Chapter 2. The challenge of coastal adaptation

The trends outlined in Chapter 1 will strain the ability of existing coastal management arrangements to maintain an acceptable level of risk at reasonable cost. This chapter analyses how different adaptation strategies can be used to respond to rising coastal risks and their distributional consequences. It then examines how the misalignment between incentives, capacity and roles in the coastal zone can discourage risk reduction, create policy lock-in and lead to inefficient outcomes overall.

This chapter was written by Lisa Danielson and Michael Mullan, OECD, with contributions from Alexander Bisaro, Global Climate Forum.

2.1. Balancing competing priorities in the context of rising risk

Coastal adaptation aims to maintain an acceptable level of coastal risks for society and the environment, today and into the future. Maintaining an acceptable level of risk is not the same as maintaining the *status quo* at all costs. Indeed, the acceptable level of risk for society and the environment requires balancing the economic, social and environmental consequences of inaction, as well as the costs of risk-reduction measures (OECD, 2013[1]). It is neither technically nor financially feasible to aim to achieve a "zero risk" level, as there are usually competing demands and more productive allocation choices for available resources (OECD, 2014[2]).

Defining what constitutes an acceptable level of risk is the result of a political process, which can be informed by both evidence-based assessments of the risks as well as the financial costs involved (OECD, 2013[1]). Stakeholders' views about what constitutes an acceptable risk level will differ based on risk preferences and context, including level of information. Decision makers, including households, companies, local or national governments, are likely to have different risk thresholds. In some cases, the acceptable level of risk in a given area is the cumulative result of different decisions taken for different reasons, rather than a deliberate choice. For example, allowing an area to be exposed to coastal erosion may not be the result of an explicit risk assessment, but is instead linked to low concentration of assets and population in that area. In other cases, such as the construction of structural flood defences, governments make use of technical decision support tools, such as a cost-benefit analysis, for determining acceptable levels of flood risk. Whether implicit or explicit, the judgement regarding the acceptability of coastal risks strongly influences the response adopted, the role of government, and the current and future cost of risk management (OECD, 2013[3]).

Defining the acceptability of coastal risks allows for proportional policy responses, but coming to a decision on what is acceptable can be challenging in an area that involves multiple stakeholders with different values and expectations (OECD, 2014[2]). Depending on the level of risks faced, continuing with traditional approaches to risk management may be disproportionally costly, and more transformative approaches will need to be adopted. For example, if an area will soon face major flooding, relying on post-disaster emergency management, or small seawall repairs, will eventually become unsustainable. Planning to retreat from the area, while highly disruptive, may be more efficient for some areas over the long term. Yet, without sufficient political will, common understanding of what level of risk is acceptable and tolerable, or increased levels of stakeholder engagement, adopting transformational change may be impossible.

Moving from traditional approaches of increasing protection towards new ways of mobilising risk-reduction behaviour across actors through a "whole-of-society approach" (Box 2.1) can help to build resilience in coastal zones (OECD, 2017[8]). Countries are embracing inclusive approaches to risk reduction in coastal areas, but greater implementation will be needed given the scale of potential risks.

Box 2.1. Embracing a whole-of-society approach to risk management

A whole-of-society approach involves all relevant stakeholders in the policy-making process, including individuals, households, government bodies and businesses. The adoption of an inclusive risk management approach enables the development of a shared vision of the risks and the distribution of responsibilities between stakeholders. With this comes recognition that government efforts cannot be effective if private sector actors and individuals do not contribute their share in terms of risk-adapted behaviour and self-protection investments.

The OECD *Recommendation of the Council on the Governance of Critical Risks* promotes such a whole-of-society approach, and suggests governments facilitate two-way communication with households and businesses to encourage whole-of-society engagement in disaster risk management. This includes:

1. the provision of tailored risk information that is accessible in a manner appropriate to diverse communities, sectors, industries and with international actors
2. the combination of targeted communication with incentives and tools for stakeholders to work together and take responsibility for self-protective and resilience-building measures
3. providing notice to households about different scales of hazards and human-induced threats, and supporting informed debate on the need for prevention, mitigation and preparation measures
4. informing and educating the public in advance of a specific emergency about what measures to take when it occurs, and mobilising public education systems to promote a culture of resilience.

Sources: OECD (2014[4]), Recommendation of the Council on the Governance of Critical Risks, www.oecd.org/gov/risk/Critical-Risks-Recommendation.pdf; OECD (2017[5]), Boosting Disaster Prevention through Innovative Risk Governance: Insights from Austria, France and Switzerland, https://doi.org/10.1787/9789264281370-en.

A key element of coastal adaptation is that policies need to be able to accommodate increasing risk profiles into the future. Planning for future sea-level rise (SLR) is especially challenging due to the "deep uncertainty" of risks themselves, meaning that the range of probabilities and outcomes cannot be known (see Chapter 1). There are inherent uncertainties in projecting the effects of SLR, but also in other drivers of risk. The twin issues of increasing risks over time and deep uncertainty have implications for decisions taken now, as measures implemented now face the possibility of being inappropriate for the future that actually materialises.

Decisions that do not consider the future can lock-in patterns of coastal development and may be impossible to undo without prohibitive expense and effort. An illustrative example of lock-in is the construction of protective infrastructure, either engineered or nature-based, which can create a cycle of coastal development and increased protection, termed "the levee effect". Once structural protection is built, the perception of increased safety can lead to further development in the flood plain, which can have the perverse impact of increasing vulnerability in the longer term (OECD, 2014[6]). If those defences then fail, the results can be catastrophic. In some jurisdictions, the provision of defences can create a responsibility for sustaining them: in Australia and the United States, local governments have come up against legal challenges when trying to cease maintenance of coastal defences (Hino, Field and Mach, 2017[7]).

The following sections review the main coastal strategies, detail their potential distributional impacts and examine how different institutional arrangements can influence the choice of adaptation strategy.

2.2. Strategies to manage rising coastal risks

Coastal adaptation strategies manage risks using a combination of protection, accommodation and retreat (Wong et al., 2014[8]), which are elaborated in Table 2.1 and further described below. Each strategy has implementation costs, and each provides a distribution of benefits based on how they modify coastal flood and erosion risks.

There are no universally appropriate solutions to address SLR risks; the locally appropriate strategy will depend on the nature of the area, the policy and institutional context, and the risks it faces. Each option has limitations. For example, constructing a seawall has high upfront costs, and can lock in increased development. Nature-based options are not always technically possible. Building codes only work for new development and therefore can be a slow mechanism to enact change, and require proper enforcement. Even strategies that pass a cost-benefit test can be blocked in implementation by institutional and political challenges.

The suitability and acceptability of different adaptation strategies depends in part on countries' broader institutional contexts. OECD countries tend to rely on structural coastal defence to manage flood risk in densely populated coastal areas (Tol, Klein and Nicholls, 2008[9]; Harman et al., 2013[10]; Gralepois et al., 2016[11]). This reflects both the existing investment in coastal assets and infrastructure as well as the institutional and political challenges of measures that disrupt the *status quo* and have potentially adverse impacts on individual properties (Harman et al., 2013[10]; Filatova, Mulder and Van der Veen, 2011[12]).

Table 2.1. Strategies to manage coastal risks

Objective	Measure	Benefits	Limitations
Protect (reduce the likelihood of the hazard)	Build/maintain hard defences	• Proven to be effective at preventing damage to infrastructure during extreme events • Well-established engineering guidelines and certainty under certain margins	• Displacement of beach and associated amenities • Maintenance costs once infrastructure is established • Lack of flexibility and the potential for lock-in • Risk of infrastructure failure in the future • Can create a sense of security for communities which inadvertently discourages the adoption of other risk-reduction measures
	Beach nourishment and dune restoration	• Preserves beach amenities and associated tourism activities • Is reversible and can be easily modified to the actual rate of sea-level rise	• Expensive to continue in the long term • In some cases, can be environmentally damaging to continually dredge new sand • Effectiveness is expected to decrease over time as beaches become more unstable
	Replace/reinforce shoreline protection with "living" shorelines – through planting vegetation, etc.	• Reduces negative effects of protective infrastructure (downdrift erosion) • Maintains beach habitat in enclosed areas	• Requires more planning and materials than traditional protection • Not suited for high-wave energy areas such as open beaches • Implementation and monitoring of success is not as advanced as other strategies
Accommodate (reduce vulnerability)	Change building codes and design standards to account for sea-level rise, for example in building elevation and foundation design	• Provides flexibility to manage future coastal inundation and flooding • More incremental change than other options	• Adds upfront development costs • Only applicable for new buildings or refurbishments • Requires a high degree of co-ordination between planning and implementing agencies
	Encourage the use of property-level measures for both new and existing properties	• Flexible and easily combined with other measures • Raises household awareness of risks	• Property-level technology still underdeveloped
	Emergency management	• Mitigate loss of life and assets from coastal flooding	• Uncertainty of storm-surge predictions within early warning systems • Significant financial cost for evacuation of people
Avoidance and planned retreat (reduce exposure)	Prevent new development in areas at risk of flood or erosion through land-use regulation/zoning	• Flexible to address different conditions and needs within a community • Provides opportunity for additional access to waterfront area • Reduces potential for coastal squeeze	• Removing existing zoning rights can be a slow process that requires compensation • Only applicable for new development
	Physical relocation of people and critical assets, including removal of existing hard protection	• Protects existing and creates new intertidal habitats, which are a natural form of flood protection • Can save communities from future costs of flood protection	• Often substantial financial cost if existing property owners need to be compensated • Direct impact on those living in affected properties

Note: Non-exhaustive list.

Sources: Wilby, R.L. and R. Keenan (2012[13]), "Adapting to flood risk under climate change", https://doi.org/10.1177/0309133312438908; Spalding, M.D. et al. (2014[14]), "The role of ecosystems in coastal protection: Adapting to climate change and coastal hazards", http://dx.doi.org/10.1016/J.OCECOAMAN.2013.09.007; Harman, B.P. et al. (2015[15]), "Global lessons for adapting coastal communities to protect against storm surge inundation", https://doi.org/10.2112/JCOASTRES-D-13-00095.1.

The following section describes each strategy in more detail.

2.2.1. Protect

Measures to protect against SLR hazards are typically static, engineered structures designed to reduce wave damage and flooding. They can also be designed to decrease shoreline erosion. Sometimes termed "grey" or "hard" infrastructure, these structures include seawalls, levees/floodwalls and storm surge barriers. Many countries have long histories of using hard defences, such as most of Western Europe and Japan. The technical characteristics of these types of measures is generally well understood and they are projected to play a significant role in reducing the expected damages from sea-level rise across a range of scenarios (see Chapter 1).

While this hard protection has proved to be effective at reducing coastal flood risks, these defences may become financially unsustainable in some locations due to their recurring and costly maintenance to match increasing risk (Driessen et al., 2016[16]; Keeler, McNamara and Irish, 2018[17]). Furthermore, conventional coastal defences can intensify land subsidence and prevent the natural accumulation of sediments by tides, waves and wind (Temmerman et al., 2013[18]), thereby undermining the natural adaptive capacity of shorelines to keep pace with relative SLR.

Nature-based defences are increasingly being used as complements or substitutes to grey infrastructure. These defences mimic or enhance natural features, such as barrier islands, vegetated dunes, coastal wetlands, mangrove forests and reefs (see Box 2.2 for an example). Diverse terminology is used to describe these measures, which include natural infrastructure, green infrastructure, nature-based solutions and ecosystem-based adaptation. There is a distinction between strategies that favour natural defences, which is the protection potential of existing coastal habitats, and those that favour nature-based defences, which is restoration with coastal protection as an objective (Narayan et al., 2016[19]).

Coastal habitats reduce the vulnerability of communities through wave attenuation, sediment capture, vertical accretion, erosion reduction, and the mitigation of storm surge and debris movement (Spalding et al., 2014[14]). A 2016 review found that coastal habitats (which included coral reefs, mangroves, salt marshes, seagrass/kelp beds) reduce wave heights by 35-71% (Narayan et al., 2016[19]). Strategies such as retreat or limiting development in a specific area are often paired with the understanding that leaving a natural landscape in place, or allowing a landscape such as a wetland to regenerate, can then serve as a buffer from coastal hazards.

Box 2.2. The advantages and disadvantages of beach nourishment

Beach nourishment is a nature-based coastal erosion control strategy that involves adding new sand to shorelines in an attempt to stabilise and artificially maintain a minimum beach width. Beach nourishment is a popular measure to combat erosion as it provides a flexible and modifiable approach to adapt to sea-level rise (SLR). It is also reversible, easily modified to the actual rate of SLR, and can complement hard protection measures such as seawalls. The natural appearance of beach nourishment projects also means these schemes are aesthetically pleasing, promoting recreation and tourism. Beach nourishment is gaining in popularity in OECD countries. In the United States, the federal government spends an estimated USD 150 million every year on beach nourishment. In the Netherlands, "the Sand Engine", a EUR 70 million project, was completed in 2011, which is a 21.5 million m^3 pile of sand that juts out into the North Sea, steadily eroding so that beaches down current will be continually replenished.

Beach nourishment can also have disadvantages. First, beach nourishment can threaten coastal biodiversity, both by harming species that relied on the dynamic nature of existing beaches and by disturbing the seabed where offshore dredging happens. This can have downstream impacts on groups such as fishers, who depend on functioning coastal ecosystems for their livelihoods. Nature-based protection can also lock in increased development, similar to the levee effect described above. As beach nourishment is not without costs, getting locked in to a continuous cycle of nourishment could eventually become financially unsustainable. In addition, in some areas, dredged sand is not limitless and it is possible that neighbouring communities end up competing for an increasingly expensive resource.

Sources: McNamara, D.E. et al. (2015[20]), "Climate adaptation and policy-induced inflation of coastal property value", https://doi.org/10.1371/journal.pone.0121278; Gopalakrishnan, S. et al. (2016[21]), "Economics of coastal erosion and adaptation to sea level rise", https://doi.org/10.1146/annurev-resource-100815-095416; Gopalakrishnan, S. et al. (2017[22]), "Decentralized management hinders coastal climate adaptation: The spatial-dynamics of beach nourishment", http://dx.doi.org/10.1007/s10640-016-0004-8.

One of the key differences between nature-based approaches and hard engineering is that ecosystems are highly dynamic in response to physical changes and, in some cases, can recover and regenerate following damage (Spalding et al., 2014[23]). However, regeneration is not immediate, and overall ecosystem resilience can be compromised by poor ecosystem health (Spalding et al., 2014[14]). Another advantage of natural measures is that they can deliver multiple benefits beyond coastal protection through a range of other ecosystem services. These include tourism, recreation, fish nurseries and habitat, transport, and cultural heritage and spiritual benefits (Mehvar et al., 2018[24]; Temmerman et al., 2013[18]; Guerry et al., 2012[25]). Despite the increase in awareness of its benefits in the international policy community (Wong et al., 2014[8]), most examples of implementation in OECD countries remain at a smaller scale (Arkema et al., 2017[26]; Spalding et al., 2014[14]). Additionally, uncertainties about their effectiveness is much higher than engineered defences, which can prevent implementation.

2.2.2. Accommodate

Accommodation strategies aim to reduce vulnerability and are usually implemented via regulatory and planning instruments. They are particularly suitable as a response to occasional, short-term impacts (e.g. impacts from coastal storm events or seasonal flooding) and is an appropriate response when the practicality of protecting coastal assets is outweighed by the costs, and/or the effectiveness would be limited to a relatively short period of time. Examples include changing building codes to emphasise resilient measures (examples in Box 2.3), risk-informed land-use planning that allows space for flood water, and emergency management plans.

Box 2.3. Incorporating sea-level rise resilience in urban building codes for coastal cities

Building codes and design standards have a crucial role in making development resilient to predicted sea-level rise (SLR) impacts through measures such as building elevation, foundation design, moisture entrapment and damage from debris. Examples of cities that have used building codes and design standards to address SLR include:

- Helsinki, Finland, initiated changes to design standards addressing coastal flooding and SLR in the late 1980s, which resulted in the decision to raise floor levels in the inner-city suburb of Ruoholahti from 1 metre to 3 metres above mean sea level (EC, 2009[27]).
- Christchurch, New Zealand, updated its city plan in 2011 to account for climate change-induced SLR and flooding. It now contains provisions that control development in areas vulnerable to flooding, including raised floor levels and set-backs from waterways (Christchurch, 2010[28]).
- Vancouver, Canada, updated minimum flood construction levels to be a metre higher in 2014 to account for SLR projections up to 2100.

Encouraging household-level risk-reduction measures is an accommodation strategy with multiple benefits. Measures such as flood proofing, elevating properties and keeping protective items like sandbags on hand can significantly reduce flood risk (Kreibich et al., 2015[29]), while still being flexible and a low regret risk management strategy, as they do not lock in as high costs as protection or retreat (Wilby and Keenan, 2012[13]). In addition, the use of household measures spreads awareness and responsibility for adaptation beyond the public sector, which is considered a best practice in risk management (elaborated in Box 2.1) (OECD, 2014[4]). Finally, accommodation measures can reduce residual risks of flooding when other measures are in place, and thus are important complements to coastal risk management (Koerth, Vafeidis and Hinkel, 2017[30]).

2.2.3. Avoidance and planned retreat

Retreat reduces exposure through the managed withdrawal of assets and people from hazard-prone areas of the coast. This may involve relocating or abandoning assets in high-risk areas, preventing any new development in coastal areas through risk-informed land-use planning, and/or allowing development to take place on the condition that it will be abandoned if necessary (Nicholls, 2011[31]). Retreat can be planned or reactive, and the latter generally occurs in response to major or repetitive hazard events. The modelling in Chapter 1 suggests that this will be particularly important for managing increasing risks in lower density coastal areas.

While retreat has long been acknowledged as part of the suite of coastal adaptation strategies, it is far less employed than strategies that include elements of protect and/or accommodate (Gibbs, 2016[32]). Retreat policies are highly physically and emotionally disruptive to those directly impacted, and have associated political and legal challenges in implementation (OECD, 2017[5]). In many cases where implementation has been attempted, relocation programmes have suffered from low levels of participation (OECD, 2016[33]). Finally, buying back properties can have high up-front costs – based on early experiences, the financial cost of managed retreat to implementing parties varies from USD 10 000 to well over USD 100 000 per person (Hino, Field and Mach, 2017[7]). Despite these challenges, there are select examples in OECD countries where coastal retreat has been attempted (Table 2.1).

Table 2.2. Examples of coastal retreat in OECD countries

Location	Description	Implementation status
Byron Bay, Australia	Byron Shire Council adopted a policy of retreat in 1988, in which structures would need to be removed once the coastline eroded to within a certain distance of their property. This policy was revised as landowners sued the council on the grounds that the policy devalues their property.	On hold
United States	Since 1989, the Federal Emergency Management Agency has used its Hazard Mitigation Grant Program to purchase properties from willing homeowners after disasters. The land is then restored to open space.	Reactive (after an event)
United Kingdom	The UK government's Coastal Change Pathfinder Programme (see Chapter 7) funded five pilots to test "rollback" schemes between 2009 and 2011. The programme bought out properties at high risk from erosion. Each pilot relocated around ten households in different communities.	Pre-emptive
De Noordwaard, Netherlands	As part of the Room for the River programme, a lengthy community engagement process was conducted to decide how to improve the existing flood risk management system to cope with future climate extremes. This resulted in the decision to lower the dikes surrounding De Noordwaard, and the government supported the resettlement of 75 displaced households between 2009 and 2014.	Pre-emptive
France	The French parliament has adopted a draft bill on coastline retreat that will restrict development within 100 m of the coast. The law will also allow for the retreat of people and assets further inland.	Proposed

Sources: Niven, R.J. and D.K. Bardsley (2013[34]), "Planned retreat as a management response to coastal risk: A case study from the Fleurieu Peninsula, South Australia", https://doi.org/10.1007/s10113-012-0315-4; Verchick, R. et al. (2013[35]), "When retreat is the best option: Flood insurance after Biggert-Waters and other climate change puzzles", http://repository.jmls.edu/lawreview; Defra (2012[36]), *Coastal Change Pathfinder Review Final Report*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69508/pb13720-coastal-pathfinder-review.pdf; Schut, M., C. Leeuwis and A. van Paassen (2010[37]), "Room for the River: Room for research? The case of depoldering De Noordwaard, the Netherlands", http://dx.doi.org/10.3152/030234210X12767691861173.

Despite the political, legal and social challenges in implementation, retreat is increasingly viewed as a preferable alternative to continued protection in some cases. First, retreat can protect and create new intertidal habitats, which can then themselves serve as flood buffers (Kousky, 2014[38]). Second, it can save on the costs directed towards flood protection measures in the future and has minimal financial costs once implemented, in contrast to recurring costs for the maintenance of protective infrastructure (Verchick et al., 2013[35]; Hino, Field and Mach, 2017[7]). Implementing planned retreat in a way that dedicates sufficient time to the process, ensures community coherence and minimises the costs for affected communities is a better option than the alternative of being forced to move after a disruptive event (OECD, 2017[5]).

2.3. The political economy of coastal adaptation decisions

The potential costs and benefits of adapting to SLR vary significantly between coastal actors (see Table 2.4 for a list of actors). This diversity is due to physical factors, such as the risk of storm surge, expected SLR and the topography of the area (Hinkel et al., 2015[39]), as well as socio-economic factors, such as the variation in the density and location of development, and the capacity of a community to adapt (Fletcher et al., 2015[40]).

The way the distribution of SLR risk is perceived by coastal stakeholders will drive reactions on how best to manage them and, ultimately, the acceptance of different strategies (e.g. protect, accommodate, retreat) among different stakeholders. The different impacts of strategies (summarised in Table 2.3) will determine politically feasible paths to reform.

Table 2.3. Direct and indirect impacts of coastal adaptation strategies

Strategy	**Direct impact** (i.e. through physical change to coastal risks)	**Indirect impact** (e.g. through tax and investment value)
Protect	• The potential to cause/increase vulnerabilities in other locations, e.g. unwanted impacts to other public or private assets alongside/downstream where the barrier has been constructed[1]	• Deterioration on surrounding natural environment can cause losses in sectors that depend on tourism (e.g. beaches) • Devaluation of property resulting from restrictions on the use of land/view (to create more space for the new/reinforced infrastructure) • Reduction in insurance premiums for those benefiting from increased protection • Depending on public finance scheme, the subsidisation of at-risk properties by the rest of the community
Accommodate		• Increase in property values for the area where development is allowed at the expense of areas where development is forbidden • Costs usually borne by smaller group (those directly at risk) than for protection measures • Development opportunities shift to neighbouring communities
Retreat	• Large financial and physiological impact on households that must relocate	• Depending on public finance scheme, subsidisation of at-risk properties by the rest of the community

1. In contrast to hard protection such as a seawall, beach nourishment at one location can cause the shoreline to erode more slowly at the neighbouring location, depending on the direction of net sediment transport (Gopalakrishnan et al., 2017[22]).

Sources: Gibbs, M.T. (2016[32]), "Why is coastal retreat so hard to implement? Understanding the political risk of coastal adaptation pathways", http://dx.doi.org/10.1016/j.ocecoaman.2016.06.002; Colgan, C.S. (2016[41]), "The economics of adaptation to climate change in coasts and oceans: Literature review, policy implications and research agenda", http://dx.doi.org/10.15351/2373-8456.1067.

Early experiences with coastal adaptation have shown that the adoption of an adaptation strategy often involves social conflict and opposition (Gibbs, 2016[32]). There are numerous examples of conflicts arising over coastal adaptation attempts. For example, on the Italian Adriatic coast, conflicts have arisen between the tourism sector which welcomes beach nourishment as it directly benefits them by maintaining beach-related revenues, and environmental groups who are strongly against introducing foreign materials to the coast (Prati et al., 2016[42]). In Louisiana, small commercial fishing interests have challenged the method of using river diversions to deposit more sediment on the coast, which serve as additional wetland build up and protection (Gotham, 2016[43]). Conflicts can also arise in situations where a small number of properties benefit from a strategy but a community as a whole is expected to fund it, as has been seen in Australia (Fletcher et al., 2015[40]).

In many countries, the impact of adaptation measures, whether real or perceived, on real estate values can create strong support and opposition for different measures. For example, coastal defences can reduce future coastal flood risk, but may also reduce present-day high-value amenities, such as beach width and access. As such, coastal property owners will have a vested interest in influencing coastal decision making and can potentially block measures that reduce the value of their property. This can serve to lock in existing policy choices: for example, a 2015 study in North Carolina (McNamara et al.[20]) estimates that the removal of federal subsidies for nourishment projects would decrease the value of coastal properties by as much as 34%.

In jurisdictions where taxes are calculated based on property values, local governments may also be exposed to a change in value from an adaptation decision. For example, a study undertaken in New York City found that reductions in property value caused by updated flood risk mapping has the potential to reduce property taxes by USD 22 million per year (Dixon et al., 2017[44]).

The way the costs and benefits of protecting, accommodating or retreating from SLR are distributed will, in part, depend on existing policies and institutional arrangements. In the case of residential property, for example, an increase in the risk faced by coastal property will be borne by households in the first instance, through higher insurance premiums, or higher uninsured losses for those unable or unwilling to purchase insurance. At the limit, households may lose the total value of their property due to submergence or coastal erosion. However, policy interventions to subsidise insurance or provide *ex post* disaster relief (such as grants, tax deductions or subsidised loans) shifts some of this cost to taxpayers in lower risk areas.

2.4. The alignment of incentives, capacity and roles in the coastal zone

Coastal adaptation goes beyond the technical issue of building flood defences, elevating houses and risk-based land-use planning: the institutional arrangements behind these strategies matter. Institutional arrangements determine how adaptive capacity is mobilised in the public and private sector through policy frameworks and regulation, incentives, allocation of resources, and co-ordination. These arrangements encompass decisions that involve creating policies or regulations to build adaptive capacity (the enabling environment for adaptation) and action that implements operational adaptation decisions (implementing strategies) (Adger, Arnell and Tomkins, 2005[45]; Wilby and Keenan, 2012[13]).

In 2014, the OECD carried out research on countries' disaster risk-reduction policies, which brought to light how ineffective institutions can undermine the incentives needed for a whole-of-society approach to disaster risk reduction (Box 2.1) (OECD, 2014[2]). Existing institutional arrangements may undermine effective and efficient adaptation, by distorting market signals or providing perverse incentives, and uncoordinated policies can trigger individual economic behaviour that is counter to an overall policy goal of reducing risk (OECD, 2014[2]). Drawing on the findings from the 2014 report, Table 2.4 maps key actors who take decisions related to coastal risk and adaptation, describes drivers of behaviour, and gives examples of areas where misaligned incentives can lead to inefficient outcomes overall.

Table 2.4. An overview of actors, drivers of behaviour and policy misalignments

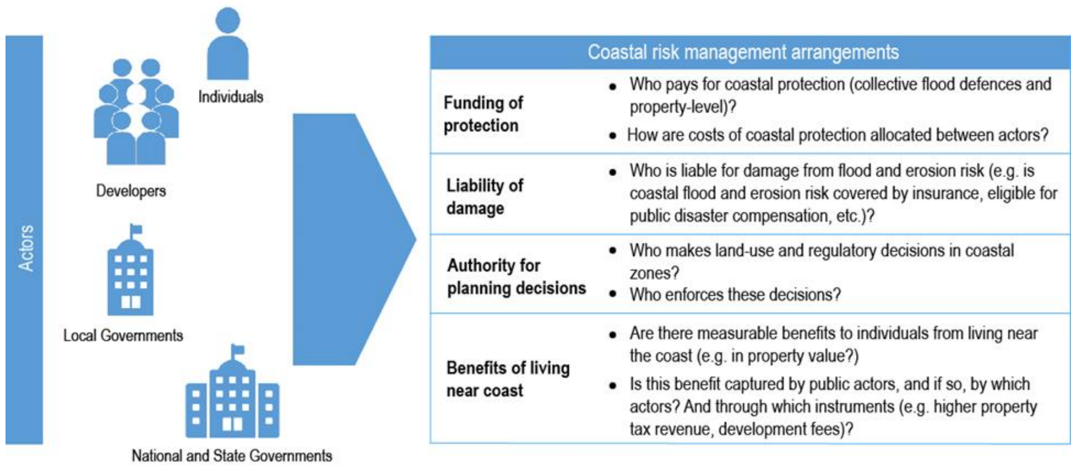
KEY ACTOR AND ROLE	DRIVERS OF BEHAVIOUR	EXAMPLE OF MISALIGNED INCENTIVES
	PRIVATE ACTORS	
Individuals/property owners • Prospective homeowners take decisions about the location and material of their home. • Existing homeowners can invest in property-level risk-reduction measures, as well as purchase insurance (where available).	• Motivated to reduce the cost of potential damages and preserve the value of their asset. • Face the direct financial costs and intangible consequences (such as mental health impacts) of an extreme event.	If governments assist homeowners in post-disaster recovery and reconstruction, regardless of their insurance take-up prior to the shock, it undermines individual homeowner incentives to invest in *ex ante* risk-reduction or transfer measures.
Property developers • Take decisions about the construction of new housing and investing in maintaining existing housing stock.	• Incentive to preserve property value and reduce additional costs. • Coastal real estate usually has high value due to the proximity to amenities and view of the water.	If property prices/insurance premiums do not reflect risk, and coastal property is highly valued, there will be a strong incentive to continue to invest and build in high-risk coastal areas.
	PUBLIC ACTORS	
Local governments • Often have responsibility and jurisdiction for coastal adaptation through land-use planning, emergency management and educating the community.	• Benefit from development through the generation of local tax revenues. • Can be directly exposed to financial risks from sea-level rise-induced hazards through changes in property values. • Can bear the costs of relief and recovery, reconstruction of public assets, payments as compensation to individuals and businesses (often first in line for providing support).	Local governments may permit construction in risk-prone areas if they gain from increased economic activity and tax revenues, while the costs/portion of costs are borne by other levels of government.
National/state governments • Role in ensuring the relevant actors have adequate incentives and tools to adapt, including the provision of climate risk information, and provision of resources for investments in risk reduction.	• Can bear the costs of relief and recovery, reconstruction of public assets, payments as compensation to individuals, business and/or subnational levels of government, and public insurance/(re)insurance schemes that provide coverage for damages and losses.	Political cycles can discourage long-term investments in sea-level rise adaptation, as their benefits may be less visible in the short run or not visible at all within the period of a government's mandate.

Sources: OECD (2014[2]), *Boosting Resilience through Innovative Risk Governance*, http://dx.doi.org/10.1787/9789264209114-en; OECD (2014[6]), *Water Governance in the Netherlands: Fit for the Future?*, http://dx.doi.org/10.1787/9789264102637-en.

The way coastal incentives, capacity and roles are allocated influence the way each individual actor decides about whether or not to invest in resilience (OECD, 2014[2]). Different approaches to risk allocation imply trade-offs between cost-efficiency, effectiveness and social equity. From an economic perspective, aligning incentives provides a strong mechanism for people to manage their exposure to risk. If an individual is responsible for the costs that are incurred from a hazard event, they will be more likely to invest in preventative measures, or move away from the at-risk area. However, this may run counter to an objective of social solidarity.

Existing institutional arrangements also influence what overall adaptation strategy is implemented. As described above, institutions influence how the risks and costs of adaptation are distributed, which influence which strategies may be politically viable. In a similar vein, the scales at which adaptation decisions are taken and funded can influence the types of adaptation measures being implemented. Building an understanding of these issues is vital to the design of institutions that can improve resilience. Figure 2.1 gives an overview of the key questions needed to understand the institutional arrangements related to coastal risk management.

Figure 2.1. Coastal flood risk management arrangements



The following section outlines how different institutional arrangements (those covered in Figure 2.1) can influence the choice of adaptation strategies, leading to outcomes that run counter to the goal of cost-efficient and flexible coastal risk reduction.

2.4.1. Funding of protection

Building new and maintaining existing structural coastal defences requires significant resources, which poses challenges for government budgets. A 2011 study found that the additional annual cost of adaptation to SLR through hard defences for Europe alone will be EUR 1.5 billion[1] annually in the 2050s (current prices), excluding annual maintenance costs (Brown et al., 2011[46]).

Funding maintenance is a particular challenge. A 2017 comparative study on disaster risk management (not only coastal) in Austria, France and Switzerland (OECD[5]) found that countries' previous investments have created a significant stock of protective infrastructure; however, the financial allocations for these measures generally do not include a budget for ongoing maintenance expenses. As a result of the lack of financial planning for maintenance of disaster risk prevention infrastructure, the levels of maintenance vary within countries (OECD, 2017[5]). While not focused on coastal protection, it can be extrapolated that funding the ongoing maintenance of coastal protection, especially in the context of SLR, will pose ongoing problems for national budgets. In many European countries, existing protective infrastructure is in need of repair to continue maintaining standards of protection (Alexander, Priest and Mees, 2016[47]). The lack of maintenance of coastal protection infrastructure has led to coastal disasters in the past, with the damage in New Orleans from Hurricane Katrina being a prominent example (Kates et al., 2006[48]).

Given the high costs and public good aspect of coastal defences, they are most often funded by the public sector in OECD countries; however, the funding allocation between levels of government differs across countries. In some countries, such as in Japan and Poland, the national level is directly responsible for providing funding. In others, such as Belgium, Canada and Germany, it is primarily the responsibility of a state or regional government, though there are co-financing arrangements with the national and local (municipal) government. For example, in Germany, as detailed in the case study in Chapter 4, in the *Länd* (state) of Schleswig-Holstein, costs from 2001 to 2013 were 50% covered by the

Länd, 37% by the federal government and 13% by the European Union. Meanwhile, in Sweden, flood (including coastal) defence measures are mainly managed and financed at the local level. This can fall on municipalities, firms, individuals or combinations thereof, depending on land ownership and protection needs (Gralepois et al., 2016[11]). Australia has a model similar to Sweden's, and coastal adaptation funding is predominately the responsibility of local governments, with the exception of some major infrastructure projects that cross jurisdictions and *ad hoc* state funding grants for coastal planning and management works. In some cases, private landholders have responsibility to fund the construction of their own protection (Harman et al., 2013[10]).

In countries where national governments cover the majority of coastal defence costs and solidarity is the guiding principle, the regional nature of the public good provided can cause challenges. For example, a regional or local government on the coast may consider funding an adaptation measure to be socially or economically optimal, while a national government funding the same measure may not, if funding comes from the national tax base (Bisaro and Hinkel, 2018[49]). Conflicts can also emerge from the distribution of public money between a location receiving public support for coastal protection and non-coastal actors paying for this through taxes. For example, in the Netherlands, costs of protection against flood risks are borne by the community at large, including by communities in the east and south of the country which are not part of the main dike system, whereas benefits accrue to a smaller set of stakeholders (OECD, 2014[6]). However, it could be argued that the solidarity principle is justified in this case, as areas not covered by protection measures benefit indirectly from the protection of coastal areas, where the main economic activities of the country are located (OECD, 2014[6]).

In cases where local governments have full responsibility for funding coastal defences, such as areas of the United States and Australia, the ability to raise funds is often cited as a barrier to implementing such coastal risk management measures (Fletcher et al., 2013[50]; National Research Council, 2014[51]). This is partially due to acute political economy factors at the local level (National Research Council, 2014[51]). For all levels of government, coastal adaptation funding needs compete with other priorities. Coastal protection investments are made to avoid longer term damages, and decision makers are rarely rewarded for avoiding crises. Local decision makers face pressure to make investments to address more frequent and immediate issues, as well as operate on short-term political cycles (Brown, Naylor and Quinn, 2017[52]). Conflicting policy and regulation can also cause challenges; for example, in many countries, there are limits on how much local governments can borrow, which makes financing a large-scale project challenging.

There are emerging examples of areas where funding for protection has shifted towards a beneficiary-pays model. In the United Kingdom (Box 2.4), the shift was done in part to encourage community ownership of risk management, and to secure funding over the lifecycle of an investment (Penning-Rowsell and Priest, 2015[53]). Conversely, many towns on the east coast of the United States have used differential property tax rates as an instrument for funding beach nourishment, recognising the political difficulty of raising collective taxes for a project that will disproportionally benefit oceanfront property owners (McNamara et al., 2015[20]).

Box 2.4. Partnership funding: UK model for funding flood defences and coastal protection

The funding system for flood risk management (including coastal flood) in England and Wales underwent a substantial change in 2011. The existing system was funded by block grants from the central government and administered by the Environment Agency. The new system of "partnership" is an arrangement that promotes sharing of costs between the local and national levels. This change shifted part of the burden of investments on those who would benefit from the associated risk reduction.

The cost-sharing agreement is determined by the total value of benefits for households, businesses and environment that result from flood or coastal erosion risks being managed. In addition, the percentage of national funding contributed is on a scale that depends on the income level of a community to favour more high-risk, low-income communities receiving assistance. The policy change included a provision that properties built after January 2012 are ineligible for funding, to avoid encouraging inappropriate development in areas at risk**.**

One of the primary goals of the policy change was to allow more projects to be funded. In addition, communities with a financial investment in managing risk should have an incentive to manage project costs throughout the project life cycle. Early assessments of this new funding arrangement appear to be favourable and have documented an increase in external funding, although the difficulties of securing contributions at the local scale and from the private sector is still an express concern.

Sources: Defra (2011[54]), *Flood and Coastal Resilience Partnership Funding: An Introductory Guide*, https://www.gov.uk/government/publications/flood-and-coastal-resilience-partnership-funding-an-introductory-guide; Penning-Rowsell, E.C. and S.J. Priest (2015[55]), "Sharing the burden of increasing flood risk: Who pays for flood insurance and flood risk management in the United Kingdom", http://dx.doi.org/10.1007/s11027-014-9622-z.

2.4.2. Financial liability for damage

Many countries have started to take note of the rising costs of publicly funded flood[2] recovery (OECD, 2016[33]). For example, in Canada, payments under the Disaster Financial Assistance Arrangements, the national programme that reimburses provinces and territories for a portion of disaster response and recovery costs, have increased dramatically in the past 20 years. Costs have risen from an average of CAD 291 million per year in the period 1995-2004 to CAD 410 million per year in the period 2005-14, and are projected to increase to more than CAD 650 million annually over the period of 2017 to 2022 (PBO, 2016[56]).

Even without legal or policy frameworks, there is often an expectation that governments will take some responsibility to provide financial support for disaster recovery and reconstruction purposes beyond explicit commitments. These expectations create an implicit contingent financial liability for the government, as well as political risks (Hall et al., 2012[57]). Many countries allocate significantly more funds to disaster response than to risk-reduction measures such as coastal defences (OECD, 2016[33]). While there is limited coastal-specific data, overall disaster spending figures reveal the trend: for example, in Japan, 25% of disaster spending goes to *ex ante* disaster risk-reduction measures, 75% goes to *ex post* spending on recovery and reconstruction; in Mexico, only 3% of disaster spending is allocated to *ex ante* measures, whereas 97% is spent *ex post* on recovery and reconstruction (the reconstruction is required to meet betterment objectives) (OECD/World Bank, forthcoming[58]).

Box 2.5. Monitoring and mitigating the cost of natural disasters risks

Disaster-related costs, including those from coastal risks, can be high, with single shocks causing damages of up to 20% of gross domestic product (GDP), affecting local economies and populations disproportionately.

Governments tend to bear a significant share of the costs of disasters, particularly in countries with modest insurance coverage rate. The nature of these costs ranges from payments made to compensate for business and household losses to public asset recovery. In addition, disaster-related declines in tax and non-tax revenues due to economic disruptions may affect government finances negatively. Government budgets can also be affected by deteriorations in the terms of refinancing or raising new public debt.

In a recent report, the OECD and the World Bank argue that the costs that disasters impose on governments are a type of contingent liability (and contingent revenue loss). Damage to public assets, such as public buildings and infrastructure, are reportedly the largest disaster-related contingent liabilities for central and subnational governments, followed by post-disaster assistance for individual households.

The study shows that many governments have significant information on the sources and potential level of disaster-related contingent liabilities. This information, however, is scattered through different parts of the government and rarely brought together to inform financial planning, including fiscal risk monitoring and mitigation.

The report also shows that disaster costs tend to be higher in countries that have made limited or only very general explicit ex ante commitments to provide disaster recovery assistance. It thus argues that ex ante identification and quantification of disaster-related fiscal risks is key to designing mitigation strategies in the form of clear government commitments for assistance needed to increase countries' financial resilience to natural hazards. Disaster risk-reduction strategies should include clear cost-sharing mechanisms across levels of government that act in a way that encourages stakeholders to carry out disaster risk prevention and mitigation measures. Countries should also consider the formulation of multi-pronged financial strategies that include contingency budgets, risk transfer instruments or catastrophe bonds.

Source: OECD/World Bank (forthcoming[58]), "Boosting financial resilience to disasters: Understanding and strengthening the role of government".

Across the OECD, countries rely on various models to fund response and recovery from a coastal hazard event. Different models of financial liability for damage can be categorised by how direct the link is between experiencing damages and responsibility to pay for those damages. As adapted from Penning-Rowsell and Priest (2015[55]), these categories are:

- loss bearing, where the victim is responsible for all losses
- loss sharing, where losses are spread more widely, for example through flood insurance where individuals contribute premium payments
- compensation, where national, regional or local governments provide financial assistance to those affected by coastal hazards.

Most OECD countries fall somewhere between loss sharing and compensation. The role of national governments varies from very little intervention (e.g. United Kingdom) to a fully state-implemented insurance scheme (e.g. France, the United States) and to recovery mainly covered by public compensation. There are, however, nuances and differences within these distinctions (OECD, 2016[33]).

The design of public assistance mechanisms and insurance programmes has implications for a whole-of-society approach to risk reduction through the possibility of moral hazard. Moral hazard refers to households' lack of inclination to carry out risk-reduction measures or resettle out of flood-prone areas if they can expect to receive insurance pay-outs or public compensation in the event of a disaster (Hanger et al., 2017[59]; OECD/World Bank, forthcoming[58]). Moral hazard can potentially occur between levels of government in countries where subnational governments are responsible for funding protection but national governments are responsible for funding response and recovery (OECD, 2016[33]). In Australia, Canada and New Zealand, post-disaster compensation is provided to subnational governments based on a cost-sharing formula, and reimburses a share of eligible expenses incurred by subnational governments for costs such as emergency response, restoration and reconstruction of public assets. In Mexico, the FONDEN scheme has implemented specific conditions to address moral hazard between levels of government, as subnational governments are only eligible for compensation a second time if they have undertaken certain protection measures as part of initially supported recovery and reconstruction efforts (OECD/World Bank, forthcoming[58]).

Systems based on solidarity can lack an inherent link with risk reduction (with some exceptions), but have the benefit of ensuring widespread and affordable coverage. This can prevent the burden of risk management and recovery from falling solely on households, who may not be well-equipped to respond (Dixon et al., 2017[44]; Hudson et al., 2016[60]; OECD, 2016[33]). For example, research on exposure to flood risks in the United Kingdom suggests that residents of lower social classes were disproportionately exposed to coastal flooding (Walker and Burningham, 2011[61]).

As climate change increases risks, the principle of solidarity may be called into question given the expected rise in the cost of damages and the strong concentration of risks in a few geographical areas. In France, for instance, which is covered by a solidarity-funded national insurance system, municipalities on the Mediterranean coast experienced an average of 6.9 natural disasters between 1982 and 2009, compared with an average of 2.5 in the country as a whole (Clément, Rey-Valette and Rulleau, 2015[62]).

Box 2.6. Coastal risks and rising insurance premiums

Insurance companies can play a key role in coastal adaptation through assessing, pricing and assuming risk. As businesses, they have a strong incentive to understand the risk profile of potential customers so that they can set premiums accordingly. In liberalised markets, the premiums charged will be sufficient to cover those risks and the insurer's costs. While premiums provide a signal to property owners of the current level of risk, they do not provide a signal of how those risks may evolve in future.

Sea-level rise will increase underlying risks due to higher and/or more frequent losses, which increase the challenges of offering affordable coverage. As a result, insurance premiums are likely to rise or coverage will no longer be offered to those owning the riskiest properties (Wolfrom and Yokoi-Arai, 2015[63]). The costs of this will ultimately be borne by property owners, but it could also have negative implications for insurers insofar as it leads to reduced demand or negative public reactions. Unaffordable premiums reduce take-up rates, which then reduces the resilience of households and communities to flood events. Premium increases can additionally reduce property values, increase loan defaults, lower tax revenue and create hardships for current residents in flood-prone areas (Dixon et al., 2017[44]). There may also be transitional impacts for insurers if they fail to reflect changing risk trends in their capital provisions and in the coverage and pricing that they offer.

The benefit of loss-bearing and loss-sharing systems is that they can provide a direct incentive to reduce risk. However, while the ability of risk-based flood insurance coverage to incentivise risk reduction by households has received wide attention in the policy community, in practice this incentive is hindered by low levels of insurance coverage and premium subsidies in many coastal areas (OECD, 2016[33]; Surminski, 2013[64]). For example, there remains mixed evidence of the success of insurance in encouraging risk-reduction behaviour at the household level (discussed more thoroughly in Chapter 3) (Surminski and Thieken, 2017[65]). In addition, coastal communities face significant challenges that limit the deployment of insurance. Risk concentration, which relates to catastrophe events where many insureds are simultaneously impacted, is highly likely in heavily populated coastal areas. This then limits the availability and affordability of coverage (OECD, 2016[33]). Finally, slow-onset, foreseeable climate impacts, such as SLR-induced erosion, are often not insurable (Wolfrom and Yokoi-Arai, 2015[63]).

2.4.3. Authority for planning decisions

Land-use planning can have a significant impact on coastal risk, and inappropriate land-use development can be a substantial driver of increased losses (OECD, 2016[33]). For example, in the United States, high-risk, repetitive loss properties represented 38% of all claims payments between 1978 and 2004 (OECD, 2016[66]). Decision makers should aim to reduce the level of human or fixed assets exposed to flood risk.

Coastal zones are frequently managed by a patchwork of local, regional, national and international authorities looking after specific aspects of land use, such as flooding, transport, development and conservation. For example, in the United States, responsibilities for coastal risk management are shared between a number of federal, state and local agencies, and each agency has its own distinct objectives (National Research Council, 2014[67]). This can lead to a system in which decisions taken by one agency affect other agencies' mandates, and can lead to difficulties in implementing anything other than incremental change (Verschuuren and Mcdonald, 2012[68]; National Research Council, 2014[51]).

In most OECD countries, land-use planning is a local responsibility, but split incentives and capacity constraints may hinder effective implementation (OECD, 2017[69]). In particular, local governments often face pressures to allow development of desirable coastal land, as this leads to increased tax revenue. An underlying challenge in many countries lies with implementation of restrictive land-use regulations at the local level. In Italy, for example, gaps in compliance and number of amnesties provided for properties constructed without regard to flood hazard level have limited the effectiveness of legislative requirements for assessing flood hazard in new construction (OECD, 2016[33]). Some countries have held local decision makers to account for failing to incorporate hazard information into their land-use decisions. In France, responsibility for enforcing hazard zones falls on mayors, who can and have been found liable for ignoring these, such as in the coastal town of La Faute-sur-Mer (OECD, 2017[5]).

The implementation of land-use policies is often a local responsibility, but other levels of government have an important role in providing guidance and incentives (Box 2.7) for risk reduction. In countries where coastal risk management systems is co-ordinated nationally, such as the *plans de prévention des risques (risk prevention plans)* in France or Shoreline Management Plans in the United Kingdom, local implementation gaps have been reported.

Box 2.7. Insurance programmes can encourage better land-use management

In a number of countries, public (re)insurance schemes have been established to provide insurance coverage for flood damages (available for all properties or only residential or high-risk residential properties). In many countries, these schemes specifically include incentives, requirements or exclusions aimed at encouraging flood risk management at the local level.

In the United Kingdom, for example, the reinsurance coverage provided through Flood Re (which is meant to ensure the availability of affordable insurance for high-risk properties) is only available for developments constructed before 2009. This means that developers of more recent properties will need to ensure that the level of flood risk at individual properties is within the risk appetite of private insurers who may otherwise choose not to offer coverage in newly-built high-risk areas, putting at risk the possibility for homeowners to secure mortgage financing (which normally requires comprehensive property insurance coverage).

In the United States, insurance coverage through the public National Flood Insurance Program (NFIP) is only offered in communities that agree to implement a set of minimum NFIP floodplain development standards, including the use of flood maps in development planning, requirements for a base flood elevation and building standards to ensure that new buildings will be protected. In addition, a Community Rating System has been established to provide insurance premium discounts to households in communities that adopt recognised flood risk management practices (land-use planning and other risk-reduction measures) above the NFIP minimum requirements.

Source: OECD (2016[33]), *Financial Management of Flood Risk*, https://doi.org/10.1787/9789264257689-en.

Local governments can also face conflicting advice and capacity constraints in implementing land-use regulations. For example, during post 2013-14 storm recovery in the United Kingdom, central and local funding sources as well as misaligned land-use policies resulted in coastal infrastructure being rebuilt in the same original location, rather than further inland, as was suggested by both local communities and shoreline management plans (Brown, Naylor and Quinn, 2017[70]). In Australia, Canada and New Zealand, concerns around liability are frequently cited as barriers to implementing land-use decisions that account for uncertain future hazards (Verschuuren and Mcdonald, 2012[68]; Lemmen et al., 2016[71]) Box 2.8).

Box 2.8. Liability in planning decisions

In general, a decision by a local government to approve a development in a flood-prone area which is later flooded would not be considered as subject to claims of liability directed towards the relevant decision maker. However, climate change impacts are setting new precedent in countries and protection from liability for local planning decisions may not be assured. For example, in New Zealand, there have multiple cases where a precautionary sea-level rise adaptation measure taken by a territorial authority was challenged by a holder of property rights in the coastal area. In Sweden, local councils have been found liable for flood damage in areas deemed unsuitable for development. In general, liability issues can arise around:

- legal liability associated with the failure of an engineered structure for the owner/operator of the structure (often national governments)
- legal liabilities associated with existing zoning approvals of new development in areas anticipated to be affected by sea-level rise
- legal questions over property rights and with the development of more restrictive zoning regulations aimed at limiting development.

Sources: OECD (2016[33]), *Financial Management of Flood Risk*, https://doi.org/10.1787/9789264257689-en.

2.4.4. Benefits of living near the coast

People choose to occupy or use the coast due to substantial benefits, such as access to the environmental amenities that the coast provides. The benefits of coastal living is reflected in property values: research in the United States found that the prices of houses located within 150 metres of the sea were 100% higher than equivalent properties that are more than 10 km inland (Krause, 2014[72]).

The benefits of coastal living also go beyond homeowners. These benefits accrue to developers, engineers, architects and builders, as well as local and state governments in the form of contracts, profits and tax revenue. Development provides tax revenues, can result in greater local employment and, in some cases, reflects the preservation of historical and cultural community values (National Research Council, 2014[51]). It is therefore often perceived as being in the best interest of the property owner, developer, builder and municipality to undertake new development regardless of future public risk and other externalities.

All things being equal, a property in a risky location should be worth less than an identical one in a safer location; however, in practice the situation is more nuanced. A review of the literature examining the relationship between property value and SLR risk (Beltrán, Maddison and Elliott, 2018[73]; Bernstein, Gustafson and Lewis, 2018[74]; Keenan, Hill and Gumber, 2018[75]; Bakkensen and Barrage, 2017[76]; Warren-Myers et al., 2018[77]) found the following trends:

- In general, future SLR risks alone are not sufficient to reduce coastal property values, especially if the property has yet to be affected by a hazard event (e.g. experienced flooding or erosion). This is mainly due to inaccurate perceptions of risk and inadequate provision of risk information.
- In many cases, the value attached to proximity to coastal amenities outweighs the risk of increased exposure to SLR hazards.
- While information about SLR risk does not always affect value, the experience of actual flooding/erosion of a property is highly likely to adversely affect property values.
- Investments in public risk-reduction measures such as seawalls can raise property values again, as individuals and investors perceive the risks as being lower.
- Once sufficient time has passed without significant hazards occurring, property prices are also likely to increase as the impact of past events fade from memory and individuals discount future risks.

These trends point to a potential "coastal value gap", where the values of coastal properties may not accurately reflect their current or future risk. When a flood or erosion event does occur, the ensuing drop in property value has the potential to be dramatic and cause cascading adverse consequences.

2.5. Impact of institutional arrangements on future adaptation responses

OECD countries vary widely in their approach to coastal risk management, with the level of attention and degree of action often being correlated with the risks they face (Tol, Klein and Nicholls, 2008[9]). In countries that have been exposed only recently to persistent weather events or climate change-related effects, and in cases where there is a lower share of the population at risk, approaches tend to be less developed and more fragmented (Harman et al., 2015[15]). Non-economic factors also play an important role in explaining differences in the approaches to coastal management in different areas. These include different societal views on how to cope with risk, the historic approach to coastal risk management, including past investments in protective infrastructure, experience of floods and the division of institutional responsibilities (e.g. degree of centralisation). While there are large variations among OECD countries' arrangements for coastal risk management, general country typologies, and potential implications for adaptation, are described in Table 2.5.

Table 2.5. Implications of increasing coastal risk for different institutional arrangements

Typology	What will be the impacts of increasing coastal risk?	What adaptation strategies are likely to be prioritised?
1. Centrally funded, centrally co-ordinated (e.g. France, the Netherlands, Poland)	Increasing risk will be distributed throughout the country, and more and more public spending will go towards preparedness and response. This could lead to growing dissatisfaction from those who do not feel the benefits of increased spending on coastal protection, and call existing principals of solidarity into question.	• Heavy reliance on increased protection. • Potential for strong emphasis on large-scale, nature-based infrastructure and innovative responses due to consistent national funding.
2. Centrally supported, locally implemented (e.g. Belgium, Canada, Germany, United Kingdom, United States)	Due to difficulty in raising funds for ongoing maintenance and repair of existing coastal defences, effectiveness will likely drop below current standards. This could lead to a growing burden on emergency management to deal with increasing frequency of flooding events and other ongoing impacts of rising seas, which in turn means increasing costs for the general tax base, especially if risks become uninsurable.	• A mix of hard protection and household-level protection, both hard and nature-based. • Potential for unplanned retreat, especially after a major event, if financial resources cannot be raised for rebuilding and protection. • Low likelihood of transformational change, unless initiated by the community.
3. Local funding, local implementation (e.g. Australia, New Zealand, Sweden)	Increasing risks will be felt by individuals and communities along the coast. In some cases, this direct risk will incentivise individual action, but the lack of co-ordination will likely lead to *ad hoc* responses. It is possible that wealthier communities continue to raise funds for protection, which could have negative downstream effects on communities without the means for similar measures. In the short term, it is likely that local governments continue to pursue policies that are rational from a local perspective, but create inefficiencies overall, such as granting building permits in higher risk areas.	• A mix of *ad hoc* protection (both hard and nature-based) and individual measures, likely correlated to community resources opposed to community risk profile. • Low likelihood of transformational change, unless community initiative.

Notes

[1] The estimated costs of adaptation vary significantly based on the level of future climate change, the level of acceptable risk protection and the framework of analysis (risks protection versus economic efficiency) (Brown et al., 2011[46]).

[2] Comprising riverine and coastal flooding.

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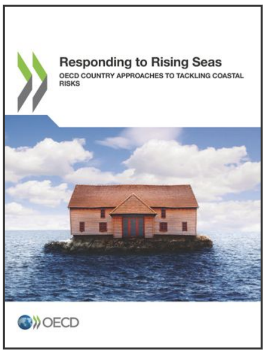

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