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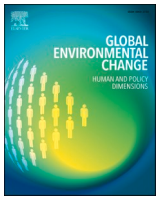

Challenges to anticipatory coastal adaptation for transformative nature-based solutions

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ABSTRACT

Much of England's coastline is underprepared for adapting to long-term coastal change, with many coastal areas moving from 'hold the line' to managed realignment as this century progresses. This paper offers a unique case study of a frontage experiencing this transition. It explores the perspectives of Bacton and Walcott residents and coastal policymakers on managing the risk of coastal change for the Bacton-Walcott frontage on the Norfolk coast (UK), after the projected lifetime of a nature-based solution (NBS), known as sandscaping. Drawing upon survey and interview data, this research finds local residents have an increased sense of security of future coastal change through the perceived importance of the nearby Bacton Gas Terminal (currently supplying up to a third of the UK's gas supply), and the protection afforded to it by sandscaping. For policymakers, sandscaping has bought time to prepare for managed realignment, whereas for residents, sandscaping has bought time to postpone it. There is a risk of maladaptation if reduced concern of future erosion affects willingness to engage in coastal adaptation in the present. This case study highlights the multiple temporal and spatial interests in coastal management, where decision-making at a local level has national-scale implications for domestic energy supply, and where novel nature-based solutions may bring additional uncertainty and complexity to building social resilience. It provides insights on the challenges of anticipatory adaptation, which is of relevance to other coastal areas looking to mitigate climate impacts and better prepare against future risk.

1. Introduction

It is widely argued in literature that anticipatory adaptation to climate change is needed, to ensure a more just and resilient response that reduces or avoids maladaptation (Folke et al., 2010; O'Brien, 2017; Haasnoot et al., 2021; IPCC, 2022). 'Anticipatory' or 'proactive' adaptation refers to actions in advance that prepare for future climate impacts, in contrast to reactive adaptation, which is a response during an event (IPCC, ibid). Coastal areas are particularly vulnerable to natural change and climate change impacts, where rising sea levels and more intense and frequent storms threaten areas of significant population density, infrastructural assets, or cultural heritage (Nicholls et al., 2013). Despite this vulnerability, there is currently limited worldwide progress (Magnan et al., 2023) in preparing for future coastal change through anticipatory adaptation. This is evident in England (CCC, 2018; 2023), where nearly a third of the coastline may be required to adapt from its current location ('hold the line') to a revised configuration, possibly through 'managed realignment', as this century progresses, under high warming scenarios (2–4 °C) (Sayers et al., 2022).

Managed realignment is a policy option that allows the shoreline to change position (in contrast to 'hold the line' where a fixed position of the shoreline is defended) (Oppenheimer et al., 2019). It is often used synonymously with 'managed retreat', which refers to the movement of property, infrastructure, or whole settlements at risk away from the coast (Oppenheimer et al., ibid). With rising risk, the current Flood and Coastal Erosion Risk Management Strategy (FCERM) (Environment Agency, 2020) advocates moving from more reactive to anticipatory coastal adaptation measures, such as planned property rollback (moving or redeveloping infrastructure at risk of erosion further inland) and the relocation of settlements. Undefended coastal areas across England have a limited window of opportunity to enact anticipatory adaptation, and in several places demolition of at-risk property has already been necessary,

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such as in Hemsby and Happisburgh, both located in Norfolk (BBC, 2023a). Research is therefore urgently needed to understand how to facilitate a willingness to adapt proactively to coastal change amongst affected communities.

Whilst it is strongly argued that communities need ample time to prepare for coastal adaptation (Day et al., 2015; MacDonald, 2016; NNDC, 2016; Environment Agency, 2020), other authors have argued an overemphasis on time, and an overemphasis on the future, affects the way in which individuals perceive and adapt to risks in the present (Nobert and Pelling, 2020). Studies on adaptation to extreme heat (Wolf et al., 2009; Porter et al., 2014; Nobert and Pelling, 2020) find households typically opt for reactive adaptive measures (e.g. clothing choices) rather than proactive or anticipatory measures with long lead-in times (e.g. retrofitting air conditioning). In a coastal context, international studies highlight that coastal defences can undermine risk perceptions for vulnerable communities (Luis et al., 2015; Arias et al., 2017; Nunn et al., 2021) where over time experience of storms and strong attachment to the coast combine to increase risk normalisation (i.e. acceptance of coastal risk) (Luis et al., 2015; Domingues et al., 2017; 2021; Bertoldo et al., 2021). Crucially, Luis et al., (ibid) argue the role of risk perception in motivating coastal adaptation may be time-sensitive, and weaken if risk is perceived to be far into the future. A large number of factors have been found to contribute to risk perceptions or concern of climate change, and include perceptions of personal vulnerability (Sjöberg, 2000), the scale of the issue (Kollmuss and Agyeman, 2002), direct experience of flooding or extreme weather (Spence et al., 2012; Capstick et al., 2015; Demski et al., 2016; Arias et al., 2017; Bruine de Bruin and Dugan, 2022), political values (Whitmarsh, 2008; Ogunbode et al., 2017) and age (Grothmann and Reusswig, 2006; Whitmarsh, 2008; Zaalberg et al., 2009).

Nature-based solutions (the use of natural features and processes rather than man-made infrastructure (Seddon et al., 2020)) are increasingly framed as an alternative to the repeated use of hard defences in coastal management (Nunn et al., 2021) which can result in long-term maladaptation. While one potential role of certain nature-based solutions in buying time and providing a stepping stone from 'hold the line' to 'managed realignment' has been acknowledged for UK coastal management (Brown et al., 2023), there is little research directly evaluating this and the practical dimensions of the policy transition (Brown et al., 2023), alongside a lack of case study research at a local level on adaptation to coastal change (Harcourt et al., 2023; Magnan et al., 2023). Anticipatory adaptation in contexts where nature-based solutions are introduced has been understudied, with previous research on nature-based solutions instead exploring public perceptions on their effectiveness (Gray et al., 2017; Joseph and Humphries, 2018; Anderson and Renaud, 2021), uptake (Moraes et al., 2022) or underlying policymaker or stakeholder motivations for their introduction (Santoro et al., 2019; Ferreira et al., 2022).

This paper explores the significance of the Bacton-Walcott sandscaping scheme, a coastal nature-based solution on the Norfolk coast, in regards to local residents' perceptions of future coastal risk, and a future policy of managed realignment. The Bacton-Walcott scheme was implemented to protect the nationally important Bacton Gas Terminal, and adjacent villages of Bacton and Walcott, from flood and erosion risk for 15–20 years (Johnson et al., 2020). Sandscaping has dramatically increased the height and volume of Bacton and Walcott beach (Johnson et al., 2020), and is argued in this paper to be a transformative nature-based solution, given it fits all three of Kates et al's. (2012) categories of transformational adaptation, in that it is innovative, large-scale, and significantly alters the geomorphological (and thus very likely the ecological) structure and functioning of the coastline. Sandscaping has brought significant socio-economic benefits to the area, alongside coastal protection (Day, 2020; Cotton et al., 2022; Day et al., 2023), one of which is providing the high-risk coastal frontage with time to prepare for managed realignment after the lifetime of the sandscaping. This study in this paper seeks to understand local residents' perspectives of coastal management post-sandscaping, and how these perspectives may differ from those of coastal policymakers. At the time of writing, there has been no public communication by either the local council or Bacton Gas Terminal operators that the sandscaping scheme will be repeated. There has, however, been frequent media coverage speculating that Bacton Gas Terminal will repurpose into a Bacton Energy Hub in the future and supply renewable energy (for example EDP, 2023). Drawing upon survey and interview data of local residents elicited in 2022, three years after the sandscaping occurred, alongside interviews with coastal policymakers in early 2023, this paper examines perceptions of future coastal risk and a future managed realignment policy at Bacton and Walcott, amongst the two different stakeholder groups.

2. Materials and methods

2.1. Introduction to case study

The Bacton-Walcott frontage is located on the North Norfolk coast (see Fig. 1), and sits within Shoreline Management Plan (SMP) 6 (Kelling Hard to Lowestoft Ness) (AECOM, 2012). It encompasses the villages of Bacton (1,194 residents) and Walcott (548 residents) (ONS, 2011), and Bacton Gas Terminal, nationally important energy infrastructure that currently supplies up to a third of the country's gas (as well as supplying gas internationally) (Shell, 2021), with potentially a shift to renewable energy in future (see below). The revised SMP 6 publication in 2005 designated a 'hold the line' policy for Bacton Gas Terminal, and managed realignment from 2025 at Bacton and Walcott (AECOM, 2012). The frontage is highly susceptible to erosion and flooding (RH, 2017), with approximately 200 properties damaged during the 2013 floods (Mott MacDonald, 2016). Long-term average erosion rates are estimated to be 1.3–1.7 m yr^{-1} (at Bacton) and 1.0–1.2 m yr^{-1} (at Walcott) (from 1937–2016, (RH, 2017)), with the terminal becoming increasingly near to the cliff edge. Meanwhile, the residual lifetime for pre-existing hard defences (timber revetments and a sea wall) was estimated to be 5–15 years (Mott MacDonald, 2014).

As a result, a UK first in the form of mega-nourishment ('sandscaping') was completed in summer 2019 (Johnson et al., 2020). Sandscaping involved placing 1.8 M m^3 sediment on the coastal frontage, a significantly larger-scale process than traditional beach nourishment (Mulder and Tonnon, 2010). Sandscaping is described as a coastal nature-based solution in this paper, because it utilises longshore drift and other coastal processes to redistribute sediment cross-shore and alongshore over time, resulting in a more natural beach shape and buffer from the effects of coastal storms (POST, 2021). Like other coastal nature-based solutions, sandscaping therefore works with natural coastal processes to create a dynamic coastal system, and mega-nourishments like sandscaping can support dune formation, a type of living shoreline (Hoonhout and de Vries, 2017; van Bergen and Nijhuis, 2020). The scheme cost £21 M, two-thirds of which was funded by Bacton Gas Terminal, and the remainder through the Environment Agency, the local council (North Norfolk District Council, NNDC) and other local funding contributions (Johnson et al., 2020). The availability of private revenue to fund the majority of the project cost, through a partnership approach, made the scheme economically viable (Vikolainen et al., 2017).

In December 2022, the Bacton Energy Hub Special Interest Groups (2022) produced a report outlining the business case for renewable energy development at the site (hydrogen, offshore wind, and Carbon Capture and Storage (CCS)). Soon after the Government's announcement in summer 2023 of continued annual gas and oil licenses in the North Sea (HM Government, 2023), Bacton Gas Terminal was officially granted a license for CCS from the North Sea Transition Authority (NSTA) in September 2023, the first time such permits were authorised (NSTA, 2023). During a visit to Bacton Gas Terminal in Autumn 2023, the UK Prime Minister Rishi Sunak described it as a 'hidden hero' for UK domestic energy production (BBC, 2023b), signalling strong political

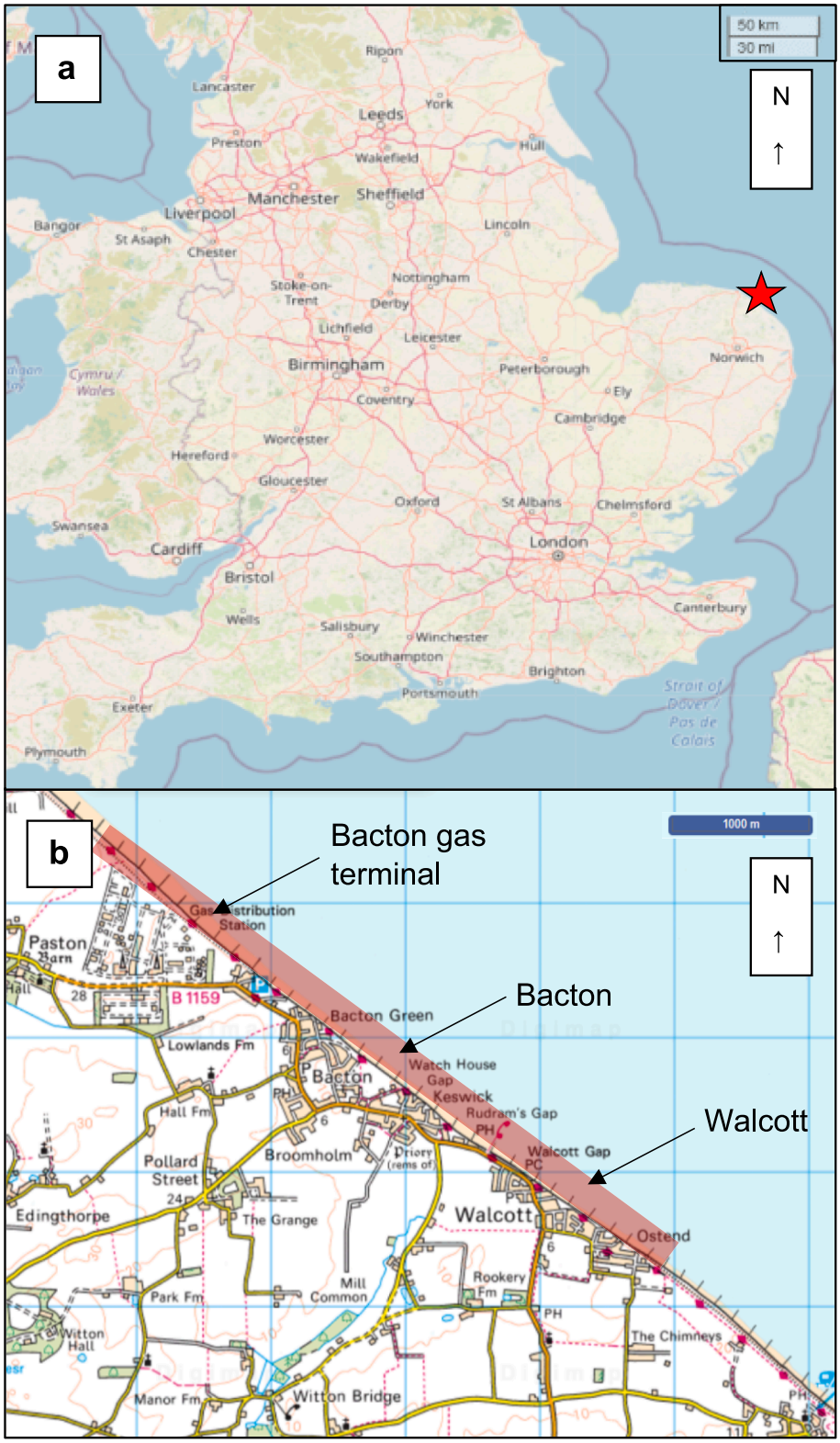

Fig. 1. Case study location of the Bacton-Walcott Sandscaping scheme on the North Norfolk coast (East coast of England, starred in map a). Red shading in map b indicates the approximate area of initial placed sediment and coastal protection of the sandscaping scheme, July 2019 (annotated from © Edina Digimap). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

interest at a national level in continuing to protect the gas site from the risk of coastal change, and the role it could play to meet the UK's 2050 Net Zero target. In 2023, the local council (NNDC) launched Coastwise, which is one project that is part of a £36 M programme funded by Defra to trial different initiatives at a local level for coastal adaptation. The Coastwise website (NNDC, 2023, p.1) includes information about "*the plan for the Bacton to Walcott coastline once the sandscaping has depleted*". It states there is a possibility 'further coastal work' may take place by Bacton Gas Terminal, but it does not specifically refer to a repeat of sandscaping, nor that any future work would protect the villages of

Bacton and Walcott again. Instead, it stresses that the frontage should prepare to adapt to coastal change (under managed realignment):

> *"The project* (sandscaping) *looks to provide up to 15 years of protection for the Bacton Gas Terminal, creating time to plan and prepare for coastal change in this area. The terminal may complete further coastal work to protect the site in the future. This may benefit the Bacton to Walcott coastline, but this is not certain. We will need to work with the communities to plan for future coastal change, and Coastwise allows us to begin this planning process" (*NNDC, 2023*, p.1).*

2.2. Data collection

Local resident perspectives of managing future erosion risk for the Bacton-Walcott frontage were investigated through a paper survey (in January 2022) and semi-structured interviews (October and November 2022). This data collection corresponded with approximately two years (survey) and three years (semi-structured interviews) after the sandscaping occurred in July 2019. Paper surveys were delivered to approximately every other domestic house and collected the following week, excluding holiday parks and business properties. The survey elicited views on the impacts of the sandscaping scheme, its perceived effectiveness, and perspectives of managing coastal change in the present-day and future. Respondents were invited to take part in an interview to explore these topics in further detail, by opting-in at the end of the survey; interviewees were also recruited through word of mouth and by advertising through local community groups and pages. In particular, interviews explored residents' views on the future of Bacton Gas Terminal, and managing coastal risk at Bacton and Walcott during and after the sandscaping scheme. An information sheet was provided to participants detailing more information about the study and how research data would be stored and used, but did not provide background information on sandscaping or coastal climate change impacts, so as to not influence public perceptions. The study received ethics approval from the researchers' University internal ethics committee in December 2021.

Participants had the choice to complete the survey using the paper version distributed to their home, or online, and take part in a more in-depth interview in-person, online, or over the phone, with the format chosen by the participant. In total, the survey yielded 77 responses out of 372 delivered surveys; from Bacton (48) and Walcott (29) (a 21 % response rate overall). In addition to this, 22 residents took part in the more in-depth interview (15 from Bacton and 7 from Walcott). This included one walking interview, where due to weather conditions it was not possible to record or transcribe. Subsequently, six policymakers (identified through purposive sampling) working within a coastal flooding or erosion context were interviewed about managing coastal change on the Bacton to Walcott frontage, and coastal adaptation. This comprised of policymakers working at a local, regional and national level, all of whom were familiar with the sandscaping scheme and SMP policy context at Bacton and Walcott. Interviews with policymakers took place online (on Microsoft Teams) in January and February 2023.

2.3. Data analysis

Closed-text survey questions were analysed using descriptive statistics in Microsoft Excel, and open-text survey questions and interview data were thematically analysed using a three-stage approach advocated by Charmaz (2006) (1 – initial codes, 2 – focused codes, and 3 – theoretical codes), therefore moving from inductive to deductive coding. Interview transcripts were imported and coded in NVivo (release 1.6.1-1.7.1) (QSR, 2022). In step 2 where relevant, some parent codes were divided further into a subset of related 'child' codes. Parent codes were subsequently arranged according to three overarching themes in the data ('coastal management', 'scale' and 'adaptation').

3. Results

Table 1 summarises the codes and themes emerging from the interview data. The results section is ordered according to these three themes, and first presents views of sandscaping and Bacton Gas Terminal (section 3.1, which corresponds to codes under the first theme 'coastal management' in the Table), followed by views on managed realignment in general and maladaptation (section 3.2, which corresponds to codes under the other two themes 'scale' and 'adaptation' as set out in the Table).

3.1. Feeling secure and the future of Bacton Gas Terminal

3.1.1. Local residents' perceptions

Over three-quarters (n = 17) of the Bacton and Walcott residents interviewed expressed a sense of security from the risk of coastal erosion or coastal flooding by living adjacent to Bacton Gas Terminal. The terminal was described as an infrastructure that will be protected at any cost. Although the community were vulnerable to flooding and erosion before sandscaping, some residents who had previous direct experience of storms commented that the introduction of sandscaping has assuaged any previous concerns about property damage.

> *"I said 'Look. Look out of our window, you've got two aerials there, and you've got Bacton gas site. They are not going to let that drop into the sea, because it supplies a third of the country's gas'. So, as long as that is there, this little house will be fine"* ~ Bacton resident
>
> "*I think that we're very lucky 'cause we're one of the sort of safest places on the North coast for erosion because, we have got the gas site and they will never let it fall into the sea*" ~ Bacton resident
>
> *"Our house had been trashed, and we had to move out for 15 months… We weren't overconcerned, unless we heard that the wind, the tides, and what have you were going to get that surge again… while that sandscapings there, I don't believe it will. I believe we are perfectly safe"* Bacton resident

Contributing to this perceived sense of security is the observation that the implementation of sandscaping occurred at a time when elsewhere along the Norfolk coast there had been no further intervention, despite high erosion risk:

> *"I should imagine that Happisburgh, Hemsby, Scratby and that area, they'll be the areas that will be in need of moving, because already properties have fallen into the sea, so again, it may not look the prettiest thing, but the gas works in Bacton are really significant to Walcott, because they've got to protect that in the short term"* ~ Walcott resident
>
> *"Bacton feels like a really secure location because so much has been committed to ensuring we stay buffered…when everything else is so uncertain at the moment, I mean the fact that we can be fairly sure that we won't fall into the sea like Happisburgh residents"* ~ Bacton resident

Furthermore, residents reflected that Bacton Gas Terminal will only increase in importance in the coming decades: socioeconomic and geopolitical issues at the time of the interviews (Autumn 2022), such as the cost of living crisis and war in Ukraine, were both mentioned by resident interviewees as evidence that the terminal is of great importance to the UK's energy security. While several residents debated whether this would change through the pursuit of green energy policies, it was more commonly thought that the terminal will repurpose as a hydrogen and CCS site in the future, and therefore remain a critical energy infrastructure for the UK in the decades ahead.

> *"I did read an article. I need to reread it, which I think said something about using the gas field, the empty gas field, for carbon capture? …Yeah, so they'd have to maintain that, I suppose, wouldn't they?* ~ Bacton resident
>
> *"The money that the North Sea is going to generate, to put that sand there again by the Dutch, it's peanuts…they earn so much money out of those*

Table 1
Themes (column 1) and codes (columns 2 and 3) arising from 21 interviews with Bacton and Walcott residents, and six interviews with policymakers. As outlined in section 2.2, counts for Column 4 in Table 1 are out of 21 rather than 22, due to one resident walking interview where it was not possible to record or transcribe. Some parent codes (column 2) are divided further into relevant child codes (column 3) (parent codes without child codes are listed as 'n/a' (not applicable) in column 3). In columns 4 and 5, codes with light grey shading = expressed by residents only, codes with dark grey shading = expressed by policymakers only, codes with no shading = expressed by both interview groups. (T the number or % references by policymakers are shown in brackets). Codes are arranged within each theme group (column 1) according to most common codes (see number of interviews that expressed a particular code, column 4).

1. Themes	2. Parent Codes	3. Child Codes	4. No. interviews expressing code (policymakers only shown in brackets)	5. No. references expressing code (policymakers only shown in brackets)
Coastal management	Bacton Gas Terminal	n/a	17 (4)	34 (29%)
	Feeling secure	n/a	17	47
	Perceived responsibility	Policymaker responsibility	13	26
		Community responsibility	(2)	2 (100%)
Scale	Scalar mismatches	Temporal	18 (6)	29 (52%)
		Spatial	13 (2)	19 (11%)
		Jurisdictional	13 (5)	43 (70%)
	Environment/ social tensions	Climate change	11 (3)	21 (24%)
		Need to consider environment	8	16
	Uncertainty	n/a	8 (5)	22 (73%)
Adaptation	Infrastructural intervention	n/a	19	37
	Coastal Transition Accelerator Programme (CTAP)	Perceptions on purpose	13 (6)	24 (63%)
	Adaptation	n/a	(6)	37 (100%)

gas licences now, 'cause we're not going to buy a Russian gas again. Nor is Europe" ~ Walcott resident

There is evidence that the sandscaping scheme has impacted the property market, with a few new residents confirming they would not have moved to the area without the scheme:

"*I hadn't really considered the coast because of coastal erosion…and then when we came here and we saw the sandscaping, and I think it sort of gave that, sort of, dream that I could live by the sea, that it would be safe for a while*" ~ Bacton resident

"I thought 'sod it, I'm going to go for it' 'cause it's going to be safe now for Bacton Gas Station, the terminal. And so they're going to protect that" ~ Walcott resident

Drawing on the observations above, there is a widespread hope amongst residents that sandscaping, or some form of coastal protection, will continue beyond the current project. 51 % (n = 35) of survey respondents called for sandscaping to be repeated after the current scheme's projected lifetime,[1] and a further 28 % (n = 19) of respondents called for more hard defences or some form of alternative sea defences. In interviews, while some residents expressed a hope for further intervention, for others this was more strongly felt as an expectation that the coastline at Bacton and Walcott will remain defended:

"I would hope for that by the time that this needs to be done again, I'm hoping that Bacton Gas Terminal is still important enough that needs to happen again" ~ Bacton resident

"That's a lot of money's worth there. They're not going to let that be undermined by the sea. They're going to save that" ~ Walcott resident

"Bacton gas site, it supplies a third of the country's gas, well, if that isn't in the national interest, I don't know what is…it's a national thing like the Channel Tunnel. And it needs to be looked after appropriately, and that needs national funding" ~ Bacton resident

3.1.2. Policymakers' perceptions

Despite these views expressed by interviewees, there is not currently, nor has there ever been, any public communication indicating that sandscaping will be repeated. Interviews with policymakers confirmed this is merely speculation at present. There is a lot of uncertainty, currently, about the future of the Terminal, the future decision-making of Terminal operators, and its implications for the coastal management policy of the frontage.

"There are going to be those discussions sort of with, I imagine with government, with planners, about those possibilities and those companies. And then if it is re-used like that, it's like well within that mix needs to be the 'well, OK, how's the site going to be managed? Is it going to roll back from the coast or is there the potential for future, for the sandscaping, or other activities like that?' So, but I wouldn't want to say that would be the case because it's a complete unknown" ~ Local policymaker

"I think, so that is the big question as to whether they (the terminal operators) *have future, you know, aspirations to repeat a similar sandscaping exercise in 15 years' time"* ~ Regional policymaker

[1] In response to survey question; "*What coastal management, if any, do you think should happen in your village in 15–20 years, which is after the projected lifetime of the Sandscaping scheme?*" (total responses to question: 68).

"The sandscaping project has certainly been successful in terms of buying time to have conversations, particularly with the community in that area, around long-term adaptation and that need to live with rising tides. And that's not to say that a future way of improving resilience wouldn't be another sandscaping. So I think it's too early to say" ~ National policymaker

In summary, the implementation of sandscaping appears to have contributed to confidence within the local community that the Bacton and Walcott coastal frontage will remain protected. This confidence has led to increased anecdotal evidence of buying and selling of local property, and reflects a hope or expectation for many residents that sandscaping will be repeated at the end of its lifetime. There is evidence that this perceived sense of security is becoming more strongly felt by local residents since sandscaping was completed in 2019, due to emerging socioeconomic and geopolitical contexts that further underline the importance of Bacton Gas Terminal. However, a second sandscaping scheme is currently purely speculation, and there has been no official communication, by local government or the terminal operators, that the current project would be repeated.

3.2. Perspectives on future managed realignment at Bacton and Walcott

3.2.1. Policymakers' views

The strongest cross-cutting theme from policymaker interviews, discussed at length and on multiple instances by all interviewees (regardless of whether they work in a local, regional, or national context) is the need to prepare now for a future managed realignment policy at Bacton and Walcott (code 'adaptation' in Table 1). Policymakers unanimously discussed the purpose of the sandscaping scheme as ultimately an opportunity to 'buy time' to prepare for adaptation:

"What was sort of woven throughout the business case that was submitted for the funding to Bacton and Walcott is the need to adapt and the need to start thinking about adaptation and that's really what the frontage needs to be considering" ~ Regional policymaker

"It was about buying time, and we kind of said it's like turning the clock back. But when we get, we'll get back to a situation where we're going to need to change and adapt. So we need to use this time wisely" ~ Local policymaker

Policymakers stressed it was important to begin engaging with local residents on adapting to a managed realignment policy, and referred to the current Coastwise project in Norfolk (then known nationally as the Coastal Transition Accelerator Programme (CTAP) as an opportunity to do this, which will involve developing adaptation or 'transition' plans for an area:

"We've reduced that risk, we've now given ourselves time, bought time, to really need to adapt the frontage and this is where I think CTAP can start to come in. And because one of the deliverables from CTAP is going to be transition plans amongst other things…So that's what we need to start thinking about how we are going to adapt this community" ~ Regional policymaker

While local policymakers described discussions about adapting to managed realignment in Bacton and Walcott as in an early stage, policymakers also felt a sense of urgency is recognised by local residents on the need to plan for adapting to managed realignment:

"I think at the outset and in the early community engagement before the sandscaping was built, it was quite clearly highlighted…that this was a 20 year timeframe sort of project, and it was about buying time to allow communities to adapt. And so that message was clearly delivered" ~ Regional policymaker

"They (Walcott residents, parish council meeting in 2022) *wanted to talk about adaptation and the Parish Council…they were talking about the need to plan to adapt. You know, what do we need to do next. Which was music to my ears, to be perfectly honest, that they're thinking like that. Rather than just thinking 'oh, well, we're safe now' or 'when's the next Coast Protection Scheme'* ~ Local policymaker

3.2.2. Views of local residents

However, these policymaker perceptions do not appear to reflect the perspectives of the majority of residents surveyed or interviewed for this study. The need to prepare now and plan for erosion risk after the sandscaping scheme's lifetime was not explicitly expressed by a single resident interviewee. Furthermore, an open-text survey question[2] asking residents if any actions should be taken now (other than sandscaping) to prepare for future coastal change found a third of responses called for more, or better maintained, hard defences (33 %) (n = 19). In addition, residents called for improved drainage or some other form of coastal management intervention. Only a handful of survey answers referred to community discussions or consultation, and no answers referred to adapting to managed realignment. Among more elderly residents, should any property rollback or wider relocation form part of a managed realignment plan at Bacton and Walcott, there is a general perception this will be outside their lifetime, regardless of whether sandscaping is repeated or not. Interview data indicates that this group of residents is not unduly concerned about, or sees the personal relevance of, future coastal management post-sandscaping.

"*If, once and if, they ever do decide that we won't be getting gas anymore and they don't change what they do there, then any kind of protection we get, oh, I can see it will just go, but again I'm thinking it's not going to be in my lifetime*" ~ Bacton resident

"*People were 'oh ok, the sand's here, the sea's gonna last 20 years'. Lot of old people were saying, 'well, that will see me out. I'd be happy with that'*" ~ Walcott resident

One resident expressed a strong desire not to move, regardless of the future situation of erosion risk or an offer of property planning rights elsewhere. Their reflections underline the strong sense of place many residents feel to Bacton and Walcott:

"In 10 years time if they turn around and say 'oh your house is right on the edge of the cliff, and you've got to be moved', I'd rather they spent the money to keep the cliff farther out to sea. Or they do the seawalls in good maintenance, and for me to see my time out here, 'cause I'm settled here and I'm happy here. And again, as you get older, being uprooted is even harder. To turn around to a young couple with a couple of kids or just a young couple or even a middle-aged couple and say, 'well, we're gonna offer you your full right to your house and then you can go and move to somewhere else'. 'Yeah, OK fine'. They might be able to do that, by try moving a 70/80 year old person out of their property, they'll turn around and say 'I'll drown here'. They will" ~ Walcott resident

Even amongst younger residents, a common perception was that erosion risk would not return immediately post-sandscaping, and that the residual life of the sea wall and other currently redundant hard defences at Bacton and Walcott would buy an additional amount of time so that this group of residents will also not be directly affected. This was a view expressed both by interviewees living a few streets inland and on the immediate coastal frontage:

"*Even if it wasn't replenished, and the seawall becomes more exposed again, then it's still probably another 10–15 years before the seawall would be breached*" ~ Walcott resident

"*There's a government website about flooding risk… and it was something like 50 years before where our house might be affected. Well, that's out of our lifetime. That's somebody else's problem, you know*" ~ Bacton resident

[2] Survey question; "*Other than Sandscaping, do you think any actions could be taken now to prepare for future coastal change in your village?*" (total responses to question: 58).

> "*We'd have to move. Yeah, and I certainly know at Happisburgh people have been assisted in moving. So I imagine that if it came to that, there would be something like that, but we don't expect it in our lifetime, really*" ~ Walcott resident

In summary, there is an urgent need, according to policymakers, to prepare for managed realignment at Bacton and Walcott, and sandscaping is framed as a vital project that has enabled a space for anticipatory adaptation to future erosion risk. However, across different generations at Bacton and Walcott, it appears this sense of urgency expressed by policymakers is not similarly felt by many residents, and that sandscaping has taken the question of coastal management outside of local residents' direct concerns, at the time interviews were conducted (Autumn 2022, over three years after sandscaping was implemented). While largely confident that the frontage will remain protected (section 3.1), residents are at the same time fearful of what a managed realignment policy might entail, and refer to the rollback that can be witnessed at present at Happisburgh, also on the North Norfolk coast. There is a hope by many local residents that sandscaping has bought enough time that residents do not have to be directly confronted by a managed realignment policy.

4. Discussion

4.1. Perceived sense of security from coastal erosion

Three years on from the introduction of sandscaping at Bacton and Walcott, the results highlight three significant, and related, perspectives of local residents: an expectation that Bacton Gas Terminal will continue to be protected, a hope that sandscaping will be repeated (or other coastal defences reinstated), and no strong sense of urgency (in contrast to coastal policymakers), to prepare now for coastal change post-sandscaping. Although there are different views amongst local residents about how quickly redundant defences would deteriorate, and how soon a significant risk of erosion would return, a contrast can nonetheless be seen between policymakers and local residents on the need for anticipatory adaptation to enable managed realignment. For policymakers, sandscaping has bought time to prepare for managed realignment, whereas for residents, sandscaping has bought time to postpone it.

Research on coastal risk management worldwide has demonstrated a link between enhanced physical protection to flooding and reduced social risk perceptions or resilience (Logan et al., 2018; Brown et al., 2023). This has been termed the 'levee effect', where lack of exposure to flood events increases social vulnerability to future events (Di Baldassarre et al., 2015). The implementation of higher sea walls and greater flood defences in New Orleans, United States and in Japan was argued to decrease societal risk perception, and contribute to a false sense of security for extreme events (Di Baldassarre et al., 2015; Plumper et al., 2017; Boret and Gerster, 2021; Rafliana et al., 2022). Furthermore, communities protected by infrastructural engineering are less aware of flood risk (Ludy and Kondolf, 2012) and have lost an important feedback loop for learning, through exposure to flood events, which is argued to be critical for building social resilience (Colten and Sumpter, 2008; Logan et al., 2018, Plumper et al., 2017; Martinez et al., 2020). Other authors argue the relationship between awareness of coastal change and risk perceptions is not clear cut, and the observed maintenance of defences can be used as evidence by communities – already highly aware of coastal issues – to reinforce a desired sense of security from the risk of coastal change (Luis et al., 2015). The latter findings appear to have relevance in this context, where Bacton and Walcott residents show high awareness of issues of coastal change and rollback occurring elsewhere on the Norfolk coast. Therefore in this case study context, the impact of sandscaping on coastal risk perceptions appears to be not reduced awareness and learning, but reduced prioritisation and personal relevance of risk.

Recent research on UK public attitudes to climate change adaptation (Harcourt and Dessai, 2023; Harcourt et al., 2023) argues that whilst concern for climate change is increasing, it can be superseded by what is perceived to be more immediate societal impacts. In this case study, the immediate relevance of the war in Ukraine and the cost of living crisis, explicitly mentioned by multiple resident interviewees, similarly appears to demote residents' concerns about future coastal change. Furthermore, some residents reflect that the risk of coastal erosion will only return to significant levels outside of their lifetime, a perception similarly observed in other high-risk, undefended coastal communities in South Portugal (Costas et al., 2015; Domingues et al., 2017). This relates to longstanding research highlighting the challenge of psychological distancing in relation to climate change (Lorenzoni et al., 2007; Harcourt and Dessai, 2023) where individuals express lower concern for impacts they perceive will occur in the future (Spence et al., 2012). Although perceived longevity of coastal nature-based solutions (and implications for adaptation) has not been explored, psychological distancing has been observed in coastal communities in relation to the risk of coastal erosion (Domingues et al., 2017), suggesting that like coastal defences, the deployment of nature-based solutions may inadvertently work in a similar way to reduce concern of future coastal change.

These findings highlight a potential risk of transformative coastal management approaches such as sandscaping on maladaptation. Despite the significant socio-economic benefits of sandscaping in the present day and an opportunity to proactively prepare for adaptation to managed realignment, the results also highlight a risk of maladaptation if sandscaping results in less community buy-in for future adaptation. Naylor et al. (2019) and Sayers et al. (2022) argue there is currently a strong risk of maladaptation in England where 'hold the line' policies are continued in areas where it cannot be sustained indefinitely, and that a desire to avoid blight in coastal towns is leading to delays in adapting to managed realignment (Brown et al., 2023). This is notwithstanding many other 'lock-ins' that have been identified as entrenching 'business as usual' in coastal management in England, such as lack of national funding and clearly defined roles for coastal adaptation (Groen et al., 2023). It is likely that the findings in this case study are rooted in the time period with which they were analysed (approximately 2–3 years after sandscaping was implemented, amidst the backdrop of the war in Ukraine and emerging new stories on the terminal repurposing to hydrogen). Further research is required to explore perceived responsibility and urgency of coastal adaptation later on during the sandscaping scheme, and once discussions between policymakers and local residents on adapting to managed realignment at Bacton and Walcott are formally underway, through the local authority project, Coastwise or otherwise. Further research could also examine if other coastal nature-based solutions similarly lead to a potential risk of future coastal maladaptation, in contexts where they may similarly have been introduced to manage rising coastal risk.

4.2. Uncertainty

The resident and policymaker perspectives reveal sandscaping has bought additional uncertainty to coastal management at Bacton and Walcott. This includes geomorphological uncertainty in terms of how long placed sediment will remain at the Bacton and Walcott frontage, but also uncertainty about the future of Bacton Gas Terminal. If community engagement in Coastwise occurs at a time when attention is dedicated to the future of Bacton Gas Terminal, this could deter attention from conversations on managed realignment. This highlights the challenge of introducing innovative nature-based solutions like sandscaping in the short-term, for coastal frontages that will require managed realignment in the long-term. Whether a second sandscaping scheme is funded by terminal operators, when the current scheme approaches its end-of-life, and crucially what coastal area this may cover, has much wider national and international-scale considerations, given the

presence of the nationally important Bacton Gas Terminal within this frontage, and highlights the spatial and temporal trade-offs in coastal management that has similarly been highlighted in previous research (Cooper and McKenna, 2008; Brown et al., 2023). As speculated by interviewees, this includes the role of Bacton Gas Terminal in the UK's future energy portfolio, and international geopolitical factors that have a bearing on UK energy security. This raises issues of power and justice, in how, by whom, and at what scale, coastal management decisions are made, and who decides, who causes, and who feels the effects of climate change.

Studies internationally of communities facing coastal retreat similarly emphasise the relevance of uncertainty as a barrier to adaptation (Costas et al., 2015). In New Zealand, Hanna et al. (2020) argue an 'uncertainty contagion' can be seen, whereby numerous forms of uncertainty interplay and spiral into more uncertainty for where, when, and how coastal adaptation to managed retreat (a policy term used interchangeably with managed realignment) can be facilitated. In this case study, the introduction of sandscaping has added further uncertainty, of both geomorphological and social dimensions, to future adaptation under a managed realignment scenario. Hanna et al., (ibid) argue manifestations of uncertainty in managed retreat ultimately all stem from political inertia on a lack of funding and clarity on how it be financed and supported. The challenge, Hanna et al., (ibid) argue, is where uncertainty on coastal retreat builds up to such an extent that it begins to cause paralysis. This can be seen at an individual level in Fairbourne, Wales, where media reports of some residents not spending money beyond essentials, given the unknown on when and where they may need to relocate, and how much this will cost (BBC, 2022).

Across the interview data, a divergence can be seen in how policymakers and local residents respond to such uncertainty. With a responsibility to manage erosion risk for the frontage, policymakers articulate it is impossible to give a date on when Bacton and Walcott will transition from 'hold the line' to 'managed realignment', and that using a trigger-based scenario in community engagement and community transition plans is more practical (such as when levels of placed sediment from sandscaping falls below a certain threshold, or when overtopping of the seawall occurs to a significant extent). The challenge for local policymakers is that local residents use a personal lifetime, rather than trigger-based scenario, in their perception of coastal risk. Whether a sea wall is decommissioned in 10 or 30 years' time makes a sizeable difference at an individual level to a local resident's future, in terms of whether they will be directly affected by managed realignment or not. Going beyond an individual framing, and using an intergenerational justice narrative to convey the importance of a community transition plan for future generations living in the area, may be useful for policymakers to persuade local residents on the need to collectively prepare transition plans for future coastal change.

5. Conclusions

A nature-based intervention (sandscaping) to bring about transformative change in managing the coast (via a temporary respite from immediate erosion risk to a later requirement for managed realignment) may inadvertently create additional challenges in the longer-term transition from the current management focus of 'hold the line'. This includes decreased risk perceptions of future coastal change, through reduced urgency and perceived personal relevance of risk, alongside increased uncertainty and complexity in managing risk for Bacton Gas Terminal, with competing national and local-level, short-term and long-term coastal policy interests. This paper has provided a case study example of additional challenges to the use of nature-based solutions in the short-term, despite its immense benefits of coastal protection. While sandscaping has provided time to prepare for managed realignment, there is a risk of maladaptation on longer timescales (i.e. 20+ years) through decreased societal risk perceptions and relevance of coastal change. There is a need for further community engagement now, so that short-term physical resilience is not achieved at the expense of building longer-term social resilience to coastal change. Wide-reaching, sustained community engagement on future scenario planning, that adopts an intergenerational justice framing, could be one way in which the local authority's project Coastwise can facilitate community buy-in for discussions on managing future coastal change.

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CRediT authorship contribution statement

Isabel Cotton: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Johanna Forster:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Methodology, Formal analysis, Conceptualization. **Irene Lorenzoni:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Methodology, Formal analysis, Conceptualization. **Trevor J. Tolhurst:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Author 1 reports a relationship with Royal Haskoning DHV UK that includes: consulting or advisory. Author 3 reports a relationship with Royal Haskoning DHV UK that includes: consulting or advisory. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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