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Key Points:

- Structural and non-structural accommodation should be assessed separately to better understand the solution space for coastal adaptation
- The current use of structural accommodation measures is fragmented in Europe and poorly integrated in long-term coastal adaptation planning
- An integrated approach across all coastal adaptation is needed to understand the barriers, limits and benefits of structural accommodation

Supporting Information:

Supporting Information may be found in the online version of this article.

Correspondence to:

U. Pasquier,
u.pasquier@uea.ac.uk

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Author Contributions:

Conceptualization: U. Pasquier, R. J. Nicholls, G. Le Cozannet, P. Sayers, J. Hinkel, A. Toimil

Data curation: U. Pasquier

Formal analysis: U. Pasquier, R. J. Nicholls, G. Le Cozannet, P. Sayers, V. Völz, J. Hinkel, A. Toimil, C. Wolff

Funding acquisition: R. J. Nicholls, G. Le Cozannet

Investigation: U. Pasquier, R. J. Nicholls, G. Le Cozannet, P. Sayers, V. Völz, J. Hinkel, A. Toimil, C. Wolff







Methodology: U. Pasquier, R. J. Nicholls, P. Sayers

Project administration: R. J. Nicholls, G. Le Cozannet

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Structural Accommodation as a Coastal Adaptation Response to Sea-Level Rise: Lessons From Europe

U. Pasquier¹ , R. J. Nicholls^{1,2} , G. Le Cozannet³ , P. Sayers⁴ , V. Völz⁵ , J. Hinkel^{5,6}, A. Toimil⁷, and C. Wolff⁸ 

¹Tyndall Centre for Climate Change Research, University of East Anglia, Norwich, UK, ²School of Engineering, University of Southampton, Southampton, UK, ³Risk and Prevention Department, BRGM, Coastal Risks and Climate Change Unit, Orléans, France, ⁴Sayers and Partners LLP, Watlington, UK, ⁵Global Climate Forum, Berlin, Germany, ⁶Resource Economics Group, Thae-Institute of Agricultural and Horticultural Sciences, Humboldt Universität zu Berlin, Berlin, Germany, ⁷IHCantabria—Instituto de Hidráulica Ambiental de la Universidad de Cantabria, Santander, Spain, ⁸Department of Geography, Coastal Risks and Sea-Level Rise Research Group, Christian-Albrechts University Kiel, Kiel, Germany

Abstract Global sea-level rise is intensifying pressures on coastal regions, increasing the need for adaptation strategies (e.g., protect, retreat, accommodate). At the same time, decision makers require a better understanding of the available responses to address the widening adaptation implementation gap. Structural measures aimed at reducing the impacts of coastal hazards as part of the accommodation strategy have received limited attention in the coastal adaptation literature with few studies looking at how it is currently considered to address sea-level rise. We first advance a conceptual framework that separates structural from non-structural accommodation, recognizing that this distinction is essential to accurately define the adaptation “solution space.” Building on this framework, we synthesize scientific and gray literature, conduct a multilevel review of policy and technical documents, and draw on expert input to not only evaluate the current state of structural accommodation in Europe but also to highlight generic lessons for its potential implementation. This includes consideration of its advantages and disadvantages. Uptake remains fragmented and highly localized, embedded mainly in municipal spatial planning rather than national adaptation agendas, and is hampered by financial, institutional, and technical constraints. We argue that stronger policy integration and dedicated financial incentives could overcome these barriers and harness accommodation's value as a flexible option capable of reducing risk and avoiding long-term lock-in. This study improves our understanding of how this strategy can contribute to coastal resilience in Europe and beyond.

Plain Language Summary As sea levels rise coastal communities around the world need new ways to adapt and stay safe. One approach is to elevate homes or vulnerable parts of buildings above predicted flood levels, referred to here as “structural accommodation.” While these types of measures are common in the United States, Southeast Asia, and some small islands, their role in Europe is poorly understood. In this study, we reviewed scientific research, government policies, and expert insights to clarify what structural accommodation means, examine where and how it is being implemented, and identify the conditions under which it can be most useful. We found that its use varies widely across Europe, is generally limited to local projects, and is often overlooked in national adaptation policies. This lack of integration with other adaptation strategies may hinder the planning of a long-term response to sea level rise. Although our focus is on Europe, the lessons on the benefits, challenges, and limits of structural accommodation are relevant for coastal adaptation worldwide.

1. Introduction

Relative sea-level rise (SLR)—the change in the height of the sea's surface compared to land—resulting from global climate change and vertical land movement is increasing coastal hazards worldwide and the need to respond and adapt. A range of adaptation strategies are available to safeguard human life and assets in coastal areas. Categorizations of adaptation responses to SLR tend to distinguish between “protect,” “retreat” and “accommodate” (Dronkers et al., 1990; Haasnoot, Winter, et al., 2021; Zhu et al., 2010). More recent typologies also include “advance” or “attack”, as well as ecosystem-based adaptation responses, which can be used to support and achieve the other strategies (Bongarts Lebbe et al., 2021; Oppenheimer et al., 2019). As the most common adaptation response, protect has received the greatest attention in earlier literature and Oppenheimer et al. (2019) highlight that there is a lack of studies analyzing other responses, including accommodation.

Resources: U. Pasquier, R. J. Nicholls, G. Le Cozannet, P. Sayers, A. Toimil, C. Wolff

Supervision: R. J. Nicholls, G. Le Cozannet

Visualization: U. Pasquier

Writing – original draft: U. Pasquier, R. J. Nicholls, G. Le Cozannet, P. Sayers, V. Völz, J. Hinkel, A. Toimil, C. Wolff

Writing – review & editing: U. Pasquier, R. J. Nicholls, G. Le Cozannet, P. Sayers, V. Völz, J. Hinkel, A. Toimil, C. Wolff

Early definitions of accommodation describe it as an approach where “people continue to use the land at risk but do not attempt to prevent the land from being flooded” (Dronkers et al., 1990). As in retreat (and unlike protect) all natural system effects are allowed to occur, but human impacts are minimized by adjusting human use of the coastal zone (Nicholls, 2018) or increasing society's ability to cope with the effects of extreme events (Zhu et al., 2010). Examples of accommodation measures include the introduction of salt-tolerant crops in response to salinization (e.g., van den Burg et al., 2024), or structural measures such as raised or floating buildings reducing the impact of erosion and flooding (e.g., Pasquier et al., 2024; Trang, 2016).

The Intergovernmental Panel on Climate Change's (IPCC) Special Report on the Ocean and Cryosphere in a Changing Climate expanded on previous definitions describing accommodation as “diverse biophysical and institutional responses that mitigate coastal risk and impacts by reducing the vulnerability of coastal residents, human activities, ecosystems and the built environment, thus enabling the habitability of coastal zones despite increasing levels of hazard occurrence” (Oppenheimer et al., 2019). While this definition includes early warning systems, hazard mapping or insurance schemes as part of accommodation, others consider these “information or preparedness measures” as separate cross-cutting and complementary approaches which also potentially support protect, advance and retreat (Nicholls, 2018). As discussed in the next section of this paper, there is value in adopting a disaggregated view of accommodation, and here we focus on structural measures. Increasing the resilience of infrastructure and human settlements to climate change impacts represents one of the main thematic areas laid out in the United Arab Emirates Framework for Global Climate Resilience that was agreed at the 2023 Conference of the Parties of the United Nations Framework Convention on Climate Change (COP 28) (United Nations, 2024), reinforcing the need for structural accommodation to be addressed separately.

Elevating buildings (e.g., on stilts or pillars) is a technique that has been utilized to vertically avoid flooding in coastal areas for millennia (Cheirchanteri, 2024). The practice is common in the United States, where it has been institutionalized since the 1970s as part of the National Flood Insurance Program (NFIP) (Horn & Brown, 2017; Leatherman, 2018). While Glavovic et al. (2022) describes accommodation as the second most widely used adaptation strategy next to hard protection, the provided examples of structural measures are limited to the US (e.g., Aerts et al., 2014, 2018) and Southeast Asia (e.g., Buchori et al., 2018; Jamero et al., 2018). The raising of dwellings and infrastructure above ground level is also implemented in some small islands of the Pacific and the Caribbean (Magnan et al., 2018; Mycoo et al., 2022) as well as in Australia (Dedekorkut-Howes et al., 2021). In a review of global coastal adaptation, Magnan et al. (2023) found few cases of structural accommodation measures, with exceptions including French Polynesia and Helsinki, Finland. As they argue, the current state of climate adaptation remains unclear and few studies have assessed structural accommodation in Europe. Pasquier et al. (2024) showed that structural accommodation is integrated within the scope of flood risk management via local spatial planning, yet this study only focused on the cases of France, the United Kingdom and Ireland. The experience of these three countries is not representative of the rest of Europe due to the varying geographies, nature of hazards, adaptation and hazard management policies, economic context and political priorities of the European coastline.

Haasnoot et al. (2020) argue that a better understanding of the “solution space” for climate adaptation—the space within which opportunities and constraints determine why, how, when, and who adapts to climate risks—is required to accelerate efforts, which includes an assessment of options and governance actors. The aim of this study is not to provide an exhaustive account or inventory of accommodation measures and practices in European countries. Instead, this paper aims (a) to qualitatively assess the current state-of-the-art of structural accommodation in Europe to better understand the solution space for coastal adaptation and (b) to use these lessons to provide generalized insights into structural accommodation as a response to SLR. The objectives of the paper are (a) to provide conceptual clarity on definitions of accommodation and categorizations of different measures, (b) to assess the varying ways structural accommodation is presently implemented to address rising sea levels in Europe, and (c) to identify advantages and disadvantages of structural accommodation, the barriers that have limited its adoption and discuss how these could be overcome for structural accommodation to better support coastal adaptation in the future globally. While the potential benefits and limitations of structural accommodation are discussed, it should be noted that an assessment of the feasibility and effectiveness of the presented measures falls outside of the scope of this study.

This paper is organized as follows. Section 2 presents a conceptual framework to understand the diverse nature of accommodation and the fundamental differences between structural and non-structural measures. Section 3

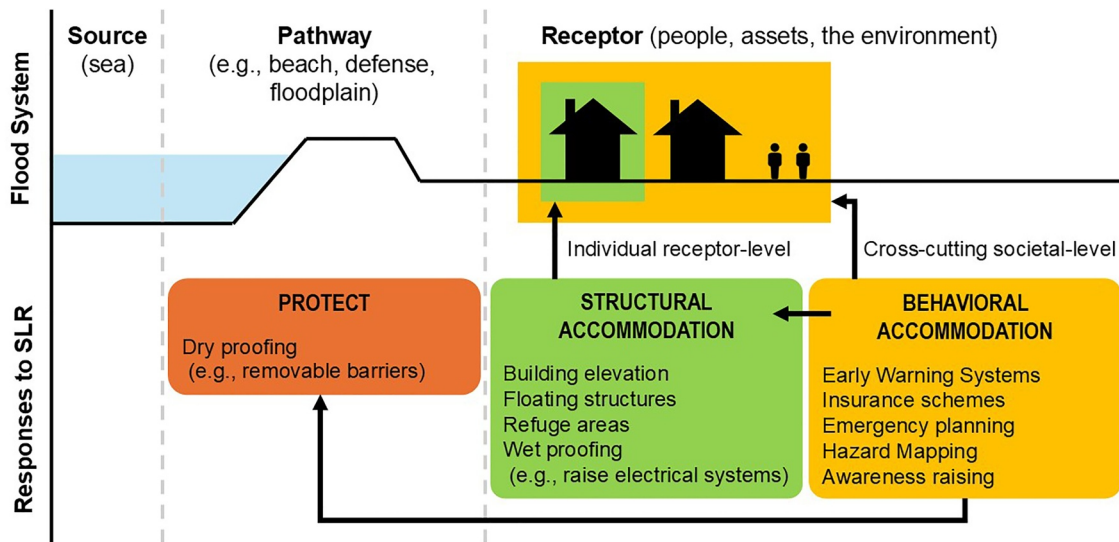


Figure 1. Examples of measures commonly associated with accommodation mapped to the different components of flood risk in the SPR model. Adapted from descriptions of the SPR model (Sayers et al., 2002, 2015) and of the coastal flood system (Narayan et al., 2014; Nicholls et al., 2015). Structural accommodation adapts individual (or a set of) receptors while information and preparedness measures, or behavioral accommodation, act at broader societal scales. These latter cross-cutting measures generally inform subsequent decision-making or lead to behavior change. Dry proofing is often considered as accommodation but as it influences the horizontal pathway, it is here considered as a form of protection at the property level.

describes the types of structural accommodation measures that exist in Europe and where they can be found, drawing from a review of scientific and gray literature, as well as case studies. Section 4 addresses the different levels of governance with policies on structural accommodation from the European to the national and local level. Finally, Section 5 discusses generalized lessons learned on barriers and limitations, how they can be addressed in the future, and opportunities for structural accommodation to adequately respond to the coastal changes expected in the coming century.

2. A Structural View of Accommodation

Broad definitions of accommodation can refer to a wide range of individual measures that do not serve the same function in reducing risk. This leads to a lack of clarity in past assessments of accommodation in the adaptation literature. The source-pathway-receptor (SPR) model is commonly used to understand the different components of the flood system (Sayers et al., 2002; Thorne et al., 2007; Zanuttigh et al., 2014), which can help define a conceptual framework for accommodation. In the SPR model, for a risk to arise, there must be a hazard that consists of a “source” (e.g., the sea), a “receptor” (e.g., properties) and a “pathway” between the source and the receptor (e.g., defenses). The consequences of a flood represent an impact (e.g., economic) reflecting both the vulnerability of the receptors and the chance a given receptor is exposed to the flood (Sayers et al., 2015).

Figure 1 shows adaptation responses to SLR mapped to the different components of the SPR model. Here, we separate structural accommodation measures such as building elevation from non-structural, or “behavioral” accommodation, such as early warning systems or hazard mapping. While the latter aim to reduce the vulnerability of receptors by increasing their resilience, they act at the societal scale to manage the consequences of flooding. Previous studies applying the SPR model to coastal flood risk have referred to such measures as part of “societal perception and responses” (Narayan et al., 2014; Nicholls et al., 2015). They moreover tend to be complementary measures to help inform and take decisions concerning other adaptation responses such as structural accommodation and protect (Figure 1). Structural accommodation measures on the other hand are engineered adaptation options that address risk at the level of individual receptors. Grouping both sets of accommodation measures is problematic for adaptation science and in practice as they perform fundamentally distinct functions and therefore require separate assessments. It should be noted that in the US, government agencies list building elevation as a “non-structural” option, as “structural” approaches only refer to protection measures in their terminology. This can also be a source of confusion, and we here follow the United Nations

Office for Disaster Risk Reduction (UNDRR) definition of structural measures: “any physical construction to reduce or avoid possible impacts of hazards” (UNDRR, 2017).

In assessing coastal adaptation in Europe, Galluccio et al. (2024) state that accommodation measures are the most widely identified, ahead of protection measures. This conclusion reflects the widespread implementation of non-structural measures such as early warning systems or climate risk insurance schemes and does not apply to structural accommodation. The need for discretization is also emphasized when assessing accommodation's feasibility. While Oppenheimer et al. (2019) argue that accommodation measures have high benefit-cost ratios, economic and practical constraints are much greater for structural measures, particularly the raising of properties. Finally, non-structural measures will have different synergies with other adaptation strategies, which affects how to consider an integrated response to SLR. For example, structural accommodation and retreat may only occur sequentially, as opposed to information measures which tend to be complementary to most other adaptation responses. Information and preparedness approaches have received much more attention in previous studies in Europe (e.g., Bogaard et al., 2016; Ciavola et al., 2011; Harley et al., 2012) further emphasizing the need for a greater focus on structural accommodation.

As a receptor-scale strategy, structural accommodation overlaps with property-level resilience strategies in flood risk management, namely “avoidance”, “flood resistance” and “flood resilience” (Sayers et al., 2015). While avoidance is generally used to reflect efforts to restrict development in floodplains, building elevation can be considered an avoidance approach to reduce exposure vertically. Flood resilience measures (or wet flood-proofing), such as raising electrical systems, and efforts to increase reparability also align with structural accommodation as they aim to avoid long-lasting damage in buildings and promote recovery. While it can be practical to include flood resistance (or dry flood-proofing) as part of accommodation (e.g., Koerth et al., 2013; Völz et al., 2025), it does not fulfill the definition used here that requires leaving natural systems unrestricted. As shown in Figure 1, we here consider measures like removable barriers as representing the last point of the pathway, before reaching the receptor. As Oppenheimer et al. (2019) argued, flood resistance represents an edge-case with room for interpretation, which can be considered a protection strategy at the scale of individual properties.

3. Description of Structural Accommodation Measures and Examples

The methods for this study combined a review of academic and gray literature, case studies, an analysis of existing policy and input from expert knowledge. It should be noted that this approach did not aim to be comprehensive but rather to produce a representative account of structural accommodation in Europe, as this is lacking in the adaptation literature. This study focused on the continent of Europe, encompassing countries both within and outside the European Union (EU) that have a coastline. European Directives, national policy and technical documents, such as recommendations on building codes and design, were analyzed to identify the role of structural accommodation in coastal adaptation. For countries in the EU, a similar approach to Bisaro et al. (2024) was used to assess national-level progress on structural accommodation using the EU's governance monitoring framework, which provides climate adaptation policies of countries on the Climate-ADAPT platform. Analogous climate adaptation policy documents were individually identified in countries outside of the EU, such as the UK. Information gathered from both a review of literature and inputs from experts, notably within the Coastal Core Climate Services (CoCliCo) EU project, was also used to identify countries and municipalities with an existing structural accommodation strategy manifested outside of policies dedicated to adaptation. In such cases and when data was made publicly available, spatial planning documents were assessed to identify national and municipal-level guidelines on structural accommodation.

While evidence of structural accommodation in Europe is still limited, its realization can be described by how it fundamentally departs from the US's experience with raising coastal buildings on three points. The first is that, although structure elevation is common in the US, there is no allowance for relative SLR in the definition of the base flood elevation and extreme water levels are stationary. In Europe, where minimum floor levels are recommended, these generally consider SLR, as is discussed in more detail in the next section. Secondly, structural accommodation generally occurs in sheltered locations in Europe, where some level of natural or artificial protection is already in place and wave action is limited (Pasquier et al., 2024). This residual risk approach differs from the US where elevated buildings are common on open coasts. In the US, areas behind flood protection barriers have no base flood elevation requirements and no requirement to purchase flood insurance as they are

Table 1
Non-Exhaustive Overview of the Types of Structural Accommodation Measures That Can Be Found in Europe: (a) Minimum Floor Levels, (b) Raising Vulnerable Systems, (c) Refuge Area, (d) Indoor Floor Raising, (e) Floating/Amphibious Buildings

Country	a	b	c	d	e	Source
France	•	•	•			Pasquier et al., 2024; DGPR, 2014
England	•	•	•			Pasquier et al., 2024; EA, 2020
Wales	•	•				Pasquier et al. (2024)
Scotland	•	•				Pasquier et al., 2024; SEPA, 2022
Northern Ireland	•	•				Pasquier et al. (2024)
Ireland	•	•				Pasquier et al., 2024; OPW, 2019
Denmark	•					Danish Coastal Authority (2025)
Finland	•				•	Mees et al., 2014; Schmidt-Thome & Peltonen, 2006
Sweden	•					Segge and Mauerhofer (2023)
Estonia	•					Looring (2013)
Germany	•	•				State of Schleswig-Holstein (2021)
Italy	•			•		Municipality of Venice, 2020; Nunes et al., 2005
Netherlands					•	Huebner, 2025; Penning-Rowsell, 2020

considered outside the flood risk zone. Therefore, while the US uses structural elevation more systematically, it does not employ it in the context in which it is most often found in Europe. Finally, due to the high costs associated with elevating masonry and stone buildings (Aerts et al., 2013), raising entire structures is generally only considered for new developments during the construction phase in Europe (European Commission, 2023). For existing developments, the preferred approach is to elevate parts of the structure, for example, by creating a refuge floor or raising vulnerable systems and appliances. In the US, where wood framed constructions are more standard, raising structures in flood-prone areas has been a government-promoted strategy (Attems et al., 2020; FEMA, 2014). A summary of measures and sources discussed in this section can be found in Table 1.

3.1. Minimum Floor Levels for New Developments

The primary accommodation measure in Europe is to define minimum floor levels for new developments in high-risk areas as part of local spatial planning. This measure can originate from efforts to manage coastal flood risk that outdate coastal adaptation strategies but can also respond to SLR by adding a climate change allowance to a contemporary design extreme sea level (e.g., 100-year event) and some margin for uncertainty, or freeboard (Pasquier et al., 2024).

This approach can be found in France, the UK, Ireland, Denmark and Finland, where national guidelines are translated at the local level to determine an appropriate elevation for new buildings (Figure 2). Local-level recommendations at the municipal level can also exist in the absence of national guidelines, particularly in countries where municipalities are relatively autonomous and required to manage flood risk. This is the case for example, in five municipalities in Sweden (Segge & Mauerhofer, 2023) and in Haapsalu in Estonia (Looring, 2013). In the Municipality of Venice, Italy, building regulations state that the ground floor of buildings in the historical center must be set at 1.30 m above sea level, while new developments in the surrounding island settlements must be at a height of 1.60 m above sea level (Municipality of Venice, 2020). However, these elevation standards do not explicitly consider SLR and are influenced by the protection provided by Venice's flood barrier system, MOSE, which is designed to be activated when water levels exceed 1.30 m.

The Netherlands and Belgium are defended at very high standards and rely primarily on protect as the dominant strategy. In these countries, structural accommodation is minimal and restricted to exceptional or experimental cases (Figure 2). This indicates that while structural accommodation tends to occur in sheltered or protected coasts in Europe, it is no longer considered as a strategy to manage residual risks when protection standards reach a high enough threshold. A similar pattern can be found in the State of Schleswig-Holstein, where local guidelines for minimum floor levels exist but are restricted to the Baltic coast. In contrast, on the North Sea coast, which is defended at much higher standards, structural accommodation is applied only on a case-by-case basis, rather than

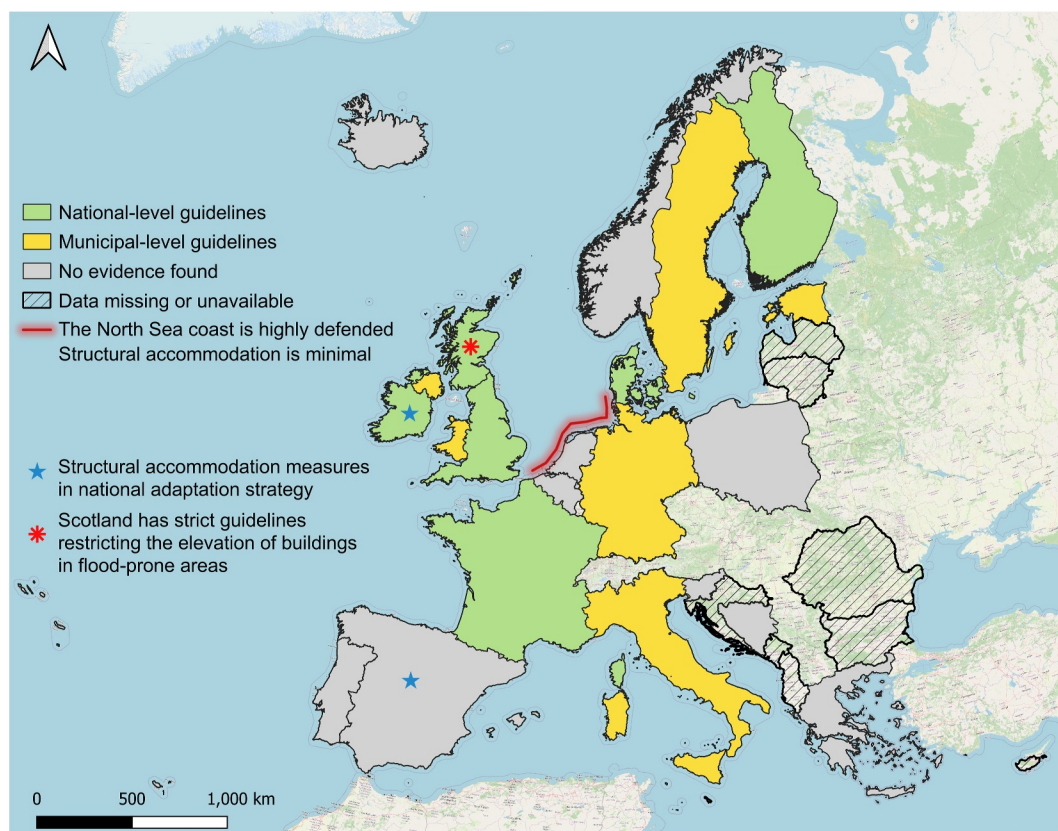


Figure 2. Evidence of existing guidelines promoting building elevation, for example, with recommended minimum floor levels, for developments in areas prone to coastal flooding and SLR. These guidelines tend to be localized in spatial planning at the municipal/city level (yellow) with few countries providing national-level instructions on the level (or how to determine it) at which buildings should be elevated (green). Even fewer countries were found to have explicit references to structural accommodation measures to address SLR in their national adaptation strategy (blue star). More information on the primary sources used in this map can be found in Table S1.

as a standardized elevation rule. Still, the lack of spatial planning rules does not prevent some adaptation from taking place at the level of individual households. In a survey of 257 households on the North-Sea coasts of Germany and Denmark, Koerth et al. (2013) found that 27% reported elevating their house on a mound as a proactive adaptation to SLR.

The method to achieve the elevation of new buildings varies between countries and depends on building codes as well as local restrictions. A common approach is to raise the ground floor on top of a void space created with concrete pillars (Figure 3a). The use of crawl spaces is generally restricted to ensure that the underside of buildings remains unused and allows for free conveyance of water (e.g., Scotland). Municipalities that accommodate can also consider stilts as inappropriate measures and instead recommend that living spaces in buildings are raised on less vulnerable (or “sacrificial”) floors such as parking or storage areas, which are common in England for example, (Figure 3b). The presence of guidelines does not necessarily signify the implementation of accommodation measures. In Finland, while nation-wide recommendations that include SLR have existed since at least 2002, many cities have allowed building close to the coast at lower elevations (Finnish Meteorological Institute, 2014; Schmidt-Thome & Peltonen, 2006).

3.2. Retrofitting

Retrofitting is also practiced in Europe where only parts of existing structures are raised. In Venice, Italy, a common practice is to raise interior floors by covering the existing flooring with a new structure where ceiling heights are high enough. Although there is a need for an updated inventory, Nunes et al. (2005) reported that more than 18% of businesses in Venice used this method. Still structural accommodation is rare in historical buildings

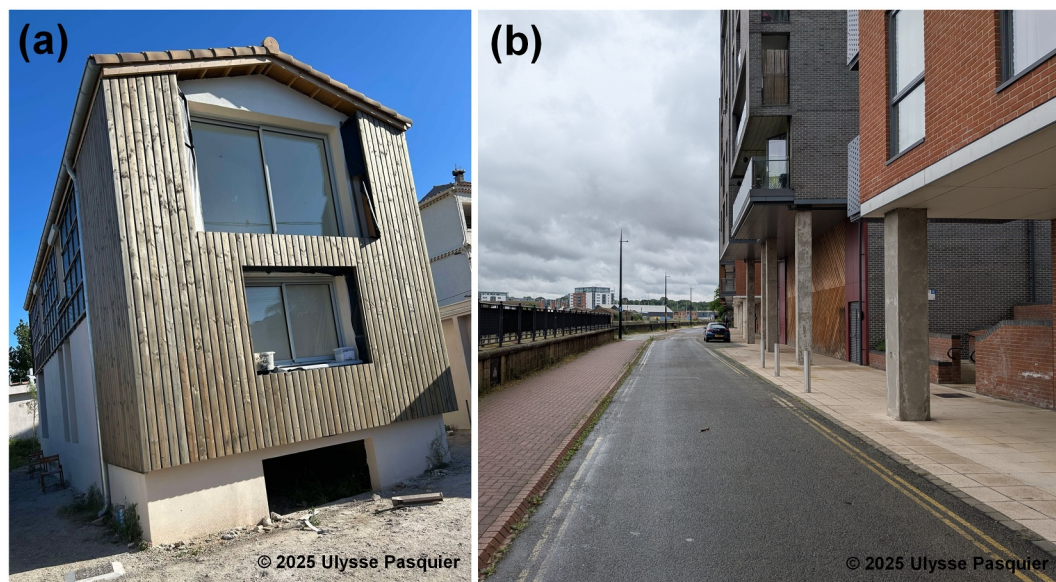


Figure 3. Examples of elevated residential structures in Europe. (a) A redevelopment in France, Mediterranean coast. The new construction is elevated on a crawl space to respect local urban planning rules for minimum floor heights in high flood risk areas. (b) Residential buildings elevated on top of a less vulnerable parking space in Ipswich, UK. The area is at risk of tidal flooding and is protected by flood walls along the riverbanks and a tidal barrier.

where technical considerations and cost are important limiting factors. Another retrofit option is to build refuge areas on top of single-story houses to provide a place for shelter and escape during a flood event. This accommodation measure is applied in France, where it has become an integral part of local adaptation strategies in high-risk areas in the wake of significant fatalities during the 2010 Cyclone Xynthia (Creach et al., 2020; Pasquier et al., 2024).

The raising of indoor vulnerable equipment (i.e., electrical, heating or sewage systems) can be considered an accommodation measure that overlaps with recent efforts to promote property level resilience (Attems et al., 2020; Proverbs & Lamond, 2017). This strategy is recommended at the European level in technical guidance on best practices when adapting buildings (European Commission, 2023). As a relatively cheaper measure (Aerts et al., 2013), it is commonly recommended as part of general wet flood-proofing strategies for different sources of flooding (Koerth et al., 2013; Kreibich et al., 2015).

3.3. Transformative Measures

Transformative adaptation broadly refers to measures that change the fundamental attributes of a socio-ecological system to deal with climate risks (IPCC, 2022). Despite the growing recognition of the limits of incremental change (Wannevitz et al., 2024), transformative adaptation is still largely at the theoretical stage rather than common practice. This is the case for coastal adaptation efforts, which Magnan et al. (2023) found to be incremental globally. As Clarke and Murphy (2023) argue, elevating individual houses is an example of incremental adaptation where the fundamental system characteristics remain vulnerable despite accommodating change. Still, some examples of structural accommodation can be assessed through the lens of the key dimensions associated with transformative change in previous literature (e.g., Termeer et al., 2024), namely: depth, scope and pace. Despite unavoidable trade-offs between these three dimensions, the motivation for transformative adaptation is that in-depth (radical shift in values, goals and beliefs), system-wide (broad scope, involves multiple sectors and domains) and rapid change can help limit short-term focused actions and effectively reduce climate risks (Engbersen et al., 2024).

Structural accommodation offers opportunities for innovative non-traditional strategies in city and building design. HafenCity in Germany is a notable example of an adaptive urban redevelopment project of a former port area using accommodation (Restemeyer et al., 2015). Located outside of the dike system in Hamburg's harbor, buildings in HafenCity are elevated to a height of approximately 8 m above mean sea level on top of dwelling



Figure 4. The floating neighborhood of Schoonschip in Amsterdam, Netherlands.

mounds that are incorporated as basements for parking areas or shops (Mees et al., 2014). While dwelling mounds can represent a concern by restricting flows and leading to increased flood risk for neighboring homes, HafenCity is designed as a whole with elevated livable areas and floodable surrounding streets and outdoor public spaces at lower elevations. This approach allows connection with the water in a way that is not possible behind a dike.

Another radical accommodation strategy is floating or amphibious urban development. The combined pressures of urban expansion and SLR have led to a rising interest in this type of architectural solution, which can provide additional housing as well as increase urban resilience (Penning-Rowsell, 2020). However, few examples of floating structures exist in Europe except isolated cases in the Netherlands (Figure 4) or Finland (Mees et al., 2014). The Netherlands are increasingly exploring alternative flood management strategies, such as “living with water”, which can include floating structures (Kraan et al., 2025). Floating housing is still rare and experimental, with no clear agreement on building types and standards, and is far from being considered as a tool for adaptation (Huebner, 2025; Penning-Rowsell, 2020).

In the classification of transformative change proposed by Termeer et al. (2024), both HafenCity and floating neighborhoods can be argued to fall in the “Small Wins” pathway. To different levels, these are local innovations that radically change existing practices and could result in transformative change if such initiatives accumulate. While they aim, or require, a radical change in existing practices and values, these structural accommodation measures are yet to be upscaled and remain local and marginal (Bednar-Friedl et al., 2022). Both port redevelopment or repurposing (e.g., HafenCity) and floating developments are observed in regions unexposed to waves, where the protect strategy dominates and most attention for the next century is still to upgrade defenses. They also tend to be restricted to areas with high population densities, where significant investment is easier to justify.

4. Governing Structural Accommodation: From EU and National Policy to Local Planning

4.1. European and National Climate Adaptation Strategies

In Europe, the governance of accommodation is distributed across multiple levels from European to subnational levels. At the European level, while accommodation as a response to SLR is not explicitly recognized, one of the key principles of the European Commission's Climate Adaptation Strategy is that investing in resilient, climate-proof infrastructure is an effective way of reducing climate-related risks. The EU's Climate Adaptation Strategy prompted the development of national adaptation strategies. Using the information available on the Climate-ADAPT platform, Bisaro et al. (2024) found that although all Member States had adopted a strategy dedicated to coastal adaptation, only five countries—Estonia, Ireland, the Netherlands, Portugal and Spain—included specific measures to address SLR. Of these, only Ireland (Office of Public Works, 2019) and Spain (Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente, 2016) recommend structural accommodation measures.

It should be noted that the existence of national strategies does not guarantee the implementation of adaptation at the local level (Heidrich et al., 2016), as was found for Spain (Losada et al., 2019). The final decision to implement structural accommodation measures is typically taken on a case-by-case basis at the level of households (Pasquier et al., 2024). The Spanish Coastal Climate Change Adaptation Strategy addresses structural accommodation (e.g., ensure the structural adequacy of new and existing buildings) and recommendations have been provided on codes to follow when raising buildings in flood-prone areas (Ministerio para la Transición Ecológica y el Reto Demográfico, 2019). Still, there is little evidence of structural accommodation being implemented as a response to SLR, and the use of temporary flood resistance measures (e.g., dry proofing) is more widespread. Structural accommodation initiatives (e.g., urban design criteria in areas vulnerable to SLR) have been identified as part of the adaptation plans in northern Spain, such as in San Sebastian, but they are still in planning or early implementation stages. A further challenge in identifying structural accommodation is that structure elevation can occur for reasons other than a response to SLR. For example, mid-20th century seaside developments in Spain commonly incorporated stilts or raised ground floors for architectural reasons, reflecting urban design choices aimed at visual openness and functional permeability, rather than an explicit coastal adaptation intent.

While they do not feature specific measures, the national adaptation plans of France and England are also relevant to structural accommodation. The first measure in France's recently updated national adaptation strategy (French Government, 2025) is to enhance its Risk Prevention Fund (“Fonds de Prévention des Risques Naturels Majeurs”, FPRNM). The FPRNM is France's main funding mechanism for structural accommodation, among other risk prevention measures. In response to this plan, the French Climate Change Committee highlighted that adaptation financing remained too low. It noted that funding from the FPRNM could have been further increased if the additional tax revenue collected as of 2025 from the higher premiums feeding the French public-private reinsurance system had been fully directed to prevention (Haut Conseil pour le Climat, 2025). The Committee also argued that a more effective governance on adaptation could be achieved with a better definition of the role of different actors, as well as a clearly stated hierarchy of objectives on specific measures. It remains unclear what the role of structural accommodation will be and how it will relate to other adaptation responses. In England, the National Adaptation Program (Department for Environment, Food and Rural Affairs, 2023) refers to the Flood and Coastal Erosion Risk Management Strategy, which includes raising floor levels as a method to improve individual property resilience. Structural accommodation is less prevalent in the rest of the UK, including in Scotland where a national policy statement on elevated buildings restricts their implementation to exceptional circumstances (Pasquier et al., 2024; SEPA, 2022).

4.2. Flood Risk Management and Spatial Planning

Like its Climate Adaptation Strategy, the EU's Floods Directive does not address accommodation directly. The introduction of a risk-based approach to managing flooding in Europe nevertheless has promoted a shift toward proactive action. The Directive has been in part responsible for the growing emphasis on “multi-layered safety” and the benefits of the diversification of flood risk management strategies (Kaufmann et al., 2016; Priest et al., 2016). Looking at the cases of Belgium, France, the Netherlands, Poland and Sweden, Hegger et al. (2018) argued that on the ground implementation of a diversified set of strategies that include accommodation was slow

and lagged behind discourses on diversification. In practice, flood protect remains the dominant strategy for populated coastal areas in Europe. Structural accommodation is minimal in regions with very high standards of protection (i.e., the Netherlands, Belgium and the German North Sea coast) (van Doorn-Hoekveld et al., 2022).

In England, where diversified flood mitigation approaches are historically better established (Fournier et al., 2016), structural accommodation has garnered more attention as it coincides with the emerging concept of “avoidance” as part of property-level flood resilience (Attems et al., 2020; Proverbs & Lamond, 2017). In Europe and beyond, the term “avoidance” is more commonly used to refer to steering new developments away from hazard prone areas, such as floodplains. While this approach is recognized as the prioritized strategy to reduce flood risk, “avoidance” is also used to refer to raising properties above predicted flood levels in France, England and Ireland (Pasquier et al., 2024). In France, the uptake of policies fostering decentralized approaches to flood risk, including raised buildings in coastal areas, have also accelerated following the 2010 Cyclone Xynthia disaster, where more than 50 deaths occurred behind failed defenses (Creach et al., 2020).

Accommodation, when it is considered, is driven by efforts to manage flood risk in local spatial planning, meaning that its implementation will not only vary between countries, but also from one municipality to another (Pasquier et al., 2024). This includes differences in how SLR is represented in accommodation measures, even when national guidelines exist. Focusing on Sweden, Segge and Mauerhofer (2023) made a similar observation that while municipal authorities at the forefront of adaptation to SLR, important local discrepancies exist. Another consequence of the largely localized and bottom-up nature of accommodation is its disconnection from other adaptation responses. In Europe, protect and retreat tend to be managed at larger geographic scales of floodplains and management units and up to the catchment and “coastal-cell” level as for example, in England's Shoreline Management Plans (Nicholls et al., 2013). As accommodation is applied at the individual property level, it is not considered in policy-level analysis such as Shoreline Management Plans.

5. Challenges and Opportunities

5.1. Financial Barriers

Retrofitting or elevating buildings entails significant capital expenditure, which typically falls on the individual developer or owner. While raising awareness of risk and the benefits of property-level resilience measures can promote uptake, the cost burden discourages the implementation of structural accommodation. Previous research has found that protecting populations from flooding is perceived as a state responsibility (White et al., 2018), which disincentivizes private investment in adaptation. Without clear regulatory or financial incentives, adaptation to SLR therefore tends to gravitate toward larger-scale shared responses in Europe, such as protect, or retreat. Reactive decision-making also tends to dominate whereas a proactive approach to structural accommodation is beneficial as it allows a wider range of options and because measures are generally cheaper to implement during the construction process (Attems et al., 2020). Previous studies outside of Europe have also found that raising new building floors to be a cost-effective way to reduce potential damage losses in coastal areas (Aerts, 2018; Wang et al., 2015). Still, more research is needed to assess how the cost of structural accommodation compares to that of other adaptation strategies, under different scenarios of SLR.

Lessons can be learned from the US, which encourages building elevation through several mechanisms managed by the Federal Emergency Management Agency (FEMA, 2025). Communities that meet elevation requirements may be eligible for discounts on flood insurance premiums and eligible to grants like the Hazard Mitigation Grant Program, which commonly funds measures like the elevation of structures or the construction of refuge areas. These types of incentives are largely missing in Europe. In France, the FPRNM is one of the few existing sources of public funding, which includes coverage for some structural accommodation measures (Pasquier et al., 2024).

Flood insurance plays an important role in controlling the uptake of property-level adaptation measures but can also have undesirable effects. The US's NFIP has received criticism in the past for encouraging development in flood-prone areas (Michel-Kerjan & Kunreuther, 2011), for its limited adoption rates (Choi et al., 2024) and for not reflecting growing flood-related risks associated with SLR (Kousky et al., 2021). Previous studies have shown that countries in Europe where the reinsurance mechanisms institutionalize solidarity among households in low and high-risk areas experience a reduction in the incentive to adapt (Delannoy, 2025; Tesselar et al., 2023). On the other hand, risk-based insurance schemes as in the UK or Germany can not only discourage development in floodplains, but also stimulate adaptation (Surminski & Thieken, 2017). It is worth noting that as the costs of

insurance of climate risks are increasing in France, recommendations have been made to the ministry in charge of finances to develop new mechanisms encouraging wealthy households to invest in accommodation measures in high-risk areas (Langrenney et al., 2023). Similarly, in the case of England, van der Plank et al. (2021) argue for a systems approach to coastal adaptation that should better integrate spatial planning, structural measures and insurance approaches, as currently few mechanisms exist to incentivize risk reduction at the household level. An important caveat to the above points is that most existing research on flood insurance has looked at fluvial flooding. Coastal risks, and the irreversibility of SLR, entail unique challenges for the funding of adaptation measures that should be more closely investigated.

5.2. Social Perception

Elevated, amphibious or floating buildings must contend with issues of acceptability and public perception. Not only do structural accommodation measures require additional care to ensure access and egress, they can also deter the majority of people who tend to be risk averse when making a decision like purchasing a home (Penning-Rowsell, 2020). The more visible measures, such as raised houses, can act as markers for the existing risk and therefore have the unintended effect of increasing fear or uncertainty rather than providing a sense of protection or increased safety (Huebner, 2025). Botzen et al. (2013) found that 52% of homeowners would be willing to invest in elevating their house in the Netherlands, but that this would require a major shift in Dutch flood risk management. While a general shift in attitudes may be required before a wide uptake of structural accommodation measures is possible, some styles of elevated architecture are less radical and more likely to be accepted (e.g., Figure 3b). Two additional limitations to structural accommodation can affect the willingness to rely on such measures. Firstly, even when successfully implemented, structural accommodation does not prevent the flooding of areas surrounding buildings and for activities and livelihood to be disrupted (Oppenheimer et al., 2019). This includes assets such as motor vehicles, which can represent a high share of the net worth of households and can be impacted by flooding, as shown by Koller (2025) in the case of the US. Secondly, in the absence of funding schemes, structural accommodation can lead to increasing inequalities in vulnerability depending on the capacity of individual homeowners to afford property-level measures (Hudson, 2020). As is the case with other adaptation strategies like retreat (Lawrence et al., 2020), this can lead to the break-up of communities at the coast and disproportionately affect low-income households.

5.3. Physical Limitations and Effectiveness

Considering the limitations of structural accommodation measures is critical to avoid maladaptation. Local environmental conditions hold an important role in determining the feasibility and effectiveness of this type of action and can increase vulnerability if unconsidered. For example, elevated structures have been found to be more susceptible to wind damage in coastal areas (Amini & Memari, 2021). Additionally, certain methods to elevate structures may be unsuitable in areas affected by high water velocities and significant wave action during a flood. In the US, FEMA provides strict construction rules defining the type of acceptable foundations for elevated buildings in high-risk zones, such as the “V-Zone,” where waves are significant. Calcagni and Battisti (2025) find that waves and climatic conditions are limiting factors to the development of floating urban solutions, which are more suited to countries like the Netherlands. Countries like Italy also must contend with hazards that are not related to SLR such as earthquakes. Raised foundations such as stilts may be more prone to torsional forces during seismic events and therefore have the unintended consequence of increasing vulnerability to earthquakes. Structural accommodation therefore requires a multi-hazard and locally-specific perspective to be effective. There is still a lack of consistent technical guidance that considers these physical constraints in Europe (Pasquier et al., 2024).

Although measures in countries like France and England suggest that avoidance can be done both horizontally (i.e., steering developments away from floodplains) and vertically (i.e., raising buildings), this should come with the recognition that the limits of the latter will be reached much earlier. As Oppenheimer et al. (2019) argued, structural accommodation is most effective for relatively small amounts of SLR as the limits to accommodation occur earlier compared to other coastal adaptation strategies. The practical and economic limits to structural accommodation mean that a shift to protect or retreat (or even advance) will be ultimately required due to the ongoing nature of SLR, and hence it can be regarded as buying time, rather than a permanent adaptation solution. For example, the Louisiana Coastal Master Plan recommends buyouts for elevated structures depending on flood depth thresholds during extreme events under different SLR scenarios (Wilson et al., 2023).

Mechanisms to detect when these shifts are necessary are needed in dynamic adaptive policy pathways (DAPP) planning, which is increasingly recognized as a tool to support climate change adaptation decision-making for SLR (Haasnoot, Lawrence, & Magnan, 2021). The current approach to set minimum floor levels in Europe, as described in Section 3.1, leaves little space for the consideration of ongoing rising risk, widening future uncertainties and long planning timeframes. A more appropriate approach has been proposed, following the DAPP framework, in which increments of SLR are used to allow for decisions to be taken before harmful adaptation thresholds—the limits of structural accommodation—are reached (Stephens et al., 2017, 2018). Cost-effectiveness studies are essential to inform decision-making as investment in managed retreat may be necessary earlier in certain regions. While studies have shown that structural accommodation can be a cost-effective approach to reducing flood risk (e.g., Zhu et al., 2010), there is still a lack of research in the European context comparing the costs and benefits of other responses to SLR over different timeframes that acknowledge the different lifetimes of a range of adaptation measures. The above points highlight the importance of considering how structural accommodation interacts with other adaptation options in both time and space (Völz et al., 2025).

5.4. Adaptation Pathways

The previously described lack of integration between structural accommodation and other responses to SLR hinders the definition of coherent adaptation pathways. Coordination across scales and time is required to help maximize synergies. For example, Haasnoot et al. (2019) argue that accommodation measures could postpone dike construction, or extend the effectiveness of protective measures, pushing back tipping points. Structural accommodation measures could also delay the need to retreat, while leaving options open, depending on cost.

In an economic optimization of coastal adaptation options across Europe, Völz et al. (2025) demonstrated how property-level measures can lead to the postponement of dike construction and retreat. While the study focused on dry-flood proofing buildings up to one m, its conclusions can inform on the similar practical role that structural accommodation can play in different regions. They find that along the Mediterranean and Black Sea coasts, structural measures are appropriate to adapt to SLR until adaptation tipping points are reached, by the beginning of the next century under low climate change (SSP1-2.6), and by the middle to end of this century under higher climate change (SSP5-8.5). Beyond these tipping points, protect or retreat becomes necessary from an economic perspective, with protect favored in areas of higher asset concentration. Analogous research is required to understand how structural accommodation measures, for example elevating buildings, wet flood-proofing and floating structures, will be cost-effective with time under different scenarios of SLR, and how they relate to other coastal adaptation strategies.

Structural accommodation should be recognized ultimately as a temporary strategy due to the longer timescales involved with ongoing and progressive SLR (Lawrence et al., 2020). As flood frequency increases with SLR, a move to retreat, protect or even advance would be required. A typical lifetime for elevated buildings has been suggested as around 30 years (Cooley et al., 2022). However, this is better expressed in terms of the magnitude of SLR and the feasible elevation allowance which means the lifetime is uncertain and potentially could extend over many decades or even longer. Hence, a better consideration of structural accommodation in coastal adaptation strategies would utilize dynamic adaptation strategies (Haasnoot, Lawrence, & Magnan, 2021). This means setting clear decision points—when to upgrade, or retreat—based on observed sea levels and flood frequency. By identifying adaptation tipping points and changing conditions, structural accommodation can be a low-regret and preparatory action that can provide the time and space needed for society to prepare for more transformative shifts, such as managed retreat or rethinking coastal land use. In conditions where costs and risks are high, investments in structural accommodation measures can be identified as an avoidable sunk cost but again better integration within coastal adaptation strategies is required to define these practical pathways. Rather than locking in existing patterns, structural accommodation, if planned strategically, can facilitate a gradual and adaptive transition toward long-term resilience (Le Cozannet et al., 2023).

The advantages and drawbacks of structural accommodation are summarized in Table 2.

6. Conclusions

The current role of structural accommodation as a coastal adaptation response to SLR is still poorly understood. One of the reasons for this, we argued, is the lack of conceptual clarity regarding accommodation in the coastal adaptation literature. Previous assessments have commonly aggregated a wide range of measures, both structural

Table 2

Summary of Advantages and Drawbacks of Structural Accommodation as an Adaptation to SLR Based on This Analysis and Oppenheimer et al. (2019)

Advantages	Drawbacks
<ul style="list-style-type: none"> • Allows the continued use of land and does not require the acquisition of additional land • Elevated structures can lower flood risk by leaving space for floodwater • Wet flood-proofing methods maintain low hydrostatic pressures on buildings so that structures are less prone to failure during flooding • Can buy time to plan for a longer-term adaptation response • Measures on existing developments (e.g. refuge areas) can be low-regret options to increase resilience in a short timeframe • Allows for habitat migration • Elevated structures can serve purposes that are not related to coastal risks: to protect from wild animals, for functional permeability, cooling or aesthetics 	<ul style="list-style-type: none"> • Does not prevent disruption from flooding of surrounding areas or unprotected external assets • Elevated structures can be more vulnerable to other hazards (e.g. wind, earthquakes) • Requires public awareness of flood hazard and SLR (e.g. flood hazard maps) • Can create varying levels of adaptation from one household to another • Short-term gain and potential maladaptation if action is taken in isolation and without considering for long-term impacts • Raised architectural designs can represent visible markers of existing risk that may be undesirable for homeowners • Structure elevation can jeopardize access and egress, particularly for people with low mobility

and non-structural, giving a false sense of ubiquity. This also obscures the potential advantages and drawbacks that are specific to structural approaches. Accommodation covers a more diverse set of measures than protect and retreat strategies and therefore requires more granular assessments. To support this, we provided in this study a conceptual framework for accommodation, mapping the diverging roles of individual structural and non-structural measures in flood risk management.

Under this framework, we reviewed the current state-of-the-art of structural accommodation around Europe's coasts and discussed the broader implications on the challenges and opportunities that this strategy presents. Structural accommodation in practice remains limited and uneven, largely due to financial, institutional, and technical barriers. The predominance of protect, the fragmentation of governance and a lack of funding schemes have constrained the wider adoption of structural accommodation, particularly as a proactive measure, when it can be most effective. Few countries consider this approach as part of their national adaptation strategy and elevated buildings in coastal locations tend to be exceptions in sheltered areas. While the consideration of local environments and cultural norms are important conditions for the success of structural accommodation, lessons learned here from the European context are applicable more widely.

Structural accommodation holds an untapped potential as part of a diversified, sequenced and dynamic adaptive response to coastal hazards in Europe and globally. With a more integrated approach, both in terms of policy and funding, that considers structural accommodation alongside other coastal adaptation responses in the decision-making process, countries can enhance the effectiveness of their adaptation strategies. As the uptake of such measures accelerates, it will have to be done in a manner that considers their limitations to avoid maladaptation. For instance, an important potential disadvantage is for structural accommodation to create a false sense of security, or permanence, rather than being viewed as a temporary measure to consider alongside other coastal adaptation options, such as protect, retreat or advance. The implementation of structural accommodation measures should compare their cost-effectiveness to other adaptation options in a long-term planning context, accounting for incremental SLR. To better link theory and practice, and move beyond incremental change, further research should look at how a transition into, and out of, a structural accommodation strategy could be managed and implemented, particularly at broader scales. By highlighting the current state of structural accommodation, its weaknesses and opportunities, this study contributes to the understanding of the solution space for coastal adaptation.

Conflict of Interest

The authors declare no conflicts of interest relevant to this study.

Data Availability Statement

Data used in this study is listed and referenced in Table S1 and is available at the provided link as of the stated last date of access.

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