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ORIGINAL ARTICLE

Innovation in coastal governance: management and expectations of the UK's first sandscaping scheme

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Abstract

Many coastal places around the UK face change, with impacts on communities, livelihoods, and landscapes. A tidal surge in 2013 caused significant erosion and flooding on the east coast of England (UK). This was the catalyst for the innovative Bacton to Walcott Coastal Management Scheme, also known as the Sandscaping Scheme, implemented in summer 2019. It is a one-off, large-scale beach nourishment scheme with a design prediction of 15–20 years functional life, the first of its kind in the UK and worldwide outside of the Netherlands. Through stakeholder interviews and a household questionnaire survey, this paper examines the institutional and political challenges, expectations, and hopes associated with this Scheme just before its implementation. The findings indicate that a combination of factors enabled technical and institutional experimentation and innovation at this location: critical erosion risk at a site of strategic infrastructure adjacent to two highly vulnerable villages, extensive stakeholder collaboration across scales, resolute leadership, and recognition of co-benefits. Although most interviewees and local residents foresaw significant benefit from the Scheme—not least respite from the deep anxiety caused by the threat of flooding and erosion risk—tensions were expressed around uncertainty beyond the Scheme's lifetime and the need to start effective conversations about future adaptation options for the area. This study provides reflections for similar nature-based coastal management schemes elsewhere. It highlights the fundamental challenges facing the governance of natural and social coastal systems for adapting to current and future coastal change and the importance of articulating local and sometimes intangible understandings and expectations of adaptive coastal management interventions.

Keywords Large-scale beach nourishment · Sandscaping · Nature-based solutions · Adaptation · Innovation · Expectations

Introduction

For millennia, coasts have been managed and modified by humans eager to reap the benefits these zones provide. However, coasts are also dynamic environments which shift and change according to a multitude of complex processes (IPCC

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2019). The UK has and will continue to experience extensive coastal change, underpinned by natural and human drivers such as climate change (CCC 2018). In some locations, this is exacerbated by the interaction of regional conditions (e.g. isostatic adjustment and variations in sea level, Boomer and Horton 2006) with local circumstances, including the legacy of past coastal management policy, development planning, and engineered interventions (which can alter sediment flows and beach functioning). Within the UK, many coastal communities live with reshaped and vulnerable coastal landscapes requiring regular maintenance that is increasingly costly (POST 2021).

Reconciling such challenges with viable and resilient futures for coastal communities demands new policy directions (Milligan et al. 2009; O'Riordan et al. 2014; Environment Agency (EA) 2019) and proactive approaches (Naylor et al. 2019). As understandings of risk and funding priorities evolve, coastal management is also adapting. Climate change is already a major consideration: in England and Wales, it is accounted for in Shoreline Management Plans (SMPs) which provide a strategic assessment of risks to coasts and are used to inform statutory plans (UK Government and EA 2024). Working with biophysical systems rather than against them is now recognised nationally (CCC 2018; EA 2020) and internationally as key to delivering resilience in coastal zones (e.g. IPCC (2019, 2021, 2022); UNEP and IUCN 2021).

More naturally functioning solutions are increasingly being sought and implemented as options for managing transitions in dynamic systems such as coasts (Spalding et al. 2014; Narayan et al. 2016). Nature-based solutions (NbS) are defined by the IUCN as "actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits" (Cohen-Shacham et al. 2016, pxii; IUCN 2020). This distinguishes between the sustainability and costs of widely deployed, frequent beach (sand) nourishment (de Schipper et al. 2021; Staudt et al. 2021) and one-off mega-nourishment NbS projects such as De Zandmotor in the Netherlands, which utilise natural processes to distribute and redistribute sediment over longer time horizons (Brown et al. 2016a; Climate-ADAPT 2023), to address coastal and cliff erosion.

With a variety of stakeholders, the IUCN co-developed a Global Standard for Nature Based Solutions™ (IUCN 2020) which provides a framework for designing a solution, assessing if it qualifies as a NbS (or not) and evaluating its potential for scaling up. This assessment is designed to provide robust reference points with the flexibility to encourage learning and interactive solution-building, reflecting the use of NbS in different contexts and for different needs. Studies using the IUCN framework have shown its (partial) applicability, pointing to some challenges about the relationship between internationally recognised standards and contextual approaches (Châles et al. 2023). Reflections on NbS implementation have highlighted fair and inclusive engagement with local communities that respects their "cultural and ecological rights" (Seddon et al. 2021, p.1518).

Whilst adaptive coastal governance and management have long been advocated to prepare for future change, the absence of a national policy framework and guidance for coastal adaptation in the UK means that the status quo is still to react incrementally to events and crises in a piecemeal way (CCC, 2018). Only recently has the government recognised the relevance of working with communities and environmental landscapes (EA 2019; 2020) and committed to achieving key actions within a short timeframe with NbS (EA 2022). In a significant departure from earlier government-led coastal risk management, the National Flood and Coastal Erosion Risk Management (FCERM) Strategy for England (EA 2020) acknowledges the importance of embedding consideration of climate impacts into coastal management, thus recasting the consideration of risk within a wider context of achieving resilience to flooding and coastal change, through adaptation and NbS (EA 2020, 2021). Although recently funded demonstration projects have explored innovative options for improving and delivering resilience of coastal areas (DEFRA and EA 2021), and interest is growing in how to quantify resilience to support decision-making (e.g. Townend et al. 2021), currently no mechanisms and processes are available to deliver this nationally; coastal management varies locally with significant implications for existing communities (Brown et al. 2023). It has been challenging for many regional coastal communities to maintain their viability. There is a clear expectation in the FCERM Strategy that increasingly new sources of funding will have to be sought and obtained in partnership with non-public bodies to deliver local solutions (EA 2020, p38). In contrast, the approach to coastal management in the Netherlands focuses on promoting anticipatory adaptation nationally and coastal growth in proportion to sea level rise (Luijendijk and Vikolainen 2019). However, approaches that assess adaptation acknowledging the complexities shaping it are still few (Magnan et al. 2023).

Adaptive governance and responding to loss

The diverse, varied, and long-standing challenges facing coastal regions can limit the opportunities for coastal adaptation. Studies have pointed to the importance of embedding proactive adaptation in both strategic thinking and coastal practices (Magnan et al. 2016) and called for a more inclusive and continued involvement of coastal communities. Enabling proactive adaptation requires overcoming existing constraints; for example, by moving beyond sectoral

approaches to embrace strategic planning and decision-making covering multiple risks, working with multi-dimensional understandings of risk, visioning opportunities and alternatives, and implementing new governance arrangements (multi- and cross-scale, especially at the regional level) (Brown et al. 2017).

One approach to examining responses to such coastal governance challenges is adaptive governance (AG). This proposes that the more responsive (i.e. adaptive) a governance system is to socio-ecological change, the more resilient the governance system becomes (Partelow et al. 2020). Work on AG aims to understand how diverse actors and interests (formal and informal, institutions, networks, groups, and individuals) at a variety of scales collaborate, learn, and reflect to improve outcomes, especially in complex and interlinked natural and social systems (which are usually referred to as socio-ecological systems, SES). In their review, Chaffin et al. (2014) pointed to the need to further understand how opportunities for AG are created, how changes occur to allow flexibility for innovation (or conversely, where opportunities for experimentation and cross-sectoral coordination and collaboration are lacking). Proponents of AG argue that periods of instability occur when existing governance structures are unable to adapt and respond to changing SES, thus reducing resilience. Such crises and disturbances provide the space for a re-organisation of existing governance structures, actors, and their relationships, enabling transition to AG (Chaffin and Gunderson 2016).

Many case studies exist of how AG is achieved in a variety of contexts; these have pointed to the importance of networks, collaboration, leadership, and trust (Partelow et al. 2020). The social contributions to AG are understudied; we argue that work on social adaptation and resilience can help illuminate this. Faulkner et al.'s (2018) work on community resilience suggests that this can be enabled by the interaction of five key components, expressed at the individual level and reflected through shared experiences (place attachment, leadership, community cohesion and efficacy, community networks, knowledge and learning) which draw communities together. Similarly, Crosweller and Tschakert (2021) denote the role of leadership, although they highlight the discrepancies, tensions, and potentially uneven outcomes that may result from different perspectives on responsibility for resilience (individual vs collective).

An emergent yet understudied area, which we argue could contribute to and complement this work, is around the deeper consideration of how people interpret changes when these result in losses (a) of and to things they value and ascribe meaning to, and (b) to their communities and to entire societies (Tschakert et al. 2017). Some of the harm caused by climate stressors can significantly alter what is important to people and may be intangible and unquantifiable in multiple ways (Tschakert et al. 2019). Research points to how alterations to a location due to climate change can disrupt place attachment and impact mental and physical health; studies have also indicated how connections and bonds between people and places can support resilience and climate adaptation (Tschakert et al. 2017). Central to this work is the acknowledgement that people's lived experiences through their everyday practices enable them to identify what is important to them, how they make sense of their world and give it meaning. Such a focus on daily activities also reveals the power dynamics of how predominant paradigms shape responses, e.g. whose values are noticed and considered, and conversely, those whose views and voices on loss are omitted and therefore considered endurable.

The recognition of the close entwinement between people's identities and the importance of their control of their circumstance and futures is key to developing narratives of change. These may also include pre-emptive disengagement with a specific location (e.g. "place detachment" in the context of managed retreat; Tschakert et al. 2017, p. 9) which may involve working through feelings of grief and loss. In turn, this can form part of a process of creating new bonds for a new existence and identity elsewhere. In this process, people will prioritise what to conserve and what to let go. Consideration of harms, which are acceptable or intolerable, may inform negotiations of what is to be maintained or may be traded off. Importantly, these may change over time and require reconsideration in relation to adaptive actions or strategies. As a result, calls are growing for opening up opportunities that enable individuals and communities the space and time to come to terms with their experiences, to sensitively work through their understandings of their situations and the changes to these, e.g. emerging research and practice around place shaping/making (Brown et al. 2017) such as the Place Standard tool used in Scotland (Scottish Government, 2021). Embracing qualitative methods can aid in exploring narratives and desires for the future, including trade-offs, which losses may be acceptable and to whom, and how harm may be diffused before "it becomes intolerable" (Tschakert et al. 2019, p. 70), to pre-empt any potential for standstill in the consideration of future risk.

In this paper, we build on existing understandings of adaptive governance with insights on harm and loss in locations threatened by change to examine what has driven innovation in coastal management and how this relates to people's lived experiences.

The Bacton to Walcott Sandscaping Scheme

The East of England region has, over the past two decades, demonstrated notable determination in experimenting and trialling new and innovative approaches to deliver transitions in coastal adaptation (DEFRA 2012; NNDC 2024a, 2024b).

Fig. 1 Location of study site on the North Norfolk coast in the East of England. The light grey areas denote settlements, and the white are farmland/ countryside (see OSM (https://www.openstreetmap.org/copyright), OGL (https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/) licences)

One such example and the focus of this paper is the Bacton to Walcott Coastal Management Scheme (NNDC 2021; Vikolainen et al. 2017) also referred to as the Sandscaping Scheme (henceforth Scheme). It is showcased in the EA's Strategy (2020, p. 38) for its innovative funding—an aspect which can be a key challenge and often significant constraint to adaptation (e.g. Brown et al. (2017)).

The study site is located on the eastern North Norfolk coast (see Fig. 1). It incorporates the Bacton Gas Terminal ("the Terminal") whose infrastructure and operations are of national importance, as a third of UK gas imports converges here. Various coastal management options for both the Terminal site (subject to soft-cliff erosion) and the village frontages (Bacton and Walcott, subject to beach lowering, dune erosion, and highly vulnerable to seawall overtopping) had been under consideration by private and public sector organisations for many years. The December 2013 tidal surge resulted in unprecedented erosion along the Terminal frontage, removing up to 10 m of cliffs (NNDC 2021; Clipsham et al. 2021). The already-compromised existing seawall defences of the villages of Bacton and Walcott were overtopped with consequent damage and extensive flooding, particularly at Walcott. This surge, often referred to as the "highest storm surge on the east coast of England for 60 years" (Meikle 2013, in Spencer et al. 2015), was due to a combination of high winds, low pressure, and high tides; for instance, the north Norfolk coast saw high significant wave heights (H_s) with peak H_s = 3.8 m offshore, 2.9 m inshore (Spencer et al. 2015).

The impacts of the surge triggered a widespread recognition that a tipping point had been reached (Brown et al. 2016b) for coastal defences in those locations and urgent action was needed in the face of increasing risk. Intense negotiations began among many organisations[1] including private operators at the Terminal, North Norfolk District Council (NNDC) as the local authority, Crown Estate, and various agencies, leading to new working relationships, consultation, and an unprecedented funding agreement (NNDC 2021). The overall objective was to find a feasible option that would enable the Terminal to withstand the eroding action of the sea without having an adverse effect downstream.

As a result, on 16 July 2019, after 5 years of negotiation, the Scheme implementation began (Bale 2019). The Scheme utilised 1.8 million m^3 of sand from a licenced offshore dredging site, deposited along 5.7 km of coast, from north-west of the Terminal (larger quantities of sand) to smaller amounts at the south-east of Walcott (NNDC 2021). This material was shaped to the required profile by skilled operation of heavy machinery and completed within 1 month. The height and depth of the beach were as a result visibly increased. The key inspiration for the Scheme was the larger multifunctional Dutch Zandmotor on the Delfland coast completed in 2011 (Stive et al. 2013; van Oudenhoven et al. 2019). Significantly, Dutch expertise (Royal HaskoningDHV) designed and implemented the Scheme. This required translating experience from the Netherlands

[1] Governance arrangements are complex: whilst the EA has strategic overview for coastal management and responsibility for river and coastal flooding, North Norfolk District Council (NNDC) is the authority responsible for maintaining coastal defences and related infrastructure across its coastal frontage (NNDC 2022).

into the UK context, and significant reinterpretation for its implementation due to very different governance structures, priorities, and processes. In comparison, Zandmotor utilised a 21.5 million m^3 of sand and created a dune lake and lagoon at a cost of €70 million exclusively funded by public money, from the Province of South Holland and the Ministry of Infrastructure and Water Management (Rijkswaterstaat) (Climate-ADAPT 2024). The smaller Scheme cost approximately GBP19 million Clipsham et al. 2021), funded by private and public contributions including from NNDC, Bacton Terminal Operators (who provided the majority), the EA, New Anglia Local Enterprise Partnership, Norfolk Business Rates Pool, Regional Flood and Coast Committee, and the local community.

The Scheme is the first of its kind in the UK, and a world-first outside of the Netherlands (RHDHV 2024). Like the Zandmotor, it is designed to evolve with coastal processes and is not contingent upon the addition of new containment structures, or additional re-topping of sand. It is intended as a NbS, absorbing and dissipating the force of the waves, protecting the Terminal and villages from erosion and coastal flooding, for 15–20 years (NNDC 2021) when—according to the modelling (comprising beach processes, cross-sectional beach profile, wave plume, and windblown sand modelling) used to assess the technical performance of the Scheme—most of its sand will have drifted elsewhere (Clipsham et al. 2021).

Methods

This study involved a mixed methods approach to data collection in June and July 2019 prior to the implementation of the Scheme. Interviews with key stakeholders involved in the development and delivery of the Scheme were undertaken, and separately a door-to-door household survey in Bacton and Walcott. Ethical approval for this study was granted by the University of East Anglia General Research Ethics Research Committee (GREC 18-1461).

Interviews

Before the sand deposition began, a total of twelve semi-structured in-person interviews were undertaken, exploring the origins of the Scheme, expectations about its likely impacts over time, and thoughts about what the future may hold for the management of the Bacton to Walcott coastal frontage beyond the lifetime of the Scheme. Participants included technical experts and coastal management practitioners involved in the design and delivery of the Scheme (seven interviews) and community representatives with coastal expertise (five interviews).

Household survey

The aim of the survey was to understand residents' opinions and views of the Scheme before it was fully implemented. The household survey was undertaken in the villages of Bacton and Walcott between the 11 and the 16 July 2019 (after the outfall pipe was installed but just prior to sand deposition). The estimated parish population in mid-2019 was 345 for Baton and 576 for Walcott (ONS 2020). In total, 350 questionnaires were distributed by hand to every second residential house in the villages of Bacton (11 July) and Walcott (12 July); completed questionnaires were collected on 15–16 July. Business premises, uninhabited dwellings, and holiday homes (visual examination of the premises and/or verbal notification) were excluded. Where householders did not wish to take part (indicated verbally or with no cold-calling cards), the adjacent or following possible house was sampled.

The questionnaire covered five main areas (see Supplementary Material):

1. Views and feelings about living in the area, on identity and attachment to place (questions 1–3) given their relevance during times of change (Clarke et al. 2016; Tschakert et al. 2017).
2. Views and feelings about any changes the Scheme may instigate (questions 4–8).
3. Views on processes leading to the implementation of the Scheme, including provision of information and role of social actors (questions 9 and 10). Recognition diverse perspectives and perceptions of process fairness may affect response to risk (Few et al. 2007).
4. Views and perceptions of climate change, including causes, salience, and timescales of potential risks (questions 11–14). Psychological distance of climate change may relate to concern and behavioural intentions (Spence et al. 2011); views of climate change may bear on coastal management decision-making (CCC 2018, POST 2021).
5. Socio-demographic characteristics and media use (questions 15–25).

Analyses

All interviews were recorded and transcribed. Transcripts were coded and analysed using NVivo 12 qualitative data analysis software (Lumivero 2023). NVivo enables the coding and systematic analysis of textual data. A content analysis was undertaken to identify key themes emerging from the interviews. Qualitative content analysis is based on inductive reasoning to identify themes emerging from the data, through iterative exploration, comparison, and examination of such themes, the relationships between them in

the context in which they appear (see Clark et al. 2021). Advantages include flexibility, structured examination of perspectives, summarising key features, and insights. This may, however, also result in inconsistency and lack of coherence in theme development (Nowell et al. 2017). To maintain confidentiality, interviewees are referred to only by a general identifier (interviewee 1 to interviewee 12).

For responses to close-ended survey questions, quantitative codes were devised and applied. The open-ended responses were transcribed verbatim and hand coded according to the main theme/s they presented. Quantitative data were inputted into the IBM SPSS Statistics software for analysis. The thematic analyses of the content provided by both questionnaire respondents and interviewees denote the value of this mixed methods study in eliciting participants' views (Table 1).

Findings

The various themes emerging from the interviews are presented in detail in the following sections, incorporating relevant responses from the questionnaire survey when pertinent. A total of 70 completed questionnaires contribute to this analysis.[2] Of the respondents, 51% were male, and 47% female; the majority aged 55 years or over (24.3% were 55–64 and 55.7% over 65). Many respondents had lived in the area for several years (17.1% 4–6 years, 15.7% 7–10 years, 14.3% 11–18 years, 32.9% 19 years or more, and 8.6% all their life). Of those who had moved to the area, 39% indicated it was for retirement, 19% for the amenities, and 11% for family and friends. Of all respondents, 63% strongly agreed and 33% agreed they liked living in the area; 40% strongly agreed (23% agreed, 30% neither agreed nor disagreed) that they feel attached to this area. Seventy-two percent strongly/agreed they would regret having to move elsewhere, and 77% strongly/agreed that it is important for them how the area develops; 63% strongly/agreed the area was important to them because of their lifestyle. Many (67%) indicated their knowledge of the Scheme as "fair", and some (20%) as "good". Information about the Scheme was received by respondents through NNDC consultations (44%) and leaflets (87%), local media (39%), and social media (23%) (respondents could indicate more than one source). Of all respondents, 90% indicated they thought the global climate was changing; 57% of respondents attributed climate change to a combination of human and natural causes and 31.5% attributed climate change mainly or entirely to human causes.

[2] Specifically, a total of 90 responses were received. Of these, five were not complete or completed by holiday makers, and a further 15 (nine from Bacton and six from Walcott) were returned by post, after the Scheme was in place; these were all excluded from further analysis.

Partnership working and funding innovation

The 2013 surge was unanimously referred to as the major catalysing factor underpinning the implementation of the Scheme. All interviewees clearly indicated that the presence of critical national infrastructure (the Terminal) facilitated the leveraging of blended financing for the Scheme to which the Terminal operators contributed a substantial investment.

Most interviewees (nine out of 12) were emphatic that the Scheme would not have come about without genuine collaboration, a spirit of partnership working and commitment by particular individuals (who also lobbied senior staff in their organisations about the importance of the project) over a long period of time. Of these, 4/12 noted that collaboration was enabled by good relationships among organisations developed in the preceding years; thus, the institutions and networks already existed, enabling agreements required for the Scheme to come to fruition (see reflections in Vikolainen et al. (2017)) and be maintained. These were repeatedly cited as being crucially important to achieving the outcome, e.g.:

> I don't think I have ever been involved in such a project that has had such trust, cooperation and drive from a very broad range of different organisations, from both the public and private sector […] It took drive and a lot of hard work from a number of different people from a number of different organisations to overcome some very significant hurdles. (Interviewee 6)

The Scheme was perceived by all as realising community and area co-benefits through very significant private sector investment (see Clipsham et al. (2021)) and a diversity of other funding, and durable partnerships working together for its delivery over 5 years:

> It's privately and publicly funded, which is very unique in itself. Obviously if successful, there could be more of this around the country. It has been challenging and not straightforward […], It's not just big companies looking after themselves. I do think that we have managed to come up with a really good solution that benefits us all, which I think is a wonderful thing to be able to say about this project actually. (Interviewee 7)

> I think a really healthy solution has been found. I think that everyone has played their part so there is fairness in terms of private sector funding, the key businesses that work for their particular frontage. Taxpayers' money is being used to address risk in line with Government rules…so it is very fair […]. (Interviewee 6)

However, tension was highlighted by some of the interviewees (5/12) between aspirations to innovate and implement adaptive coastal management options, and the restrictive policy backdrop. Whilst the government system for

funding coastal management schemes enables grants for defence works, options which deliver adaptation do not qualify, and are not associated with any alternative funding, hence the uniqueness of the Scheme. Interviewee 3 also expressed the hope that in the future adaptation would be mainstreamed into policy, becoming business as usual, incorporating the value and co-benefits of working with nature, rather than requiring exceptional actions.

Awareness and interest in the Scheme

Ongoing coastal change was indicated by all interviewees as a key concern for the local area, currently and in future (as also found by Cotton et al. (2022)). Due to erosion and restricted sediment availability from defended cliffs, sand levels had lowered over the previous decade, causing beach access to become more difficult and dangerous, increasing the vulnerability of the seawall to erosion, making it more likely to be overtopped during storm conditions. In fact, properties at Walcott and the coast road were flooded during the storms of 2007, 2013 (this affected also Bacton), and 2017; this recent event also caused a lowering of the beach levels near the Terminal of ca. 1 m (Clipsham et al. 2021).

Interviewees (8/12) maintained there was high awareness locally among engaged individuals (e.g. Parish Councillors, people whose homes and business premises had been flooded previously), but less interest or understanding otherwise (locally, nationally), in advance of the implementation of the Scheme. Although respectful of differing views, 4/12 interviewees noted the influence of inaccurate reports on social media, in contrast to other technical information in the public domain. Interviewee 2 mentioned the difficulty of connecting with communities at the beginning of negotiations of the Scheme; some (3/12) referred to misunderstandings about the funding of the Scheme. Interviewees (3/12) felt that local understanding of the Scheme would increase significantly when households received further information such as leaflets by NNDC (in fact, 72% of survey respondents had heard of the Scheme through local authority leaflets); that media attention and public interest would increase when the works began, for instance as a tourist opportunity (e.g. interviewees 1, 4, 9) supported by the wider more accessible beach: "… when there is a beach it transforms the place." (Interviewee 2) (see also Fig. 2 and Table 1).

Most interviewees (11/12) indicated that specialist attention to the Scheme was widespread, as was national political interest. Three interviewees explicitly referred to existing interest about the translatability of such a specific scheme to other diverse locations in the UK and further afield. Several (6/12) noted the huge investment that was made in the preparatory modelling work (interviewee 6) to ascertain as much as possible the behaviour of the Scheme over time:

> […] They are looking to find out what is learnt and capture that – and could we use this somewhere else? Could we look at other ways of managing our coastline in other locations. Because there are potentially multiple benefits; coastal protection, flood protection, but also economic regeneration potential. (Interviewee 2)

Assuaging anxiety, giving hope

Four interviewees (interviewees 8, 9, 10, and 12) mentioned the long-lasting impact of past flooding experiences. Several (6/12) specifically expressed hope that the Scheme may alleviate the worry and anxiety about the next storm or high tide and wind direction (north-westerlies, mentioned by interviewee 9) that had become so tangibly associated with flooding, disruption, and devastation in recent years. They reflected on how many people, particularly in Walcott, had also suffered sleeplessness, poor health, and post-traumatic stress disorder (PTSD) since the 2007 and 2013 surges and flooding in parts of the villages:

> This is the best thing that has ever happened to this village and hopefully it will work. I mean, some people never came back after that 2013 surge you know. They saw the devastation and went away. They had their homes repaired and sold them. They never actually moved back in. It traumatised people so much. […] It is being able to go to bed at night and know that everything is going to be ok. I mean, it will take time. It won't be instant. It could take two or three years even, and slowly over time we may even get a bit blasé and start putting precious things on the floor and not go to bed thinking I might die tomorrow. Not living in fear. (Interviewee 12).

> I am quite hopeful with the Sandscaping that there is a future, because without it I don't think there is one. [...]. (Interviewee 11)

Expectations of the Scheme

All interviewees consistently explained that the Scheme is expected to have a lifetime of around 15–20 years (as projected by the modelling), and most (10/12) were explicit about the uncertainty associated with an intervention of this kind, acknowledging it may be an under- or over-estimate. Working with natural processes, some interviewees (7/12) mentioned they expected the sand to migrate, reaching perhaps the villages of Happisburgh and Winterton.

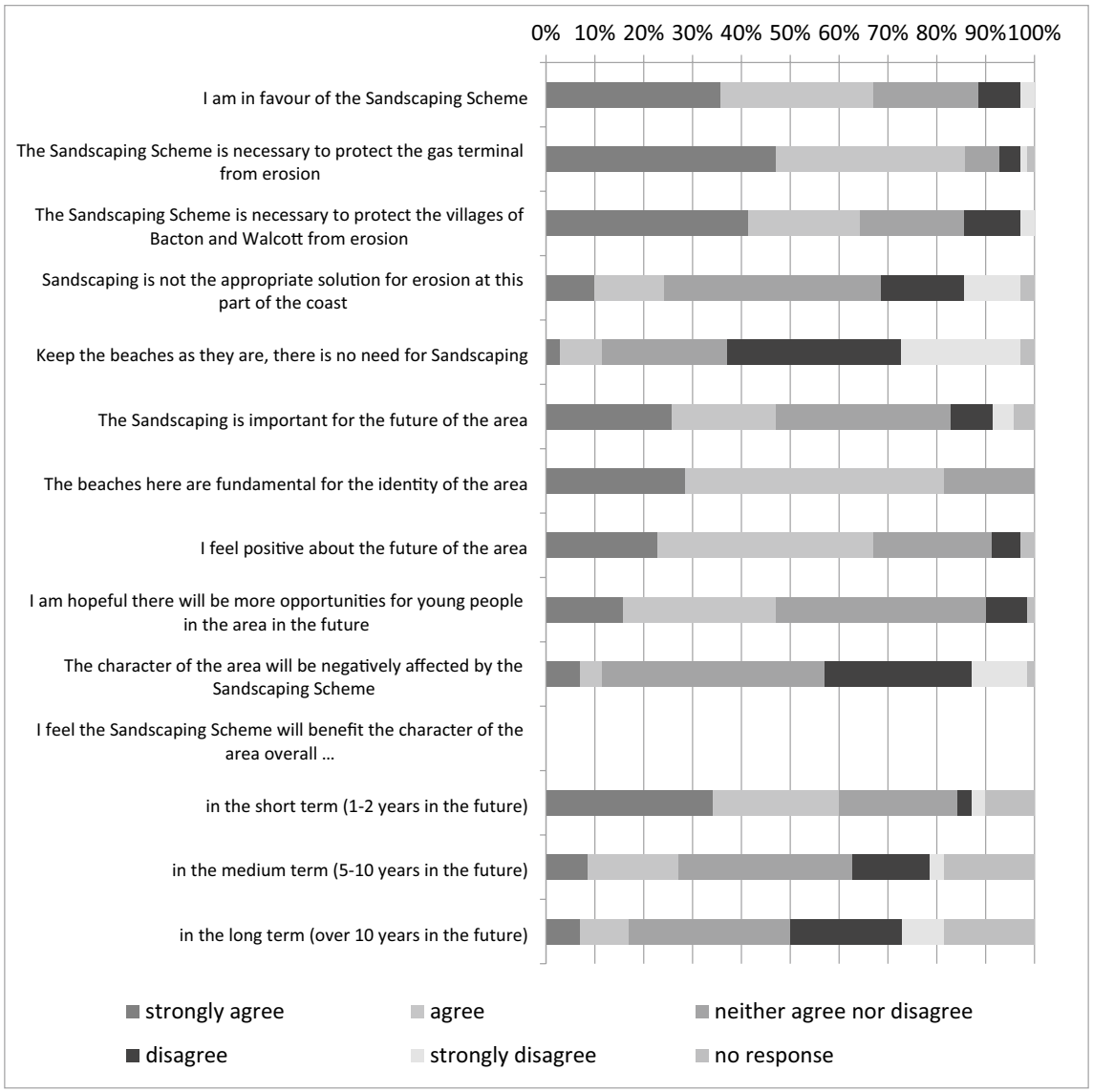

Fig. 2 Dis/agreement by survey respondents ($N = 70$) with these statements

Interviewees (9/12) were generally hopeful that it would benefit these locations; however, interviewee 1 explained that the drifting of sand is a slow process and that "it [the Scheme] is not going to resolve the issues … [in these locations] but it is not going to make it worse at least". As a NbS, over time:

> […] One of the other benefits of the Scheme is that it will technically self-decommission over time as the sand will create beaches along the coast. (Interviewee 2)

Interviewees (8/12) were aware of sceptical views, such as of those who questioned the effectiveness of the Scheme, e.g. sand could be washed away in the first big storm. However, five (out of 12) interviewees were not alarmed, recognising it could be a possibility, with the Scheme designed to function by sand moving to other areas and replenishing these. One interviewee acknowledged that this reflects natural systems which local residents have an understanding of, as beach levels fluctuate over time: "[…] people who live here have seen the beach come and go […]" (Interviewee 11).

Most survey respondents strongly/agreed with the necessity of the Scheme for protection of the Terminal (85.7%) and the villages of Bacton and Walcott (64.3%) (see Fig. 2). Few respondents (11.4%) strongly/agreed the Scheme would negatively affect the character of the area. Although survey respondents strongly/agreed that the Scheme will benefit the character of the area overall, the agreement with this reduces as longer timescales are considered: 60% strongly/agree about this in the short term (1–2 years), 27.2% in the medium term (5–10 years), and 17.1% in the longer term

Table 1 Perceived effects of the Scheme summarised from the interviews and survey responses. The interviewees often did not present these as mutually exclusive, but rather as a suite of related effects with some trade-offs. The questions and timescales were not entirely consonant for interviewees and survey participants as denoted in the table

Effects	Beneficial	Detrimental
Timescale [by interviews/survey]		
Near term [immediate/1–2 years]		
Common to interviewees and survey respondents	• More tourism attracted by the bigger beach	• Traffic congestion and parking issues due to increased numbers of visitors
Specific to survey respondents	• Protection of properties and villages • Improved beach quality and access • Benefitting the Terminal • Reduced anxiety	• Uncertainty on the permanence of the sand
Specific to interviewees	• More visitors to see sand works—good for local businesses although these are already at capacity	• Beach closures during peak season affecting local businesses • Traffic disruption due to heavy machinery/works vehicles on coast road
Near to medium term [next 5 years/5–10 years]		
Common to interviewees and survey respondents	• Changes to the beach and promenade • Protection of homes by the beach	• Windblown sand (likely in first couple of years) affecting the village
Specific to survey respondents	• As above	• Changes to the use of the beach and promenade (more restricted wheelchair access) • Uncertainty of the permanence of the sand on the frontage of the villages
Specific to interviewees	• High level of protection from flood and erosion risk, and associated hazards during storm events • Recovery/increase in house prices • Mental health benefits: ability to sleep at night, feeling safer and less anxious • Large, attractive beach • Useable beach with safe access • More beach visitors—good for local businesses although these are already at capacity • Amenity and recreation opportunities, e.g. becoming a kite surfing destination, tourism • Benefitting communities downstream	• Ongoing/increased inflation of house prices due to holiday homes • Inadequate parking facilities • Shortage of litter bins and other visitor facilities
Long term [5–20 years/beyond 10 years from now]		
Common to interviewees and survey respondents	• Protection for homes, attractive to holidaymakers	• Uncertainty on protection to current locations as sand may have been displaced over time
Specific to survey respondents	• As above	• Sand may have moved downstream thus not providing protection at these locations
Specific to interviewees	• Benefits to local economy and more sustainable communities; stability, security • Environmental benefits such as the possible development of a new promontory near the Terminal; establishment of vegetation and new wildlife habitat (e.g. Little Terns, Grey Seals) • Hope that younger people will be attracted to live in the village • Potential sand drift building up beaches further south • Opening opportunities to discuss justice for coastal communities (difficult conversations) • Translation to other UK locations • Changes in practices and policy enabling mainstreaming of adaptation into planning policy at the coast, especially important for communities at risk	• Uncertainty over performance of the Scheme (e.g. a storm, in ecological terms) • Uncertainty over wider benefits to downstream communities • Scheme may be considered too expensive to be implemented elsewhere • Options if the Scheme does not work as modelled and anticipated benefits are not realised: expensive alternatives (managed retreat, sand replenishment, other?) • Uncertainty on what happens "after the Scheme": decommissioning of the Terminal? Redeployment of the Terminal as a low carbon option (e.g. carbon storage), making it defendable again? Making managed realignment a possibility? • Complacency among residents that they will be protected in the longer term (rather than adapting)

(over 10 years in the future). The views shared by interviewees and survey respondents in open-ended questions on the potential effects of the Scheme over time are summarised in Table 1.

Interviewees unanimously underlined the dependency of the Bacton to Walcott frontage on the performance of the Scheme, in turn linked to the long-term viability of the Terminal. Seven interviewees considered there may be some sand replenishment depending on how circumstances evolve (although no communications from the Council or Terminal operators have ever mentioned that option; it is made clear that this is a one-off large-scale beach nourishment event), e.g.:

> I think it [the management of this coast after the Scheme's lifetime] is very dependent on how useful the gas terminal is in 20 years' time and if it is still fully functional then I would expect that it would re-nourish and that the Scheme would continue in some way. (Interviewee 11)

On the other hand, the Terminal could be decommissioned or moved, given evolving energy and climate policy, e.g.:

> With regard to the Gas site […] the estimate is 25 years, which is now probably 20. But that is something that will have to be an ongoing dialogue […]. I mean with climate change a big push is on renewables – will we still be wanting gas? (Interviewee 1)

Without further intervention (i.e. no more sand replenishment on the beach), one interviewee suggested the coastal system may alter perhaps more rapidly than it would have otherwise done had erosion occurred without the Scheme:

> If the gas site is decommissioned then I would expect that there wouldn't be anything done and we would be subject to quite a massive case of erosion within the next few years after that. (Interviewee 11)

Seven interviewees also indicated how the Scheme has displaced the urgency of dealing with impact at the Terminal and villages from erosion and flooding, providing time to consider adaptation in the longer term. It was recognised that such difficult conversations should be had, given the unavailability of clear guidance on adaptation governance and policy. There is a need for anticipatory adaptation (e.g. interviewees 3 and 5) and engaging with publics and local communities so that "they keep thinking about moving out of harm's way" (Interviewee 1), perhaps relocating through managed realignment (e.g. interviewees 6 and 7). The political challenges of such processes were also recognised:

> So this Scheme is buying time to think about how we can cope, and how communities can cope and adapt in light of climate change. (Interviewee 2)

> Hopefully the Scheme gives people confidence that for now they are at a much lower risk of flooding and erosion for the foreseeable future. The challenge for the local authority is going to be of course does that lead to complacency […] (Interviewee 4)

> Well, if we leave it for 20 years it will be too late. […] we have to be looking into the future […] our biggest challenge I think will be to work with the vulnerable communities to prevent them from being vulnerable. (Interviewee 1)

> I would hope […] that there are some sort of plans, definite plans, which would involve perhaps moving the community to another area […] that it is positively managed rather than ignored with false hopes and promises if you like. You know, a managed retreat I think they call it. Something along that line is the least that people should expect I think. (Interviewee 11)

In the meantime, added six interviewees, there is a need for exploration of further funding possibilities and policy innovation (such as adaptation included in planning policy) supported by longer-term collaboration, as well as honesty about the dynamic nature of the coast, its impermanence, and inherent uncertainty in future change.

Although there was a general recognition (by 10/12 interviewees) that the Scheme is a relatively short-term intervention enveloped in uncertainty, the performance of the Dutch Zandmotor was inspiring (mentioned by five interviewees) and instilled hope (e.g. interviewee 2). We note that without the willingness to experiment and innovate in the Netherlands, resulting in the Zandmotor and its somewhat unexpected benefits (Zandmotor Monitoring 2021), the Scheme would likely not have occurred.

Discussion

Experimentation and innovation in coastal management resulted in the Bacton to Walcott Coastal Management (Sandscaping) Scheme, implemented in 2019. This was undeniably triggered by the 2013 tidal surge event, which exacerbated recurrent and long-standing erosion and flood risk impacts, bringing the need for radical action and an innovative approach into sharp focus across several actors. Innovation on this scale was made possible by the presence of a major national energy asset (the Bacton Gas Terminal), run by operators willing to substantially fund and engage with other coastal management stakeholders in seeking a proactive coastal management option (which had to be considered along with the impacts on adjacent vulnerable

communities). Concurrently, the 2013 storm affected other northern European countries, opening up opportunities for diversifying coastal management, e.g. in Denmark (Sorensen et al. 2016).

The Scheme is a timely example of an opportunity for AG in the form of institutional experimentation across different spatial scales where coastal managers, the private sector, engineers, and communities actively sought to collaboratively implement another solution to a complex problem rather than defence at all costs. The findings of this study undertaken just before the implementation of the Scheme highlight the fundamental significance of the collaborative and proactive approach (e.g. Naylor et al. 2019) that was taken to deliver the Scheme. The championing of this solution through leadership and dedication of particular organisations and individuals was crucial to its implementation.

The Scheme is seen by the interviewees of this study as an innovative and tailored solution to an urgent problem, which works with natural processes and allows time for both Terminal and local communities to look to the future with relative reassurance. Expectations evoke the indirect benefits of the Scheme for the local area beyond its intended function, such as boosting the local economy as more visitors are attracted to the large beach (as occurred for the Zandmotor) and assuaging local mental health problems as the acute fear of the adverse effects of another storm event are tempered (recently residents have indicated the Scheme makes them feel safer; Morelle 2021). However, other potential negative impacts were also raised, including windblown sand (which was expected, and occurred in February 2021; Johnson 2021), traffic congestion, and lack of parking facilities (associated with likely increase in visitor numbers).

Key strategic aspects were raised mainly by interviewees, offering opportunities as well as challenges, such as space for discussion of justice for coastal communities across wider geographical areas, mainstreaming adaptation into coastal planning policy, managed realignment, repurposing of existing infrastructure (e.g. Terminal). Concurrently however uncertainties were expressed on the implications of the Scheme evolving differently to the modelling, and the options and readiness for community adaptation. Whilst acknowledging some local scepticism about the Scheme, all interviewees conveyed excitement, relief, and a strong sense of achievement on the eve of the Scheme's implementation. Among informed practitioners and public, there appears to be strong trust in the scientific and technical basis to the Scheme; also, an acknowledgement of the inevitable uncertainty over its expected performance and lifetime as it is an intervention that works with natural system processes. Fundamental to the creation of the Scheme was the willingness to experiment in the Netherlands (through, it could be argued, forms of AG), which fostered significant exchange in technical expertise between UK and Dutch collaborators. This international partnership continues to monitor the geomorphological evolution of the Scheme, whilst there is local interest in the socio-economic impacts and how these evolve over time.

As an example of a NbS, the Scheme is intentionally impermanent in its current location and its design demands low costs for further maintenance. These will be put to the test as the beach profile evolves over time. Monitoring and analysis indicate that "the scheme is behaving broadly in line with the design predictions, in terms of alongshore interaction and the scheme's lifetime" (Borsje et al. 2024, p. 1471). Many insights are yet to be learnt about the technical aspects of the Scheme, as well as on implications and repercussions for coastal governance in this area, as other effects of the Scheme emerge (possibly on economic regeneration and social well-being, the intangible co-benefits which could not be originally linked to or ascribed to the Scheme a priori; Clipsham et al. 2021, refer to the challenge of quantifying wider benefits enabled by the Scheme such as social mobility and health). The implementation differences between the Zandmotor and the Scheme highlight the importance of careful translation of such a Scheme to other locations, which may differ on a variety of elements, including coastal geographies, governance and funding requirements, community perspectives, and approaches to long-term change.

We argue that the innovation and experimentation introduced by the Scheme opens the possibility of institutional change reminiscent of AG; it is unclear to what extent this will be maintained or indeed developed in the future. This study has pointed to a crisis in environmental governance in a constraining and reactive system underpinned by a lack of coherent national policy. The Scheme has provided some relief and "is buying time". It is, however, too early in the development of the Scheme to gain insights on whether the innovation and collaboration created by the implementation of the Scheme have led to more resilient forms of governance, For example, the hope mentioned by interviewees on eventually achieving a national policy on how to effectively reconcile social, economic, and political considerations on coastal erosion and flooding to enable communities to reduce risk and adapt. We are unable yet to grasp if whether and how paradigms on coastal management are developing because of the Scheme, and whose voices and perspectives on loss and hope are built into shaping the future. Certainly, it is a unique but one of many new initiatives emerging in the UK, which are providing evidence for doing things differently as a result of a coastal governance policy framework which does not yet enable adaptive approaches. As we write the Scheme has been in place for nearly 5 years. Although the EA's Strategy calls for creating greater resilience to flooding and coastal management, this study has highlighted the need for attention to be paid to *how* to deliver resilience. The Scheme delivery team necessarily had to develop a new

funding arrangement through collaboration among a wide range of stakeholders at multiple scales, which continues to evolve—without this unconventional approach, the Scheme would not have been deliverable as a local solution. Further longitudinal work is required to examine how governance arrangements may enable an effective shift towards adaptive governance processes and outcomes.

The future of the Terminal is inextricably entwined in people's thoughts about what will happen on this coast beyond the lifetime of the Scheme. When considering that decommissioning of the Terminal may occur, many interviewees firmly articulated the need for national and regional policies and local plans to be put in place with many years (if not decades) of lead-time, to secure the future of local communities enabling resilient responses to change. Participants to this study widely acknowledged the need to overcome any complacency and start using the time provided by the Scheme to shape a hopefully more resilient future. Here, the insights from Tschakert et al.'s (2017, p. 13) work may be of assistance; they argue for time and space to collectively examine ways of deliberating and mapping possible harms and devising ways to foster agency, cope with, and "engage with unavoidable loss" that may run counter to the more established perspectives on quantifying change and assessing risks and benefits.

This mixed methods study enables an understanding of experiences and views of local communities and stakeholders in this particular context. Although the detailed findings of this study cannot be generalised to other locations, the insights already apparent may be of value to others interested in innovative technical and governance options for adaptively managing coastal change. Vikolainen et al. (2017) suggested that the Scheme could be considered a "revelatory case" for drawing lessons for other high-potential locations for large-scale sandscaping. Our study similarly finds that tailoring any sandscaping proposal to the specificity of the context in which it may be undertaken is paramount. The experience with the Scheme shows that collaboration and sustained effort among key stakeholders and funders were essential for its realisation. However, it is also evident that the ways in which local residents articulated and expressed their understandings and expected value of the Scheme partly overlapped but also partly differed from the views of those that implemented it. Thus, being receptive to the deep feelings of loss and hope and how these may shape societal responses to action once a scheme is enacted are, in our view, important lessons to consider and plan for before any such scheme is carried out.

Shared personal narratives of experiences from involvement in such experimental, innovative projects can also derive valuable insights and learning (Bontje and Slinger 2017, on the Dutch Zandmotor) and could provide inspiration for future work in this area. Crucially, conversations on the future of the local area and wider region (with coastal communities at risk and others) are required although these may lay bare deep emotive responses, as imaginaries of possibilities from now to the end of life of the Scheme and beyond are considered and discussed, cognisant of the evidence that experimental and innovative governance options can be achieved.

Conclusions

In considering the expectations associated with the implementation of the Bacton to Walcott Coastal Management Scheme, this paper highlights the importance of local and regional, corporate, and public government collaboration, fostered by individual determination, in enabling such an innovation to become a reality. Additionally, the relief and assuaging of anxiety through the security it was expected to create locally, despite longer-term future uncertainties, were palpable. Examining an anticipated Scheme of this type exposes both the vulnerability and complexity of the local situation in terms of coastal, institutional, and socio-economic dynamics, as well as a scarcity of viable response options, in space and time. Paradoxically, the need for the intervention to a suite of risks likely to be exacerbated by climate change was catalysed in part by the need to ensure security of natural gas supply as well as the safety of local settlements. This raises deeper considerations around the inter-relatedness of climate change adaptation and mitigation considerations, alongside the need to work with natural systems rather than to simply try to stop coastal change. The Scheme captures and is based upon ingenuity and innovation for incremental adaptation, which does not lock-in future commitment or vulnerability. It is important that researchers continue to engage with this and related schemes. Can and will the Scheme provide an opportunity and motivation for other flexible and adaptive coastal governance interventions? Will it contribute to discussions around local and national coastal transitions? What we can be sure of is that learning arising from the delivery of the UK's first large-scale beach nourishment scheme in North Norfolk provides important evidence for the development of local initiatives, with implications for regional coastal management and coastal policy over the coming years.

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Declarations

Ethics approval Ethical approval for this study was granted by the University of East Anglia General Research Ethics Research Committee (GREC 18-1461), which includes informed consent.

Conflict of interest Since the data collection reported in this manuscript was undertaken, Sophie Day is seconded with NNDC; Irene Lorenzoni and Trevor Tolhurst collaborate with NNDC via a PhD research project; Sophie Day, Rosalind Bark, and Irene Lorenzoni undertook a consultancy project in 2023/24 for the Royal Haskoning DHV and The Crown Estate on local views about the Sandscaping Scheme.

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