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Uplifts Associated with Flood Defence

Quick Scoping Review

March 2018


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Quick Scoping Review: Uplifts Associated with Flood Defence

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This is a report of research carried out by the Centre for Ecology & Hydrology and Atkins, on behalf of the Department for Environment, Food and Rural Affairs

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Executive Summary

The Department for Environment, Food and Rural Affairs (Defra) commissioned the Centre for Ecology & Hydrology (CEH) and Atkins in November 2017 to undertake a Quick Scoping Review (QSR) of the land value uplifts associated with investment in flood defence infrastructure. A QSR is intended to identify what evidence is available on a topic and what this evidence indicates, rather than critically appraising that evidence.

Defra is considering long term investment needs and future funding options for flood and coastal erosion management after 2021. This includes both the role of government funding and the scope for attracting contributions from others, particularly the direct and indirect beneficiaries of investment. This review will inform policy thinking on these issues.

To answer defined primary and secondary research questions, CEH and Atkins have undertaken a literature search and held semi-structured interviews with 8 relevant experts as well as receiving responses by email from an additional expert. The results of these exercises are summarised by research question below. We collected 1,639 individual results from the literature search. After initial filtering of these results for relevance, we identified 56 studies for further screening. ten of these studies met the defined screening criteria.

Primary Research Question: What evidence is there that investment in flood defence infrastructure increases land and property values?

Research by Allan Beltrán, David Maddison and Robert Elliott was raised as the principle evidence on this topic for the UK by interviewees. This shows that proximity to flood defences increases property prices by between 1% and 13%, dependent on the level and nature of risk and the type of property. However, for certain properties, defences can reduce prices by 1% to 9%. Interviewees also drew attention to a small number of similar studies for the USA that found small positive or no significant impacts.

We identified seven studies in the literature search of some relevance to this research question, though some considered flood responses other than investment in infrastructure (e.g. building regulations) or non-flood defence specific investments, such as wetland restoration. There is evidence of a positive effect of specific types of flood defence or coastal erosion management investments, though only in US studies using simulation models. Evidence from the UK, based on local interviews in relevant areas, does not indicate an impact. Impacts of flood defences are challenging to identify, due to a large number of variables which determine property and land values. Typically, the literature has assessed benefits of flood defences as avoided damages rather than value uplifts.

Secondary Research Questions:

Are there specific examples of individuals and companies benefiting financially from investment in flood and coastal erosion risk infrastructure?

The literature search did not yield any examples of primary research which identified specific beneficiaries from investment. Interviewees suggested specific examples where companies had paid levies to pay for flood defence works to protect their businesses, in Sheffield, Avonmouth, Cockermouth and Wakefield, amongst others. Benefits for businesses depend on land assets and impacts on use options, including whether flood defence schemes are part of wider regeneration projects. There may be limited empirical evidence of these benefits, and not necessarily of land value changes.

What kinds of investment in flood defence infrastructure add value to land and property?

Beltrán et al (2017), a paper raised by interviewees, suggests that the size of flood defences acted against the positive impact of flood defences on property prices, all else equal, and there was a similar negative effect on price specific to demountable flood defences. This may be due to amenity effects and perception of risk. There was a view among interviewees that natural flood defence infrastructure benefits are harder to promote to insurers or other bodies and benefits or harder to prove.

In the literature search, three studies identified positive impacts of a specific flood defence or related interventions on land or property values. Studies from the US have considered beach nourishment, on-site water retention and wetland and stream restoration. All found property value increases, but the first two use a simulated model and the latter does not identify a flood-defence specific effect.

What incentives exist for developers and landowners to invest in flood defences?

We found no direct evidence on this question in the literature, other than evidence on benefits to householders or landowners as discussed above. The search yielded book chapters on incentives for adoption of Low Impact Development practices in the USA, but these were not available to the team for review.

Interviewees identified Section 106 agreements, planning guidance and incentives from Local Enterprise Partnerships as the main incentives for investment in flood defence, as well as enhancing development potential of land. Interviewees identified a range of reasons why businesses or landowners may not be incentivised to invest in flood defences.

Are there any examples where uplift in land or property value has been captured by local or national organisations and recovered?

We did not find any evidence of this in our literature search. Interviewees identified examples of local planning authorities using Community Infrastructure Levies or similar to fund flood defence projects as well as flood and coastal erosion risk management (FCERM) investment partnerships.

What type of impacts do flood defences have on insurance costs?

Our literature search provided no primary evidence on this question. Interviewees noted that insurance costs should respond to flood defences, but identified various reasons why they may not adjust, may not adjust quickly or may not adjust in a way which is necessarily beneficial for businesses in the event of a flood (for example, premiums may fall whilst excesses rise). Insurers may for example make use of data sources that do not immediately indicate a reduction in risk following installation of flood defences. As noted above, 'hard' engineering solutions were perceived as more influential in reducing insurance premiums.

Overall, the QSR found limited evidence of the link between investing in flood defence infrastructure and impacts on land and property values. This does not necessarily mean that there is no such link however. The QSR found a very small number of documents discussing this link which suggests that there has been limited research in this area. There is much more available research and analysis on the negative impacts of flooding.

Introduction

About this study

The Department for Environment, Food and Rural Affairs (Defra) commissioned the Centre for Ecology & Hydrology (CEH) and Atkins in November 2017 to undertake a Quick Scoping Review (QSR) about the land value uplifts associated with investment in flood defence infrastructure.

Study Scope

Defra is considering long term investment needs and future funding options for flood and coastal erosion management after 2021. Building on progress made through the National Flood Resilience Review it is working with the Environment Agency, HM Treasury and the National Infrastructure Commission to consider investment needs and funding options. This includes both the role of government funding and the scope for attracting contributions from others, particularly the direct and indirect beneficiaries of investment.

In this context Defra is keen to understand what evidence, if any, there is of a link between investment in flood defence infrastructure and any resulting increases in land and property values. Defra is also interested in whether there is any evidence of specific people or organisations that have benefited directly or indirectly from the uplift in land or property values. The primary objective of this QSR is therefore to answer the following question:

"What evidence is there that investment in flood defence infrastructure increases land and property values?"

Although the primary question assumes that food defence infrastructure does not lead to a decrease in land or property value, some studies reported negative impacts and for completeness these are reported.

In addition to the primary question, the QSR is interested in any evidence relating to the following secondary questions:

- Are there specific examples of individuals and companies benefiting financially from investment in flood and coastal erosion risk infrastructure?
- What kinds of investment in flood defence infrastructure add value to land and property?
- What incentives exist for developers and landowners to invest in flood defences?
- Are there any examples where uplift in land or property value has been captured by local or national organisations and recovered?

- What type of impacts do flood defences have on insurance costs?

A QSR follows some of the guiding principles of a systematic review to objectively assess a body of evidence but is undertaken in a much shorter time scale, with less systematic procedures and no critical assessment of the quality of evidence. This reflects the reality of resource constraints for undertaking the QSR which does not represent the level of effort and rigour that would be required for carrying out a systematic review. The QSR represents a new approach to harnessing evidence for policy makers using systematic review procedures in a more rapid manner to meet constrained timescales of decision makers. There has been significant work within the UK Government Civil Service to provide guidance on how to carry out a QSR. This has been adopted and developed by the Defra Joint Water Evidence Group in the document *The Production of Quick Scoping Reviews and Rapid Evidence Assessments: A How to Guide* (cited throughout as Collins et al. 2015), which has been followed in the production of this QSR.

The aim of a QSR is to provide an informed conclusion of the size and type of evidence available and a summary of what that evidence indicates with respect to the question posed (Collins et al, 2015). It does not extend to a critical appraisal of the evidence. The purpose of this study is not therefore to assess the quality of the evidence but to identify and summarise any existing evidence.

Methodology

Literature search

Defining the search terms

The starting point of the QSR was an inception meeting between Defra, CEH and Atkins. Following the inception meeting, CEH and Atkins prepared a Protocol document which reflected the discussions held during the inception meeting, and summarised the scope of the study, the methodological approach, and the work programme for the completion of the study.

The QSR utilised the Population, Intervention, Comparison and Outcome (PICO) framework as outlined in **Table 1** below.

Table 1. Population, Intervention, Comparison and Outcome (PICO) considerations for the primary question.

PICO element	PICO element within this QSR
Population	Land and property (value) – specifically who benefits (individual/company/council) Located in UK or similar size/climate country – not influenced by different climatic conditions (e.g. tropical climates / frequent hurricanes)
Intervention	Investment in flood defence infrastructure (coastal or riverine)
Comparator	Before/after, with/without catchment comparison
Outcome	Increase/uplift (value)

Based on the above PICO elements, the study team defined the search keywords listed in **Table 2**.

Table 2. Keywords used in the literature search

Population	Intervention	Comparator	Outcomes
Land AND value	Investment AND flood defence	Following OR after	Increas*
Property AND value	Flood AND infrastructure	Compar*	Uplift
	Flood defence		Rais*
	Coastal AND Flood OR defence		Improv*
			Higher

The various possible combinations of these keywords made up the search strings used for the internet searches (80 different search strings in total). Each of these search strings were used on the following three search engines:

Web of Science – an online scientific citation indexing service maintained by Clarivate Analytics. Web of Science provides access to multiple databases that reference cross-disciplinary research, allowing for in-depth exploration of specialized sub-fields within an academic or scientific discipline.

Google Scholar – Google Scholar is a freely accessible web search engine that indexes most peer-reviewed online academic journals and books, conference papers, theses and dissertations, preprints, abstracts, technical reports, and other scholarly literature, including court opinions and patents.

Google Search – the most-used search engine on the World Wide Web.

Web of Science and Google Scholar were used to search for peer-reviewed evidence while Google Search provided access to a wider range of literature.

The search functionality differs between the various search engines so although the searches were drawing on the agreed key words, the way in which these were combined and the use of Boolean operators differed slightly between the searches.

Filtering of results

The first 30 results for each search string from each search engine[1] were recorded and combined in a list of 5,256 results in total. Once duplicates were excluded, the list consisted of 1,639 individual results. The breakdown of the results is summarised in **Table 3** below.

Table 3. Summary of search results

Search engine	Number of search strings used	Number of results carried forward for filtering	Number of results after removing duplicates
Google	80	2,400	-
Google Scholar	80	2,400	-
Web of Science	80	456	-
Total	**-**	**5,256**	**1,639**

An initial filtering of these results was undertaken to identify results of potential relevance to this QSR. This filtering was based on the title of each document and/or an initial review of its abstract to confirm that it discusses flooding and land values. This narrowed the list of documents for further screening down to 56. These documents are listed in **Appendix A**.

Screening of results

The filtered results from all three search engines went through a systematic screening process using the following four criteria:

1. Does the review team have access to the full report or full abstract?
2. Is the evidence quantifying the impacts?
3. Is the evidence based on primary research / facts rather than views or reviews?
4. Is the evidence from the UK or a similar climate/catchment size location?

The aim of the screening process was to refine the results down to primary evidence – that being original evidence, with data to validate findings, and not reviews or views. Furthermore, the QSR was primarily interested in evidence from areas with comparable

[1] Web of Science did not return at least 30 results for each search string.

climate to the UK (e.g. excluding any evidence from areas with tropical climates as the risk and extent of flooding there can be significantly different).

The inclusion criteria were applied by one reviewer to all potential articles, except where there was uncertainty, in which case a second reviewer also examined the text and a consensus decision was made. Documents that did not pass all four screening tests but were still considered to be relevant were noted. In total:

- Eight studies passed the screening criteria;
- Of these, three were found to not be relevant to the defined research questions following further consideration (for example, considered the impact of flooding on land values rather than flood defence infrastructure).
- Three studies did not meet all four screening criteria, but were deemed to still be of potential relevance.

The list of documents which were identified as meeting the screening criteria, or noted as potentially relevant, and summaries of their content, are presented in Appendix B:. Those documents judged to be relevant are discussed further in the subsequent chapter (where these did not meet all screening criteria this has been noted).

Expert interviews

To complement the literature search, the research team undertook interviews with a range of subject matter experts. These were structured using the primary and secondary research questions. The objective of the interviews was to capture knowledge or identify gaps in knowledge that might not be apparent through a search of the existing literature. Any additional literature identified in the expert interviews is discussed in the Expert Interviews chapter.

Interviewees were initially identified on the basis of a horizon scan of industry and academic individuals relevant to the subject area and suggestions from the project board. Further interviewees were identified through the consultations. We interviewed eight experts in total, and received responses to questions by email from an additional expert. A full list can be found on page 13.

Analysis of results

Defining the search terms

Much of the literature discusses the adverse economic impacts of flooding, including the adverse impacts on land and property values, as well as on insurance premiums. There is less evidence about the actual positive effect on land and property values of investing in flood defence infrastructure.

It could be argued that it could be inferred that if flooding reduces land values then any scheme that mitigates the risk of flooding would have a positive impact on land values. But as the objective of this QSR is to record evidence rather than make any inferences, this section focuses exclusively on the actual evidence that was identified as part of this review.

Review of evidence

What evidence is there that investment in flood defence infrastructure increases land and property values?

Of the 56 initial filtering results, we identified seven that were of relevance to this research question though some considered flood-related interventions other than traditional flood defence infrastructure. Limited evidence for such an effect was identified in our review, other than several relevant studies from the USA. Two studies estimate simulation models, parameterised to local conditions, to estimate the impact of infrastructure or similar interventions. McNamara et al (2015) develop a model to estimate results that suggest a large share of coastal property value in North Carolina, USA represents capitalised erosion control, benefiting from federal beach nourishment subsidies. They estimate average property inflation at 9% to 16%, though could be as high as 34% in some locations. Another US-based study found that development designs promoting on-site water retention and reduced downstream flooding could generate downstream property value benefits of up to $19,400 per hectare (Johnston et al, 2006). Though the research team did not have access to the full book (and therefore it did not meet screening criterion 1), the introductory chapter of Thurston (2011) stated that Chapter 7 (Thurston, 2011a) "estimates some of the benefits of stormwater management applications, and especially how these are affected by property values".

Large scale wetland and stream restoration was found to increase the value of land between 0.5 miles and 0.75 miles away from restoration sites in North Carolina, USA, though this is not specifically attributable to a flood defence effect (Kaza and BenDor, 2013).

Evidence from the UK and New Zealand has found no impact of flood defence infrastructure or related policies on property values. In the case studies of Carlisle and

West Bay in Dorset, researchers found little evidence of any impact of flood defence schemes on house values, based on consultation with local estate agents (Penning-Rowsell and Pardoe, 2012). Montz (1993) found that flooding hazard area disclosure in an area of New Zealand had no identifiable impact on property values.

One study identified potential negative impacts of flood-related building regulations, though not specifically of flood defence infrastructure. Dehring (2006) found that costs of compliance with building regulations in response to flood risk decreased prices of vacant land on Florida's barrier islands by up to 30%, however this tropical climate may be of limited relevance to the UK (see screening criterion 4).

Are there specific examples of individuals and companies benefiting financially from investment in flood and coastal erosion risk infrastructure?

The research reviewed has not identified specific examples of individuals or companies benefiting financially from investment. Penning-Rowsell and Pardoe (2012), reflecting on evidence from two UK case studies, suggest that the main realised benefit of flood risk management is the direct flood damage avoided. Beneficiaries are therefore householders and owners/users of commercial property. The authors also identify insurance companies (and shareholders) benefit from investments, as premiums appear not to decline with reduced risks following investment (this conclusion is based on secondary research by the authors into insurance premiums).

What kinds of investment in flood defence infrastructure add value to land and property?

Studies based on simulated models have suggested that beach nourishment and on-site water retention could add value to land and property (McNamara et al, 2015; Johnston et al, 2006). There is evidence that investment in wetland and stream restoration adds value to land and property, though it is not known whether this is due to a flood defence effect (Kaza and BenDor, 2013).

What incentives exist for developers and landowners to invest in flood defences?

We have found little evidence on this question. Penning-Rowsell and Pardoe (2012) identify that the main economic benefit of flood defences is direct flood damages avoided, and therefore the main beneficiaries are householders and commercial property owners. We do not have evidence on whether this is a sufficient incentive to invest.

Though the research team did not have access to the relevant chapters at the time of writing (and therefore did not meet screening criterion 1), the introductory chapter of Thurston (2011) describes Chapter 5 of the same book (Garmestani et al, 2011) as "an applied look at the costs and benefits of LID [low impact development] practices, and...

[discussion of] some of the programs that stormwater facilities and municipalities around the country have used to incentivise the adoption of LID" (pp. 4-5).

Are there any examples where uplift in land or property value has been captured by local or national organisations and recovered?

We did not find any evidence of this in our literature search.

What type of impacts do flood defences have on insurance costs?

Our literature search provided limited evidence on this question. Penning-Rowsell and Pardoe (2012) cite other studies, not reviewed as part of this exercise, suggesting insurance costs are not responsive to changes in risk due to flood defences.

Expert interviews

Introduction

To complement the internet searches discussed in the previous chapters, the review team conducted a series of focused telephone interviews with experts in the areas of flood economics:

- Dr Jessica Lamond, University of the West of England
- Professor David Proverbs, Birmingham City University
- Dr Gayan Wedawatta, Aston University
- Graham Quarrier, Environment Agency
- Harry Walton, Environment Agency
- Carolann Simmonds, Principal Flood Economist, Atkins
- Professor David Maddison, Birmingham University, and Allan Beltrán-Hernandez, LSE (face to face meeting)

In addition to the above, the review team received responses to questions by email from Richard Walker at the Environment Agency.

The interviews were focused on answering the primary and secondary questions discussed in Chapter 1 of this report.

Findings

What evidence is there that investment in flood defence infrastructure increases land and property values?

There is little direct evidence identified by interviewees on the topic of a relationship between flood defence investment and land or property values. A UK-wide study authored by Allan Beltrán, David Maddison and Robert Elliott, which uses Land Registry data to deliver a hedonic pricing study, was identified as key evidence that directly addresses this question. The most up to date version of this research is currently subject to referee review prior to publication. The authors were able to provide a copy of an earlier version of the paper shared at the 2017 EAERE Conference (Beltrán et al, 2017).[2]

[2] This document was not identified through the web searches.

The study examines the effect of 1,666 flood defences built between 1995-2014 on house prices (as recorded by sales) in England. The results of the study suggest that flood defences increase property prices by between 1% and 13%, dependent on the level and nature of risk and the type of property. However, for rural properties and flats, defences can reduce prices by 1% to 9%. The authors consider this to be due to the loss of amenity value as well as limited initial risk in the case of flats. The authors suggest that negative impacts can also potentially be explained by flood defence investment increasing the perception of flood risk. Discussion with the authors suggested that subsequent research, currently unpublished, indicated that there was evidence that positive impacts on property values were concentrated in the area close to the flood defence, with negative impacts experienced further away.

Interviewees also identified some relevant evidence from the USA. One study estimates that investment in coastal dunes raised coastal house prices by approximately 3.6% (Dundas, 2017). Another study found a positive though largely statistically insignificant impact of levees on commercial property sale prices (Fell and Kousky, 2015). Another paper, of which only a non-citable draft exists at present, presented evidence on property value impacts of beach nourishment in North Carolina, USA.

The majority of evidence related to this topic examines impacts of flooding, rather than flood defences, on property and land values. It has been suggested that in a rational actor model, researchers would observe a situation whereby flood defences reduce flood risk which in turn increases land and property values in areas previously at risk. Though not necessarily evidence of a positive effect of mitigating the risk, interviewees identified an existing meta-analysis which quantified the negative effects on property values of flood risk, which found a large range of positive and negative estimates of the property price impact of being located in a flood plain, based on 37 published works. The meta-analysis suggested a ‘rule of thumb’ 4.6% price discount of being located within an inland 100-year floodplain (Beltrán et al, 2018).

Experts noted that while homeowners may benefit from flood defence infrastructure (so called ‘welfare benefits’) these are only reflected in land and property values if priced in through markets. Experts noted that a lack of clarity over the relationship between land value and flood defence investments is compounded by the large number of relevant factors and variables. These include local market characteristics, land use, different types of flood defences, risk variance, investment levels and perceptions of investment and risk.

Several interviewees identified case studies that show avoided damages as benefits from flood defences. However, this is not the same as observed property value increases. Examples in the Lake District, Yorkshire and Devon mentioned by interviewees have not separated other factors (e.g. market demand, event occurrence and type of flood defence infrastructure) but highlight that flood defence investment could have a positive impact on land value.

The relationship between flooding, flood defences and land value is deemed to be complex. Several factors were identified as important, including the property market,

insurance markets as well as ownership and tenancy of land. Land values often do not reflect the associated levels of risk. This is particularly in areas with high demand and low supply such as London and the South East, where areas prone to flooding maintain high land and property values.

Are there specific examples of individuals and companies benefiting financially from investment in flood and coastal erosion risk infrastructure?

Interviewees identified the example of Sheffield, where companies implemented a levy to pay for flood defence works to protect their businesses. This resulted in continued economic performance and perceived land value or development potential gains. Interviewees also identified examples in Avonmouth, Cockermouth and Wakefield as pertinent. Although specific value uplifts were unknown and other variables identified as important, these were suggested as examples of where property values had been at least protected and probably risen as a result of flood defence infrastructure. For these examples, the empirical evidence is not always available as, for example, had not been subject to project evaluation or academic research. It was suggested as a follow up work that reviewing land value changes shortly after the introduction of flood defence interventions could identify a positive relationship.

The role of wider regeneration near flood defence schemes was highlighted as an important factor for value uplifts but also for financial benefits. Where regeneration had not occurred, it was felt that values may not have increased or been observed. The type of business involved or affected by flooding is also important. Larger businesses will be more likely and inclined to invest in and benefit from flood infrastructure investment (suggested examples include Sheffield Meadowhall and Astra-Zeneca in Cheshire). Other interviewees responded that benefits for businesses depend on their land assets and whether flood defence schemes affect the viability and potential uses of these assets. Smaller companies have a variety of different responses (depending on how long they have been operating and their location). Several theoretical examples were discussed (e.g. experience of flooding in York) but there is little academic or empirical evidence to highlight financial benefits or gains.

What kinds of investment in flood defence infrastructure add value to land and property?

Beltrán et al (2017) found that larger flood defences (in terms of height and length) had a negative impact on property prices, all else equal. The authors suggest this could be due to negative amenity impacts. There is also some evidence that demountable flood defences have a negative effect on prices, again all else equal. The authors propose this could be due to increasing perceived risk, by making evident the existence of a risk (through the permanent foundations) whilst not providing permanent protection.

Whilst there was a general agreement that flood defence infrastructure impacts upon property prices would vary, there is a view that natural flood defence infrastructure benefits are harder to promote to insurers or other bodies. Building a wall or bank has a much more immediate and obvious protection which is perceived to be ‘psychologically’ better. Although natural defences are being promoted by the Environment Agency, their benefits are more difficult to prove. Therefore the perception of the effectiveness of a flood defence scheme can be as important as its actual effectiveness.

Other interviewees identified that there was the potential for a negative impact on land or property values due to a negative amenity effect, e.g. flood defence infrastructure impacting a view. The use of glass wall flood defences was cited as evidence for this as a concern.

It is not known if there is a direct link between different types of flood defences and any changes in land or property values but it was suggested there are ongoing studies on this subject (specifically the research by Beltrán, Maddison and Elliot, discussed elsewhere in this report).

What incentives exist for developers and landowners to invest in flood defences?

Interviewees identified incentives such as Section 106 agreements, planning guidance and moral motivations as the key for developers and landowners to invest in flood defences. Interviewees also mentioned other incentives for developers or landowners to invest in flood defences. These include financial incentives from Local Enterprise Partnerships (LEPs) and to enhance development potential (and subsequent economic growth prospects). Recent planning guidance changes also support investments in sustainable drainage systems which would incentivise developers and landowners to invest in this type of flood defence design.

Companies often see different motivations for investing in flood defences. Some companies can be reluctant and generally companies need to see an urgent business need for investing in flood defences. Businesses tend to have a shorter term view which does not justify investing in flood defences, as investments may need to be recouped in, for example, 10 years. Lease arrangements are also important as businesses may not necessarily be situated in the same location in the long-term. Different types of businesses may have different likelihoods of contributing to flood defences; for example, low value distribution businesses are unlikely to contribute, whilst high value activities may be more likely (interviewees gave the example of Pfizer in Sandwich). Conversely, landowners may be less concerned about flooding impacts than tenant businesses.

A peculiarity is that emergency funding for flood defences can, at times, undermine private sector or community incentives for flood defence infrastructure by enhancing the public-sector investment and role in flood defences, which reduces appetite among other stakeholders.

It was felt that going forward, incentives would continue to exist for local planning authorities and LEPs to invest in flood defences to address housing shortages and economic growth constraints. Interviewees suggested that LEPs may be more interested in the economic benefits of flood defences as it is a more significant part of their project funding appraisal process. However, interviewees were not clear about the evidence LEPs might be using as part of their funding decision-making.

Are there any examples where uplift in land or property value has been captured by local or national organisations and recovered?

Environment Agency respondents discussed FCERM investment partnerships, which had secured circa £150 million of negotiated contributions into FCERM schemes, supported by beneficiary analysis largely based on development opportunities. When supported to make informed investment choices, local development interests can support FCERM schemes which will enable future growth.

Respondents identified examples of local planning authorities using the Community Infrastructure Levy (or similar) to capture land value uplift, specifically by Sedgemoor District Council with regards to the Bridgwater flood defence barrier and by Portsmouth City Council with regards to the Portsea Coastal Strategy.

Several experts noted the inquiry into land value capture launched in January 2018 by the Communities and Local Government Select Committee as a relevant ongoing concern for this question and potential source of evidence. As yet (5th February 2018) no evidence has been published by the inquiry.

What type of impacts do flood defences have on insurance costs?

It was discussed by interviewees that flood defences should have positive impacts upon insurance costs. However, this is not always the case. Several factors were identified as important. Different insurance companies have different ways of modelling risk and insurance costs and need to be satisfied that the risk has reduced. This can mean that delays are experienced or costs do not come down quickly. Furthermore, the perception and profile of flooding can impact how an insurance company sets insurance premiums now and in the future. Insurance premium costs may reduce or stay the same but the excess could rise significantly, which could have negative impacts in the future.

It was suggested that insurance providers will utilise Environment Agency flood risk maps but some providers will use other information and data which may have different emphasis or highlight other risks. The type of flood defence infrastructure (e.g. natural or hard) is also an important factor, with hard engineered solutions often deemed to be most effective for reducing insurance premiums.

Conclusions

The review of the documents found through the internet searches and the interviews with key experts provided broadly similar findings. While there is a lot of literature and research about the economic impacts of flooding (including on land and property values), there is generally very little evidence that investing in flood defence infrastructure has a positive impact on land values. The major exception to this in the UK context is emerging research by Beltrán, Maddison and Elliott. The lack of evidence is primarily because there appears to be very little published research on the subject, rather than there being no impacts. The experts that were interviewed as part of this QSR agreed in principle that there should be a positive impact but there is little published evidence that quantifies this. Despite this perception, there is some evidence that flood defences can have a negative impact perhaps due to reduced amenities or increased perception of risk.

Another interesting finding is that even though flooding has an adverse impact on land and property values, this seems to be temporary with evidence showing that in many cases prices return to previous levels.

Few specific beneficiaries of flood defence investment were identified, or where these were identified it was not clear that empirical or academic evidence of these benefits existed.

The perception of the effectiveness of flood defence measures appears to be at least as equally important as their actual effectiveness. As an example, hard engineering solutions appear to have more of an impact on people's perception of risk mitigation, and therefore are more likely to affect their economic choices such as buying or selling property, compared to natural flood defence schemes. However it is also possible that there is a negative amenity effect associated with larger infrastructure.

Evidence on incentives are limited, and there is little distinction made between benefits and incentives to invest. There are various reasons why businesses and landowners may not be incentivised to invest. There is evidence of local authorities and other bodies incentivising investments, for example through Section 106 agreements. These are effectively often similar to public bodies capturing value uplift in order to fund flood defence infrastructure.

It has also been suggested that while flood defence infrastructure reduces risk, insurers may not amend the terms of coverage in line with the reduction in risk.

In conclusion, there is some evidence of a possible positive impact of flood defence infrastructure investment on land or property values. However, evidence on this question is currently limited in the UK context and there is equally evidence, and some theoretical rationale, for a negative impact in some cases. There is little evidence on specific beneficiaries of flood defence investment or on incentives to invest. There is some

evidence that the value impacts of flood defences vary based on the characteristics of the flood defence infrastructure, potentially linked to perceived risk.

Based on the findings of this QSR, there is limited evidence that investing in flood defence infrastructure has an impact on land and property values. This lack of evidence, however, reflects the lack of research in this area and does not necessarily mean there is no actual link between flood defence infrastructure and land and property values. This is an important issue that could have important policy implications, and further research is needed to provide a definitive answer.

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Appendix A: List of screened documents

3 Flood Risk Management Benefits: Theory and Practice - MCM-Online

B.E. Montz. 1993. Hazard Area Disclosure In New-Zealand - The Impacts On Residential Property-Values In 2 Communities. Applied Geography. 13; pp. 225-242.

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Appendix B: Summary of documents which met screening criteria

Studies that met all screening criteria and relevant to research questions

Johnston, D.M., J.B. Braden and T.H. Price. 2006. Downstream economic benefits from storm-water management. Journal of Water Resources Planning and Management. 132(1).

Summary: This paper uses benefits transfer methods to assess the downstream economic consequences of development designs that promote greater on-site water retention. It estimates that for residential properties, the economic value of flood mitigation and water quality protection is on the order of 0–5% of market value depending on the difference that retention makes to downstream flood exposure. It estimates downstream property value benefits resulting from on-site storm water storage using a case study of a rapidly developing area near Chicago, Illinois, USA. Reduced downstream flooding with the employment of conservation design practices generates up to $19,400 of benefit per hectare.

Notes: The document appears to estimate potential benefits rather than measuring actual benefits.

Kaza, N. and T.K. BenDor. 2013. The land value impacts of wetland restoration. Journal of Environmental Management. 127; pp. 289-299.

Summary: The study investigates the effect of large-scale wetland and stream restoration on surrounding land values in North Carolina, USA. The study found that land parcels within 0.5 miles of the wetlands have lower prices, whilst land between 0.5 miles and 0.75 miles away gain substantial value.

Notes: This effect may not be specific to the role of wetlands in flood mitigation.

McNamara, D.E. et al. 2015. Climate adaptation and policy-induced inflation of coastal property value. PLOS ONE.

Summary: The study presents a model, paramaterised for coastal properties and physical forcing in North Carolina, USA, which shows that a large share of coastal property value represents capitalized erosion control. In effect, the nourishment subsidy results in inflated values of oceanfront properties as they capitalize the total benefits from nourishment but pay only a share of the costs. The document states that the property value decreases as the rate of background erosion (e.g. from sea level rise) increases and as the rate of storminess increases. Therefore, a sudden removal of federal nourishment subsidies could

trigger a significant downward adjustment in coastal real estate values, as much as 34% in some locations.

Notes: The document appears to estimate potential benefits rather than measuring actual benefits.

Meyer, V., S. Priest and C. Kuhlicke. 2012. Economic evaluation of structural and non-structural flood risk management measures: examples from the Mulde River. Natural Hazards. 62(2); pp. 301-324.

Summary: The paper provides examples and applications of methodologies to evaluate the economic costs and benefits of 'non-structural' flood risk mitigation measures (specifically a resettlement option and a warning system). The paper is based on a case study in the Mulde River area of Germany and discusses the methods and results for the evaluation of the cost-effectiveness of structural and non-structural methods. The study however does not consider the effects on land or property values.

Montz, B.E. 1993. Hazard Area Disclosure in New-Zealand - The Impacts On Residential Property-Values In Two Communities. Applied Geography. 13; pp. 225-242.

Summary: The article considers two case studies of areas in New Zealand who have implemented hazard area disclosure, one of flooding. Evaluation of residential real estate sales before and after disclosure suggests that hazard designation and related policies have had no marked impact on property values. The document notes that other local economic factors can be more important than those related to disclosure or they may mask the disclosure-related impacts. Location and increased demand for centrally located housing are two such factors.

Penning-Rowsell, E.C. and J. Pardoe. 2012. Who benefits and who loses from flood risk reduction? Environment and Planning C: Politics and Space. 30(3)

Summary: The paper states that for those implementing flood risk management measures the question of who gains and who loses has been of secondary interest (if considered at all), compared with efficient risk reduction for society as a whole. This is possibly because the source of funding for most flood defence interventions has been national taxation rather than local beneficiaries.

Using the UK as a case example, the paper investigates the distribution of the tangible economic impacts of flood risk management measures. In simple terms, the conceptual framework for this research is to catalogue and map distributional effects by illuminating the links between the funding of FRM investment - and those who contribute to this funding - with those who directly or indirectly benefit from that investment.

The paper discusses three case studies, two of which include consideration of impacts on land and property values:

Carlisle, Cumbria - Serious flooding in Carlisle in January 2005 affected approximately 1,844 properties. Two engineering schemes were promoted to alleviate this flooding, both a combination of bank raising and channel improvements. The two schemes cost £13m and £38m respectively. Analysis of the 2005 event showed little or no evidence of falls in residential property prices after the flood; on the contrary the general trend was upwards until the recession of 2007–12 (HR Wallingford, 2008). Interviews with estate agents verified that the flooding did not depress the housing market, so the two schemes appear unlikely to have the opposite effect and lead to increased house values.

West Bay, Dorset - Following a major storm and flood in 1974 causing widespread damage and the evacuation of local people and holidaymakers, the West Bay Coastal Defence and Harbour Improvement Scheme was completed in 2004, designed to address a range of issues. The cost of the scheme was £20 million. Interviews with three local Bridport estate agents suggested that the scheme had not had a noticeable effect on either house prices or sales.

The evidence from the case studies shows that the main realised benefit of flood risk management measures is the direct flood damage avoided. Beneficiaries include individual householders and the owners or users of commercial property, through risk reduction resulting in significantly less future flood damage. The benefits per property affected vary widely (from £12,510 to over £75,000).

The exploration of insurance effects suggests strongly that insurers and their shareholders are the main beneficiaries of investment in hazard reduction, given that insurance premiums appear not to decline with the reduced risks and flood damage that this investment brings. The paper concludes that those gaining from this investment are therefore relatively high-income insurance shareholders, through insurance companies seeing lower costs while maintaining their income.

Studies that met all screening criteria but not relevant to research questions

Filatova. T., J.P.M. Mulder and A. van der Veen. 2011. Coastal risk management: how to motivate individual economic decisions to lower flood risk? Ocean & Coastal Management. 54(2); pp. 164-172.

Summary: The study reviews existing literature to demonstrate that flood damage depends on individual location choices in the housing market and on individual flood awareness. It states that various factors increase individual risk awareness, including 'technical instruments like building on high elevations'. The study provides evidence that these factors affect housing prices and land use patterns. The more individuals become aware of flood risk, the less potential damage is going to occur. The study identifies this as a potentially self-reinforcing cycle with a positive effect of decreasing flood risk resulting in the government achieving its goal of decreasing flood risk and individuals and private investors benefitting as well. Raising flood risk awareness has the potential to make

microeconomic behaviour working in line with policy-goals and thus to exploit the capacity of shared responsibilities for flood risk reduction between the government and the citizens.

Lamond, J. & D. Proverbs & F. Hammond. (2010). The Impact of Flooding on the Price of Residential Property: A Transactional Analysis of the UK Market. Housing Studies

The paper states that many studies have looked for flood impacts on residential property values but the findings vary significantly. It states that in the UK, three studies (Eves 2004[3], Building Flood Research Group 2004, Kenney et al. 2006) have surveyed the opinions of valuers and other stakeholders on the question of the impact of flood on the value of property. Typically, the impact of a flood event was found to be greater than that of designation, but variation was still considerable within those categories depending on local factors.

The paper refers to evidence from other papers showing that the land value uplift of being on a waterfront location was greater than the discount due to flood risk (Speyrer and Rajas, 1991; Bin et al., 2006). It refers to the survey of valuation professionals carried out by the Building Flood Research Group (2004) which estimated that the median discount for flooded property was 12-15%, with the average discount for property flooded more than 3 times being 35%.

It quotes the Building Flood Research Group investigation (2004) and also in the study by Eves (2004) which conclude that flood impact would decline with time elapsed after a flood. The paper states that for the vast majority of floodplain properties, flood impacts on property prices are small and temporary which implies that the natural concern experienced by property owners about long term equity in their home is largely unfounded unless market conditions alter.

The paper provides useful evidence about the impact of flooding on land and property values but does not provide any evidence about ant land value uplift as a result of flood defence infrastructure investment.

Studies that did not meet all screening criteria but relevant to research questions

Dehring, C.A. 2006. Building codes and land values in high hazard areas. Land Economics. 82(4); pp. 513-528.

Summary: The study considers vacant land values under different building regulatory regimes in the USA (National Flood Insurance Program, Coastal Building Zone, Coastal Construction Control Line). The findings suggest that benefits of safety from increased

[3] Eves, C. 2004. The impact of flooding on residential property buyer behaviour: an England and Australian comparison of flood affected property. Structural Survey. 22(2); pp. 84-94.

building standards are outweighed by the additional costs of compliance brought about by the code changes. The results suggest that land prices decrease by up to 30% for affected properties following changes in construction codes.

Thurston, H.W. (eds). 2011. Economic Incentives for Stormwater Control. CRC Press.

Summary: Though the research team did not have access to the relevant chapters at the time of writing, the introductory chapter describes Chapter 5 (Garmestani, Clements, Pratt and Hair) as "an applied look at the costs and benefits of LID practices, and begin to talk about some of the programs that stormwater facilities and municipalities around the country have used to incentivise the adoption of LID" (pp. 4-5). Chapter 6 (Walsh, Milon and Scrogin) "concludes that housing values increase significantly in the face of improved water quality due to better control of stormwater runoff" (pp. 5). Chapter 7 (Thurston) "estimates some of the benefits of stormwater management applications, and especially how these are affected by property values".