having an understanding of the individuals who will be engaging with a visualization, such as the considerations discussed Section 2.3, could help in tailoring how information is communicated and the media through which it is communicated. Tailoring messages to the people involved in a project is an important aspect of effective communication (O'Riordan *et al.*, 1993; McEwen, 2011; Hine *et al.*, 2014). Simply informing the individuals will not necessarily lead them to act or change their behaviour and decisions, so, in order to promote reflection and possibly action, the issue must be made relevant and engaging (Clayton, 2015), including making it personal, local, and urgent (Moser, 2010).

When the message is not tailored to the audience, it may lead to negative perceptions of the visualization and of those creating / presenting the visualization (Nicholson-Cole, 2005). Wissen *et al.* (2008) describe how one participant in their study felt manipulated and questioned the credibility of what was shown to them because local conditions – which the person felt strongly about - were not taken into account in the visualization used. This is an example of how visualizations will not always meet the needs of every user. Adapting information to local context is also supported by McEwen (2011), who found that making science relevant was important to participants. Another consideration when creating tailored messages is data availability: not all locations have detailed data on all elements that visualization creators may wish to include (Muro, 2012).

2.4.4 Realism and detail

This section covers both realism and detail in visualizations. They are different concepts that are closely inter-related. Lovett *et al.* (2015) define realism as "... the degree to which a visualized scene or element resembles its real-world counterpart" (p. 88). It has been argued that realistic visualizations can help individuals identify with a landscape and help to facilitate and encourage discussion (Wissen, 2011; Lovett *et al.*, 2015).

Bishop (2015) suggests that participants' understanding will benefit from visualizations that provide more information while a participant is experiencing a landscape, e.g. augmented reality. Many authors have supported the idea that sense of place, place identity, and place attachment will influence the way individuals perceive visualizations and landscape changes

(Bishop, 2015; Harwood *et al.*, 2015; Sheppard, 2015). These studies primarily focus on the influence of place on how visualizations are perceived. Recognizable landmarks are a key element in creating visualizations (Brown *et al.*, 2006). Making a visualization more realistic, to make it feel as if the user is experiencing the issue being visualized, can be more impactful than visualizing the issue in a way that makes the situation less real. However, limitations of realistic visualizations occur when inaccurate data are used to create realistic visualizations, creating misconceptions; furthermore, realistic portrayals do not always lead to corresponding perceptions of reality because interpretations of the visualizations can vary considerably (Downes and Lange, 2015).

On the other hand, studies have shown that abstract (i.e. less realistic) visualizations can help to focus individuals on specific features e.g. the spatial extent represented in the visualization. It has been found that for some individuals, abstract visualizations may not distract from the main message being communicated; and less complex visualizations, i.e. less realism and detail, can appeal to a more diverse group of people (Lovett *et al.*, 2015). In a workshop, Wissen (2011) found that using abstract visualizations, participants were facilitated in understanding what was being visualized and they took decisions based on these visualizations quickly. However, abstract visualizations are not suitable for all individuals or situations; they best serve individuals who already are concerned with an issue, have concrete ties to a landscape, and are used to abstract visualizations (Weber, 2010; Wissen, 2011). A reason for this is because it has been found that abstract visualizations do not always enable individuals to make strong associations to the real world, which may translate into lower concern for the issues being explored through these types of visualizations (Weber, 2010).

A detailed visualization does not signify it is necessarily realistic, nor vice versa. Increasing the level of detail of visualizations in certain circumstances can be beneficial to engage users and show change in a landscape (Lange, 2001) although the amount of detail may not be proportional to perceptions of realism. In order to include detail, there must first be the data and technology available to support it (Appleton and Lovett, 2003). Higher levels of detail in a visualization would most likely be better at a stage where there is a general consensus on the overall issue and there is a need to then focus on detail at a specific scale (Lovett *et al.*, 2015). Increased levels of detail can make a visualization relatable and help participants to "imagine for themselves the landscape that is being presented." (Appleton and Lovett, 2003, p.130). In a study visualizing coastal erosion in Norfolk, UK, Brown *et al.* (2006) found that participants generally welcomed more detail; however, the author also states that

misleading participants with too much detail used in the visualizations needs to be avoided. The level of detail included in the visualizations often stimulates discussion but can cause confusion among those using it if they find the detail difficult to interpret. Therefore, it is argued that it is important to ensure that there is not too much information on one image (Wissen, 2011) as this can be misinforming or distracting (Lovett *et al.*, 2015) for the people interacting with the visualization.

The degree of realism and detail in a visualization depends on the purpose of the visualizations (Appleton *et al.*, 2002; Lange, 2001). Data availability and technology are a deciding factor on the amount of realism and detail in a visualization because there are compromises that will occur between these in representations. There is still a need for further research to on what constitutes adequate detail and realism in different circumstances, and how individual and group characteristics influence how these are perceived and used.

2.4.5 Interactivity

Interactivity is the ability of a visualization to alter perspective, content, and physical position (Heim, 1998). Lovett *et al.* (2015) distinguish between different types of interactivity. The authors mention that with the advancement of technology, interactivity has changed, with those interacting with a visualization now being able "…to freely navigate around a landscape… (p.89)." The ability of users to modify the content of visualizations is another form of interactivity where participants have greater input into visualizations (Lovett *et al.*, 2015), as opposed to an animation or navigating a model. Appleton *et al.* (2002) state that because of the increased need to process realistic visualizations, there is a trade-off with the level of interactivity of visualizations, i.e. in a more exploratory type of visualization, interactive graphic quality may not be the main focus (Lovett *et al.*, 2015; Bishop *et al.*, 2013). Improvements in technology allow for not only new types of interactive visualizations to be utilized, e.g. augmented reality and virtual reality, but also for improvements such as creating more interactive yet realistic visualizations (Sheppard, 2012; Appleton *et al.*, 2002).

Several authors have discussed the importance of social learning and co-production of knowledge in engagement of publics in decision-making (e.g. Petts, 2007; Klenk *et al.*, 2017; Vries, 2016; Beirle, 1998; White, 2010). Use of web-based platforms could be useful in this co-production of knowledge and increase interactivity with visualizations. Participatory GIS (PGIS) is an online platform enabling individuals to contribute to or comment on the visualizations by gathering, organizing and integrating local knowledge and history (McBride *et al.*, 2017) thus making it a bottom- up as opposed to a more traditional top-

down approach (Kingston, 2011). However, most of the literature on visualizations use premade future landscapes when engaging with participants. There have been few studies utilizing visualizations that work with participants in the development of future options from the outset, i.e. not using pre-made future scenarios. Despite the potential for a bottom-up approach to aid in the decision-making process, there are no set methods for designing a PGIS project, instead, practitioners rely on frameworks, rules of thumb, and examples to implement PGIS (Jankowski, 2011). This is unsurprising because of the traditional benefits and necessity of tailoring visualizations to an audience and situation for effective communication, see Section 2.4.3. There is still more research needed in order to fully understand the benefits and limitations of such a participatory process.

There is scope for different technologies to support interactivity at different levels of immersion in the visualization. Hiem (1998) describes immersion as making "…a person feel transported to another place" (p. 7) through devices that "isolate the senses" (p.7). Examples of the various ways in which immersion could be enhanced is the inclusion of sound, virtual reality, wider views, etc. Recent uses of sound and augmented reality in the literature around visualizations in decision-making show the shift in the field of landscape visualization for a more immersive participatory experience (Wissen Hayek *et al.*, 2018). Higher levels of interactivity require more considerations, in terms of the technology available to create and present the visualized landscapes (Lovett *et al.*, 2015), and the time and money that would need to go into developing an interactive visualization (Jude, 2015), but it has been noted that a lack of immersion does not appear to have a large effect on the success of displaying visualizations over the internet (Lovett *et al.*, 2015).

2.4.6 Visualization evaluation approaches

Projects such as Making Space for Water and the Pathfinder program, described in Section 2.2, span multiple years (DEFRA, 2005; Fenn *et al.*, 2015). The second generation SMP took 6 years from pilot to adoption and the 2012 SMP has been in use for 6 years as an aid for coastal management, shown in Figure 2.1. The development and implementation of coastal management strategies, and research into considerations that can impact the decision-making process, e.g. place attachment, perceptions of risk and uncertainty, and engagement, are studied over long periods of time. Temporal scales were discussed in Section 2.2 in relation to identifying the origin of barriers in order to overcome them. This is also relevant to visualizations because many of the studies visualizing coasts have attempted to use models to visualize future change (Brown *et al.*, 2006; Bateman *et al.*, 2009; Bishop *et al.*, 2013).

However, the literature on visualizations identifies the lack of longitudinal studies (Bishop *et al.*, 2013; Capstick *et al.*, 2015; Sheppard, 2015; Moser, 2016). Bishop *et al.* (2013) explain that over time there is a possibility of visualizations triggering changes in awareness and actions that can lead to "profound outcomes" (p.219). The authors also state that, although there is this possibility to elicit change, establishing direct links back to the use of visualizations is difficult in terms of demonstrating their effects (Bishop *et al.*, 2013; Schroth *et al.*, 2015). Longer term studies would also need to consider the possibility of external factors to influence perceptions and behaviours (Schroth *et al.*, 2015), and may not be cost-effective. Most studies using visualization in the decision-making process are short term, i.e. less than a year, or are a single instance of engaging participants (e.g. O'Riordan *et al.*, 1993; O'Riordan *et al.*, 2014; Wissen 2011; Bishop *et al.*, 2013). Therefore, it is suggested that more longitudinal studies utilizing visualizations take place, and the connectedness of concepts such as place attachment and other considerations of participatory decision-making (refer to Section 2.3) to the creation and utilizations of visualizations should also be further researched.

Despite the need to understand the implications of visualizations in decision-making, a variety of criteria are used to measure the effectiveness of visualizations and their contribution to decision-making processes as these vary considerably in scope and purpose (Bishop *et al.*, 2013; Knight, 2001; Lewis, 2012). These criteria can be separated into two general groups: content and format. Sheppard (2012) describes five procedural criteria for effective visualizations in communicating and engaging with communities: clarity, engagement, connectivity, trust, and feasibility. These criteria are similar to the suggestions for the successful implementation of an integrated management approach, refer to Section 2.2. On the other hand, Knight (2001) focuses on usability and suitability of visualizations to measure effectiveness. The usability of the visualization tool, or the ability of a tool to allow the user to accomplish tasks (i.e. serve a purpose), is widely used in the literature to measure the effectiveness of a visualization (Bishop *et al.*, 2013; Sheppard, 2012; Plaisant, 2004; Knight, 2001). (These criteria are further discussed in Chapter 5.)

Along with these criteria used in evaluating the effectiveness of visualizations, there are specific attributes of visualizations that influence effectiveness. Tailoring and making visualizations accessible affect whether the visualization is suitable for the task and representation, as well as being usable by the users (Knight, 2001). These suggested criteria in the literature can aid in understanding the role of visualizations in decision-making processes.

Visual representations can enhance communication with a wide variety of people, which is an important factor in ICZM and other inclusionary management approaches (Downes and Lange, 2015). These management approaches can make use of visualizations to communicate on current and future landscapes (Sheppard, 2005; Lange, 2011). Appleyard (1979) stated, almost four decades ago that, "Once visible, an action must create an enduring image in the viewer's mind (p.148)." As the previous sub-sections have described, visualizations have the capacity to make something invisible become visible.

2.5 Conclusion

To summarize the arguments so far, coordinating people and planning is complex. Coastal management is a complex process; current approaches aim to take into account various contextual factors including stakeholders and publics' views to improve the possibility of successfully implementing suitable and fair coastal management. There is also a strong push towards greater transparency and inclusiveness in decision-making processes, including ICZM and adaptive coastal governance, and the importance of the relevance of contextual factors (e.g. place attachment and identity, previous experiences with management projects, and ability to engage in a project) on their success and impact.

The literature on visualizations shows that they can be useful tools in the management and decision-making process in communicating complex ideas; they can aid in thinking about and managing future landscapes. There are various factors during the creation and presentation of visualizations that need to be carefully considered in order to best serve the individuals that will be using and interacting with the visualizations, and to limit unintended (detrimental) consequences. Furthermore, there are few studies in the visualization literature that utilize longitudinal approaches and there are various criteria used to measure the effectiveness of visualizations.

The next chapter details the methodological approaches used in this research including creating visualizations using a bottom up approach, integrating the adaptation frameworks and risk management components outlined in Section 2.2, and considering the criteria of effective visualizations discussed in Section 2.4.

Chapter 3 | Methodology

3.1 Introduction

This chapter outlines the methodology underpinning the study in this thesis. It builds upon gaps identified in the literature, where it is uncommon to find research which engages a group of participants over several sessions and over an extended period. Furthermore, many studies assessing the effectiveness of visualizations are not iterative and do not include a process in which visualizations are modified based on discussions with participants (e.g. O'Riordan *et al.*, 1993, Pettit *et al.*, 2011, and Bishop, 2015). The study in this thesis draws on these limitations and utilizes an iterative and longitudinal research design, with sequential data collection steps and mixed methods. Section 3.2 outlines the research design, the philosophical research positions underpinning the choice of methodology and analysis, and the use of mixed methods. It is followed by Section 3.3, a description of the phases of data collection. Section 3.4 describes the case study site, including the political and historical context in which this research takes place. Finally, the limitations of the methods are discussed. Surveys and protocols used during data collection can be found in Appendix 1, and are referred to throughout this chapter.

3.2 Research design

As outlined in Chapter 1, the aim of this thesis is to understand the roles of visualizations in participatory decision-making processes during a longitudinal study. A longitudinal study is defined by this thesis as a study taken over an extended period of time with the same group of individuals. In order to achieve this, a longitudinal and unique case study, i.e. a case that aims to understand a unique or extreme situation over a period of time (Bryman, 2016; Flyvbjerg, 2006), is utilized. Case studies usually concentrate on a single case study which is suitable for testing theory or as a pilot for further case studies. It has been argued that case studies are important for the development of in-depth understanding of specific contexts, thus enriching disciplinary knowledge and insights (Flyvbjerg, 2006). However, case studies have traditionally been regarded as "…lacking rigour and objectivity …." (Rowley, 2002, p. 16) and they have been critiqued for creating difficulties for generalization of findings (Rowley, 2002; Bryman, 2016). These claims have been countered by arguing that theoretical and methodological rigour can be applied to case studies, and whether generalization is necessary has to be questioned (Rolwely, 2002). For this thesis, a single case study to examine the role of visualizations in decision-making processes was deemed

appropriate because of the insights that would be gained from focussing on a situation where coastal management issues are longstanding, and where the process for developing future options may be relevant for the visualizations and engagement literatures.

Although most case studies usually have a longitudinal component (Bryman, 2016), the benefit of using a longitudinal research design is that it allows for the study to be undertaken over a long period of time in the same location. Limitations of longitudinal studies are recognised (e.g. time and resource constraints, ensuring participant involvement, acknowledging changes in local circumstances, participation fatigue). A longitudinal case study for this research was applied to enable an iterative approach to the creation and evaluation of visualizations, reflecting suggestions in the literature (Bishop *et al.*, 2013; Schroth *et al.*, 2015; O'Neill and Graham, 2016).

3.2.1 Epistemological and ontological considerations

The philosophical position underpinning a research project affects the gathering and interpretation of data collected throughout the study (Guba and Lincoln, 1994). Scotland (2012) explains that epistemology is concerned with what it means to know something, while ontology is concerned with how things work and what constitutes reality.

Positivism is a philosophical view rooted in the natural sciences, according to which facts are gained through direct observation and experiences, and examined in an objective manner. The philosophical view of Interpretivism –more prevalent within the social sciences- is counter to Positivism, maintaining that the subjective meanings of actions in the social realm need to be interpreted (Bryman, 2016). In between is Realism; its epistemological perspective is that both natural and social sciences may apply the same approaches to data collection, analysis and interpretation, based on the notion that there is a reality which can be understood independently of human interpretation of it (Byman, 2016). A realist approach therefore seeks to identify, describe and understand the structures, mechanisms, and conditions that cause actions or events (Sayer, 2000). On the other hand, critical realism is thought to address some of the critiques of realism, as it posits the importance of social constructs when understanding reality (Bryman, 2016; Burr, 2015). The epistemological position of critical realism recognises the social and natural realities, and maintains that the structure of the social world must be understood to make sense of how reality is perceived and presented (Sayer, 2000; Bryman, 2016).

More in line with Interpretivism is the philosophy of social constructivism, which maintains that social constructs and views define and will affect what constitutes reality; reality is

continually being revised by social actors (Bryman, 2016). However, social constructivism also highlights the importance of language and culture in shaping individuals and interpreting events (Burr, 2015). It is relevant to note that there are similarities between the epistemological positions of critical realism and social constructivism. The similarities between these two epistemological positions can be summarized by their acceptance that social factors influence our observed reality and our observed reality is not reality in actuality (Bryman, 2016; Burr, 2015).

This research is grounded in a critical realist ontology and epistemology, mindful of the connections with the social constructivist epistemology as outlined above. This is reflected in the research objectives presented in Chapter 1 (see Section 1.2) which focus on understanding the social processes that influence decision-making. Objective one explicitly aims to understand the multiple realities of coastal change and the future for each participant. Furthermore, the longitudinal component to this study considers that these realities can change over time. Therefore, both natural and social realities are the focus of this research in the context of coastal change; their implications affect future decisions.

3.2.2 Mixed methods

A mixed methods approach is used throughout the phases of data collection in this thesis. Robson and McCartan (2016) and Bryman (2016) discuss the argument that qualitative and quantitative research methods are incompatible because they are associated with different paradigms. However, in line with the position of critical realism (see Section 3.2.1), this type of design utilizes qualitative and quantitative methods and data types which support and inform the other (Bryman, 2016; Robson and McCartan, 2016). The use of mixed methods has been suggested in the context of evaluating visualizations, which this thesis aims to explore. Bishop *et al.* (2013) propose considerations for evaluating visualizations, which the authors suggest the use of a combination of various techniques to confirm findings of other techniques that may be utilized, including quantitative and qualitative techniques. The following sections introduce the various phases of data collection and the related methods utilized in each.

3.3 Phases of data collection

Data was collected in six phases from August 2016 to September 2018. The following sections discuss the recruitment process and methods employed for each phase of data collection beginning with the exploratory interviews (Section 3.3.1). Sections for the individual phases are discussed, as well as preparations, i.e. creating surveys (Section 3.3.2) and visualizations (Section 3.4.5), for different phases of data collection. The ethical considerations of this study are discussed in Section 3.3.10. This section concludes with a brief discussion pertaining to the methods of data analysis. Figure 3.1 depicts the phases of data collection with the months and years that data collection took place, as well as the number of participants in each phase.

Figure 3.1: Timeline of the phases of data collection during this study, including the number of participants in each phase and external events that happened around the same time of each phase of data collection.

3.3.1 Exploratory interviews

Exploratory interviews aimed to gain insight to the issues that villagers are most concerned about, as well as general views of the village. The North Norfolk District Council provided a contact in the village and then the snowball method was employed to recruit more participants to participate in the initial phase of study. Participants were primarily contacted via phone to schedule exploratory interviews. The questions asked were aimed at better understanding the history of erosion, important physical locations in the village, and how people perceive future changes (see Appendix 1.1).

From September to October 2016 18 exploratory interviews were conducted with 18 participants of varying backgrounds. Most were over the age of 50. Five of these interviews were with participants who have lived in the village all their lives, five other participants were from the Norfolk area, and the rest of the participants were from other areas of England and had moved to the village for various reasons. Four of the participants had mobility issues due to old age and it was decided that they would not be asked to participate in future phases of the research that required meeting at a location other than their houses. Section 4.3.2 discusses the findings from these exploratory interviews.

3.3.2 Creation of surveys in preparation for the focus groups

This thesis draws upon the Community Awareness to Action (C2A) framework, which Sheppard (2012) first developed because they felt that "seeing", the individual's experience with information through visuals or within the physical landscape, was missing from other methods of engaging communities in decision-making. The C2A framework is based on literature pertaining to visualizations, perceptions, and behaviours, landscape-based approaches, and landscape architecture tools. The C2A framework also outlines external influences identifiable within several of its stages. There are seven stages in the C2A framework including: *hearing, seeing, values, knowing, recognizing, caring,* and *action* (see Table 3.1). Each stage in the framework has unique perceptual barriers hindering the individual moving towards action. Table 3.1 adapts work from Sheppard (2012) to define C2A stages, and include examples of perceptual barriers to climate action for each stage. The C2A framework is not meant to be linear, but that there can be multiple pathways to actions. Furthermore, the individuals in the community can be at several of the stages that affect each other and there is not a sequence that must be followed.

Table 3.1: Examples of perceptual barriers for each stage of the C2A framework adapted from Sheppard's (2012) Climateville example.

Stage	Description	Examples of barriers
Hearing	The individual has been exposed to second-hand information primarily conveyed verbally and in written formats. (This does not include first-hand experiences.)	An individual may not have the necessary understanding of an issue at this stage if they have not had (specific) information clearly conveyed to them. Not understanding basic concepts may also not allow the individual to improve in the next stage of the framework.
Seeing	The individual has seen information through visual media or within the community landscape.	The individual may not be able to see the impacts of the issue they are facing. If they are not living in the community or the impacts are not inherently evident, then the individual may be stalled in their understanding at the *seeing* stage.
Values	The impacts of society and personal world views on how an individual perceives an issue.	As discussed in section 2.3, there are many considerations such as framing of an issue, and past experiences that will affect perceptions of issues.
Knowing	The individual is able to process and understand the information communicated to them.	The individual at this stage may not have appropriate information that is correct and unbiased. Without clear and accurate information the individual may not improve in this stage.
Recognizing	The individual is able to recognize the changes in the landscape and understand the significance.	If the individual still lacks key evidence of community impacts or they are unable to see these impacts themselves, then they will be unable to *recognize* an issue. The individual could be overlooking important information or have misunderstandings about the issues they face.
Caring	There is an emotional response and a response towards bettering the community.	Place attachment and identity, discussed in section 2.3.3, are examples of the way in which emotional connections with a community can affect willingness to change/act.
Action	The individual is able to follow through with an action to create change or develop a plan for further adaptation and development.	If the individual does not act, it could be caused by the individual at any stage not being able to overcome the perceptual barriers. External barriers such as funding can also contribute to a lack of action.

The identification of the perceptual barriers can be used to distinguish the needs of the individual and determine the purpose of the visualizations and for that reason, the C2A framework becomes a valuable tool when deciding which visualizations would be most suitable for a situation. The proposed implications of using visualizations in relation to the C2A framework is to help the individuals overcome their perceptual barriers. Sheppard (2012) emphasizes that this framework is not an exact model for perception shifts, but a way for the public to deal with the problems associated with diverse perspectives. Daniels (2018) worked at expanding the hearing stages of the C2A framework through the inclusion of two-way communication, the results of which found that dialogue was important in overcoming barriers and that there was a strong relationship between age, concern, and engagement. This case study is one of the first to utilize the full framework by drawing from the literature on psychology and management to expand on how this framework can be used to identify barriers and opportunities in decision-making processes, thus leading to new strategies for communication.

The stages of the C2A Framework, informed by descriptions of potential barriers in Shepard (2012), were used to create survey questions. The surveys consisted of open-ended questions and 5-point Likert scales. For the Likert questions, the participants could choose from five options on a Likert scale: 5="Strongly Agree", 4="Agree", 2="Disagree", 1="Strongly Disagree", and 3="Unsure". The questions aimed to understand participant's feelings about the future and coastal change in the village, and to track participant's perceptions at each point in time.

Each of the surveys contained 21 Likert scale statements that were related to the barriers to action of each stage of the C2A framework described by Sheppard (2012) in his example of Climateville. These statements were created to identify potential barriers for each participant and understand how their views have changed over time, if at all. The statements for the "values and caring" stages of the C2A framework were taken from the revised New Environmental Paradigm (NEP) Scale shown in Hawcroft and Milfont (2010), p. 145. In order to make sure that the survey was not too long, only 5 statements from the revised NEP scale were used. The statements were chosen so that there was a balance of the types of questions asked from the revised NEP scale, so that possible pro-environmental values, values that mean a person is more likely to act, could be identified for each participant (Hawcroft and Milfont, 2010). These statements can be found in Appendix 1.2.1.

3.3.3 Focus groups

Based on the responses during the exploratory interviews and the literature on research methods it was decided that focus groups should be conducted to gain more focused information about the village and the participants' views of the village's future. A focus group allows for a better understanding of why participants view a topic a certain way through interaction between participants (Bryman, 2016). Critiques around focus groups are around the inability of a focus group to satisfactorily gauge an individual's views and opinions or the strength of these (Robson and McCartan, 2016). To avoid this, participants were given surveys, see Section 3.3.2, which targeted specific views of the individuals- which was based on the exploratory interviews and C2A framework.

Participants from the exploratory interviews were asked to return for focus groups after an analysis of the exploratory interviews. Three focus groups were scheduled based on availability of all participants from the exploratory interviews. A short description of the project indicating focus group times, and inviting people to participate in them, was put into the village newsletter and the local magazine, The Crab Tales (Issue 98). This method of advertisement was not successful at eliciting more participation from the community. In total 10 community members were able to attend the focus groups, including one new participant who did not participate in the exploratory interviews.

The focus group discussion began with the participants being asked to draw the village and explain what they drew. Drawing on the literature pertaining to place attachment, this activity aimed to identify important physical locations in the village as well as to open up the discussion about current issues and concerns in the village (Lewicka, 2011). Questions were then posed to the group with the researcher acting as the facilitator. This included discussions about what types of visualizations the participants would like to see (type and of what issue/place) the concerns of the participants in terms of coastal erosion and management, and community engagement, and what role participants wanted the project to play for the village (see Appendix 1.2.1 for full focus group protocol). These questions were intended to inform the creation of the visualizations that would be used in the workshops (see Section 3.3.6) by identifying a purpose for visualizations, and what types of visualizations would be feasible to use in the context of the case study (Hine *et al.*, 2014, Sheppard, 2012; Nicholson-Cole, 2005; Scannell, 2013; Chou *et al.*, 2009).

3.3.4 Village questionnaire

The focus groups highlighted that, in order to gain a better insight to the views of the whole village, the project needed to be opened to the wider community outside the core group of community leaders and those who frequently participate in village events. To do this, 168 copies of a village questionnaire survey were distributed to all the houses in the village, see Appendix 1.3. Sixty-six individuals responded to the survey and 30 different respondents gave contact information.

A mixture of open and closed questions were asked throughout the survey to collect quantitative and qualitative data. The questionnaire included questions about sense of community (modified from the BSCI; Long and Perkins, 2007), what participants felt were barriers in dealing with coastal erosion, what visualizations participants would like to see, as well as demographic and personal information. The questions were aimed at identifying potential barriers to adaptation and what potential visualizations the community would like to see. Demographic information was also inquired about to better understand who is being engaged and to help inform future methods of communication with the community. Respondents were given the opportunity to provide contact information if they wished to be contacted to participate in future discussions.

3.3.5 Preparation for the Workshops

The aim of the workshops were to discuss future change in the village and engage participants in decision-making using visualizations. In order to do this, there were some preparations that needed to occur prior to holding the workshops. This section begins by detailing the creation of the visualizations presented at the beginning of the workshops, followed by the modification of the focus group surveys.

Creation of visualizations

The literature on visualizations suggests tailoring visualizations for use by the individuals who will be engaging with them (Hine *et al.*, 2014, Sheppard, 2012; Nicholson-Cole, 2005; Scannell, 2013; Chou *et al.*, 2009). Based on the exploratory interviews, it was shown that most of the participants were not used to using technology on a regular basis, and that the internet and phone service in the village was also a consideration that needed to be taken into account when deciding which types of visualizations and visualization software would best serve the purposes of what the community wanted to accomplish. The participants stated in the exploratory interviews that word-of-mouth was the most common form of news communication in the village, but the responses in the community survey suggested that

television, newspapers, and radio were the most used news sources. This indicated that older forms of communication were more widely used and thus the visualizations should be considerate of how people were used to being communicated with. For these reasons, PGIS was not considered as an approach when creating the 3D aerial VNS visualizations as it tends to rely on online platforms (i.e. Jankowski, 2011 and McBride *et al.*, 2017).

The purpose of the 3D aerial VNS visualizations was to spark discussion, and help the participant visualize the landscape and how it could change in the future. Basic visualizations of the village from different angles were created using Visual Nature Studio (VNS) 3 (3D Nature, 2015). VNS was chosen because of the ability to modify the loaded landscape with 3D images, terrafactors, and ecosystems. Environment Agency (EA) 2 meter 2015 LIDAR Digital Terrain Model (DTM) and 2015 Ordinance Survey (OS) Master Map of the village was used to create the topographical layout of the village and overlay specific ecosystems and ground cover types to make the visualizations a semi- realistic representation of the village. Esri AcrGIS was used to isolate the vectors for Trimingham. The important landmarks that were identified in the previous phases of this project were included so that participants could identify where everything was in relation to the landmarks in the village. Figure 3.2 shows the VNS interface including a list of vectors, and different views of the village, including a rendered image of the new village hall (bottom right).

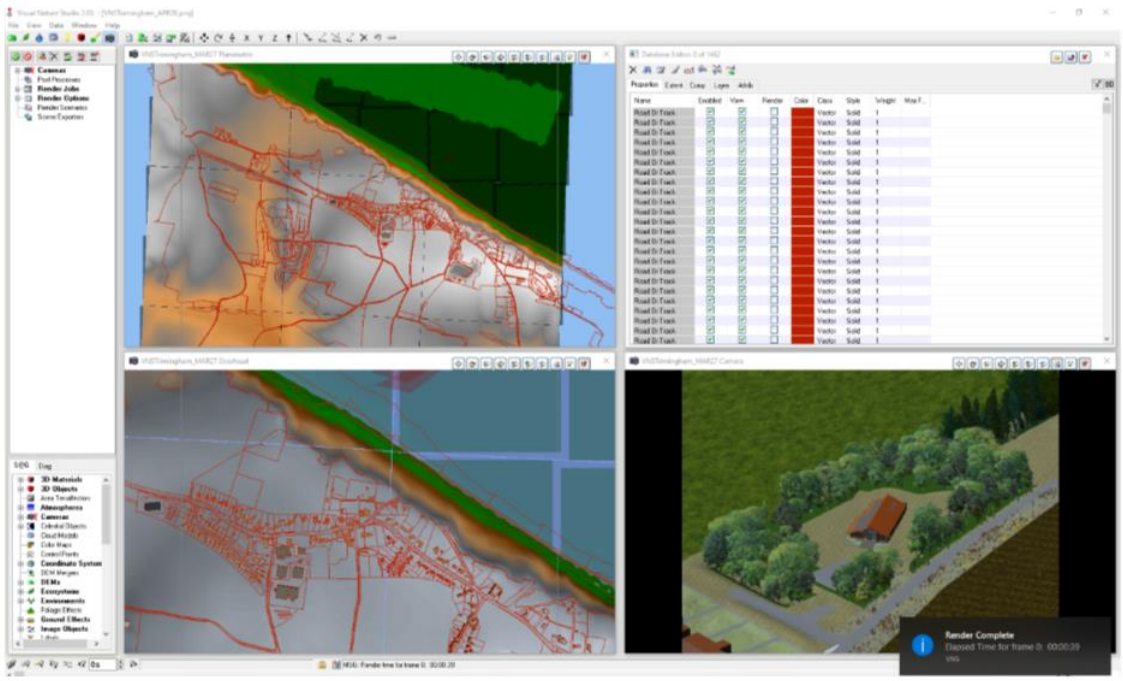


Figure 3.2: Visual Nature Studio 3 interface including a list of vectors (selected and cut using ArcGIS), two un-rendered views of the village, and a rendered view of a 3D model of the new village hall.

At the time these 3D aerial VNS visualizations were created, there was a lack of data of future cliff movement that could be used to visualize future change to the coast of Trimingham. Since the 3D aerial VNS visualizations were created there has been more research to increase understanding about complex cliff movement. Recently, the Environment Agency published a report highlighting the complexity of modelling coastal change in areas where the geology of cliffs are complex (such as the cliffs in Trimingham), and suggested that further research be done to improve modelling of cliff movement and interactions with coastal structures (Lopez De San Roman Blanco *et al.*, 2019). Further highlighting the challenges of communicating the complexity of coasts in North Norfolk, the National Coastal Erosion Risk Map (NCERM) does not include complex cliffs such as those found in North Norfolk, which can erode unpredictably over multiple landslides (Committee on Climate Change, 2018). The lack of information available to inform decision-making has been mentioned in the literature as a hindrance to decision-making processes (Moser and Ekstrom, 2010). The diversity and complexity of the North Norfolk coast, as well as social considerations, could create challenges for coastal communities and decision-makers to manage and adapt to future changes. However, the purpose of the 3D aerial VNS visualizations were to aid in the discussion of future options, and as a template that future options could be visualized during the workshops. Thus the information available at the time was satisfactory to use when creating the 3D aerial VNS visualizations, shown in Figure 3.3.

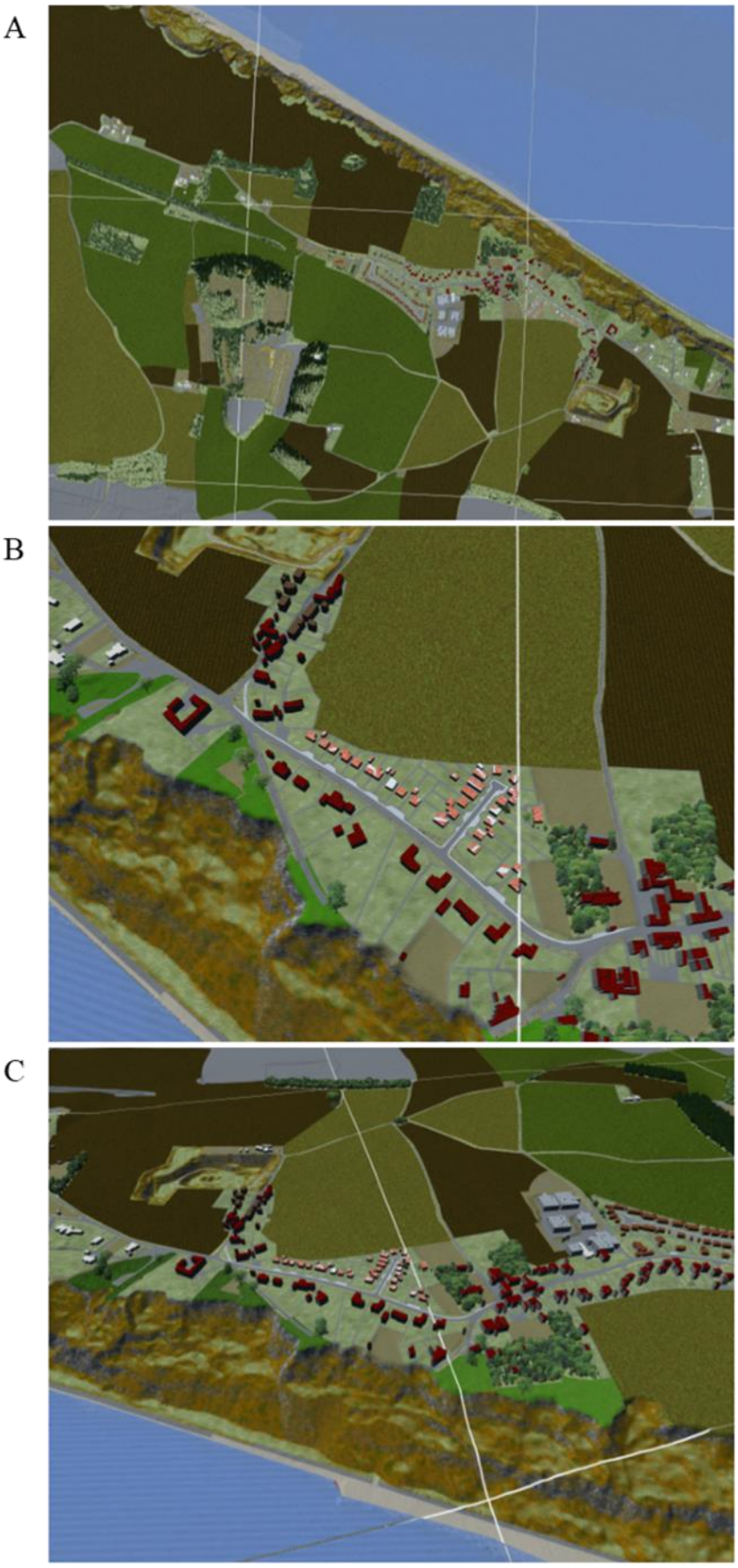
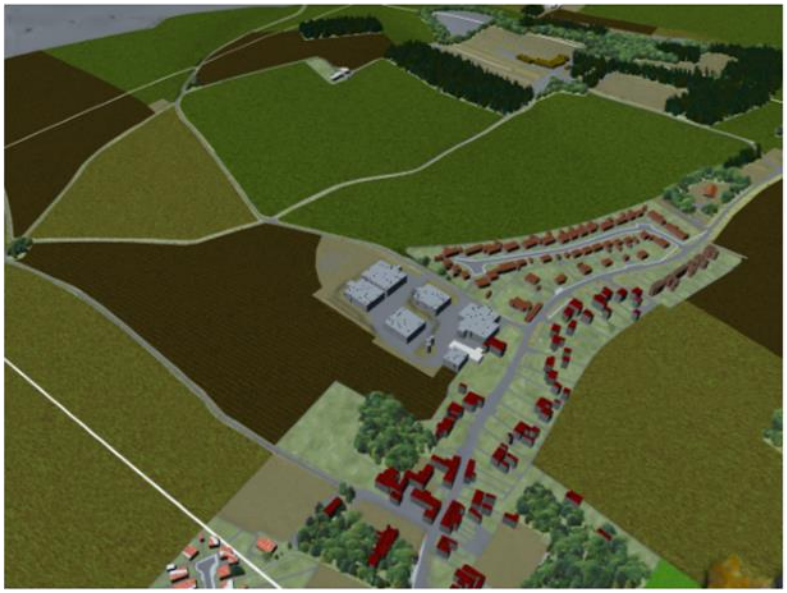


Figure 3.3A-C: Initial visualizations were created using VNS to be presented to participants in the workshops. 3.3A depicts an aerial view of the entire village. 3.3B-C show aerial views from different perspectives and of different parts of the village.

D



E

Figure 3.3D-E: Initial visualizations were created using VNS to be presented to participants in the workshops. Figure 3.3D show aerial views from different perspectives and of different parts of the village. Figure 3.3E depicts the new village hall.

Figure 3.4 shows a visualization created using Esri Story Maps online application to show change over 100 years using two maps, 1915 and 2015, and a sliding centre bar. A Story Map was created to compare a map of the village in 1915 and 2015 OS Master Map data. This 100-year comparison was used because most of the participants indicated in the interviews or focus groups that they wanted to see a past, present and future comparison of the village landscape. This application was useful in that it is accessible online and open to the public to view for free. The map is also able to be embedded into web pages and presentations. Finally, a birds-eye-view map of the village was printed out on an A4 so that participants could draw and modify different village features on it during the workshops.

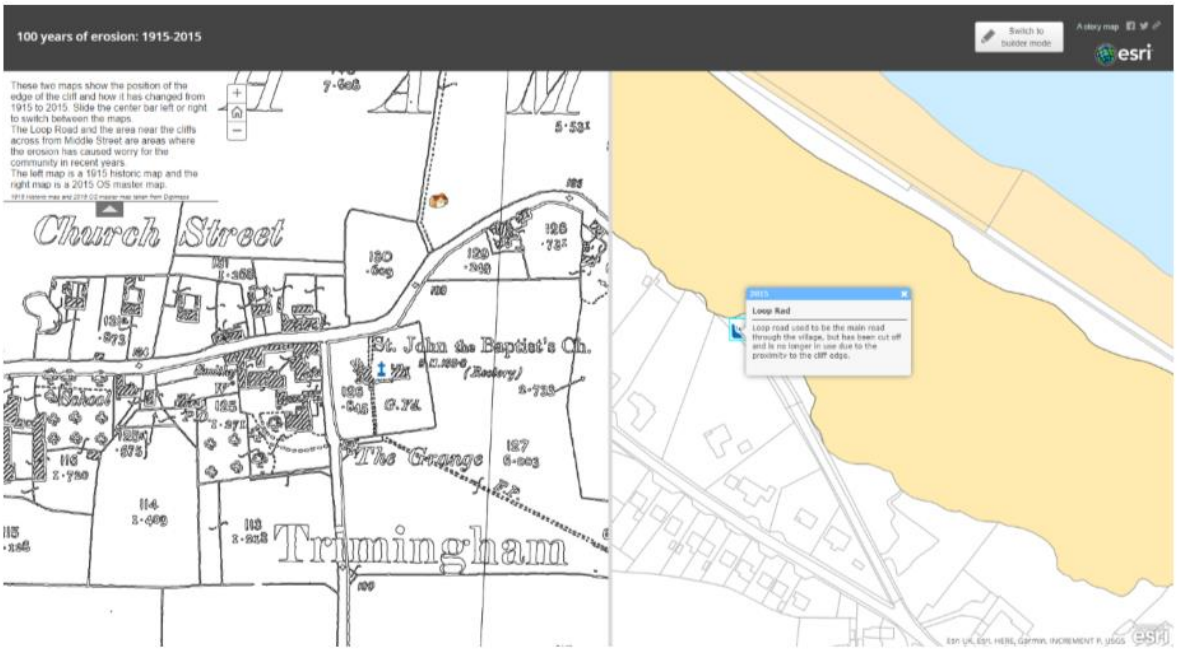


Figure 3.4: ESRI Swipe Style Story Map created using a historic 1915 map and 2015 OS Master Map data. Indicators for physical locations discussed during the exploratory interviews and focus groups.

While creating the visualizations using VNS, the DTM files were too large to download multiple files onto VNS without slowing down the program. VNS would freeze and shut down if too many changes to the landscape were made in a short period of time. To overcome this, only the DTM files necessary would be left active on VNS, no programs using large amounts of computing power, such as ArcGIS and 3DSMax, would be used at the same time as VNS, and the project was saved periodically. Another issue that was relevant to the presentation of the visualizations was the grid lines that showed because VNS splits the DTM file into 4 squares that do not perfectly align. This meant that larger scales would show the grid lines. The DTM files could be merged on ArcGIS so that there would not be gridlines. However, there were issues with the size of the merged file being too large to convert into a usable format on VNS; thus, the separated tiles were kept. Section 3.3.7 outlines how the issue of visible gridlines was overcome.

Modifying surveys and including a post survey

For the sake of avoiding participation fatigue (Capstick *et al.* 2015), the 21 statements from the focus group surveys, Appendix 1.2.1, were shortened to 11 statements for the workshops, Appendix 1.4.1. After participants completed the surveys from the focus groups it became evident that participants were having difficulty responding to the statements based on the NEP scale. Furthermore, place attachment became a major theme during the focus group

discussions; thus it was decided that the statements should be modified to reflect this change. The BSCI was decided to be the most relevant set of statements to identify potential barriers because they gauged values relating to place attachment and efficacy in relation to local communities. Long and Perkins (2007) use the BSCI in a U.S. city, thus terminology was changed to be relevant to the rural U.K. The use of BSCI is discussed at greater length in relation to the findings of this study in Chapter 6. Table 3.2 shows the final C2A statements used after the focus groups.

Table 3.2: The statement variable ID used in the PCA (numbered 1 to 11 in the left column) with the corresponding C2A statement and stage. Participants were asked to indicate their dis/agreement with the statements using the Likert scale indicated in the table. The negatively-phrased statements were reversed during coding (indicated in italics).

Variable ID	**Statement**	**C2A stages**
1	The village should remain a peaceful and quiet place to live. *Modified Statement: The village should evolve and change.*	Seeing
2	Government agencies are trustworthy sources of information pertaining to coastal change in the village.	Hearing
3	There are more important priorities than coastal erosion that keep me from fully participating in village discussions. *Modified statement: There are not more important priorities than coastal erosion that keep me from fully participating in village discussions.*	Knowing
4	There is a lack of community engagement from other villagers for thinking of ways to deal with coastal change. *Modified statement: There is community engagement from other villagers for thinking of ways to deal with coastal change.*	Recognizing
5	The village should adapt and develop to deal with coastal change.	Seeing
6	Funding issues can prevent small communities from implementing plans to deal with coastal erosion. *Modified statement: Funding issues do not prevent small communities from implementing plans to deal with coastal erosion.*	Acting
7	There are areas in the village that are more at risk than others for coastal erosion.	Recognizing
8	It is important for communities to deal with coastal change in a positive, proactive manner.	Acting
9	I have almost no influence over what this village is like. *Modified statement: I have an influence over what this village is like.*	Values
10	If there is a problem in the village people who live here can get it solved.	Caring
11	I feel confident that I have been given the chance to influence future decisions in the village through my participation.	Values
Scale: 5= Strongly agree, 4= Agree, 2= Disagree, 1=Strongly disagree, Unsure= null		

Building on the modifications to the surveys from the workshops, and drawing upon the suggestion by Bishop *et al.* (2013) to use post-workshop surveys, post-workshop surveys were created. Along with the C2A statements, the survey after the workshops (and exhibition, see Section 3.3.8) included statements which aimed to understand the effectiveness of the visualizations using the measures of an effective visualization, see Table 3.3, as described in Section 2.4 (Sheppard, 2012). 5-point Likert scales were also used for these statements. Full surveys for each phase of data collection can be found in Appendix 1.4.1.

Table 3.3: Statements used in the questionnaire adapted from the descriptions of the measures of an effective visualization from Sheppard (2012).

Statement	**Measure of an effective visualization**
The visualizations were clear and understandable.	Clarity
The visualizations were engaging (i.e. interesting and accessible).	Engagement
The visualizations made the issue of coastal change more personal.	Connectivity
The visualizations helped to think of positive futures for the village.	Trust
The visualizations were an accurate representation of the current village.	Clarity
The visualizations were respectful towards the views of the participants.	Trust

3.3.6 Workshops

Participants who participated in previous stages of data collection were contacted to participate in the workshops. Based on the exploratory interviews, focus groups, and community surveys, the participants were grouped into three workshops that were designed to be comprised of participants who showed i.) moderate views on change in the village, ii.) openness about potential changes in the village, iii.) and hesitancy about change compared to other participants. These groupings were decided based on responses from the exploratory interviews and focus groups. During the focus groups there were also some conflicts that arose because of the discussion and the grouping was intended to manage possible conflicts

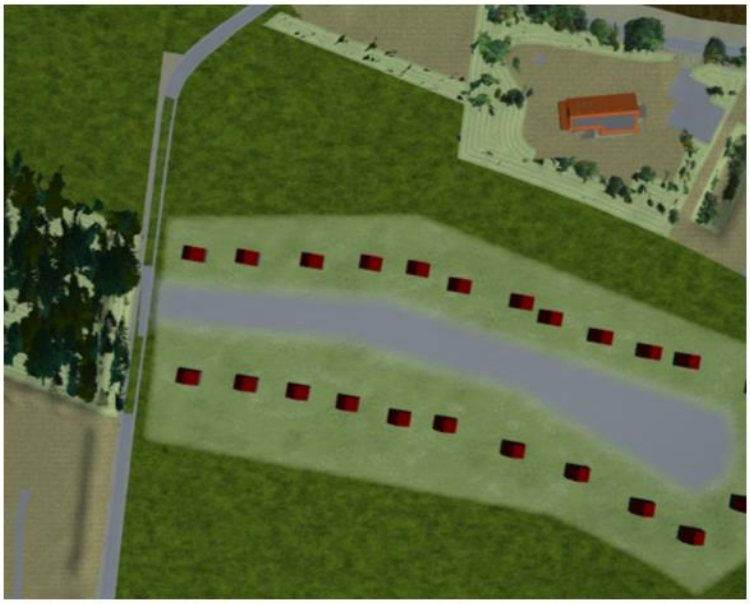
of interest and to avoid any major confrontations between the participants during the discussion. This grouping also aimed to encourage open discussion from all participants, including those with more moderate views- who were sometimes also less vocal in the focus groups. Thirteen participants attended the workshops, including eight returning participants, one participant invited from the village questionnaire responses, and two new participants that came with another participant of the workshops. The purpose of the workshops was to not only discuss issues occurring in the village, as with the focus group, but to also go through a decision-making process that would have an output at the end of each workshop. In the case of the workshops these outputs would be several visualized future options.

The design of the workshop was based partially on the first three generic components of risk management reviewed in Chapter 2, outlined by Renn 2008: i.) option generation, ii.) option assessment, iii.) option evaluation and selection. Similarly, The Process of Adaption Framework (PAF) by Moser and Ekstrom (2010) also contributed to the design of the workshop. The PAF consists of nine stages including: i) Detect the problem, ii) Gather/ Use information, iii) Define the problem, iv) Develop options, v) Assess options, vi) Select options, vii) Implement options, viii) Monitor option and environment, and ix) Evaluate. The stages from implementation onwards were unable to be completed within the scope of the workshops. Section 2.2.1 outlines the similarities and differences between these frameworks. Drawing on these two frameworks, the workshop was organized into four sections: discussion of general views of Trimingham (stages i-iii of PAF), visioning of the future part 1 (option generation/ Develop options), discussion of future changes (option assessment/ Assess options), and visioning the future part 2 (option evaluation and selection/ Select option). The workshop protocol can be found in Appendix 1.4.

Prior to the workshops, participants were asked to complete a survey to gauge their thoughts and feelings about change before the activity. Following this, the participants were asked to draw the areas where they believed change would occur in the next ten years that may increase the resilience and long-term viability of the community and the village. They each generated options for increasing the viability of the village in the future and then they were given the opportunity to share their ideas with the group. This generated a variety of options and gave the participants opportunities to share their thoughts and views so that they could then discuss, as a group, the different options that everyone thought of. The facilitator of the workshop wrote down the different options on poster paper that were then organized into larger themes.

In order to focus the discussion even more, the participants were asked to take three coloured sticky dots, red, yellow, and green, and put the green dot on the option theme they felt was the most important to discuss, the yellow dot on their second choice, and the red dot on their third choice. This ranking activity was inspired by Sheppard and Meitner (2005), who used a point allocation system with participants to create a suitability index for forest management scenarios. In this study, the top three themes were discussed and, if participants desired, other themes would also be discussed if there was still time available. The following discussion gave participants the opportunity to discuss reasons for or against certain options for the future of the village in more detail. Specific options were notated on poster paper by the workshop facilitator as they were being discussed. After this more in-depth discussion pertaining to the main themes, another ranking exercise was done (using the same format as the previous ranking exercise), to decide on which specific future options participants believed to be most beneficial for the village. After this final ranking exercise, participants were given a short break so that the initial 3D aerial visualizations of the village could be modified to incorporate the top three options. The top three future options were visualized during this time. Future options varied between the workshops, and options such as drainage were unable to be visualized because they are under the ground -which was unable to be visualized with the available data and software. Future housing, road development, and changes to existing infrastructure were the three main themes for future options, extracted from the workshops. The visualizations created during the workshops were basic and showed the changes suggested using basic shapes, lines, and pre-set 3D images and ecosystems. These modified visualizations (see Figure 3.5), were shown to the participants after the session was resumed, and participants were given another opportunity to discuss if the options for future changes depicted what was expected or wanted. Changes were made again during this final discussion if the participants chose to change what they wanted to see visualized. This discussion was meant to give participants the opportunity to evaluate and select the options they would like to see visualized (option evaluation and selection). The workshop participants were asked how they believed their neighbours and friends in the village, not present at the workshops, would react to the suggestions made and agreed upon by the participants.

A



B

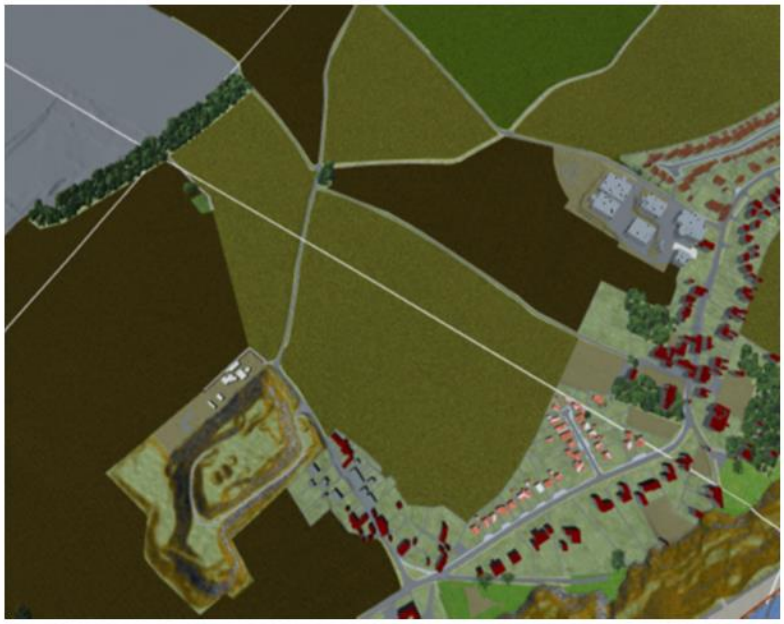
Figure 3.5A-B: During the workshops participants had the opportunity to contribute to visualizations of future options. Figures 3.5A and B were created during the first Workshop, Figures 3.5C and D during the second workshop, and Figures 3.5E and F were created during the third workshop.

C

D

Figure 3.5C-D: During the workshops participants had the opportunity to contribute to visualizations of future options. Figures 3.5A and B were created during the first Workshop, Figures 3.5C and D during the second workshop, and Figures 3.5E and F were created during the third workshop.

E



F

Figure 3.5E-F: During the workshops participants had the opportunity to contribute to visualizations of future options. Figures 3.5A and B were created during the first Workshop, Figures 3.5C and D during the second workshop, and Figures 3.5E and F were created during the third workshop.

After participants were satisfied that the visualizations depicted adequately the future options they selected, participants were asked to complete another survey to assess if there are any changes to participants' thoughts and feelings about future change. This survey was the first instance that the use of visualizations were assessed using quantitative methods. The surveys also consisted of the same C2A statements from the survey at the beginning of the

workshops. The surveys were given to participants in the same packet. This became an issue when some participants recognized the C2A statements and copied their answers on the survey after the workshops. At the time the researcher tried to make sure that the participants did not look at their previous responses when answering the post-workshop survey questions; however, during analysis it was evident that some participants did do this.

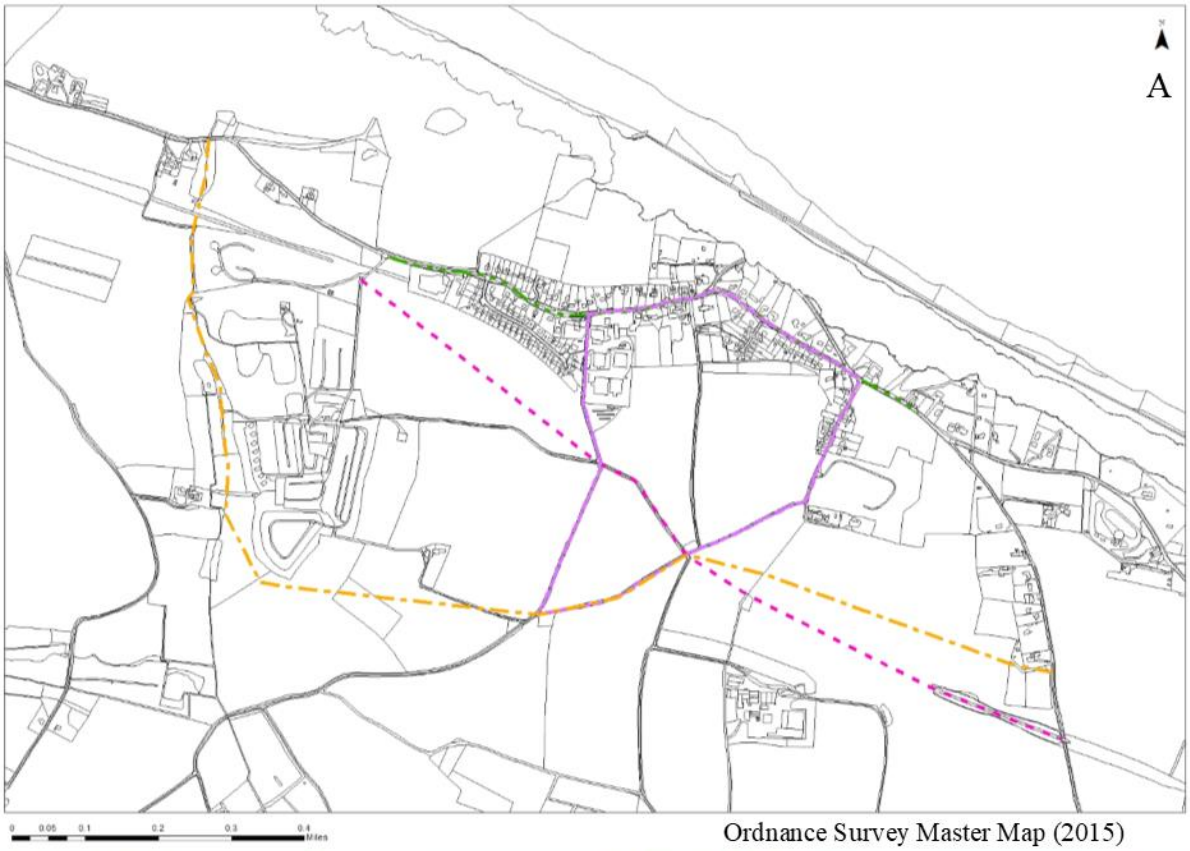
3.3.7 Modification of visualizations

Changes to the workshop visualizations after initial modification were primarily changes to make the scene more realistic and plausible. After the workshops, the visualizations were made more realistic and the camera angles were changed. The changed camera angles, as well as photo editing software, helped to overcome the issue of visible gridlines from the DTM (see Section 3.3.5). To achieve a more realistic visualization, Autodesk 3DS Max (2018) and SketchUp were used to create 3D models of buildings and structures to add realism to the visualizations in VNS. These two programs had the capability to convert 3D objects from the program format to .obj and .3ds files, which are compatible with 3DS Max and VNS. The University of East Anglia also had 3DS Max resources from the School of Computing Sciences that were available for use. Esri ArcGIS was used to create point and shape files to assign locations for physical landmarks in VNS. The models created and edited using 3DS Max and SketchUp were also assigned to points. VNS was used to modify the terrain using terrafactors. Table 3.4 lists the data used to create the visualizations used in this study, along with the file type, and its source.

One of the limitations that was highlighted while modifying the visualizations was the use of multiple programs that required a lot of computing power. This list of programs included ArcGIS, 3DSMax, VNS, and NVIVO. If more than one of these programs were used at the same time then the programs, and sometimes the computer, would freeze or shut down. Another issue that occurred specifically with the 3D models, was converting the models into a usable format on VNS without the model changing. VNS only allows a certain number of shapes and materials per model to be uploaded onto the program. This caused models to load onto VNS incomplete, i.e. missing shapes, and the models would lack realism. To bypass this issue the shapes were combined in 3DS Max and given the same material. This took away some of the detail, but it was necessary to be able to create some level of realism in the scenes. As stated before, VNS would freeze or shut down when too many changes were made in a short period of time. The solution for this issue as discussed in Section 3.3.5 was implemented during the creation of the visualizations shown during the exhibition (see Figure 3.6).

Table 3.4: Data used as base layers and 3D models to create the visualizations presented in this study. This table includes the file type and source for the data.

Title	File type	Source
Base Layers		
2015 OS MasterMap Topography Layer	.shp	Digimap: http://digimap.edina.ac.uk
2016 OS 2M Terrain Model	.elev	Digimap: http://digimap.edina.ac.uk
1888-1915 County Series 1st Revision	.tiff	Digimap: http://digimap.edina.ac.uk
3D Models		
Car	.w3o	TurboSquid: https://www.turbosquid.com/3d-models/free-volkswagen-golf-3d-model/630040 Edited using 3DSMax
Wooden tables and chairs	.obj	TurboSquid: https://www.turbosquid.com/3d-models/free-obj-mode-dining-set-corona-chairs/889123 Edited using 3DSMax
Trimingham village hall	.w3o	Provided by SMG Architects Ltd Edited using 3DSMax
Pilgrim Shelter	.obj	Provided by the Urban Modelling Group at the School of Computing Science (University of East Anglia) Created using 3DSMax
Housing duplex	.w3o	Provided by the Urban Modelling Group at the School of Computing Science (University of East Anglia) Created using 3DSMax
Housing bungalow	.w3o	Provided by David Drinkwater (University of East Anglia) Edited using 3DSMax
Seawall	.obj	Created using 3DSMax



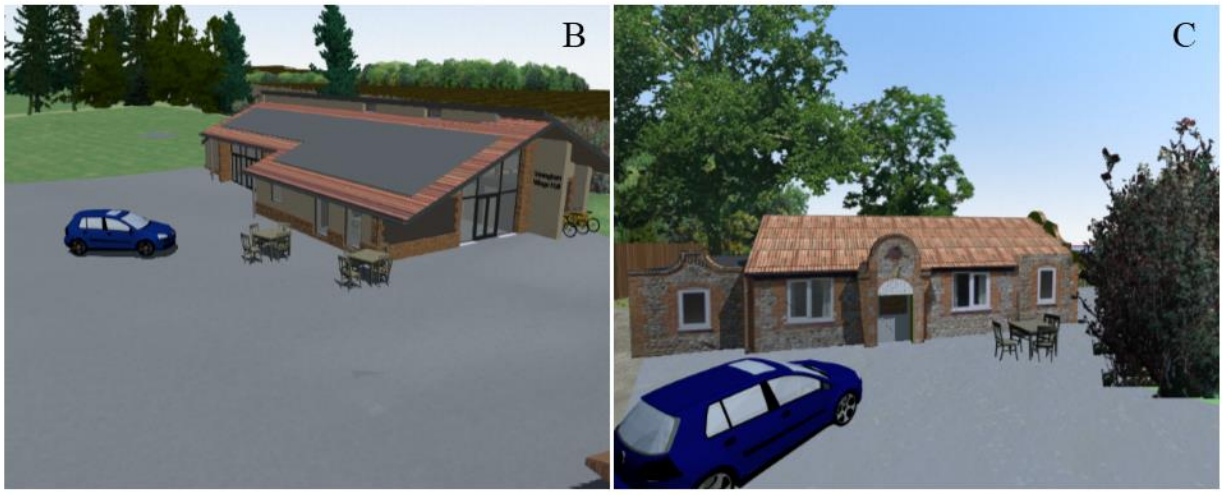


Figure 3.6A-C: Visualizations modified after the workshops. Figure 3.6A depicts an aerial view of the village showing proposed changes to the roads in the village. Figure 3.6B depicts a ground view of the new village hall and Figure 3.6C depicts a ground view of the Pilgrim Shelter. These figures were created using the process described in section 3.3.5 and 3.3.7.

D

E

F

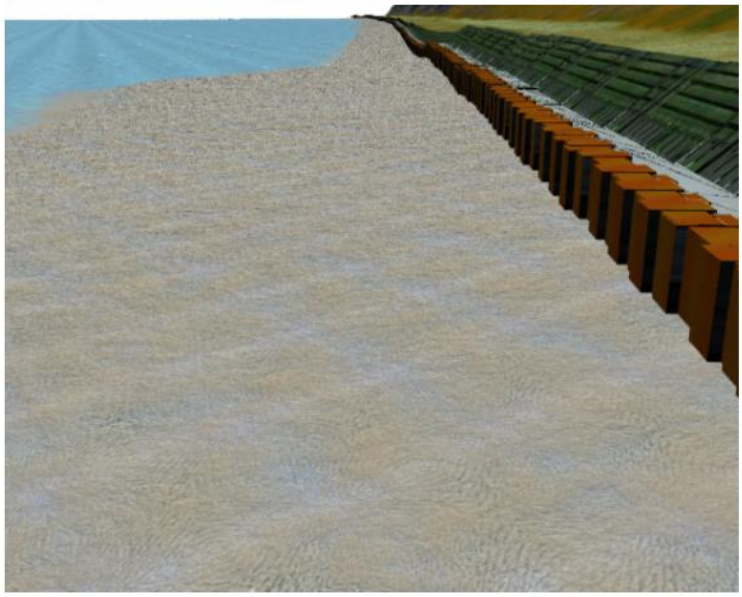


Figure 3.6D-F: Visualizations modified after the workshops. Figure 3.6D and 3.6E depict housing options behind the new village hall and Broadwood Close. Figure 3.6F depicts how the beach along the village would look like without the dilapidated sea defences. These figures were created using the process described in section 3.3.5 and 3.3.7.

3.3.8 Community exhibition

In order to gain a better understanding of the views towards future change and the generated visualizations from a wider population in the village, a community exhibition was organized in November 2017. In preparation for the exhibition, the modified visualizations, depicted in Figure 3.6, were shown to landscape planners/ managers to give feedback on the feasibility of the options for long-term viability of the village that were generated during the workshops. This was done to aid in managing expectations pertaining to what can be accomplished in the village. After their suggestions were taken into account, posters were created with the modified visualizations. The visualized options were grouped into three categories: housing, roads, and other. These were the titles of the three posters that were used during the exhibition (see Figure 3.7), and were grouped in this manner as the options suggested fitted into these three categories, and the number of posters could be contained. With the visualizations, a short description of the suggested options, based on the discussions with participants during the workshops, was included to help others better understand the reasoning behind the options. A map inlay was also included to help participants in the exhibition better understand where the suggested option would take place. An A4 map of the village was also provided to show a wider view of the village if necessary.

To increase the chances that members of the community would participate in this phase of research, flyers were handed out to every house in the community. This allowed time to speak with the homeowners about the case study and inform them on what their participation would require on the day of the community exhibition. Two time slots were scheduled on a weekend, and one time slot on two weekdays in order to try and attract the maximum amount of participants. The aims of the exhibition were: i.) to allow the community the opportunity to give feedback on the visualizations and suggestions provided by participants during the workshop to help the village continue to be a viable place for people to live in for the future, and ii.) to better understand the views of the wider community about future change in the village. However, on November 2nd and 4th the NNDC held talks with the community about small building developments in the village. When going door-to-door on the days when the exhibition was held, villagers confused the exhibition with the NNDC sessions about possible housing. This misunderstanding led to some villagers not wanting to participate in the exhibition either because they felt it would not be productive or because they had previously participated in the NNDC sessions and did not want to participate in another activity.

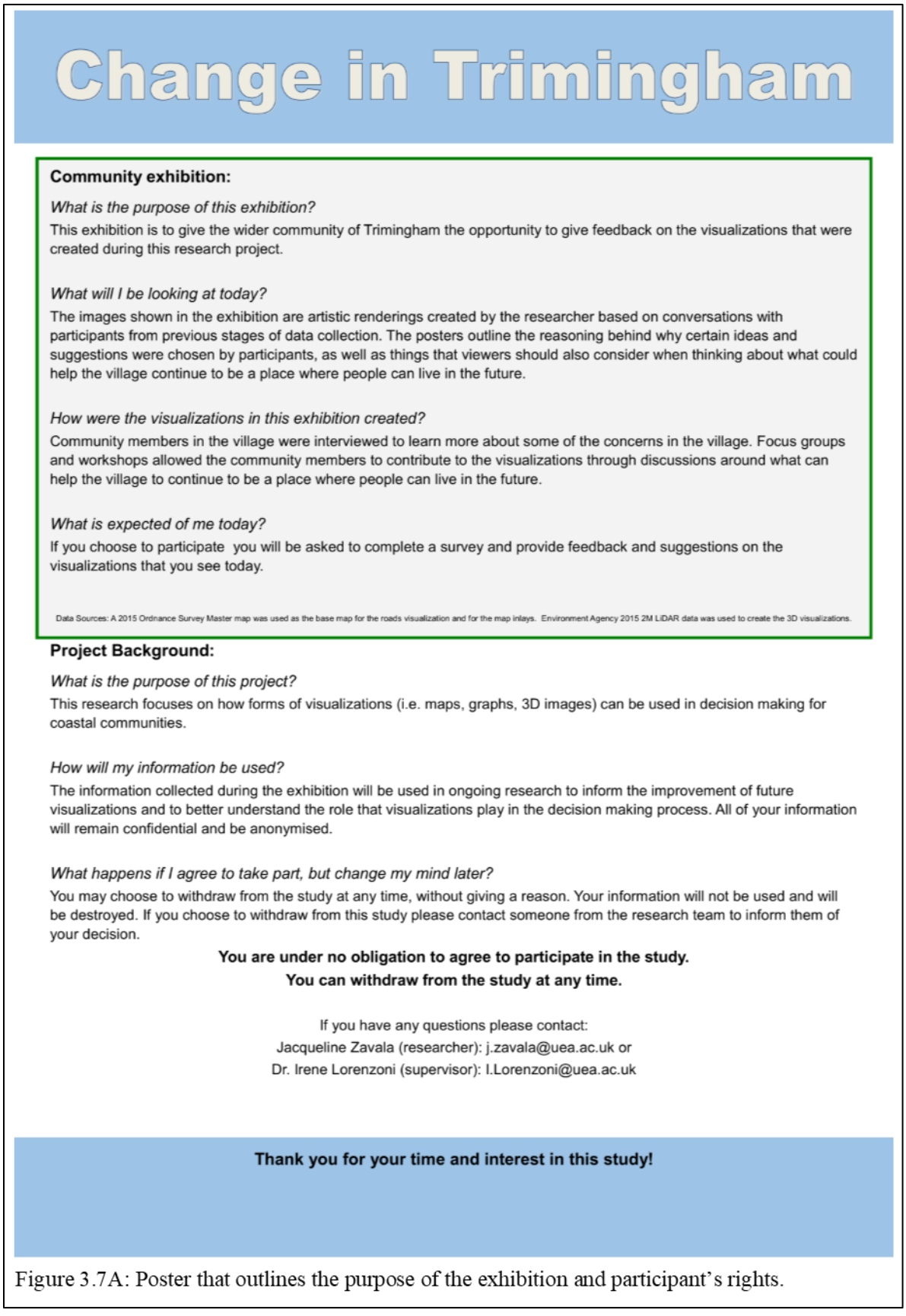
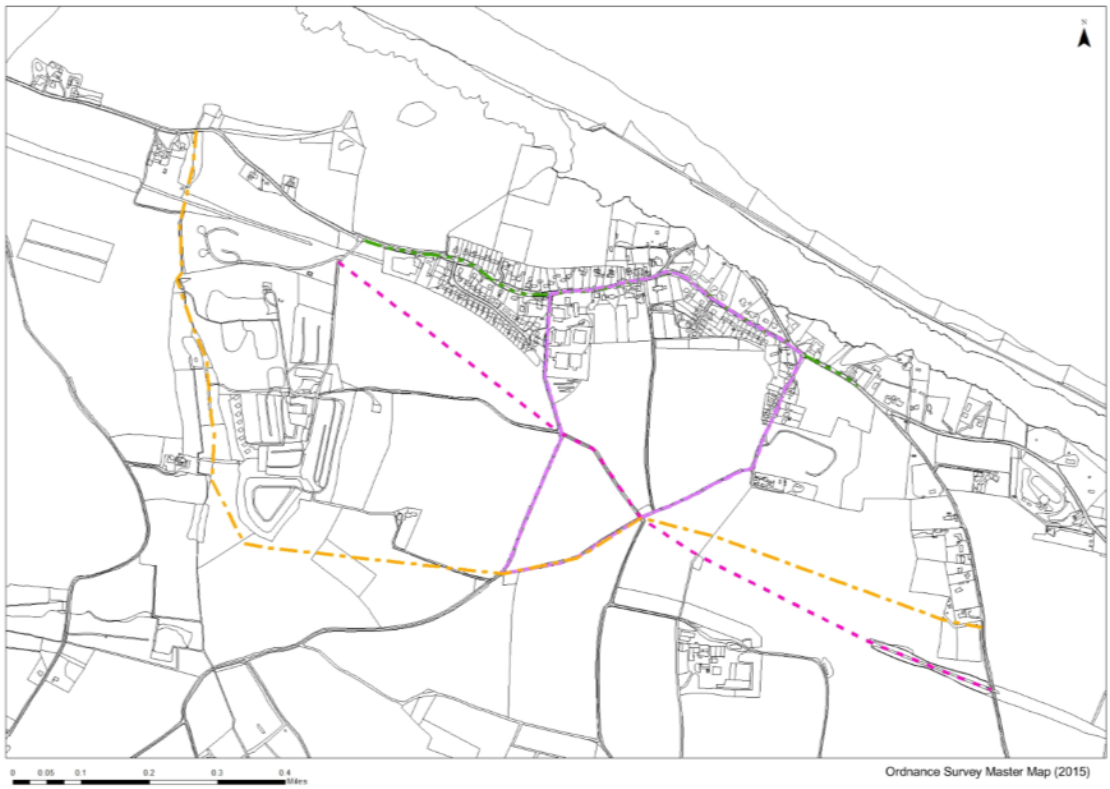


Figure 3.7A: Poster that outlines the purpose of the exhibition and participant's rights.

Roads



The image above shows the different suggestions to improve the current transportation links so that the village can continue be a viable place for people to live in the future.

Green line: Traffic calming on the main coastal road through the village was suggested for safety purposes. 20 mph was proposed as the new speed. A roundabout in front of the Woodlands Holiday Park(area west of village centre) entrance was also suggested as a way to slow down traffic.
Things to consider: funding, land availability

Purple line: The purple line shows the roads that could be used in a one-way system to help improve the transportation in and out of the village using the existing roads.
Things to consider: funding, traffic direction, amount of traffic,

Pink line: The old railway embankment was a suggested as a path for a new road to get in and out of the village.
Things to consider: funding, land availability, land-use policies,

Orange line: A new road going around Woodlands was suggested to pass by the back of the village towards Gimingham.
Things to consider: funding, and availability, land-use policies,

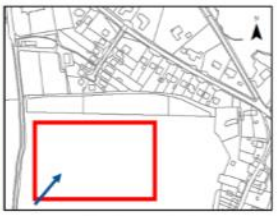
Figure 3.7B: Poster showing different suggestions from the workshop about future road development.

Housing

The following images show how housing developments of different types could look like in different parts of the village. They are artistic renderings created by the UEA researcher based on other housing developments of similar sizes and conversations with participants in the study. The images do not represent any current housing development plans for the village.

Behind Broadwood Close

A mixed housing development was suggested behind Broadwood close to help with developing the village further inland. A barrier of trees was also suggested between Broadwood close and the new housing development. The suggested number of houses was about 40.

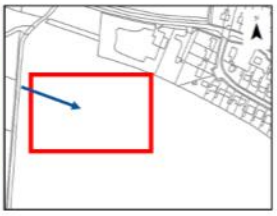


Things to consider: funding land availability, land-use policies, community acceptance, increased population

The red box outlines the area in the village the image represents and the blue arrow indicates the direction the camera is facing.

Behind the new village hall

A new housing development was suggested behind the new village hall to help with the drainage in the area as well as to help the village move further inland. The suggested number of houses was about 30.



Things to consider: funding, land availability, land-use policies, community acceptance, increased population

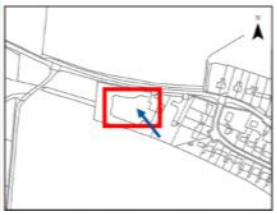
The red box outlines the area in the village the image represents and the blue arrow indicates the direction the camera is facing.

Figure 3.7C: Poster showing different suggestions from the workshop about future housing developments.

Other

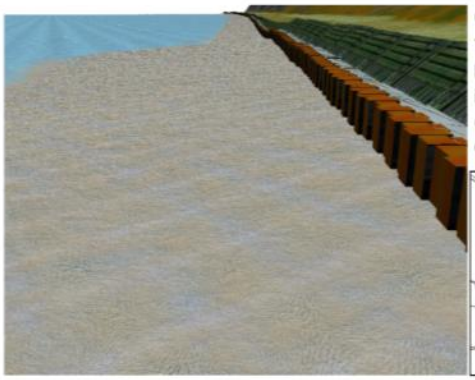
New village hall

Suggested uses for the new village hall include: (1) an event centre, (2) a pop up medical facility, (3) a village shop, and (4) an area for church services. The new village hall is expected to be completed by March 2018. It is hoped that the village hall will engage the community in village events and provide services for the community.



Things to consider: funding, community need, community involvement

The red box outlines the area in the village the image represents and the blue arrow indicates the direction the camera is facing.



Coastal management

This image shows what the beach and cliffs behind the Pilgrim Shelter look like currently, but without the wooden groynes. (Only the current iron toe is shown.) Suggested options to slow down erosion included (1) tree planting, (2) maintaining current sea defences, (3) improving drainage, and (4) farming a certain distance from the cliff edge.

Things to consider: cliff geology, funding, land availability, land-use policies

The red box outlines the area in the village the image represents and the blue arrow indicates the direction the camera is facing.

Pilgrim Shelter

The Pilgrim Shelter is currently a place for village events and acts as the village hall. Once the new village hall is built, it was proposed that the Pilgrim Shelter continue to serve as a central meeting place in the village. Suggested uses for the Pilgrim Shelter include: (1) post office, (2) discovery and learning point, (3) café, and (4) village shop. The new village hall is expected to be completed in March 2018.

Things to consider: funding, community need, community involvement

The red box outlines the area in the village the image represents and the blue arrow indicates the direction the camera is facing.

Figure 3.7D: Poster showing different suggestions from the workshop about future changes to existing physical locations.

An information pack was created (see Appendix 1.5) to use in the exhibition so that participants could spend as much time with the visualizations as necessary. The survey at the beginning of the packet also aimed to gauge participant views about coastal change. The same statements relating to the C2A framework, in the same format, were included in the surveys given to participants during the exhibition as well. However, to limit the same situation during the workshops where participants copied their responses if they recognised the C2A statements, participants were required to complete and return the first part of the packet in order to start the next activity of the exhibition. After they turned in the first part of the activity, they were given a second packet that had a worksheet where the participants could give both positive and negative feedback about the different future options. Posters were chosen as the method of presentation because it would allow participants to spend as much time as was necessary to understand the options presented and document their thoughts. After participants viewed the posters, they were given the instructions to use sticky dots (green, yellow, and red) to rank the top three options based on what they wanted for the village or what they believed would be most beneficial for the village. Green was their top choice, yellow was their second choice and red was their third choice. They were also given a blue sticky dot that would allow them to indicate the option that they did not want to be implemented or believed would be the least helpful for the village. However, the instruction for this activity could have been clarified better because some participants misunderstood the instructions to rank their top three options overall, and ranked the top three options on each poster. After participants completed this activity they were asked to complete another survey. As was previously mentioned, the survey had the same C2A statements as the survey completed at the beginning of the exhibition packet. Some of the participants noticed that they were the same and inquired about their previous responses. The researcher made sure to emphasise that there were no right or wrong answers and that they should answer honestly how they currently feel. The same statements from the survey completed after the workshops, which aimed to assess the effectiveness and usefulness of visualizations, were used in the survey given after the exhibition.

3.3.9 Final Interviews

This phase of data collection provided an opportunity for participants to reflect, using some structured questions, their experience of involvement in the case study. Nine of the participants who had previously participated in this study, and one individual who had not previously participated in this study attended the final interviews. Two coastal managers also participated in final interviews. The questions asked during the final interviews can be found

in Appendix 1.6. Prior to the interviews, participants' comments on coastal change, community engagement, and future change from each phase of data collection was compiled and summarized so that these comments could be read back to participants, who were given the opportunity to discuss why they think they may have felt a certain way at the time, and if they felt the same way at the time of the final interviews. After the comments were read back to participants for further clarification, participants were shown their responses to the C2A statements in the workshop and exhibition surveys.

Following this, participants were asked if they remembered any of the visualizations they were shown during the study, and subsequently shown the different visualizations. At this point the participant who did not previously attend any other phases of data collection was guided through the different visualizations. After viewing all of the visualizations, all participants were asked questions pertaining to the effectiveness of visualizations as described by Sheppard (2012), Bishop *et al.* (2013) and Knight (2001) - the criteria to assess effectiveness are discussed further in Chapter 5. These questions pertaining to visualizations were included so that participants could compare the various types of visualizations used during this study and reflect on the different aspects of the visualizations that affected their suitability in this study. Subsequently, a discussion was opened about the participant's thoughts about the findings and what future steps they would like to take now that the study is completed. They were also asked about the longitudinal aspect of the study to gauge whether this contributed positively to the study, and whether they would change anything about the way that the study was conducted. The interview was closed by asking participants if they had any questions for the researcher.

After the final interviews, there were 27 unique participants that participated in this study at least once, with nine who consistently participated throughout the study. The individuals who participated in the case study can be considered stakeholders, or individuals who feel they have a stake in the village. This is through their property ownership, but also because of their role in the village. Most of the participants can be considered as local champions, are knowledgeable about current village events, and were likely to assemble around the issue of coastal change. Table 3.5 gives insight into participants' backgrounds and roles in the village. The table does not include respondents to the village questionnaire because they were anonymous, most did not return for other phases of data collection, and the information presented in the table could not be completed using the responses, i.e. retirement and role in the village was not explicitly asked. 'Y' in the table indicate that participants are retired and/or have a special role in the village, while 'N' indicates that they are not/ do not have a

special role in the village. “Special role” in this case can include a variety of roles in the village including, but not limited to, positions on special committees and councils.

Table 3.5: Participant IDs with corresponding information pertaining to years lived in the village, retirement status (Y indicates they are retired/ N indicates that they are not), level of engagement in the village (very active in the community (black), somewhat active (grey), and not very active (white)), participation in different phases of data collection (exploratory interviews (EI), focus groups (FG), workshops (WS), exhibition (EX), final interviews (FI)), and if they have a unique role in the village (Y indicates that they do/ N indicates that they do not)

Participant ID	**Years lived in village**	**Retired?**	**Participation in study**	**Special role in village?**
TV01	>10	Y	ALL	Y
TV02	<10	Y	ALL	Y
TV03	<10	Y	ALL	Y
TV04	>20	Y	ALL	Y
TV05	<10	Y	ALL	Y
TV06	<10	Y	ALL	N
TV07	>20	N	EI	Y
TV08	>20	Y	ALL	Y
TV09	>50	N	EI	N
TV10	>20	N	EI &WS	Y
TV11	>50	Y	ALL	Y
TV12	>50	Y	EI	N
TV13	>40	N	EI &FG	Y
TV15	>20	N	FG	N
TV16	NA	N	FI	Y
H01	>90	Y	EI	Y
H02	>90	Y	EI	N
H03	>90	Y	EI	N
S32	<10	Y	ALL	N
W01	<10	Y	WS	N
W02	<10	N	WS	N
A1	>10	Y	EX	N
A6	<10	Y	EX	N
A10	>10	Y	EX	N
A12	<10	Y	EX	N
CM01	NA	N	consultations	coastal manager
CM02	NA	N	consultations	coastal manager

3.3.10 Ethics

Ethical considerations were continuously assessed throughout the study. Ethical approval was obtained through the General Research Ethics Committee (GREC) at the University of East Anglia. Approval was obtained at three different points so that new methods of data collection were accounted for as the study evolved. Ethical clearance was obtained for

interviews and discussions with participants on August 16, 2016 and it was amended to include the questionnaire on December 19, 2016. Ethical approval was also given on May 25, 2018 for the final interviews to renew the previous ethical approval. (Reference GREC 16-565) These letters of approval can be found in Appendix 1.7.

i. **Consent:** Participants were given an information sheet and a consent form before the exploratory interviews were conducted in September 2016. Participants who joined during later stages of the research were also given the same information sheet and consent form. Consent forms were for permission to use the information collected in this study and to record the conversations. Consent forms were filled out and signed at the beginning of the workshops, exhibition, and final interviews. At the beginning and end of the village questionnaires, participants were informed that by filling out and returning the questionnaire they were agreeing to allow for their responses to be used in this study. The consent forms and information sheets included contact information of the research team if at any point they chose to withdraw their participation in the research.

ii. **Group discussions:** Prior to the focus groups and workshops, participants were explicitly reminded about the responsibility of everyone present in maintaining the confidentiality of entire group, see Appendix 1.2. They were asked to not share views that may have emerged during the discussions from other individuals in the group, but reminded that they were allowed to share their personal views outside of the discussions if they chose to.

iii. **Anonymity and confidentiality**: All participant information is anonymized and any information that could reveal the participants identity was removed. The participants were given ID's that were used in transcriptions and data visualizations throughout the project.

iv. **Data Protection**: The information sheet outlined how participant information would be stored and used. Physical information such as surveys, drawings, and questionnaires were kept in a locked drawer, in a locked office. Digital data, including audio from the different phases of research, transcriptions, and digitized maps were password protected.

3.3.11 Data Analysis

Section 3.3 introduced the use of mixed methods for this study. The use of a longitudinal methodology allowed for each phase of data collection to be analysed to inform the next phase of data collection. The audio from the exploratory interviews were listened to and

notes were taken using Microsoft Excel to identify major themes of the discussions and any frequent responses. These interviews were later partially transcribed using NVIVO (QSR International Pty Ltd., 2014). Furthermore, thematic analysis was undertaken using transcriptions from the exploratory interviews, focus groups, workshops, open question responses, and final interviews. Brun and Clarke (2006, p79) define thematic analysis as "…a method for identifying, analysing and reporting patterns (themes) within data." Thematic analysis was chosen as the method of analysing the qualitative data from this case study because, within the frame of critical realism, it can aid in understanding the experiences of participants and how these perceptions relate to the 'reality' of the broader context. The phases that Braun and Clarke (2006) described are: 1.) Familiarizing yourself with your data, 2.) Generating initial codes, 3.) Searching for themes, 4.) Reviewing themes, 5.) Defining and naming themes, and 6.) Producing the report. This process was used to code the various stages of data collection into nodes using NVIVO (QSR International Pty Ltd., 2014). This thematic analysis is primarily presented throughout Chapter 4.

Dimension reduction was the main quantitative data analysis presented in this thesis and was used to aid in the interpretation of participant responses to the C2A statements from the workshop and exhibition surveys. Specifically, Categorical Principal Component Analysis (CATPCA) was the dimension reduction model run on SPSS to reduce the variables to two dimensions. The rotated components were analysed to understand which variables were most represented for the two dimensions. This analysis is discussed in greater detail in Chapter 6. The analysis only consisted of surveys from the Workshops and Exhibition because the C2A statements used in the focus group were modified to reflect the discussions from the focus groups and shorten the survey for the convenience of participants.

3.4 Case study site: Trimingham

The Norfolk coast is an area of the UK that has seen coastal change for many centuries, and at present is proving challenging to manage at critical points (Environment Agency, 2012; Spencer *et al.*, 2014). This section introduces Trimingham as the case study site, on the North Norfolk coast, and discusses coastal management and planning considerations for the village. It sets the historic context for the case study site, which informs the approaches used in this research.

The coasts of North Norfolk are diverse and constantly changing; some parts are made of cliffs of glacial till that erode at rates of about 1m per year (Dawson *et al.*, 2015); others are low lying and accreting over time. The village of Trimingham (Figure 3.8), located on the

Norfolk coast between Cromer and Mundesley, is of particular interest to this study because the village has been affected by erosion over many decades and there is an interest among residents to consider this and address it for the future of the village.

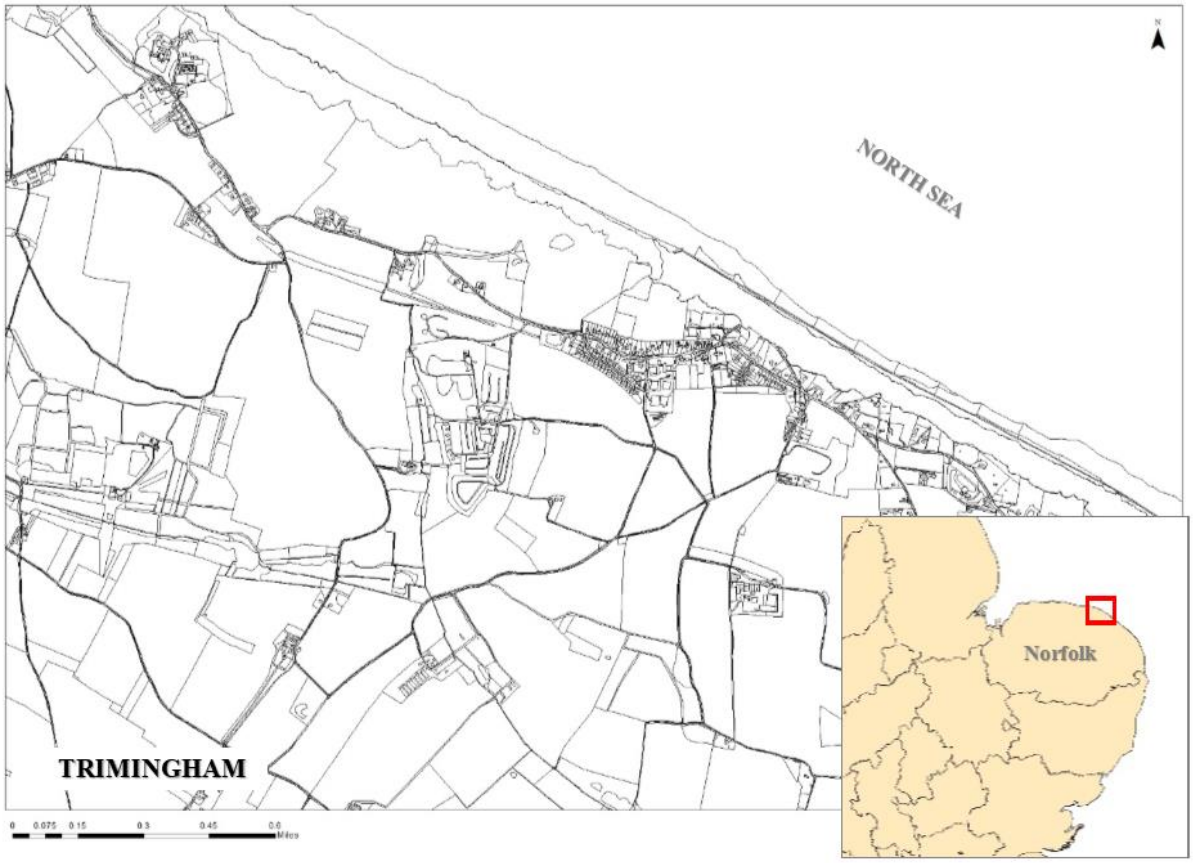


Figure 3.8: The village of Trimingham is on the North Norfolk coast of the UK. The red box indicates the general region of North Norfolk the case study took place. Maps contain OS data © Crown copyright and database right (2017).

Trimingham is located on the coast; its cliffs are 60 m high, and as they erode contribute sediment to beaches in other locations along the shore in both northwest and southeast directions. Trimingham's history of coastal change spans almost two centuries. The earliest record of sea defences in Trimingham are found in White's directory stating that a breakwater was put in place in 1842 by Sir T.F. Buxton Bart (White, 1864). Up to that point, there were two documented farmhouses that fell over the cliff side (White, 1883). The next recorded, and most recent, fall was in 1935 and then two more houses fell into the sea in 1958 (Mrs Slipper's) and 1965 (Miss Piggot's, see Figure 3.9). Newspaper articles covering these two events stated that heavy rain was a concern for further slippage after the main cliff fall (North Norfolk News, 1965; Eastern Daily Press, 1958).

Figure 3.9: The images were provided by the village and show Miss Piggot's residence falling over the cliff in March of 1965. Source: Ann Dack

Mines had been placed on the beaches and in the cliffs in Trimingham during World War II, which were cleared by the army in 1957 (Weston and Weston, 1994). In 1972 the North Norfolk District council was prepared to defend the coast at Trimingham through a £346,000 grant; however, the total cost of the sea defences escalated (almost twice the original cost for less than half of the project). The project was completed in 1975, but within a few years the defences were damaged and needed to be removed (Eastern Daily Press, 1977). In 1981 a new sewer system was proposed to protect the cliffs from surface water runoff (Eastern Daily Press, 1981). In 1987 the Nature Conservatory Council halted this scheme because the area was a site of special scientific interest. This caused residents of the village at the time to become dismayed at the prospect of losing their land and homes. One member of the community was quoted as saying, "They are not thinking of people's lives. How can they sit there and watch lives destroyed?" (Eastern Daily Press, 1987).

More recently there have been several marked episodes of erosion by the site where the Crown and Anchor pub used to stand. Figure 3.10 shows three photographs that depict the changes to this area in particular throughout the study. This shows that coastal change has been a visible part of life in the village throughout this study.

Figure 3.10: Pictures of part of the cliff in Trimingham, between August 2016 and September 2018, that has had several recent erosion events that have caused concern for villagers. Source: Author

In addition to the complexity of the physical landscape and social considerations, policies affecting the coastal management in Trimingham are relevant to understand the local context. The Core Strategy was adopted in 2008, and is still used by the North Norfolk District Council (NNDC), to inform coastal management practices in the area. The strategy provides a general approach to development and sets long-term objectives and policies as a guide for both the public and private sectors. The Core Strategy also categorizes villages such as Trimingham as "countryside" thus restricting the types of development allowed to be undertaken in the village. The village is restricted in the development of new housing further inland and is required to maintain open green spaces between urban and rural areas (North Norfolk District Council, 2008). Trimingham also has the distinction of being in an Area of Outstanding Natural Beauty (AONB) and a Site of Special Scientific Interest (SSSI), with specific nature conservation priorities, which challenge any proposed modifications to the landscape (Natural England, 2017; Natural England, 2013). The North Norfolk coast is also designated as one of 32 Heritage Coasts in England (Land Use Consultants, 2006) and the North Norfolk District Council has policies in place that preserve places of special historic or architectural interest. For the village this means designing homes while being sensitive to the traditions and character of the area.

Another document used to inform decisions on the North Norfolk Coast are the Shoreline Management Plans (SMP), which suggest policy options for managing the coasts of England and Wales (see Section 2.2). The Shoreline Management Plan 6 (SMP6), adopted in 2012, outlines policy options for North Norfolk. SMP6 describes the coast from Cromer to Happisburgh as the main supplier of sediment for much of the coast down current (Environment Agency, 2012). The SMP states that "The alongshore movement of sediment eroded from cliffs is essential to provide beaches locally and further afield." (Environment Agency, 2012, p.22) It also suggests that specific sections of coast are prioritized for protection over others because of existing international directives, e.g. Norfolk Broads (Environment Agency, 2012). The cliffs are currently protected by wooden revetments and groynes, which absorb some of the wave energy before reaching the cliffs and catches eroded cliff sediment. However, this has prevented some sediment from being distributed to beaches down current to protect places like the Norfolk Broads, from flooding as required by EU legislation (Mokrech, 2011). The history with coastal change in the village discussed previously suggests that the suggestion in the SMP to not maintain coastal defences in the village may not be seen positively by individuals living in the village. Local councils like NNDC are responsible for maintaining coastal defences and related infrastructure, as well

as managing adaptation to coastal change for specific coastal communities. One of the ways that NNDC has supported the village adapting to coastal change is by awarding Trimingham £200,000 through the Pathfinder Program to build a new village hall further inland (Fenn *et al.*, 2015). The Big Lottery Fund has also added £460,797 towards its construction (National Lottery Community Fund, 2017). Construction of the new village hall began at the end of 2017 and was completed in March 2018.

Trimingham was chosen because the people in the village showed a readiness to explore future changes in the village and ways to deal with erosion, which is particularly meaningful given the long history of erosion in the village. Other villages were considered; however, communication with these villages fell through. This highlights the importance of leadership in enacting changes, discussed further in Chapter 4. The relationship with village leadership created opportunities to speak with other individuals who are active members of the village. Furthermore, the village could be representative of the situations faced by many coastal communities because of the environmental and coastal change along parts of Norfolk, which can also be seen elsewhere.

3.5 Case study limitations

This section briefly discusses three limitations as they relate to the methodology employed in this study. These limitations will be revisited in future chapters. First, there was a small portion of the village that participated consistently and regularly throughout the project and not necessarily representative of the wider views in the village. This was a concern mentioned in Few *et al.* (2007), whether or not the few represented the larger population. Trying to engage those that usually do not engage in village events in this cases study was difficult from the outset. This limitation is discussed further in Chapter 4.

Secondly, there are limitations associated with case studies including the overall generalizability of the findings and, in the case of longitudinal case studies, the unknown change that external factors caused in the study (Bryman, 2016). These external factors can include recent weather, current events, and recent personal experiences. For example, the NNDC came to the village to discuss building new houses in the village. This influenced whether the villagers chose to participate in the exhibition, and it could have affected the way that people viewed the housing options presented during the exhibition. Some participants thought that the exhibition was connected to the NNDC events that were held the week before. Bishop (2013) suggested using before and after analysis to see if there have been any changes in the views of participants, but the study that they conducted was over a

shorter period of time with different stakeholders. As stated in Sections 3.3.5, an issue with the same participants seeing the same questions multiple times is that they focus on whether or not they are answering the same as before. This is not so much a limitation of the case study as it is a suggested consideration when engaging with the same stakeholders over a longer period of time. Limitations of a longitudinal process are discussed in Chapters 6 and 7.

The final limitation discussed in this section are limitations relating to the use of VNS. Some of the limitations of the visualization software were discussed in previous sections. VNS is a powerful visualizations software and is valuable when making changes to landscapes in a short period of time. There are some issues with the program's capability of dealing with large amounts of very detailed landscape data, but at the moment there are steps that can be taken to bypass this issue. Although the range of tools to change the landscape were useful in providing a higher level of realism, navigating through the interface was not straight forward and it could not be expected that people with no previous experience with the program can make changes to the landscapes themselves using this program. This is further discussed in Chapter 5.

3.6 Conclusions

This chapter drew on the existing literature (Chapter 2) and adopted a methodology which could enhance the understanding of how visualizations could contribute to the decision-making process. The village of Trimingham was introduced as the case study site, and a discussion of the political and historical context of coastal change followed. The design of this case study allowed a two- way discussion between participants and researcher, and researcher and decision-making bodies at all stages so that there is not contradicting information presented to the participants. It aimed to provide opportunities for the community to participate in this study and to frame the issue of future change in a positive way. A mixed methods approach, e.g. discussions and surveys, was utilized to gain a deeper understanding of the feelings and thoughts of participants. Furthermore, the use of a longitudinal and iterative methodology to create and evaluate the use of visualizations in decision-making processes is unique to this study. The use of this type of methodology can contribute to the literature on potential ways to implement the use of visualizations in decision-making processes. The following chapters describe the results of using this methodology in the case study in Trimingham.

Chapter 4 | Views of Trimingham and aspirations for the village's future

4.1 Introduction

This chapter focuses on participants' current views of the village, aspirations for the village's future, and barriers and opportunities for enacting change in the future. It draws from the thematic and content analyses of face-to face discussions with participants, which took place during the exploratory interviews, focus groups, and workshops (outlined in Chapter 3; see Appendix 1) and quantitative analysis of the village questionnaire. All aimed to gain insight to the issues and priorities for villagers in Trimingham. This chapter aims to examine and understand how participants living along the coast view the future of where they live and why (addressing the first research objective). This chapter also provides the context of this case study for evaluating visualizations (Chapter 5) and perceptions of the village over time (Chapter 6).

Sections 4.2 to 4.6 explore themes that emerged from discussions with participants. They are organised according to the frequency in which they emerged from the analyses. The themes include views on physical changes in the village, experience with living on the coast and organizations working along the coast (e.g. NNDC, EA, Natural England, etc.), availability of facilities, and perceptions of future changes. The extent to which these themes are discussed varied throughout the phases of data collection: some themes are more prominent in particular phases of data collection, while others are consistently present throughout. Other themes that are not as frequently discussed, but could potentially aid in understanding participant responses are also mentioned throughout this chapter. Following this, Section 4.7 reflects how these themes relate to the current body of literature on perceptions and responses to change.

4.2 Key themes from the four phases of data collection

The four phases of data collection drawn upon in this chapter are part of a longer, longitudinal case study and took place over three months (Figure 3.1). The study was iterative, where one phase of data collection informed the focus, organization and content of subsequent phases of data collection. Thematic analysis shows that frequency of themes and length of discussions of themes varied depending on the phase of data collection, given their different foci, participation and timing.

The exploratory interviews were designed to establish contact with the villagers, share information about the project and their views about the village. Participants were asked about their experiences of living in the village and their views about changes they had experienced or knew about, including of the coast. Engagement and erosion emerged as the most frequent themes from this phase. Fifteen participants described their experiences and thoughts on coastal change, personal concern about erosion, identified specific areas of the village that are eroding, and barriers when trying to deal with erosion. During these conversations, some ambiguity was present between the potential causes of erosion outlined in policy documents and local knowledge of erosion. Six participants express positive feelings about the future of the village. However, reluctance to change also emerged during discussions, along with the theme of enjoying and maintaining the peacefulness in the village. This phase of data collection was also an opportunity to understand how communication occurs in the village, to inform the creation of visualizations in later phases.

The focus groups aimed to further understand participants' feelings about change in the village and potential futures they envision. Funding for a new village hall had recently been procured at the time of the focus groups, with some participants being instrumental in this (see Section 4.4) This led to several discussions around the impacts the new village hall could have on engagement and other aspects of village life. More participants throughout the focus groups referred to an increase in community spirit compared to the interviews, although issues of engagement continued to emerge as a theme. Similar to the exploratory interviews, the focus group participants enjoyed the peace and quiet of the village, as well as the general area, which could include participant's property. However, place attachment and identity, as well as sense of community, emerged more frequently in the focus groups, which provided participants occasions to discuss future opportunities for the village as well as the barriers to these. Discussions in the groups also focussed on types and content of visualizations, building upon the previous conversations from the exploratory interviews, to inform the creation of visualizations for the workshops.

In January 2017, every household in the village received a questionnaire, aimed at eliciting views around sense of community, place attachment, and place identity explicitly for the first time in this study, for example through the use of the Brief Sense of Community Index (BSCI) used by Long and Perkins (2007). It was also intended to help understand the low participation in the study (despite advertising of research events such as the focus groups to the whole village via its newsletter). The questionnaires helped to inform the creation of visualizations for the next phase of data collection.

The workshops introduced participants to computer-generated visualizations in relation to future change; therefore this phase of data collection did not discuss past changes in the village at length, unlike other conversations in previous phases. In the workshops, sense of community was discussed in the context of future changes, and the implications of physical changes for engagement and other future features of the village, including demographics. The main coast road was discussed at greater length in relation to planning for when it may become unusable, and participants provided feedback on the visualizations they initially saw and the ones they helped to create.

The main themes emerging throughout all these phases of study were erosion and engagement. These encompass past and future changes, as well as participants' perceptions about Trimingham. As the study progressed, a shift from focusing on past changes to future changes occurred, enabling participants to discuss different future options for maintaining the viability of the village at greater length and the various barriers associated with them.

4.3 Participants' Perceptions of Trimingham

This section presents analyses of research participants' perceptions of the village and future changes including general views, feelings, connections to individuals and physical spaces.

4.3.1. Characterising Trimingham

The UK census population data provides demographic data for Trimingham; however, the village is divided between two output areas. One of the areas containing part of the village is combined with the neighbouring village of Sidestrand, resulting in a population of 244. The other area including the village goes beyond current parish boundaries towards Gimingham village and has a population of 241. It is difficult therefore to get an accurate indication of the population of the village. The questionnaire data provides an indication of the demographics of the village at the time of the study, based on a response rate of 39% (43% of questionnaires distributed were returned with less than half or no responses filled out.) Over 80% of those questionnaires returned completed, completed demographic questions about age, gender, and education levels. Questionnaire respondents were 41% male and 50% female, with the remaining 9% choosing to not answer this question. Of respondents, 50% indicated that their highest level of education was less than a bachelor's degree, including GCSE, A-level, or a vocational degree. Another 22% of respondents indicated that they had a bachelor's degree or higher. Table 4.1 shows some similarity in

regards to age from the village questionnaire and the census, with a greater proportion of 65-74 year olds completing the survey.

Table 4.1: Count and percentage of age groups from the Trimingham village questionnaire. The percentages for the village questionnaire are rounded up, this is the reason for the total percentage equalling 101%. Census percentages of age groups for comparison are included in the far right column. This is a combination of the two census boundaries. Not included was census information for under 18 because this age group did not participate in the village questionnaire.

Age	Village questionnaire count (n=64)	Village questionnaire (%)	Census (%)
18-24	1	2%	6%
25-34	3	5%	5%
35-44	6	9%	8%
45-54	8	12%	13%
55-64	18	28%	22%
65-74	19	30%	17%
75+	9	14%	13%

Throughout the four phases of data collection considered in this chapter, a large proportion (45%) of participants indicated they moved to the village because they liked the area or their property. All participants had some experience living by the coast through holidays or permanent living outside of the village. During the exploratory interview, focus group, and workshop discussions participants mentioned that they enjoyed the pace of the village, living in the countryside and the unspoilt character of the area, giving examples such as no light pollution. Most of the participants in the exploratory interviews, focus groups, and workshops were retired, and the majority of respondents (~70%) were over the age of 55. This is in line with 2011 UK census data which shows that the average age is 49 for the two areas that encompass Trimingham (compared to the mean age in England being 39 years, increasing to 47 in North Norfolk). Few participants lived in the village their entire lives.

Throughout the various phases of data collection, participants mentioned other villages for spatial referencing. For example, during the exploratory interviews, participants referred to Cromer, Mundesley, and Sidestrand and Overstand when describing different aspects of the village, see Figure 3.2. Using other nearby locations as spatial references is also found during the focus groups, but the diversity of locations mentioned in the workshops was greater. This is because during the workshops there was a greater emphasis on future changes, and participants used other places as a way to spatially orient other participants and the researcher when describing their ideas for future changes in the village. Other locations were also used

as examples of change and when explaining the history of dealing with erosion in the Eastern UK.

During the exploratory interviews, participants compared the "way of life" in Trimingham, e.g. no noise and light pollution, village life, slow paced, etc., to more urban locations. Participants also compared the village to other locations in the context of coastal change. For example, one individual compared Trimingham to the process of adapting to coastal change in Happisburgh, i.e. possibility of blight, fundraising, and engaging villagers in decision-making. Several participants during the exploratory interviews referred to the efforts by the villagers in Happisburgh to fight for positive changes in the village, engaging in decision-making to plan for a rapidly changing coastline. They mentioned proper planning and local leadership as reasons for the successful adaptation in Happisburgh. Participants in the focus groups and workshops tended to compare Trimingham to other villages along the North Norfolk coast including Cromer, Mundesley, Overstrand, and Bacton. However, it is notable that every workshop mentioned Happisburgh; some workshops focussed more on the sea defences put in place, and others discussing the situation of blight that occurred in the village before Happisburgh was able to implement any measures to deal with their changing coast. Overall, comparisons of the village to other coastal locations primarily focused on insights from these places to overcome barriers, i.e. funding, planning and leadership, when pursuing opportunities to mitigate or adapt to changes to the coast.

4.3.2 Desirability for Permanency and Change

Throughout the study, participants expressed varying views on future change. Complex combinations of ideas and feelings about change seemed to reflect how participants outlined the future of the village. Such nuance emerged from representations of the village provided by the participants in the focus groups (see Figure 4.1A and Figure 4.1B) and workshops (see Figure 4.1C and Figure 4.1D). Colours on the map, green and pink, are participants' road ideas drawn by them with highlighters. Chapter 3 outlines the rationale and process of these activities in greater detail.

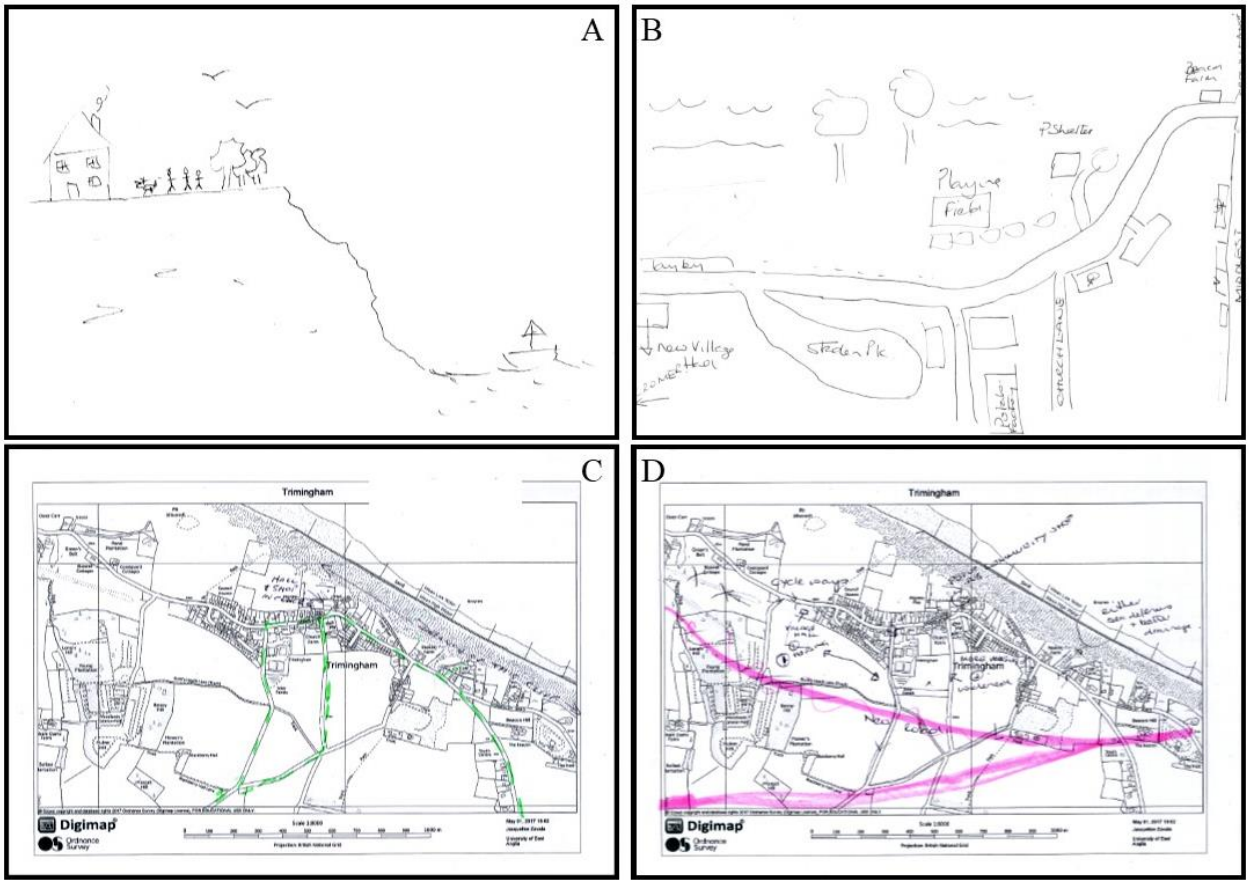


Figure 4.1: During the focus groups participants were asked to draw Trimingham and in the workshops participants were asked to draw potential future changes they would like to see. The first drawing (4.1A) is of the participants house and back garden. 4.1B is an example of a drawing of the village that is detailed and includes various landmarks. 4.1C is an example of a participant drawing subtle changes compared to other participants and 4.1D is an example of a participant drawing various types of future changes compared to other participants. These maps were digitized using GIS and used to create Figure 4.2.

ArcGIS was used to digitize and assess if the areas identified in the focus groups align with the areas identified for potential future change as per the workshops, which enabled the identification of physical locations most frequently drawn (darker shading indicating higher frequency) in both the focus group drawings (Figure 4.2A) and workshop maps (Figure 4.2B). Figure 4.2C is created by overlapping Figure 4.2B (at 30% colour transparency) with Figure 4.2A, thus creating the purple areas which indicate the same physical locations identified in the focus groups and the workshops. The cliffs and coast are shown in Figure 4.2C as dark purple, showing that they were discussed as important physical features of the village, as well as areas of future change. However, Figure 4.2C also shows that many of the places that participants indicated when describing the village do not coincide with areas where participants drew suggested future changes. Locations that were drawn in the focus group and not as a place for potential change include, Woodlands holiday park (area 1), St. John the Baptist Church, and Broadwood Close (area 3). Most of the locations described in

the focus groups are in the central area of the village (in area 3), and the areas of change indicated in the workshop tend to be on the outskirts of the village, i.e. farmland in areas 1 and 4.

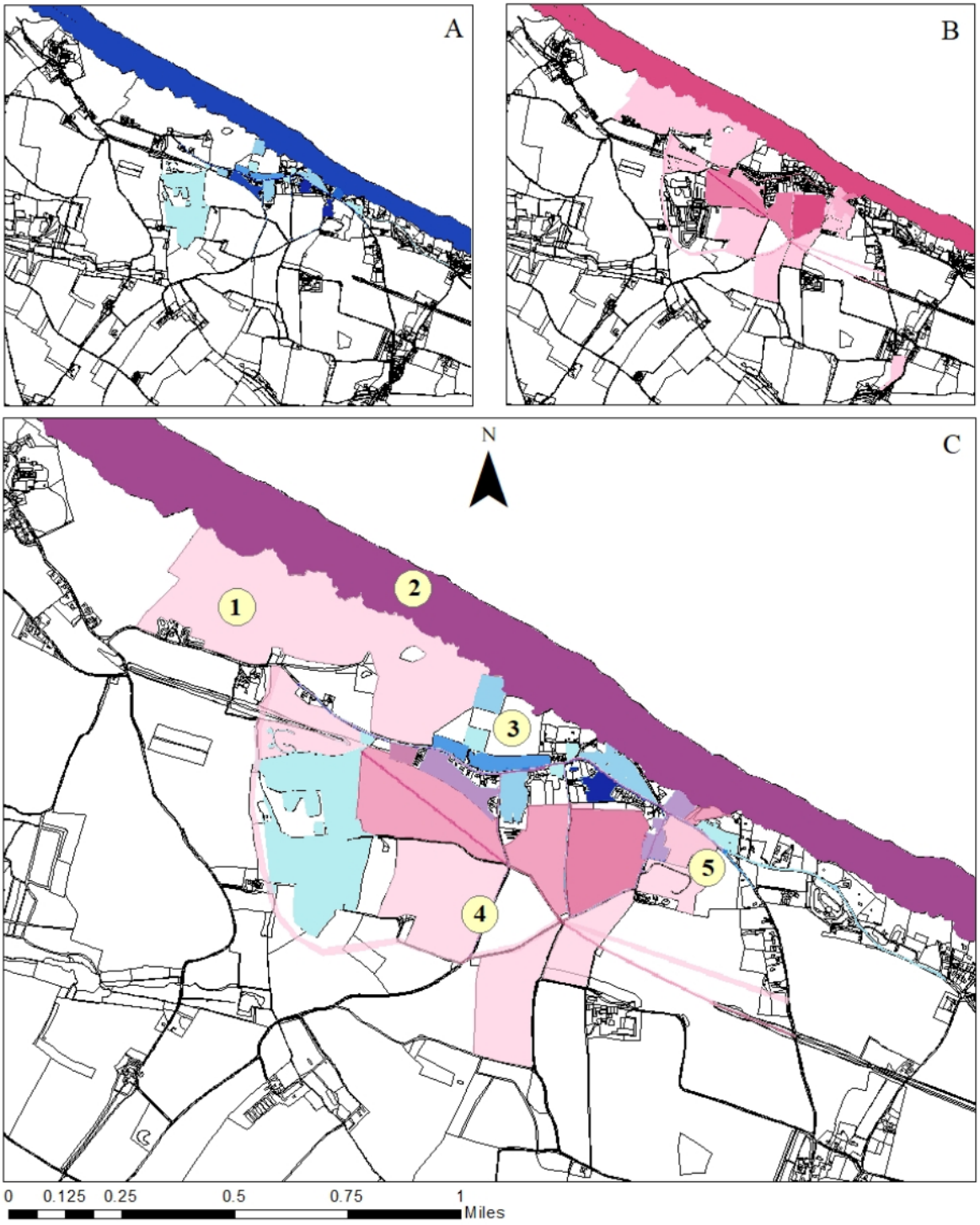


Figure 4.2: Map A (Blue): physical locations in the village drawn by participants transposed onto a map by the researcher. Map B (Pink): locations participants indicated observed change. Darker colour indicates the location is referred to more frequently. Map C (bottom) is the two top maps overlaid, with map B at 30% colour transparency. Five general areas in the village are indicated; 1, 3, and 5 indicate the left, centre, and right areas of the village. The cliffs are indicated with a 2, and 4 indicates farmland that is further inland. Maps contain OS data © Crown copyright and database right (2017).

In the exploratory interviews, some participants believed that the housing market, i.e. the high cost of houses in the area, and a lack of employment opportunities contribute to unchanging demographics in the village. Specifically, they refer to these two aspects as not being attractive to younger people and families. In the focus groups, participants mention these reasons for fixed village demographics, as well as a lack of facilities that would attract younger people, for example the village currently lacks a pub. The Crown and Anchor pub burned down in 1988, and participants identified the absence of a pub throughout the study as an important focal point for the village and one that would attract younger residents. However, one participant explicitly mentioned that this was not possible because, in their view, a pub needed to be in an old building and there was not a suitable place in the village available for this purpose. One of the disagreements on what has changed in the village concerns erosion. Some participants felt that the coast has not changed much; while others felt like there has been a visible change, especially in recent years, see Section 4.3. Discussion about the cliffs included how to slow down or stop erosion as well as how the coast has and will change in the future. Discussions such as these, on permanency and change, provide deeper contextual understanding to the drawings that participants made in the focus groups. Participants represented locations that were important to their daily lives, such as roads, their homes, and physical features characteristic of the village, i.e. the church, the pilgrim shelter, and the coast. Thus, stemming from the focus group discussions, questions aiming to understand place attachment and identity were included in subsequent phases of data collection, including the village questionnaire and workshops (see also section 4.4.).

Participants also referred to characteristics of Trimingham that they or other villagers would not want to change, indicating attachment to these. Such features varied considerably among participants and some ambiguities were expressed. In the exploratory interviews, in contrast with most of the participants to other phases of data collection, a few participants indicated they did not want more people visiting the village. One participant referenced how more visitors could spoil the cleanliness and peacefulness of the beaches. Participants in one of the focus groups gave similar examples for not wanting streetlights in the village. In this case, all participants in this focus group agreed that streetlights would not be to their liking; however, they did acknowledge that many of the families with younger people would prefer to have streetlights for safety reasons. Another focus group mentioned that some villagers do not want playgrounds built in the village, while other villagers feel that a playground is a

facility that could attract younger families. The most frequent reasons for retaining a particular feature was because of the effect it would have on the peacefulness of daily life in the village.

Participants in the workshops did not discuss village characteristics that have not changed in the past; rather, they focused on features of the village that could not change in the future: this is expanded upon in Sections 4.4 and 4.5 when participants discuss future opportunities and barriers, as well as in Chapter 5 (in relation to the creation of visualizations). The workshop formatting, which focused on discussing and visualizing future changes, prompted these discussions.

4.4 Physical changes to the coast in Trimingham

As discussed in Chapters 2 and 3, the Shoreline Management Plans (SMP) outline policy options for the English coast, including the coast of Trimingham (SMP6), and provide erosion projections for the long-term (50-100 years), medium-term (20-50 years), and short-term (0-20 years). SMP6 states that erosion of the cliffs in the area covered by the SMP, i.e. from Kelling to Lowestoft Ness, is necessary for building beaches down current through sediment transfer. The current SMP policy suggestion for Trimingham is "no active intervention", which would result in property and infrastructure loss in the village (SMP, 2012). The SMP6 strategic environmental assessment focusses on the influence that the geology of the cliffs and dredging of offshore aggregate have on erosion in the area (NNDC, 2013). The SMP also states that short-term measures should be taken if possible to minimise the impact on individuals living in the village; however, in the long-term, it is unlikely that there will be the economic justification necessary for large investments in coastal defences (SMP, 2012). Participant discussion around how the coast has changed, including around coastal erosion, were present throughout all the phases of data collection. Erosion is a major theme throughout the case study and is related to other emerging themes. This section discusses how participants perceive coastal change and erosion, and the opportunities and barriers in dealing with these in the future.

4.4.1 Concern about erosion

This sub-section focuses on the various ways in which concern about erosion is referred to throughout the first four phases of data collection. The term 'concern' is used by participants interchangeably with the term 'worry', i.e. a state of feeling anxious or troubled. It is also used to relate to issues that the village faces, including concern for the Cromer-Mundesley

coast road, concern for property, and concern over time (as detailed in this section). There is also a distinction between concern for others and concern for oneself.

Half of the exploratory interview participants mentioned the coast road, and expressed worry about what would happen to the village should it become un-useable in the future because of damage due to its current proximity to the cliff edge. Concern was primarily due to this road being the main road in and out of the village. Several participants shared photos of the area of erosion closest to the coast road to show the erosion that has occurred there. In the exploratory interviews, outcomes such as "the village will die", and the village becoming a cull de sac, are mentioned. Similar worries are also expressed during the focus groups and the workshops, as the excerpts from the focus groups indicate:

> TV04: the road is my main concern. Really because it all hinges on that. Because if the road goes, the village goes.
> (Focus group 1)

> TV13: Uh, I think Middle street end it [erosion] will just keep going. I think eventually, it will creep out to the road. […] They're [NNDC] not going to do anything as a safety measure.
> (Focus group 3)

Alongside TV04, another participant also expresses their concern about the road in focus group 1; however, this was the only instance during this focus group where participants stated their concern for the main road. This is important to note because in the workshops the topic of concern around the main coast road is discussed at greater length. TV13 raises the issue of the coast road when discussing with group 3 how they believe the village would look like in the future. This continues with a discussion on why nothing is done as a "safety measure" for the road. Discussions around the coast road during the focus groups and workshops include concerns around accessibility. Participants mention potential issues with engagement of individuals from outside the village, as well as, the hindering of villagers' ability to access facilities outside of the village, e.g. the hospital and work, should the coast road become unusable. The excerpt by TV13 above also introduces a view on who is responsible for management of change and when they will take action to create change, discussed in more detail in Section 4.3.3.

In the workshops, the coast road became a more prominent theme. It was discussed in the context of not only expressing worry about the future of the road itself, but also in relation to the future opportunities and barriers for the potential loss of the coast road in the near to mid future. This could potentially be attributed to the framing and goals of the workshop compared to previous phases of data collection. Each workshop also discussed different

future opportunities to maintain a viable village based on participants' personal beliefs about road development and what they felt was feasible. In total, 15 participants expressed worry about the coast road at some point during the first four phases of data collection; however, only four participants consistently discussed it throughout the entirety of the case study. These discussions show the village's dependence on the coast road for accessibility to other villages, each other, and the potential implications the loss of the coast road will have on social aspects of the village (discussed further in Section 4.4).

The coast road is currently less than 100 meters, in some places around 65m, from the cliff edge; some coastal properties are also at risk, with some being less than 30m from the cliff edge. This has resulted in some participants being concerned about the longevity of their properties; depending on the location of their property, and familial and financial situation, their concern varied. Some participants indicated that they are concerned about erosion, but they would address the issue at a later time for reasons including individuals not wanting this concern to affect their enjoyment of their property and lives. This also emerges from the village questionnaires in that the number of respondents who answered 'very concerned' when asked about erosion at varying times (i.e. Presently, 5 years, 10 years, and 15 years), increased in the future (Table 4.2); 78% of respondents indicated some level of concern for erosion for 5, 10, and 15 years in the future.

Table 4.2: Percentage of Likert scale responses to Question 8 of the village questionnaire, "Please tell me how unconcerned or concerned you are about coastal erosion in Trimingham now, in 5 years, in 10 years, and in 15 years in the future."

	Very Concerned	Concerned	Neither concerned or Unconcerned	Unconcerned	Very Unconcerned
15 years (n=59)	54 %	24 %	15 %	5 %	2 %
10 years (n=59)	49 %	29 %	15 %	5 %	2 %
5 years (n=60)	33 %	45 %	17 %	3 %	2 %
Presently (n=61)	26 %	48 %	20 %	3 %	3 %

Similarly to village questionnaire responses, all of the focus group and workshop participants had some level of concern about erosion, but this concern varied by timescales. The following excerpt provides an example of a participant expressing their concern about erosion in the village during the focus group, and how they have chosen to cope with their concern:

> TV05: Um, so, well I think, yes we are very concerned about it [erosion], but I think, we'll kind of look at it in 10 years' time and start worrying then. I, we-we decided, didn't we, that we couldn't live our lives here, where we love living, worrying everyday about losing our home. It's not going to go for the next 20 years. It's not, maybe not gonna go even longer than that. We don't know, but you can't spend every day worrying about it.
>
> (Focus group 1)

Views similar to that in the excerpt above informed questions about timescales in the village questionnaire. That concern about erosion will increase in the longer term reflected in both the focus groups and questionnaires; however, it is difficult to directly compare them because of the differences in formatting and goals, and participant anonymity in the questionnaires. This excerpt is also similar to the previous excerpt from TV02, who, however, referred to a shorter timescale when discussing concern for erosion.

These same timescales are also mentioned in relation to community engagement, demographics, and political action. As was outlined in Chapter 3, participants were prompted to think at varying timescales during the exploratory interviews and workshops. In the exploratory interviews, participants generally referred to the short term. When encouraged to consider longer timescales, some participants would respond that they could not answer or that it was difficult to answer how they felt the village would look like in the future. During the focus groups participants were asked what they would like to see visualized. Participants suggested that comparisons of the village in the past, present and future would be interesting, and others in the village may also like to see that type of comparison. This was fed into the workshops where participants were shown a 1915 map and 2015 map of Trimingham next to each other (see Section 3.3). Future maps with the same level of detail could not be produced because of the lack of available erosion data at the time. Despite this, this comparison was used to prompt participants to think on longer timescales because they found this difficult during the exploratory interviews and focus groups. Limitations and perceptions of visualizations, including options and feedback, are further discussed in Chapter 5.

Along with temporal scales, some participants referred to concern about erosion in relation to specific locations. Table 4.3 shows participant responses to the village questionnaire, which asked about concern at three spatial scales: in their personal life, Trimingham, and nationally. This question does not differentiate in how the participant interpreted personal concern, e.g. if the concern was for themselves or for others; in the responses there is also overlap between those who felt the same level of concern at different spatial scales. Around half or slightly over half of respondents were concerned or very concerned about erosion

overall. Slightly more were very concerned / concerned for Trimingham, followed by concern for themselves.

Table 4.3: Percentage of responses to Question 7, which asked: "Please indicate below (ticking the relevant box) how concerned or unconcerned you are about coastal erosion in your personal life (7A), for the village of Trimingham (7B), and nationally for the UK (7C)."

	Very Concerned	Concerned	Neither concerned or Unconcerned	Unconcerned	Very Unconcerned	No response
Personally	30%	44%	17%	3%	3%	3%
Trimingham	45%	36%	11%	2%	3%	3%
Nationally	30%	39%	15%	3%	5%	8%

Plotting the three responses seems to indicate that participants tended to feel less concern as the scale increases, with a clearer relationship in the change from the personal scale to the village scale, i.e. Figures 4.3A and Figure 4.3B. These areas of concern for different spaces are also found in the interviews, focus groups, and workshops.

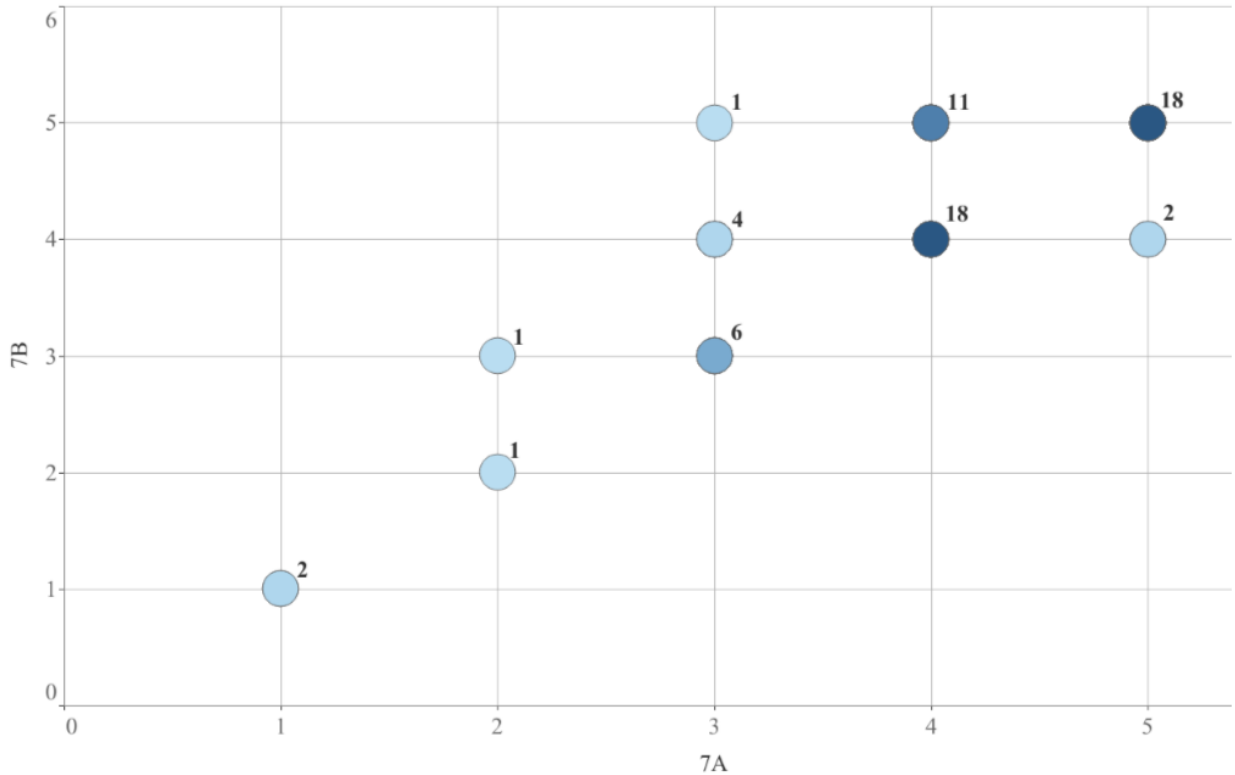


Figure 4.3A: Responses to question 7A and 7B plotted against each other. Question 7 asked: "Please indicate below (ticking the relevant box) how concerned or unconcerned you are about coastal erosion in your personal life (7A), for the village of Trimingham (7B), and nationally for the UK (7C)." A 5-point Likert scale was used with very concerned coded as 5 and very unconcerned coded as 1. The frequency of responses were grouped into five categories (20-15, 14-11, 10-5, 4-2, and 1) which were indicated using darker colours for higher frequencies. (n=64)

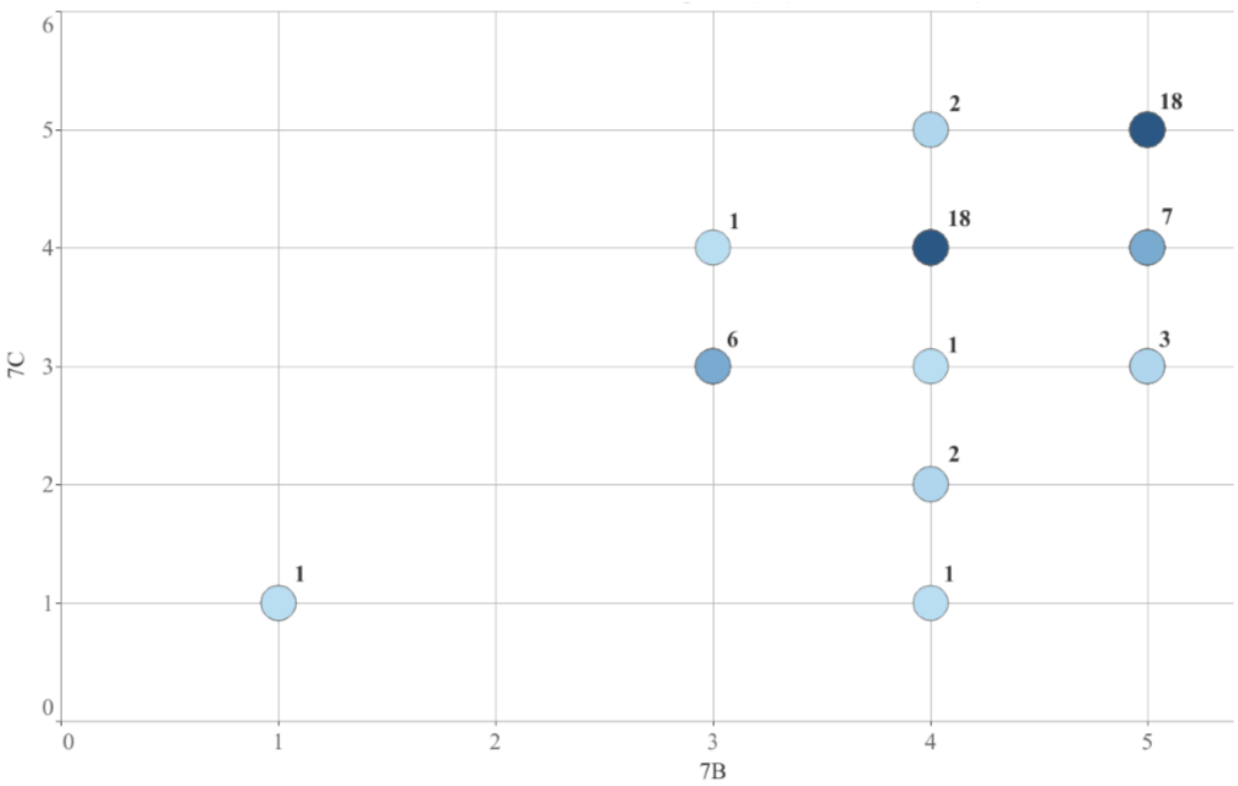


Figure 4.3B: Responses to question 7B and 7C plotted against each other. Question 7 asked: "Please indicate below (ticking the relevant box) how concerned or unconcerned you are about coastal erosion in your personal life (7A), for the village of Trimingham (7B), and nationally for the UK (7C)." A 5-point Likert scale was used with very concerned coded as 5 and very unconcerned coded as 1. The frequency of responses were grouped into five categories (20-15, 14-11, 10-5, 4-2, and 1) which were indicated using darker colours for higher frequencies. (n=60)

Participants' discussions also indicate that they distinguished rates of erosion, and concern about these, within the village. For example, they often mentioned the Mundesley side, or Middle Street side, of the village when discussing erosion in the village. Longer timescales were related to locations further inland, which reflected in participants' views of where future developments should occur and which areas need attention (and solutions developed) in the shorter-term. Participants mention specific areas where they feel there is a slower rate of uneven, or less pronounced impact from erosion when compared to other areas in Trimingham, such as in these excerpts:

> TV01: The hall we're sitting in was deemed to not have a very long life expectancy, that it would be falling into the sea eventually. Which actually is nonsense, in my view it's got perhaps 100, 200 years ahead of it, but they're saying oh 30 or 40 years. This particular part of the coast really hasn't moved for many years. I mean a matter of decades; almost nothing has taken place here. Although there are parts of Trimingham where you can see quite large collapses. (TV01 interview)

> TV15: […] I can't see it affecting us directly in our lifetime. […] there's so many factors that you- know, a rise in sea level, a change in temperature. All these things suddenly, I don't know.
>
> TV13: I don't know either. I don't tend to worry.
>
> (Focus group 3)

TV01 indicates their knowledge on the history of erosion in the village: they are referring to the stretch of coast behind the Pilgrim Shelter. This participant's experience of living with erosion in the village and interaction with representatives from local government, has built their experiential knowledge on causes of, and options for, slowing down erosion, e.g. vegetation and cliff slope. They consistently distinguished areas they felt were currently going through a period of erosion and areas that they felt have not or will not experience much erosion in the near future. Similarly, TV13 and TV15 have experience living along the coast and seem to suggest less concern about erosion, referring to the length of time before the categorisation of risk changes. TV15 also references potential uncertainties and causes of erosion that may lead to them to worry about their property. All focus group participants discussed erosion even if they did not have a direct experience or particularly strong concern for this. This is another indication as to the importance of discussing erosion, and the barriers and opportunities associated with this issue in the village, during subsequent phases of data collection.

4.4.2 Contributions to erosion

Throughout the phases of data collection referred to in this chapter, participants identified various contributors to erosion (naturally occurring, human-made or a combination of both); the perceived extent of their effect differs. Examples include poor drainage, rainwater runoff, underground streams, cliff geology, wave action, and agricultural practices.

During the exploratory interviews, focus groups, and workshops, all of the participants mentioned or agreed that one of the most significant contributions to erosion on the cliffs in the area was water draining off the land, including underground streams and springs that have been improperly capped, and water from irrigation or water draining directly through the cliffs. This theme is consistently mentioned throughout the first four phases of data collection and showed a disparity between some local knowledge / understandings and currently available information, i.e. the SMP (which focuses exclusively on the causes of erosion due primarily with wave action). However, the SMP indicates that the implementation of sea defences does contribute to changes in other coastal locations because of the lack of sediment transfer (SMP, 2012). Along with irrigation, participants also referred

to the weight of farming machinery and cliff geology as contributor to the destabilization of the cliffs in Trimingham:

> TV04: But I mean the well, the well was near enough opposite you, and for that under the village. The-The actual well was, [TV06: Right.] near enough opposite you so you've got –you've got the streams that are running down [TV08: Feeding it] that used to- used to feed the well.
>
> TV06: Yes.
>
> TV04: Where people used to take the water out, but the water isn't taken out now, [TV05: No.] so I can presume that it's not been capped properly. You know cause it should- should- that it should be capped so that it doesn't flood.
>
> (Focus group 1)

> TV02: […] If you look at the frontage through the village, from the coastguard cottages up to Beacon farm, there's been very little movement of the coast along that stretch. But if you look at the two ends, where there's literally nothing happening between Trimingham and Sidestrand where you've got that intensive farming going on, they're losing masses and masses of- as you said where you walk up to Sidestrand you see those big scallops in the fields where the cliffs going off. […]
>
> (Focus group 2)

> TV13: I don't know. There's so many theories as to why it, um, as to why the cliffs eroding. We discussed this last time. People say it's the farming methods, it's the, you know, weather changing, but I really don't know. I just kind of like what you said it's eroding and that's it. […] That must have something to do with it. And then the peo- and then the experts say, 'no it's not.' So I really don't know what's causing it. I think it's a combination of things. What's say you?
>
> TV15: Well it's soft isn't it. It's not a rock cliff. If it was, it wouldn't erode. It's soft. Chalk.
>
> (Focus group 3)

In focus group 1, participants discussed reasons that underground streams could be affecting erosion in certain areas of the village. The excerpt touches on the uncertainty about whether the wells are capped properly and suggests that capping the wells would be a potential solution to erosion. TV02's quote indicates how he believes that farming is contributing to erosion, while the excerpt from focus group 3, specifically from TV13, shows that there are various opinions as to the extent that farming is contributing to erosion. TV13 also expresses the view that the government and local authorities do not know what is causing erosion, but believes that it is a combinations of various elements. TV15 also adds the geology of the cliffs in Trimingham as a reason for erosion in the village. This view is also shared by other participants in the focus groups. Similarly, the workshop participants continued to mention underground water and various other contributors to erosion. Drainage is discussed at a greater length during the workshops; however, the causes of erosion were not as frequently discussed in the workshops compared to previous phases of data collection. Thus, throughout

the various phases of data collection contributors to erosion are mentioned regularly. In most discussions, there was a discrepancy between the causes mentioned in SMP6 and what participants identified based on their local knowledge. Discussions on the contributions to erosion are also sometimes followed by proposed opportunities for dealing with these, which were varied and are examined in the following section.

4.4.3 Opportunities and barriers for dealing with erosion

The opportunities to deal with erosion discussed during the exploratory interviews were not as diverse as in subsequent phases of data collection. This may be attributed to the framing of the exploratory interviews, which were not as targeted to discussing the future of the village, unlike the focus groups and workshops. Several opportunities that are mentioned during the exploratory interviews included hard sea defences and soft sea defence by one participant specifically. Others mentioned drainage and general adaptation as an opportunity. Six interview participants believed that there was no solution for erosion, citing various barriers including current policies, funding, and an unwillingness to enact change from villagers themselves.

These same suggestions for future opportunities for dealing with erosion are also mentioned in the focus groups, aside from drainage. Although the discussions around future opportunities and barriers for dealing with erosion are discussed at greater length overall throughout the focus groups, focus group 1 focused more on identifying the various causes of the erosion in the village and did not discuss many options for dealing with erosion.

When discussing future opportunities for the village to continue to be a viable place to live in more detail during the workshops, participants indicated the interlinkages between different future opportunities. For example, they discussed how if new housing is built then drainage issues in the area could be improved during the construction process. Furthermore, the workshop participants considered various options for the new coast road and more housing in the village, e.g. locations for potential housing, type of housing, traffic management, and locations for a new road. The structure and goals of the workshop allowed more time to discuss barriers faced by the village compared to previous phases of data collection. Although along a similar thread as those barriers described during the exploratory interviews and focus groups, the discussions during the workshops were more specific and attributed barriers to specific actors.

Overall, the most frequent barriers to adaptation mentioned throughout the four phases of data collection were lack of funding, lack of government action (e.g. policy changes,

prioritizing the village) and difficulties of engaging relevant actors in pursuing opportunities. The lack of funding is most frequently discussed in conjunction with barriers in maintaining current coastal protection, and obtaining more extensive coastal protection (funding was also mentioned as a barrier to bringing some social changes to the village as well, see Section 4.4). Participants suggested soft sea defences as well as hard sea defences, and when discussing hard sea defences, e.g. groynes and revetments, participants described their importance in keeping sediment from being washed away by waves after they have slumped due to destabilization and water run-off. This mirrors the village questionnaire, with 46% of the respondents citing funding as a barrier for dealing with erosion. Funding was also discussed in terms of how it would enable improving current facilities, and creating new facilities in the village (see Section 4.4). As well as funding, there are other institutional barriers when trying to address the issue of erosion:

> TV03: I think that their [NNDC] policy at the moment is preventing that [adaptation] change.
>
> TV02: It's a myriad of different things. As I said to you earlier, the reasons that the policy is in place is because we are an area of outstanding natural beauty. […] And of course that tends to be a negative to allow the village to adapt to the current situation. […]
>
> (Focus group 2)

In the excerpt, TV02 refers to specific policies that are acting as barriers to adaptation. In the case of this excerpt, barriers to enabling rollback, or the relocation of existing houses further inland (see Section 2.2), in the village comes through the designation of the area where Trimingham is located as an Area of Outstanding Natural Beauty (AONB) and a Site of Special Scientific Interest (SSSI) (see Section 3.3). In addition to rollback, housing has also been discussed in the context of changing demographics in the village, i.e. attracting younger people, which was mentioned in Section 4.3. Many other participants in the focus groups do not specifically cite those designations and only two focus groups discussed policy and the role of government. Similarly, only a few participants in the exploratory interviews refer to policies and government. Throughout the interviews and focus groups, participants mentioned they have been involved in, or have knowledge of, current discussions about future plans in the village. Participants frequently interact with government at the local parish council and district council level. These interactions and experiences affect how participants perceive governing institutions (see Section 2.3). Overall participants seem to have had positive experiences with the individuals representing the local authorities.

Participants' trust in the information provided by government was discussed primarily in the exploratory interviews (it was only briefly mentioned in the focus groups and workshops). For example, quite regularly participants referred to interpretation of available information:

> TV02: That is something, I think, that is marked about what's happened in the immediate past because when we came 7 years ago we were looking at the shoreline management plan, everybody will refer to it as the SMP, and the shoreline management plan said it would be a hundred years before it hits the coast road. Well the way it comes across over there it seems to be accelerating quite markedly. And I firmly believe that sort of information should be made relevant to people that are moving to the area because you're looking at data that's so far out of date- not that it-it's giving the wrong picture to people that want to move to the area.
>
> (TV02 interview)

In this excerpt, the participant refers to the information in the SMP as out of date instead of inaccurate, raising questions about how reliable the available information is. The last part of the excerpt expresses concern that the information available via the SMP may be misleading to people moving to the village. Another interview participant also alluded to the SMP and suggested that more short-term measurements be used to more accurately predict erosion rates in the village. Generally, the conversations around trust in the information used and provided by government institutions revolves around the issue of erosion; primarily around erosion rates, but other topics such as causes and opportunities for erosion are briefly mentioned. Such perspectives indicate feelings of government agencies and authorities not having accurate information, expressed for example through the SMP, which was also linked to participants' lack of trust in the past actions of governing bodies and authorities. For example, one participant in the focus groups questioned if the old wells in the village were properly capped (generally referring to government), while another argued against a NNDC policy not allowing for garden rubbish to be thrown over the cliff edge to help "…bind the soil together…."

Another barrier to adaptation identified during this study is engaging relevant actors. During the focus groups, several participants expressed that they believed it was important to work with local landowners to deal with the concerns in the village. Landowners are seen as one of the major drivers of potential changes in the village. For the most part, the relationship between landowners in the village and villagers is amicable and understanding. The roles of landowners in the decision-making process are discussed at greater length during the workshops because this is where specific future opportunities and barriers are outlined.

In the workshops, conversations about barriers to maintaining the viability of the village primarily focused around funding, rather than policy or governance. This could be in part due to discussions prior to the workshops by villagers with local authorities about potential housing in the village or because funding was in participants' minds as they were fundraising for a new village hall at the time of these phases of data collection. There is currently a push for more affordable housing to be built in the UK, and NNDC are looking for potential locations for future housing. Trimingham has been explored as a potential location for housing. Along with this, as mentioned in Chapter 3, the village received funds from the Lottery fund and the Pathfinder project for the building of a new village hall. Participants fundraised for the remainder of the funds needed for this development; most of them have been directly involved in the planning and running of fundraising events.

One of the aspirations for the future of the village, emerging from the workshops, was for a proactive plan in dealing with erosion. However, participants who refer to any sort of government-led future planning often have negative views on the government's ability to create a plan for the future of the village. Some participants explicitly state that the government does not have a plan for the future. Part of this is because of the uncertainty of events like erosion, and another is that participants feel that the village is not a priority. Participants alluded to the current use of cost-benefit analysis in planning, mentioning phrases such as not enough houses and not enough people to enable the government to take action. Currently local funding for FCERM projects can be applied for through Grant in Aid (GiA) (see Section 3.3). If full funding from GiA is not received, the local community can jointly fund the project (Priestley and Uberoi, 2017). This process was followed to seek and obtain funding for the new village hall.

The barriers to addressing erosion discussed so far in this chapter, e.g. lack of funding, lack of government action (e.g. policy changes, prioritizing the village) and difficulties of engaging relevant actors in pursuing opportunities (see section 4.5), are reviewed using the barriers framework outlined in Moser, Ekstom and Turn (2011), and Moser and Ekstrom (2010) (see Chapter 2). Both were found to exhibit elements in common and are analysed jointly in section 4.6 below.

4.5 Engagement in Trimingham

Discussions emerging during the four phases of data collection covered in this chapter around engagement are generally about village events or decision-making; however, there are also conversations around engagement of relevant actors in the decision-making process

that are not part of the community in Trimingham. Participants refer to the concept of community in relation to engagement; however, the concept of community is a highly disputed concept in social science and the term community is often-times used without clear definition (Head, 2007). Participants in this study refer to community in various ways throughout the different phases of data collection. It used to refer to the physical location of the village, as well as the social aspect of the village. The term community is also associated during discussions by words including: "thing", "sense", and "spirit", to describe the social aspects of community. Sense of community and community, discussed in more detail in the following sections, are referred to by participants in terms of feelings of togetherness, e.g. coming together for events. However, participants also referred to community generally to refer to a group of people. This thesis will refer to community in the same way that participants do. In Chapter 2, engagement of stakeholders was defined as the participation of different groups of stakeholders in decision-making and any subsequent actions. However, engagement of the community and its implications are discussed in different contexts throughout this study, including engagement in decision-making and engagement in village social events. This section assesses the opportunities and barriers to increasing engagement, and seeks to understand the changes in community engagement in the village.

During the focus group discussions, participants were asked how involved they believed a community should be in the decisions made in, and about, their village. The participants agreed that it was important for the community to be involved in making the decisions that affect them:

> TV03: I mean consultation with villagers, with the community, is vital. You need to as their opinion, even if you don't like the opinion you've been given you have to give them the opportunity and NNDC should give them more of an opportunity to –to become involved.
>
> (Focus group 2)

> TV15: I think the community should be very involved.
>
> TV13: It is the same people isn't it.
>
> TV15: Um, yeah. In an ideal world the community should be involved, but the community doesn't have the power to affect it's- the outcome anyways.
>
> (Focus group 3)

The first excerpt refers to the local council and their role in providing more opportunities for communities to be involved in decision-making. The second excerpt from focus group 3 touches on who is involved, as well as one of the barriers that could keep villagers from participating in decision-making: efficacy. If villagers do not feel that they have the ability to influence decisions then they may be less inclined to participate in decision-making. This

prompted questions added to the village questionnaire to gauge efficacy levels in respondents, this includes questions 5, 14, and 15 (see Appendix A1.3). The responses to the village questionnaire similarly showed a lack of efficacy: 62% of respondents indicated "I have almost no influence over what this village is like" (question 5D). Question 11, "What degree of influence do you believe you and the village have to affect decisions made in Trimingham?" was included in the village questionnaire to ask respondents in another way about feelings of efficacy in the specific context of decision-making. A majority of respondents (77%) felt that they had very little to no influence over decisions in the village and that the village had more of an influence over village decisions compared to themselves as individuals. It can be assumed that the village refers to those involved in decision-making because there have previously been responses to discussions that indicate there is a group of individuals in the village who are frequently involved in major village events and decisions.

As sense of community, efficacy and place attachment emerged in the focus groups (and have relevance in coastal management literature, see Section 2.2, sometimes as potential barriers to future change), the village questionnaire included items on these. Question 14 (Q14) in the village questionnaire, "Would you say that you feel a strong sense of community with others in the village, very little sense of community or something in between?", asks about Sense of Community (SOC). The Spearman's Rank-Order correlation analysis run between Q5D, as described in the previous paragraph, and Q14, and found a significant correlation between these variables (p-value = 0.003). Table 4.4 shows the responses for Q14 and Q5, indicating that 23% of respondents had no / little sense of community and felt no influence in the village. However, 63% of respondents who felt no influence in the village (Q5) had some/strong sense of community, and 32% of respondents felt they had some influence in the village and some/strong sense of community. This shows that those who have greater SOC also have higher levels of self-efficacy.

Table 4.4: Count of responses true/ false responses to Question 5: "I have almost no influence over what this village is like."

	TRUE	FALSE	No response	Total
Strong sense of community	6	8		14
Some sense of community	20	13	2	35
Very little sense of community	12	1		13
No sense of community	3			3
No response		1		1
Total	41	23	2	66

Furthermore, the same correlation analysis was done comparing Q14 with Question 5E, "If there is a problem in the village people who live here can get it solved.", and found a significant correlation, p-value = 0.028. This indicates that, similar to the relationship with Q5D, as feelings of SOC increased, so did collective efficacy. These findings are similar to the study by Long and Perkins (2007), where they found that residents' Sense of Community (SOC) and collective efficacy, a term used to indicate participants', "…trust in the effectiveness of civic action" (p. 556), were positively related at neighbourhood level and at the individual level (Long and Perkins, 2007). Furthermore, they also found that collective efficacy was one of the predictors of SOC, and that higher SOC and efficacy were indicators of place attachment. Given that this study found low efficacy and some sense of community, among some questionnaire respondents, the question arises in regards to how they may engage with decision-making in the village and how this may affect development of future options for the village. In this study, the Hierarchical Linear Model (HLM) analysis could not be undertaken due to the low number of respondents who completed all BSCI questions from the questionnaire (n=63).

Length of residence can also be an indicator for place attachment (Quinn, 2013; Hernandez *et al.*, 2007). This was found also in this study. The options developed by participants having lived longer in the village, during the workshops and on future changes decided on, indicate that these participants preferred the least amount of change, especially those changes that would affect the character of the village, i.e. countryside living discussed before. There are however exceptions. It seems that participants who have lived in the village their entire lives are more accepting of physical and social changes in the village. They refer to erosion as being a natural process that has always affected the village, and will continue to affect the village in the future. Therefore, although the village is part of their identity, they accept that it is characterised by change, like erosion, that people living on the coast have to deal with.

The following excerpt from focus group 3 is the clearest example of the differences between place attachment and identity in this study. TV13 was not born and raised in the village and has been living in the village for less than 20 years:

> TV15: Um, I, We often talk about this. I don't have a particular affinity for Trimingham. I like Trimingham. I think it's a nice place to live. It's nice and rural. It's a nice place to have a family and all of those kind of things, but if this was another coastal village, I wouldn't care. Does that make sense? I like where we live. I like our house. Uh, I like the cliff tops and the walk and all of that, but I don't have a particular place. If we moved tomorrow to a place that was equally nice, I wouldn't miss Trimingham. Does that make sense?
>
> (Focus group 3)

This excerpt shows that some participants may feel some sense of attachment to physical locations in the village, e.g. homes, but these physical locations do not form part of their identity. This participant accepted erosion as a natural occurrence, and advocated for various changes, including those that could affect the demographics in the village, e.g. have a pub in the village and have more events for younger people. Other participants during the exploratory interviews and focus groups identified as being from Norfolk, and stated that it was important for them to return to the area.

4.5.1 Changes in community engagement

Two main views emerged from discussions with participants in these four phases of data collection about changes to community engagement over time. One view is that there was a greater sense of community in the village in the past. The other is that the community has come together more in recent years. Participants mentioned these two views separately, or in reference to the natural increase and decrease of sense of community over time in Trimingham. They have also identified reasons why they believe these changes are happening.

During the exploratory interviews, participants who lived in the village over 20 years provided narratives that indicated feelings of a loss of community. Participants attributed this feeling to the loss of facilities in the village (i.e. work, pub, and school), the current population aging, and changing demographics (people from other parts of the UK moving in after retirement). One participant described a time when most of the men in the village worked in the village and village life revolved around agriculture. Participants who described this history of agriculture, did so with a fondness for the past. The views of agriculture in the village have changed over time. All participants in the focus groups and workshops mentioned or agreed with general statements that the change in demographics has caused social changes, with most stating or agreeing with statements about how this shift in demographics has hindered community engagement.

Among participants who joined the village within the last 15 years, most agreed that there has been a rise in community engagement and community spirit in recent years. Four participants in the exploratory interviews mentioned this; they had lived in the village less than 10 years at the time of the interviews and were active members of the community. In comparison, seven participants across all focus groups mentioned that there was an upsurge in community spirit, with two participants agreeing that community spirit comes in waves, i.e. people moving in and out of the village. Participants in the focus group attributed the

increase in community spirit to current events and strong leadership in the village. Fundraising for the new village hall led to more events being held and more villagers becoming involved. Participants have also attributed the success of fundraising for a new village hall to a few strong leaders in the community who have organized these events. At the time of the focus groups, participants had recently received news that funding for the new village hall had been awarded to the village:

> TV06: But also I think there is, I hope, some grounds for optimism that, as [TV08] was saying earlier on, that when our new village hall is completed and we start getting people coming in from other villages, that might awaken a little bit more community spirit in Trimingham. I, we've all tried to foster that and I think there has been a slight upsurge in community spirit.
>
> TV08: Oh yeah. We are getting new people to different events all the time. We're getting them involved, but [TV06: Yes. Yes.] It is a slow process.
>
> TV06: It's a slow process. Absolutely. There's nothing as hard to shift as inertia. (Focus group 1)

This conversation shows that participants felt that recent event have been a positive change for the engagement of villagers in Trimingham. TV06 also references getting people from outside of the village to participate in village events, and the role that this increase in participation could have for the village. A notable comment by the participants was that engagement was "…a slow process" that takes time. This also indicates this exchange was independent of length of stay in the village, because TV06 and TV08 had resided in the village very different periods of time.

Contrary to what was said in the focus groups, one participant in the workshop maintained that there was not an increase community engagement towards fundraising for the new village hall because the community saw the village hall as a "white elephant". However, the participant attributed the success of obtaining funding for the village hall to strong leadership in the village. Another workshop participant expanded on engaging the community, by referring to a need of engaging those who have an influence over decisions; however, this participant did not elaborate on this point further. All workshops also mentioned the role that this study could play in engaging more of the community with the issue of erosion and future change. When asked for suggestions on how to engage more of the village in this study, participants suggested showing visualizations on computer screens or holding an exhibition. Some participants also felt that it would be important to have some of those who attended the workshops at the exhibition to describe the visualizations of the future that they created. Other participants expressed that booklets with visualizations of future change, with short

descriptions, could be distributed to every household in the village as another way to engage the wider community in decision-making (discussed further in Chapter 5).

4.5.2 Opportunities and barriers for community engagement

Most participants expressed the need to engage the community in decision-making. During the various conversations with participants, different barriers to achieving increased engagement and opportunities to overcome these barriers were discussed; these are explored in this section.

The discussions surrounding the impacts of physical locations in the village on the social community make up the bulk of the discussions within the theme of a lack of facilities in Trimingham. For example:

> TV06: Uh, I think, well, important to the village is that the pilgrim shelter, […] looked quite tatty and now it's all been improved. Mostly with villagers helping to do it or doing it and it's improved vastly so that we can put many more things on.
> (Focus group 1)

This excerpt from TV06 is one example of how changes to an existing facility provided a space for more engagement in the village, i.e. villagers participating in village events. Five participants, across two of the focus groups, also mentioned the lack of a village shop. Participants suggested that the pilgrim shelter could be used as a shop or café, in order to provide more services in the village, but this was met with scepticism by one of the participants who questioned the feasibility of a shop. During the workshop, there was some discussion about how the village lacks facilities to maintain its viability into the future. One participant consistently voiced their belief that the current facilities in the village would not attract younger people and families to the village. The workshop served to discuss ways that facilities could be created to improve community engagement.

In addition, lack of available work within the village was discussed in relation to the social implications, which five participants in the exploratory interviews mentioned. Of these participants, two also mentioned this during the focus group discussions. One participant recounted a situation where people were actively looking for work so that they could live in the area. Similarly, some participants argued that some villagers may need to move away from Trimingham given the lack of schools, activities aimed at younger people, and work opportunities.

When participants were asked in the village questionnaire what hinders them from participating in village events, the most frequent responses were lack of time, work

commitments, uninterested in events, and caring for elderly family. Respondents also frequently indicated that they would move away from the village when they became of old age or needed care. During the exploratory interviews, five participants mentioned age playing a role in the lack of participation in village events; with three discussing how old age affects participation (e.g. they are unable to attend events because of mobility or health issues) and one person discussing how being younger than the average age in the village affects participation (e.g. village events are aimed at older people and there are not many young people in the village). Similarly, two participants in the focus group discussed a lack of participation from older people in the village, while two others discussed this about younger people. Also, in the workshops, these two aspects were discussed by one participant each. The way participants framed their discussion was based on their age, with younger participants discussing how being younger in the village affects participation, and older participants referencing old age. In the workshops, discussions around engaging older disabled people focused on the facilities of the new village hall enabling access for older people.

Figure 4.2 shows that Trimingham is a ribbon village which results in, according to participants, a situation of "us and them". Participants in the focus groups mention that this physical aspect of the village has contributed to a lack of engagement from the villagers. This view is also shared by a few participants from the exploratory interviews who would refer to specific neighbourhoods in different ways, positively and negatively, in terms of how they engage with the rest of the community. Most of the participants lived on one side of the village and most of the changes discussed, including the new village hall, were in different areas of the village compared to where they lived. This suggests that there may be issues related to villagers being able to get to the new location where events are held. This could also cause a divide in who is able to attend events. Although the village hall is located on one end of the village, workshop participants suggested that villagers would be willing to support others (e.g. by providing transport for those that cannot drive to the village hall) to use the facilities and attend events. The discussion around the village hall being located on one side of the village indicates that the movement of a physical location can shift the social dynamics, i.e. different people may be more inclined to attend events because of proximity while others may be limited in their attendance.

4.6 Analysis of barriers and opportunities regarding erosion and engagement

This section analyses the barriers and opportunities regarding erosion and engagement, voiced and proposed by study participants, adapting Moser and Ekstrom's (2010) Process of Adaptation Framework (PAF) to organize barriers identified in this study, and how they can be or have been overcome. The PAF enables the identification of an issue requiring adaptation, processes and options that may be put in place to enable this, and implementation of adaptation options. It is deemed that some phases of this framework are relevant and useful for organising opportunities and barriers to adaptation in Trimingham, as discussions in the village have focussed (even before the current study was undertaken) on planning for adaptation and change. This section then reorganises the main barriers identified using the PAF for the four phases of data collection, combining barriers into two main groups and concludes.

The PAF proposes the adaptation process be described by three phases: Understanding, Planning, and Managing, each of which is composed of three stages. The first phase of the PAF, Understanding (which includes problem detection and initial framing, information gathering and use, and problem definition) focuses on detection and definition of the problem/s, while seeking to understand the importance of information and individuals' perceptions in shaping adaptation. The Planning phase consists of option development, assessment, and selection stages. It focuses on the options to deal with problems identified and defined in the previous phase. The Managing phase consists of implementation, monitoring, and evaluation. This phase focuses on the availability of resources to implement, monitor and evaluate the options developed in the Planning phase.

The barriers and opportunities identified by participants to this study, analysed in this chapter, can be categorised according to the first two phases of the PAF (Understanding and Planning), which are re-interpreted to organise the barriers and opportunities identified by study participants. In some instances there is considerable overlap between categories within each phase; when this occurs, they are presented grouped together. However, the management of identified options was not part of this study because the options could not be implemented; therefore this phase is therefore not examined here.

4.6.1 Understanding: problem detection and framing (stage 1)

The barriers in this stage of the PAF are: i) existence of a signal, ii) detection/perception of a signal, iii) threshold of concern, iv) threshold of response need and feasibility. There were two barriers identified for this stage (sectioned in bold).

Threshold of concern (iii)

It was clear to the study participants that the main issue for the village was erosion: signals for this included specific erosion events and village events. Amongst the study participants, different thresholds for concern seem apparent, as Section 4.4 highlighted. Furthermore, participants indicated that an additional threshold for concern about coastal change is the view that the government does not care or is not concerned enough to take action for the village.

Focus group 2 refers to government inaction, which is also reflected in comments made by participants during the third workshop. This is indicative of the way some participants felt their concerns about erosion were not listened to or acted upon. Some participants were involved in discussions with representatives of local authorities; there was some indication that they felt these types of interactions could potentially create a more positive relationship and create opportunities for conversations on some of these aspects, with a view to addressing feelings of government's lack of concern or care and enact change.

Threshold of response need and feasibility (iv)

Moser and Ekstrom (2010) indicate that another possible barrier in this stage is not reaching a threshold of response need. As discussed in this chapter, some participants had a desire for permanency and did not see a need for changes in the village. It was suggested earlier in this chapter that this could relate to individuals' place attachment, such as length of stay and desire for permanence in the village (see Quinn *et al.*, 2015, Scannell and Gifford, 2013). Participants also view the lack of concern from governing institutions as a barrier to the feasibility of any response.

Participants in this case study identified funding as the largest barrier they would have to overcome to maintain the viability of the village. Similarly, Ekstrom and Moser (2013) found that funding and political institutions were the most frequently identified barriers to adaptation. Participants also mentioned various issues with governance, including a lack of trust in government past actions and available information, and a lack of proactive action for dealing with erosion. However, more recent discussions promoted by local authorities on potential housing locations (during the time of this study) may have affected participants' views, and their consideration of this as a potential option to maintaining the viability of the village. In addition, in this analysis, it was found that there was strong leadership in the village, which was described as necessary for both successful adaptation and good governance (see sections 4.3 and 4.5).

4.6.2 Understanding: Gather/ Use information (Stage 2)

This PAF stage includes eight main barriers: i) Interest and focus, ii) Availability, iii) Accessibility, iv) Salience/ Relevance, v) Credibility and Trust, vi) Legitimacy, vii) Receptivity to information, and viii) Willingness and ability to use information. Five of these (highlighted in bold) were evident in the discussions by study participants. Availability and Accessibility are discussed together because of the overlap between the two barriers. These are examined in turn.

Interest and Focus (i)

During the discussions no unanimous consensus was reached regarding which issues were most important for the future viability of the village. This relates to perceptions participants have about concern and the necessary response (see PAF stage 1). A ranking exercise during the workshops was utilized to focus and decide on issues participants wanted to discuss democratically (see Section 3.3) given this barrier was identified during the previous stages of data collection.

Availability (ii), Accessibility (iii), and Credibility and Trust (v)

Information on coastal change was accessed by participants generally online in what were described as long, formal, jargon filled documents such as the SMP:

> TV03: It's very much how it's done. How it's written. I mean so many things that are produced, if you don't mind me saying are in a language that people find very difficult to read. Very difficult to take on board. I mean, some of the things that NNDC churn out, I mean they are, they're just not- you're not able to understand most of it. It's just got jargon. It's not just plain English. If you're talking about something just put it in plain English so people can read it and understand.
>
> (Focus group 2)

This participant expressed frustration at the difficulty to access this information due to its format, in the context of discussions about the goals participants would like to achieve through this study. Generally, participants in this study indicated uncertainty about the causes and rates of erosion (see Section 4.4); it has indeed been acknowledged that the geology of the area is complex.. In general, participants indicated that information relevant to the issues discussed was available, although they mentioned lack of accurate data on erosion rates for the village. The participants proposed that the SMP could be improved by including the findings of more accurate modelling of erosion in the area, as a basis for developing policy suggestions. The British Geological Survey (BGS) was researching the geology of the cliffs in the village with the intent to create a more accurate erosion model

when this study was undertaken, although this information and model was not available when creating the visualizations for this study. The SMP is currently under review (at the time of writing) and this could provide the opportunity to acknowledge and explore local knowledge to include in a new SMP. Furthermore, these conversations seem to call for new, more widely accessible and comprehensible formats for the SMP and other relevant coastal data.

Receptivity to information (vii)

Participants do not generally question the legitimacy of policy documents; however, participants have mentioned that there are people in the village that would not be receptive to information because it is not in line with their values, beliefs, or perceptions. So although the participants were generally receptive to the information of policy documents, this barrier could still be present among others who did not take part in the study.

As study participants were willing to share their knowledge and experiences during the discussions, using and sharing information and knowledge they have, the PAF barrier of willingness and ability to use information of the PAF did not emerge during the first four stages of this study.

4.6.3 Understanding: (Re) Define the problem (Stage 3)

The main barriers for this stage are i.) Threshold of concern, ii.) Threshold of response need, iii.) Threshold of response feasibility, and iv.) Level of agreement or consensus. All of these barriers were identified in the first four phases of data collection. During this stage participants were able to redefine the problems that they wanted to solve through further discussion of their ideas for the future of the village.

Threshold of concern (i), Threshold of response need (ii), and Threshold of response feasibility (iii)

As highlighted earlier in Section 4.6.1, there was not agreement about which concerns (e.g. erosion, engagement, and influence on decisions) are the most pressing for the village and how to overcome these concerns. The focus groups initially identified the concern in the village and response need. Subsequently, the workshops discussed concerns and responses, but went further to discuss and debate feasibility of response. As the study progressed, discussions brought individuals together with varying perceptions on different identified issues to exchange ideas, information and views, and to understand which problems in the village may be of concern such that response need and feasibility are considered.

Level of agreement or consensus (iv)

This study found that participants had varying values and beliefs, and prioritised certain issues before others. This meant that there was consistent disagreement about what should be done in the best interest of the future viability of the village. Similarly, as was mentioned when discussing the previous stages, there is still a lack of consensus as outlined in Moser, Ekstrom, and Turn (2011), and the literature also supports the difficulty of achieving a consensus (Brown *et al.*, 2006; Milligan *et al.*, 2009). The workshop ranking activity focused the discussions to a few topics such as infrastructure, erosion, engagement, and tourism (see Section 3.3). Participants did not oppose to discussing the top three options. They accepted the group decision and continued a more focused discussion about the selected future options.

4.6.4 Planning: Develop options (Stage 4)

Stage 4 of the PAF identifies six barriers which include i.) Leadership in leading process, ii.) Ability to identify and agree on goals, iii.) Ability to identify and agree on a range of criteria, iv.) Ability to develop and agree on a range of options that meet identified goals and criteria, v.) Control over process, and vi.) Control over options.

The fourth and sixth barrier were the only two barriers identified for this stage (elaborated on below). Participants in the village referred to strong leadership and its effect on achieving change in the village over the last few years, i.e. funding and permission for the new village hall; this is identified as a component of good governance (Schmidt *et al.*, 2014; Ekstrom and Moser, 2013). Hence the first barrier was not found in this study. Participants generally agreed on goals for this study, what they would like to accomplish through their participation, and thought that this study could engage more villagers in decision-making. This study, however, did not explicitly set out to define criteria for creating and evaluating proposed options. Thus, the third barrier and part of the fourth barrier are not relevant to the purpose of this study. The fifth barrier is also not present because the process of developing the options in the workshops were organized based on previous discussions with participants, and suggestions from the literature (see Section 3.3).

Ability to develop and agree on a range of options that meet identified goals and criteria (iv)

Participants were prompted to think about all the options they believed would benefit the village during the workshop. They presented their thoughts by drawing these proposed changes and presenting them to the group. This process showed that participants were able to develop options that, in their view, would help the village be a viable place to live in the future. Some of these options included those discussed in Sections 4.4 and 4.5, e.g. new village hall being built, new coast road being built, etc.

Control over options (vi)

This barrier was more or less prominent depending on the issue being addressed. For the most part, participants felt the village had more control over options to do with engagement because it has autonomy over the organization of village events. On the other hand, most of the options suggested to deal with erosion required the coordination of various actors outside of the village.

4.6.5 Planning: Assess options (Stage 5)

This stage also emphasises the availability, accessibility, and credibility of information in terms of how they affect the assessment of options. According to the PAF, the barriers for this stage are: i.) Availability of data/information to assess options, ii.) Accessibility/usability of data, iii.) Availability of methods to assess and compare options, iv.) Perceived credibility, salience, and legitimacy of information and methods for option assessment, v.) Agreement on assessment approach, if needed, and vi.) Level of agreement on goals, criteria, and options.

However, some were not identified in this study, namely the third (as the visualizations were used to compare options – see also Chapter 5), the fifth (as this study did not include assessing the options proposed by participants), the sixth (the participants expressed varying levels of agreement over the options, but also a consensus on the general goals of the options).

Availability of data/information to assess options (i), Accessibility/usability of data (ii), and Perceived credibility, salience, and legitimacy of information and methods for option assessment (iv)

Participants continued to question the accuracy of the information provided by local authorities and official documents, thus reflecting similar considerations to those raised in Stage 2 (see Section 4.4. on the discrepancy between the causes/ rates of erosion described by these sources and the rates and causes of erosion referred to by participants).

4.6.6 Planning: Select options (Stage 6)

This Planning phase includes five main barriers - i.) Agreement on selecting options, ii.) Sphere of responsibility/ influence/control over an option, iii.) Threshold of concern over potential negative consequences, iv.) Threshold of perceived option feasibility, and v.) Clarity of authority and responsibility over selected option.

Agreement on selecting options (i); Threshold of concern over potential negative consequences (iii); Threshold of perceived option feasibility (iv)

Even at the workshop phase, participants still had varying views on what options would be most beneficial for the future viability of the village, although the ranking exercise enabled some agreement to be reached. Regarding the feasibility of the proposed options, participants discussed the various barriers they face when trying to develop a proactive plan for dealing with coastal change: participants still had different views about the feasibility of certain future options. Furthermore, some participants were concerned that changes in the village would change the character of the village, i.e. housing may mean that the village will not remain peaceful and quiet (see Section 4.4).

Sphere of responsibility/ influence/control over option (ii); Clarity of authority and responsibility over selected option (v)

Participants felt that their responsibility, influence, and control over the options was limited. They also expressed confusion as to which authority holds responsibility over option implementation. Coordination of different decision-making organizations and individuals was identified as a barrier although participants identified the importance of engaging relevant actors for adaptation to occur, including the district and parish councils, Environment Agency, DEFRA, and individuals in the village, thus reflecting other studies on involvement of decision-makers for a holistic approach to coastal management (Schmidt *et al.*, 2013).

4.6.7 Reviewing the main barriers identified in this study

The previous sections have demonstrated how the PAF can be used to identify and organize barriers emerging to coastal management and future village viability, during the first four phases of the study. Several barriers emerged regularly throughout these four phases from discussions with participants. Table 4.5 organizes and condenses these into two main ones (information and data, and consensus building) and presents the opportunities for overcoming these.

The Information and Data category encapsulates those barriers which reflect the effect of participants' experience and knowledge on their perceptions of the future of the village, including concerns relating to policy, institutional coordination, funding and availability of information, which is affected by its accessibility. Consensus building consists of barriers that shaped by participants' perceptions of change, values, and experiences (see Sections 4.3, 4.4, and 4.5). Most of the opportunities refer to external events happening in the village simultaneously to this study, primarily implemented in the workshops. The table indicates how some opportunities were proposed as options that could address more than one type or set of barriers concurrently, for example, holding an event or having the space for discussion and knowledge exchange.

Table 4.5: List of barriers identified during the first four phases of data collection and opportunities to overcome them.

Main Barrier category	Barriers	Opportunities
Information and data	• Lack of trust in current erosion projections: – Erosion is faster/ slower than predicted • Mixed perceptions about feasibility of future options: – Policies do not allow for changes to occur – Needs for government coordination – Funding is unavailable • Accessibility: – Unfamiliar with technology used – Did not have access to technology/ information – Accurate information about local erosion did not exist	• Create space to discuss collective knowledge: – Participants are involved in various decision-making bodies/ forums/ committees – There are people in the village with experience in fundraising. – Discussions with local authorities about future change are currently ongoing – Hold events to create spaces for wider engagement of the community *(see Consensus Building)* • Update policy documents: – SMP under review – Include latest BGS research on coastal change in the village • Increase access to technology: – Improving internet and phone service in the area
Consensus Building	• Mixed levels of acceptance for future change: – Some do not want character of the village to change – Some believe change is necessary – Some accept erosion as a normal occurrence • Problems and future options are prioritized differently – Some people are not interested in participating in discussions about future change • Need for increased engagement: – Same people participating in village events – Low perceived efficacy among some villagers – Acceptance of erosion as a natural process that cannot be changed	• Hold an event to: – Inform villagers about coastal change and current research – Discuss future options – Galvanize opinions • There is currently strong leadership in the village • A ranking exercise was used to decide how to prioritize discussions and future options

4.7 Conclusion

The exploratory interviews, focus groups, village questionnaires, and workshops give insight to how the participants view the village where they live. These views are related and discussed throughout the chapter to the literature on perceptions of change and engagement in decision-making processes. The two main themes discussed in this chapter are erosion and engagement. The physical and social characteristics of the village that are important to participants are encompassed in these two themes.

The aim of this chapter is to set the context of how participants view the future of the place where they live in order to inform the creation of visualizations and understand perceptions of visualizations (discussed in Chapter 5). Section 4.6 analyses the barriers identified during the first four phases of data collection using the PAF and condenses these, alongside the opportunities suggested, into two main categories. The findings in this chapter also show that methodological choices, i.e. the use of an iterative longitudinal study and diverse activities, create opportunities to overcome barriers, and aid in deciding on future options to be visualized during workshops (the role of visualizations will be discussed in Chapter 5). The analysis of the first four phases of this study explores why participants made particular choices regarding options for the future viability of the village. In the following chapter, these discussions are used to examine the role of visualizations in the decision-making process. Chapter 5 evaluates visualizations as formulated and used by participants in discussions about future changes in the village.

Chapter 5 | Role of Visualizations in Decision-Making in Trimingham

"In summary we find that (a) 'evaluation sucks' [8] (b) it sucks because it is hard and (c) but if you think about it differently it may not be so bad after all and so (d) you can actual[ly] do it right."(Ellis and Dix, 2006, p. 15)

5.1 Introduction

As discussed in Chapter 2, a visualization is defined in this thesis as a tool to engage individuals and facilitate learning and understanding. This chapter explores the role of visualizations in decision-making about future physical and social landscapes, using a specific longitudinal case study. It builds upon the thematic analysis of Chapter 4 in order to analyse participants' perceptions of the visualizations, and the roles that these images played during the workshops, poster exhibition, and final interviews.

Section 5.2 outlines the goals and purpose of visualizations in this study. It sets the basis for evaluating the visualizations created and modified during the workshops, and presented in the exhibition. Section 5.3 evaluates the role of visualizations during the workshops, and assesses the critiques and commentary during the poster exhibition. Furthermore, the section uses the final interviews to assess how participants felt about the visualizations, and identifies aspects of the visualization process that could be improved upon. Section 5.4 draws upon the analysis of the previous two sections in order to examine the effectiveness of the visualizations created and modified in this study. It assesses the relevance to this study of the criteria for effective visualizations, and suggests how the criteria could be used to engage communities in decision-making using visualizations. Section 5.4 also reflects on the process of creating the visualizations for this study, with reference to the longitudinal aspect of this research.

5.2 Tailoring criteria for effectiveness

The quote from Ellis and Dix (2006) introducing this chapter highlights the difficulty of evaluating visualizations, but also suggests that evaluation is possible if considered differently, i.e. undertaken with pertinent and appropriate evaluation of visualizations methods and tools. Multiple criteria for evaluation are proposed throughout the landscape visualization literature, acknowledging that no one combination of criteria may be suitable to evaluate all visualizations (Bishop *et al.*, 2013; Knight, 2001; Lewis, 2012; Haines-Young and Potschin, 2011; Sorensen, 1997), because an evaluation has to be pertinent to the purpose of the visualizations (Bishop *et al.*, 2013). Two decades ago, Beierle (1998) emphasised the

importance of identifying a goal when evaluating programs, e.g. policy and public participation. More recently, Burgess and Chilvers (2006) stressed the importance of purpose in their conceptual framework on the design and evaluation of participatory processes. Similarly, evaluating visualizations according to their intended purpose is important. To evaluate the effectiveness of visualizations in this study, the purpose of the visualizations, and the criteria that are most relevant to evaluating the visualizations based on their purpose, were clearly denoted.

This study set out originally to explore and understand the role of visualizations in decision-making processes, specifically in the context of future coastal change. Based on the literature, the purpose of visualizations for this study was envisioned at the outset to be a tool for engaging participants in discussions about future change, and facilitating learning and understanding (see Section 2.4). However, study participants were also encouraged to indicate during the focus groups what goal they would like to achieve through this study, to understand what they felt about the goals and purpose of visualizations in this study. As three participants indicated:

> TV06: Well I think it [this study] will help to clarify the overall vision of where the village is, where it needs to go, and possibly, how to get there. Uh, that's the overall impression to me, is that you can facilitate the vision that people have and we have.
> […]
> TV01: [We could] come up with a recommendation to the authorities. Couldn't we?
> (Focus group 1)

> TV15: I think it [this study] could, let's say if you were coming up with a way of giving people some sort of visualization or projection of where the village could be in 20 years. I think that's really worthwhile. And I think that can be used to galvanise opinion. Um, to maybe increase the appetite to maybe do something about it or at least make everybody aware. Get everyone on the same page. 'Look this is the best guess. This is the possibility. What we gonna do about it?' And if the answer is, 'well we can't do anything about it.' Then at least everyone's had an opportunity to understand it, have an opinion, make a comment.
> (Focus group 3)

The first quote indicates that TV06 felt that the study could "facilitate the vision" for the village's future, contributed by participants to the study, and others more widely, and how to achieve this. Most other participants in the focus groups also shared this view. In this same discussion, TV01 proposed that this study could be used to make recommendations to local authorities. Several participants throughout the study also frequently mentioned using this study as an opportunity to devise suggestions to be presented to the local authorities. The

excerpt from TV15 expresses that this study could act as a way to increase debate and engage villagers in decision-making for the future of the village. The participant uses the term "galvanize" to indicate that engagement of villagers could be increased through the presentation of shocking information. Several other participants in the focus groups and workshops agreed to similar suggestions; this is further discussed in Section 5.4. The two excerpts above are representative of the proposed goals of the visualizations voiced and agreed upon in each of the focus groups; these goals were used to inform the development of the visualizations to be shown in the workshops.

The goal of this study, as proposed by participants, is therefore to i) engage villagers in the process of decision-making, and ii) to elicit opinions about future changes in the village, with a view to discussing if and how these maybe achieved and with the intention of creating proposals, which some indicated could be directed to the local authorities. It should be noted that participants used the term engagement to refer to eliciting more participation from villagers, while the original purpose of the study - based on the literature and before discussion with participants – viewed the term engagement to refer to including participants in the study in decision-making using visualizations. In other words, the former focuses on engaging some individuals in participating in this study, and the latter aims to engage those already participating in the creation and use of visualizations during decision-making processes. Combining these two, a revised goal for this study was developed: use of visualizations as tools for eliciting discussion on future change and engaging villagers in the decision-making processes.

Examples in the literature of criteria to evaluate the effectiveness of visualizations include clarity, engagement, connectivity, trust, feasibility (Sheppard, 2012), usability, suitability (Knight, 2001), generalizability, precision, and realism (McGrath, 1994). Seven criteria were chosen to evaluate the visualizations created throughout this study: clarity, engagement, connectivity, trust, feasibility (Sheppard, 2012), usability, and suitability (Knight, 2001), as these criteria reflect the purpose of the visualizations (both in content and presentation) used in this study.

Table 5.1: Definitions of criteria used in visualization evaluation; summarized and modified from Sheppard (2012) and Knight (2001).

Criteria used when creating and evaluating visualizations
Clarity: A visualization that is clear, unambiguous and simple in its message while still being informative. The visualization itself must be able to attract attention and send a strong message.
Engagement: A visualization that is interesting to look at and interact with. It must be accessible in reaching the most people possible by using multiple methods of explanation.
Connectivity: A visualization that is relevant and personal. It must show connectedness between the location and the big picture without becoming too complicated to understand.
Trust: A visualization that is accurate, credible and transparent in terms of the data and information it is based on. It must be respectful to the areas it represents and people with whom it is used to communicate.
Criteria used when considering technology for visualization
Feasibility: A visualization that is cost-effective for the users. The visualization must be usable, able to be replicated and kept up-to-date.
Usability: A visualization that is accessible to those interacting with it, enabling users to accomplish a task that the visualization is meant to support.
Suitability: The visualization is suitable for the task it is intended for, and is an appropriate representation of the data presented.

Clarity, engagement, connectivity, and trust (Sheppard, 2012) are the primary criteria used for evaluating the content of visualizations. Clarity is an important factor in any planning process (Ekstrom and Moser, 2014) as well as a widely applied criterion for the effectiveness of visualizations (Harwood *et al.*, 2015; Downes and Lange, 2015; Lewis, 2012). Engagement was also chosen as a criterion because the purpose of the visualizations for this thesis emphasises the importance of engagement of participants with the visualizations, as well as more widely. In fact, engagement is advocated as a central component of integrated coastal zone management (ICZM) (Schmidt *et al.*, 2013), which is a model for the participatory process attempted by this study. Similarly, connectivity is relevant as a criterion due to the importance of rendering the contents of the visualizations relevant with a view to eliciting action (Clayton, 2015; Moser, 2010). In fact, the visualizations used in the workshops and exhibition render multiple proposed future options (see Section 3.3) and, as discussed in Section 5.3, many of the future options proposed by participants can address multiple issues in the village that participants wish to overcome, e.g. drainage, lack of housing, etc. Trustworthiness of the visualizations was a key criterion borne in mind when

developing and evaluating the visualizations, as participants voiced early in the study that there were discrepancies between what they observe and believe around erosion in the village, and what the government has stated in their public documents, e.g. SMP (see Chapter 4). In addition, trust has also been proposed as a key criterion for integrated management approaches such as adaptive governance, see Section 2.2.1 (Schmidt *et al.*, 2013).

Feasibility (Sheppard, 2012), usability, and suitability (Knight, 2001) were used primarily in informing the first stages of the visualizations when determining which technology to use and how to present the visualizations. In fact, participants in the exploratory interviews were asked what mode of communication they most commonly use in their daily lives, and what types of visualizations participants have interacted with before. Participants primarily communicated via word of mouth and other village documents, i.e. pamphlets, and newsletter. Several participants also expressed that they do not frequently use computers or smartphones, and that there was poor internet and phone service in the village. This information was used to determine suitability, feasibility, and usability of different types of visualizations for this study, i.e. it would not be feasible to use augmented reality apps because many participants do not own smartphones, and the internet connection available in the village would not support their use. Suitability is related to the ability to accomplish a task. It was decided that 2D and 3D still visualizations would be suitable and they would be adequately usable and accessible by participants. A summary of the criteria considered during the creation of the visualizations for this study are shown in Table 5.1.

Other criteria proposed in the literature on evaluation of visualizations were not included as criteria for effectiveness in this study. For example, realism as defined by McGrath (1994) (see Section 2.2.4) was not considered to be relevant, for this study, to evaluate visualizations. It is recognised that how accurately visualizations portray features of the aspects represented will affect how a visualization is perceived. Similarly, generalizability (i.e. the population of publics that can be included) was not required in the visualizations for this study because of the emphasis in tailoring the visualizations to align with the needs of the village participants.

This section has reflected on criteria for evaluating the effectiveness of visualizations and outlines how relevant criteria can be chosen and used in combination based on the purpose of visualizations. Section 5.3 discusses the visualizations created and used throughout this study in order to understand participants' perceptions of them.

5.3 Views on visualizations created through participation

This section examines the visualizations that participants engaged with in the workshops and exhibition and how participants remembered the visualizations, including their thoughts and feelings about the visualizations, in the interviews at the conclusion of the study.

5.3.1 Visualizations during the workshops

Participants were given the opportunity to discuss future changes in the village that could contribute to the future viability of the village during four workshops held with a total of 12 participants (The workshop rationale is described in Chapter 3). Workshop 1 was a mixed group of individuals with moderate views on change in the village; some were participating in the study for the first time. Workshop 2 included participants who had previously expressed more openness to change compared to other participants, and Workshop 3 was comprised of participants who showed more hesitancy towards change compared to other participants. The workshop activities were also run separately for an individual that could not take part in the other workshops. This section focuses on the discussions from the three workshops with the nine participants who regularly participated in this study. The fourth workshop consisted of one participant, who did not participate further in this study, but made suggestions for future change in the village. Their views are included when describing overall views of participants; however, because of the views of this participant expressed during the workshop, their views may not be explicitly obvious.

At the beginning of the workshops, as an opening activity, participants were shown visualizations of the village including Esri Story Map, which depicted a map of the village from 1915 next to a map of the village in 2015 (Figure 5.1) that were interactive, i.e. moveable bar between the two maps. The creation of the Story Map was informed by suggestions from the focus groups about what participants would like to see visualized in the workshops. It was presented at the beginning of the workshops as a tool to elicit discussions about future change. The initial aerial 3D visualizations of the village, Figure 5.2, were shown individually on a projector screen as a starting point for the visualizations, to familiarise participants to the type of 3D representations that they would be commenting on and discussing during the workshops. It should be noted that these visualizations are not a true 3D visualization because they are presented as still images. Using 3D visualizations and Visual Nature Studio to create the 3D aerial VNS visualizations was decided to be the most suitable type of visualization and software available to make semi-realistic visualizations in real-time. Furthermore, as was discussed in Section 3.3, the lack of reliable

internet service in the village meant that relying on solely internet-based software like Story Maps could have potentially hindered the working speed of the workshop if internet was slow. Participants' experience using technology was also being taken into account when deciding to use these types of visualizations. The visualizations in Figure 5.2 include both vertical and oblique views, unlike the Swipe Style Story Map which is vertical only. Participants showed more interest and engagement with the interactive Story Map as opposed to the initial, still, visualizations of the village. This is discussed further in Section 5.4.

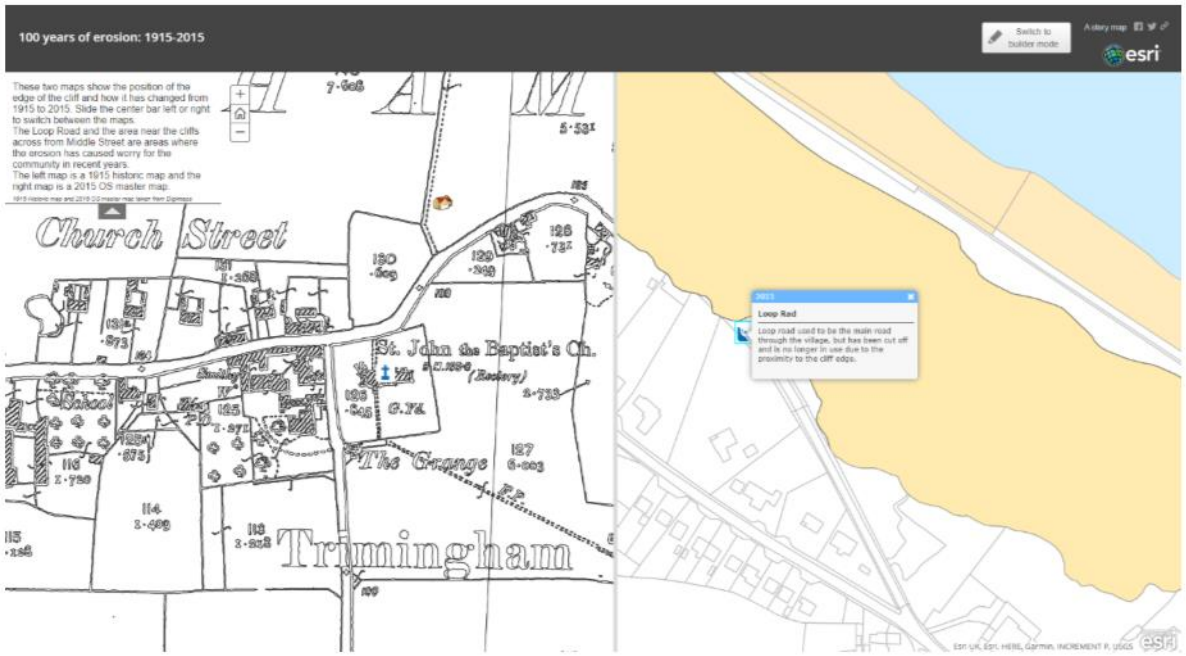


Figure 5.1: ESRI Swipe Style Story Map created using a historic 1915 map and 2015 OS Master Map data. Indicators for physical locations discussed during the exploratory interviews and focus groups. (This is an exact copy of Figure 3.4.)

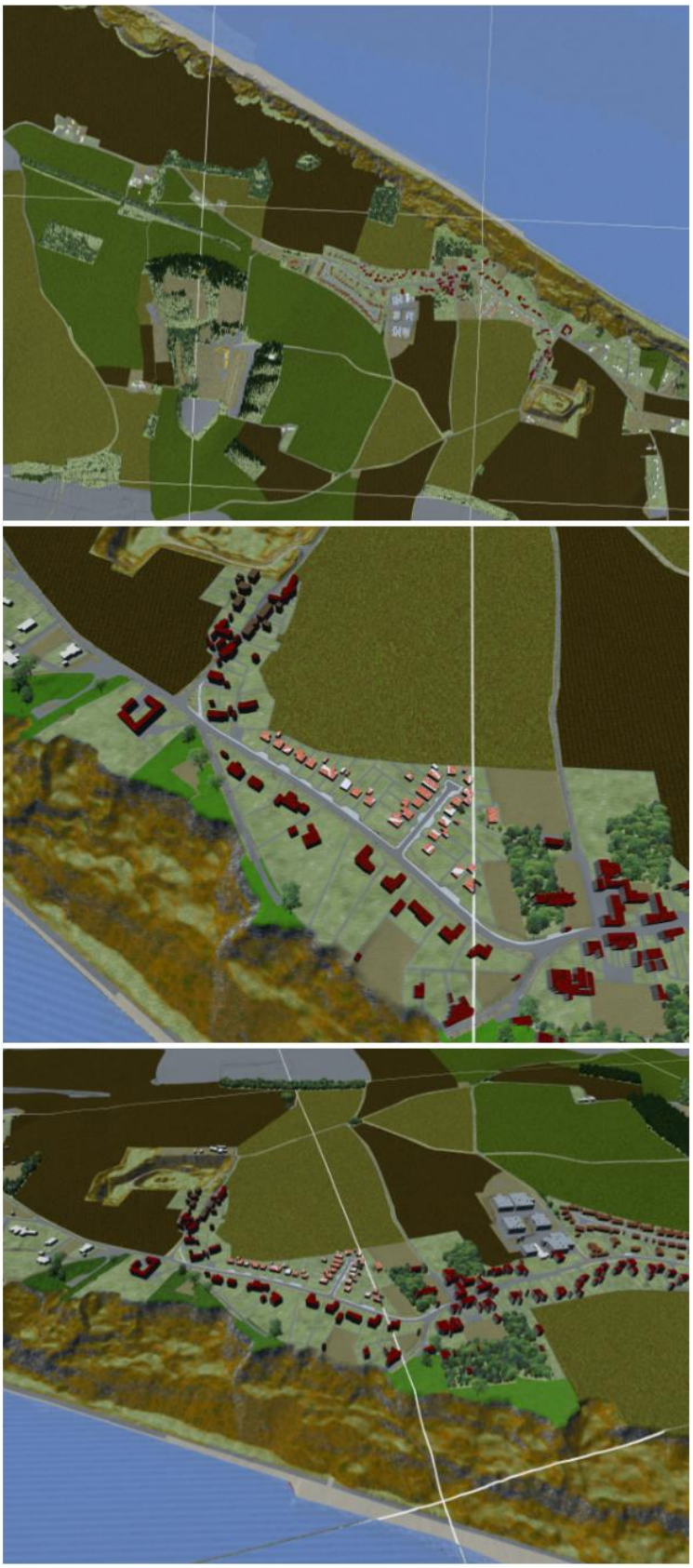


Figure 5.2A-C: Initial visualizations were created using VNS to be presented to participants in the workshops. 5.2A depicts an aerial view of the entire village. 5.2B-D show aerial views from different perspectives and of different parts of the village. Figure 5.2E depicts the new village hall. (This is an exact copy of Figure 3.3)

D

E

Figure 5.2D-E: Initial visualizations were created using VNS to be presented to participants in the workshops. 5.2A depicts an aerial view of the entire village. 5.2B-D show aerial views from different perspectives and of different parts of the village. Figure 5.2E depicts the new village hall. (This is an exact copy of Figure 3.3)

Following the short viewing and discussion of the Swipe Style Story Map, used to spark conversation about how the coastline has changed, and 3D aerial VNS visualizations (see Section 3.3), the workshop participants were asked to draw on an A4 map of the village and describe what changes they believed would allow the village to continue to be a viable place to live in the future, i.e. in 5+ years. (The workshop protocol is included in Appendix A1.4.) The first workshop participants suggested 10 unique options for the future; the second workshop proposed 22 unique suggestions, and the third workshop proposed 19. Figure 5.3 shows the topics initially proposed and discussed, and specific future options discussed in detail after the ranking exercise (see Section 3.3 for more details on this process).

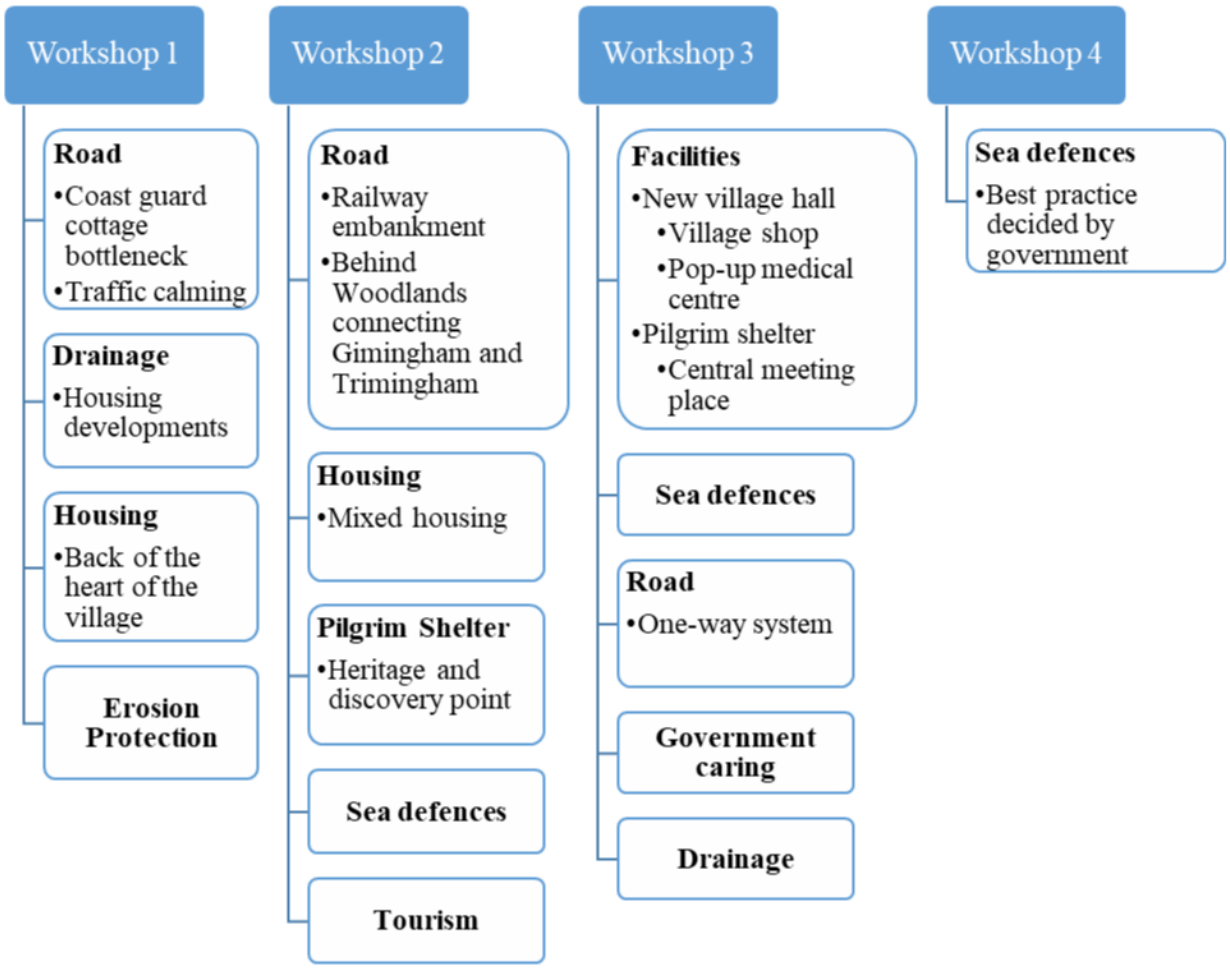


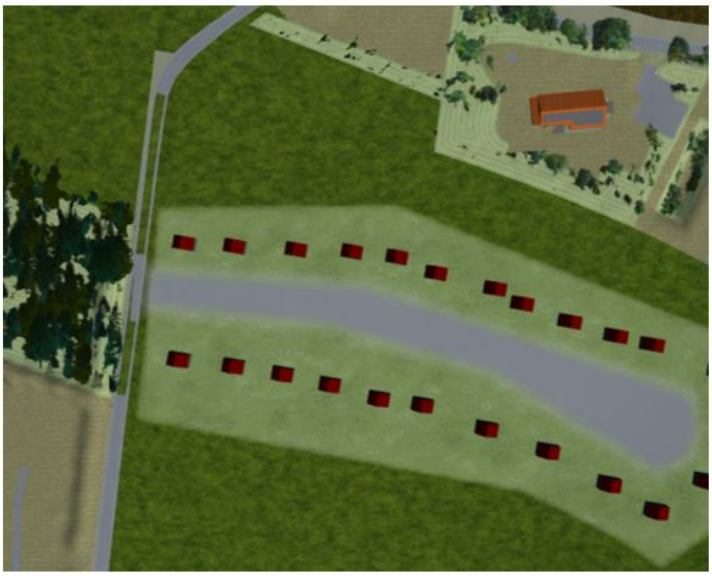
Figure 5.3: Main topics (in bold) discussed during the workshops and specific options (bullet points) discussed in greater detail after the ranking exercise.

After the first discussion about future options and a ranking exercise, outlined in Section 3.3, visualizations were created during the workshops as a way to represent the highest ranked future options suggested by participants. Figure 5.4 shows the final visualizations modified by the researcher during the workshops based on comments from the participants. After seeing the visualized options, participants were given further opportunities to discuss the visualizations and modify them if they wished, with the researcher adapting the visualizations in 'real-time'. The first workshop was the only one to make any major change to the underlying options being visualized. This change occurred after seeing a visualized housing development in one area of the village; participants had a discussion in terms of location, and decided to move the housing development from the Mundesley side of the village to the Sidestrand side of the village, as the following quote indicates:

> S32: Yeah. That's the road that comes up from - and that's all field there, so if the houses were behind the village hall, the road could then join the Woodlands access road […] I think there will be more benefit for the houses there than up at the top of the village.
>
> TV06: I think a lot of these ducks will all fall into line.
>
> (Workshop 1)

These changes were proposed after participants saw the visualized options they initially proposed, i.e. housing in the "heart" of the village, which sparked discussion about road access and other changes (referred to as 'ducks' in the above quote) that would become necessary if housing were built there. This indicates that the use of visualizations encouraged further discussion about the initial visualization proposal. The second workshop added a grove of trees as a barrier between current houses and the suggested housing development in the "heart" of the village because they felt the people in the houses nearest the suggested location for new housing would prefer to maintain a more natural view. In contrast to the first two workshops, the third workshop did not make changes to the main options initially visualized, and participants focused on details such as building orientation and tree cover. The differences between the changes made after seeing the modified visualizations raises questions as to whether options participants already had in mind based on their knowledge, values and experience had an effect on changes made after seeing the visualized options (e.g. see Section 4.3 on values around sense of community, place attachment, and place identity).

A



B

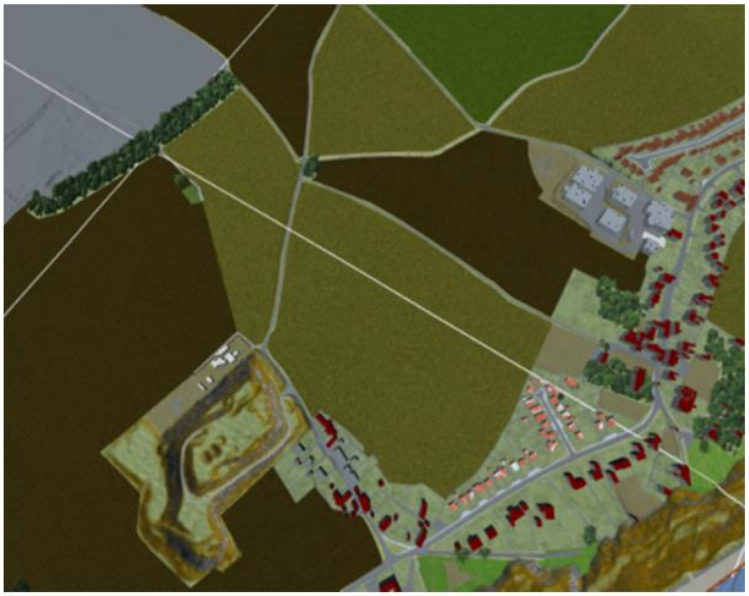
Figure 5.4A-B: During the workshops participants had the opportunity to contribute to visualizations of future options. Figures 3.5A and B were created during the first Workshop, Figures 3.5C and D during the second workshop, and Figures 3.5E and F were created during the third workshop. (This is an exact copy of Figure 3.5)

C

D

Figure 5.4C-D: During the workshops participants had the opportunity to contribute to visualizations of future options. Figures 3.5A and B were created during the first Workshop, Figures 3.5C and D during the second workshop, and Figures 3.5E and F were created during the third workshop. (This is an exact copy of Figure 3.5)

E



F

Figure 5.4E-F: During the workshops participants had the opportunity to contribute to visualizations of future options. Figures 3.5A and B were created during the first Workshop, Figures 3.5C and D during the second workshop, and Figures 3.5E and F were created during the third workshop. (This is an exact copy of Figure 3.5)

When asked about their thoughts on the use of visualizations throughout the workshop, two participants specifically mentioned that the Swipe Style Story Map was interesting and eight participants had positive comments about the visualizations in general. This is also supported by participant responses in the survey after the workshop. Figure 5.5 shows the percentages of the responses to Question 3 of the survey after the survey, asking participants to "Please indicate below (ticking the relevant box) to what level you agree or disagree with the following statements about the visualizations used during the workshop today." Overall, participants felt positively about the visualizations, and all participants agreed, to some

extent, with five of the seven statements asked about visualizations. Figure 5.5 shows that participants felt that the visualizations were clear and understandable, engaging, made coastal change more personal, helped think of positive futures, and were respectful towards their views.

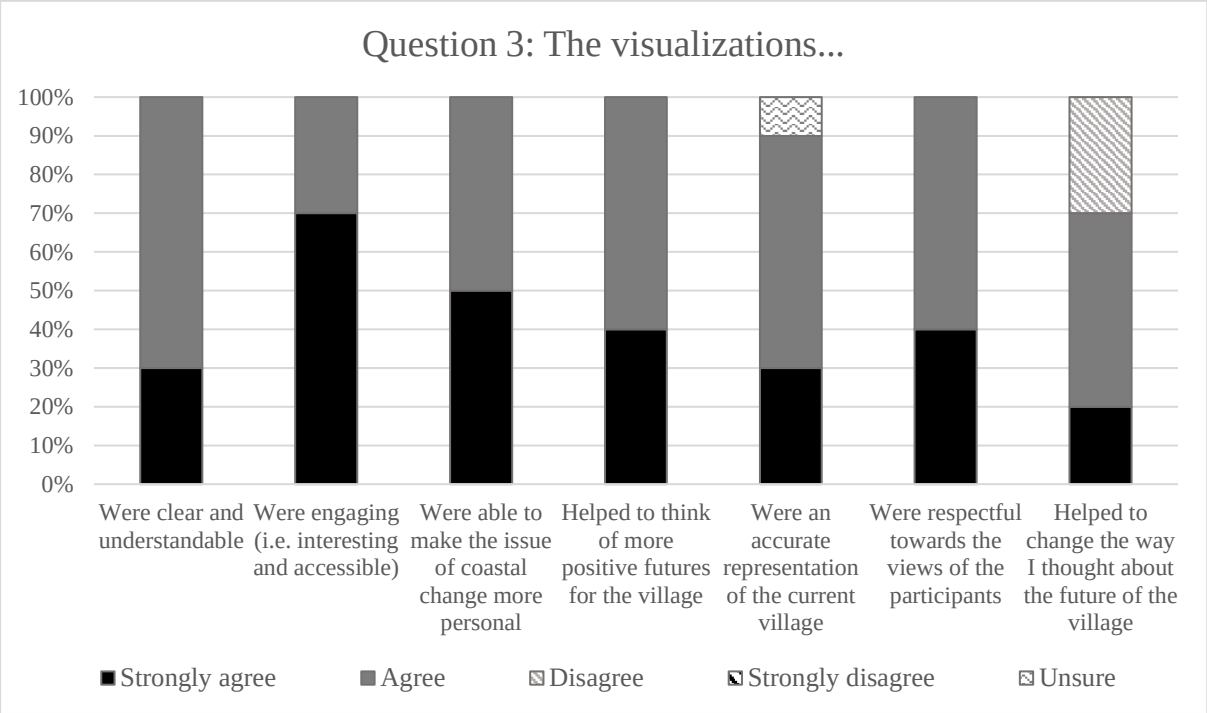


Figure 5.5: Question 3 in the survey after the workshops asked participants to answer on a 5-point Likert scale the degree to which they agreed with the seven statements charted above. "Question 3: Please indicate below (ticking the relevant box) to what level you agree or disagree with the following statements about the visualizations used during the workshop today."

Three participants (~33%) felt the visualizations did not help change the way they thought about the future of the village. These same participants felt that their feelings or views about coastal change had not changed since before the workshop. Two other participants responded that their views on coastal change had not changed, but also responded that the visualizations helped to change the way they thought about the future of the village. This indicates that participants viewed coastal change and the future of the village distinctly from each other.

Participants were asked how their views about coastal change in the village changed from before the workshop. In their responses, some participants mentioned the process of using visualizations in the workshops in a positive way:

> TV01: More positive. It has helped to remind us of how much can be done by a comparatively small group of people working together. The big picture (even when sometimes impractical and over-optimistic!) is a helpful tool in making us imagine what is possible.
> (Workshop 1: After Workshop Survey)

TV02: Very positive. Good to see these details [future options] being visualized. (Workshop 2: After Workshop Survey)

The two quotes indicate that these participants felt positive about coastal change, and about the activities in the workshops, i.e. visualizing future change and discussing it. The first excerpt stated that they felt more positive about coastal change, and specifically felt positively about the process of discussing and visualizing future options. This view was also shared by another participant. All participants responded that they felt that the visualizations were helpful in focusing the discussion, visualizing potential futures of the village, and agreeing on which futures were most feasible in their surveys after the workshop. Only one out of these ten participants felt that modified visualizations were not helpful in organizing their thoughts. How helpful and relevant the visualizations are in the context of the exhibition is further discussed in Section 5.3.4.

During the workshops, a few participants found it difficult to identify physical locations using the visualizations, but this was always resolved with the help of other participants in the workshops. Participants that had difficulty orienting themselves using the visualizations asked about the roads and buildings to help orient themselves. Other participants and the researcher helped in answering these questions about the visualizations. Although there were participants who did not feel the visualizations helped in changing the way they thought about the future of the village, the visualizations, along with the discussions, created positive experiences during the workshops for participants, as discussed above.

5.3.2 Limitations of visualization creation during the workshops

One of the main limitations to the process of modifying visualizations during the workshops was the computing power necessary (refer to Section 3.3 and 3.5) to modify visualizations in real-time in front of participants. This is also related to the amount of detail and realism that could be included in a time-constricted environment. The visualizations that participants saw during the workshops were unrealistic and fairly abstract, e.g. the houses were blocks and the roads were not smooth. Greater realism would have required more computing power, which was not available for this study. One of the most agreed upon issues to address in the workshops was drainage, but Visual Nature Studio (VNS) was not the proper tool to visualize changes to drainage suggested, i.e. connecting all houses to main drainage instead of using septic tanks. In fact, VNS is a powerful tool that allows the users to modify landscapes with 3D models of vegetation and building. This software is not intended for underground structures such as pipes to visualize drainage. In this case, it may be more

relevant in future discussions to move away from realistic visualizations created using VNS, to other types of visualizations, i.e. abstract and information visualizations.

5.3.3 3D ground view VNS visualizations

In order to maintain realistic expectations of what is feasible to accomplish in preparation for the exhibition, coastal managers were contacted after the workshops and shown the modified visualizations that were created based on the workshop discussions. Coastal managers were contacted because participants indicated a lack of confidence in government's past actions and their ability to affect change, see Section 4.4. Furthermore, managing the expectations of what future options are feasible and what this study could accomplish are an integral part of maintaining a positive relationship with participants.

The coastal managers were impressed with the range of options developed during the workshops and commented on all the options suggested during the workshops and their limitations, which were considered before presenting the final options to the village. These included options for housing development, road and infrastructure development, and coastal protections, see Figure 5.3. The participant from the fourth workshop that suggested best practice sea defences did not suggest a specific option for sea defences even after questioned on this topic further. Instead, the participant suggested speaking with planners to determine the "best practices" for sea defences. The following excerpts are from this interview, discussing sea defences:

> CM1: In this location the policy is managed realignment, so the practice is decommissioning and coastal adaptation. That would be the best practice, if you want to call it that.
>
> CM2: And at the end of the day, Trimingham is a really complex landslide, so actually, are there any sea defences that would stabilize that landslide? It would be extremely expensive to put something in that may be unsuccessful because the landscape is so complex in that location.
>
> CM1: Which wouldn't get consent to be put in anyways due to the designations of the cliffs.
>
> (Interview with coastal managers prior to the exhibition)

These excerpts indicate that coastal managers consider logistical and designation aspects of management options. They referred to political, geological, and financial barriers to implementing sea defences near the village, referring to best practice sea management. Similarly, the coastal managers identified funding as a barrier for developing any new road system. They also discussed how housing and road development could be connected as a potential way to obtain funding for road development. It should be noted that participants also mentioned these barriers and future opportunities for overcoming them to varying

degrees throughout the first four phases of data collection, see Chapter 4. These elements, identified by the participants and the coastal managers, were included on all of the exhibition posters under the description that accompanied each visualization. Referred to as "things to consider", those elements identified by participants included funding, community engagement, community need, land availability, geology, policy, traffic direction and amount, increased population putting stress on current infrastructure, and community acceptance. Coastal managers had more knowledge about future options that would be more feasible from the perspective of local authorities; however, future outlooks from coastal managers and participants were mostly aligned in terms of addressing the erosion in the village, and the social concerns associated with it.

Participants were asked to rank the options suggested during their workshop and the top three options for each workshop were discussed (shown in Figure 5.3). However, participants suggested a variety of options during the workshops that were not ranked within the top three options of that particular workshop. These details of individual future options were included in descriptions of the visualizations for a general future option, so that the range of options generated during the workshops were represented. For example, participants in the first two workshops suggested different approaches to coastal management that included the implementations of hard and soft sea defences, as well as improvements in drainage; however, these options were not ranked in the top three options for these workshops. The fourth workshop, which comprised of a single individual, ranked "best practice" coastal management as the top, and only, option. Therefore, the options for coastal management (see Figure 5.6D) suggested by the other workshops were included in the description of the visualizations of the coast. This description also included suggestions that coastal managers stated were feasible. Similarly, although the new village hall and Pilgrim Shelter as multi-use facilities were only ranked in among the top three options in the third workshop, suggestions for these two buildings from the first and second workshops were also included in the poster (Figure 5.6D). A small map indicating the location within the village that was proposed was included as well as an arrow indicating the directional view for the visualization (please refer to Section 3.3 in Chapter 3 for full details about the creation of the posters in the exhibition). Figure 5.6 shows the final modified visualizations resulting from the workshop discussions, as well as the "things to consider" for each option.

Change in Trimingham

Community exhibition:

What is the purpose of this exhibition?

This exhibition is to give the wider community of Trimingham the opportunity to give feedback on the visualizations that were created during this research project.

What will I be looking at today?

The images shown in the exhibition are artistic renderings created by the researcher based on conversations with participants from previous stages of data collection. The posters outline the reasoning behind why certain ideas and suggestions were chosen by participants, as well as things that viewers should also consider when thinking about what could help the village continue to be a place where people can live in the future.

How were the visualizations in this exhibition created?

Community members in the village were interviewed to learn more about some of the concerns in the village. Focus groups and workshops allowed the community members to contribute to the visualizations through discussions around what can help the village to continue to be a place where people can live in the future.

What is expected of me today?

If you choose to participate you will be asked to complete a survey and provide feedback and suggestions on the visualizations that you see today.

Data Sources: A 2015 Ordnance Survey Master map was used as the base map for the roads visualization and for the map inlays. Environment Agency 2015 2M LiDAR data was used to create the 3D visualizations.

Project Background:

What is the purpose of this project?

This research focuses on how forms of visualizations (i.e. maps, graphs, 3D images) can be used in decision making for coastal communities.

How will my information be used?

The information collected during the exhibition will be used in ongoing research to inform the improvement of future visualizations and to better understand the role that visualizations play in the decision making process. All of your information will remain confidential and be anonymised.

What happens if I agree to take part, but change my mind later?

You may choose to withdraw from the study at any time, without giving a reason. Your information will not be used and will be destroyed. If you choose to withdraw from this study please contact someone from the research team to inform them of your decision.

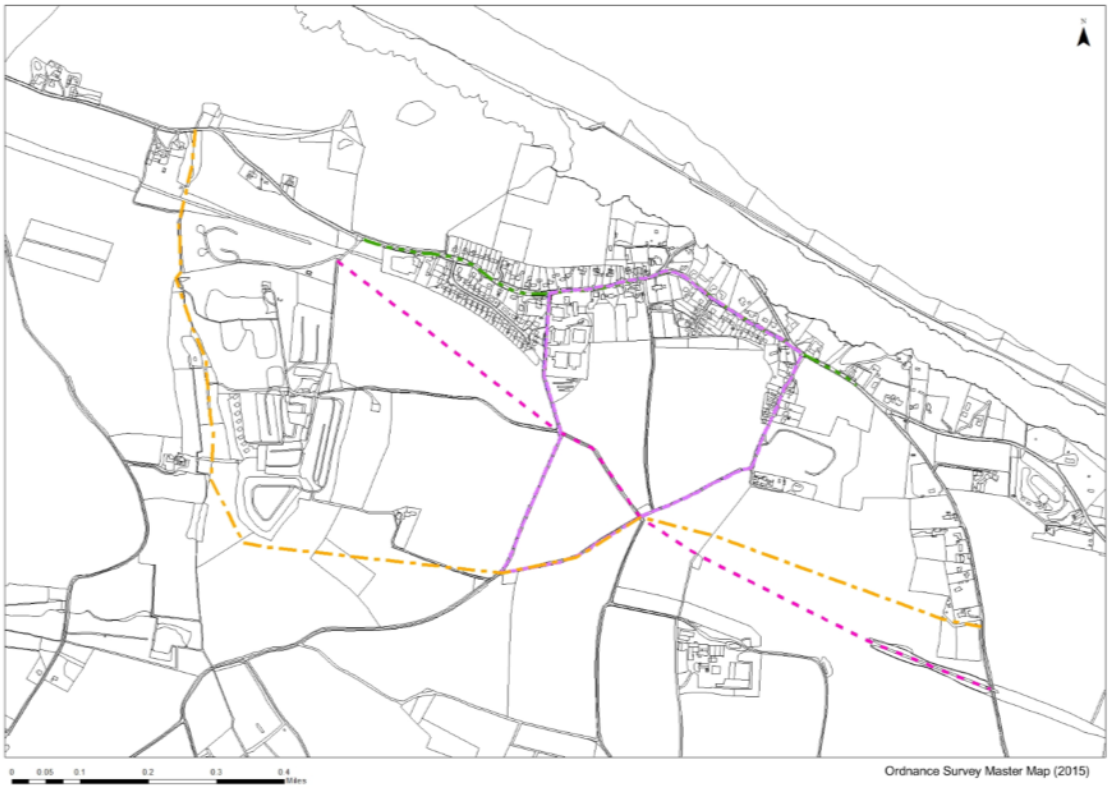
You are under no obligation to agree to participate in the study.
You can withdraw from the study at any time.

If you have any questions please contact:
Jacqueline Zavala (researcher): j.zavala@uea.ac.uk or
Dr. Irene Lorenzoni (supervisor): I.Lorenzoni@uea.ac.uk

Thank you for your time and interest in this study!

Figure 5.6A: Poster that outlines the purpose of the exhibition and participant's rights. (This is an exact copy of Figure 3.7)

Roads



The image above shows the different suggestions to improve the current transportation links so that the village can continue be a viable place for people to live in the future.

Green line: Traffic calming on the main coastal road through the village was suggested for safety purposes. 20 mph was proposed as the new speed. A roundabout in front of the Woodlands Holiday Park(area west of village centre) entrance was also suggested as a way to slow down traffic.

Things to consider: funding, land availability

Purple line: The purple line shows the roads that could be used in a one-way system to help improve the transportation in and out of the village using the existing roads.

Things to consider: funding, traffic direction, amount of traffic,

Pink line: The old railway embankment was a suggested as a path for a new road to get in and out of the village.

Things to consider: funding, land availability, land-use policies,

Orange line: A new road going around Woodlands was suggested to pass by the back of the village towards Gimingham.

Things to consider: funding, and availability, land-use policies,

Figure 5.6B: Poster showing different suggestions from the workshop about future road development. (This is an exact copy of Figure 3.7)

Housing

The following images show how housing developments of different types could look like in different parts of the village. They are artistic renderings created by the UEA researcher based on other housing developments of similar sizes and conversations with participants in the study. The images do not represent any current housing development plans for the village.

Behind Broadwood Close

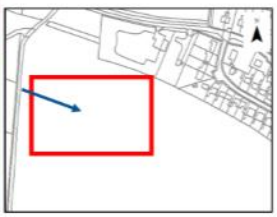
A mixed housing development was suggested behind Broadwood close to help with developing the village further inland. A barrier of trees was also suggested between Broadwood close and the new housing development. The suggested number of houses was about 40.

Things to consider: funding land availability, land-use policies, community acceptance, increased population

The red box outlines the area in the village the image represents and the blue arrow indicates the direction the camera is facing.

Behind the new village hall

A new housing development was suggested behind the new village hall to help with the drainage in the area as well as to help the village move further inland. The suggested number of houses was about 30.



Things to consider: funding, land availability, land-use policies, community acceptance, increased population

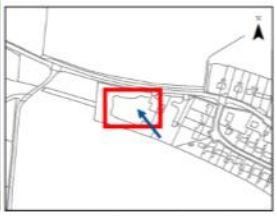
The red box outlines the area in the village the image represents and the blue arrow indicates the direction the camera is facing.

Figure 5.6C: Poster showing different suggestions from the workshop about future housing developments. (This is an exact copy of Figure 3.7)

Other

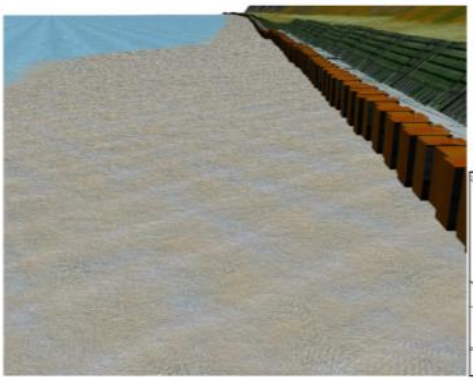
New village hall

Suggested uses for the new village hall include: (1) an event centre, (2) a pop up medical facility, (3) a village shop, and (4) an area for church services. The new village hall is expected to be completed by March 2018. It is hoped that the village hall will engage the community in village events and provide services for the community.



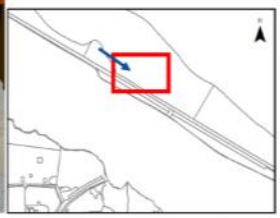
Things to consider: funding, community need, community involvement

The red box outlines the area in the village the image represents and the blue arrow indicates the direction the camera is facing.



Coastal management

This image shows what the beach and cliffs behind the Pilgrim Shelter look like currently, but without the wooden groynes. (Only the current iron toe is shown.) Suggested options to slow down erosion included (1) tree planting, (2) maintaining current sea defences, (3) improving drainage, and (4) farming a certain distance from the cliff edge.

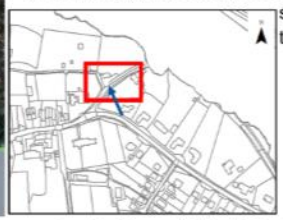


Things to consider: cliff geology, funding, land availability, land-use policies

The red box outlines the area in the village the image represents and the blue arrow indicates the direction the camera is facing.

Pilgrim Shelter

The Pilgrim Shelter is currently a place for village events and acts as the village hall. Once the new village hall is built, it was proposed that the Pilgrim Shelter continue to serve as a central meeting place in the village. Suggested uses for the Pilgrim Shelter include: (1) post office, (2) discovery and learning point, (3) café, and (4) village shop. The new village hall is expected to be completed in March 2018.



Things to consider: funding, community need, community involvement

The red box outlines the area in the village the image represents and the blue arrow indicates the direction the camera is facing.

Figure 5.6D: Poster showing different suggestions from the workshop about future changes to existing physical locations. (This is an exact copy of Figure 3.7)

The exhibition was visited by 13 individuals, nine of which also attended the workshops. (Exhibition packets can be found in Appendix A1.5) They were asked to comment on the advantages and disadvantages, and likes and dislikes, of the nine options presented during the exhibition (Figure 5.6), and, similar to the workshops, rank their top three options and the option that they would least like (see Table 5.2). There was not an allotted time for discussion during the exhibition, but participants were not restricted from speaking with others who were also viewing the posters. There were not extensive discussions between participants about the visualizations or the options during the exhibition. They were prompted to consider what they believed would help the village continue to be a place where people can live in the future. Two participants did not correctly fill out the ranking exercise and thus their responses are not included in the counts shown in Table 5.2. To find the ranking of each option, the researcher gave scores, based on ranks, to the counts shown in Table 5.2. This is similar to the process described in Sheppard and Mietner (2005). Points were allotted for each participant that chose an option. Three points were given for options ranked first, two for options ranked second, and one for options ranked third. This was done to understand how options were considered in terms of helpfulness by participants overall.

Table 5.2: Ranking of options for the future viability of the village. Rank 1 is the most helpful, 2 is the second most helpful, 3 is the third most helpful, and No is the option that is least helpful or least wanted by the participant. The most frequent responses are highlighted. n=11

	Rank 1 Count	**Rank 2 Count**	**Rank 3 Count**	**"No" Count**	**Weighted Score**
New village hall	**5**	**3**	1		22
Traffic calming	1	3	**4**		11
Coastal management	3		1		10
Pilgrim Shelter		**3**			6
Housing behind Broadwood Close	1	1	1	3	6
Housing	1				3
Road behind woodlands			1	3	3
Roads		1			2
One way system			2	**4**	2
Housing behind new village hall			1	1	1

Table 5.2 shows that there was a general consensus that the new village hall was important for the future of the village. The new village hall was the highest first ranked (and tied for the second highest ranked) among the options, receiving double the rank score of the second highest rank score. All participants felt that the new village hall and the services it could provide to the community would be a positive change.

> "This will bring a new era to the village."
> (TV06 Exhibition Packet)
>
> "The village has worked very hard to get the funding and there is a long list of events planned and more in the pipeline- only one church service a year."
> (TV04 Exhibition Packet)
>
> "The new hall could help the community cohesion, but we need participation. [Doctor's] Surgery is a good idea."
> (A10 Exhibition Packet)

TV04's statement focuses on the funding making the village hall possible, while TV06's statement shows excitement about the contribution of the new village hall to the village. Participant A10 brought up an issue that has been mentioned by other participants in previous phases of data collection, that of needing to get more people involved in village events and use the new village hall to build "community cohesion" (see Section 4.5). This was also mentioned by another participant as a consideration about the variety of functions of the new village hall, along with other barriers including the costs associated with running and managing the village hall.

Traffic calming was ranked third by many exhibition participants, and was ranked second by two participants. This made traffic calming the second highest rank score overall. Traffic calming options represented in the poster included adding a roundabout at the beginning of the village on the Sidestrand side, and lowering the speed limits in the village. Some of the disadvantages indicated by participants include the enforcement of new speed limits and potential costs; however, participants were unsure about the cost, if any, of implementing traffic management. In addition to this, one participant commented that a roundabout would not be a good idea. On the other hand, some of the advantages of the traffic calming option were that participants felt it would be easy and low cost to implement, help manage the traffic generated by the new village hall, and would generally make the village safer for driving and walking.

Coastal management was the second most frequent choice as first ranked option, and achieved the third highest rank score. This option included suggestions for both hard and soft sea defences, e.g. tree planting. Although participants felt sea defences would be advantageous, participants also questioned the feasibility of maintaining or creating new sea defences, with funding being the most frequently identified barrier for this option. This is in line with the previous discussions with participants and in the community survey, refer to Chapter 4. Other disadvantages for this option were the cliff geology, attitudes, government caring, and policy.

Although the Pilgrim Shelter's weighted score was joint fourth (with housing behind Broadwood Close), the Pilgrim Shelter and the new village hall were both the most frequently second ranked options (see Table 5.2). The Pilgrim Shelter visualization was one of those shown in the exhibition (Figure 5.6). Participants all felt that the Pilgrim Shelter could be used as a gathering place and a new facility for the village supporting tourism; it could include a café, deep history coast learning centre, shop, extra activity centre, and a post office. However, some of the participants felt hesitant about the use of the Pilgrim Shelter as another facility in the village for various reasons:

> It might be a distraction and a dilution of local energy to run two social centres.
> (TV01 Exhibition Packet)
>
> If not used it will decay further before it falls into the sea.
> (TV05 Exhibition Packet)
>
> There may have to be money spent on converting this building for a different purpose.
> (TV06 Exhibition Packet)

These excerpts show the diverse responses to potential drawbacks of repurposing the Pilgrim Shelter. The most common concern for the future of the Pilgrim Shelter was around erosion; the quote from TV05 reflects this. The proximity of the Pilgrim Shelter to the cliff edge is also the reason why the village began to pursue options for building a new village hall. The Pilgrim Shelter is centrally located in the "old" part of the village. Multiple participants have also identified it as an important historic location in the village.

The final part of the ranking exercise done with participants was for the options that they least preferred or did not want, see Table 5.2. The option that was least preferred, i.e. the "no" option, was the one-way system. Most participants felt that this option was not practical because of the current infrastructure. They responded that the roads in the village are too narrow and that it was too long of a detour, which could make using public transportation difficult for villagers. Only three participants mentioned advantages to this option, which was that traffic would be diverted outside of the village and would make the centre of the village safer from speeding and large vehicles.

Similar to the workshops, participants were asked how they felt about the visualizations (see Section 3.3 and Appendix A1.5). Figure 5.7 shows all participants felt that the visualizations were clear, understandable, engaging, accurate, and respectful to the views of the village. However, there were more participants that disagreed with the statements compared to the workshop. Participants who had disagreed with the final statement ("The visualizations helped to change the way I thought about the future of the village.") after the workshops,

also disagreed with this statement in the survey after the exhibition. This suggests the visualizations primarily served to reinforce participants' views rather than modify them, this is confirmed in the final interviews. This reflects the purpose of the visualizations as used in this study, as tools for learning and understanding. Another participant indicated about their views on coastal change:

> "The suggestions made, however, do help to crystallise one's views. The traffic calming, for example, is a fairly new and realistic suggestion and that is one thing this exercise has highlighted."
> (TV01 Exhibition Packet)

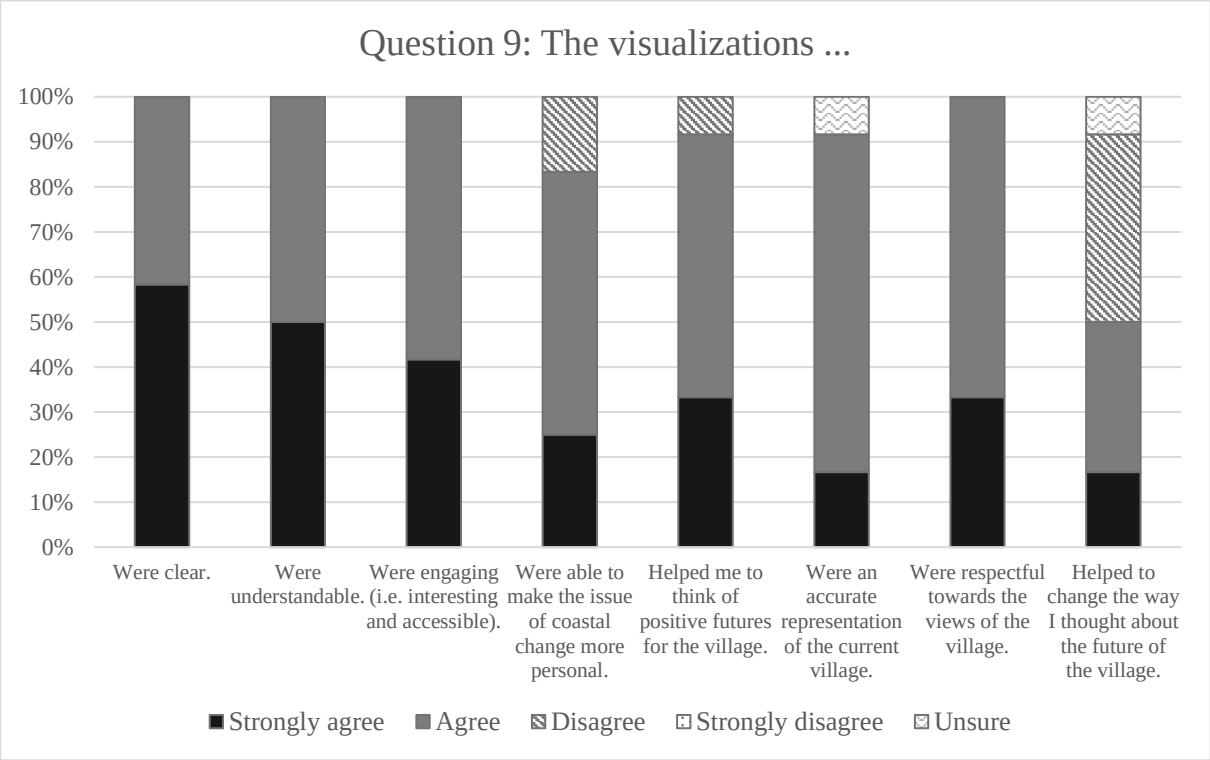


Figure 5.7: Responses to Question 9 in the survey after the exhibition. "Please indicate below (ticking the relevant box) to what level you agree or disagree with the following statements about the visualizations used during the exhibition today." On a five point Likert scale. n=13

The only suggestions for improving the visualizations were to include the Swipe Style Story Map, and highlighting landmarks on the road map (Figure 3.6A):

> "The road map is a little difficult to follow. Perhaps highlighting the church P[ilgrim] shelter etc. would have helped."
> (TV03 Exhibition Packet)

Participants were also asked in an open question if and how the visualizations helped consider options for the future. Two participants, who also responded that their views on future and coastal change in the village had not changed, responded that visualizations did not help consider options for the village. One participant elaborated on this:

> "Because [I'm] heavily involved in new village hall most of the ideas have already been considered, but [visualizations] will help some villagers realise what could or will happen."
> (TV04 Exhibition Survey)

However, there were other participants indicated that the visualizations helped consider options for the village:

> "They have helped make us see the village both in smaller detail and as an overall community."
> (TV01 Exhibition Packet)
> "Housing and roads always seemed set in stone. Maybe there will be some forward thinking."
> (TV08 Exhibition Packet)

As was stated previously in this section, these excerpts suggest that there are various reasons why participants found the visualizations helpful or not in considering future options. This could include the type of experience the participant has had when engaging in village events and decision-making, the participant's openness to other options and change, and which future changes participants are interested in. The exhibition responses were similar to the workshop in many ways, but also led to further questions as to what and how participants' experiences, and values affect the way that participants perceive visualizations and the processes through which they have been developed in this study. These were explored in the final interviews.

5.3.4 Final interviews: response to and memory of visualizations

Two coastal managers, along with nine participants from the workshops, and one new participant, were available for the final interview. The new participant was given the opportunity to look over all of the visualizations that the other nine participants viewed and helped create. They were then asked the same questions relating to the effectiveness of the visualizations as the other participants. Questions based on the criteria described in Section 5.2 were asked to gauge past perceptions, and perceptions at the time of the final interview, of the visualizations used throughout his study. Participants were also asked to express their views and opinions about which visualizations they preferred, and to provide feedback on the visualizations.

Before any of the visualizations were shown, participants were asked if they remembered any of the visualizations. Out of the nine participants who created and evaluated the visualizations in the workshops and exhibition, four did not remember any visualizations. Two participants remembered the housing visualizations, two the Swipe Style Story Map, and one remembered the changes they made to the visualization of the new village hall. All

participants were able to recognize the visualizations once they were shown them again, and, despite the extended period of time between interacting with the visualizations, participants were still able to remember their feelings at the time they saw the visualizations.

Participants were asked about the clarity and ability to understand the visualizations; as well as their preferences for interactivity and detail of the visualizations. Most participants believed that the visualizations, images and underlying future options, were adequately clear and understandable; however, participants did express that in some instances there could be improvements on these. Two participants indicated they had difficulty understanding visualizations that were 2D maps, i.e. the Swipe Style Story Map and the roads map (Figure 3.6A). The one participant who had difficulty interpreting the roads map suggested that putting greater emphasis on landmarks such as the church, Pilgrim Shelter, and new village hall, would help them orient themselves better. Three other participants attributed the difficulty of understanding the future options throughout the study to the presentation of the visualizations:

> I didn't like the coast thing [3D aerial VNS visualizations: Figure 5.2] at the beginning, I found them very difficult to look at. Those [the 3D aerial VNS visualizations, Figure 3.3], they are very difficult to tune in to. But once I got beyond them, I mean they are personally the sort of thing I would like to study more, but they were difficult whereas going onward it was much easier.
>
> (TV08 Final Interview)

> […] I guess probably the ones [3D ground view VNS visualizations: Figure 3.7/ Figure 5.6] on the left of the housing estates, perhaps smaller, or another picture perhaps from a little further away to depict exactly where they [the housing estates] are.
>
> (TV16 Final Interview)

> […] When they were the drawings on the wall [the exhibition posters; Figure 5.6] I did have a problem initially getting my head around them. Not just visualizing that, but trying to link in all the salient points. I was thinking would that work would that not work. […]
>
> (S32 Final Interview)

These excerpts indicate different issues relate to the presentation of the visualizations and how they could be improved. TV08 found the 3D aerial VNS visualizations difficult to interpret, while TV16 and S32 focused on the 3D ground view VNS visualizations. TV16 wanted the 3D ground view VNS visualizations to give a better indication as to where the housing estate would be located in the village, suggesting changing the camera zoom and angle to aid spatial orientation, which is similar to what was previously suggested about the roads visualizations (Figure 3.6A and Section 5.3.3). This suggests that an interactive

visualizations that would enable this change would be useful. Following from this, S32 found it difficult to link the future options and compare them using only the posters.

When participants were asked if the visualizations were an accurate representation of the options, most gave feedback on how they could be improved. Most of these comments pertained to changing details of the visualizations to make them more accurate. Three participants commented about changing the layout and size of the housing developments visualized, and one commented about the road options; however, most participants did not suggest changes, indicating that they were, in their view, adequate representations of the future option. Participants were also asked which activities in the workshops they felt helped to make the visualizations accurate. This was done to explore whether there was a particular exercise that participants preferred or helped them envision the future. Four participants mentioned the activity where they drew future changes on an A4 map, one mentioned having facilitated discussions, and three mentioned the discussion in general. This was consistent with participants' positive responses about discussions during the workshops. The participants who said that the A4 map activity was most helpful also preferred to draw on the map to indicate potential changes. These responses also show the diversity of what participants felt contributed to making an accurate visualization.

Participants related the accuracy of the visualization to the level of detail and the specific details presented. Although participants all felt that the level of detail was adequate, most participants preferred one type of visualization to another. Eight out of the ten village participants preferred the 3D ground view VNS visualizations because they had more detail, making them more understandable compared to the other visualizations, presented more information, and made the options more realistic. One participant explicitly stated that realism was a factor in how they interpreted the visualizations. Although participants did not all prefer the more realistic visualizations, all of the participants felt that their interpretation of the options were facilitated by the use of visualizations. Two participants preferred less detailed visualizations because they felt that it helped them to "look at it and think" (TV08 Final interview) and was not distracting with too much detail. Similarly, a participant that preferred more detail also acknowledged the drawbacks of too much detail. When asked if they would like more detail to be added to the 3D ground view VNS visualizations participants stated:

> No. Not necessarily. No, because the more you put in, the more fussy it becomes. You need to see the basics. You need to understand where things would be without filling up too much.
>
> (TV03 Final Interview)

> You don't -if you're simply discussing where things are going, you don't need a huge amount of detail do you. Um, it's helpful perhaps to have a picture, they often do artists impressions don't they of what this will look like. […]
> (TV02 Final Interview)

These two excerpts are examples of participants indicating that the visualizations were suitable for the role they were tasked with in the workshops. They also highlight the debate around abstract vs. realistic visualizations, and which is suitable for different purposes (see Section 2.4.4). TV03 also identifies potential challenges of too much detail, i.e. distraction. Both excerpts also call attention to the importance of considering the purpose of the visualizations when creating them, i.e. suitability of the visualization.

Participants felt that the Swipe Style Story Map and 3D ground view VNS visualizations in particular could be used to engage more people in discussions around future change. Some participants had clear ideas about how to use the visualizations to engage more people; a variety of suggestions were provided on how to accomplish engagement processes and the possibility of increased engagement. The most frequent suggestion was to hold a presentation at the village hall advertised in the village newsletter. Other suggestions included distributing leaflets or brochures with the visualizations and their descriptions, and using the visualizations to spur discussions through presentations and showing villagers visualizations that "galvanize" (to use some of the participants' terms) opinions. These suggestions are similar to those proposed by participants in the focus groups and workshops on ways to engage more people and are further discussed in Section 5.4.1. However, in the author's experience, using the village newsletter and a local magazine to elicit participation in the focus groups from the wider population in the village was not successful. This may therefore call into question some of the suggestions proposed by study participants. Thus other suggestions, such as presenting the visualizations in conjunction with the local authority, could be explored further as an alternative. However, other aspects need to be considered with this option, including existing relations with the local authority. Participants also acknowledge the difficulties of engaging more people and some did not have clear proposals of how to overcome these.

During the final interviews, participants were also asked if they felt that the visualizations were useful tools for the discussions. Usefulness is different from the effectiveness of visualizations. Participants directly responded to the usefulness of visualizations based on their views, while effectiveness of the visualizations is measured using the seven criteria discussed in Section 5.2. Aside from the one participant who explicitly stated that they believed that the visualizations were not useful for them personally "Because my views

haven't changed so it [visualizations] hasn't influenced me in any respect" (TV11 Final Interview), the rest of the participants felt visualizations were useful tools that guided discussions during the workshops. However, some of participants felt that, although helpful, visualizations were not necessary in the decision-making process. Participants felt that the visualizations potentially helped the discussions because it helped them to articulate their ideas better, but some also felt that future change could still be envisioned and discussed without the use of visualizations, i.e. visualizations were not necessary, but helpful. Despite this, the diversity of visualizations aided participants to voice their opinion and explore the ideas of others. Furthermore, participants all stated that they enjoyed participating in this study and most thought the process of discussing future options with the help of visualizations was a useful exercise. Participants also felt that the visualizations clarified and contextualized the future options, and put them into perspective.

It should be noted that events occurring concurrently to the study are likely to have affected participants' views. Around the time of the focus groups, the funding for the new village hall was confirmed (November 2016). Similarly, the community surveys were held around the time a storm surge created an erosion event in the region (January 2017). The workshops were held a few months before the opening of the new village hall (May 2017) and many of the participants were excited and optimistic about this project. A few weeks prior to the exhibition (November 2017), a local NNDC representative held an evening session on potential housing in the village; some villagers were not enthusiastic about the ideas presented. This meeting was discussed informally among participants during the exhibition, and many confused this study with the housing work being done with NNDC. Finally, prior to the final interviews, there was roadwork and a one-way system was temporarily in place (September 2018). Many in the final interviews reflected on how a one-way system was not a good idea, although it was considered at the workshops, after their negative experience with it a few days prior:

> Yes. It's been a journey and you by a stroke of, I'm sure skill as well as good fortune, you happened to choose the two years which was sort of a hinge point. […] And it's been a very positive period for the village, so it wasn't just the coastal aspect. It was the social thing that you saw kind of mini revolution taking place. So yes, […] your part in this has been very positive and you've been sort of caught up in it aren't you. You've been sort of a leader in an interesting fictional background to this. And we've had actual changes and we've had you making us think of ways in which things might change and even more revolutionary ways. So it's been a real kick. It's helped.
>
> (TV01 Final Interview)

There was a need to account for these events in order to understand participants' responses. For example, people thought more positively about funding after funding for the village hall was secured. This shows how current events had an impact on the focus of discussions and what participants felt was important for the village. Events could also have affected the way participants perceived the visualizations, and their overall effectiveness in facilitating discussions and engaging more individuals to consider options for the future.

5.4 Evaluating effectiveness of visualizations

The previous sections outline the complexity of evaluating visualizations because of the various factors that contribute to an individual's perception of visualizations. This section takes these elements into consideration, assessing the effectiveness of the visualizations in this study based on the criteria outlined in Table 5.2.

5.4.1 Criteria for effective visualizations

Table 5.3 shows the seven criteria used to assess the effectiveness of the visualizations created in this study. The shading of the table is based on an interpretation of the workshops as well as the final interviews, and indicates the frequency that individuals identified difficulties or preferences for specific visualizations based on the seven criteria at least once. Each visualization is assessed against all criteria. If most participants (5 out of 9) felt the visualizations did not meet a specific criterion, then the criterion for that visualization is coded as white. If less than half of participants felt the visualization did not meet a criterion then the criterion for that visualization is coded as grey. Finally, if most participants felt a visualization satisfied a specific criterion, that criterion for that specific visualization is coded as black. The following sections examine the visualizations used throughout this study as they relate to the criteria and evaluate the factors that influenced the effectiveness of the visualizations.

Table 5.3: Effectiveness of visualizations created throughout this study. Colour indicates the effectiveness of the visualizations for each criterion. If most participants (5 out of 9) felt the visualizations did not meet a specific criterion, then the criterion for that visualization is shaded white. If less than half of participants felt the visualization did not meet a criterion then the criterion for that visualization is shown in grey, and if most participants felt a visualization satisfied a specific criterion, that criterion for that specific visualization is shaded black.

Criteria	3D Aerial VNS Visualizations (Figure 5.2)	Swipe Style Story Map (Figure 5.1)	Modified Visualizations (Figure 5.4)	3D ground view VNS Visualizations (Figure 5.6)
Clarity				
Engagement				
Connectivity				
Trust				
Feasibility				
Usability				
Suitability				

5.4.1.1 Clarity

Table 5.3 shows that clarity was the criterion that all visualizations fulfilled the least. The hardest visualizations to interpret were the 3D aerial VNS visualizations and maps. Several participants needed assistance orienting themselves (i.e. understanding where the visualization view was in relation to the real-world) and identifying physical landmarks, and found the basic buildings confusing. The landmarks were abstract and basic in some of the visualizations, without much, if any, realism; furthermore, the landmarks were not as visible in some cases because of the camera angle and scale used in some of the visualizations. This supports work indicating that having recognizable landmarks are a key feature in creating visualizations (Brown *et al.*, 2006). Similarly, some participants had difficulty interpreting the Swipe Style Story Maps, and visualizations created/ modified during the workshops and exhibitions; however, the participants were able to orient themselves faster compared to the 3D aerial VNS visualizations. The participants found that the presentation of the visualizations in the workshops made them difficult to understand. Some gave the example of the posters used in the exhibition as difficult to clearly view because of where they were displayed; the lighting in the Pilgrim Shelter is limited on some walls. This suggests that the clarity of the visualization was connected to the way that they were presented, i.e. on a screen using a projector (Lovett *et al.*, 2015). Furthermore, participants suggested clearer ways of showing the location of the proposed future change in the village for the 3D ground view

VNS visualizations. These suggestions included changing the camera angles or including a map to show where in the village the future option was suggested to be. Similarly, participants also expressed their dislike of the camera angles, some showing preferences for either closer to the ground or aerial view, used for the 3D aerial VNS visualizations. The positioning and scale of the visualizations were also cited as reasons for a lack of connectivity, which is further discussed in Section 5.4.1.3. Despite this, participants expressed that they were still able to visualize future options:

> S32: I can visualize that.
> TV01: We can visualize that. From what you've done before I can see that is-
> TV05: Yes. We can visualize it. That's where we were going to have a roundabout. We were weren't we? In that area.
> (Workshop 1)

This excerpt from the first workshop indicates that, despite the difficulty associated with the presentation of the visualizations, the participants were still able to understand the underlying future options being visualized. Presentation issues were exacerbated by the need of creating the visualizations in real-time.

Detail and realism were frequently cited in conjunction with each other when discussing clarity. At some points detail was mentioned in relation to the realism of the visualizations. The 3D ground view VNS visualizations were the most preferred visualizations by participants in terms of detail and realism. The 3D aerial VNS visualizations were all abstract and unable to show the issues that participants previously identified as important. The lack of realism in the 3D aerial VNS visualizations could also be a contributing factor to the lack of discussion by participants in the workshops (this has also been reported by Wissen, 2011). Realism, as well as interactivity and tailoring of messages for audiences, are qualities that are subject to individuals' preferences (see Section 2.4) and are important in understanding the effectiveness of visualizations. Appleton *et al.* (2002) states that the realism of a visualization should be related to the purpose of the visualizations. As was mentioned in the Section 5.3, there were mixed responses about the use of detail. The general view was that there should be enough detail to create realistic visualizations, but that the level of detail should be relevant to the purpose of the visualization. There were no explicit comments about the realism or level of detail of the Swipe Style Story Map; however, participants expressed that the visualization clearly showed the changes in the coastline for the last 100 years. It was not feasible to create realistic and detailed visualizations in the time allotted during the workshop. VNS requires time to render images from the data, and thus some detail and realism was omitted to increase render speed. Some participants were not concerned by

the lack of detail and realism, while others preferred this and this affected the way they perceived the visualizations (see Section 5.3.4).

To summarize, clarity was affected by the presentation of the visualizations, which include technology used for the presentation, i.e. projector and posters, camera angles, and the level of realism and detail. Although not overly concerned with the amount of detail in a visualization, participants generally preferred the visualizations that were more realistic; some participants explicitly mentioned that they did not find the maps clear because they generally have difficulties reading maps (those who were participants who were used to reading maps and did not have any issues interpreting them). This suggests that individual preferences and previous experiences with different types of visualizations affects how clear the visualizations are perceived to be.

5.4.1.2 Engagement

Section 5.2 explored the different ways that engagement is perceived in this study, and how it relates to the purpose of visualizations. Several participants stated and agreed to statements indicating that the study and visualizations could be used to elicit engagement through shocking images. This finding is similar to the suggestions that participants in Nicholson-Cole's (2005) study made, i.e. to use shocking stories to make climate change seem more important. However, in a more recent paper, O'Neill and Nicholson-Cole (2009) found that shocking representation of climate change, although successful in garnering attention, can also disengage people. This study chose to maintain positive framing of the visualizations by using positive wording, e.g. future opportunities, and being sensitive to the way erosion is visualized.

As well as being the least clear, the 3D aerial VNS visualizations (Figure 5.2) were also seen as the least engaging compared to the other visualizations. This is highlighted in Table 5.3. Compared to the 3D aerial VNS visualizations, the modified visualizations created during the workshops and Swipe Style Story Map fostered more discussions about future options enabling comparison of options in a visual way. This is in line with the aims of the Assess Options stage of the Process of Adaptation Framework, which is the stage where options for adaptation are compared and assessed (Moser and Ekstron, 2010), see Section 4.6.5. Subsequent visualizations did seem to spark more conversations and engage participants in the decision-making process. This could be because participants were more familiar with the type of visualizations used in this study, i.e. 3D visualizations, or because more of their ideas were being visualized.

The Swipe Style Story Map was created because participants in different focus groups explicitly asked to see a visualization comparing past, present, and future maps of the village. The data to create an accurate future representation of the village, that was the same quality of map as the past and present maps, were unavailable at the time of creating the visualizations for the workshops. There have been recent attempts by the British Geological Survey (BGS) to model erosion rates in the village with greater accuracy that could be used to visualize future representations of the coast, see Chapter 4. However, these data were not available in time to create visualizations of future erosion in the village as requested by the participants. To incorporate what participants wanted to see visualized, the Swipe Style Story Map compared a 1915 historic County Series map and 2015 Ordnance Survey Master Map data. The positive response to the Swipe Style Story Map when compared to the 3D aerial VNS visualizations could indicate that participation engagement in creation of visualizations may result in more positive feelings towards the visualizations; participation has been observed to lead to more positive feelings towards engagement in decision-making (Milligan *et al.*, 2009). The Swipe Style Story Map in this study was a 2D map, had less detail than the 3D aerial VNS visualizations, but was shown at a larger scale so that the detail present was easily visible. Not only did participants find the Swipe Style Story Map engaging because of its interactivity and functions, but participants also suggested that the Swipe Style Story Map could be used to engage other villagers and make the issue of erosion more relevant to the wider population:

> S32: For me the most positive was seeing the erosion in the last 100 years and that's not going to stop. It's still happening. Where do we go from here? Because if we have a voice we could change things.[…] but I think if people knew what the salient points were, points that can affect them, and I don't really mean by us, do you know what I mean, […] but maybe it does need to be a little provocative.
> (Workshop 1)

The participants in Workshop 1 agreed that the Swipe Style Story Map is a useful tool to engage individuals in discussions about erosion in the village. However, the 3D groundview VNS visualizations were the preferred type of visualizations because of their realism, and were also suggested as a way to engage more villagers in the discussion about future change in the village (see Section 5.3.4). These were also the visualizations that participants suggested could be presented to local authorities to discuss the changes that villagers would prefer.

After participants saw the Swipe Style Story Map again in the final interviews, most participants expressed that they remembered it, unlike the 3D aerial VNS visualizations,

which none of the participants remembered when prompted. This raises further question about the relationship between memory of a visualization and how effective they were in their role (e.g. were the Swipe Style Story Maps more effective in terms of format and detail and thus better remembered?). The Swipe Style Story Map was also the most interactive, in that participants could easily change the position (in two dimensions and zooming) of the visualization, which is the definition of interactivity suggested by Heim (1998), see Section 2.4.5. This visualization is an example of trading some level of realism for interactivity. This is in line with what the literature finds, i.e. that increased realism can come with a decreased level of interactivity or vice versa (Appleton *et al.*, 2002; Lovett *et al.*, 2015; Bishop *et al.*, 2013). In this case, this trade-off does not seem to negatively affect the way this visualization is perceived.

Overall, therefore, the 3D aerial VNS visualizations were not engaging, especially when compared to the later visualizations. Participants' preferences for the visualizations also aligned with how engaging the visualizations were. They also suggest that the different visualizations can be used for different types of engagement; i.e. Story Maps for showing coastal change and potentially eliciting concern from other villagers, and the 3D ground view VNS visualizations to galvanise opinions from other villagers and to show to the local authorities.

5.4.1.3 Connectivity

Connectivity is defined in Table 5.1 as a visualization that is relevant and personal, and shows connectedness of ideas in a way that is understandable. Participants found the 3D aerial VNS visualizations difficult to understand and connect to the goals of the workshop, citing the clarity and camera angles. Similarly, the ground level camera angles used for the 3D ground view VNS visualizations made it more difficult for some participants to see where the option was located in relation to other locations in the village, and how the option affected other physical features in the village. Participants needed the aid of a map and some explanations to understand the option, and how it related to the landscape. A map of where the option was located was included next to the visualization of the future option; however, a participant suggested that a map showing the location of the option in relation the entire village should be included. A large-scale map was used, i.e. the view was of a specific plot of land. Perhaps indicating the locations of the future options in a different way, i.e. a single map with coloured dots to indicate the location of the different future options, could be more effective in showing the connectedness of the different options. Story Map has functions that allow these suggested changes.

Participants felt that the Swipe Style Story Map could be used to make other villagers feel more urgency towards coastal change or make it more relevant to them. The visualizations modified in the workshops had slightly different perspectives and the zoom of the camera was between that of the 3D aerial VNS visualizations and the 3D ground view VNS visualization. Participants attributed the lack of clarity and the lack of connectivity for the initial and 3D ground view VNS visualizations to issues around the use of perspective and scale. This suggests that the perspectives preferred and most effective were those that were close enough to ground level to create a more realistic visualization, but had a wide enough perspective to show how the future option relates to the larger landscape. Again, a more interactive 3D visualization could address this issue by allowing for multiple viewpoints for each option.

5.4.1.4 Trust

Trust is a criterion that can be reflective of who is leading the participatory process and creating the visualizations, as well as the content and material in the visualizations. Table 5.3 shows that trust was not a barrier to using visualizations in this study. Participants indicated they believed that the visualizations were an accurate representation of the village and trusted the information presented in them. However, for visualizations that are more technical and have been distributed by local authorities, i.e. SMP erosion prediction lines, trust could become an issue. Discrepancies have been identified in this study between what the SMP states, government action, and what participants believe, see Section 4.4.2. Mixed views were expressed about why these discrepancies between the SMP and government action, and local knowledge and aspirations occur:

> TV03: […] I don't believe that NNDC or county are really taking it [coastal erosion in the village] on board. I think it's a bigger problem than they imagine it to be.
>
> (Focus group 2)

> TV01: We know it's [the time before the Pilgrim Shelter is not usable] more likely to be 150- 200 years. It's not looking like 20.
>
> TV05: Well it's not really 20, but the reason they do that is because of people like us where we've lost a lot. It means that you can look for a piece of land and they actually have to give you that information so you can actually plan for your particular future. That's why they [government] do it.
>
> TV01: So it's both. They're covering themselves and they're being helpful.
>
> (Workshop 1)

These excerpts indicate that trust in the information provided by local authorities is perceived differently. The participants in Focus group 2 had more negative views about why there is a difference in perceptions of causes of coastal erosion, and how these may be addressed. On

the other hand, the participants from Workshop 1 believed that the discrepancies and overestimation of erosion rates, in their views, are purposeful to help those living along the cliff edge make proactive decisions.

Although maintaining trust is important to the decision-making process, trust and the relationship built with participants throughout the study can also be a limitation in the evaluation of visualizations. The disagreements and contradictory statements made by participants from discussions compared to survey responses at the same events can indicate that participants may not have felt as free to comment negatively on the visualizations, potentially because of the good relationship with the researcher. Therefore, there needs to be further research into methods of data collection and how people express their views comfortably where trust and a good relationship need to be maintained. In this study, participants were asked to answer honestly; however, face-to-face questioning the day participants first interacted with visualization compared to in the final interviews showed different responses from several participants. The differences in responses were even more noticeable when comparing participants' survey responses to their responses when directly questioned by the researcher. During the final interviews, participants made more suggestions to improve the visualizations, and commented more on their dislikes about the visualizations compared to the workshops and exhibition. Again, this raises questions about participants' levels of comfort to comment on the study and visualizations, and seems to suggest (aside from a genuine change of opinion) that over the course of the study participants became more comfortable to comment on the visualizations as trust and the relationship between them and the researcher was built.

5.4.1.5 Feasibility

ArcGIS online is free to use to a certain extent, so is available for use by participants. The main technical limitation of the Swipe Style Story Map is that it requires access to the online platform and data sets. However, in comparison to the Swipe Style Story Map, the other visualizations had even lower feasibility. The reason for this is because, in addition to access to data sets and software (which can sometimes be costly), the use of VNS requires greater experience and knowledge of the program to create and update landscape visualizations due to the greater capabilities to create landscape visualizations comparative to Story Maps. The village does not currently have the resources or expertise to use VNS to create and modify landscape visualizations such as those created during the workshop. In the case of this study, there were several months that were dedicated to learning to use VNS. Discussions with representatives from local authorities showed that they also lacked the necessary resources,

i.e. time, expertise, and access to software, to produce and maintain these types of visualizations. The village also does not have access to the 3D models or 3D software used to create the realistic landscapes. Furthermore, it was difficult to modify the visualizations in real time because of the computing power necessary to change and render them on VNS (see Section 5.3.2.). In the author's opinion, the Story Map platform can be more easily learned and used in the village (and by other organizations such as the local council), compared to VNS because of its interactive design, layout, and support options. Further limitations of the visualizations used in this study are discussed in Chapter 7.

5.4.1.6 Usability

Sections 5.2 discussed the findings from the first three phases of data collection that informed the creation of the visualizations for the workshops, see Section 3.3.5. Most participants expressed early in this study that they preferred not to use the computer unless necessary. They also expressed that the internet and mobile data in the village was poor. For this reason, 2D and 3D still images were chosen as the primary forms of visualizations used in this study. Table 5.3 shows that the Swipe Style Story Maps were not as usable compared to the later visualizations because of this poor internet connection in the village. The maps took several minutes to fully load, thus exploring the village using the Swipe Style Story Map to compare the changes to the coast took longer than what it would have with faster internet speeds. Although accessible in terms of type of visualization chosen (i.e. 3D still images), the 3D aerial VNS visualizations' lack of clarity made it difficult for participants to interpret and use these visualizations, and they were not able to serve their purpose of being useful to the participants because it was not engaging or sparked discussion.

The usability seemed to increase as the study progressed due to participants' increased input into the creation of the visualizations. Similar to feasibility, the purpose of the visualization and the audience should be carefully taken into account when considering the usability of a software or type of visualization. The input from participants could aid in finding a type of visualization that best served the purpose of the visualizations and the needs of the participants.

5.4.1.7 Suitability

Table 5.1 describes suitability as a characteristic of a visualization that is suitable for a task and appropriately represents the data. The 3D aerial VNS visualizations were not intended to be the main visualizations of the workshop; however, they were unable to facilitate discussion on future change, and participants suggested these should not be presented to the wider village population to elicit opinions. However, as was mentioned in Section 5.3.4,

participants agreed that that the 3D aerial VNS visualizations were suitable for their function as a basis to which changes could be made to produce further visualizations. Despite participants responding that the 3D aerial VNS visualizations were suitable for the task of facilitating discussions in the final interviews, Table 5.3 shows suitability of the 3D aerial VNS visualizations in grey because participants had the most difficulty understanding these visualizations. Furthermore, it is suggested that future research could omit or replace these types of generic visualizations by visualizations that are tailored based on participants' suggestions in a clearer, more engaging way that generally fulfil the criteria used to evaluate the effectiveness of visualizations (e.g. Swipe Style Story Maps).

The Story Map application was suitable for the comparison of erosion over time because it allowed two maps to be placed next to each other, and had a sliding bar, which was useful in indicating the amount of erosion that had occurred over the last 100 years. Similarly, the modified visualizations created during the workshops and 3D ground view VNS visualizations achieved their purpose of comparing the future options for further discussion and gathering opinions. All three of these visualizations were also engaging for participants. Participants also trusted all the visualizations presented by this study, and felt that they were accurate representations of the village and their proposed options.

5.4.2 Summary and suggestions for the use of criteria in evaluating visualizations

Some criteria were more relevant for evaluating the effectiveness of visualizations in this study compared to others. The relevance of a criterion is based on the purpose of the visualizations.

- **Suitability** was the criterion that was more closely reflective of achieving the purpose of a visualization, which has been cited by various authors for its importance in evaluating visualizations (Bishop *et al.*, 2013), see Section 5.2. The suitability of a visualization affects, and is affected by, the other criteria. For these reasons, suitability is considered the most relevant criterion for evaluating the effectiveness of visualizations out of the seven presented in this study.
- **Clarity** also affected other criteria; it relates to a participant's ability to understand the visualization. It is also the criterion that requires the most attention if the visualizations in this study are to improve, and perhaps needed more consideration during the creation of the visualizations. There did seem to be some improvement in clarity as participants had more input into the creation of the visualizations based on Table 5.3; however, increased realism and detail also seemed to confuse or distract

from the larger picture of the future village, so it cannot conclusively be said that clarity improved with greater participant input.

- **Engagement** is the next most relevant criterion because it was one of the goals participants set for the visualizations in this study. Although engagement was defined in different ways, this study showed that there were varying levels of engagement by existing participants with the various visualizations, and plans for using the visualizations to engage other villagers in decision-making. However, there is skepticism about the visualizations' ability to engage those who do not already engage in village events.
- Suitability, clarity, and engagement affected the **connectivity** of the visualization. Part of the purpose of the visualizations was to consider various future options. Connectivity became more of a prominent criterion as future options were discussed and compared. Participants found that different solutions to problems they identified in the village were connected, and the visualizations could similarly show how the various options could be related to each other. However, there were issues with connecting issues that were difficult to visualize such as underground drainage improvements.
- The **feasibility** of the visualizations is a criterion that was primarily considered when deciding the type of visualization and technology to use for the visualizations. This criterion was considered from the beginning of the processes to create visualizations.
- **Trust** was less of a factor in the actual effectiveness of the visualizations used in this study, and more in the evaluation process. Trust had the greatest effect in this study when considering how comfortable participants' were when responding to questions about the visualizations. From the outset, participants were reminded that this study was independent from work done by the local authorities. For this reason, participants did not have the same issues with trust, such as a lack of trust in past and future actions taken in the village that a representative from a local authority may have.
- Finally, although widely used in the literature as a criterion to measure effectiveness, **usability** as it was described by Knight (2001) was the criterion that could potentially be omitted in the evaluation of effectiveness of visualizations when using this specific combination of evaluation criteria. This is because usability is similar to both feasibility and suitability. The explicit inclusion of accessibility of the visualization is the main difference. Instead of including usability as a criteria to measure effectiveness, feasibility could be expanded to explicitly include accessibility in the

description: “A visualization that is cost-effective for the users. The visualization must be usable, *accessible*, able to be replicated and kept up-to-date.”

The evaluation indicates that the 3D aerial VNS visualizations were the least effective, while the Swipe Style Story Map and modified visualizations were the most effective overall. The process of engaging with participants over time indicated that as participants had more input into the creation of visualizations, the more effective the visualizations became based on these seven criteria; with the exception of connectivity because of the camera angles used for the 3D ground view VNS visualizations, which had not been tried before with the participants. Overall, the later visualizations, i.e. the modified visualizations created during the workshop and 3D ground view VNS visualizations, as well as the Swipe Style Story Map, fulfilled their purpose as defined by the researcher and participants. They also served to elicit the opinions and thoughts of those present, and it was suggested that the 3D ground view VNS visualizations be shown to local authorities. In terms of engagement, aside from the 3D aerial VNS visualizations, the visualizations in this study were useful tools in engaging participants in discussions about future change. However, visualizations alone, as well as the longitudinal participatory process utilized in this study, were unable to elicit more participation from other villagers. This could potentially be attributed to external factors not associated with this study (Schroth *et al.*, 2015). For example, the North Norfolk District Council held discussions pertaining to housing in the weeks leading up to the exhibition which led to some interest, but also led to a few potential participants declining to participate because of the fatigue and negative perceptions of participating in discussions about the future of the village. (Chapter 6 discusses the contribution of external factors to perceptions assessed in this study.) The study participants had a larger role in the creation of the Swipe Style Story Map, the modified visualizations created during the workshop, and 3D ground view VNS visualizations. These visualizations also had the most positive comments throughout the study. This positive reception of these visualizations could be attributed to their participation and role in their creation (Downes and Lange, 2015; Clayton, 2015; Milligan *et al.*, 2009) and tailoring the messages visualized based on participation (such as recommended by O’Riordan *et al.*, 1993; McEwen, 2011; Hine *et al.*, 2014).

5.5 Conclusions

This chapter examines the role of visualizations by outlining the purpose of the visualizations from the researcher’s and participants’ perspectives. There have been studies, in particular in Norfolk, that have attempted to create visualizations to improve communication with

stakeholders (Brown *et al.*, 2006; Batemen *et al.*, 2009; Jude *et al.*, 2015); however, including participants in the creation of visualizations from the outset of a project has rarely been undertaken previously (see Section 2.4). This study shows that over time, with greater input from participants, albeit a small number, the visualizations improved and became more effective tools.

Conducting multiple discussions with participants over time allowed more time to discuss future opportunities and perceptions of future change. The use of a longitudinal study allowed for multiple iterations of discussions and visualizing of future options to address change in the village. Criteria for determining the effectiveness of visualizations are relevant in trying to improve visualizations for the decision-making process. It should be taken into consideration that there were other factors, e.g. personal preferences, what was being visualized, and current events that affected perceptions of the visualizations. For these reasons, it is important to be flexible with the way these criteria are considered for evaluating the effectiveness of visualizations, i.e. they should be used in tandem with other methods of measuring a visualization's effectiveness (Bishop *et al.*, 2012; Ellis and Dix, 2006). Furthermore, there was not a single visualization that all participants preferred; participants in this study perceived the visualizations differently (which resonates with other studies, e.g. Appleton *et al.*, 2002; Nicholson-Cole; 2005). Participants' preferences for specific aspects of visualizations were not explicitly accounted for throughout this study and can only be generated from discussions throughout the different phases of data collection. Further research could be done to explicitly and quantitatively to question participants about preferences for features of, or techniques to create, visualizations, e.g. sliding scales for realism and detail. Over time, with greater direct input into their creation, the visualizations can become more suited to fulfilling the role that participants proposed for the visualizations, i.e. to communicating with other villagers to participate in decision-making about future changes.

With the time constraints and technological experience necessary to create visualizations using current technology, it is understandable that most studies using visualizations in decision-making have opted to create several visualized options prior to engagement as opposed to attempting to make changes to visualizations during the discussions. This study also showed that presenting generic visualizations, such as the 3D aerial VNS visualizations, is not useful in eliciting discussion. Future research should still create a base visualization of some sort that can be modified prior to the workshops to manage time; however, because the VNS visualizations were not shown to be helpful in the discussion process another type

of visualization, e.g. A4 maps, should be used to supplement discussions instead. Improvements to technology, i.e. more computing power and more intuitive visualization software, can help to improve the use of visualizations in decision-making processes; however, it is cautioned that visualization technology should continue to be used when it is most appropriate and not simply for the sake of using new technology.

Overall, aside from the 3D aerial VNS visualizations, visualizations in this study were shown to be useful tools to aid decision-making, but did not seem to affect perceptions about future change in any major way (Section 5.3). Furthermore, the majority of participants felt that visualizations, although they served a purpose, were not necessary to the process of decision-making (Section 5.3.4). This supports the main finding that the role of visualizations in the decision-making process is as a tool and aid to learning and understanding as opposed to elicit action and change perceptions (Bishop *et al.*, 2013; Lewis, 2012). The following chapter assesses perceptions of participants throughout the study using the Community Awareness to Action (C2A) framework, in order to further understand what could have affected participants' perceptions of Trimingham, and how visualizations can be integrated more successfully into the decision-making process.

Chapter 6 | Perceptual Changes over Time

6.1 Introduction

This chapter explores the effect and findings of the longitudinal process utilized in this study. It builds on Chapter 4 to explore how participants individually engaged with, and responded to, the study processes, and how these informed a longitudinal and integrated approach.

Section 6.2 explores whether and how participants' views have (not) changed over time, based on their participation and responses to before and after surveys of the workshops and the exhibition. This analysis is supported by combining insights from the thematic analysis of the workshops, exhibitions, and final interviews. This mixed methods approach is used to create characterizations of participants that are reflective of their responses. Section 6.3 analyses how participants' perceptions compared at different points in time. The findings are discussed in Section 6.4 and a conclusion provided in Section 6.5.

6.2 Analysis of individual responses to C2A statements: Characterizations of Trimingham Villagers

Nine individuals consistently and regularly participated in this study; data provided by them can be used to analyse their perceptions of the village and its future over time. Informed by the literature, a mixed methods approach is utilized, drawing upon the Community Awareness to Action (C2A) framework statements (see Section 3.3) and participants' views voiced in the focus groups, workshops and interviews. This method is used to examine participants' positions, and changes to these, in regard to action toward addressing the issues identified in Chapter 4, i.e. coastal erosion and engagement, with reference to the study process (see Chapter 3) and the creation and use of visualizations (see Chapter 5).

To do so, several steps were followed. Initially, statements describing the C2A stages (see Table 6.1) were analysed using a Categorical Principal Component Analysis (CATPCA), (see Section 6.2.1). Subsequently, the rotated component loadings for each variable were assessed (Varimax rotation) to identify which views were most represented by each dimension from the CATPCA model's output plot. This enabled to understand how participants views relate to each other based on their before and after responses in the workshops and exhibition. Participant discussions and comments during the exploratory interviews, focus groups, and workshops served to interpret how participants scored in each dimension of CATPCA output plots. This information is then used to create characterizations

of individuals' views, drawing inspiration from the "Climateville" example narratives described by Sheppard (2012), see Section 6.3.

6.2.1 Categorical Principal Component Analysis (CATPCA)

To extract the most important information from a data set, compress and simplify the dataset, and analyse the structure of the input variables, various analytical methods can be used, including dimension reduction, such as Principal Component Analysis (Bryman, 2016; Abdi and Williams, 2010). One of the benefits of using PCA is that it aids in the interpretation of the data by reducing the data set to its main components, thus extracting the most important information, and to analyse the relationships between the variables to further aid in the interpretation of the data set (Meulman and Heiser, 2011; Abdi and Williams, 2010). It should be noted that PCA make the assumption that there are three cases that are valid, i.e. contain positive integers and does not have missing values (Meulman and Heiser, 2011). This means that cases where there is missing or negative values will be omitted from the analysis, missing out on information that could affect the loadings for the cases in the output PCA.

PCA is used in a variety of ways across the scientific literature, including in decision-making (Ning and You, 2018) and climate change (Thornton *et al.*, 2011). In the case of Ning and You (2018), PCA is utilized primarily for its ability to measure uncertainty in the two output dimensions, as opposed to its ability to reduce the dimensions. PCA was used in conjunction with other data analysis techniques, e.g. smoothing and modelling, to measure uncertainty, this is done using the principal component scores (Aversano *et al.*, 2019; Ning and You; 2018); however, Abdi and Williams (2010) state important information is omitted from analysis if principal components with Eigen values over 1 are not included. Furthermore, limitations of this type of analysis arise when there are more than two principal components that make up the majority of the variance or have an Eigen value over 1, as more than two principal components make it more difficult to interpret the correlations among the variables, and to the components. This study applies PCA for its dimension reduction capabilities. For example, Thornton *et al.* (2011) uses PCA to interpret responses to transportation, i.e. to reduce the number of variables and identify the most relevant information from the dataset.

A specific type of PCA, categorical PCA (CATPCA) was used for analysing the responses to the C2A questions, because it could be conducted with a small sample size (n=9 participants) (Wetzelhütter and Bacher, 2015). It has been argued that individuals often do not consider Likert scale intervals to be commensurate in absolute terms (e.g. the interval between strongly agree and agree may not be the same as between disagree and strongly

disagree) and therefore ordinal response points on Likert scales can be treated as categorical variables with CATPCA (Bryman, 2016). However, CATPCA is still often run with larger datasets, as this is when PCA, and subsequently CATPCA, are most effective (Meulman and Heiser, 2011; Wetzelhütter and Bacher, 2015; Thornton *et al.*, 2011). CATPCA, similarly to PCA, enables the variables to be reduced to a smaller number of dimensions, supporting interpretation of data. Therefore, in this study, CATPCA is used to assist in the interpretation of participants' responses to the C2A statements, in conjunction with the qualitative data analysis of the exploratory interviews, focus groups, workshops, exhibition, and final interviews, see Section 6.2.2.

The CATPCA was run with the dimension reduction with optimal scaling feature in SPSS 25 (IBM-SPSS, 2017). Each of the nine participants completed four surveys, before and after the workshops and exhibition, that consisted of eleven statements relating to the various stages of the C2A framework, and used as the CATPCA variables, Table 6.1. This meant that there were 44 data entries used for each of the nine participants in the CATPCA, and 36 data points for each variable. Participants were asked the degree to which they agreed or disagreed to the elven statements or if they were unsure. "Unsure" was treated as a missing value in this analysis because it is not related to agreement or disagreement. Zero was not used for the SPSS input because CATPCA treats zero as a missing value. Furthermore, treating unsure as a missing value creates a separate category aside from the Likert scale in CATPCA (Meulman and Heiser, 2011). CATPCA applied here also allowed participants' "unsure" responses to be used (which in a PCA would otherwise be excluded, limiting the number of cases included in the analysis), thus maintaining the largest amount of cases and reflecting the full range of participants' responses.

Two dimensions were extracted from the CATPCA model and the component loadings were rotated to aid in interpretation. The first dimension of the CATPCA output accounted for approximately 33.2% of the variance, while the second dimension accounted 20.5%. In all, the CATPCA using all variables only accounts for about 53.7% of the variance in this analysis, meaning that 46.3% of the variance is not accounted for. For this reason, CATPCA outputs were analysed in the context of the discussions with participants in order to more fully understand and interpret the outputs of this type of analysis. Table 6.1 shows the rotated component loadings for the eleven variables on both dimensions. These component loadings show correlations between the variables in each dimension (Meulman and Heiser, 2011).

Table 6.1: The statement variable ID used in the CATPCA (numbered 1 to 11 in the left column) with the corresponding C2A statement and CATPCA rotated component loading for each dimension. Participants were asked to indicate their dis/agreement with the statements using the Likert scale indicated in the table. The negatively-phrased statements were reversed during coding (indicated in italics). The first dimension indicates feelings of efficacy. The second dimension indicates the relationship between a lack of funding and trustworthy information, and the village's ability to affect pointed change in a positive and proactive manner.

Variable	**Statement**	**Dimension**	
		1	**2**
1	The village should remain a peaceful and quiet place to live. *Reversed Statement: The village should evolve and change.*	0.574	-0.178
2	Government agencies are trustworthy sources of information pertaining to coastal change in the village.	-0.105	0.802
3	There are more important priorities than coastal erosion that keep me from fully participating in village discussions. *Reversed statement: There are not more important priorities than coastal erosion that keep me from fully participating in village discussions.*	-0.129	0.310
4	There is a lack of community engagement from other villagers for thinking of ways to deal with coastal change. *Reversed statement: There is community engagement from other villagers for thinking of ways to deal with coastal change.*	0.353	0.259
5	The village should adapt and develop to deal with coastal change.	0.823	-0.319
6	Funding issues can prevent small communities from implementing plans to deal with coastal erosion. *Reversed statement: Funding issues do not prevent small communities from implementing plans to deal with coastal erosion.*	-0.047	0.820
7	There are areas in the village that are more at risk than others for coastal erosion.	-0.304	-0.662
8	It is important for communities to deal with coastal change in a positive, proactive manner.	0.383	-0.694
9	I have almost no influence over what this village is like. *Reversed statement: I have an influence over what this village is like.*	0.723	-0.098
10	If there is a problem in the village people who live here can get it solved.	0.849	0.105
11	I feel confident that I have been given the chance to influence future decisions in the village through my participation.	0.834	-0.116
Scale: 5= Strongly agree, 4= Agree, 2= Disagree, 1=Strongly disagree, Unsure= null			

Figure 6.1 shows the individual loadings for each participant (indicated by varying shapes). There are four points per participants, indicating the four moments at which they compiled the surveys. These four points are indicated on Figure 6.1 by data labels number 1-4. For the first dimension the variables, and subsequently the C2A stages, that are highlighted include: V1 and V5 (seeing), V9 and V11 (values), and V10 (caring). The second dimension's high

loading variables are V6 and V8 (acting), V2 (hearing), and V7 (recognizing), with V7 and V8 loading negatively.

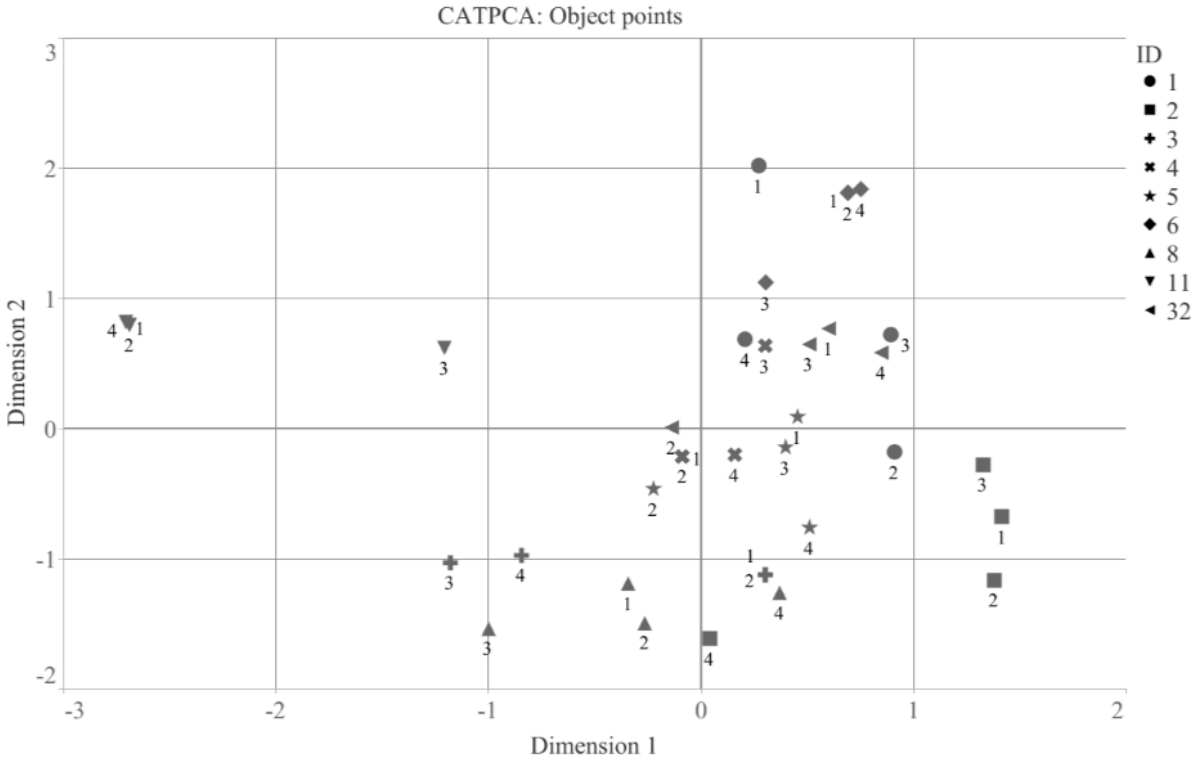


Figure 6.1: CATPCA output plot for participant object points. Shown are the participant loadings for each of the four surveys they responded to. Surveys before the workshop are indicated by data labels showing 1, after the workshop by 2, before the exhibition by 3, and after the exhibition by 4.

Using the rotated component loadings, as well as analysing individual responses, the first dimension can be interpreted as being an indication of participants being open to future change, and feeling that they -and the village- have the ability to influence change, i.e. efficacy, and that change may be necessary:

> […] Cause they [local government] haven't got any money and that's why I'm very much an advocate of "if you're going to get anything done you've got to fight for yourself." You got to keep banging the drum until someone listens to you and you're not going to achieve a lot are you, but you'll have little successes in little places; the village hall and perhaps 10 or 12 community houses so you get little successes. You go along and that's really all you can hope for.
>
> (TV02 Final Interview)

This excerpt is an example of how the first dimension relates to comments made by participants in the final interviews, i.e. a participant who has high efficacy and believes in the village's ability to affect change. The majority of participants scored over 0 on the first dimension, indicating that most participants were open to future change and believed in the ability of the village and themselves to effect change. Generally, participants that loaded greater than 1 and lower than -1 on the first dimension were those that showed the strongest views for or against future change. Although variables one and five loaded above 0.5 on the

first dimension, participants who loaded negatively did not necessarily always disagree with these statements, instead, they did not agree as strongly in most cases. Furthermore, the interpretation that most participants agreed with the fifth variable is supported by the statements made by participants in the interviews, focus groups, and workshops where participants stated that they enjoyed the peace and quiet of the village. A majority of the participants also stated that the village should adapt and develop, even if it was only in relation to physical locations like the village hall and Pilgrim Shelter. Those that load negatively on this first dimension would feel like they had less of an influence over village decisions compared to those that loaded positively.

Compared to the first dimension, the second dimension is not as intuitive and needs closer inspection to accurately interpret the loadings. If the second dimension is taken as positive loadings equal to agreement, then the second dimension is indicative of positive views about government agencies in providing information on coastal change that can be trusted, and that funding does not necessarily create a barrier to dealing with coastal erosion. However, these views are not reflective of what participants responded in actuality. The second dimension also seems to indicate that participants do not feel risk is constrained to some parts of the village only, and -surprisingly- that coastal change does not need to be dealt with by communities in a positive and proactive manner. This point may be understood in light of discussions with participants. For example, during the focus group and workshop discussions, there were differences in ways that participants believed that villagers should be communicated with:

> S32: And I think also, what we talked about getting more of the village to engage, if this building could be used as a, you know, for this sort of thing, an exhibition, to let people come in because a lot of people don't want to particularly come to a meeting and because they might be shy, might not be very vocal, but this would then at least allow them to see certain things and then maybe get them positively engaged.
> […]
> S32: For me the most positive was seeing the erosion in the last 100 years and that's not going to stop it's still happening. Where do we go from here because if we have a voice we could change things. I know we can't change the sea. […] but I think if people knew what the salient points were, points that can affect them, and I don't really mean by us, do you know what I mean, but I think they really need - but maybe it does need to be a little provocative.
> (Workshop 1)

The majority of participants in this study did not want to frighten other villagers or be alarmist in order to get people engaged in discussions about coastal change. The excerpt from the workshops indicates the differences in the ways that a single participant can feel

about the different ways to communicate change with other villagers. S32, when discussing the visualizations in the workshops, felt that the visualizations should potentially be provocative in order to engage other villagers in the discussion on coastal change in the village; however, prior to this, in the same workshop, S32 also felt that people should be engaged in a positive way. Furthermore, participants all responded in the before and after surveys that they felt that it was important for participants to deal with coastal change in a positive and proactive manner. Thus it can be inferred that the loadings on the second dimension are best described as a reflection of the relationship between the variables as opposed to a direct indication of participants' actual responses. This is also reflected by the CATPCA of the individual before and after surveys, which show the second dimension reversed, i.e. V7 and V8 loading positively, and V2 and V6 loading negatively (Table 6.1). Thus, it can be reasoned that the second dimension variables should be assessed with closer inspection of actual responses of the individual participants in order to obtain a clearer interpretation.

> I don't think we will get anything nationally. We're too small a place. They're just not interested. I think the parish council need to be more active on the erosion and the road.
>
> (TV04 Final Interview)

This excerpt is an example in the final interviews of a participant's feeling that local government should take more action on issues in the village, e.g. coastal erosion and the road, and not to rely on national government for support.

The second and sixth variable are related to government in the context of this study. Chapter 4 outlined the views and experiences with finding funds for projects in the village that participants shared during the exploratory interviews, focus groups, and workshops. It also showed that funding was the most frequently identified barrier for enacting change in the village, see Section 4.4.3. Variable two, as it is reflected in the second dimension, shows few participants who mainly agreed with the statement (loading the highest). Those that more consistently disagreed with V2 loaded more negatively on the second dimension. The participants who loaded below zero on the second dimension are also characteristically those that have had the most experience with and knowledge about local fundraising efforts. They are also the participants who have had more experience working with local government on a variety of issues, including plans for future changes in the village. Most responses for statement six indicated that participants did feel that funding issues could prevent small communities from dealing with coastal change. This dimension is showing the level to which participants felt that funding was an issue.

Looking at the relationship between the highest component loadings, it can be interpreted that there is a negative correlation between the statements that loaded positively (V2 and V6), and the statements that loaded negatively (V7 and V8). Therefore, this dimension could indicate that participants are relating a lack of funding and lack of trustworthy information to not being able to deal with pointed risk related to coastal change in a positive and proactive manner. The second dimension could also indicate participants wanting more government action to occur in the village. The second dimension supports the importance of coordinating local and national governments to balance local needs and national expectations, as discussed by Schmidt *et al.* (2013).

Variables three (knowing) and four (recognizing) do not load highly on either dimension, meaning that they do not have any strong relationship to other variables. The third statement was a statement that several participants had difficulty responding to, so this is further evidence that this statement could be omitted or revised for future research using CATPCA. If future research chooses to include V3, it could be revised to "There are more important priorities than coastal erosion" in order to more pointedly ask about how coastal erosion is prioritized. When V3 and V4 are omitted from the CATPCA, there are no changes to the components that loaded highest. Although variable four ("There is a lack of community engagement from other villagers for thinking of ways to deal with coastal change.") does not load high, participants' views on this aspect can be supplemented with data from the interviews, focus groups, and workshops. Chapter 4 discussed how participants felt about engagement in these discussions. For the most part participants did not feel that there was much community engagement in general and this is also reflective in their responses to the surveys, with only 19.4% of participants feeling that there was community engagement to deal with coastal change. Participants in this study were all active members in the community and had mixed views when responding to this statement.

My reflection on the use of the eleven statements in this study indicates that one statement per stage is unable to encompass the breadth of what each stage describes as barriers and potential opportunities for overcoming those barriers. The eleven statements that were used to represent the different stages of the C2A framework were chosen based on the "Climateville" narratives and stage descriptors of barriers (see Section 3.3), so that there was at least one representing each stage. This suggests that future research may aim to develop a C2A framework which could include a more expansive set of items more accurately representing the various facets in each of the C2A stages for that particular context. This would improve the analysis in that it would provide a clearer picture on how participants'

responses to the C2A statements compare to each other, possibly at different points in time, and explore whether statements should be reflective of changing circumstances or may have a certain longevity. This type of framework would aid in the analysis of perceptual changes over time and barriers that contribute to hindering individual actions. Questionnaires could be used alone, but in conjunction with a framework such as the C2A, a structure of perceptual changes can be categorically outlined.

6.2.2 Characterization Profiles

In this section, the CATPCA results are used to create vignettes, which are characterizations of imaginary narratives in order to provide a general understanding of the types of individuals who may be encountered by someone wishing to discuss future change and perceptions of the place where they live. These characterizations, shown Figures 6.2-6.5, are reflective of the nine participants' general perceptions of the village and change based on their responses to the C2A statements, and supplemented by their comments about themselves and others in the village during the exploratory interviews, focus groups, workshops, and exhibition (see Figure 6.1). The names used are fictitious and do not represent any individual participant. The village questionnaire was used to create the characterizations by using information about why some participants cannot participate, levels of participation, where people lived, and basic socio demographic information about respondents. This was to supplement the quantitative and qualitative data from the nine participants to garner more general typologies of individuals. Most of the participants loaded above zero on the second dimension, and, based on knowledge of the participants' involvement in the village, this can be inferred to be reflective of their level of activity in the village and, potentially, characterise those most likely to participate in future studies. Therefore, the vignettes aim to capture a variety of possibilities by not only depicting characterizations (focusing on those who loaded further from the axes) of the participants of this study, but also with consideration of others who did not participate in this study for various reasons. The implications of these vignettes are further discussed in Chapter 7.

The included fictional narratives, see Figures 6.2-6.5, can be influential tools in decision-making processes (Betsch *et al.*, 2011). For example, vignettes and narratives have been used to create comparable measures (Salomon *et al.*, 2001), summarize cases (Frost *et al.*, 2018), and discuss sensitive topics (Barter and Renold, 1999). However, it has been argued that vignettes can be used as tools in conjunction with other methods in order to represent individuals' beliefs and actions, and should be clear, plausible, and contextual (Barter and Renold, 1999). Similarly, Sheppard (2012) uses his "Climateville" narratives to explain

barriers to climate action that can be identified based on the C2A framework; however, these narratives were not underpinned by specific empirical data. The vignettes in this study use C2A framework stages. CATPCA is then used to support the characterizations. The vignettes are not necessarily inclusive of all types possible in the village, and will change with a more diverse and inclusive study. However, the typologies depicted in the vignettes reflect concerns around coastal management, engagement, and futures of places that are found in the wider literature (e.g. Long and Perkins, 2007; Wissen *et al.*, 2008; Milligan *et al.*, 2009); therefore, the vignettes can represent the particular views assessed in this study more widely. Further research can be done to expand the survey with C2A statements in order to further justify the typology characterizations of villagers.

Vignette 1: The "other priorities" neighbours

Dimension 1 (x): negative (-3-0) ***Dimension 2 (y): positive (0-3)***

Characterized by low feelings of efficacy, and a propensity for believing government information and that risk should be communicated in a positive manner.

They are unsure of their ability to affect change in the village. They could feel strongly about not wanting change in the village, or that peace and quiet is not necessary for the village. They are not as involved in village activities or participate periodically compared to other villagers, and are not involved in making final decisions about the village. They don't question the accuracy of the information government provides about coastal change as much as other people in the village. They potentially do not recognize the risk of coastal change in their own lives, choose to ignore it, or feel it is not a priority.

Ava:

Ava moved to the community recently to be closer to her parents. She and her husband work in in another town, and their children go to school outside the village. She is not interested in many of the events held in the village and only knows a few of her neighbours. She wishes there were more activities in the village for herself and her children. She is aware of coastal change in the area, and has heard about the recent erosion event, but doesn't participate in those discussions. She thinks there are more important issues that need to be discussed including making the village safer for walkers.

Oliver:

Oliver has lived in the village for over 20 years and is enjoying his retirement. He attends events in the village and is relatively informed about coastal change. He would prefer it if the village could remain peaceful. He doesn't understand why so many people want more houses in the village if they will end up as holiday homes. He thinks there needs to be a plan to deal with coastal change, but doesn't think anything radical needs to happen or can happen currently.

Figure 6.2: Characterization of individuals who may fall in Quadrant 1 of Figure 6.1. Gendered narratives included based on discussions with participants and village questionnaire. Names are fictitious and do not represent any participant.

Vignette 2: The "positive" neighbours

Dimension 1 (x): positive (0-2) ***Dimension 2 (y): positive (0-3)***

Characterized by high feelings of efficacy, and a propensity for believing government information and that risk should be communicated in a positive manner.

They are more confident of their ability to affect change in the village. They care about the character, i.e. peace and quiet, of the village, but are open to or encourage change. They are involved in village activities, but are not involved in major village decision-making. They don't question the accuracy of the information government provides about coastal change as much as other people in the village. They potentially do not recognize the risk of coastal change in their own lives, choose to ignore it, or feel it is not a priority.

Harry:

Harry moved to the village over 5 years ago. He commutes to work, but is close to retiring himself so is trying to become more involved in village life. He attended the opening of the new village hall and enjoys the regular art shows they hold in the village. He frequently walks along the cliff edge near his home and feels that the Shoreline Management Plan must be accurate since there hasn't been much cliff movement on that side of the village.

Willow:

Willow worked in London, but moved to the village to take care of her disabled mother. She lives in the most recent housing development in the village and walks her dog daily. She has met many of her neighbours this way and plays whist in the new village hall. She will occasionally attend a parish council meeting when they discuss speeding and pavement options. She hears people discuss the urgency of addressing erosion in the village, but she thinks that the parish council should prioritize making walking around the village safer. She doesn't question erosion projections like others who live on the other side of the village.

Figure 6.3: Characterization of individuals who may fall in Quadrant 2 of Figure 6.1. Gendered narratives included based on discussions with participants and village questionnaire. Names are fictitious and do not represent any participant.

Vignette 3: The "realistic, but proactive" neighbours

Dimension 1 (x): negative (-3-0) ***Dimension 2 (y): negative (-2-0)***

Characterized by low feelings of efficacy, and a propensity for not believing government information and that risk does not need to be communicated in a positive manner.

They are unsure of their ability to affect change in the village. They could feel strongly about not wanting change in the village, or that peace and quiet is not necessary for the village. They are involved in village activities, and are involved in major village decision-making. They question the accuracy of the information government provides about coastal change more than other people in the village. They recognize the risk of coastal change in their own lives and in the village

Poppy:

Poppy has lived in the village over 20 years. She is involved in all of the village events and even organizes a few. She believes that local government should send people who are local and live in the area to be able to understand the extent that erosion is affecting certain people in the village. She has a lot of ideas for what can be done for the future of the village, but feels that you need to be realistic when discussing what will be done about the erosion in the village.

Arthur:

Arthur is an active member of the village, but only likes to attend and not get involved with the running of events. He believes that the village doesn't need to change and likes the peace and quiet. He is vocal about his disagreements with the causes for erosion that the local council cites, and believes that there are other contributors to the erosion in the village. Arthur is one of the few villagers who will go to the parish council meetings and is concerned about erosion, but feels that he tends to be more practical about what can be done in the village compared to others.

Figure 6.4: Characterization of individuals who may fall in Quadrant 3 of Figure 6.1. Gendered narratives included based on discussions with participants and village questionnaire. Names are fictitious and do not represent any participant.

Vignette 4: The "positive and highly involved" neighbours

Dimension 1 (x): positive (0-3) ***Dimension 2 (y): negative (-2-0)***

Characterized by high feelings of efficacy, and a propensity for not believing government information and that risk does not need to be communicated in a positive manner.

They are more confident of their ability to affect change in the village. They care about the character, i.e. peace and quiet, of the village, but are open to or encourage change. They are involved in village activities, and are involved in major village decision-making. They question the accuracy of the information government provides about coastal change more than other people in the village. They recognize the risk of coastal change in their own lives and in the village.

George:

George has been spearheading efforts to deal with the changing coast. He moved to the village less than ten years ago and is concerned by the marked loss of land in certain parts of the village. He hopes that the government can provide funds for more housing to keep the village alive. He doesn't believe that the Shoreline Management Plan is totally accurate and that erosion is occurring at a faster rate. They erosion in the village over the last five years is causing him to be more concerned about his "legacy", but is nonetheless hopeful.

Evelyn:

Evelyn moved to the village when she retired over 15 years ago. She has made it a point to become a part of the community and that has led her to be on the parish council. She takes part in many of the events in the village. She is not directly affected by erosion, but her friend's house has been losing land much faster recently. She thinks it is because of the dry summers, over watering of crops, and wet winters. She believes that the government is not as knowledgeable about the situation as the people in the village and wishes they would consult with them.

Figure 6.5: Characterization of individuals who may fall in Quadrant 4 of Figure 6.1. Gendered narratives included based on discussions with participants and village questionnaire. Names are fictitious and do not represent any participant.

6.3 Final Interviews: Value of the Study

This section analyses the final interviews in relation to the data analysis in Chapter 4 to analyse perceptions of participants throughout this study. During the final interviews, participants were asked if they agreed with views and statements expressed primarily in relation to erosion and engagement (see Chapter 4) compiled from their participation in discussions, e.g. exploratory interview, focus group, workshop, and exhibition. Although there has not been an indication of any significant changes to participants' perceptions during the final interviews, this section aims to contextualize why there may have been minor shift in views of the future and village, how the utilization of a longitudinal methodology affected this, and further suggestions on how this process can be supplemented.

6.3.1 Prioritization

The use of a longitudinal methodology seemed to give some participants time to reflect on their previous comments and contextualize them at the time of the final interviews. This is reflected in the quantitative and qualitative data analysis. Furthermore, current events will also affect the level of worry and thus how individuals will prioritize issues (Weber, 2010; Capstick, 2015). In the case of this study, the major events that participants cited were about physical changes that had a social impact, i.e. the new village hall and potential housing. Many of the participants discussed recent discussions with the North Norfolk District Council (NNDC) about housing in the village that made them believe that housing was feasible, and in small numbers would not invade on village peace and quiet (which concerned some). In addition to this the new village hall being built, and in use for several months at the time of the final interviews, allowed participants to have greater insight into not only the potential for the new hall, but also the possibility of needing to sell the Pilgrim Shelter. For example, two participants, who had previously expressed that they would like to continue to use the Pilgrim Shelter after the hall was built, mentioned that the cost of keeping the Pilgrim Shelter could be put to better use as the Pilgrim Shelter was rarely used after the opening of the new hall. These are examples of how current events have influenced participants' responses, but is also a consequence of utilizing a longitudinal study.

Similarly to some views expressed during the study, some participants at the time of the final interviews also voiced that they did not feel that coastal change was a priority or that there were other priorities more important to them:

> Well, to be honest, that was after seeing the visuals and listening to the discussion that I thought, "Yes, those things probably are a bigger priority than such and such."
> (S32 Final interview)

> I do believe that engaging people and making sure the community stays vibrant and supportive are more important that the coast.
> (TV03 Final Interview)

> Its most probably- you know-we were doing the new village hall and there were all sorts of things that were on your mind more than coastal erosion. As I say you can't worry about it too much. You'll just get yourself in too much of a state.
> (TV04 Final Interview)

The excerpt from S32 in the final interview shows that the participant changed the way they prioritized different issues because of the study. However, another participant stated that there were "Different things to get interested in […]" when asked about why their priorities changed during the study. The excerpt from TV03 shows the continued importance of continuing to build community through engaging more people in village events. This sentiment was shared by several other participants. Many of the comments on engagement were in relation to the new village hall, which had recently been completed and opened at the time of the interviews. Other participants mentioned personal priorities that took precedence over coastal change. This supports the previous point that external factors can influence the way participants respond throughout the study, and that there are a variety of variables that will contribute to participants' perceptions (McEwen, 2011; Renn, 2008; Moser and Eckstrom, 2010; Beisbroek, 2013). Section 2.3 discussed the contribution of experiences in perceptions of risk and uncertainty, and how prioritization influences worry (Weber, 2010; Capstick, 2015) and, subsequently, actions taken by individuals.

Prioritization was also discussed in Chapter 4, however, this was in the context of the village not being a priority for the government. Section 4.4 described how participants questioned past government actions, and if government would take action in the future to deal with coastal change. The final interviews did not diverge from this, with participants continuing to not feel confident about the government's ability to enact changes that would help address the erosion in the village:

> I mean 20- 30 years ago there was a stated policy of hold the line, […] 30 years later, turned on its head. […] Well, it was nature 30 years ago so what's changed? That's changed. There's just no money around.
> (TV02 Final interview)

Funding and government action, including providing support (i.e. funds and information) for local actions, are two topics that participants generally discussed in tandem. These two

themes are also two of the highest loading variables on the second dimension of the CATPCA plot, se Figure 6.1. Funding continued to be a barrier to enacting change in the village, see Section 4.4.3, and was discussed with the intention of addressing the physical and social implications of coastal change in the village. In addition to expressing scepticism about government action, some participants continued to express a lack of confidence in government information as well, for example:

> […] I still think they've got their head in the sand. They still don't accept that their Shoreline Management plans are completely wrong and it would help if they came out and looked occasionally, but there.
> (TV03 Final interview)

This comment is in line with others that were made in the focus groups and workshops. However, there were participants that trusted the information provided by the government, and rationalized the discrepancies in erosion rates that they viewed as the government being "[…] anxious to protect themselves (TV01 Final interview) […]."

Another example of participants' views changing based on current events is views about utilizing a one-way system when the main road is no longer usable. The previous analysis in Chapter 4 showed that participants were concerned about erosion, more specifically the coast road. During the workshops, participants developed a variety of options for the future after the main road is closed, see Figure 5.3. During the final interviews, most participants agreed that the coast road was still a concern. Three participants mentioned that one of the suggestions for future use of roads, the one-way system, would not be feasible because the recent closing of the main road, where a one-way system was used, did not adequately divert traffic and was dangerous for drivers. This is not too different from the views expressed about the one-way system after the exhibition, as the one-way system was the most frequent "No" option, i.e. future option that participants least wanted, or thought would be least beneficial for the future of the village.

6.3.2 Longitudinal Process of Engaging Participants

In the final interviews, participants were asked how they would like their information to be used after the analysis, what they would like to see happen for the future of the village, and how they felt about the overall process of participating in the study.

All participants expressed the desire for the information in this study to be distributed in some form to the wider population of the village. Most suggested a presentation in the village hall. Other suggestions included leaflets, and speaking with those responsible for coastal management at the local council. On this note, most participants also expressed uncertainty

about the value of this study in enacting change in the village. They expressed that most information developed through participation, such as this study, does not lead to implementation of tangible changes or outputs. As was discussed in Chapter 2, (Sections 2.1-2.3), implementation of an idea is a mark of success (O'Riordan *et al.*, 1993), but a method to successfully implement an idea is difficult to identify (EEA, 2006). In the same way, although participants were able to develop ideas for future changes in the village based on their priorities, views, and goals, they were unable to provide concrete suggestions on successful implementation of these ideas. The final phase of the Process of Adaptation Framework (PAF) (Moser and Ekstrom, 2010), which occurs after implementation, was not undertaken in the scope of this study; upon reflection, further research should be done on the process of implementation of such an integrated approach.

Participants were also asked in the final interview about their thoughts about the entire process of participating in a longitudinal study over 2 years. The majority of participants stated that they found the activities interesting and helpful.

> Yes. It's been a journey and you, by a stroke of, I'm sure skill as well as good fortune, you happened to choose the two years, which was sort of hinged point.[…] And it's been a very positive period for the village. So it wasn't just the coastal aspect, it was the social thing that you saw kind of mini revolution taking place. So yes, your part in this has been very positive […] You've been sort of a leader in an interesting fictional background to this. And we've had actual changes and we've had you making us think of ways in which things might change and even more revolutionary way. So it's been a real kick. It's helped.
>
> (TV01 Final Interview)

> Oh I found it very interesting. Yeah it's communicating from ground level what is required by people rather than just sitting in an office and working out a theory. […] And I think with this sort of thing, if you can feedback a bit of what the local community have thoughts on and knowledge of, it would be worth getting it back to the right people. Whether they'll listen is another matter but at least it gets there.
>
> (TV08 Final Interview)

The excerpt by TV01 shows that the participant felt positively about the time that they have spent participating in this study. They refer to the "fictional" aspect of this study, i.e. the creation and visualization of future options, and how this was done simultaneously as real changes were occurring in the village. The second excerpt discusses the bottom-up approach utilized in this study in the creation of the future options and visualizations. This view is in line with the recent trend for greater inclusivity and localized management in the planning process (O' Riordan *et al.*, 2014; Rocle and Salles, 2018; Schmidt *et al.*, 2013) and highlights the importance of local knowledge (Wissen et al, 2008). Furthermore, it relates to the earlier

point to confidence in the ability to create change through implementation of the future options developed through this study. One participant questioned if the process was necessary because they did not personally think that any of their views about the future of the village had changed throughout the study or that future change was necessary.

Figure 6.6 depicts a word cloud of the most frequent words used by participants when discussing the process of participating in this study for 2 years during the final interviews. The most frequent words are shown larger, with the three most frequent words being: think, people, and village. Something is mentioned by participants when referring to their desire for "something" to be done or needed to be done. It supports that participants thought of the process of participating in this study as a way of developing ideas for the community and the village of Trimingham.

Figure 6.6: Word cloud of the 100 most frequent words when participants discussed the overall process of engagement used in this study.

Overall, participants expressed in their final interviews that their views had not significantly changed and that they generally agreed to past statements that they made. There was little evidence, both in the surveys and in the discussions with participants, that there were any perceptual changes that were the result of the longitudinal methodology utilized. Furthermore, participants felt that they would have preferred if the time it took to participate in this study was shortened. Bishop *et al.* (2013) suggested the use of longitudinal studies could garner "profound outcomes" (p. 219) and changes in awareness. In this case study, it is difficult to support this idea. Maintaining engagement can be difficult, and maintaining it over a longer period of time using a longitudinal study may not be worth the actual outputs. A longitudinal study also means that there is more time for external events to influence participant responses because perceptions are shaped by personal experience (Schroth *et al.*, 2015; Milfont, 2012; McEwen, 2011; Renn, 2008; Beisbroek, 2013) and current events (Weber, 2010; Capstick, 2015), and this makes perceptions difficult to change. However, as was mentioned in Chapter 4 and in earlier sections of this chapter, participants felt positive about their participation, in that it allowed them to develop and discuss ideas that could be useful for the future of the village. Participants also were able to suggest future steps to enact change, and how they would want the visualizations to be used.

6.5 Conclusion

The CATPCA two-dimensional output showed that efficacy and local vs. national actions were related. Based on the findings in this chapter, there are different types of individuals who may participate in decision-making (the vignettes in Section 6.2.2) which reflect the views of those who were able to, or were willing to, participate. Vignettes allow for the sensitive issue of coastal change be contextualized through the interpretation of the finding in this study for future use. There are those that are more easily engaged than others, and alternate methods of communication and engagement may need to be utilized for those that cannot attend face to face meetings, but still wish to be involved. However, the vignettes are generalizations; they are typologies of views, not comprehensive descriptions of individual views; they will also evolve over time and with changing circumstances.

A situation that is as sensitive as coastal erosion will also create strong positions in participants that could create a hesitancy or openness to change. Even with time it may be difficult to convince individuals of the benefits or disadvantages of certain future options. This study engaged with participants over two years. It may not have been necessary to engage communities over a long period of time if the goals of creating future options and

implementing them are achieved in a shorter timeframe. A longitudinal study requires that participants remain interested enough to engage with a project; this may not be possible in all situations. Furthermore, a longitudinal study will encounter more external factors that will influence participants' responses. In addition to this, going forward, more comprehensive statements/ questions should be created if the C2A framework were used more effectively, and to assess the effectiveness of this framework in identifying individual barriers to eliciting action. Further research needs to be done to expand the C2A framework to explicitly include external factors in creating barriers to address what hinders an individual from accomplishing the action stage of the framework. This could be done by expanding the description of the Acting stage from intent to act, to implemented action.

The following Chapter discusses the main findings, contributions, implications and recommendations of this research, including the potential use of visualization in management processes.

Chapter 7 | Discussion and Conclusions: Visualizing the Future through Participatory Decision-Making

7.1 Introduction

Visualizations are tools that can help facilitate learning and understanding, and have been used in decision-making situations (Lewis, 2012; Nicholson-Cole, 2005; Bishop *et al.*, 2013; Appleton *et al.*, 2002). However, it is difficult to use visualizations in decision-making processes because of the various considerations, such as individual experiences, that will affect perceptions (Bishop *et al.*, 2013; Lewis, 2013). This thesis aims to understand the role of visualizations in bottom-up, longitudinal, coastal decision-making. The objectives of this thesis (see Section 1.2) are:

i. Understand how individuals experience coastal change and how they view the future of where they live and why;
ii. Explore the role of visualizations in decision-making about future physical and social landscapes, using a specific longitudinal case study;
iii. Explore the effects and implications of a longitudinal study;
iv. Understand the lessons and implications of integrating visualizations in decision-making processes.

Managing the diverse coasts of the UK is made more challenging when considering the physical, social and economic diversity of coastal regions. The literature finds that coordination between, and across, government and non-government actors is a factor in the successful implementation of integrated coastal management strategies (Schmidt *et al.*, 2013; Milligan *et al.*, 2009). Furthermore, there are considerations relating to the individuals being engaged that will also influence decision-making processes, including their acceptance of decisions made and perceptions of the future of where they live. Visualizations can contribute to participatory management processes such as coastal zone management, and adaptive coastal management by providing tailored messages and visualizations for specific purposes and users (Bishop, 2015; Harwood *et al.*, 2015; Sheppard, 2015). However, the literature does not point to any specific set or combination of criteria to assess the effectiveness of visualizations in decision-making (Bishop *et al.*, 2013; Knight, 2001; Lewis, 2012).

The findings of this thesis move towards the development of a more integrated approach to coastal management, i.e. greater and more imbedded participation from publics, using

visualizations. Chapter 4 analysed study participants' perceptions of coastal change and the future of Trimingham. The analysis of initial interviews, focus groups, village questionnaire, and workshops found that there were barriers to eliciting action that were present in the village, and these barriers were in line with the current literature on adaptation, management, and governance. Chapter 5 evaluated the visualizations used throughout the study based on participants' responses, and subsequently suggested that visualizations, although useful, were not perceived as necessary by participants in decision-making. Finally, Chapter 6 assessed perceptions throughout the study and created vignettes of general characterizations, informed by all the phases of data collection using a mixed methods analysis. Chapter 6 also provided an analysis of the process of engagement, i.e. participating in a longitudinal study.

This chapter discusses the lessons and implications of integrating visualizations in coastal management by first presenting and discussing the main findings of this research using the research objectives. Section 7.2 discusses the views and experiences of participants pertaining to current and future change (Objective 1). Subsequently, Section 7.3 builds on this and supports the use of visualizations in decision-making processes (Objective 2), while taking the resources necessary for this process into account. Section 7.4 explores the effect of using visualizations in a longitudinal study on the overall process of participation (Objective 3) and Section 7.5 assesses the main contributions of this study. The implications of this research (Objective 4) are discussed throughout this chapter as they relate to the findings and contributions. Finally, Section 7.6 suggests future work.

7.2 Perceptions of future change

The first research objective was to understand participants' perceptions of the village and future change (see Chapter 4). This section discusses the findings of this study in relation the existing literature which indicates that there are various ways in which publics can be engaged in coastal decision-making, and that different facets that will affect decision-making processes.

Participants had varying levels of place attachment and identity that affected their preferences for future change in the village, see Section 4.3.2. Figure 4.2 seems to suggest that, overall, participants did not want locations that they felt were important to the character of the village to change, e.g. the church, their neighbourhoods, and that the physical aspect of place attachment is equally as important as the social aspect of attachment – which some have argued requires more research e.g. Scannel and Gifford (2010). The locations that participants identified as important to the character of the village tended towards locations

that they frequented or were hosts to social events such as the Pilgrim Shelter and the location for the new village hall. Furthermore, this study also found that place attachment can happen at different spatial scales, and in some cases attachment to a region or type of landscape (i.e. coasts) could be stronger than attachment to the village (O'Neill and Graham, 2016; Devine-Wright, 2013; Scannell and Gifford, 2013). For example, as discussed in Chapter 4, one participant explicitly expressed during the focus groups that they enjoy living on the coast, but could live in another coastal village and would still be happy. These aspects of place attachment emerged from the analysis of participant responses from the exploratory interviews and focus groups. Based on these findings, questions pertaining to place attachment were included in the village questionnaire and the workshop surveys. The Story Map, based on participants' recollection of the village, also reflected the importance of these locations in that it showed changes to the coast (which was also an area identified as an important characteristic of the village) and how this affected other physical locations in the village. Throughout the study participants consistently identified similar landmarks in the village, e.g. Crown and Anchor pub site, Pilgrim Shelter, new village hall, and Middle Street, and the Story Map comparison (1915 vs. 2015) indicates that physical locations can retain their importance over time and through social changes of a location. Therefore, this thesis suggests that more research can be done to better understand the implications of changes to physical places and landscapes on attachment to a place, or perceptions of attachment to a place; this is elaborated on in Section 7.6.

Another main finding relating to this research objective is the identification of barriers throughout the study. Table 4.5 organizes these barriers into two categories: barriers relating to information and data, and barriers relating to consensus building. The table also highlights the participants' ability to develop and discuss potential opportunities to overcome these barriers. Barriers include lack of trust in erosion predictions, the mixed levels of acceptance and perceptions of future options, prioritization, and the need for greater engagement. Chapter 4 also specifically highlighted the presence of governance and institutional barriers using the Process of Adaptation Framework (PAF). These identified barriers included access to funding and trust that local government will act on coastal change. Additionally, this study also found that many of the barriers identified using the PAF could also be identified using the Community Awareness to Action (C2A) framework. For example, the five most frequent barriers that were identified using the nine participants' responses to the C2A statements include: funding, lack of community engagement, lack of trust in information on erosion provided by government, lack of efficacy, and having other, more important priorities. Trust

in government and funding being two of the most frequent barriers identified is in line with the findings of Moser and Ekstrom (2013), which found that institutional barriers were predominant in the early stages of the planning process. The findings from this thesis also seem to support the findings from Schmidt *et al.* (2013) and Ekstrom and Moser (2013), i.e. that a lack of coordination among government and non-government actors can hinder future change. These findings also raise questions about the use of these frameworks in conjunction with each other because there may be barriers that are identified at an individual level and some that may emerge in group situations, see Section 7.5.1.

7.3 Creating and using visualizations in decision-making processes

Addressing the second objective of this research, visualizations were used throughout this study in an iterative process of consideration of the future. The findings of this research supports findings from the literature on landscape visualization, that there are aspects of creating and using visualizations that will also influence the perception of visualizations and the future, e.g. Sheppard (2012), Bishop *et al.* (2013), and Wissen *et al.* (2008). This section discusses the findings for this objective in relation to the creation and the use of visualizations.

7.3.1 Creating visualizations

Participants were involved in directing the focus of the study, in that they directly influenced the creation of visualizations used in this study through their responses during discussions. Iterative processes, such as the one used in creating the visualizations, have been suggested in the literature as a way to engage individuals (Bishop *et al.*, 2013; Sheppard, 2015; Schroth *et al.*, 2014). This study used several iterations of engaging with participants to create the final visualizations, shown in Figure 5.6, and utilized different software to portray the visualizations that participants suggested during discussions.

The swipe style Story Map was one of the most positively received visualizations in this study (as shown by Table 5.3) and, based on the seven criteria for evaluating effectiveness of visualizations originally used in this study (see Table 5.1), it was also one of the most effective in the study. Positive feelings towards this visualization can be attributed to the integration of participants' suggestions on what they wished to see visualized into the Story Map, i.e. they wanted to see past, present, and future comparisons of the coast. The Story Map was the sole visualization created in direct response to what participants indicated they wished to see visualized prior to the workshops, which suggests that visualizations that are created with more direct input from participants are more effective because they may address

a direct and expressed need. This is reflected in the literature on decision-making, which indicates that participants felt more positively about actions taken if they were involved in the process (Milligan *et al.*, 2009, Muro, 2012). More on the creation of visualizations is discussed in Section 7.5.

Esri Story Maps is an online platform (see Chapter 3) and can be used for free by publics to certain extents. The type of Story Map chosen was swipe, in order to compare the 1915 and 2015 maps side-by-side. The lack of geographic data did not allow for a future representation of the coast to be visualized (see Section 3.3). Story Maps is an online platform which may restrict the use of this type of visualization to those who have access to the internet and are willing to use this type of technology. This raises questions about how groups or communities can be engaged using visualizations if they are unable to access the relevant software or technology with which they are represented, and which other alternatives can be found. In the case of this study, participants were open to trying new forms of technology, but preferred not to use technology if they did not need to.

One of the limitations that occurred while creating the visualizations is the computing power and time necessary to make changes to the visualization using Visual Nature Studio (VNS). VNS is a powerful landscape visualization tool; however, it may not be a suitable software to use when the aim is to make modifications to several 3D landscapes in a short period of time, such as real-time modifications attempted during the workshops. Furthermore, the lack of fast internet service in the village made programs such as Story Maps difficult to use because of long loading times. Future research could explore how to use tools and technology without the use of computers or smartphones to enable creation and use of visualizations. Physical models and maps could supplement technology and different types of interactivity could be used, e.g. making additions or markings on a physical model, in places where there is no access to the appropriate technology, or the participant would not be comfortable or familiar with the type of technology used. In some cases it can even be argued that physical models are just as or more effective than computer models (e.g. Houben *et al.*, 2016; Preece *et al.*, 2013). For example, Preece *et al.* (2013) found that in medical studies, there are limitations to using 3D models when showing complex 3D information, and that physical models could aid teaching for "understanding, appreciation, and application of 3D information." (p.223) This suggests that technology should be applied when it serves to achieve the purpose of visualizations; it is necessary to be realistic about what can be achieved in specific contexts, and communicate this to those involved.

7.3.2 Using visualizations

Participants were questioned about the visualizations used after the workshops, exhibition, and in the final interviews (see Section 5.3). This section discusses the process of using visualizations and the technical considerations when tailoring visualizations during this study.

During the workshops, participants were given the opportunity to view future options for the future of the village using visualizations. During the workshops, organized based on perceived openness to change (see Chapter 3), participants could discuss and further modify the visualizations. The first workshops, composed of those that had moderate views about future change, made the most noticeable change to the future option after seeing it visualized compared to the other two workshops, composed of participants with stronger views about future change (see Section 5.3). This suggested that participants who had stronger views on change did not benefit from the use of visualizations as much as those that had more moderate views about future change. This is reflected in Figures 5.5 (workshop questionnaires) and 5.7 (exhibition questionnaires), which show participant responses to survey questions pertaining to different aspects of an effective visualization (i.e. clear and understandable, engaging, made coastal change more personal, helped think of positive futures, and were respectful towards their views, and helped change the way the future was thought about). Overall, participants felt that the visualizations were clear, understandable, engaging, accurately represented the village, and respectful of their views. Some participants did not feel that the visualizations helped to change the way that they view the future of the village, and all of these participants were those that already indicated that they have strong views about the future of the village.

Similarly, during the final interviews, participants were asked how they felt about the use of visualizations during the study, and how helpful they felt Most participants felt that the visualizations were helpful during discussions and were viewed positively; however, visualizations were not considered as an integral part of the decision-making process by some participants. By this, these participants meant that, although visualizations were useful in facilitating the discussions by showing the future options for change in the village, the same ideas and discussions could have still occurred without the use of visualizations. As with the survey responses, participants who responded this way included those that had strong views about the future of the village; however, Section 5.3.4, which discusses the perceived need to use visualizations by participants, also highlights that the participants in this study were all well informed on village news and have formed opinions about what they

believe will maintain the village's viability in the future. Further research could help to understand the role that different pre-existing opinions about future change could have on the perceived role of visualizations by individuals, and ultimately the usefulness of visualizations to these different groups.

Tailoring visualizations is another consideration when creating visualizations for decision-making processes. This paragraph discusses the findings that informed the creation of the visualizations used in this study, and how this relates to the existing literature. Participants in this study had the willingness, but not the experience or expertise to use new technology. Participants also mentioned varying opinions about which camera angles and scale to show the village using the still 3D visualizations. A further iteration of this study could include exploring preferences among participants for specific aspects of visualization, for instance, scales and camera angles, at earlier stages of discussions such as the exploratory interviews. This would allow for visualizations with appropriate camera angles and scales to be produced for the workshops or when they are intended to be used. Therefore, engaging individuals with the visualizations also involved tailoring visualizations to the users, including choosing which technology would be the most relevant to use for the audience and situation (e.g. the creation of the Story Map). This indicates that the use of visualizations in other contexts, when engaging diverse groups, would most likely still benefit from engaging with participants prior to creating visualizations in order to make sure the visualizations are suitable for the situation. This reflects the literature that was drawn upon during this study, i.e. Nicholson-Cole (2005) and Appleton (2005), which indicates that a single visualization and message cannot be expected to appeal to everyone. Furthermore, the literature also posits that the type of visualization used should be adapted to suit the situation (Hine *et al.*, 2014, Sheppard, 2012; Nicholson-Cole, 2005; Scannell, 2013; Chou *et al.*, 2009). With similar findings in the literature on landscape visualizations, engagement, and communication, it may be useful for further research to focus on understanding the extent that tailoring messages, including the use of visualizations, can influence the effectiveness of communication (see Section 7.6).

7.4 Employing a longitudinal study

The third research objective aimed to understand the effects and implications of using a longitudinal study. The use of a longitudinal research design allowed this study to understand the issues present in the village, views of future change from participants, and participants' experiences with technology and visualizations over two years. One of the limitations of this type of research design, as discussed in Section 6.3, is that a longitudinal study allows for

more instances where confounding variables influence participant responses. This is in line with findings by Ellis and Dix (2006) who identified the inability to control these variables as one of the issues with studies evaluating visualizations. However, this limitation could also be seen as an opportunity to better understand the effects on participants' views and implications on use of visualizations.

Longitudinal studies can be useful in the co-creation of visualizations with participants over several months and the changes in perceptions and views over time. Within the visualization literature there is a paucity of studies using iterative methodologies to co-create visualizations. For this reason, the literature on decision-making and management was drawn upon to inform the creation of the methodology used in this study (e.g. Renn, 2008; Moser and Ekstrom, 2010; Schmidt *et al.*, 2013). Furthermore, the use of a longitudinal study enabled participant and researcher reflection on how social and external factors affected the ways which participants perceived changes to their area, and to evaluate changes in perceptions, as suggested by the literature (e.g. Schroth *et al.*, 2015; Bishop *et al.*, 2013). The nine participants that consistently engaged with this study were able to reflect on their experiences through time, and how these affected their perceptions of future options. An example is the perceptions of changes to the one-way system future option proposed during the workshops, after a one-way system during road works had been used with the same roads. This led to participants feeling that a one-way system was not feasible because of their negative experiences during the road works. The final interviews, which took place two years after the start of the study also provided valuable time to compare views from the exploratory interviews to the final interviews. Information on participants' views to improve the research design after they had been part of the iterative and longitudinal approach to coastal management was also valuable to making future suggestions on how this process can be improved. In this way, the appropriate length of time for a longitudinal study was brought into question, as some participants in the final interviews suggested that the length of the study could be shortened to improve the participation experience. One participant in the final interviews even honestly expressed that they were only still participating because they had invested their time and wished to see the end result. This may not be the case for all participants, but this suggests that two years of participation over six points in time could be too long a time period or that there were too many points of engagement, and this could have led to participation fatigue and general tiredness of participation. It is difficult to assess what timeframe would be more adequate because of the rarity of longitudinal studies in the landscape visualization literature. A constraint on shortening the time for a study in this

context is that various resources and levels of expertise and trust that need to be acquired by both participants and researcher before visualizations can be used. In the context of this study, new software (Visual Nature Studio and 3DS Max) had to be learned, which involved extra time that could have potentially been saved if the person creating visualizations was already familiar with the visualization technology, or if the technology was created in a way that was more intuitive. Nonetheless, this ease of use could come with a trade-off of losing some of the visualization capabilities such a as interactivity, amount of detail, and level of realism. Capstick *et al.* (2015) included "climate 'fatigue'" (p.54) in a description of possible influences for changing public perceptions using longitudinal studies. This, along with the findings from this research, seem to support managing the time a study takes so that participants can remain engaged in a study. It is therefore suggested that further research consider the length of time and instances in which individuals are engaged (see Section 7.6).

Clearly gauging participants' perceptions and engagement at each point in data collection is recommended to account for potential changes over the course of a longitudinal study. This study aimed to do so using the C2A statements. However, as the study evolved due to its iterative nature, it became more difficult to account for changes that occurred at a later stage, but were not explicitly considered in earlier stages; the statements therefore were not fully inclusive of perceptions and views which emerged over time. This is similarly the case with visualizations in a longitudinal study. Without explicit measurement, the identification of reasons for later visualizations seemingly being more effective is made more complicated. This thesis suggests that more research be done to understand the influence of technology literacy, content, and different forms of visualizations on the overall effectiveness of visualizations, using or developing frameworks that are adaptable over time. Future research utilizing mixed methods could carefully consider how a study can evolve and try to anticipate changes in perceptions and use an adaptable framework in order to accurately measure importance and value of specific activities, e.g. use of visualizations during the decision-making process.

The frameworks which underpin this study, i.e. Renn (2008), Moser and Ekstrom (2010), and Sheppard (2012), showed that there are stages of decision-making, see Table 2.1, which are cross-cutting between bodies of literature, and can be utilized in a variety of contexts including coastal adaptation, governance and risk management. All of these frameworks also suggest some assessment of the process undertaken. This research showed that, with reference to the specific stages in the Process of Adaptation Framework, the implementation and evaluation of said implementation, were unable to be completed within the scope of this

study, see Chapter 4. Although this study suggests that the use of longitudinal studies are not necessarily essential for the evaluation of visualizations, this method of engagement over long periods of time may be necessary when attempting to engage participants in a complete decision-making process. The stages that are suggested in all these frameworks could be used to organize future planning or management projects that engage publics in decision-making processes (further policy implications are discussed in Section 7.6).

7.5 Main contributions of this study

This section discusses the theoretical, empirical, and methodological contributions of this thesis to the current body of knowledge. This research draws from various bodies of literature including the use of different frameworks from different contexts relating to participatory decision-making. Section 7.5.1 discusses the theoretical contributions of this thesis, including the creation of a guide to aid in the creation and evaluation of visualizations. Furthermore, Section 7.5.2 discusses the empirical contributions including the use of Categorical Principal Component Analysis (CATPCA) and the identification of barriers. One of the interesting aspects of this study was the novel use of a longitudinal, "bottom-up" process to creating visualizations and engaging individuals in decision-making. Section 7.5.3 discusses these methodological contributions.

7.5.1 Theoretical

This section examines the theoretical contributions of this thesis, with reference to the literature on coastal management and the use of visualizations in management practices (Bishop *et al.*, 2013, Sheppard, 2012).

Firstly, this thesis contributes to the literature on integrated management by discussing frameworks that can be used in tandem to understand adaptation to future change and barriers associated with these processes at a collective and individual level. Secondly, the modification and development of criteria for evaluating visualizations, as well as a proposed guide to using these criteria are outlined and discussed.

First, the study undertaken in this thesis indicates there are similarities between the Process of Adaptation Framework (PAF) and C2A framework (barriers were explored using these frameworks in Section 7.2). In the literature, these two frameworks are used in different ways and contexts. Most of the barriers that were identified in this study using the PAF correspond to those that were mentioned by individuals, during the interviews and the use of the C2A questions. This is interesting as the PAF was created, and used in this thesis, to

identify barriers and move to addressing these, whereas the C2A framework focuses primarily at the individual level. Figure 7.1 shows the PAF and the C2A framework – the stages in grey are those affected by or which affect the external processes of decision-making as described in Sheppard (2012). Common barriers identified using both these frameworks include funding and varied views about change, see Chapter 4. The PAF portrays the process of adaptation as multi-stage action, whereas the C2A framework relates to the internal processing of information, reflection, possible changes, and external events. This seems to suggest that the PAF guides the collective process of adapting to change, and the C2A may be useful in exploring how the process is interpreted at the individual level.

This study suggests that using these two frameworks in conjunction with each other enables identifying barriers in decision-making processes that may be (or not) manifest at the individual and collective level. The application of these frameworks could assist with exploration of which barriers to address and how. It may be possible to encourage individuals to consider which elements are present at both levels and why, or any discrepancies between barriers identified at different levels. This may occur because at a collective level a barrier may become resolved, or the collective environment may affect responses in other ways, i.e. being comfortable with sharing opinions in a group setting. This thesis suggests that these two frameworks can be used to inform findings from the other to support decision-making at the individual and collective scales. The use of these two frameworks also holds the potential to see if common barriers present at an individual and collective level can be addressed in tandem. Based on the findings from this research, it can also be suggested that more research be done to analyse the combined use of these frameworks in identifying and overcoming barriers. This can be done through further research into the structures of the frameworks, and by engaging with individuals after a period of time following implementation of options for overcoming barriers they may have identified, discussed and proposed options for.

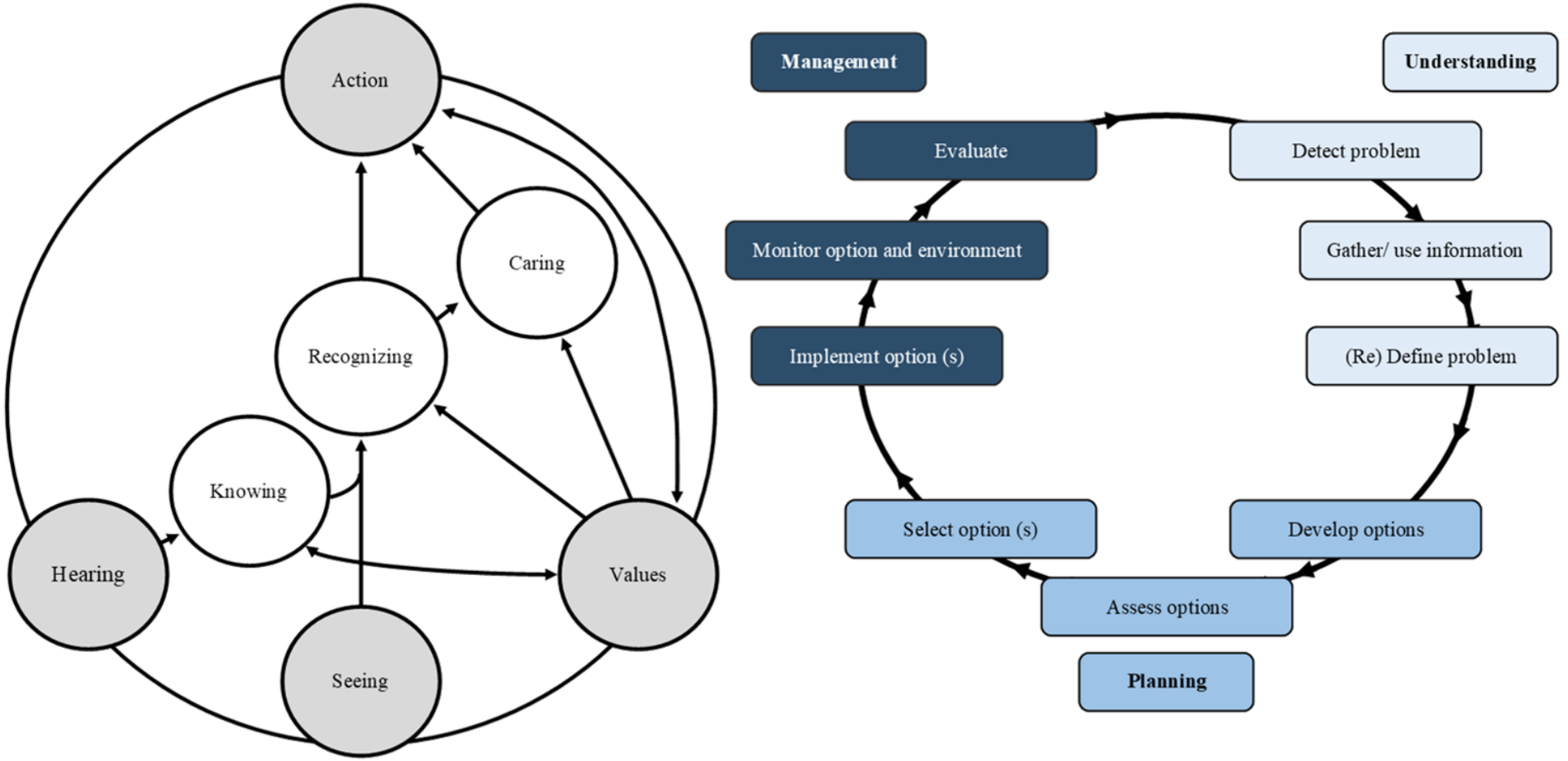


Figure 7.1: The Community Awareness to Action Framework (C2A) (left; adapted from Sheppard, 2012) and Process of Adaptation Framework (PAF) (right; adapted from Moser and Ekstrom, 2010) - which aim to aid in decision-making process through the identification of barriers. The stages of the C2A framework that are affected and can affect external processes are shaded grey. The PAF is considered in this thesis as the process of adaptation, in which the C2A is occurring at each phase of the PAF. It is suggested that these two frameworks are used to understand the individual and collective barriers that affect the decision-making process.

The second contribution discussed in this section is the modification and creation of criteria for evaluating visualizations, and the creation of a guide on how these criteria can be used. This thesis also drew upon the literature relating to landscape visualizations to evaluate the visualizations created in this study; however, the field of landscape visualizations shows discrepancies in the ways researchers evaluate visualizations. It should be noted that the debates in literature on landscape visualizations are not unique in relation to identifying effective methods and processes for evaluation. Burgess and Chilvers (2006), for example, mirror the views from Ellis and Dix (2006) that evaluation is difficult and should be undertaken carefully, with sensitivity to the context and processes that are being evaluated, with clear criteria. Chapter 2 and Chapter 5 highlight the various evaluation criteria for visualizations suggested, e.g. in Bishop *et al.* (2013), Ellis and Dix (2006), Knight (2001), and Sheppard (2012). It is found that there are inconsistencies with the definitions of criteria used for evaluation (some definitions list several aspects under one criterion) and with the application and use of criteria.

The various definitions for criteria present in the literature used to evaluate visualizations, as well as the creative and subjective nature of visualizations, hinder the creation of a single combination of criteria for measuring effectiveness. There have been suggestions in the literature for considerations for creating visualizations that are effective for communication (e.g. Sheppard, 2012) and various authors have discussed criteria they use to evaluate visualizations (e.g. Bishop *et al.*, 2013 and Knight, 2001). In fact, upon reflection of the various criteria and contexts that visualizations are used in the literature and this study, it is recommended that the choice of evaluation criteria be flexible to reflect the purpose of the visualizations.

A review of the literature indicates that effectiveness is generally meant as the visualization's ability to fulfil its purpose, e.g. desired or measurable outcomes are observed; however, authors have different views about what constitutes effectiveness (e.g. Bishop *et al.*, 2013; Knight, 2001, Glaas *et al.*, 2017). Similarly, in the literature relating to evaluation and participation, purpose is highlighted as integral to evaluation (Hertting and Vedung, 2012). However, the literature on evaluation also views purpose in different ways. Stagl (2006) suggests that the purpose should evolve throughout the decision-making process, and can be specific or generic. This thesis refers to a generic purpose for the creation and evaluation of visualizations. It should also be noted that in an iterative and longitudinal study such as the one used for this research, there is opportunity for purposes of the visualizations to change and may reflect changes to the overall process of engagement too. This study aimed to use

visualizations as tools to aid in learning and understanding. The content of the visualizations changed through participants' engagement, but the measure of effectiveness for the visualizations, i.e. did participants perceive the visualizations as helpful tools during the discussion, was kept constant throughout. This was asked explicitly, and gauged based on participant responses about specific criteria to measure effectiveness, interviews and after the workshops and exhibition (see Table 5.1). With the use of a mixed methods approach, the effectiveness of the visualizations used throughout this study was evaluated in order to better understand how these visualizations were perceived using a specific combination of criteria (see Chapter 5).

This thesis recommends the creation of guide to evaluating visualizations, with specific definitions for criteria that can be measured and quantified. This is important for creating greater consistency among studies, and using different forms of technology in different contexts. In using the criteria to evaluate the effectiveness of the visualizations in this study, it became evident that the definitions describing what was being measured by the criteria were not specific enough to accurately assess if a criterion was met. Therefore, based on the existing literature on the evaluation of visualizations, as well as drawing upon the findings of this study, the next section presents revised criteria defined so that each criterion measures a specific aspect of visualization evaluation. Following this, a guide to using these revised criteria in a decision-making process using visualizations is discussed.

Proposed criteria for evaluating visualizations

The revised definitions and criteria draw upon descriptions provided by Sheppard (2012) and Knight (2001), and proposed interim code of ethics for landscape visualization in Sheppard (2000). The definitions also incorporate some aspects of the barriers pertaining to information identified during this study using the Process of Adaptation Framework (PAF) from Moser and Ekstrom (2010). The barriers identified in this study using the PAF relating to data and information overlapped with aspects of the criteria used for evaluation (see Table 4.5), namely accessibility (which was previously embedded in usability, see Chapter 5), respect, accuracy, transparency, and credibility (which were all previously encompassed by the trust criteria, see Table 5.1). Similarly, Wissen *et al.* (2008) distinguishes between transparency and credibility. Based on the findings of this study (i.e. the identified barriers to decision-making using the PAF), this thesis also makes this distinction between transparency and credibility. The new definition of **transparency** is modified from the description by Sheppard (2012); however, credibility, another aspect of trust discussed by Wissen *et al.* (2008), Moser and Ekstrom (2010), and Sheppard (2012), is divided into the

credibility of data sources and **credibility of the producer of visualizations** as these two aspects of credibility can have different influences in the way that visualizations are perceived, and they constitute different aspects of trust. Credibility of data can be assessed initially by the producer of the visualizations and is therefore considered to be relevant to the creation and modification of visualizations. On the other hand, credibility of the creator is included with the criteria for evaluating visualizations because, in some uses of visualizations in decision-making, the creator of the visualizations may not have previously engaged with the intended audience/ users of the visualizations prior to creating visualizations. This means that the credibility of the creator may be initially assessed by participants during the evaluation of visualizations instead of prior conversations. This thesis argues that credibility of the creator cannot be assessed by the individual creating visualizations because it is the audiences' perception of the creator's credibility that will affect the effectiveness of visualizations.

Sheppard (2012) described connectivity and considering the relevance of the information visualized, as well as the visualizations' ability to show the connectedness between issues. However, after using these criteria, this study suggests that **relevance** is separated from connectivity so that **connectivity** only measures perceptions of the visualization's ability to show links between issues, while relevance gauges how meaningful the information presented in the visualization is. **Respect** is another aspect of trust as described by Sheppard (2012), and was also a barrier identified during this study. Based on this description, and findings from this research, this thesis defines respect as being sensitive to local situations. For example, a visualization can frame an issue positively, or rather, can focus on opportunities for the future. **Accuracy of user response interpretation** is included as a criterion as this is relevant when there are different views of what could be done for the future of the village. This criterion suggests that efforts be made to represent users' views and opinions as closely as possible to avoid potential conflicts and loss of credibility. Furthermore, the Story Map's positive reception suggests that inclusion of participants' suggestions for visualizations can contribute to positive perceptions of visualizations. Accuracy of user response interpretation may not be relevant if publics are not engaged in the creation of visualizations.

The criterion engagement was separated into the criteria accessibility, memorable, interactive and diversity, based on Sheppard (2012) and Sheppard (2000). The criteria have been used in a variety of ways across the literature on evaluation; however, in the previous version of engagement as a criterion, these specific aspects were not highlighted

individually. As was previously stated, **accessibility** was an information barrier identified using the PAF. This criterion specifically measures the availability of the visualization to the intended audience, i.e. if the format accessible for the audience to use. Aspects of data availability are encompassed within the credibility of data sources and **accuracy of geographic data**. Another of the engagement criteria is **memorable**. This criterion was relevant to this study given its longitudinal aspect, and is relevant to other types of studies, the message or the format that the message is conveyed in can affect how memorable a visualization is. However, a visualization may also be remembered because it is negatively perceived. An example from this case study was the one-way system being memorable because many people did not think it was a feasible transportation option due to the width of the roads, and could be potentially dangerous. **Interactivity** is a consideration when deciding on types of visualizations. Different levels of interactivity are possible and can take different forms depending on the type of visualizations used (see Section 2.4.5). The final criterion is **diversity**, i.e. a diversity of media and techniques employed in the creation of visualizations, which may not be applicable to all situations because not all studies will have the need or time to employ multiple types of media to engage the intended audiences. However, caution should be exercised about technology: this should be appropriate to suit the needs of the situation (Hine *et al.*, 2014, Sheppard, 2012; Nicholson-Cole, 2005; Scannell, 2013; Chou *et al.*, 2009).

Feasibility has been divided into the criteria usability and cost-effective. **Usability** has been specified from the description in Knight (2001) to measure how replicable and manageable a visualizations is. Thus it becomes more in line with the description of usability by Sheppard (2012). In the context of this study, there were factors such as internet service and lack of expertise that needed to be taken into account when deciding which type of visualizations would be appropriate to use and the type of software available and appropriate to use so that participants can manage and repeat the creation of visualizations themselves. The criteria derived from the previous engagement and feasibility criteria are affected by the second feasibility criterion, **cost-effective**. Resource and time constraints may hinder the use of visualizations. For example, financial costs of hardware, software, and data acquisition that individuals or groups wishing to create and use visualizations may incur. This study did not have this issue because of free educational licenses and resources provided by the university; however, even local councils may find it difficult to acquire the necessary resources to use visualizations in decision-making processes, and may find that training and experience in using these is also necessary.

Finally, **clarity** is a criterion that will be affected by the choices made when creating and presenting visualizations. In other words, how well the visualizations score on the other criteria will have an effect on how clear a visualization is perceived to be. This thesis suggests the use of clarity in the evaluation of visualizations because this will affect the suitability of the visualization. Furthermore, **suitability** is an essential evaluation criterion as it reflects the overall relevance of purpose in the creation and evaluation of visualizations (see Section 2.4.1). Table 7.1 shows suggested criteria for evaluating the effectiveness of visualizations as well as the focus of these criteria, i.e. content (what is being visualized) vs. format (how it is visualized). Within each of the groupings in the table, a proposed prioritization of the criteria has been suggested based on their potential generalizability, i.e. their use in different types of studies, and the frequency in which they were suggested or used in the literature on landscape visualizations.

Table 7.1: Redefined criteria for consideration during the creation and evaluation of visualizations. Sections separate criteria that are related to the content and format of visualizations. The final grouping of criterion) are those that have implications to both of these aspects. Criteria are prioritized within each grouping, with criterion that should be prioritize at the top of each grouping.

Criteria	**Definition**
Criteria for the content of visualizations (What is being visualized)	
Transparency:	Process of creating visualizations and data sourcing are explained.*
Credibility of data:	Sources of underpinning data are trusted. **
Relevance:	Information visualized is meaningful to the user/audience.*+
Respect:	Sensitive to local situations and conditions. *+
Criteria for the way a visualization is presented (How it is being visualized)	
Accessibility:	Available to intended audience. **+^
Diversity:	Uses multiple types of media to engage users/audiences.*+
Interactive:	Individuals can "alter" and contribute to the visualization. *+
Usability:	Replicable and manageable by others.*+
Criteria for content and presentation of visualizations	
Suitability:	Visualization is appropriate for representing the purpose and aims of the visualization. ^
Cost-effective:	Only uses available resources. *+**
Accuracy of geographic data:	The underpinning data correctly represents the geographic data to be visualized. **+
Clarity:	Clear, unambiguous message. *+
Connectivity:	Shows the links between issues, e.g. causes and impacts. *
Credibility of producer:	Creator/presenter is viewed as credible.*+**
Accuracy of user response interpretation:	Participants' views and opinions are represented as closely as possible to their intended meanings. +
Memorable:	Attention grabbing and strong message.*+
*modified based on Sheppard (2012) and Sheppard (2000) **modified based on PAF (Moser and Ekstrom, 2010) ^modified based on Knight (2001) +modified using findings from this study	

Realism and detail are characteristics of visualizations that will affect whether visualizations are perceived as clear (Wissen, 2011; Lovett *et al.*, 2015) and relevant (Bishop, 2015; Harwood *et al.*, 2015; Sheppard, 2015); therefore, they are not included as criteria because of their effect on other criteria and because they represent stylistic choices that are subjective to each individual. If these were to be included, they would be more closely aligned with the criteria that affect technology and presentation choices. It is important to highlight that having a set of explicit criteria to evaluate visualizations can also assist in the creation of visualizations.

Guide to using modified criteria in a process using visualizations in decision-making

Figure 7.2 organizes the variety of literature on evaluation of visualizations to produce a reference resource for individuals wishing to become involved in processes to create visualizations and evaluate their effectiveness. It also suggests how the use of some of these criteria can focus the evaluation of visualizations on some of their specific characteristics. The figure has been produced to address the need in the field of landscape visualization to organize evaluation criteria (Table 7.1) so that the creation and evaluation of visualizations can be made more effective and replicable. The proposed criteria for evaluating visualizations, as presented in Table 7.1, are shown in Figure 7.2 grouped using the same colour codes to indicate:

- Yellow: criteria pertaining to the content of visualizations.
- Blue: criteria pertaining the format of visualizations.
- Green: criteria that affect both content and format.

Building on Table 7.1, Figure 7.2 also shows criteria that are relevant to the creation and evaluation of visualizations. The criteria are organized according to the phase of the process of creating and evaluating visualizations that they are most applicable to, based on the findings from this study and other studies which use iterative methods (e.g. O'Riordan *et al.*, 1993). As indicated in the figure, the cyclical format indicates the iterative nature of the study, composed of the following phases:

1. **Identification of purpose:** the purpose of the visualization(s) is identified agreed; this may occur in a variety of ways among the research of project team, or through discussion and consultation with the individuals who will be using the visualizations, which may depend on context and circumstances.
2. **Creation of visualization:** relevant information to the purpose of the visualization is gathered and assessed; this may include feedback from individuals who may have

used and / or evaluated the visualizations previously. These data are brought together and applied to create the visualizations' content and format using the relevant criteria, bearing in mind the purpose of the visualization.

3. **Further considerations and modification:** drawing upon feedback or previous evaluation from individuals, and any additional considerations relating to the suitability of the visualization for the desired audience, modifications to existing visualizations can be made. Modifications can include changing the content or format of the visualization. Modification is more likely to occur in a process that aims to receive feedback pertaining to the visualizations.
4. **(Re) Evaluation:** assessment of the effectiveness of visualizations applying a set of criteria. Suitable criteria to use to evaluate effectiveness may change from one cycle of this process to another. Re-evaluation occurs when visualizations are reviewed more than once after they are created and / or used. This phase can be driven by the individuals engaging with the visualizations both as originators and users of the visualizations.

It should be noted that not all criteria will be relevant to each situation, and criteria for evaluation should be considered based on the purpose of the visualizations created. Thus, in this process, criteria are prioritized to show which are more likely to be relevant to the creation and evaluation of a visualization. Criteria that are more suitable for an iterative and longitudinal study, such as the one utilized in this study, are indicated as lower priority because of the predominance in the literature of studies which engage individuals using visualizations in a single instance. Therefore, this thesis proposes different ways that the process depicted in Figure 7.2 can occur:

- No evaluation: Visualizations are created while considering relevant criteria for effective visualizations. Visualizations are not evaluated to gauge effectiveness.
- Only one cycle: Visualizations are created and only evaluated once. Depending on the purpose of the visualizations, modification of visualizations can occur again without further evaluation.
- Multiple cycles: Visualizations were co-produced, and individuals are given the opportunity to evaluate the visualizations. Visualizations are modified based on this evaluation and suggestions from individuals; however, visualizations are shown to individuals again and re-evaluated. This process can occur multiple times.

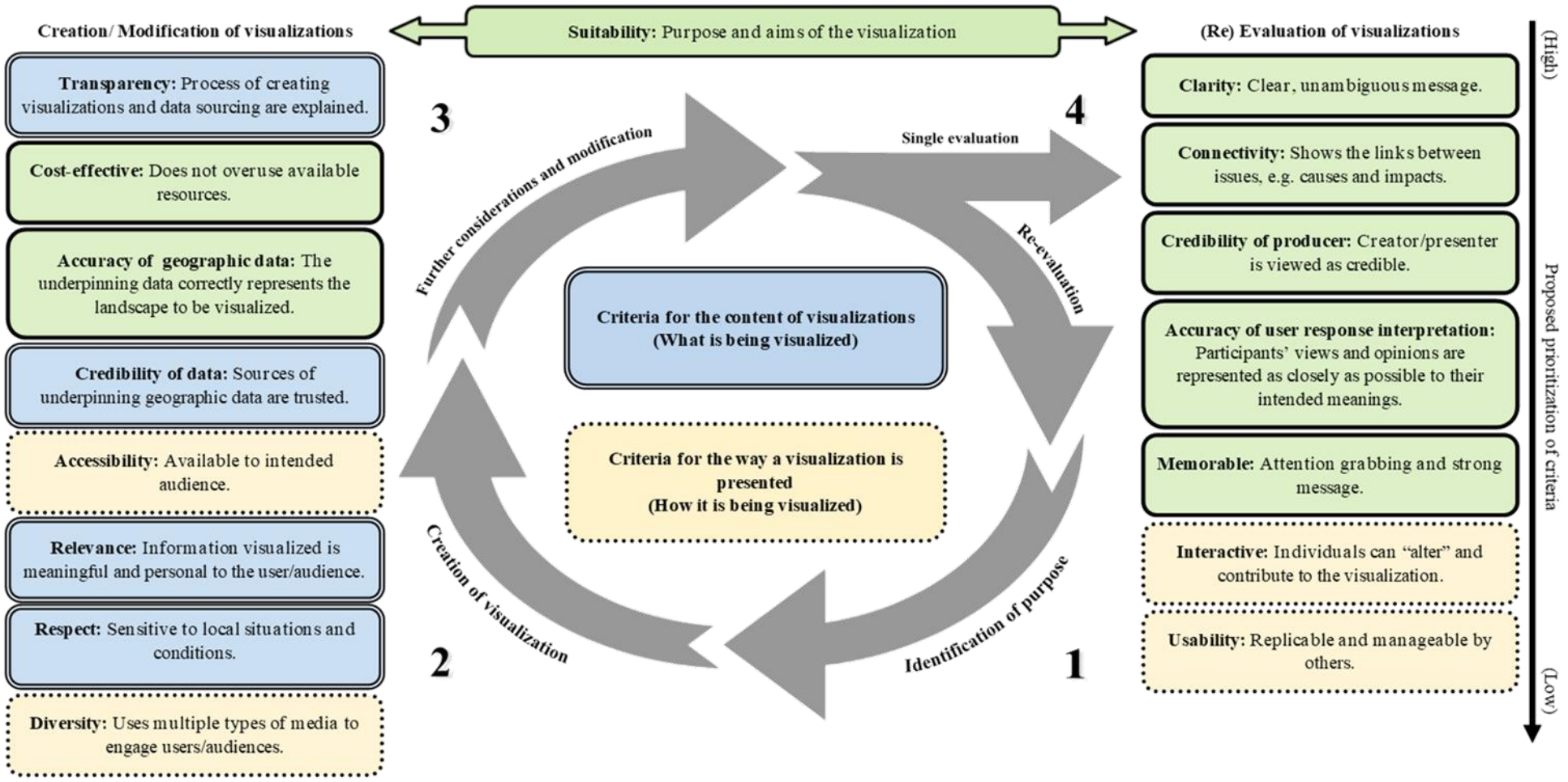


Figure 7.2: Suggested criteria for consideration during the process of creating visualizations and evaluating their effectiveness; criteria are modified from proposed and used criteria for evaluation in Sheppard (2012), Moser and Ekstrom (2010), Knight (2001), and Bishop et al., (2013). Criteria in yellow are those relating to the way that a visualization is presented, blue relates to the content, or the "what", that is being visualized, and green are those that can be used to evaluate both content and presentation. Criteria that are considered more relevant to the creation of visualizations are shown on the left, and those more closely aligned with evaluation are on the right.

7.5.2 Empirical

This section discusses the empirical contributions of this study. First, the implications of social changes on desired future physical changes are discussed. Following this is a discussion relating to information limitations from this study, and how local knowledge was used to supplement a lack of geographic data.

This research shows that the physical landscape that participants envisioned was very much affected by their desire for social changes, or preference for no changes, in the village (e.g. Figure 4.2), and highlights the importance of understanding the social context of landscape changes. Participants in this study all voiced their views on social changes in the village at some point, and the disagreements about physical changes, such as having a village shop in the Pilgrim Shelter, were debated based on the social need and feasibility of a village shop. Another example of this study supporting that social changes can drive physical changes is that the majority of the suggested options for future changes in the village were suggested with the intention of creating a greater sense of community. Similarly, those who were more opposed to major physical changes, e.g. large housing developments, to the village were not as concerned about increasing the sense of community in the village and wished for it to remain peaceful and quiet. This study also suggests that individuals with strong views about the future are less likely to make changes to their initial ideas, even after discussions with others, see Section 4.5. However, participants were accepting of the final visualizations produced, following discussions, even if it did not include their suggested options. This reflects Milligan *et al.*'s (2009) work which suggests that engagement will make it more likely that an individual will accept an outcome or decision even when their suggestions are not being implemented, but have been discussed. The implication of these findings is individuals may participate in discussions with very specific perspectives and may be willing to accept the outcomes of these if they can see that their views have been considered by others. Management of expectations from such participatory processes is essential (see Milligan *et al.*, 2009)

The coast of North Norfolk is geologically diverse, but in particular, the cliffs are made of soft glacial till that makes mapping the geology of the coast difficult. For this reason, there was a lack of data about the cliffs and future changes at the time of the study. The British Geological Survey began work in the village in 2018 to understand the geology of the cliff so that modelling could be done to aid in erosion prediction and policy development. In the focus groups some participants mentioned that they wanted to see the past, present, and future coasts compared to each other. The lack of data at the time did not allow for a future

visualization to be created; instead, the Story Map was created to compare the coast in 1915 to 2015. Furthermore, there is still uncertainty when modelling erosion in the area because of the geology of the cliff. The cliffs have a diverse composition, e.g. sand, silt, clay, and flint, and this adds to the difficulty when trying to predict which areas of the cliff are more likely to erode than others. Some participants, with many years living on the coast, have mentioned that they can predict when a piece of cliff will erode by the shape of the cliff. This supports that local knowledge and experience can be in line with or add to what experts know about the process of cliff erosion. Furthermore, recent government efforts in the UK through the Flood and Coastal Erosion Risk Management (FCERM) Research Programme and the Anglian (Eastern) Regional Flood & Coastal Committee highlight the importance of engaging publics in adaptation planning and the shift towards more inclusive decision-making processes (Kelly and Kelly, 2019; Environment Agency, 2019).

7.5.3 Methodological

This section highlights the methodological contributions of this research, as well as methodological improvements and practical considerations to compliment these contributions based on reflections of this research. First, as the Sections 7.3.1 and 7.5.1 help to highlight, the Story Map is an example of how an iterative study can be used to create an effective visualization. This was the visualization created in the study that was most directly based on participants' suggestions (see Section 5.3). This indicates that there is a benefit to engaging participants in the creation of visualizations, and prompting them to explain what they would like to see visualized. Participants were drawn to the Story Map because it was a visualization that they had previously stated they wanted to be shown, and the ability of Story Maps to show change via a sliding middle bar also drew their attention. Nonetheless, engagement takes time and, as was suggested in Section 7.4, can be improved by shortening time between instances of engagement and thus the overall process of decision-making (see Chapter 6). If the time between engagement can be reduced, the same result may be observed, or potentially a better perception of the visualizations and the process of engagement. In this way, resources are necessary to expedite this process; however, this study found a clear limitation that decision-making bodies may not have the required resources including funding, technology, and expertise.

Upon reflection, there are practical considerations in addition to the theoretical considerations that should be taken into account when utilizing a longitudinal study in the future. These practical considerations are meant to compliment the theoretical considerations discussed in Sections 7.5.1 and 7.5.2. This research advocates for the participation of

individuals in creating visualizations that will be used in decision-making processes. However, it is suggested, in time constrained situations, that visualizations are created showing various future options in order to save time. During the workshops the modification of the visualizations took longer than the allocated time. This could have potentially been avoided if participant views on what they would like to see visualized had been better anticipated, and visualizations could have been prepared with different future scenarios for discussion. These anticipated features, such as housing developments, roads, or options for coastal management can be used after discussing future options with participants, so as to not influence the discussion about future change. Another option would be to create pre-made features like housing development that could be transferred to other locations in on the visualization more easily. Visualizations can also be created using platforms that are more suitable for real time editing of visualizations. Furthermore, more research using these criteria, shown in Figure 7.2, can be done to assess their usefulness in measuring the effectiveness of visualizations. This study relied primarily on qualitative data to evaluate the visualizations in relation to the criteria. Ideally, a sliding scale could be used in future research that participants could use to assess the visualizations based on the criteria themselves, for a more accurate representation of effectiveness. It is also suggested that research can still be done to further distinguish between preference for realism and detail, and the use of realism and detail in suiting the purpose of the visualization.

In addition to findings concerning the content and format of visualizations, another key finding of this research indicates the difficulty of engaging individuals who may not be inclined to participate. In this research nine individuals consistently participated throughout this study. This means that not only are the findings difficult to generalize for other locations; they are also not representative of the village. It is a possibility that others in the village may have found visualizations useful during the decision-making process; however, because of a lack of participation, this is still unknown. The current literature on participatory processes, discussed in Section 2.3, also discusses the various factors that could hinder engagement in decision-making. Participants suggested how to use the visualizations to engage more villagers in the discussions about future change. These included leaflets and presentations. This study utilized these methods when advertising participation for this study and they had little influence in increasing engagement. More successful was speaking with villagers on the day of events to see if they were available. Participants brought neighbours and partners to events, and this also helped increase engagement. However, there was no evidence to

suggest that these could lead to long-term engagement as few participants overall actively engaged in this study.

Another methodological contribution of this study is that it is currently the only one known to use the complete C2A framework to identify barriers to decision-making. Using various existing indexes, descriptions of the C2A stages, and the "Climateville" examples (see Section 3.3), questions were devised to identify barriers before and after the workshops and exhibition. Using these and supplementing them with qualitative responses, the use of the C2A framework showed that overall there was little change in the barriers identified. Reflecting on the use of C2A framework, as suggested in Section 7.5.1 it can be improved to better identify barriers relating to decision-making by incorporating the PAF. Furthermore, the surveys used to identify barriers relating to stages of the C2A framework can be improved by expanding the surveys to address multiple potential barriers at each stage with more questions. Longer surveys could potentially lead to greater fatigue mentioned in Section 7.4; however, more expansive surveys could also be an opportunity to shorten interviews or discussions by asking more pointed questions based on responses. Due to time constraints, this study used a maximum of two questions per stage, but this has been identified after data analysis to be a point of future improvement, see Section 3.3. Prior to using the surveys, it was understood that there would be limitations to using a shortened survey; however, it was decided that the discussions could help to supplement the identification of barriers related to the C2A framework. More questions for each stage of the C2A framework would allow for participants' movement through the framework to be more accurately measured. It is suggested that future uses of the C2A framework can use modified statements or questions from tested indices like the BSCI in order to facilitate and accurately measure participant responses. However, these recommendations may not necessarily lead to better understanding of barriers alone. There were several instances where a change in response could have been affected by current events, i.e. news relating to the new village hall. In this case, the qualitative data collected during this research served to usefully support the quantitative data and provide valuable context.

The C2A statements were analysed using Categorical Principal Component Analysis (CATPCA) to create vignettes (shown in Figures 6.2-6.5) on discussions and comments from participants during the interviews, focus groups, and workshops. The vignettes were similar to those depicted in "Climateville" from Sheppard (2012). These findings indicate views of those engaged in the study, but also highlights that there are others which were unable to be characterized accurately due to non-participation. These findings can help individuals or

organizations wishing to engage local communities in decision-making by understanding the potential barriers that could be found in coastal communities dealing with change and the views they may have on these.

There are further implications for management that can be drawn from these findings. Participants in this study frequently cited visible changes to the landscapes when discussing future change, either as a concern or as a future change they believed would be most beneficial for the village. In this way, visualizations can be used as a tool for planners to show present and future changes so that publics can see a variety of future scenarios that are based on the different suggestions from the publics, and so that publics can express what they would like to see visualized. The engagement of publics in planning is already being implemented in the UK through the integration of working groups with local communities during the revising of the Shoreline Management Plans (Environment Agency, 2018). This study could help to inform future methods for managers and planners to engage with publics in landscape planning. It is also suggested that this research could be used in the more general context of the management of environmental changes. One of the interesting findings from this research is that participation and experience in decision-making does not result in trust in information provided (see Section 4.4.3). In this way, it is recommended that managers work closely with communities and not discount the effect of local knowledge and experiences in participants' responses for the sake of saving on resources, e.g. time, expertise, and funding.

7. 6 Future work

In this section future work is discussed, drawing on the empirical chapters and the previous sections. This section also makes suggestions for future work upon reflection of what could be done differently, and recommends steps that could be taken in order to gain a better understanding of the roles of visualizations in decision-making processes. There are a number of gaps in the current body of knowledge of utilizing visualizations in decision-making processes, that may emerge due to the complex and creative nature of the research process.

This research found that the visualization effectiveness criteria used in this study initially were not specific enough. Therefore, this thesis invites researchers and practitioners to test and trial the guide outlined in Figure 7.2 to examine the usefulness of the proposed criteria in evaluating the effectiveness of visualizations.

Furthermore, the success of the Story Maps also leads to the consideration that more research into the use of this online platform in decision-making processes may be worthwhile to understand the role of this format and of the technology in making this an effective visualization. Some tools of the Story Map were not fully utilized in this study; these could be used in future studies, for example to improve geolocation. Moreover, since the start of this research studies using new techniques to engage individuals using visualizations have been undertaken (e.g. Orland *et al.*, 2018 (augmented reality) and Wissen *et al.*, 2018 (audio)). This thesis suggests that there be more research into visualization platforms that would allow individuals to have greater input into the creation of visualizations. This could be through more intuitive forms of technology and software being used, or time allotted to teach participants to use the platform to create their own visualizations. This study found that measuring effectiveness using qualitative responses enabled discussions of participants' feeling about the effectiveness of the visualizations. Thus, it is suggested that future studies evaluating the effectiveness of visualizations utilize mixed methods, i.e. discussions and surveys, a co-production of options, and tools such as sliding scales in order to have a better understanding of the differences between participants, but not lose the rich context of their perceptions of the visualizations.

One of the criticisms by participants about the overall process of engaging in this project over two years, was that they felt it could have been shortened, see Section 7.4. For this reason, it is suggested that future research aim to shorten the time between engaging participants in order to potentially improve participants' overall experience and to maintain participation throughout a study. This could be achieved if there are adequate resources including expertise, technology, and funding. It is also recommended that there be future case studies that can evaluate this methodology using different types of visualizations to understand the role that the type of visualizations used in a case study will have in participants' experience engaging in decision-making. An example of this could include different groups of individuals of a similar make-up, in the same location engaging with different types of visualizations, i.e. maps or 3D images. Furthermore, the literature showed that there are differences in the measures used to evaluate the effectiveness of visualizations. However, it is also suggested that in order to understand the effectiveness of visualizations, researchers using visualizations in decision-making may perhaps use similar methods of engaging individuals so that there can be greater comparison across the field of landscape visualization. This is dependent on the situation that visualizations are used in as there may

not be the necessary resources available to conduct a similar study, i.e. studies that are longitudinal and iterative.

This thesis has drawn upon various fields of literature pertaining to decision-making and engagement. The findings suggest the usefulness of visualizations in creating future scenarios with the aid of local publics; however, it also highlights the importance of an iterative methodology when creating visualizations, an aspect that still has little research. The lack of participation from the larger population in the village is a limitation that will benefit from more research done to understand the implications of visualization in a participatory decision-making process, and whether using visualizations to increase participation is even possible in certain cases. The integration of the methods used in this case study to engage publics in decision-making in ongoing or planned environmental management projects could also further our understanding of how the integration of visualizations in an actual planning situation would be received. This study did not have a direct connection with those that would be able to implement proposed future options- which highlighted the importance of having better communication and connections with the institutions responsible for enacting decisions. Currently, the Environment Agency in the UK has been working towards better engagement of publics in decision-making processes relating to flooding and erosion through the design of community engagement programmes (currently on-going) (Kelly and Kelly, 2019). Furthermore, this thesis suggests that if this methodology is utilized in different contexts of environmental change, the actual effectiveness of this type of engagement could be better understood and potentially made as common practices among planners and managers. This suggestion is in agreement with the literature on participation and engagement, in that it highlights the importance of empowering communities through participation, thus creating greater feelings of efficacy (Few *et al.*, 2007; Milligan *et al.*, 2009, Muro, 2012; Blunkell, 2016). Section 2.3 discussed some of the considerations of participatory processes, including being clear on the purpose of participation and inclusion without setting misleading expectations (Few *et al.*, 2007).

7.7 Conclusions

This thesis concludes that visualizations have the potential to improve decision-making processes by facilitating learning and understanding, and can promote positive perceptions of opportunities to address future environmental changes. The key findings of this thesis are:

- Individuals will have varied experiences and views about where they live and the future. Engagement is challenging as external and internal (i.e. personal)

considerations that affect the way an individual perceives their physical and social environment.

- Visualizations can engage individuals in discussing and creating future scenarios for change, and incorporate local knowledge that may increase the successful implementation of future changes. Visualizations which are created with more input tend to be more positively viewed than those produced with less direct input and uptake of ideas. Therefore, iterative processes of engaging individuals in decision-making can make the production and use of visualizations more effective.
- Iterative and longitudinal studies are useful in the creation of visualizations, and reflections on perceptions of future changes; however, there are still improvements that can be made with increasing expertise and more advanced technology that will make the time engaging with individuals more effective, i.e. more focused and less resources intensive, and potentially avoid participation fatigue.
- Participatory decision-making processes can benefit by engaging with a variety of individuals when considering proposals for future changes to a landscape, and the process of creating and using visualizations can be the catalyst for discussions about the future.

The findings in this thesis show that the use of visualizations was perceived positively by participants in this study. It also showed that resources are necessary to engage individuals in a longitudinal study, and if visualizations are to be utilized in the decision-making process. On the other hand, this study showed that this novel method of engaging participants in the creation of visualization generated a variety of ideas for future options as well as constructive discussion about their feasibility. Discussions with participants also highlighted the importance and relevance of local knowledge and experience in the development of future options in that they could cite personal experiences and opinions as to why options may or may not be feasible options in the village. Furthermore, participants developed their ideas over time, and contributed and learnt from the group discussions. The benefits of engaging participants several times in order to create and evaluate visualizations of future options can be valuable in fostering trust among the participants, developing coherent and accepted options of future solutions to a changing environment, including the physical and social landscapes, and providing enhanced opportunities to discuss the complexity of implementing the options available.

Bibliography

1:2,500 County Series 1st Revision [TIFF geospatial data], Scale 1:2500, Tiles: norf-tg2637-2,norf-tg2638-2,norf-tg2639-2,norf-tg2737-2,norf-tg2738-2,norf-tg2739-2,norf-tg2837-2,norf-tg2838-2,norf-tg2839-2, Updated: 30 November 2010, Historic, Using: EDINA Historic Digimap Service, <http://digimap.edina.ac.uk>, Downloaded: 2016-07-25 13:30:31.961

3D Nature [Visual Nature Studio 3]. (Version 3.05, 2009). AlphaPixel LLC. Evergreen, CO, USA. Retrieved from homepage: https://www.3dnature.com/

Abdi, H., & Williams, L. J. (2010). Principal component analysis. *Wiley interdisciplinary reviews: computational statistics*, 2(4), 433-459.

Adger, W. N., Lorenzoni, I., & O'Brien, K. L. (2009). Chapter 1: Adaptation Now.In: Adapting to climate change: Thresholds, values, governance; Adger, Lorenzoni and O'Brien (eds). *Cambridge University Press*, Cambridge.

Adger, W. N., Lorenzoni, I., & O'Brien, K. L. (eds.). (2009). Adapting to climate change: Thresholds, values, governance. *Cambridge University Press*, Cambridge.

Allen, W. L. (2018). Visual brokerage: Communicating data and research through visualisation. *Public Understanding of Science*, 27(8), 906-922.

Appleton, K., & Lovett, A. (2003). GIS-based visualisation of rural landscapes: defining 'sufficient'realism for environmental decision-making. *Landscape and Urban Planning*, 65(3), 117-131.

Appleton, K., Lovett, A., Sünnenberg, G., & Dockerty, T. (2002). Rural landscape visualisation from GIS databases: a comparison of approaches, options and problems. *Computers, Environment and Urban Systems*, 26(2-3), 141-162.

Aversano, G., Parra-Alvarez, J. C., Isaac, B. J., Smith, S. T., Coussement, A., Gicquel, O., & Parente, A. (2019). PCA and Kriging for the efficient exploration of consistency regions in Uncertainty Quantification. *Proceedings of the Combustion Institute*, 37(4), 4461-4469.

Aytur, S. A., Hecht, J. S., & Kirshen, P. (2015). Aligning climate change adaptation planning with adaptive governance: Lessons from Exeter, NH. *Journal of Contemporary Water Research & Education*, 155(1), 83-98.

Baker, S., (2016) Sustainable Development. Routledge. New York, USA.

Barter C, Renold E. (1999) The Use of Vignettes in Qualitative Research. Social Research Update, 25, *University of Surrey*. Retrieved from: http://sru.soc.surrey.ac.uk/SRU25.html Accessed on: July 30, 2019

Beierle, T. C. (1998). Public participation in environmental decisions: an evaluation framework using social goals. Washington, DC: Resources for the Future.

Betsch, C., Ulshöfer, C., Renkewitz, F., & Betsch, T. (2011). The influence of narrative v. statistical information on perceiving vaccination risks. *Medical Decision Making*, 31(5), 742-753.

Biesbroek, G. R., Klostermann, J. E., Termeer, C. J., & Kabat, P. (2013). On the nature of barriers to climate change adaptation. *Regional Environmental Change*, 13(5), 1119-1129.

Bishop, I. D. (2015). Location based information to support understanding of landscape futures. *Landscape and Urban Planning*, 142, 120-131.

Bishop, I. D., Pettit, C. J., Sheth, F., & Sharma, S. (2013). Evaluation of data visualisation options for land-use policy and decision making in response to climate change. *Environment and Planning B: Planning and Design*, 40(2), 213-233.

Blunkell, C. T. (2017). Local participation in coastal adaptation decisions in the UK: between promise and reality, Local Environment, 22:4, 492-507, DOI: 10.1080/13549839.2016.1233525

Braun, B. and Clarke, V. (2006). Using thematic analysis in psychology, Qualitative Research in Psychology, 3:2, 77-101

Brown, I., Jude, S., Koukoulas, S., Nicholls, R., Dickson, M., & Walkden, M. (2006). Dynamic simulation and visualisation of coastal erosion. *Computers, environment and urban systems*, 30(6), 840-860.

Bryman, A. (2016). Social research methods. *Oxford university press*. Oxford, UK.

Burgess, J., & Chilvers, J. (2006). Upping the ante: a conceptual framework for designing and evaluating participatory technology assessments. *Science and Public Policy*, 33(10), 713-728.

Burgess, J., & Chilvers, J. (2006). Upping the ante: a conceptual framework for designing and evaluating participatory technology assessments. *Science and Public Policy*, 33(10), 713-728.

Burr, V. (2015). Social Constructionism. *International Encyclopaedia of the Social and Behavioural Sciences*, 2(22), 222-227.

Capstick, S., Whitmarsh, L., Poortinga, W., Pidgeon, N., & Upham, P. (2015). International trends in public perceptions of climate change over the past quarter century. *Wiley Interdisciplinary Reviews: Climate Change*, 6(1), 35-61.

Cawley, L. and Daniel, R. (2013, January 30). 1953 flood: How UK defences compare with the Netherlands. Retrieved from: https://www.bbc.co.uk/news/uk-england-essex-21258217 . Accessed on: 29 June 2017

Chilvers, J., & Longhurst, N. (2016). Participation in transition (s): reconceiving public engagements in energy transitions as co-produced, emergent and diverse. *Journal of Environmental Policy & Planning*, 18(5), 585-607.

Chou, W. Y. S., Hunt, Y. M., Beckjord, E. B., Moser, R. P., & Hesse, B. W. (2009). Social media use in the United States: implications for health communication. *Journal of medical Internet research*, 11(4).

Clayton, S., Devine-Wright, P., Stern, P. C., Whitmarsh, L., Carrico, A., Steg, L., Swim, J., & Bonnes, M. (2015). Psychological research and global climate change. *Nature Climate Change*, 5(7), 640.

Coastal Protection Act 1949. CHAPTER 74 12 13 and 14 Geo 6. (UK). Retrieved from: http://www.legislation.gov.uk/ukpga/Geo6/12-13-14/74. Accessed on: 17 August 2018

Committee on Climate Change (2016). UK Climate Change Risk Assessment 2017 Evidence Report. Retrieved from: www.theccc.org.uk/UK-climate-change-risk-assessment-2017/

Committee on Climate Change (2018) Managing the coast in a changing climate. Retrieved from: https://www.theccc.org.uk/wp-content/uploads/2018/10/Managing-the-coast-in-a-changing-climate-October-2018.pdf

Curtin, R., & Prellezo, R. (2010). Understanding marine ecosystem based management: a literature review. *Marine Policy*, 34(5), 821-830.

Davidson, N. C., Laffoley, D. D. A., Doody, J. P., Way, L. S., Gordon, J., Key, R., Pienkowski, M.W., Mitchell, R., & Duff, K. L. (1991). Nature conservation and estuaries in Great Britain. *Nature Conservancy Council*, Peterborough, 1-76.

Day, S. A., O'Riordan, T., Bryson, J., Frew, P., & Young, R. (2015). Many stakeholders, multiple perspectives: Long-term planning for a future coast. In Broad Scale Coastal Simulation (pp. 299-323). *Springer*, Dordrecht.

DEFRA (2015, August 23). Department for Environment, Food, and Rural Affairs: About Us. Retrieved from: https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs/about . Accessed on: 29 June 2017

DEFRA. (2005). Making Space for Water: Taking Forward a New Government Strategy for Flood and Coastal Erosion Risk Management in England. First Government Response to the Autumn 2004 Making Space for Water Consultation Exercise. *Department for Environment, Food and Rural Affairs*, London. Retrieved from: http://coastaladaptationresources.org/PDF-files/1329-Making-space-for-water.pdf Accessed on: 20 August 2018

DEFRA. (2017). Central Government Funding for Flood and Coastal Erosion Risk Management in England. *Department for Environment, Food and Rural Affairs*, London.

Demski, C., Capstick, S., Pidgeon, N., Sposato, R. G., & Spence, A. (2017). Experience of extreme weather affects climate change mitigation and adaptation responses. *Climatic Change*, 140(2), 149-164.

Devine-Wright, P. (2009). Rethinking NIMBYism: The role of place attachment and place identity in explaining place-protective action. *Journal of community & applied social psychology*, 19(6), 426-441.

Devine-Wright, P. (2013). Think global, act local? The relevance of place attachments and place identities in a climate changed world. *Global Environmental Change*, 23(1), 61-69.

Eastern Daily Press. (1977, February 2). Sea wall contract totals £600,000. *Eastern Daily Press.*

Eastern Daily Press. (1981, May 4). £618,000 sewer to protect cliffs. *Eastern Daily Press.*

Eastern Daily Press. (1987, December 10). Village fury at objection to defences. *Eastern Daily Press.*

Edwards, S. D., Jones, P. J., & Nowell, D. E. (1997). Participation in coastal zone management initiatives: a review and analysis of examples from the UK. *Ocean & Coastal Management*, 36(1-3), 143-165.

Eisenack, K., Moser, S. C., Hoffmann, E., Klein, R. J., Oberlack, C., Pechan, A., Rotter, M., & Termeer, C. J. (2014). Explaining and overcoming barriers to climate change adaptation. *Nature Climate Change*, 4(10), 867.

Ekstrom, J. & Moser, S. (2013). Institutions as key element to successful climate adaptation processes: Results from the San Francisco Bay Area. Successful Adaptation to Climate Change: Linking Science and Policy in a Rapidly Changing World. 97-113.

Ekstrom, J. A., & Moser, S. C. (2014). Identifying and overcoming barriers in urban climate adaptation: case study findings from the San Francisco Bay Area, California, USA. *Urban climate*, 9, 54-74.

Ekstrom, J. A., Moser, S. C., & Torn, M. (2011). Barriers to adaptation: a diagnostic framework. Rep. CEC-500-2011-004, *California Energy Commission*, Sacramento, CA.

Ellis, G., & Dix, A. (2006, May). An explorative analysis of user evaluation studies in information visualisation. *In Proceedings of the 2006 AVI workshop on BEyond time and errors: novel evaluation methods for information visualization* (pp. 1-7). ACM.

Environment Agency. (2012).Shoreline Management Plan (SMP): Kelling to Lowestoft Ness. *AECOM*. Altrincham, UK.

Environment Agency. (2012, March 1). Environment Agency: About Us. Retrieved from: https://www.gov.uk/government/organisations/environment-agency/about. Accessed on: 29 June 2017

Environment Agency. (2018). Anglian (Eastern) Regional Flood & Coastal Committee: Friday 20 July 2018 at 09.30am. *Environment Agency*. Peterborough, UK.

Environment Agency. (2019). Anglian (Eastern) Regional Flood & Coastal Committee: Friday 18 October 2019 at 09.30am. *Environment Agency*. Peterborough, UK.

European Environment Agency. (2006). The changing faces of Europe's coastal areas. *Office for Official Publ. of the Europe*. Communities.

European Environment Agency. (2019, March 19). Europe's Seas and Coasts. Retrieved from: www.eea.europa.eu/themes/water/europes-seas-and-coasts/europes-seas-and-coasts. Accessed on: 18 July 2018.

Fenn, T., Daly, E., Miller, J., Elding, C., Clarke, C. Guthrie, G., Hick, E., Frew, P., Silson, R., Hickling, D. (2015). Adapting to Coastal Erosion: Evaluation of rollback and leaseback schemes in Coastal Change Pathfinder projects. *Department for Environment, Food and Rural Affairs.* London, UK.

Few, R., Brown, K., & Tompkins, E. L. (2007). Public participation and climate change adaptation: avoiding the illusion of inclusion. *Climate policy*, 7(1), 46-59.

Flinders, M., Ghose, K., Jennings, W., Molloy, E., Prosser, B., Renwick, A., Smith, G., & Spada, P. (2016). Democracy matters: Lessons from the 2015 Citizens' Assemblies on English devolution.

Frost, J., Gibson, A., Harris-Golesworthy, F., Harris, J., & Britten, N. (2018). Patient involvement in qualitative data analysis in a trial of a patient-centred intervention: Reconciling lay knowledge and scientific method. *Health Expectations*, 21(6), 1111-1121.

Geaves, L. H., & Penning-Rowsell, E. C. (2016). Flood risk management as a public or a private good, and the implications for stakeholder engagement. *Environmental Science & Policy*, 55, 281-291.

Gill, L., Lange, E., Morgan, E., & Romano, D. (2013). An analysis of usage of different types of visualisation media within a collaborative planning workshop environment. Environment and Planning B: Planning and Design, 40(4), 742-754.

Guba, E. G., and Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of qualitative research*, 2(163-194), 105.

Haines-Young, R. and Potschin M. (2011). Integrated Coastal Zone Management and the Ecosystem Approach. Deliverable D2.1, PEGASO Grant agreement nº: 244170. CEM Working Paper No 7.

Harwood, A. R., Lovett, A. A., & Turner, J. A. (2015). Customising virtual globe tours to enhance community awareness of local landscape benefits. *Landscape and Urban Planning*, 142, 106-119.

Hawcroft, L. J., & Milfont, T. L. (2010). The use (and abuse) of the new environmental paradigm scale over the last 30 years: A meta-analysis. *Journal of Environmental psychology*, 30(2), 143-158.

Head, B. W. (2007). Community engagement: participation on whose terms?. *Australian Journal of Political Science*, 42(3), 441-454.

Heim, M. (1998). Virtual Realism. New York: *Oxford University Press*. Retrieved from: https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=151385&authtype=sso&custid=s8993828&site=eds-live&scope=site

Hernández, B., Hidalgo, M. C., Salazar-Laplace, M. E., & Hess, S. (2007). Place attachment and place identity in natives and non-natives. *Journal of environmental psychology*, 27(4), 310-319.

Hertting, N., & Vedung, E. (2012). Purposes and criteria in network governance evaluation: How far does standard evaluation vocabulary takes us?. *Evaluation*, 18(1), 27-46.

Hines, J. (2010). The Coastal Handbook. A Guide for All Those Working on the Coast.

Houben, S., Golsteijn, C., Gallacher, S., Johnson, R., Bakker, S., Marquardt, N., Capra, L., & Rogers, Y. (2016, May). Physikit: Data engagement through physical ambient visualizations in the home. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (pp. 1608-1619). ACM.

IBM Corp. (Released 2017). IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.

IBM Knowledge Center. (2017). Categorical Principal Component Analysis (CATPCA). Retrieved from: https://www.ibm.com/support/knowledgecenter/en/SSLVMB_23.0.0/spss/categories/idh_cpca.html . Accessed on: 17 August 2018

IPCC (2014a). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. *IPCC*, Geneva, Switzerland, 151

IPCC, (2014b). Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. *Cambridge University Press*, Cambridge, United Kingdom and New York, NY, USA.

Jankowski, P. (2011). Chapter 18: Designing Public Participation Geographic Information Systems. The SAGE handbook of GIS and society. [Nyerges, T. L., Couclelis H., McMaster, R. (eds.)]. *SAGE publications*. London, UK.

Jordan, A. (2008). The governance of sustainable development: taking stock and looking forwards. *Environment and planning C: Government and policy*, 26(1), 17-33.

Jude, S. R., Jones, A. P., Brown, I., Watkinson, A. R., & Gill, J. A. (2007). The development of a visualization methodology for integrated coastal management. *Coastal Management*, 35(5), 525-544.

Jude, S., Mokrech, M., Walkden, M., Thomas, J., & Koukoulas, S. (2015). Visualising potential coastal change: communicating results using visualisation techniques. In Broad Scale Coastal Simulation (pp. 255-272). *Springer*, Dordrecht.

Kelly, R., & Kelly, U. (2019) Working together to adapt to a changing climate: flood and coast – evidence review. *Environment Agency*. Bristol, UK.

Kingston, R. (2011). Chapter 19: Online Public Participation GIS for spatial planning. The SAGE handbook of GIS and society. [Nyerges, T. L., Couclelis H., McMaster, R. (eds.)]. *SAGE publications*. London, UK.

Knight, C. (2001, June). Visualisation effectiveness. In 2001 International Conference on Imaging Science, Systems, and Technology (CISST 2001) (pp. 249-254).

Kovats, R. S., Valentini, R., Bouwer, L.M., Georgopoulou, E., Jacob, D., Martin, E., Rounsevell, M., & Soussana, J. F., (2014). Europe. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. *Cambridge University Press*, Cambridge, United Kingdom and New York, NY, USA, 1267-1326.

Land Use Consultants. (2006). Review and evaluation of heritage coasts in England: Executive summary. Report to The Countryside Agency.

Lange, E. (2001). The limits of realism: perceptions of virtual landscapes. *Landscape and urban planning*, 54(1-4), 163-182.

Lewis, J. L. (2012). More art than science: the sources and effects of stylistic variation in visualization for planning and design. Environment and Planning B: Planning and Design, 39(3), 551-565.

Liquete, C., Piroddi, C., Drakou, E. G., Gurney, L., Katsanevakis, S., Charef, A., & Egoh, B. (2013). Current status and future prospects for the assessment of marine and coastal ecosystem services: a systematic review. *PloS one*, 8(7), e67737.

Lopez De San Roman Blanco, B., Woods Ballard, B., Simm, J., Brampton, A., Sutherland, J., Gouldby, B., and Rossington, K., (2019). Delivering benefits through evidence: Coastal morphological modelling for decision-makers. *Environment Agency*, Bristol, UK.

Lowe, J. A., Howard, T. P., Pardaens, A., Tinker, J., Holt, J., Wakelin, S., Milne, G., Leake, J., Wolf, J., Horsburgh, K., Reeder, T., Jenkins, G., Ridley, J., Dye, S., & Bradley, S. (2009). UK Climate Projections science report: Marine and coastal projections. *Met Office Hadley Centre*, Exeter, UK.

McBride, B.B., Sanchez-Trigueros, F., Carver, S. J., Watson, A.E., Stumpff, L.M., Matt, R., Borrie, W.T. (2017). Participatory Geographic Information Systems as an Organizational Platform for the Integration of Traditional and Scientific Knowledge

in Contemporary Fire and Fuels Management, *Journal of Forestry*, Volume 115, Issue 1, 1 January 2017, Pages 43–50.

McEwen, L. (2011). Approaches to Community Flood Science Engagement. *International Journal of Science in Society*. 2.

Mcgrath, J. E. (1994). Methodology Matters: Doing Research in the Behavioral and Social Sciences. 152-169.

Meadows, D. H., Meadows, D. L., & Randers, J. (1992). Beyond the limits: global collapse or a sustainable future. *Earthscan Publications Ltd*..

Meulman, J. J. & Heiser W. J. (2011). IBM SPSS Categories 20. IBM: https://www.csun.edu/sites/default/files/categories20-64bit.pdf

Milfont, T. L. (2012). The interplay between knowledge, perceived efficacy, and concern about global warming and climate change: a one-year longitudinal study. *Risk Analysis: An International Journal*, 32(6), 1003-1020.

Milligan, J. & O'riordan, T. (2007). 'Governance for Sustainable Coastal Futures', *Coastal Management*, 35: 4, 499 — 509.

Milligan, J., Riordan, T. O., Nicholson-cole, S. A. and Watkinson, A. R. (2009). Nature conservation for future sustainable shorelines: Lessons from seeking to involve the public. *Land use policy*, 26, 203–213.

Ministry of Housing, Communities and Local Government (2018). National planning policy framework. Presnted by the Secretary of State for Ministry of Housing, Communities and Local Government. July 2018. Accessed at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/733637/National_Planning_Policy_Framework_web_accessible_version.pdf Accessed on: August 20, 2018

Mokrech, M., Hanson, S., Nicholls, R. J., Wolf, J., Walkden, M., Fontaine, C. M., Sophie Nicholson-Cole, S., Jude, S. R., Leake, J., Stansby, P., Watkinson, A. R., Rounsevell, M. D. A., Lowe, J. A., Hall J. W. (2011). The Tyndall coastal simulator. *Journal of Coastal Conservation*, 15(3), 325-335.

Mokrech, M., Nicholls, R. J., Day, S. A., Dawson, R. J., Jude, S., & Koukoulas, S. (2015). GIS Platforms for Managing, Accessing and Integrating Model Results: The Tyndall Coastal Simulator Experience. In Broad Scale Coastal Simulation (pp. 273-298). *Springer*, Dordrecht.

Moores, AJ. and Rees, JG. (eds.) (2011). UK Flood and Coastal Erosion Risk Management Research Strategy. *Living With Environmental Change*

Moser, S. C. (2010). Communicating climate change: history, challenges, process and future directions. *WIREs Clim*. Chang. 1, 31–53.

Moser, S. C. (2016). Reflections on climate change communication research and practice in the second decade of the 21st century: what more is there to say?. *Wiley Interdisciplinary Reviews: Climate Change*, 7(3), 345-369.

Moser, S. C. and Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *PNAS* 107, 22026–22031

Muro, M., Hrudey, S. E., Jude, S., Heath, L., & Pollard, S. (2012). Making it real: what risk managers should know about community engagement. *Journal of Environmental Assessment Policy and Management*, 14(02).

National Lottery Community Fund. (2017, May 25). Trimingham matters- building a new village hall. Retrieved from: https://www.tnlcommunityfund.org.uk/funding/grants/0031049577. Accessed on: 08 November 2019.

National Trust, A Few Facts about the Coastline We Care For. Retrieved from: www.nationaltrust.org.uk/features/a-few-facts-about-the-coastline-we-care-for Accessed on: 29 June 2017

Natural England. (2013). Guidance: Sites of special scientific interest: managing your land. Land management. Retrieved from: https://www.gov.uk/guidance/protected-areas-sites-of-special-scientific-interest Accessed on: 16 January 2018

Natural England. (2017). Guidance: Areas of outstanding natural beauty (AONBs): designation and management. Landscape. Retrieved from: https://www.gov.uk/guidance/areas-of-outstanding-natural-beauty-aonbs-designation-and-management Accessed on: 16 January 2018

Natural England. (2018, May 17). SW12: Making space for water. Retrieved from: https://www.gov.uk/countryside-stewardship-grants/making-space-for-water-sw12. Accessed on: 20 August 2018

Nelson, D. R., Adger, W. N., & Brown, K. (2007). Adaptation to environmental change: contributions of a resilience framework. *Annual review of Environment and Resources*, 32.

Nicholls, R. J., Dawson, R. J., Day, S. A., Walkden, M., Watkinson, A. R., Tarrant, O., Hall, J. W. & Frew, P. (2015). Integrated coastal assessment: The way forward. In Broad Scale Coastal Simulation (pp. 349-378). *Springer*, Dordrecht.

Nicholson-Cole, S. A. (2005). Representing climate change futures: a critique on the use of images for visual communication. *Computers, environment and urban systems*, 29(3), 255-273.

Ning, C., & You, F. (2018). Data-driven decision making under uncertainty integrating robust optimization with principal component analysis and kernel smoothing methods. *Computers & Chemical Engineering*, 112, 190-210.

North Norfolk District Council. (2008). Core Strategy: Incorporating Development Control Policies. Local Development Framework. North Norfolk District Council, Cromer, UK. Retrieved from: https://www.north-norfolk.gov.uk/media/1370/3-_core_strategy_-incorporating_development_control_policies-_adopted_2008_-updated_2012.pdf . Accessed on: 26 July 2017

North Norfolk District Council. (2010). North Norfolk Pathfinder: Trimingham. Retrieved from: http://www.northnorfolk.org/pathfinder/trimingham.asp . Accessed on: 26 July 2017.

North Norfolk District Council. (2012). Glossary. Shoreline Management Plan 6: Kelling Hard to Lowestoft Ness. Retrieved from: https://www2.north-norfolk.gov.uk/smp6/glossary.html#C Accessed on: October 15, 2018

North Norfolk District Council. (2013). Kelling to Lowestoft Ness Shoreline Management Plan: Strategic Environmental Assessment – Volume 2 Environmental Report. Retrieved from: https://www2.north-norfolk.gov.uk/smp6/files/KLN_SMP_SEA_Vol2_Environmental_Report-final.pdf Accessed on: March 08, 2019

North Norfolk News (1965, March 26). Residence Collapses with Cliff. *North Norfolk News.*

O'Neill, S., & Nicholson-Cole, S. (2009). "Fear won't do it" promoting positive engagement with climate change through visual and iconic representations. *Science Communication*, 30(3), 355-379.

O'Riordan, T., Wood, C., & Shadrake, A. (1993). Landscapes for tomorrow. *Journal of Environmental Planning and Management*, 36(2), 123-147.

Orland, B., Taylor, M., Mazurczyk, T., Welch-Devine, M., Goldberg, L., Scales, M. C., Murtha, T., & Calabria, J. (2018). Augmented Reality and the Scenic Drive. *Journal of Digital Landscape Architecture*, 140-149.

OS MasterMap® Topography Layer [FileGeoDatabase geospatial data], Scale 1:1,250, Tiles: GB, Updated: 7 January 2016, Ordnance Survey (GB), Using: EDINA Digimap Ordnance Survey Service, <http://digimap.edina.ac.uk>, Downloaded: 2016-07-08 16:38:57.413

OS Terrain 50 [ASC geospatial data], Scale 1:50000, Tiles: tg23,tg24,tg33, Updated: 2 August 2016, Ordnance Survey (GB), Using: EDINA Digimap Ordnance Survey Service, <http://digimap.edina.ac.uk>, Downloaded: 2017-05-31 13:44:41.42

Parliamentary Office of Science and Technology (POST). (2009). POSTnote: Coastal Management. October 2009. 342. London, UK. Retrieved from: https://www.parliament.uk/documents/post/postpn342.pdf

Penning-Rowsell, E. C., & Johnson, C. (2015). The ebb and flow of power: British flood risk management and the politics of scale. *Geoforum*, 62, 131-142.

Pettit, C., Bishop, I., Sposito, V., Aurambout, J. P., & Sheth, F. (2012). Developing a multi-scale visualisation framework for use in climate change response. *Landscape ecology*, 27(4), 487-508.

Pickaver, A. H., Gilbert, C., & Breton, F. (2004). An indicator set to measure the progress in the implementation of integrated coastal zone management in Europe. *Ocean & Coastal Management*, 47(9-10), 449-462.

Plaisant, C. (2004, May). The challenge of information visualization evaluation. In Proceedings of the working conference on Advanced visual interfaces (pp. 109-116). ACM.

Poumadere, M., Bertoldo, R., Idier, D., Mallet, C., Oliveros, C., & Robin, M. (2015). Coastal vulnerabilities under the deliberation of stakeholders: The case of two French sandy beaches. *Ocean & Coastal Management*, 105, 166-176.

Preece, D., Williams, S. B., Lam, R., & Weller, R. (2013). "Let's get physical": advantages of a physical model over 3D computer models and textbooks in learning imaging anatomy. *Anatomical sciences education*, 6(4), 216-224.

QSR International Pty Ltd. (2014). NVivo qualitative data analysis software. Version 11.

Quinn, T. (2013). The role of place attachment in proactive and reactive adaptation to flood risk. PhD Thesis. *University of East Anglia*, UK.

Quinn, T., Lorenzoni, I., & Adger, W. N. (2015). Place attachment, identity and adaptation. In: The Adaptive Challenge of Climate Change. *Cambridge University Press*, Cambridge, UK. 160-170.

Reker, J., Belchior, C. C., & Gelabert, E.R. (2017) EEA Report No 2/2015: State of Europe's Seas. European Environment Agency. [ed. O'oherty, J.J.] *Publications Office of the European.* Luxembourg Retrieved from: https://www.eea.europa.eu/publications/state-of-europes-seas

Renn, O. (2008). Risk governance: coping with uncertainty in a complex world. *Earthscan*. (Oxon, Routedge)

Robson, C., & McCartan, K. (2016). Real world research. *John Wiley & Sons*.

Rowley, J. (2002). Using case studies in research. *Management research news*, 25(1), 16-27.

Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International journal of services sciences*, 1(1), 83-98.

Salomon, J. A., Tandon, A., & Murray, C. J. (2001). Using vignettes to improve cross-population comparability of health surveys: concepts, design, and evaluation techniques. *Global Programme on Evidence for Health Policy Discussion Paper,* 41.

Sayer, A. (2000). Realism and social science. *Sage*. London, UK.

Scannell, L., & Gifford, R. (2010). Defining place attachment: A tripartite organizing framework. *Journal of environmental psychology*, 30(1), 1-10.

Scannell, L., & Gifford, R. (2013). Personally relevant climate change: The role of place attachment and local versus global message framing in engagement. *Environment and Behavior*, 45(1), 60-85.

Schmidt, L., Gomes, C., Guerreiro, S., & O'Riordan, T. (2014). Are we all on the same boat? The challenge of adaptation facing Portuguese coastal communities: Risk perception, trust-building and genuine participation. *Land Use Policy*, 38, 355-365.

Schmidt, L., Prista, P., Saraiva, T., O'Riordan, T., & Gomes, C. (2013). Adapting governance for coastal change in Portugal. *Land Use Policy*, 31, 314-325.

Schroth, O., Pond, E., & Sheppard, S. R. (2015). Evaluating presentation formats of local climate change in community planning with regard to process and outcomes. *Landscape and Urban Planning*, 142, 147-158.

Scotland, J. (2012). Exploring the philosophical underpinnings of research: Relating ontology and epistemology to the methodology and methods of the scientific, interpretive, and critical research paradigms. *English Language Teaching*, 5(9), 9.

Sheng, Y. K. (2009). What is Good Governance? *United Nations Economic and Social Commission for Asia and the Pacific.* Bangkok, Thailand.

Sheppard, S. R. (2001). Guidance for crystal ball gazers: developing a code of ethics for landscape visualization. *Landscape and urban planning*, 54(1-4), 183-199.

Sheppard, S. R. (2015). Making climate change visible: A critical role for landscape professionals. *Landscape and Urban Planning*, 142, 95-105.

Sheppard, S. R. J. (2012). Visualizing Climate Change: A guide to Visual Communication of Climate Change Development and Local Solution. (Oxon, Routedge).

Sheppard, S. R., & Meitner, M. (2005). Using multi-criteria analysis and visualisation for sustainable forest management planning with stakeholder groups. *Forest ecology and management*, 207(1-2), 171-187.

Sheringham and Beeston Protection Act 1898. Acts of the Parliaments of the United Kingdom Part 111 (1898a) c.lxxiii (UK). Retrieved from: https://www.legislation.gov.uk/changes/chron-tables/local/111. Accessed on: 17 August 2018

Shipman, B., & Stojanovic, T. (2007). Facts, fictions, and failures of integrated coastal zone management in Europe. *Coastal Management*, 35(2-3), 375-398.

Slovic, P. (2000). The perception of risk. *Earthscan*. (Oxon, Routedge).

Smit, B., & Pilifosova, O. (2003). Adaptation to climate change in the context of sustainable development and equity. *Sustainable Development*, 8(9), 9. Retrieved from: http://www.ipcc.ch/ipccreports/tar/wg2/pdf/wg2TARchap18.pdf . Accessed on: 18 July 2018.

Sorensen, J. (1997). National and international efforts at integrated coastal management: definitions, achievements, and lessons. *Coastal management*, 25(1), 3-41.

Spencer, T., Brooks, S. M., Möller, I., & Evans, B. R. (2014). Where local matters: impacts of a major North Sea storm surge. *Eos, Transactions American Geophysical Union*, 95(30), 269-270.

Taigel, S., Lovett, A., & Appleton, K. J. (2014). Framing nature: Visualising ecosystem services using augmented reality. [Wissen HayekU. FrickerP. BuhmannE. (eds.)], Peer reviewed proceedings of digital landscape architecture at ETH Zurich, 292-299.

Retrieved from: https://www.geos.ed.ac.uk/~gisteac/proceedingsonline/GISRUK2013/ gisruk2013_submission_40.pdf . Accessed on: 20 August 2018.

Thornton, A., Evans, L., Bunt, K., Simon, A., King, S., & Webster, T. (2011). Climate change and transport choices. Segmentation Model–A framework for reducing CO2 emissions from personal travel.

Touili, N., Baztan, J., Vanderlinden, J. P., Kane, I. O., Diaz-Simal, P., & Pietrantoni, L. (2014). Public perception of engineering-based coastal flooding and erosion risk mitigation options: Lessons from three European coastal settings. *Coastal Engineering*, 87, 205-209.

Townley, G., & Kloos, B. (2011). Examining the psychological sense of community for individuals with serious mental illness residing in supported housing environments. *Community Mental Health Journal*, 47(4), 436-446.

Walton, J. (2011, February 17). The Victorian Seaside. Retrieved from: http://www.bbc.co.uk/history/british/victorians/seaside_01.shtml . Accessed on: 17 August 2018.

Weber, E. U. (2010). What Shapes Perceptions of Climate Change? *WIREs Clim*. Chang. 1, 332–342.

Weston, C., & Weston, S. (1994). Claimed by the Sea. *Wood Green Publications*. Norwich, UK.

Wetzelhütter, D., & Bacher, J. (2015). How to Measure Participation of Pupils at School. Analysis of Unfolding Data Based on Hart's Ladder of Participation. Methods, data, analyses, 9(1), 26.

White, W. (1864) History, gazetteer, and directory of Norfolk, and the city and county of the city of Norwich; comprising a general survey of the county of Norfolk, and the Diocese of Norwich; and separate historical, statistical, & topographical descriptions of all the hundreds, liberties, unions, boroughs, towns, ports, parishes, villages, hamlets, and manors and unions; the diocese of Norwich; the seats of the nobility and gentry; magistrates and public officers, and a great variety of archaeological, architectural, agricultural, biographical, botanical, geological, and ornithological information. *Simpkin, Marshall, and Co*. London, UK.

White, W. (1883). History, gazetteer and directory of Norfolk, including the city of Norwich, and comprising a general survey of the county and separate historical, statistical, and topographical descriptions of all the hundreds, boroughs, towns, ports, parishes, townships, chapelries, villages, hamlets, manors, and unions; the diocese of Norwich; the seats of the nobility and gentry; magistrates and public officers, and a great variety of archaeological, architectural, agricultural, biographical, botanical, geological, and ornithological information. *Simpkin, Marshall, and Co*. London, UK.

Wissen Hayek, U. (2011). Which is the appropriate 3D visualization type for participatory landscape planning workshops? A portfolio of their effectiveness. *Environment and Planning B: Planning and Design*, 38(5), 921-939.

Wissen Hayek, U., Endres, L., Spielhofer, R., & Grêt-Regamey, A. (2018). Sound ambiences consistent with visualizations of landscape types–An evaluation. *Journal of Digital Landscape Architecture*, (3), 172-180.

Wissen, U., Schroth, O., Lange, E. & Schmid, W. A. (2008). Approaches to integrating indicators into 3D landscape visualisations and their benefits for participative planning situations. 89, 184–196.

Appendix 1: Materials used in data collection

Note: The layout of the questionnaire and surveys in this appendix has been modified to margin requirement and does not reflect the original layout of those that were distributed. Pointed questions for individuals have been omitted in line with confidentiality and anonymity agreement.

A1.1: Exploratory Interview Questions

Can you tell me a little bit about Trimingham? What are some experiences you have had here?

What is your fondest memory of Trimingham? (Do you have a favourite memory in Trimingham?)

What do you like the best about living in Trimingham? (What is the most beautiful place in Trimingham?)

How long have you lived in Trimingham? →Why did you move here? →Why have you stayed in the village?

What are some changes that have occurred in the village? → What do you think is the main cause of the coastal change?

If you could make a postcard for Trimingham, what picture would you use and what would it say at the bottom?

How often do you take a stroll in the village? →Where do you usually walk?

What do you think Trimingham will look like in 10 years? →20 years?

What do you think is the most pressing issue Trimingham is currently facing?

Do you see coastal erosion as something that should be a priority of the village?

What do you think is the cause of the changing coast line?

How is village news communicated?

How familiar are you with different forms of technology? →How willing are you to try technology that you have not previously used?

Would you be interested to participate in a study aimed to facilitate discussion pertaining to an issue the community faces?

Do you know of anyone that you think would be interested to speak with me or participate in the study as well? →Are there any groups where I could meet people aged 18-40?

What days of the week and times are best for you to possible attend a focus group?

A1.2: Focus group Protocol

Coastal change in Norfolk: the contribution of visualizations to decision making

FOCUS GROUP PROTOCOL

Jacqueline Zavala (ENV/ UEA)

4 focus groups: Coastal change in Trimingham
Recruited via invitation and advertisement in local magazine *Crab Tales*
To be held for 1.5h

Note-taker: keep a record of which participant is speaking with brief notes of what they say – with a table plan. This is important for transcribing.

Welcome and introduction to the research ***10 mins***

Give [summary of the information sheet, consent form and] stickers for names.

Good morning/ afternoon / evening. Thank you for coming today, we appreciate you taking the time to come today and contribute to this work.

My name is Jackie Zavala. This is xxx who is helping me today. We are based at the School of Environmental Sciences at UEA in Norwich.

Regarding this research, we are interested in your views and experiences about the Village of Trimingham.

So the meeting today is about your views and opinions. We would like to discuss these in an open informal conversation among us all.

[FOR THOSE WHO HAVE NOT SIGNED A CONSENT FORM: I'd like you to firstly read through the consent form we have given you. If you are happy to do so, please sign the consent form and return it to us – this indicates you are willing to take part in this research.

Allow a few minutes for completion of all this paperwork for those that have not received a consent form already.]

Thank you.

Before we start, I'd like to mention that:

1. We are recording this discussion, so that we can have an accurate record of our conversations; xxxx is keeping hand-written notes just in case.
2. The details of our discussions today and next time will always remain confidential (only our team will use it) and if published will be made anonymous (names will be changed and any information that may identify you will be removed).

Are there any questions, comments, or concerns at this point?

I'd like to suggest some ground rules that we may like to follow during today's session:

- everybody's opinion is welcome;
- we value everyone's view,
- please feel free to share your views freely, and add to or disagree with what others are saying
- there are no right or wrong answers, we are interested in your personal views and opinions
- it would be very useful if you could speak clearly and one at a time, as this will make it easier to type up the conversation
- please respect the other participants' confidentiality by not repeating what other participants say outside this room without their permission, although you are welcome to discuss your own views and experience of this meeting with others.
- We'd like to keep this discussion to an hour and a half, no longer
- Tea / water / coffee and biscuits are available, please help yourselves,
- If at any point you need to use the facilities they are open and located over their [points to them].
- And emergency exits / facilities are located …

Make sure everyone has a nametag.

START [1.5h total]

General views of Trimingham *10* ***mins***

Let's begin by introducing ourselves. Please state your name, how long you have lived in Trimingham, and what you enjoy the most about the village. I will begin.

My name is ….

Now, to start off with, I would like all of you to draw the village as if you were making a map or giving me an overview of the village.

[Hands out bank pieces of paper]

Now I would like all of us to go around the circle and describe your drawings. → Are there any key aspects you'd like to draw attention to (e.g. any social or physical aspects you want to mention in particular?) [Ask each person individually to quickly point these out, briefly, 1 minute at a time]

Coastal Erosion **10** ***mins***

Since you have lived in the village, what sorts of changes have you noticed? → Have you noticed changes with the coastline? → Have you noticed changes within the community?

What is you biggest concern about the village now? → What about coastal change? What do you think about erosion of the beach / cliffs?

Future changes **30** ***mins***

How do you think the village will look like in the future? Why?

What would you like to see happen in the future? →What would be needed to make this happen?

What is preventing these changes that you would like to see from happening?

If they have mentioned erosion: what in your view is not allowing you / the village to deal with the changing coastline? What would be needed to overcome this (i.e. be able to adapt)?

Do you think pictorial representations of the village and surrounding area could help you think about the changes it has gone through and what it may look like in the future?

Would an image, video, or other visualization help you to understand the future changes that could occur in the village? → What key features should be included in this visualization?
Which do you think could help you to better understand what you can do in order to deal with coastal erosion?

Management of the coast **25 *mins***
How involved do you believe the community should be in thinking about and planning the future of the village?

What role you feel this project can play for you and for the village? →What is the goal you want to achieve together in this focus group?→ What would you prefer to see visualized for the next focus group? (Cliffs today, history of erosion, future possibilities for adaptation etc.).

Would you like to see any of these changes even where they may not be possible (e.g. develop the land) so that we can talk about them later? → What time scale would you like to see (past, present, future)?

Wrap up ***5 mins***
To wrap up our conversation, I would like everyone to turn the page that they used when we drew the village and turn it over to the blank side.

If you could please write down one or two things that you found interesting that came up during our discussion. [Wait for everyone to finish writing].

Thank you. If you could write down one or two things that you would want to see visualized the most. [wait]

Finally, Next, please write down 2 or three things that I could do to improve the next focus group.

"Thank you every one. Please help yourselves to tea and biscuits. I will be staying back for a bit longer if you want to speak with me. I will send you an email when the next focus group will be scheduled. I hope to see you all there. Please feel free to contact me if you have any questions or concerns about the project."

A1.2.1: Survey prior to focus group

Coastal change in Norfolk: the contribution of visualizations to decision making

Name		Date	

The following statements have to do with daily life in Trimingham. Please read each statement and indicate to what extent you agree or disagree with each statement on the 1 -5 scale. If you do not agree or disagree with the statement, then you would choose 3 (unsure).

	1 = strongly disagree	2 = disagree	3 = unsure	4= agree	5= strongly agree
Word of mouth is the most important source of information about coastal erosion.	☐	☐	☐	☐	☐
I am unsure of where to find local information on coastal change that is trustworthy.	☐	☐	☐	☐	☐
There are enough opportunities for people who have little time to discuss coastal erosion.	☐	☐	☐	☐	☐
Dealing with coastal erosion is not a priority for me.	☐	☐	☐	☐	☐
I feel I do not have enough relevant information about coastal change in Trimingham.	☐	☐	☐	☐	☐
The village should remain a peaceful and quiet place to live.	☐	☐	☐	☐	☐
There are areas in the village that are more at risk than others for coastal erosion.	☐	☐	☐	☐	☐
Coastal erosion affects or will affect my daily life within the next 5 years.	☐	☐	☐	☐	☐
There is a lack of community involvement in Trimingham when thinking of ways to deal with coastal change.	☐	☐	☐	☐	☐
The village should adapt and develop to deal with coastal change.	☐	☐	☐	☐	☐
Humans are meant to rule over the rest of nature.	☐	☐	☐	☐	☐
When humans interfere with nature it often produces disastrous consequences.	☐	☐	☐	☐	☐
Humans have the right to modify the natural environment to suit their needs.	☐	☐	☐	☐	☐
Despite our special abilities, humans are still subject to the laws of nature.	☐	☐	☐	☐	☐
The balance of nature is very delicate and easily upset.	☐	☐	☐	☐	☐
I am able to easily access information about coastal change in the local area.	☐	☐	☐	☐	☐
When the community knows what they want to achieve, the community is able to plan and implement a project.	☐	☐	☐	☐	☐

	1 = strongly disagree	2 = disagree	3 = unsure	4= agree	5= strongly agree
It is important for Trimingham to deal with coastal change in a positive, proactive manner.	☐	☐	☐	☐	☐
Funding issues can prevent small communities like Trimingham from implementing plans to deal with coastal erosion.	☐	☐	☐	☐	☐
I feel that there are ways that Trimingham can take positive action to overcome political barriers to deal with the changing coastline.	☐	☐	☐	☐	☐

Participant information					
Age *:*		**Gender:**	*Male / Female*	**Do you live in Trimingham?**	Yes / No
If yes, how long have you lived in Trimingham?					
If No, where do you currently live?					
Please use the space below if you have any comments:					

A1.3: Village questionnaire

Your personal views of Trimingham and living on the coast

Hello, I am a postgraduate researcher at the University of East Anglia in the school of Environmental Sciences. As part of my research, I am interested finding out about people's views about living in Trimingham which will be used to better inform the creation of visualizations to support discussions about the changing coastline in the village.

I would appreciate if you would complete this survey. Your answers will be kept strictly confidential and used only in anonymized form, this means you will not be identifiable from any analyses of the findings from the survey. All data collected from the survey will be stored in paper form in a locked cupboard at UEA and on my computer, password protected. The data will not be passed on to any third party and will only be shared in summary form with my supervisory team. The findings of this survey will be used in my thesis and any resulting publications. Your participation in this research is entirely voluntary. If at any time you wish to withdraw from this study, you may so without giving a reason. By completing and returning this survey, you are consenting to take part in this research by allowing me to use the information from this survey.

If you have any questions, please contact me by email at J.Zavala@uea.ac.uk or you can contact my research supervisor Irene Lorenzoni at i.lorenzoni@uea.ac.uk.

Thank you for your time.

Please leave your completed questionnaire by your front door in the envelope provided.

Please leave the survey out for collection by 10am on Saturday, February 4, 2017.

About your life in Trimingham

1. How many years have you lived in Trimingham? (Please round to the nearest year.)

___ total years

   a. If you have moved away from the village for period longer than a year and then returned, how many years has it been since you've been back?

___ total years

2. Please answer the question(s) that apply/ies to you.

   a. If you moved to Trimingham, never having lived here before, please say why in the box below.

   b. If you have lived in Trimingham all your life please say why in the box below.

   c. If you've moved away and returned please say why in the box below.

3. On the map of Trimingham below please indicate the general area or neighbourhood of the house / property that you currently live in. I am collecting this information to see if there are differences in responses based on where the people are located in the village.

Trimingham

4. Do you participate in any village events (i.e. quiz night, dog show, beach walks, etc.)?

a. If yes, how often do you participate? And why?

b. If no, what has kept you from participating? What would make you want to participate in an event?

5. Please answer the following statements.

a. Very few of my neighbours know me. ☐True ☐False

b. I can recognize most of the people who live in my village. ☐True ☐ False

c. My neighbours and I want the same things from the village. ☐True ☐ False

d. I have almost no influence over what this village is like. ☐True ☐False

e. If there is a problem in the village people who live here can get it solved.

☐True ☐ False

Coastal Erosion

6. What are your views on the changing coastline in Trimingham and any related changes?

7. Please indicate below (ticking the relevant box) how concerned or unconcerned you are about coastal erosion in your personal life, for the village of Trimingham, and nationally for the UK.

	Very Concerned	Concerned	Neither concerned or unconcerned	Unconcerned	Very Unconcerned
Personally	☐	☐	☐	☐	☐
Trimingham	☐	☐	☐	☐	☐
Nationally	☐	☐	☐	☐	☐

8. Please tell me how unconcerned or concerned you are about coastal erosion in Trimingham now, in 5 years, in 10 years, and in 15 years in the future.

	Very Concerned	Concerned	Neither concerned or unconcerned	Unconcerned	Very Unconcerned
Presently	☐	☐	☐	☐	☐

5 years	☐	☐	☐	☐	☐
10 years	☐	☐	☐	☐	☐
15 years	☐	☐	☐	☐	☐

9. What do you think should be done, if anything, about coastal erosion in Trimingham?

10. When do you think it would be most appropriate to start doing something about the future of the village in regards to coastal erosion in Trimingham?

Presently	5 years	10 years	15 years	Nothing needs to be done
☐	☐	☐	☐	☐

11. What degree of influence do you believe you and the village have to affect decisions made in Trimingham?

	Strongly influence	Somewhat influence	Very little influence	No influence	I don't know
Yourself	☐	☐	☐	☐	☐
Village	☐	☐	☐	☐	☐

12. What do you believe, if anything, is keeping the village from being able to deal with coastal erosion?

Future in Trimingham

13. How long do you plan to remain in Trimingham? Why? Please tell me in your own words.

    a. If you were to move, what would be the reason?

14. Some people say they feel like they have a sense of community with the people in the village; others don't feel that way. Would you say that you feel a strong sense of community with others in the village, very little sense of community or something in between?

I have no sense of community	I have very little sense of community	I have some sense of community	I have strong sense of community	I don't know
☐	☐	☐	☐	☐

15. Would you say that it is very important, somewhat important or not important to you to feel a sense of community with the people in the village?

Very unimportant	Somewhat unimportant	Neither important or unimportant	Somewhat important	Very important
☐	☐	☐	☐	☐

16. What would you like to see happen in the future that could enhance the community sense in the village?

17. Thinking about the future of Trimingham, is there any information that you would like to have or see represented in some form to help you consider how the village would look like or how you'd like it to be in the next 20-50 years?

    a. If yes, please provide more details in your own words in the box below, about what information you'd like to have and in what way you would prefer it to be presented (e.g.. videos, pictures, charts, graphs, etc.)

Now please tell us a little about yourself.

18. What is your gender? ☐ Male ☐ Female

19. What is your age?

18-24	25-34	35-44	45-54	55-64	65-74	75+
☐	☐	☐	☐	☐	☐	☐

20. What is the highest educational or professional qualification that you have obtained? (Please select one.)

☐ O- Level/ GCSE
☐ Vocational Qualifications
☐ A-Level
☐ Bachelor degree or equivalent
☐ Masters/ PhD or equivalent
☐ Other
☐ No formal qualifications
☐ Still studying

21. How many children under the age of 16 live in this household? (Please select one.)

☐ None
☐ 1
☐ 2
☐ 3
☐ 4 or more
☐ Refused

22. What are the three main sources that you receive your news from? (Sources of information include television, radio, newspapers, word of mouth, social media, etc.)

1.	
2.	
3.	

23. What groups or organizations are you a part of, if any? Please list them below.

If you would like to be informed about future work that will be done in Trimingham in relation to this research project, please fill out the section below with your contact information. This information will be kept confidential and only be used to contact you for research purposes.

Name: _____Phone number: _____

Email address: _____

Thank you very much for taking the time to complete this survey.

Please leave it outside your door by 10 am on Saturday, February 4, 2017 for collection.

A1.4: Workshop Protocol

Coastal change in Norfolk: the contribution of visualizations to decision making

WORKSHOP PROTOCOL (6th and 13th May 2017)

Jacqueline Zavala (ENV/ UEA)

Coastal change in Trimingham
Recruited via invitation
To be held for 2.5h

Note-taker: keep a record of which participant is speaking with brief notes of what they say – with a table plan. This is important for transcribing.

Materials check list:

___ Map of Trimingham	___ Laptop	___ Consent forms
___ Pens and highlighters	___ Flip chart	___ Information sheets
___ Projector	___ Flip chart markers	
	___ Coloured dots	

Welcome and introduction to the research ***10 mins***

[Give summary of the information sheet, consent form and stickers for names.]

Good morning/ afternoon / evening. Thank you for coming today, we appreciate you taking the time to come today and contribute to this work.

My name is Jackie Zavala. This is xxx who is helping me today. We are based at the School of Environmental Sciences at the UEA in Norwich.

Regarding this research, we are interested in your views and experiences about the Village of Trimingham.

So the meeting today is about your views and opinions. We would like to discuss these in an open informal conversation among us all.

I'd like you to firstly read through the consent form we have given you. If you are happy to do so, please sign the consent form and return it to us – this indicates you are willing to take part in this research.

Allow a few minutes for completion of all this paperwork for those that have not received a consent form already.

Thank you.

Before we start, I'd like to mention that:

3. We are recording this discussion, so that we can have an accurate record of our conversations; my assistants are keeping hand-written notes just in case.
4. The details of our discussions today and next time will always remain confidential (only our team will use it) and if published will be made anonymous (names will be changed and any information that may identify you will be removed).

Are there any questions, comments, or concerns at this point?

I'd like to suggest some ground rules that we may like to follow during today's session:

- everybody's opinion is welcome;
- we value everyone's view,
- please feel free to share your views freely, and add to or disagree with what others are saying
- there are no right or wrong answers, we are interested in your personal views and opinions
- it would be very useful if you could speak clearly and one at a time, as this will make it easier to type up the conversation
- please respect the other participants' confidentiality by not repeating what other participants say outside this room without their permission, although you are welcome to discuss your own views and experience of this meeting with others.
- We'd like to keep this discussion to 2 and a half hours, no longer
- Tea / water / coffee and biscuits are available, please help yourselves,
- If at any point you need to use the facilities they are open and located over their [points to them].
- And emergency exits / facilities are located …

Make sure everyone has a nametag.

START [2.5h total]

General views of Trimingham *15* ***mins***

I would like to start off this workshop by giving you all a few updates on how the project has progressed so far. I have been able to conduct my research because of your participation and patience. Everyone has been very helpful and I cannot stress how grateful I am for that.

So far I have conducted focus groups, interviews and a community survey. So some of the things that I was looking at and that came up while I was doing my research were how people viewed things like the new village hall, the main Cromer-Mundesley road, and their role in the village in terms of engaging in events in the village and village decision making opportunities.

People also mentioned that visual representations of Trimingham could be useful. Some of the types of visualizations that were suggested were past, present and future comparisons. If you look at the screen, I have projected a visualization that I have made. It has two maps side by side and. The one on the left is a map from 1915 and the map on the right is from 2015. You can slide the middle bar back and forth to switch between the two maps. Does anyone want to move the map view and bar?

[give participants 5 minutes to look at the visualization and give feedback]

There was also interest in seeing future erosion. Unfortunately it was not feasible to create a visualization with the time and data that was available to me. Despite this, I hope that we can still create a visualization as to what we would like the village to look like in 5+ years today.

So, I have asked everyone to come together to begin working to help further develop your thoughts on coastal change and the village using visualizations and discussions. I hope that by the end of the workshop we can come up with a visualization that reflects our discussion and your views of the village.

Let's begin by introducing ourselves for those that we may not be well acquainted with. Please state your name, and why you decided to participate today.

My name is Jackie. I am a researcher at the UEA. I can tell that there are people who really care for the village and I enjoy being a part of this research that has allowed me to gain the insight into the village to see how people feel about it.

[Continue around the room]

Visioning the future part 1 (option generation) **10** ***mins***

We are handing out a map of Trimingham and the surrounding areas. *[Assistants help to hand out A4 maps]*

For the next 5 minutes we will be trying to imagine how we think the village could change in the future.

What do you believe would need to happen for the village to continue to exist in the next 10 years? → What will affect the existence of the village in 10+ years?

Please draw your ideas on the map to indicate where you would prefer a facility or resource for the village to be located. This can include infrastructure changes, new buildings, pavement, beach accesses, the new village hall, the pilgrim shelter etc. Or anything else you feel is important, even if you cannot locate it on a map. We will discuss your ideas afterwards to see some of the pros and cons of each option and what we would need for it to happen or if you believe it is feasible.

Future changes (option assessment) **50 *mins***

For this next part we will be discussing what futures we imagined. The goal of this discussion is to try and come up with 1-3 options for the village to be able to be sustained in the far future *[deal with coastal erosion]*. Everyone here has some knowledge and experience that could greatly improve this discussion so I encourage everyone to contribute when they feel comfortable.

I would also like to remind everyone that their opinions and views are all valid and important. Everyone will have 2-3 minutes to talk about what they drew and why without interruption from us. As people are explaining their ideas, my assistant will be writing them down on this flip chart. If you have a comment, please write it down and we can address it after they have finished their explanation.

[Go through everybody's explanations]

So these are all of the different themes that came up. I know some may have different thoughts about the details on how they imagined these themes, but these are the general ideas that everyone mentioned.

Everyone will be given three dots. Please place the dot with the one next to the option for the future that you believe will best help the village to continue to exist in the future, the dot with the 2 on your second choice and the dot with a 3 on your third choice. If you do not feel like coming up and putting your dots you do not have to.

[let the participants go and put their dots on the flip chart]

So the ones that seem to have the most dots are …..

Let's discuss these ideas further. Let's start with the first theme

Why would this option benefit the village? → At what scale do you think most people in the village would be accepting of this option?

What are some of the positive impacts that this could have for the village in 10 years? 20 years? 50 years? → What are some issues that are related to getting this idea implemented? → Is there something that would keep this idea from happening? → What would need to happen for this to be beneficial for the village to continue to exist in the far future?

So these are all of the different elements of each theme.

Everyone will be give three more dots. Please place the dot with the one next to the option for the future that you believe will best help the village to continue to exist in the future, the dot with the 2 on your second choice and the dot with a 3 on your third choice. If you do not feel like coming up and putting your dots you do not have to.

[let the participants go and put their dots on the flip chart]

Thank you. Now I will let you know a bit more about why I asked you to do this exercise.

This information is to modify a visualization that I created based on some of the previous feedback I got from villagers last year. I have tried to include certain things that were mentioned in earlier discussions so that it could reflect some of the character of the village.

First let me put up some images of the visualization that you can look at.

Is there anything about the visualization that you do not like? → Is there anything you want to point out that you particularly like?

Let's take five minutes to talk over what we like and don't like about this visualization and what we would like to see in a visualization if it was possible.

Thank you for your comments. This discussion is very helpful in making sure that this visualization is completely generated by the group. We will now take a 20 minute break. Please help yourselves to tea, coffee and biscuits.

Break ***20 min***

[During the break the visualization will be edited to include the changes that people wanted. Several options will possibly be generated depending on the responses in the previous section.]

Visioning the future part 2 (option evaluation and selection) 40 *mins*

I hope you all had a good break. I am sure you will be happy to know that we are more than half-way done. Please feel free to get another cup of tea or coffee before we get started again.

So now we will look at the option(s) that you agreed on through the visualization software. The elements we added were…

Does this visualization look similar to what you imagined it to look like? → What would you change?

How did the visualization affect your view about the future of the village?

Did you find that certain options that were added to the visualizations were better for the village than others in terms of long term viability? → Was there anything that you did not think was feasible that now you think could be a positive change that could help the village to continue to exist in the far future? → Was there anything that you thought would be a positive change in order for the village to continue in the future that ended up not being as feasible as you thought? →

Let's go back to our flip chart. The original three elements that were added to the visualization were…

Out of all of the original options under the three themes please write down the three options that, in your opinion, are most feasible and beneficial for the village to continue in the far future and rank them 1-3 with one being the option that is most important in your opinion. Write it on the back of your map in the section labelled part 2. It is ok if it has not changed from what the group originally decided.

Which of the activities that we've done today do you think would be helpful in engaging others outside of this workshop? → How do you think your neighbours will view the visualizations we made today?

Wrap up ***5 mins***

To wrap up our conversation, I would like everyone to please fill out this questionnaire. Please answer honestly so that I can improve your experience the next time we meet.

"Thank you every one. Please help yourselves to tea and biscuits. I will be staying back for a bit longer if you want to speak with me. I will send you an email when the next focus group will be scheduled. I hope to see you all there. Please feel free to contact me if you have any questions or concerns about the project."

A1.4.1: Before and After Workshop Surveys

Coastal change in North Norfolk: the contribution of visualizations to decision making

By completing this survey you are agreeing that your answers may be used in this research. All of your answers and personal information will be kept confidential and stored in a secure space. Your name is necessary so that your answers can be compared to earlier responses during the research.

Name: _____ Date: _____

Pre-workshop

1. Please indicate below (ticking the relevant box) to what level you agree or disagree with the following statements.

	Strongly agree	Agree	Disagree	Strongly disagree	Unsure
The village should remain a peaceful and quiet place to live.	☐	☐	☐	☐	☐
Government agencies are trustworthy sources of information pertaining to coastal change in the village.	☐	☐	☐	☐	☐
There are more important priorities than coastal erosion that keep me from fully participating in village discussions.	☐	☐	☐	☐	☐
There is a lack of community engagement from other villagers for thinking of ways to deal with coastal change.	☐	☐	☐	☐	☐
The village should adapt and develop to deal with coastal change.	☐	☐	☐	☐	☐
Funding issues can prevent small communities from implementing plans to deal with coastal erosion.	☐	☐	☐	☐	☐
There are areas in the village that are more at risk than others for coastal erosion.	☐	☐	☐	☐	☐
It is important for communities to deal with coastal change in a positive, proactive manner.	☐	☐	☐	☐	☐
I have almost no influence over what this village is like.	☐	☐	☐	☐	☐
If there is a problem in the village people who live here can get it solved.	☐	☐	☐	☐	☐
I feel confident that I have been given the chance to influence future decisions in the village through my participation.	☐	☐	☐	☐	☐

Post- workshop

1. What do you believe helped to focus the discussion, organize your thoughts, and helped you to imagine the potential futures of the village and the implications of the different possibilities?

2. Please indicate below (ticking the relevant box) to what degree have the visualizations shown today been helpful or unhelpful for the following aspects of the workshop.

	Very helpful	Helpful	Not very helpful	Not helpful at all	Unsure
Focusing the discussion	☐	☐	☐	☐	☐
Visualizing potential futures of the village	☐	☐	☐	☐	☐
Organizing your thoughts	☐	☐	☐	☐	☐
Agreeing on which futures were most feasible	☐	☐	☐	☐	☐

3. Please indicate below (ticking the relevant box) to what level you agree or disagree with the following statements about the visualizations used during the workshop today.

	Strongly agree	Agree	Disagree	Strongly disagree	Unsure
The visualizations were clear and understandable.	☐	☐	☐	☐	☐
The visualizations were engaging (i.e. interesting and accessible).	☐	☐	☐	☐	☐
The visualizations were able to make the issue of coastal change more personal.	☐	☐	☐	☐	☐
The visualizations helped to think of positive futures for the village.	☐	☐	☐	☐	☐
The visualizations were an accurate representation of the current village.	☐	☐	☐	☐	☐
The visualizations were respectful towards the views of the participants.	☐	☐	☐	☐	☐
The visualizations helped to change the way I thought about the future of the village.	☐	☐	☐	☐	☐

4. What would you change, if anything, about the visualizations shown to you today? (the 2D maps, the current village 3D visualization, the 3D visualization of the possible futures for the village)

5. Please indicate below (ticking the relevant box) to what level you agree or disagree with the following statements.

	Strongly agree	Agree	Disagree	Strongly disagree	Unsure
The village should remain a peaceful and quiet place to live.	☐	☐	☐	☐	☐
Government agencies are trustworthy sources of information pertaining to coastal change in the village.	☐	☐	☐	☐	☐
There are more important priorities than coastal erosion that keep me from fully participating in village discussions.	☐	☐	☐	☐	☐
There is a lack of community engagement from other villagers for thinking of ways to deal with coastal change.	☐	☐	☐	☐	☐
The village should adapt and develop to deal with coastal change.	☐	☐	☐	☐	☐
Funding issues can prevent small communities from implementing plans to deal with coastal erosion.	☐	☐	☐	☐	☐
There are areas in the village that are more at risk than others for coastal erosion.	☐	☐	☐	☐	☐
It is important for communities to deal with coastal change in a positive, proactive manner.	☐	☐	☐	☐	☐
I have almost no influence over what this village is like.	☐	☐	☐	☐	☐
If there is a problem in the village people who live here can get it solved.	☐	☐	☐	☐	☐
I feel confident that I have been given the chance to influence future decisions in the village through my participation.	☐	☐	☐	☐	☐

6. How do your feelings or views about coastal change now compare to your feelings or views from before this workshop?

Thank you for completing this survey.

A1.5: Exhibition Packet

Your personal views of change in Trimingham

Hello, I am a postgraduate researcher at the University of East Anglia in the school of Environmental Sciences. As part of my research, I am interested finding out about people's views about the future of Trimingham.

I would appreciate if you would complete the following packet. Your answers will be kept strictly confidential and used only in anonymized form, this means you will not be identifiable from any analyses of the findings from the survey. All data collected from the survey will be stored in paper form in a locked cupboard at UEA and on my computer, password protected. The data will not be passed on to any third party and will only be shared in summary form with my supervisory team. The findings of this survey will be used in my thesis and any resulting publications. Your participation in this research is entirely voluntary. If at any time you wish to withdraw from this study, you may so without giving a reason. By attending the exhibition, completing and returning the survey, you are consenting to take part in this research by allowing me to use the information from the survey.

If you have any questions, please contact me by email at J.Zavala@uea.ac.uk or you can contact my research supervisor Irene Lorenzoni at i.lorenzoni@uea.ac.uk.

Thank you for your time.

Change in Trimingham

By completing this survey you are agreeing that your answers may be used in this research. All of your answers and personal information will be kept confidential and stored in a secure space. Your name is necessary so that your answers can be compared to earlier responses during the research.

Name: _____ Date: _____

Before you start!
Please fill out this survey to let me know a bit about what you think about the village and the coast. Please try to be as honest as possible. Your thoughts and opinions are appreciated!

a. How many years have you lived in Trimingham? (Please round to the nearest year.)
_____ total years

b. If you have moved away from the village for period longer than a year and then returned, how many years has it been since you've been back? ____ total years

2. How long do you plan to remain in Trimingham? Why? Please tell me in your own words.

b. If you were to move, what would be the reason?

3. When do you think it would be most appropriate to start doing something about the future of the village in regards to coastal change in Trimingham?

Presently	5 years	10 years	15 years	Nothing needs to be done	I don't Know
☐	☐	☐	☐	☐	☐

4. What degree of influence do you believe you and the village have to affect decisions made in Trimingham?

	Strongly influence	Somewhat influence	Very little influence	No influence	I don't know
Yourself	☐	☐	☐	☐	☐
Village	☐	☐	☐	☐	☐

5. If you live in the village, please indicate below (ticking the relevant box) to what level you agree or disagree with the following statements. If you don't live in the village, please skip this question.

	Strongly agree	Agree	Disagree	Strongly disagree	Unsure
The village should remain a peaceful and quiet place to live.	☐	☐	☐	☐	☐
Government agencies are trustworthy sources of information pertaining to coastal change in the village.	☐	☐	☐	☐	☐
There are more important priorities than coastal erosion that keep me from fully participating in village discussions.	☐	☐	☐	☐	☐
There is a lack of community engagement from other villagers for thinking of ways to deal with coastal change.	☐	☐	☐	☐	☐
The village should adapt and develop to deal with coastal change.	☐	☐	☐	☐	☐
Funding issues can prevent small communities from implementing plans to deal with coastal erosion.	☐	☐	☐	☐	☐
There are areas in the village that are more at risk than others for coastal erosion.	☐	☐	☐	☐	☐
It is important for communities to deal with coastal change in a positive, proactive manner.	☐	☐	☐	☐	☐
I have almost no influence over what this village is like.	☐	☐	☐	☐	☐
If there is a problem in the village people who live here can get it solved.	☐	☐	☐	☐	☐
I feel confident that I have been given the chance to influence future decisions in the village through my participation.	☐	☐	☐	☐	☐

6. In the box provided below, please describe your feelings or thoughts about coastal change in the village?

7. What is your gender? ☐ Male ☐ Female ☐ Prefer not to say

8. What is your age?

18-24	25-34	35-44	45-54	55-64	65-74	75+
☐	☐	☐	☐	☐	☐	☐

Poster Exhibition

Please go to each poster and fill out the table below with your thoughts about each option. Please include what you liked and disliked about each option, as well as the pros and cons of each.
Once you have completed this please use the sticky dots provided to rank your top three choices that you believe would help the village to continue to be a place where people can live in the future. Use green for the option that you feel would be most helpful, yellow for the second most helpful, and red for the third most helpful option. Use the blue sticky dot to show the option that you believe would be least helpful for the village.

Ranking	Roads	Pros	Cons
	Traffic calming (Green line)		
	One-way system (Purple line)		
	Railway embankment road (Pink line)		
	Road behind woodlands (Orange line)		

Ranking	Housing	Pros	Cons
	Behind Broadwood Close		
	Behind new village hall		

Ranking	Other	Pros	Cons
	New village hall		
	Coastal management		
	Pilgrim shelter		

Before you go …
Please fill out this next section to let me know how you felt about this exhibition and what can be done to improve it. Please complete this part AFTER you have gone to every poster and given a bit of feedback.

9. Please indicate below (ticking the relevant box) to what level you agree or disagree with the following statements about the visualizations, the images, used during the exhibition today.

	Strongly agree	Agree	Disagree	Strongly disagree	Unsure
The visualizations were clear.	☐	☐	☐	☐	☐
The visualizations were understandable.	☐	☐	☐	☐	☐
The visualizations were engaging (i.e. interesting and accessible).	☐	☐	☐	☐	☐
The visualizations were able to make the issue of coastal change more personal.	☐	☐	☐	☐	☐
The visualizations helped me to think of positive futures for the village.	☐	☐	☐	☐	☐
The visualizations were an accurate representation of the current village.	☐	☐	☐	☐	☐
The visualizations were respectful towards the views of the village.	☐	☐	☐	☐	☐
The visualizations helped to change the way I thought about the future of the village.	☐	☐	☐	☐	☐

10. What would you change, if anything, about the visualizations shown to you today to make them more clear and/or understandable?

11. Have the visualizations helped you to consider the options for the village? Yes or No
    a. If yes, how have they helped?

12. What would you change, if anything, about the suggestions for making sure the village is a place where people can continue to live in?

13. What do you believe, if anything, is keeping the village from being able to deal with coastal change?

14. If you live in the village, please indicate below (ticking the relevant box) to what level you agree or disagree with the following statements. If you don't live in the village, please skip this question.

	Strongly agree	Agree	Disagree	Strongly disagree	Unsure
The village should remain a peaceful and quiet place to live.	☐	☐	☐	☐	☐
Government agencies are trustworthy sources of information pertaining to coastal change in the village.	☐	☐	☐	☐	☐
There are more important priorities than coastal erosion that keep me from fully participating in village discussions.	☐	☐	☐	☐	☐
There is a lack of community engagement from other villagers for thinking of ways to deal with coastal change.	☐	☐	☐	☐	☐
The village should adapt and develop to deal with coastal change.	☐	☐	☐	☐	☐
Funding issues can prevent small communities from implementing plans to deal with coastal erosion.	☐	☐	☐	☐	☐
There are areas in the village that are more at risk than others for coastal erosion.	☐	☐	☐	☐	☐
It is important for communities to deal with coastal change in a positive, proactive manner.	☐	☐	☐	☐	☐
I have almost no influence over what this village is like.	☐	☐	☐	☐	☐
If there is a problem in the village people who live here can get it solved.	☐	☐	☐	☐	☐
I feel confident that I have been given the chance to influence future decisions in the village through my participation.	☐	☐	☐	☐	☐

15. How do your current feelings or views about coastal change compare to your feelings or views from before this activity?

Thank you for completing this survey.

A1.6: Final interviews

The main sections of questions include: a.) Participant past responses reflection pt. 1, b.) Views about the use of visualizations pt. 1, c.) Participant past responses reflection pt. 2, and d.) Views about the use of visualizations pt. 2, and e.) wrap-up. The main questions will be asked to the nine participants that have participated in previous stages of data collection, as well as any interviews with participants that have participated in more than one stage of data collection. Subsequently, questions for specific groups of participants are found after the wrap-up section.

Depending on which phases of data collection someone has participated in, questions in or the entire section of "Participant past responses reflection pt. 1" and section, "Participant past responses reflection pt. 2" will be excluded. The section, "Views about the use of visualizations pt. 2", can be asked to all participants because they will be show the various types of visualizations. The questions that have been highlighted are questions that will be asked to ALL participants whether or not they have previously participated in other phases of data collection or live in the village. Italicized wording indicates what the researcher will be saying and actions the researcher will take.

Participants will sign consent forms prior to the interview beginning. Audio recorder will be turned on after this point.

Main Questions- Duration: 1.5 hrs	***Reasoning***
Participant past responses reflection pt. 1- 30 min	
Hello. Thank you for participating in this interview today. Two years ago I first came and spoke with you. In the first interview I had with you, you said… Would you say your views are the same or have changed? → How have your views changed? →What do you think could have affected your responses to these questions? *The next time we spoke was in a focus group. At that point our conversations were around… and you said…* Would you say your views are the same or have changed? → How have your views changed? →What do you think could have affected your responses to these questions?	These are the questions to make sure to include for the description of participant's previous responses. --- Asked during the Interview: [What do you think the village will look like in 5, 10, and 20 years? → What social and physical changes to you envision happening in the future?] --- Asked during the focus groups: [What would you like to see done for the future? → What do you feel is keeping you from being able to accomplish this? → Would you say that you have an influence in decisions made about the village?]
So in the workshop we talked about…. During our conversations you mentioned…. [Show participants radar charts as well] What do you think could have affected your responses to these questions? →Is there anything that you feel you have changed your views on?	Asked during the workshop: [What do you think the village will look like in 5, 10, and 20 years? → What social and physical changes to you envision happening in the future? What would you like to see done for the future? → What do you feel is keeping you from being able to accomplish this? → Would you say that you have an influence in decisions made about the village?]

Views about the use of visualizations pt. 1- 5 min minutes	
Do you remember any of the visualizations I showed you? → Do you remember any of the future options for the village that you mentioned before? →Of those you can remember, what are your overall impressions? [after this you can go into detail about specific ones one at a time, or you may have discussed them with the radar charts before]	This line of questioning is to see if participants remember the visualizations they were previously shown and if they can remember what they had previously responded.

At this point of the interview the researcher will draw the attention of the participants to the visualizations that they interacted with throughout the project including (when available): the A4 map altered by the participant, the story maps, the drawing the participant made of the village, the workshop visualizations, and the exhibition visualizations. If the participants have never previously participated in any other phase of data collection then they will first be given a short introduction to the project, then shown the visualizations.

Participant past responses reflection pt. 2- 10 min	
For your responses during the exhibition, you wrote about the future options that… Also, if you remember, I asked you the same questions from the workshop surveys in the exhibition surveys. These were your responses [Show participants radar charts as well] What do you think could have affected your responses to these questions? →Is there anything that you feel you have changed your views on?	This section was put after the first part of visualizations because the line of questioning in this section needs to first introduce participants to the visualizations.

Views about the use of visualizations pt. 2- 30 minutes	
Were the visualizations visually clear? →Are there any in particular that were the clearest? →Most unclear?	Clarity is another aspect that is considered as important for a visualization to be effective. This question is to understand if the participants felt that the visualizations were clear and if there were any in particular that they felt were unclear to get an idea of what they view as "clarity".
How accurate or inaccurate were the visualizations, in terms of representing the changes you had wanted to see in the village? → What activity or activities, i.e. workshop, focus groups, interviews, do you feel affected the accuracy?	Accuracy was mentioned in Sheppard (2012), Bishop et al., 2013 and Pettit et al., (2011). This line of questioning aims to gauge how accurate participants felt the visualizations were and which activities they felt were the most useful in tailoring the visualizations.

Was the level of detail adequate? →Why? → How would you change the level of detail?	The use of varying levels of detail is discussed by various authors, e.g. Lange, 2001; Lovett et al., 2015; and Brown et al., 2006. This question is to ask about this specific aspect of the visualizations that participants were shown and how/if they would change the detail.
Do you feel that there was enough interaction with the visualizations? → Why? → How much interaction would you like in a visualizations?	Another aspect of visualizations, interactivity has been discussed in the landscape visualization literature. This line of questioning is to understand the level of interaction that the participants would want with the visualizations.
How do you think the visualizations affected the way you interpreted the information about the future options? → Was the underlying concept clearly visualized?	While the previous question focused on visual clarity, this question is to see how participants felt the visualizations affected the way in which they interpreted the information and whether the underlying information was clear or not.
Do you think that visualizations can be used to engage the wider community in the village? →Why? → How?	This is to get feedback on the use of visualizations and how the participants felt this aspect of participation could have been improved.
How did you feel about the use of visualizations during the discussions? → What did using visualizations allow you to view or address that you couldn't have done without visualizations?	This line of questioning is meant to understand how participants felt about the visualizations they were shown and their usefulness.

Wrap up- 15 min	
How would you like the information that I collected during this study, including the visualizations, to be used now? → In an ideal world what would you like to happen in regard to the future of the village? →What would the role of policy makers be?	This line of questioning is to see how participants would like to take the information from this case study forward and what they would like to accomplish with this type of information.
How did you find this whole process of participating in this research project? → Is there anything that you would change? → Why?	This line of questioning is to receive feedback on the entire process of participation including the participant's feelings about a longitudinal study.
How do you feel about interacting in this research project over these two years?	This question is to better understand how the participant feels about engaging in this research for 2 years. This it to look at how participants feel about participating in a longitudinal study.
Is there anything else that you would like to add that we may not have covered today?	This question is to make sure that participants have an opportunity to mention everything they wish to even if it may not have been asked.

Do you have any questions for me?	This is to give participants the opportunity to ask the researcher any questions they may have for them.

"Thank you very much for your participation in this study. I really appreciate all of the time you have put into my research and I will let you know of any further developments. Please feel free to contact me if you have any questions or wish to withdraw your participation."

Specific questions for other groups of participants:

Questions for Coastal Mangers- 2 coastal managers scheduled for an interview	These are questions that I would like to ask specifically to coastal managers. These questions will be asked after the section, "Views about the use of visualizations pt. 1".
When I showed you the visualizations of future options, these are a few comments you gave about them…. What do you think could have affected your responses to these questions?→Is there anything that you feel you have changed your views on?	This line of questioning will replace section, "Participant past responses reflection pt. 2"
What do you think the implications/ contributions of this research can be? → How does the longitudinal element of my study relate to some of your current work? →Do you think visualizations can be a useful tool in management?	This question is to understand how coastal managers view this project and the future possibilities for the uses of the findings from this research.
With the SMP being "refreshed", What do you think this research can contribute to this process?	This is to probe the coastal managers about the future updates to the SMP and how they feel this research can potentially be used during this process.
If you wanted to implement method of engagement with visualizations, are there people with the skills to create visualizations? → What help and/or resources would you need to be put into place or made available in order to utilize this sort of method of engagement?	This line of questioning is to better understand what would need to happen for the local council to implement a method of engagement using visualizations.
How do you think this project could have been improved?	This is to understand how, from a coastal managers perspectives, this research could have been improved.

Appendix 2: Index of USB contents

A2.1: USB contents

Figures contained within this USB are named in the form "X.YZ" where X.YZ represents Figure X.YZ in the thesis.

"1-Initial visualizations" - directory, containing:

- High-resolution versions the figures contained within Figure 3.6, in PNG format.

"2- Visualizations created during workshops" - directory, containing:

- High-resolution versions of all figures contained within the Figure 3.8, in PNG format.

"3-Exhibition visualizations" - directory, containing:

- High-resolution versions of all figures contained within Figure 3.9, in PNG and JPG formats.

"4-Exhibition posters" - directory, containing:

- High-resolution versions of all figures contained within Figure 3.10, in PNG format.

Story map can be accessed using URL: http://arcg.is/2lCJ8BV

A2.2: Data References and copyrights

1:2,500 County Series 1st Revision [TIFF geospatial data], Scale 1:2500, Tiles: norf-tg2637-2,norf-tg2638-2,norf-tg2639-2,norf-tg2737-2,norf-tg2738-2,norf-tg2739-2,norf-tg2837-2,norf-tg2838-2,norf-tg2839-2, Updated: 30 November 2010, Historic, Using: EDINA Historic Digimap Service, <http://digimap.edina.ac.uk>, Downloaded: 2016-07-25 13:30:31.961

OS MasterMap® Topography Layer [FileGeoDatabase geospatial data], Scale 1:1,250, Tiles: GB, Updated: 7 January 2016, Ordnance Survey (GB), Using: EDINA Digimap Ordnance Survey Service, <http://digimap.edina.ac.uk>, Downloaded: 2016-07-08 16:38:57.413

OS Terrain 50 [ASC geospatial data], Scale 1:50000, Tiles: tg23,tg24,tg33, Updated: 2 August 2016, Ordnance Survey (GB), Using: EDINA Digimap Ordnance Survey Service, <http://digimap.edina.ac.uk>, Downloaded: 2017-05-31 13:44:41.42