



Coastal loss innovative funding and financing (CLIFF)

Phase 1A quick scoping review



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Executive summary

Problem statement

There are 370,000 residential homes in England and Wales at risk of coastal erosion and flood inundation at present. This figure could rise to more than 1.2 million homes by 2080 due to climate change.¹ Currently, there is no right to compensation from the UK Government for damage from flooding or coastal erosion, given that these are natural processes and the government funds defences under permissive powers. The UK Government published its Flood and Coastal Erosion policy statement² in July 2020 where it committed to explore the availability and role of financial products or services that can achieve a managed transition of property and infrastructure away from areas at risk of coastal erosion. Local Authorities develop appropriate approaches to manage this risk through Shoreline Management Plans and their local planning policies. In this report, we explore potential options that deploy such financial mechanisms, and propose further investigation on those that are likely to drive the most effective outcomes for coastal populations.

Scope and methodology

In October 2019, Marsh was commissioned by Coastal Partnership East (CPE), with support from the Department for Environment, Food and Rural Affairs (Defra) and Natural Resources Wales (NRW), to undertake a holistic review of past research and case studies, and garner expertise across the insurance, banking, government and non-governmental organisations (NGO's) sectors to inform the development of potential solutions. The scope of this project was restricted to England and Wales, however the principles have the potential to be applied more broadly throughout the UK.

The methodology followed 4 steps:

- a. **Problem definition:** outlining of the problem and establishing the project scope with CPE and Defra.
- b. **Evidence review:** inventorying of 1,246 academic articles and 13 additional external reports, each reviewed to shortlist 18 relevant resources for incorporation into the solution option design.
- c. **Expert interviews:** interviews with over 25 industry experts from insurers, UK Government, NGOs and banks to complement the evidence review.
- d. **Option screening:** development and detailing of potential solution options, followed by prioritisation of options to target resources during a detailed feasibility assessment.



1 Environment Agency, 2010; Committee on Climate Change, 2018; Jacobs, 2018.

2 Defra, 2020a.

Solution options explored

Five solution options were developed from the evidence review and expert interviews:



1. Coastal Accumulator Fund. Homeowners pay into a fund tied to their property over time. The build-up of the property fund over many years could balance any depreciated property value once it reaches the end of its life expectancy. Funds can be released directly to the homeowner to support them post-loss.

- **Outcome:** Underpinning mechanisms of a Coastal Accumulator Fund are shown to be a viable coastal adaptation option and should be further developed in any subsequent work phases.



2. Local Authority Coastal Adaptation Fund. Local Authorities collect funds from properties at risk via an agreed mechanism. Funds can be released when agreed conditions are met to support coastally exposed households and communities.

- **Outcome:** Very strong potential option. Exploring this option in subsequent work phases may also provide Local Authorities with a sustainable funding vehicle that has broader applications into resilient adaptation or protection in coastal areas, for example.



3. Levy Model. Levy raised via mechanisms such as household insurances, which are specifically allocated to pay out to an agreed entity once coastal properties at risk of erosion or permanent flood inundation become uninhabitable. This potentially offers greater participation into a scheme at a national level, for example.

- **Outcome:** Levy-type models have been deployed globally to cover many risk types. Specific mechanisms that could underpin a 'coastal loss' levy require further consideration to understand its overall viability as an adaptation option for the UK.



4. Rollback Model. Demolition of at-risk properties and providing homeowners with the opportunity to develop a plot of land and relocate.

- **Outcome:** Rollback has proven viability in the UK through previously completed and successful national pathfinder projects; its cross-applicability with other solution options (including, Local Authority Coastal Adaptation Fund) should be explored in subsequent work.



5. Compensation Model. At-risk residents are provided with compensation (such as, a like-for-like replacement, deposit for a new property, or loan) prior to or following loss.

- **Outcome:** UK Government policy does not currently provide for compensation caused by coastal erosion making viability of a compensatory mechanism low. Unless the Government's policy position changes, there is limited benefit in exploring how this model could work in the UK.

Option shortlisting and next steps

In order to deepen analysis at the next stage, the highest-potential three options will be progressed to a more detailed feasibility assessment. These are:

1. Coastal Accumulator Fund.
2. Local Authority Coastal Adaptation Fund.
3. Levy Model.

Each will be assessed against several feasibility criteria, including its strategic scope, operational requirements, financial/economic viability, and social, commercial, political and legal requirements. The results will be published in a follow-up Phase 1b paper. Note, the 'Rollback Model' has been explored in other studies, so while it remains a priority policy option, it has been de-scoped from further analysis here.

Project background

Currently, there are over 370,000 residential homes (including private ownership and tenanted properties) in England and Wales at risk of coastal erosion and coastal flood inundation (Committee on Climate Change, 2018).

When these properties are lost, many of these residents will lose their home and primary financial asset and lack the means to relocate. This problem is becoming increasingly prevalent, with predictions indicating that more than 1.2 million residential properties could become exposed to both coastal erosion and flooding by 2080 (Environment Agency, 2010; Committee on Climate Change, 2018; Jacobs, 2018). While coastal erosion and flood inundation are natural processes that always have and always will shape our coastline, Local Authorities currently utilise Shoreline Management Plans to determine the most appropriate mitigation options for coastlines, putting defences in place where it is sustainable and affordable to do so and letting it function naturally, where this is not the case.

Although coastal areas are managed through Shoreline Management Plans, it is unlikely to be economically viable, socially desirable, or environmentally sustainable to protect many areas of the coast with traditional defence structures. Therefore, other alternative options including potential relocation measures need to be considered. Whilst there is no legal duty to provide defences to reduce coastal risk, nor to provide compensation to those suffering loss as a result, there remains a need for residents to be able to relocate if and when their homes are no longer sustainable. In areas where traditional defences are not an option, as determined through an area's Shoreline Management Plan which is a collective decision with Local Risk Management Authorities, then the UK Government does not fund coastal protection works. However, future property losses do not only affect the residents themselves, but also the wider community, council tax payers in the constituency (who will have to pay for the additional costs incurred at the local level), and taxpayers in the county who may be impacted by lost economic opportunities (such as tourism) and, potentially, taxpayers across the country who may have to pay to help an area recover from widespread impacts.

For coastal flood events, properties are currently covered by the existing Flood Re insurance programme. However, for coastal erosion and permanent coastal flood inundation caused by sea level rise, there are currently no established government financing or funding mechanisms available to incentivise residents to relocate from high risk areas or provide financial security to those that lose their homes. These risks are the focus for this project.



Problem definition and objectives

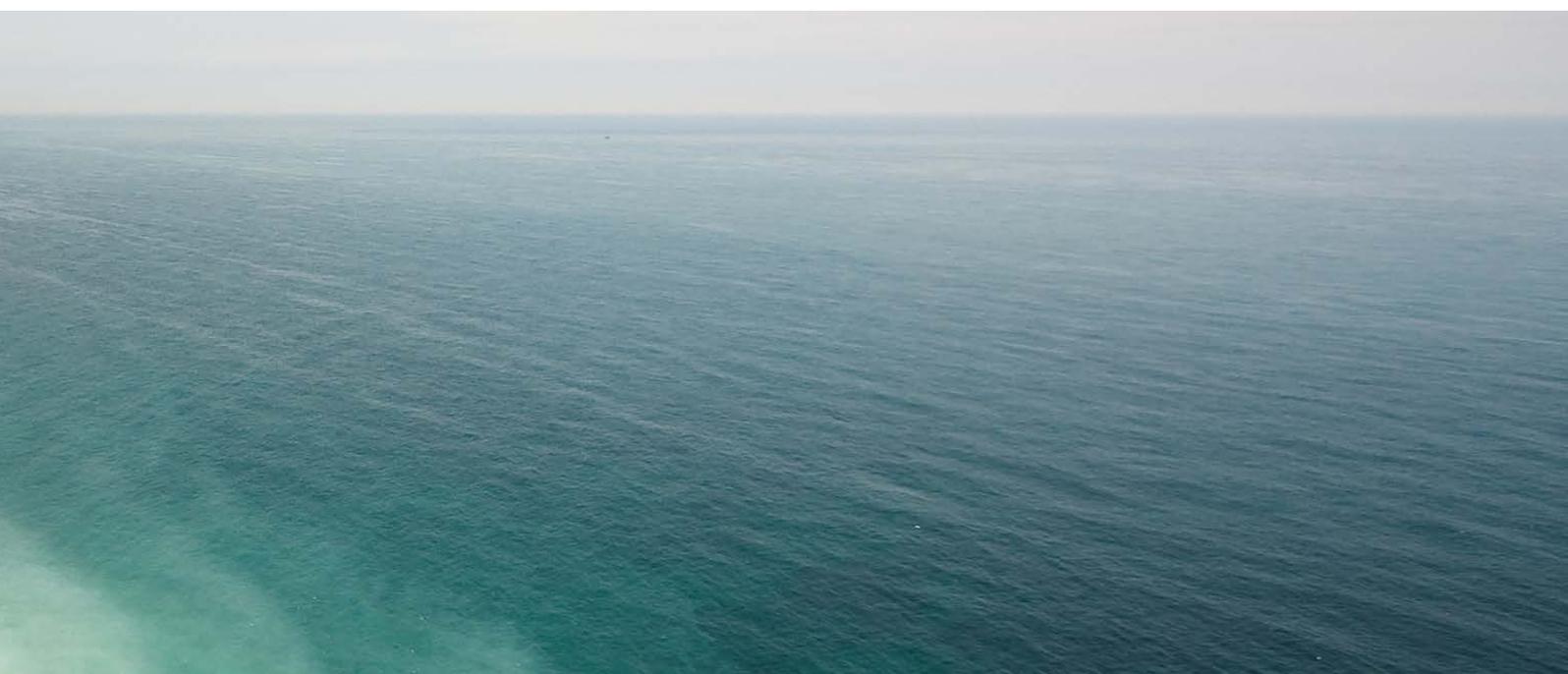
In October 2019, Marsh were commissioned by Coastal Partnership East (CPE), with support from the Department for Environment, Food and Rural Affairs (Defra) and Natural Resources Wales (NRW), to undertake a Quick Scoping Review (project Phase 1a), involving a holistic review of past research and case studies, and interview-based expert opinions to inform the development of potential solutions to this problem. The aims of this project were developed by the project steering committee consisting of Marsh, CPE, Defra and NRW.

Primary aim

This project investigates potential financing and funding options that could provide safety and security to residents who must relocate because of losing their property to coastal erosion and/or permanent coastal flood inundation. Specifically, the project looks at privately owned, tenanted, and housing association residential properties in England and Wales. The rationale for the target populations selected is noted in Figure 1.

01| Types of property that are included within this quick scoping review.

Property Type	Included/Excluded	Rationale
Privately owned	✓	Local authorities have a duty to re-house residents in need following the loss of their property.
Tenanted	✓	
Housing association	✓	
Commercial premises	✗	Current local authority mandate is to relocate residential properties, thus excluding these property classifications from the scope of this study.
Industrial assets	✗	
Public buildings	✗	
Other (e.g. non-profit premises, agricultural buildings)	✗	



Conceptual model

Overview

In order to approach this project in the most effective manner, a ‘coastal risk profile’ conceptual model was produced to clearly define the problem and refine the scope of the project (Figure 2). The coastal area was conceptualised into 3 distinct zones to help understand which funding options identified in the project would fit into each coastal zone.

Coastal risk profile model

In the coastal environment, each property has a unique space/time risk profile, termed here as the property ‘life expectancy’. Within this Coastal Risk Profile Model, the profiles of those-at-risk are grouped into distinct zones, within which a range of protection options are explored that would seek to enable residents to relocate from high risk areas or provide them with better financial security. Existing coastal risk zonation frameworks are not used here (including local authority shoreline management plans, which use three zones) to prevent potential option design and thinking being constricted to these pre-determined zones.

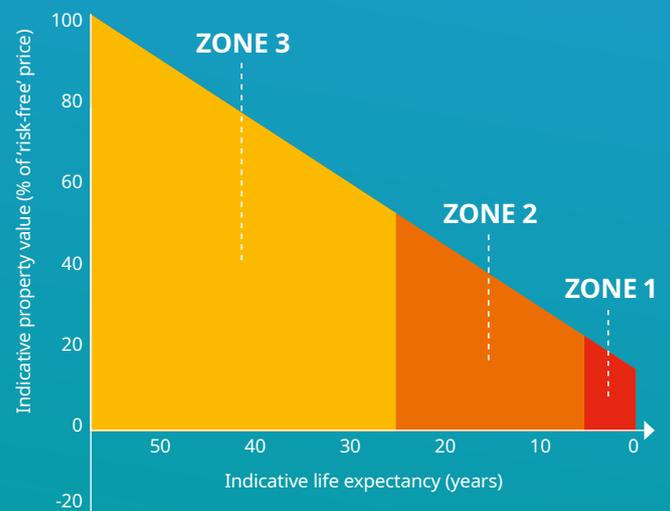
The model also conceptualises how property value is linked to the coastal zones, highlighting that as the property life expectancy decreases, typically the house price would be expected to fall. Ultimately, property loss is inevitable; however, factors such as sea level rise, climate change, geology, erosion rate and topography can make determining the exact timing of loss uncertain. As highlighted in the coastal model, once a property is lost, its value may effectively drop below zero because property owners will be required to cover the cost of demolition, although some may be eligible for a contribution towards demolitions costs through the Defra Coastal Erosion Assistance Grant (Defra, 2020b).

02| Coastal life expectancy model.

This model conceptualises the number of properties at risk of coastal erosion and permanent coastal flood inundation into space / time zones (EA, 2010; Jacobs, 2018; Committee on Climate Change, 2018).

- Property value is linked to its indicative ‘life expectancy’.
- Loss is inevitable but uncertainty around timing exists.
- Once lost, demolition costs cause property value to drop below 0%.

A range of protection options are available for each zone to enable residents to relocate from high risk areas or provide them with financial security.

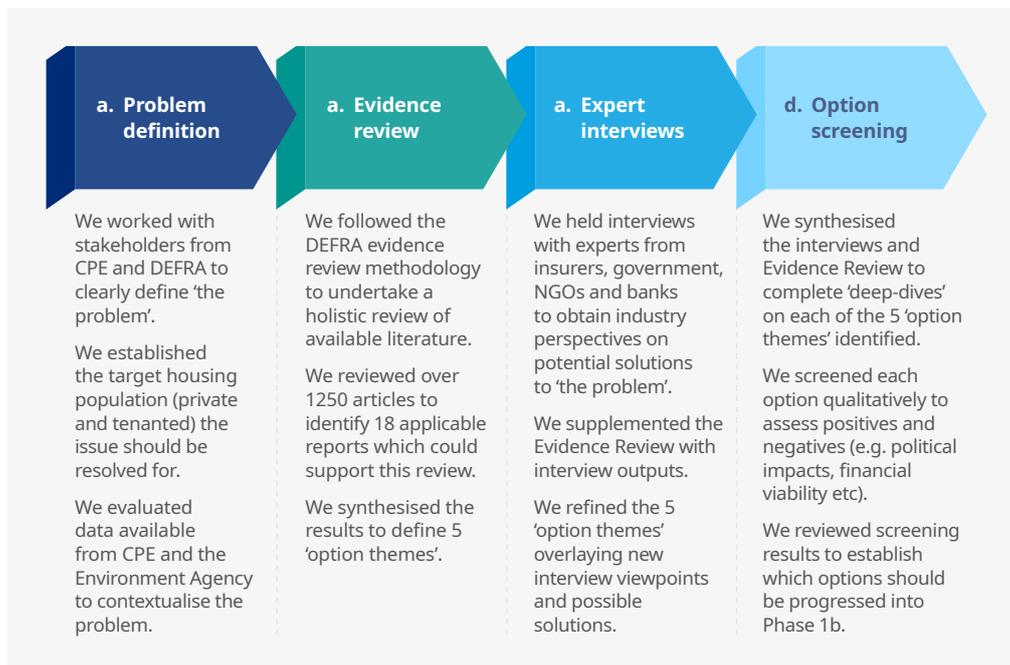


Methodology

Overview

The methods for this project follow Defra guidance, as detailed in “The Production of Quick Scoping Reviews and Rapid Evidence Assessments – A “How-to” Guide” (Collins et al., 2015). The initial evidence review followed a four-step process and informed both which literature was most relevant to the project and which experts to target through interviews. An overview of the process is shown below in Figure 3.

03| Outline of the 4-step project methodology.



a) Problem definition

The overall strategy and problem definition was agreed in consultation with the project steering committee consisting of CPE, Defra and NRW (please refer to section 1 for full description).

b) Evidence review

Search strategy

Following Collins et al. (2015), a comprehensive evidence review was conducted to establish existing research and literature relevant to the project. The strategy was agreed with the steering committee and consisted of three key phases as outlined in detail below: (i) search inclusion criteria, (ii) search term selection, and (iii) search source inventorying.

i) Search Inclusion Criteria

To identify relevant studies to be evaluated in the evidence review, literature and reports that investigated alternative coastal management and mitigation strategies, coastal financing and coastal erosion, flooding and coastal flood inundation were targeted. Each of these specific themes were reviewed and confirmed with the steering committee.

Stakeholders noted that a range of existing solutions and concepts may have been developed globally. Therefore, the searches permitted all global literature from any time period with the only restriction being that results had to be in English due to language limitations.

ii) Search Term Selection

Search terms were formulated by the steering committee to ensure evidence gathered would adequately cover project aims and objectives. The search terms used are outlined in Figure 4 and were deployed in combination to search online databases and websites for relevant literature. The Boolean '*' operator was used to ensure that searches were restricted to matching keywords; for example, manag* would permit manage, managed, managing, management and so on. Searches were restricted further by adding the word qualifier 'coast*'.

04| Keywords and qualifiers used in the literature search.

Coastal erosion/permanent flood inundation	Coastal management	Coastal financing
Flood*	Manag*	Financ*
Inund*	Realign*	Fund*
Ero*	Govern*	Insur*
Sea Level*	Zon*	
Change	Mitigat*	
Estua*	Expropriat*	
Surge	Protect*	
Soft Cliff	Rollback	
	Relocat*	
	Adapt*	
	Plan*	
	Defen*	

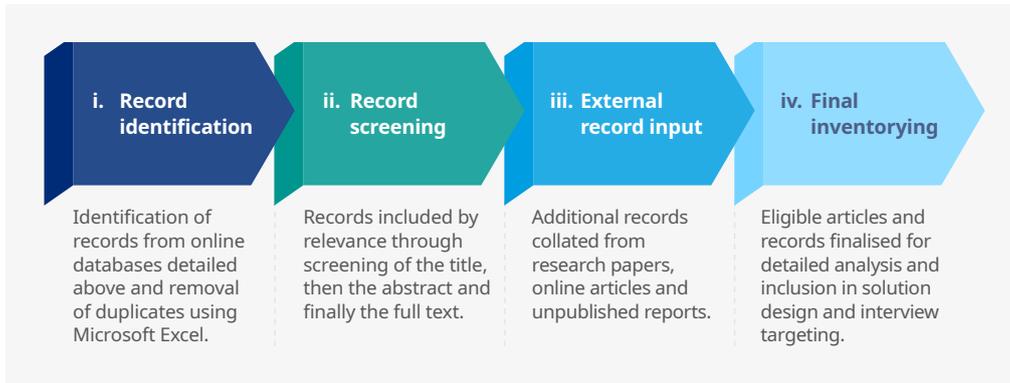
iii) Search source inventorying

A holistic search utilising multiple information sources was used to create an unbiased database, capturing a sample of peer-reviewed scientific and grey literature ('grey' literature here relates to any non-commercial / unpublished reports, such as government reports and policy statements). Search source inventorying followed a systematic process. Initially, each search term outlined in Figure 4 was entered into the following online search databases to identify records:

- **DART-Europe E Thesis:** <http://www.dart-europe.eu/basic-search.php>
- **GreenFile:** <http://www.greeninfoonline.com>
- **Google Scholar:** <http://www.scholar.google.co.uk>

The first 20 results from each search were imported into an excel database. Once the full database was compiled, each record was screened for relevant information by examining the title, abstract and full text. Relevant external records provided by CPE and Defra from unpublished reports were also added before finalising the record inventory. The process is outlined in Figure 5.

05| **Search source inventorying process.**



Appendix A provides a summary of the records included in the final inventory and outlines how the key information extracted informed the choice of interview candidates and options identified.

c) Expert interviews

Link to the evidence review

The initial evidence review provided an overview of coastal adaption techniques, which have been hypothesised, trialled or implemented worldwide. The evidence review database created was used to identify where specific concepts warranted further examination and/or required additional clarity from targeted interview deep-dives. For example, from reading the Halcrow Report (2008), the principles of Law Barnier were found to have potential linkages with a Levy style solution (Option 3). To develop these concepts further, we reached out for interviews with CCR (Caisse Centrale de Réassurance), Flood Re and the World Bank to better understand how the details of how a Levy style model could operate as a UK-based solution (see Appendix A).

Interviewees

Interviewees were determined in consultation with the steering group and a shortlist of high priority interviews was constructed. To ensure that a variety of perspectives outside of academic literature were explored, industry experts were selected from insurers, Government, NGOs and banks. The list of candidates was refined to ensure that they had the right expertise to explore any concepts identified from the evidence review which required more detailed discussion on, for example, financial underpinnings and UK policy implications.

Interviewees were identified from these sectors as appropriate to ensure that any additional ideas, concepts and potential solutions could be incorporated into the option design stage of the project. As part of the interview process, 10 companies/corporations were included. The interview list is outlined in Figure 6 below.



06| List of expert interviews conducted.

Company	Industry	Role
Coastal Partnership East	Public Sector	Head of Coastal Partnership East Flood and Coast Risk Management Senior Advisor Strategic Funding Manager Coastal Manager (North) Coastal Technical Assistant
Natural Resources Wales	Public Sector	Flood and Water Officer
Defra	Public Sector	Policy Officer Economic advisor
Marsh and McLennan Companies (MMC)	Insurance, Consulting and Financial Advisory	Head of Strategic Risk Consulting (Marsh) Head of Financial Solutions Group (Marsh) UK&I Digital Leader (Marsh) Senior Financial Services Consultant (Mercer) Senior Financial Services Consulting Manager (Mercer) Senior Investment Consultant (Mercer) Regional Head of M&A Securities (Guy Carpenter) Director of Marsh and McLennan Insights (Oliver Wyman)
Flood Flash	Insurance	Co-founder
Terrafirma	Environmental Services	CEO and Founder
CCR - Caisse Centrale de Réassurance	Insurance	Deputy Chief Executive Officer Head of Public Funds and Prevention Department
Legal and General	Asset Management	Director, Pension Risk Transfer Solutions Pension Risk Transfer Client Solutions Director, Strategic Private Capital Investment Team LGR Investments
Flood Re	Insurance	Chief Actuary
World Bank	Intergovernmental Organisation	Global Lead and Program Manager, Disaster Risk Financing and Insurance Program, World Bank and GFDRR Insurance and Disaster Risk Finance Manager

Interview technique

Each interview was conducted either in-person or by phone in a structured format. Initially, a 2-page problem statement was sent out to all potential interviewees, providing them with an overview of the current situation and the situation the project is looking to resolve (see Appendix B for the interview briefing). Members of the steering committee were involved in each interview. During interviews, participants were invited to brainstorm new solutions. Following each interview, the options discussed, key points raised and outstanding questions were documented.

d) Option screening

Following the completion of evidence review and expert interviews, common themes and concepts identified were grouped to develop a distinct set of potential financing and funding options. These options were intended to incorporate the full spectrum of potential solutions available based on the evidence and interviews conducted. Once established, the project steering committee considered each option in terms of its policy/financial viability and social acceptability to determine the priorities that should be pursued in the next phase.

Results

Evidence review and expert interviews

The full evidence review breakdown is represented in Figure 7. As part of the initial evidence review, 1246 academic articles were examined, of which 5 articles and reports were found to be relevant to the needs of this study. An additional 13 reports from research papers, online articles and reports were also found to be significant, and were added to the evidence review. These additional sources were gathered from unpublished sources and provided by Defra/CPE to provide additional context on potential solutions.

The full text of the final 18 eligible articles and reports was reviewed in detail searching for potentially useful methodologies, candidate solutions, learnings and pitfalls.

07| Evidence review results.

Phase	Review stage	No. records identified	Records excluded
Record identification	Identification of records from database research	1246	
	Removal of duplicates from database	976	→ 270
Record screening	Title	45	→ 931
	Abstract	17	→ 28
	Full text	5	→ 12
External record input	Additional records collated from research papers, online articles and reports	13	↓
Final inventorying	Articles and records eligible for primary and secondary questions	18	1241

Following the evidence review, the most informative articles were further evaluated, considering the type of solution identified, positives and negatives with the approach, additional factors to be considered and any areas requiring further improvement. Key concepts were carried forward to the interview stage as “seed ideas” to accompany the brainstorming exercise, with additional concepts, mechanisms, or solutions discussed also recorded.

Once a full set of ideas and solutions were established, common themes and linkages across the ideas were identified to establish a set of distinctive financing and funding options that cover the full spectrum of potential solutions available.

Each option established is presented in the following section and has its foundations set in the literature examined and interviews conducted during the evidence review. **A thorough overview of how each option aligns to policy evidence, literature examined, and interviews conducted is presented in Appendix B.**

Financing and Funding Options

By synthesising the evidence review and knowledge gained from the expert interviews, five funding and financing solutions were outlined for properties at risk of coastal erosion and/or permanent coastal flood inundation due to sea-level rise. To aid interpretation, each option is categorised in terms of the funding source used to finance the scheme and the type of pay-out received by eligible recipients. These categories are outlined in Figure 8.

08| Financing and funding options 3X3 matrix.

		WHAT COULD ELIGIBLE PROPERTIES RECEIVE?		
		Tenanted property/shared ownership/affordable housing	Private resident property/land ownership	Cash
WHO ARE THE MAIN FINANCIAL CONTRIBUTORS?	Individual homeowners			Coastal Accumulator Fund (1) Homeowners pay into a fund which allows them to recover depreciated property value
	Direct contribution from public or private fund (e.g. tax, levy)	Local Authority Coastal Adaptation Fund (2) Local Authorities build fund to support coastal adaptation amongst the most at risk coastal properties	Levy Model (3) Levy raised which is specifically allocated to pay out a cash sum once the property is lost	
	Government (local and/or central)		Rollback Model (4) Demolition of at risk properties and provision of homeowners with the right to develop a plot of land	Compensation Model (5) At risk residents are provided with a like-for-like replacement once their property is lost

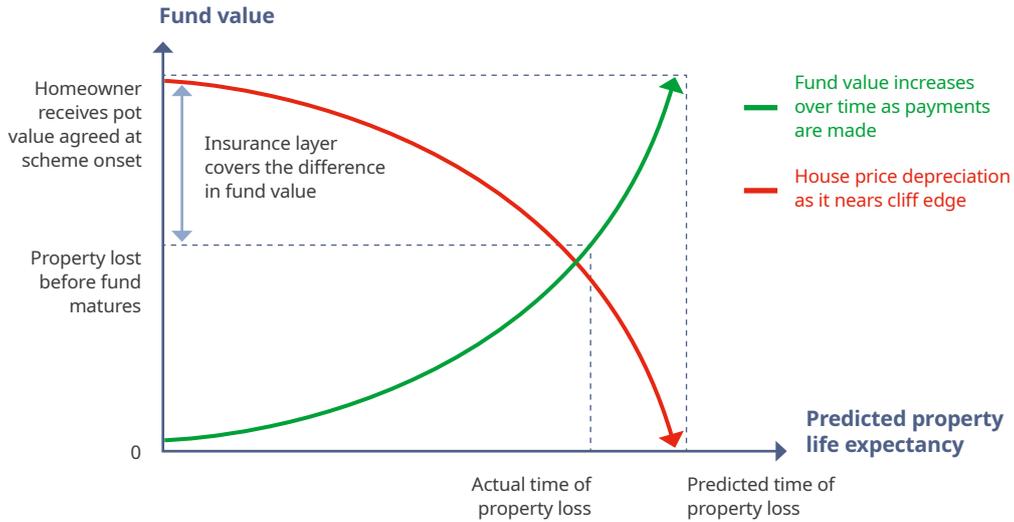
As a Quick Scoping Review, the following sections outline the concept and key design considerations. However, a more detailed feasibility assessment will follow in the next phase of work (phase 1b).

1) Coastal Accumulator Fund

Option summary

The Coastal Accumulator Fund would involve individual homeowners paying an annual contribution over the predicted 'life expectancy' of their property into a fund that accumulates over time (Mercer, 2020). A conceptual model, outlined in Figure 9, was constructed to outline how the financial framework could operate. As the value of the property depreciates over time (for example due to shoreline erosion; CPE, 2020), the fund size will conversely grow, thus allowing for participating assets to maintain its value. In order to create the critical level of investment needed for a fund of this type, individual housing funds would need to be pooled by the underwriting body to create a much larger investment fund (Legal and General, 2020; Marsh Roundtable, 2020).

9| Coastal accumulator fund conceptual model.



In the literature reviewed, and in the interviews conducted, it was noted that coastal erosion is comparable to a life assurance scheme (Richards, 2016; Legal and General, 2020; Mercer, 2020). Where properties are lost due to coastal erosion/permanent flood inundation earlier than the 'life expectancy' model predicts, the larger pooled fund would subsequently enable homeowners to receive a pay-out in full which covers any difference in fund value; this would likely be achieved through implementing a reinsurance layer to the fund which could cover any potential difference in value between property fund maturation and the total fund value agreed at the scheme onset (Marsh Roundtable, 2020; Guy Carpenter and Oliver Wyman Roundtable, 2020) to ensure that property owners are still able to receive a payment in full for the property. Although the risk of loss itself is inevitable, the timing of the event for any one home is uncertain, and thus in theory insurable. If properties last longer than the predicted 'life expectancy', homeowners may (depending on specific the fund model mechanisms) be required to continue paying into the fund.

The potential mechanisms that could be employed to operate this solution were explored in collaboration with pension risk transfer experts from Mercer³ (2020). Specifically, it was established that there would need to be two key elements underpinning the model: 1) how the annual contribution is paid, and 2) how the 'life expectancy' of the property is calculated. For (1), Mercer (2020) and Legal and General (2020) both noted that one possible mechanism for calculating an annual contribution could be to base payments on each properties house price and its relative 'life expectancy' (for example, its location in the coastal risk profile conceptual model, Figure 2). However, interviews with Defra (2020b) and CPE (2020) also indicated that metrics such as property council tax band and location of any defences that benefit the property could be included in the underwriting model. In both circumstances, 'life expectancy' underwriting models would need to rely on accurate mapping and forecasting of coastal erosion rates.

³ Mercer is one of the world's leading global asset advisory and pension risk transfer specialists.



Design choices and considerations

- Life expectancy – payments in to the fund will likely need to be based on the remaining ‘life expectancy’ of each property. For zone 1 of the conceptual model (Figure 2), it is unlikely there will be enough time to build up a fund. Therefore properties would need to be within a minimum life expectancy zone to enable them to pay into a coastal accumulator fund (zones 2 and 3). The precise time requirements to build up a fund still need to be calculated.
- Fund payment options – as informed by interviews with Mercer (2020), Legal and General (2020) and some of the concepts articulated by Richards (2016)
 - Defined contribution: homeowners pay a set contribution each year and receive the amount that the pot has built up over time.
 - Defined benefit: homeowners pay a monthly premium and, irrespective of the time of loss, a lump sum is agreed to at the policy's inception (applicable for properties with a long enough life expectancy — specifically, zones 2 and 3).
- Availability of property risk data – property risk data based on the life expectancy of the property is an essential requirement for this solution option. Data will be required based on hazard (for example, distance to cliff), vulnerability (for instance, rate of erosion/frequency of flood inundation) and exposure (for example, property value). Potential sources include existing shoreline management plans, Coastal Change Management Areas where applicable (for example, Halcrow Group, 2015) or alternative third-party sources such as Terrafirma's (2020) shoreline erosion model.
- Recalibration period – as erosion/permanent flood inundation models improve, periodic re-calibration of the policy may be required to account for the changes in policy underwriting, such as, erosion rate/sea level rise. This was noted as an important consideration from discussions with Legal and General (2020).
- Voluntary vs. Compulsory – this option requires large numbers to make it economically viable. Therefore, three primary outstanding questions are:
 - Which properties will the scheme apply to e.g. all properties in zones 2 and 3 of the coastal life expectancy model (Figure 2)?
 - Would the scheme need to be mandated by law to ensure there is enough uptake to support the fund? For example, buyers of future new builds in coastal areas could be mandated to pay into a property-specific fund that can be accumulated over time to offset the impact of potential future coastal erosion events (Defra, 2020b).
 - Are incentives required to improve take-up into the scheme? The interview with Defra (2020b) noted that there is limited policy basis to strictly enforce homeowners to pay into a fund, however incentives (such as tax breaks) could be offered.
- Tax subsidisation - similar to a pension, these funds could be eligible for tax-subsidies (such as council tax reduction; CPE, 2020) that would incentivise property owners to take up the scheme and have the secondary benefit of promoting growth in the fund.

2) Local Authority Coastal Adaptation Fund

Option summary

This option acts as a Local Authority funded pool which can be used to support residential properties at immediate to longer-term risk of coastal erosion and/or permanent flood inundation. Some of the underpinning concepts behind this option were explored by Alexander et al. (2011) in Australia, who examined how Local Authorities managed the removal of residents at risk of coastal perils. It was noted that compensatory approaches are typically too costly, often meaning sustainable adaptation approaches targeted across specific communities are better for coastal resilience. Thus, for this option, the specific support mechanisms Local Authorities use would need to be chosen based upon its appropriateness for the specific properties/residents at risk and their constituent coastal exposure profile (for example demolition grants for properties dangerous/already lost, social rehousing for vulnerable populations).

Following interviews with CPE (2020) and Natural Resource Wales (2020), it was established that participating authorities could contribute a pre-determined annual premium into a pooled fund. The annual premium would likely be set by a fund manager based on each authority's coastal property exposure profile (such as the number of expected losses per year; Mercer, 2020). Ideally, Local Authority funds would be pooled with other coastal authorities to create a larger, more viable coastal adaptation fund which can then be invested to accelerate pool growth (Legal and General, 2020).

However, there is further consideration required to understand how the Local Authority funds should be invested and what design choices are available, such as UK Government investment requirements (for example gilts and bonds) or private investment funding options (Defra, 2020b).

Once a property is deemed at risk by a participating Local Authority, funds would be released from the collective pool to enable the authority to support an exposed resident(s). To ensure funds are used consistently between authorities, CPE (2020) suggested that specific support mechanisms could be established in agreement with participating authorities. For example, funds could be released for demolition grants or social housing depending on the risk profile of an individual area or per its specific Coastal Change Management Area (CCMA; Halcrow Group, 2015).

Design choices and considerations

- Trigger point – at what point do properties trigger the Local Authority Coastal Adaptation Fund policy? This could be time-bound, i.e. when they have < 5 years left or based on the risk profile of the specific community/property of interest, such as using CCMA's.
- Risk pooling – decision as to whether the risk pools are held locally or managed at the regional/national level (Defra, 2020b; Legal and General, 2020).
- Fund management – the combined funding pool would need to be managed. Options differ depending on the resultant size of the pooled fund, but could include central Government (for example, gilts), private banks and insurers (Mercer, 2020).
- Support Mechanism – several options exist to support homeowners at risk of coastal erosion. Most critically, interviews with Natural Resource Wales (2020) and CPE (2020) noted a need for greater options around rehousing exposed individual(s), which may include social/affordable housing, rented accommodation and private housing. In support of this, the interview with coastal policy experts at Defra (2020b), indicated that linkages with the Ministry of Housing, Communities and Local Government (MHCLG) scheme may allow for authorities under a Local Authority Coastal Adaptation Fund option to redevelop land on the coast for the purpose of social housing for those at risk of erosion.
- Funding source – Local Authorities vs. Central Government involvement must be decided (through government matching, tax breaks and so on).
- Relocation requirements – decisions around whether social housing allowances or government tax breaks could be used by developers to designate new build properties for the needs of those to be relocated.
- Life expectancy – this option lends itself more specifically to properties located within zone 1 and potentially zones 2 and 3 of the life expectancy model (Figure 2). This could make it a potential option for properties that do not have enough time left to be eligible for a coastal accumulator fund (option 1). Similar to option 1, property risk data based on the life expectancy of the property will be an essential requirement for this solution option in order to determine the risk profiles of specific locations/communities and thus which support options are most appropriate to implement. Potential sources could include existing shoreline management plans, CCMA's where applicable (such as Halcrow Group, 2015) or alternative third-party sources such as Terrafirma's (2020) shoreline erosion model.

3) Levy model

Option summary

The fundamental mechanism behind this option relates to implementing a mandatory levy on a target population, which can be used to subsidise losses incurred to homeowners caused by erosion or permanent coastal flood inundation/sea level rise.

This options provides a mandated funding 'guarantee' which could take many forms, such as funding from the general taxation pool (González Dávila O. et. al., 2014) or a new climate change-type levy which covers multiple perils (CPE, 2020). Another levy type could relate to a participating insurance carrier or a direct government insurance scheme, where all insured homeowners contribute a coastal/flood inundation levy to a dedicated reinsurer as part of their standard property home insurance premium. Similar insurer-led schemes have been set up in the UK (such as Flood Re for inland flooding; Flood Re, 2020) and internationally, including France's 'Law Barnier' for natural disasters (CCR, 2020); Spain's Consorcio de Compensacion de Seguros for disaster compensation (González Dávila O. et. al., 2014) and Mexico's multi-peril FONDEN scheme (Guy Carpenter and Oliver Wyman Roundtable, 2020). Although a coastal-specific levy may also be an option, there are currently no known function coastal erosion levy schemes.

In theory, a levy-based scheme could potentially be 'bolted-on' to an already established administrative programme such as Flood Re in the UK. Flood Re provides short-term insurance pricing relief to properties at risk of temporary riverine, pluvial, groundwater and coastal flooding, while mitigation measures such as property flood resilience are introduced enabling property owners to manage their risk and thereby achieve affordable insurance after Flood Re support ends in 2039. Currently, any loss caused by coastal erosion is not covered by Flood Re. It is less simple for losses for permanent tidal inundation with regards to Flood Re and further understanding would be beneficial in a subsequent phase of work. When discussing the potential extension of Flood Re's remit to encompass such risks (during interview with Flood Re, 2020), it was noted that this would likely be "non-trivial and require thorough consideration because fundamentally, erosion and permanent flood inundation losses are inevitable" (100% probability at some future point in time), requiring relocation rather than risk mitigation measures from an insurance pay-out. This inevitability has been a key determinant of why traditional coastal erosion insurances are not offered by insurers today (Floodflash, 2020).

Despite this, it was noted that other, international levy-style models are comparable to this solution option. One example is France's 'Law Barnier', which is a nationwide levy used to re-house those exposed to natural hazards. This option was discussed extensively in our interviews with the Natural Resource Wales (2020) association and the French government's reinsurer Caisse Centrale de Réassurance (CCR, 2020). The Law Barnier scheme operates by applying a state surcharge of 12% on all property insurance, of which 4% can be used for the Law Barnier fund. CCR reported that in practice some compensation cases are more clear-cut than others. For example, properties where "human life is at stake" (such as at the top of a clay/limestone cliff) may have the right to indemnification, however, properties too close to the beach are typically not covered as these properties are generally not insurable against erosion / sea level rise. As an exception to this, CCR did note that recently a historic vacation home at the beach has been declared eligible for compensation by the French Courts after years of dispute.

Moreover, interviews with Guy Carpenter and Oliver Wyman (2020) and literature reviewed (Adler et al., 2019) noted the USA's National Flood Insurance Programme (NFIP) was another example of a federally-backed rather than levy-funded insurance solution. In return for communities adopting and enforcing effective flood plain management, NFIP indemnifies at-risk homeowners via direct insurance (such as between an insured and the Federal Emergency Management Agency (FEMA)) and 'Write Your Own' insurance (for example administrated by participating insurers on behalf of FEMA) mechanisms. Established in 1968, the scheme has historically struggled with self-funding via premium revenue, and is currently over \$20 billion in debt to the US tax payer (Insurance Journal, 2020). However, more recently, Adler et al. (2019) have proposed an alternative 'discounts for buyouts' scheme, as an extension to NFIP. Under this scheme, homeowners would agree to allow NFIP to buy out their property for a pre-agreed sum following the next flood event. This means that rather than insurance being paid out for repairs, homeowners are actively encouraged to move away from at-risk areas. It is noted that a similar concept could be explored as an adjustment to Flood Re were it to continue after 2039 in a different form.

Finally, it is noted that under the 1985 Housing Act, a Government-supported levy scheme may be able to mandate relocation from at-risk properties when they reach a threshold trigger (including distance from the cliff edge and frequency of flood inundation). In the Netherlands, while coastal erosion risk is minimal due to governmental planning regulations, there is a buy-out scheme where property owners are offered the current market value by the government for the property public defence works required to mitigate erosion risk (Halcrow Group, 2008). If the owner does not agree, the Government has the authority to force the owner to sell for a cash pay-out through a compulsory purchase order.

Design choices and considerations

- Insurance and levy administration – could be administered through an existing mechanism such as Flood Re or an alternative Government-supported solution.
- Trigger Threshold
 - Timing – eligibility for the scheme, in terms of at what point is a property deemed at risk – including life expectancy and distance to cliff edge.
 - Decision makers – a designated body should be responsible for determining the threshold/trigger point for when a property is deemed a threat to life – potentially Local Authority or Central Government.

- Ownership and Repurposing – the entity/person legally responsible for the land after the homeowner relocates needs to be established. Based upon the timing of any mandatory relocation, there may be scope to repurpose the land to reclaim some of the costs.
- Recipient payment – it would need to be decided exactly how the levy pay out payment is used. For example, pay-outs could fund affordable housing provision or temporary rented accommodation. Equally, recipients could also receive their original property value or partial property value (full value of the property at an agreed moment in time, or a payment to enable relocation in conjunction with a mortgage). The pay-out amount could also be standardised across all coastal areas or could be variable according to measurable parameters (such as council tax band).
- Levied population – decision about whether the levy should be applied nationally (Law Barnier), regionally, or limited to coastal authorities with exposure (NFIP amendment discussed by Alder et al. 2019).
- Demolition – there is an outstanding decision point around whether the cost of demolition should be included in the pay-out or if it can continue to be covered under the existing coastal erosion assistance Grant in Aid scheme.

4) Rollback model

Option summary

The rollback model targets properties at an imminent risk of coastal erosion and/or permanent flood inundation (zone 1 in Figure 2). Local authorities provide eligible homeowners with development rights to build on a new area of land away from the at-risk coastal zone. Due to planning restrictions, these rights may be highly sought after (Defra, 2011; 2012).

The new landowner is then responsible for personally raising the funds to utilise these development rights and build a property on the land. They may do this in conjunction with the rollback site owner and together create uplift (for example by building several properties and recovering their investment upon sale). Alternatively, the homeowner could sell the development rights (possibly to another party) and use the funds to purchase an alternative property (North Norfolk District Council, 2008; 2009). The rollback model also includes support through a coastal erosion assistance grant (CEAG) from the Government, which covers the cost of demolition and clean-up once a property becomes uninhabitable. This grant is already available up to a value of £6,000.

The rollback option was explored in detail during interviews held with CPE (2020) and Defra (2020b). The scheme is enabled through the enactment of the EN12 rollback policy in advance of property loss, and has been trialled at five sites in the UK. The trial process and results are detailed in the 2011 Coastal Change Pathfinder Review and Summary (Defra, 2011; 2012). The locations examined included: East Riding; North Norfolk; Scarborough; Waveney; and Tendering. Although successful in several locations, the longevity of the scheme was difficult to justify at the time, largely due to a number of legal risks associated with the 'buy and leaseback' component (CPE, 2020); although the Localism Act (2012) has since resolved some of these issues. The pathfinders were government funded, but going forward a cost-neutral financing mechanism is needed to purchase the rollback sites and thus make this a more sustainable option (Coastal Services North Norfolk District Council, 2019; CPE, 2020).

For further information on the Rollback Model, please refer to the additional information outlined below:

- Coastal Services North Norfolk District Council. (2019). Planning opportunities for owners of property at risk from coastal erosion.
- LGA Coastal SIG. (2017). Coastal Adaption Review Paper.
- Department for Communities and Local Government (2010). Planning Policy Statement 25 Supplement: Development and Coastal Change Practice Guide.
- Department for Environment, Food and Rural Affairs (2012). Coastal Pathfinder Review: Final Report.
- Department for Environment, Food and Rural Affairs (2011). Coastal Pathfinder Evaluation: An Assessment of the Five Largest Pathfinder Projects. November 2011.
- North Norfolk District Council (2008). North Norfolk Core Strategy.
- North Norfolk District Council (2009). Development and Coastal Erosion Guidance.

Design choices and considerations

- Rollback site purchase – the point at which rollback is initiated and lands are purchased from a potential landowner needs to be established.
- Rollback triggering – Local Authorities would need to decide at what point residents are considered to be at imminent risk and thus be relocated out of danger. This must give sufficient lead-time for residents to relocate.
- Land purchase and development questions:
 - Decision makers – who decides which land is made available to relocated residents? How is this enforced?
 - Compensation – who compensates the original landowner for their land?
 - Development rights – what development is permitted on the new land, can residents sell the land onwards, at an increase in value?
- Building finance – the options available to residents with insufficient funds to build a new property require greater clarity. For example, ‘seed financing’ could be made available to residents to enable them to begin building a property on the new land. Similarly, rollback specific mortgages could be an option to enable cheaper, more affordable financing of rollback.
- Community – possibility for larger, designated zones to be allocated for development to assist with keeping relocated communities/neighbourhoods together should be explored in greater detail.
- Long-term viability – there is no guaranteed protection in the form of housing/temporary accommodation. It is contingent on the resident using the rights to rebuild, or selling their right and using the funds to relocate.

5) Compensation model

Option summary

The compensation model funds the rehousing of residents who have lost their property, by providing homeowners with cash or in-kind compensation. Once residents have received compensation and relocated, the at-risk land/housing would become the property of the Government/Local Authority. This may provide an opportunity to offset some of the cost of compensation, if, for example, the location’s life-expectancy is sufficient for repurposing the land/housing stock to make a financial return on it (such as through private investment; Marsh Roundtable, 2020). The interview with CPE (2020) noted that the compensation model is unlikely to be financially viable due to the high amount of government funding required to compensate homeowners and residents. However, it should be noted that currently the UK Government does not provide compensation for losses due to coastal erosion as these are seen as natural events (Defra, 2020b). That said, use of public funds for managed relocation (for example, Coastal Resilience Grants) is a compromise between economic and socio-political considerations. An example of this current compromise is the inclusion of risk reduction to single properties through property level resilience for flooding; this mechanism isn’t indicative of a public good but has a sole beneficiary (CPE, 2020; Defra, 2020b). Funding transition or relocation using public funds would be consistent with this approach.

This option has parallels with the USA’s federally funded Hazard Mitigation Grant Program (HMGP), which has recently been launched by the Department of Homeland Security (2020) and FEMA. The HMGP will offer government funding for large-scale and nationwide relocation of properties at risk of flooding and will utilise eminent domain to evacuate and compensate homeowners. This scheme can apply to both communities at risk and individual properties although currently it is unclear whether the scheme will apply to those at risk of coastal erosion. As the scheme proposes to benefit NFIP-insured properties, it is unlikely to benefit coastal erosion areas in this initial rollout phase.

Similarly, there is a compensation scheme operated in New South Wales, Australia, where central Government have the ability to purchase residential properties at risk to natural hazards. Homeowners are not mandated to accept the purchase offer, meaning any purchase will only proceed on a voluntary basis. Once agreed, central Government will fund the initial 50% of the house price, with the additional 50% made up from a Local Authority fund matching scheme.

Kotaka et al. (2001) have also examined usage of eminent domain in as a way of relocating and compensating property owners for 11 countries in the Asia-Pacific. Their paper notes that typically, the use of eminent domain (also known as 'compulsory purchase', where the Government has the power to acquire / buy an owners estate in return for compensation), is often only used as a last resort in the context of environmental risk management. For example, Australia, Japan and South Korea will often only utilise eminent domain to obtain property where it is needed for temporary emergency public safety requirements or protection from natural disasters (e.g. wildfires and landslides). We found no examples of where compensation has been used to relocate properties at risk of coastal erosion or loss due to sea-level rise.

Design choices and considerations

- Housing provision – this type of compensation should be considered further. For example, residents could be entitled to like-for-like housing provision (where homeowners continue to be homeowners) or they could be offered alternative housing (such as rented social housing or emergency housing).
- Compensation policy – authorities are not currently permitted by law to compensate an individual for their loss unless it is directly due to a change in policy from the Government. This would have to be adapted accordingly (Defra, 2020b).
- Compensation level – a key decision point relates to whether homeowners are entitled to receive at risk property value, original property value or partial property value (namely full value of the property at an agreed moment in time, or a payment to enable relocation in conjunction with a mortgage). Compensation could also be standardised across all coastal areas or could be variable according to measurable parameters (including council tax band).
- Private sector incentives – there may be options for the UK Government to structure compensation packages as an attractive investment opportunity for the private sector (for instance, a student loan-esque type mechanism for those that lose their home which can be secured against another property).



Conclusions

Option summary

In summary, this quick scoping review has outlined five potential options that could be implemented to provide security to residents losing properties due to erosion and/or permanent coastal flood inundation. Positives and negatives associated with each option are outlined below in Figure 10.

10| Summary of positives and negatives for the five potential options.

	Option	Positives	Negatives
1	Coastal Partnership East	<ul style="list-style-type: none"> Allows homeowners to remain in control of their asset and maintain its value, providing them with the choice to keep or sell their house to a new buyer even when it begins approaching the higher risk (i.e. imminent) zone. Provides a level of financial means to move when necessary for safety reasons. Covers all properties with sufficient life expectancy (exact timing to be determined). Enables settlement areas to remain viable places to live even as properties become increasingly exposed. 	<ul style="list-style-type: none"> Does not provide support to homeowners within the imminent zone due to the timeframe required to grow the property fund. Requires critical housing numbers to ensure financial viability – the exact pool size has yet to be determined. May need an ‘incentive strategy’ to encourage residents to sign up (e.g. tax break). Is only available to homeowners with the financial means to invest in the fund.
2	Local Authority Coastal Adaptation Fund	<ul style="list-style-type: none"> Offers a short- to long-term solution for residents unable to afford an alternative option (e.g. coastal accumulator fund). Pooling the funds of Local Authorities provides a financial advantage by establishing a larger investment pot to grow over time. Has linkages with the MHCLG policy which allows authorities to re-develop coastal land and turn it into social housing. Could give Local Authorities a self-sustaining long-term funding mechanism to provide alternative housing / adaptation. Has scope to incentivise private sector participation to manage the scheme minimising up-front government funding. 	<ul style="list-style-type: none"> May need seed investment (either central/local government or private funding) to get the solution up-and-running until the fund reached a sustainable size. May require policy guidance for Local authorities in order to participate in the fund. Local Authorities would need to identify and raise funds to input into a Pool.
3	Levy model	<ul style="list-style-type: none"> Provides a mandated funding ‘guarantee’, which could take many forms (e.g. general taxation pool, climate change levy, national levy, coastal property levy). Funding becomes ‘instantly’ available once the levy has been deployed. Has the potential to ‘bolt-on’ to the existing Flood Re programme or be used to design a new Law Barnier type programme. Bolt-on options could provide a short-term solution whilst a longer term option is developed for coastal communities. There is precedent internationally for a successful levy schemes. 	<ul style="list-style-type: none"> Obtaining buy-in from insurers who have traditionally not covered inevitable coastal erosion or permanent flood inundation losses may be challenging. Levying only coastal properties is unlikely to create a large enough pool to tackle the problem. Those not at-risk may object to a levy supporting others at risk (although this is not dissimilar to the current Flood Re model in the UK). Administering a nationwide levy is challenging and costly. Leveraging an existing framework. (e.g. Flood Re) via a coastal bolt-on would only be a temporary solution.

<p>4</p>	<p>Rollback model</p>	<ul style="list-style-type: none"> • Covers properties at imminent risk. • Property owners can benefit from on-selling developable land. • Enables the 'community aspect' of coastal regions to be maintained by allowing residents to relocate within the local area. • Uplift has the potential to offset the initial cost of implementing the rollback model. 	<ul style="list-style-type: none"> • Requires landowners to raise sufficient funds to take advantage of the planning opportunities. • No guaranteed protection / security in the form of housing/temporary accommodation. • Landowners are only rehoused if they can afford to build a new property, or on-sell the land / rights making sufficient profit to rehouse. • Rollback limited by the availability and suitability of developable land. • May require policy guidance for Local authorities in order to participate in the fund. • Local Authorities would need to identify and raise funds to input into a Pool.
<p>5</p>	<p>Compensation model</p>	<ul style="list-style-type: none"> • Homeowners are provided with a financial means of rehousing. • Early compensation of residents may enable land to be repurposed, with the potential to offset some of the initial cost of compensation. 	<ul style="list-style-type: none"> • Policy change is required for the UK Government to be able to compensate an individual who has experienced a loss directly. • Requires the Government to make a substantial upfront funding investment, either in the form of payments of establishing a loan/ mortgage solution (e.g. student loan style product).



Option prioritisation and evaluation

Out of the five options identified, this quick scoping review recommends that the following three options are prioritised for Phase 1b assessment:

1. Coastal Accumulator Fund.
2. Local Authority Coastal Adaptation Fund.
3. Levy Model.

Figure 11 provides justification for this recommendation. In summary, the Rollback Model (4) has already been subject to a successful pilot study through a Pathfinder programme and is thus comparatively well-defined. In comparison, the Coastal Accumulator Fund (1), Local Authority Coastal Adaptation Fund (2) and Levy Model (3) require detailed evaluation to guide and inform future viability. The Compensation Model (5) is not deemed a viable option to take forward due to UK Government policy constraints around compensating individuals who have experienced loss.

11| Evaluation and recommended prioritisation for each option identified.

	Option	Coastal Life Expectancy Zone (Figure 2)	Evaluation	Recommendation
1	Coastal Accumulator Fund	Zone 2 Zone 3	<ul style="list-style-type: none"> For properties with sufficient life-expectancy, owners are able to build up a fund that eliminates the risk of asset depreciation, provides the financial means to relocate and continue as property owners. We recommend this option is prioritised to establish its viability for zone 2 and zone 3 properties. 	Option prioritised for the next phase of work.
2	Local Authority Coastal Adaptation Fund	Zone 1 & potentially Zone 2 Zone 3	<ul style="list-style-type: none"> For properties at risk, local authorities are able to utilise a managed pool of funds to provide at-risk residents with support through defined benefits such as allocated/ dedicated social housing. We recommend this option is prioritised to determine its feasibility for zone 1 and potentially other zone 2 and zone 3 properties in due course. 	Option prioritised for the next phase of work.
3	Levy Model	Zone 1 and properties in Zone 2 / 3 where coverage is denied	<ul style="list-style-type: none"> Mandatory property insurance levy tax providing coastal residents with cash pay-out to relocate once coastal risk exceeds predetermined level. Specific levy mechanism needs to be established. We recommend this option is prioritised for further evaluation of the types of levy that could be established. 	Option prioritised for the next phase of work.

4	Rollback model	Zone 1 and in due course Zone 2 Zone 3	<ul style="list-style-type: none"> Existing solution successfully piloted through pathfinders in 2011, but sustainable financing mechanism for rollback site purchase yet to be established. We suggest this option is not progressed further until it can be evaluated comparably against other key options. 	Option prioritised but not progressed to next phase of work.
5	Compensation model	Zone 1	<ul style="list-style-type: none"> High level of financial commitment required from Central Government. Potential issues around political sensitivity of offering 'compensation'. We recommend this option is not progressed through this project. 	Option not prioritised.

Next steps

For the next phase of work — Phase 1b feasibility assessment — indicative evaluation themes are proposed to enable a comprehensive evaluation of the potential solutions. A sample of these themes and their constituent parts are outlined below (Figure 12):

12| Sample evaluation themes to be used as a basis for Phase 1b feasibility assessment.

	Theme	Summary	Evaluation
1	Strategic scope	Deep-dive analysis covering the strategy and technical aspects of each option prioritised.	<ul style="list-style-type: none"> Expected effectiveness to solve problem. Types of financing options available (e.g. private, public). Types of supplementary policies available (e.g. planning opportunities, grants) to support option financing.
2	Financial/ economic	Indicative and appropriate cost-benefit evaluation of each option identified.	<ul style="list-style-type: none"> Implications of financing mechanisms utilised. Ease/cost of implementation. Level of expected benefit to homeowners.
3	Operational	Evaluation and plausibility of key operational components of each option.	<ul style="list-style-type: none"> Set-up and implementation timescale. Short-term vs. long-term viability. Number of properties required for solution. Solution overlap with existing programmes (e.g. Flood Re, Law Barrier).
4	Policy/ social /legal/ commercial	Examination of potential policy and socio-economic challenges of the options prioritised.	<ul style="list-style-type: none"> Likely levels of public / policy support. Alignment with current Government policies. Types of populations to be included in solution. Risk of loop-holes/profitteering. Implications on who bears the cost (e.g. private/public).

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Appendices

APPENDIX A OPTION EVIDENCE SUMMARY

The table below provides an overview of literature examined in the evidence review and outlines how the records identified were used to inform interviews and establish solution options. Evidence is included that supports or challenges the viability of solution options.

Option	Definition	Policy evidence	Literature/interview evidence	Viability summary	Evidence gaps (to be considered in next phase)
1 Coastal Accumulator Fund "Home-owners pay into fund"	For properties with sufficient life-expectancy, owners are able to build up a fund that offsets the risk of asset depreciation, provides the financial means to relocate and continue as property owners.	<p>1949 Coastal Act – can enable a levy for coastal protection but has limited functional opportunities for raising funds for alternative coastal adaptation approaches.</p> <p>Housing Policy – further exploration of detailed issues with policy officials (including MHCLG) will likely need to be included in the next stage of this study.</p> <p>Noted that there may be limited policy basis to 'enforce' people to pay into a housing fund however incentives (e.g. Government grants, tax breaks) could be offered which may improve take-up of a future scheme.</p>	<p>Defra (2020b) interview noted that there are upcoming programmes looking to update the national erosion risk maps for England and Wales which could support a 'coastal accumulator fund' underwriting model.</p> <p>Guy Carpenter and Oliver Wyman Roundtable (2020) interview noted that given the number of properties involved, coastal erosion risk lends itself to a pooled fund type solution akin to the TCIP (Turkish Earthquake Insurance Pool), PAID (Romania's national disaster insurance pool) or the CEA (California Earthquake Authority). They also noted that coastal erosion and permanent flood inundation couldn't work as a traditional insurance product due to the inevitability of loss.</p> <p>Halcrow Group Ltd. (2015) report produced for East Riding of Yorkshire Council delivers guidance for "the identification and delivery of Coastal Change Management Areas (CCMAs) and the development of suitable adaptation approaches". In order for sustainable change to occur in line with the National Planning Policy Framework (NPPF), it outlines a 4-stage approach for coastal adaptation. Stages 2 and 3 relate primarily to the identification and mapping of areas at risk in CCMAs which are major requirements for sustainable adaptation to occur – it is noted that accurate coastal change information is a primary requirement for use in any coastal 'life expectancy' forecasting.</p> <p>Legal and General (2020) interview picked up on the similarities that at-risk coastal properties have to life assurance, noting that traditional 'flood' style insurance where a loss is followed by recovery would be tricky to implement for erosion risk due to the "inevitability of coastal loss". Moreover, the interview noted that being able to establish a viable fund required a critical target level of investment / fund size. Their experts highlighted that the number of properties paying into the fund and the payment type (defined contribution or defined benefit) would alter the 'attractiveness' of the coastal accumulator fund to potential investors. They also noted that a fund model may have cross-applicability to businesses/freehold owners, infrastructure assets and other public buildings which could help increase the number of contributing properties, improving its investment viability.</p> <p>Marsh Roundtable (2020) interview with the Financial Solutions Group and Strategic Risk consulting teams emphasised that traditional insurance cover likely wouldn't work for coastal erosion and permanent coastal flood inundation. They identified similarities between 'inevitable' coastal losses and human life insurance principles and how alternative re-insurance type products can be applied onto life insurance funds to cover differences in timing / pay out between expected life-expectancy and actual property loss.</p>	Policy, literature and interview evidence is positive and indicates that the coastal accumulator fund has the potential to become a viable option to pursue in further phases of work.	<p>Implications for Government policy (e.g. MHCLG, housing policy) to be explored further with policy officials.</p> <p>There is a need to understand whether the critical level of investment needed for a 'pooled-fund' can be met with current and projected future numbers of properties at risk from coastal erosion and flood inundation from sea level rise.</p> <p>Evaluation of coastal erosion and sea-level flood inundation data required to understand ability of current data to support any property 'life-expectancy' forecasts and predictions.</p> <p>Data availability – there is a need for accurate data to understand the number, location and risk profile of current properties at risk in coastal zones. This will support both the fund underwriting model and any cost-benefit analysis required to better understand financial viability.</p>

Option	Definition	Policy evidence	Literature/interview evidence	Viability summary	Evidence gaps (to be considered in next phase)	
			<p>Mercer (2020) interview highlighted the similarities with life-insurance principles, noting the inevitability element around properties eventually being lost. Risk-transfer experts also noted that as is the case for pension funds, where losses are incurred earlier than the predicated time of loss, an (re)insurance layer could be used to cover a difference in fund value before it 'matures'. As is the case for life-assurance policies, where properties last longer than their predicted life expectancy, properties would likely have to continue paying a premium into the fund until maturation.</p> <p>Richards, E. (2016) highlights similarities between human-life insurance and coastal properties and argues that properties have an expectancy defined by future sea-level rise. The paper primarily looks at applying human life expectancy principals to coastal losses caused by permanent flood inundation as a result of sea-level rise. A linkage between human-life insurance and losses arising from coastal erosion is not presented.</p> <p>Terrafirma (2020) interview explored how the gradual receding of high-tide marks serves as a proxy for coastal erosion, which in turn could be used to predict the rate of change and overall life-expectancy of a property to coastal erosion. It was noted that additional characteristics such as geology and defences would need to be factored into any calculation of property life expectancy.</p>			
2	<p>Local Authority Coastal Adaptation Fund "Local Authorities pay into fund"</p>	<p>For properties at imminent risk, Local Authorities are able to utilise a managed pool of funds that has been built up via contributions from risk-bearing councils, to provide at-risk residents with access to alternative accommodation through allocated/ dedicated social housing.</p>	<p>Possible adaption of the MHCLG scheme could allow authorities to redevelop land on the coast into social housing, which can then be used to rehouse people at imminent risk of coastal erosion.</p> <p>In 2015, East Riding of Yorkshire Council published Coastal Change Adaptation Planning Guidance to support Local Authorities to better manage and adapt to coastal change</p> <p>As noted in Alexander et al. (2011), Queensland have implemented a Sustainable Planning Act (2009) that requires local councils to compensate owners when a planning decision reduces a homeowner's property value.</p>	<p>Alexander et al. (2011) explore the concept of managed coastal retreat in the context of Australian Governmental policy, examining the interplay between the insurance industry and the role of the local council. They note how removing at risk residents is challenging as retreat policies impose significant costs on affected communities. Using the example of the Sustainable Planning Act in Queensland where residents are compensated where a planning decision affects property value, they stress the importance that mitigation policy must engage both Local Authorities and residents to give communities greater 'ownership' on the design and implementation of a new policy, to ensure it is fit-for-purpose.</p> <p>CPE (2020) interview highlighted that a Local Authority led pool could be used to establish self-sustaining funds that can support a selection of adaptation mechanisms in the coastal zone (e.g. rehousing, mitigation, rollback etc.) depending on its specific risk profile. A linkage to Coastal Change Management Areas (CCMA) was noted, whereby "better planning and utilisation of regular funds in the coastal risk zone could support a more holistic risk-managed approach" to exposed communities.</p> <p>Defra (2020b) interview highlighted that a local-authority led fund would not be able to compensate losses caused by coastal erosion to homeowners. Coastal policy experts discussed how Coastal Change Management Areas (CCMA's) could be used to better support homeowners at risk of coastal erosion. Principally, discussions focussed on how CCMA's can be utilised by Local Authorities to "prepare, adapt and respond to coastal change risk".</p> <p>Guy Carpenter and Oliver Wyman Interview Roundtable (2020) highlighted that there are examples of Governments pooling funds in anticipation of future losses. There are national Government schemes that set aside funds for meeting social rehousing and infrastructure rebuilding needs after events (FONDEN, the Mexican natural catastrophe fund). In the case of the Caribbean, multiple governments contribute to a central pool to fund rebuilding after catastrophic events (CCRIF, the Caribbean natural catastrophe fund). However, they did not know of any covering coastal erosion.</p>	<p>Interviews, policy evidence and coastal adaptation literature indicates a Local Authority Coastal Adaptation Fund is worthy of further exploration as a funding vehicle to support exposed communities.</p>	<p>There is a need to understand whether a local-authority fund can deliver the critical level of investment needed for a 'pooled-fund'.</p> <p>Further evaluation of Government housing policy is proposed to understand how Local Authorities could use funds to support coastal adaptation schemes such as rehousing at-risk homeowners.</p> <p>Funding mechanisms require greater evaluation to understand their viability in coastal change zones (e.g. participating authorities, contribution mounts, fund pay-out mechanisms).</p> <p>Data availability – there is a need for accurate data to understand the number, location and risk profile of current properties at risk in coastal zones.</p>

Option	Definition	Policy evidence	Literature/interview evidence	Viability summary	Evidence gaps (to be considered in next phase)	
3	Levy Model "Levy raised on a target population"	Mandatory levy on a focus population (to be defined) providing coastal target with funding to relocate once coastal risk exceeds pre-determined level. Specific levy mechanism needs to be established.	<p>Flood and Water Management Act (2010) - local councils pay levies based on a constituent authority's council tax base to support flood and coastal risk management undertaken by the Environment Agency.</p> <p>Spanish Insurance Compensation Consortium – gives homeowners suffering loss from natural catastrophe event to be indemnified without disaster declaration being given.</p> <p>Housing Act (1985) – allows for Local Authorities to mandate evacuation from at risk properties.</p> <p>USA NFIP – proposals from Adler et al (2019) have highlighted that policy could be adapted to allow for homeowners to be compensated by FEMA for a pre-agreed amount once the property is impacted by flooding.</p> <p>Differential insurance pricing driven through policy in the Netherlands is used as an incentive to limit property ownership in very high risk areas.</p>	<p>Legal and General (2020) interview highlighted that there is a target amount of investment required for a managed fund to be set up. For full explanation see notes from Coastal Accumulator Fund (1).</p> <p>Mercer (2020) interviewees noted that a 'local-authority' led, pooled fund could act as an alternative to a coastal accumulator type model whereby contributions are made by Local Authorities who manage properties in coastal erosion areas. This fund would then be ring-fenced so that Local Authorities can then draw down on the fund to support residents at risk of coastal erosion who have no alternative funding means. Specific support mechanisms would subsequently need to be determined which are most applicable for the given residents and the coastal location (e.g. social rehousing, demolition grants, shared-ownership options etc.).</p> <p>Natural Resource Wales (2020) interview prompted initial discussion into the possibility of "adapt[ing] existing UK Government policy to enable better adaption and redevelopment of at-risk coastal areas", with the intention of allowing Local Authorities and councils to offer more support to those affected by coastal erosion and coastal flood inundation from sea level rise.</p> <p>Adler et al. (2019) propose a 'discounts for buyouts' scheme as an extension of the USA's National Flood Insurance Programme. Currently, homeowners in the USA are able to purchase insurance to cover losses from inland floods and coastal storm surges from hurricanes. However, these funds are traditionally used to help policyholders rebuild their home after an event. Although only focussed on flood events, the discounts for buyouts proposal Adler et al. present would offer "homeowners a guarantee of a future buyout as a benefit of their flood insurance coverage, in exchange for a discounted insurance rate" (p.10322). Funds would be paid out by FEMA through the National Flood Insurance Fund from the levies collected from insurance policies.</p> <p>CCR (2020) interview provided detailed context on how the French Natural Disaster Compensation Scheme (also known as 'Law Barnier') operates. Following an 'exceptional' event (typical examples include river flooding, avalanche, subsidence), the Government have 18 months to make a natural disaster declaration. Once raised, "property insurers indemnify insureds and the insurers are then reinsured by CCR". CCR has unlimited guarantee so can fund extreme events. The scheme is funded by a state surcharge of 12% on all property insurance, of which 4% can be used for the Law Barnier fund.</p> <p>- The interview also noted that the natural disaster compensation scheme does not cover uninsurable events. When discussing the context on cliff erosion, it was noted that "in isolated cases of coastal erosion where few properties are affected, it is unlikely to be considered a Natural Disaster, and thus not be covered by CCR or property insurers". However, it was noted that should a large scale erosion event occur which "impact a community, for example, then a natural disaster declaration may be made" leading to it being covered by the scheme.</p> <p>Clarke, M. (1998) discusses the occurrence of differential insurance premiums in the UK whereby properties in unprotected flood prone areas are charged higher premiums. It is suggested that this differential policy rate raises awareness of the risk posed to homeowners by settling in hazard prone areas.</p>	Globally, levy-type models have been deployed widely to cover a broad range of risks. Overall, UK and international policy evidence in addition to a wide body of literature and interview input shows a levy model is worth considering as a viable option for the UK.	<p>Levy type – globally, levies have been applied to homeowners, councils and private insurers in order to support pay-out. For coastal erosion, further examination is needed to establish a fit-for-purpose levy model.</p> <p>Insurability – currently erosion is deemed uninsurable however there may be elements of the problem which can be insured (e.g. loss timing). Discussions with insurance bodies, e.g. the ABI, would be beneficial here.</p> <p>Policy bolt-ons – further conversations with policy experts are required to understand the ability for coastal erosion and flood inundation to be integrated in to existing schemes in the UK.</p> <p>Policy adaption – greater clarity is required on where levied funds can be used to relocate (or compensate) individuals suffering loss (e.g. in line with the USA NFIP, Spanish Consortium Scheme and Netherlands flood extension etc.).</p>

Option	Definition	Policy evidence	Literature/interview evidence	Viability summary	Evidence gaps (to be considered in next phase)
		<p>UK Flood Re Scheme (2014) - property owners are levied through insurance premiums to ensure all UK properties can buy affordable insurance for flooding. Currently does not permit coastal erosion and permanent flood inundation from sea level rise.</p> <p>Law Barnier Fund (CCR) - French policy that compensates individuals following disasters. Requires 'insurable event' which erosion is not yet considered.</p>	<p>Floodflash (2020) interview examined whether parametric insurance options could be linked to coastal erosion. Currently, parametric insurance for natural catastrophe events in the UK is limited to river flooding. It was noted that due to the inevitability of coastal erosion, it would be challenging to have a fully parametric solution. However, it was discussed that there may be an insurable element relating to the timing of loss caused by coastal erosion. The example provided related to a theoretical "property which the Shoreline Management Plan predicted it had 75years remaining, however, a through one process or another, it actually lasted only 50years". This difference in event timing was noted as a potential avenue for further examination to determine whether elements of coastal erosion could be deemed insurable.</p> <p>Flood Re (2020) interview discussed how the current UK scheme provides short-term insurance pricing relief to properties at risk of riverine, pluvial, groundwater and coastal 'storm-surge flooding (set-up in 2014 to run until 2039). Currently, permanent loss due to sea level rise and coastal erosion are not included in Flood Re due to the inevitability of loss. It was noted that erosion could have the potential to be 'bolted-on' to Flood Re. However this would require wider ratification through insurers and likely some Government support to enable pay-outs to be met. As "pay-outs for erosion losses would be covering relocation as opposed to recovery, there may also be policy considerations on the compensatory aspect of indemnification".</p> <p>González Dávila O. et. al. (2014) highlight several case studies in Italy, Spain, France and the UK where different 'insurance-led' schemes have been developed to promote resilience in coastal flooding and erosion zones. In particular, the paper notes how Spain have an Insurance Compensation Consortium (Consortio de Compensacion de Seguros) which indemnifies homeowners suffering from natural catastrophes if it is not covered by their property insurance. The consortium is funded by homeowner levies and homeowners have "full rights to being indemnified without an official declaration of "catastrophe" being made (p. 5). This scheme is also able to pay-out to homeowners suffering from coastal erosion.</p> <p>Guy Carpenter and Oliver Wyman Interview Roundtable (2020) highlighted that the inevitability of loss relating to coastal erosion and coastal flood inundation meant that it was unlikely insurers would be able to obtain reinsurance. They recognised that there are national Government pools that support the insurability of natural catastrophe perils (e.g. Flood Re covering UK flooding, TREIF covering Taiwanese earthquake, and TCIP covering Turkish earthquake). However they did not know of any covering coastal erosion.</p> <p>Halcrow Group Ltd. (2008) highlights the example of the Netherlands where flood insurance coverage is extended to private homeowners through a risk-based premium. This is used as an incentive by insurers to limit property ownership in very high risk areas and thus minimise exposure.</p> <p>Natural Resource Wales (2020) interview discussed how the French Government, since 1982, have implemented a scheme called "Cat-Nat" (Catastrophes Naturelles) which is a Government-led reinsurance scheme that guarantees to pay out when people are affected by natural disasters. Although a compensatory mechanism, funds are raised through a premium surcharge - to understand the funding mechanisms better, a second interview was set up with CCR (Caisse Centrale De Réassurance) who administer the natural disaster compensation scheme.</p>		<p>Data availability - there is an urgent need for accurate data to understand the number, location and risk profile of current properties at risk in coastal zones. This will support more effective development of a levy-type model in subsequent phases.</p>

Option	Definition	Policy evidence	Literature/interview evidence	Viability summary	Evidence gaps (to be considered in next phase)
4	Rollback Model “Local Authority adaptation grants”	The relocation/ replacement of properties at risk of coastal erosion and sea-level rise to areas that are inland, away from the coastline.	World Bank (2020) interview provided the opportunity to understand alternative disaster risk financing options that could be examined. To their knowledge, there are “currently no known schemes [that have been] implemented to provide continued financing to properties suffering losses due to coastal erosion”. Several coastal management programs have been set-up and funded by the World Bank and Global Facility for Disaster Risk Reduction (e.g. West Africa Coastal Areas Management Program, Resilient Shores in Vietnam project, amongst others), however these projects are principally focussed on building community resilience rather than establishing sustainable, financing options for those needing to relocate following coastal loss.	Proven viability through previously completed and successful pathfinder projects.	Note, the ‘Rollback Model’ has been explored in other studies and so, while it remains a priority policy option, it has been de-scoped from further analysis here. Consideration should be given to whether other solution options (as outlined above) could generate the funds needed to implement rollback for suitable locations (e.g. as part of an adaptation toolkit authorities can use in the most appropriate settings). Data availability – there is a need to understand which locations on the coast may be suitable areas to benefit from rollback. This could be achieved through more accurate and up-to-date coastal risk mapping. Ability of Localism Act (2012) to mitigate legal risks associated with buy and lease mechanism required for rollback could be explored in additional detail.
5	Compensation Model “Government-funded adaptation grants”	Homeowners required to relocate due to coastal erosion or sea level rise, are compensated by the Government or Local Authority.	UK Government does not currently provide compensation for losses due to coastal erosion as these are natural events. Adler et al. (2019) paper identifies how elements of the current USA’s National Flood Insurance Programme could be adapted so that homeowners are guaranteed a pre-determined amount of ‘compensation’ following a future flood loss. Compensation, in the USA example, could be awarded through funds generated by a national flood insurance levy. However, it is noted that the current NFIP programme is currently in significant debt, requiring continued bailouts from the US Government, meaning any compensatory pay-outs will require some level of Government support.	Currently, UK Government policy does not provide for compensation caused by coastal erosion. Therefore, viability of a compensatory mechanism is low. Unless the Government’s policy position changes, there is limited benefit in exploring how this model could work in the UK.	Note, as current UK policy does not provide for compensation caused by coastal erosion, this option is not to be explored in any further phases until the Government’s policy position changes.

Option	Definition	Policy evidence	Literature/interview evidence	Viability summary	Evidence gaps (to be considered in next phase)
		<p>Flood Mitigation Assistance Grant scheme for properties insured under NFIP are eligible for compensation where the Government mandates that they need to relocate.</p> <p>E.g. Several Governments hold the ability to mandate relocation of homeowners in emergency situations utilising eminent domain.</p>	<p>Defra (2020b) interview discussed whether compensation by the UK Government, currently, was a viable option. It was noted that at the moment, the UK Government does not currently provide compensation for losses due to coastal or erosion as these are natural events. In exceptional circumstances, after large scale multiregional events, grants may be made available to help support the recovery and rehabilitation of those people affected.</p> <p>Department of Homeland Security (2020) in the USA has recently launched a new Hazard Mitigation programme called the 'Flood Mitigation Assistance' (FMA) Grant scheme. Although currently in early development, the scheme will offer Government funding to pay for large-scale relocation nationwide by using eminent domain to evacuate and buy-out people at risk of flooding. This scheme can apply to both communities at risk and individual properties. It is unclear whether the scheme will reach those also at risk of coastal erosion however as the scheme proposes to benefit NFIP-insured (National Flood Insurance Programme) properties so is unlikely to benefit coastal erosion areas in this initial phase.</p> <p>Kotaka et al. (2001) paper examines compulsory purchase of land/property in 11 countries in the Asia-Pacific Region. All 11 countries shows it is the right of the constituent Government to be able to reclaim private property through the use of eminent domain. If required, each country also offers "some measure of compensation to the private owner" (p. 108) of the property. However, typically the use of eminent domain, and thus compensation, is often only used as a last resort in the context of environmental risk management. For example, Australia, Japan and South Korea, will often only utilise eminent domain to obtain property where it is needed for temporary emergency public safety requirements or protection from natural disasters (e.g. wildfires and landslides). There are no examples of where compensation has been used to relocate properties at risk of coastal erosion or loss due to sea-level rise.</p> <p>Landry, C. and Jahan-Parvar, M. (2010) paper discusses how insurance is taken up in the coastal zone in the USA, particularly in areas affected by coastal erosion. It is noted that in areas benefitting from coastal protection, insurance take-up is typically higher and the insurance industry offer cheaper premiums and greater flood insurance coverage to homeowners. Conversely, areas not benefitting from coastal defences or mitigation are negatively affected by higher insurance premiums (even when inland and insuring against coastal flooding). Similarly, in these areas, insurance coverage is often limited, likely due to the impact of coastal erosion losses, meaning that insurance is frequently not an option. This leaves compensatory mechanisms as an alternative option for supporting exposed communities and homeowners.</p>		<p>Policy adaptation – it may be worth evaluating if Flood Re could be adapted to allow homeowners to be offered compensation in the form of relocating from permanent flood inundation and erosion areas, similar to the schemes in the USA NFIP as suggested by Adler et al. (2019) and the upcoming FMA scheme. This should be done in tandem with additional work phases exploring the levy model in more detail.</p>

APPENDIX B INTERVIEW BRIEFING NOTE

Coastal Loss Innovative Funding & Finance (CLIFF) Rapid Scoping Review

Context

Currently, there are 370,000 of residential homes (incl. private ownership and tenanted properties) in England at risk of coastal erosion and / or permanent inundation^[1]. When these properties are lost, many of these residents will lose their home and primary financial asset and lack the means to relocate. This problem is becoming increasingly prevalent, with predictions indicating that more than ~1.2 million residential properties could become exposed to both coastal erosion and flooding by 2080^[1].



Problem

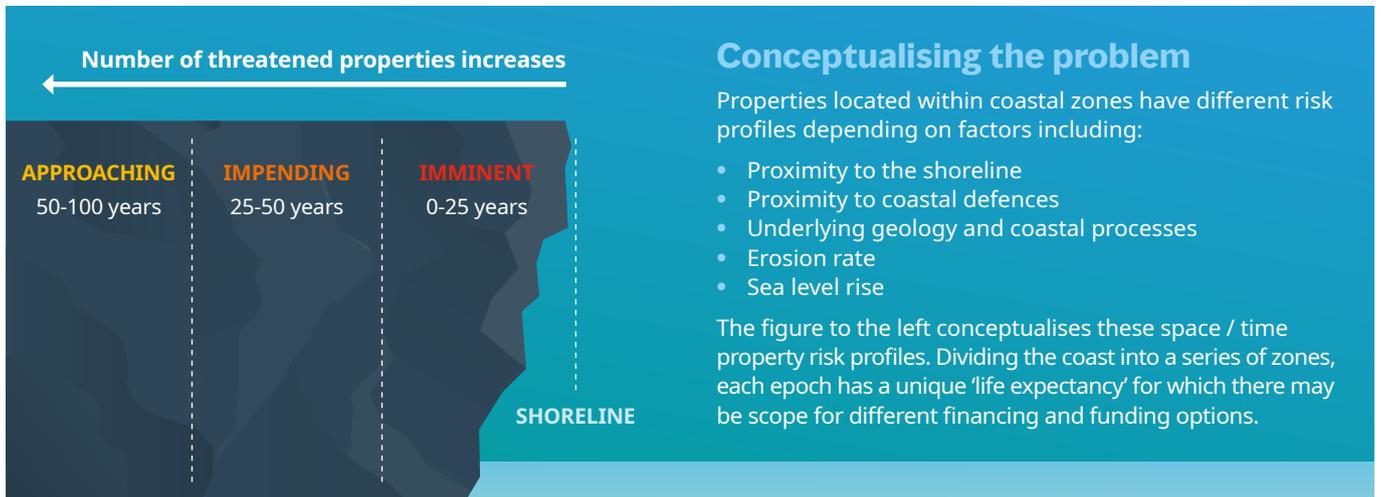
Currently, there are no established financing or funding mechanisms available to support residents with becoming more resilient and provide financial protection to those that lose their homes.

Aim

CLIFF is the scoping and review study commissioned by DEFRA and Coastal Partnership East to investigate potential solutions to this problem.

Approach

To conduct a series of interviews with key subject matter experts to brainstorm potential solutions to the problem and assess their relative feasibility.



Examples of risk profile data available to support future financial solutions

The Environment Agency and local coastal authorities have data available to help support hazard and vulnerability modelling.

Source	Example dataset
Environment Agency	National level view of properties exposed to coastal flooding and erosion
	5% flood extent AEP plus climate change and coastal defences for 2115
Coastal Partnerships East	Number of properties at risk from coastal inundation & erosion
	Erosion rates extracted from Shoreline Management Plans

[1] Environment Agency, 2010; Committee on Climate Change, 2018; Jacobs, 2018.

Case studies

The following illustrative examples put the issue into perspective, helping to visualise the problem and guide collective thinking about potential solutions.

Status	Photograph	Location	Name	Situation
Imminent (0-25 yrs)		Hemsby	Bill and Sarah's family home	A family with three children who moved to Hemsby before the level of erosion risk was clearly apparent. They originally bought the house when it was over 50m from the cliff edge at a value of £140,000. Faster than expected coastal erosion means the house is now dangerously close to the cliff edge. Given the limited financial value of their home, Bill and Sarah now have limited options remaining.
Imminent (0-25 yrs)		Happisburgh	Peter and Joan's residential property	Peter and Joan bought their property when authorities had planned to protect the coast long-term with sea defences. Later, coastal protection was deemed not economically viable and their home is now at risk of coastal erosion. They cannot sell their property and the couple's future depends on their ability to relocate via the 'roll back' strategy using current planning policies. However, they have no funds to do this.
Impending (25-50 yrs)		Fairbourne	Gwen's home and holiday-let	Gwen lives in Fairbourne in a property with several acres of land. She uses this land as a site for holiday-lets which is her only source of income. Fairbourne lies below sea level and is protected by expensive defences. A large coastal inundation event could destroy her entire property and render the current protection redundant. Climate change induced sea level rise means the frequency of inundation events will also increase.
Impending (25-50 yrs)		Thorpeness	Margaret and John's home for retirement	Margaret and John have lived in the village of Thorpeness for many years and plan to retire. The property is at medium term risk and due to this they are not able to release equity from their home to fund their retirement.

Potential financing options

The purpose of this project is to consider a full range of potential financing or funding mechanisms to incentivise residents to relocate from high risk areas or provide financial protection to those that lose their homes. To assist in your thinking, we have identified several potential options:

Options increase with time	Zone	Option	Description
	Imminent (0-25 yrs)	Accept loss	Properties with too little residual value for creation of financial solution
		Incentivised relocation	Property owners offered an incentive to relocate through a central fund
	Impending (25-50 yrs)	Buy and repurpose	Purchase property and repurpose it to generate income (holiday let, wind farm)
	Approaching (50-100 yrs)	Pension style scheme	Payments made into a pot accessible when the property becomes uninhabitable
Levy fund		Residential properties pay a small levy into a central pot to fund properties lost	

The options list is not exhaustive and a property will most likely require a combination of options forming part of a broader solution.



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