



Joint Defra/EA FCERM R&D programme - project FD2662

Flood and coastal erosion risk management and the local economy

TOOLKIT: full report

March 2014

Preface by Defra

- This “toolkit” is the key output of research project FD 2662 “Flood and coastal erosion risk management and the wider economy” commissioned from Frontier Economics as part of the Joint Defra and Environment Agency R&D programme.
- We commissioned this work as a step towards making the existing economic appraisal system for FCERM projects more useful for local partners such as Local Authorities, Internal Drainage Boards, Local Enterprise Partnerships, business groups and other beneficiaries of flood and coastal management and land drainage. The rise of partnership working and funding in FCERM and land drainage means that the emphasis of appraisal is shifting from a centralised option-selection tool for Risk Management Authorities spending national Grant in Aid, to a more holistic assessment of impacts on a range of partners, including those assessing the local case for contributing their own funding to supplement Grant in Aid.
- As such, this “toolkit” focuses on methods to explore the local economic benefits of FCERM and land drainage, moving beyond the usual estimation of “avoided damages” to consider wider impacts on local income or Gross Value Added, which are potentially of at least equal interest to local stakeholders. We hope the “toolkit” and forthcoming case study and other materials (to follow soon) are useful within the context of local debates on funding, but we recognise this research constitutes a first step. We would be very interested to receive feedback (to the email address below) on how the approach is working and how it might be improved.
- The toolkit is entirely voluntary and is not meant to displace any existing appraisal methods which partners may already be using to explore the local benefits of FCERM. For example, established methods borrowed from mainstream regeneration and economic development practice, particularly for assessing the benefits of enabled inward investment. Again, comments on how the methods in this toolkit compare with those approaches and whether there are useful developments we could make, would be welcome.
- The methods in this toolkit are not suitable for estimating national-level GVA or economic growth impacts and as such should be used for local assessment only, rather than populating national-level cost-benefit analysis used for FCERM Grant in Aid allocation. Displacement of GVA impacts between local areas is likely to be a key issue at the national level. Whilst Frontier have conducted a preliminary assessment of situations in which national-level impacts may arise in their “national note” published as part of the research outputs, further work will be required to consider whether this has workable implications for economic appraisal.

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About this “toolkit”

Introduction

This document provides a “toolkit” for practitioners of approaches to assess the costs and benefits to a **local** economy of flood and coastal erosion risk management (FCERM) and land drainage.

These impacts are not currently assessed within the Defra/Environment Agency FCERM appraisal process, in which impacts are considered from the national perspective. This national perspective informs Flood Defence Grant in Aid (FDGiA) funding from the Exchequer, but ignores locally important benefits for which other funding streams may be available.

This toolkit therefore complements, rather than replaces, standard FCERM appraisal approaches. It is aimed at Local Authority practitioners and other local economic interests such as Local Enterprise Partnerships who may be considering non-FDGiA funding contributions for FCERM under the Partnership Funding system. The toolkit is intended to inform local debate about funding FCERM to provide local benefit.

The purpose of the toolkit is to provide an understanding of:

- The ways in which FCERM leads to potential benefits for businesses and their employees, both in terms of first-round impacts (avoided damage to commercial property, agricultural output, inventories etc); and, dynamic impacts which occur in the economy over time as businesses respond to the lower level of flood, or coastal erosion, risk, or drainage regime.
- Methods to estimate the scale of potential impacts on the

local economy

- How to interpret results for the purposes of informing funding decisions.

In this report references to **flooding** also implicitly include adverse water levels as influenced by **land drainage**, to which similar thinking can be applied. However it is fully recognised that **coastal erosion** raises inherently different implications for businesses than flood risk or suboptimal drainage. Therefore, dedicated advice on the assessment of the GVA impacts of FCERM where it addresses coastal erosion is provided in Annex 6 of the main toolkit report.

This toolkit is structured in two parts:

- **Part 1: non-technical summary.** This sets out in non-technical terms who the toolkit is for; how the assessments can help local communities and those co-ordinating Partnership Funding (which comprises FDGiA from central government alongside contributions from local partners); what we mean by the ‘local economy’; the ways in which FCERM benefits the local economy; how this toolkit relates to standard FCERM appraisal guidance; and, how to get started.
- **Part 2: technical material.** This section is split into two sub-sections.
 - (i) The framework – this presents the underlying rationale for the approaches suggested. In particular, the channels through which FCERM impacts on the local economy.
 - (ii) A step-by-step approach for how to assess the impacts on the local economy, with worked examples.

NON-TECHNICAL SUMMARY

Non-technical summary: the toolkit and how it can help local partners

Who is this toolkit for?

This toolkit is intended for local bodies (principally Local Authorities) who are considering, or would like to encourage others to consider, contributing partnership or other funding for FCERM. This is in recognition of the local economic benefits of FCERM and to complement funding which may be available through Flood Defence Grant in Aid.

What do we mean by the local economy?

Businesses and their employees located in the geographical area that is of interest to the local practitioner. For example, this could be the Local Authority boundary or a much smaller scale, such as the area protected by the particular FCERM intervention under consideration (which is recommended). The unit of impact considered here is a monetary measure of the value added by businesses to the local economy, called Gross Value Added (GVA).¹

How can this toolkit help local authorities or project leads?

This toolkit, and associated evidence it informs, are likely to be useful for local partners in several ways. These include:

- **Supporting the case for action:** by assessing the costs and benefits to a local economy of managing flood or coastal erosion risk, it could help local authorities make informed decisions about the relative returns from investing in different policy areas.
- **Engagement tool:** evidence on the costs and benefits of action to manage flood or coastal erosion risk can be a valuable tool to engage local partners – including local businesses, Local Enterprise Partnerships, community groups etc – on the need to invest in FCERM options.

This is particularly true if the detailed approach proposed in this toolkit is used.

- **Pragmatic and proportionate effort involved:** recognising the likely constraints on resources, this toolkit offers practitioners with two approaches for undertaking the analysis. The first is ‘light touch’ which estimates the likely orders of magnitude of impacts using publically available reports and data, along with suggested assumptions (based on evidence). **Results can therefore be generated relatively swiftly.** The second is the more ‘detailed’ approach which involves investing in primary research to understand business perceptions and likely responses to FCERM. Practitioners therefore have the choice to use the approach which best meets their needs.
- **The process of undertaking the detailed approach could be a valuable mechanism to generate local business buy-in to the need for action and the proposed intervention.** The detailed approach involves extensive stakeholder engagement – such communication can play an important role in building required relationships for effective partnership working.
- **Understanding how impacts on the local economy can occur and their potential scale provides the opportunity to design interventions to maximise local economic gains.** Involving businesses or other local partners early enough in the process i.e. scheme design stage or before, can help generate buy-in to the intervention, maximise economic gains and encourage local contributions.

¹ GVA is an established measure of local economic activity. The focus in this toolkit is business responses and how they can impact GVA – it is recognised that a holistic assessment of the impacts on the local economy would consider the wider community (including public infrastructure). Evidence is however currently constrained on such effects so this will be kept under review.

Non-technical summary – understanding the impacts on the local economy

What are the potential impacts on the local economy?

The size of an economy is typically measured by the value created by businesses and their employees. This depends not only on the total amount of goods and services produced, but also how efficiently they are produced. Business efficiency can take three forms:

- **Productive efficiency:** producing goods and services to a high quality and at least cost;
- **Allocative efficiency:** allocating resources to the most productive uses; and,
- **Dynamic efficiency:** encouraging and embracing innovation to improve what is offered over time and how, along with offering new products or services.

FCERM can alleviate the adverse impacts of flood risk on each of these, and therefore deliver benefits for the economy.

Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG) already estimates the scale of **‘first-round impacts’** on the local economy. These assume no change in the composition of businesses or their behaviour over time and include reductions in:

- Expected damage to commercial properties (premises, inventories, machinery etc.);
- Damage to public infrastructure (utilities, for example);
- Business travel disruption;
- Loss of agricultural output and yield.

These sit alongside other impacts assessed in FCERM-AG.

Measurement

FCERM-AG estimates impacts for different flood return periods based on evidence from past flood events. First round impacts for this toolkit are entirely based on the sum of relevant components of the FCERM-AG project appraisals.

Building on FCERM-AG, additional impacts on the local economy may, however, arise. This is because changes in flood risk could alter business decisions and behaviour over time. We refer to these as **‘dynamic impacts’**.

Such business decisions are assumed to be driven by two key factors: adaptive capacity and location dependence:

- **Adaptive capacity:** The degree to which a business is able to prepare, respond and recover appropriately given its size, resources (financial and knowledge, experience or information), and nature of activity.
- **Location dependence:** The degree to which a business is likely to consider moving to another area with lower flood risk. This would be influenced by its dependence on factors in the local area (or ‘location dependence’).

On the basis of a business’s adaptive capacity and location dependence, a business may decide to stay in its current location and do nothing (stay + do nothing); stay where it is but invest in adaptation (stay + adapt); move away from the flood risk to another area (move) or cease trading (shutdown).

Dynamic impacts in this toolkit assess the outcomes of business behaviour change when FCERM is implemented, compared to the case in which it is not.

Non-technical summary – understanding impacts on workers and businesses

‘Dynamic impacts’ of FCERM are assessed in terms of:

- **Business continuity and sector composition:** FCERM lessens the extent to which businesses are disrupted by flooding. In addition, it could also provide the incentive for a business to stay in its current location and carry on trading whereas it otherwise may have moved away, or even shut down, without the FCERM.

Measurement

These impacts can be assessed by considering the value of economic activity of businesses. This uses data on the business sector, number of employees and region, along with annual earnings data. This is used to estimate the value of avoided disruption and the value of retained businesses.

- **Unlocked investment:** it is possible that FCERM can lower flood risk to the extent that planning approval for new site developments is granted, whereas without FCERM it would not have been. Those developments may also be more viable as a lower level of investment is needed to meet property-level standards of flood protection. Foreign Direct Investment may also be attracted to the areas that would otherwise not have been viable because of the flood risk.

Measurement

Site development can be valued in terms of the economic activity i.e. earnings generated (assuming less or even none would have been there otherwise).

- **Spillover impacts:** These include:

- Agglomeration:** clusters of businesses can be more productive because of the ability to share ideas, knowledge, skills etc across businesses. Where FCERM facilitates businesses to remain in clusters, productivity gains are likely (relatively to what otherwise would have happened without FCERM).
- Infrastructure interdependencies:** businesses rely on infrastructure to enhance their efficiency. FCERM which better protects that infrastructure benefits businesses.
- Costs of insurance:** FCERM could lower insurance premia which means more businesses can afford to purchase insurance. This could in turn provide the business with greater access to finance (flooding insurance is often a pre-condition of loans).
- Incentives to invest in the growth of the business:** lowering the risk of flooding could enhance business confidence and lower operational uncertainty. This could lead to greater investment.
- Land values:** land values may rise in areas better protected by flooding (care is needed to avoid double counting when assessing this impact).

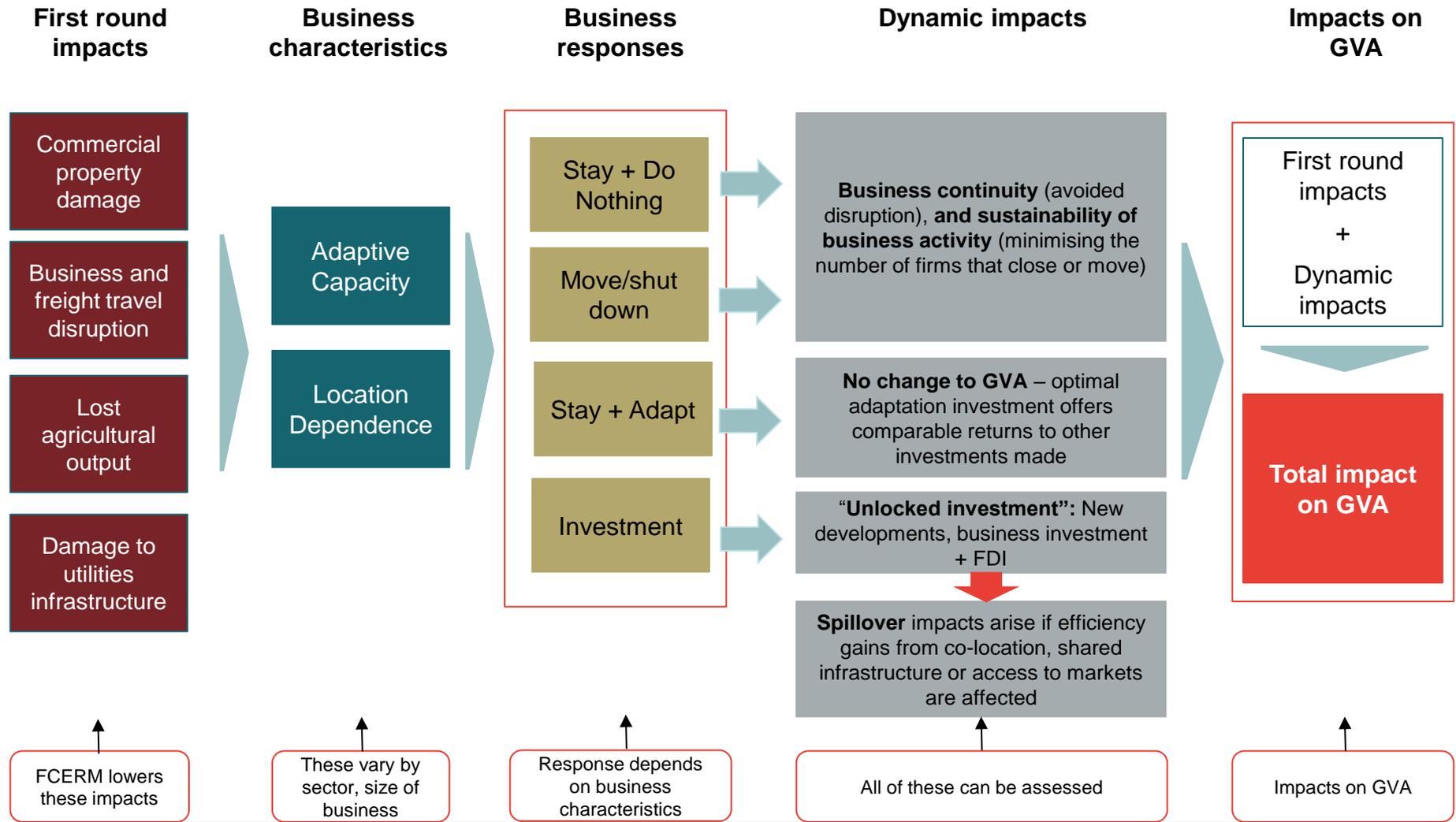
Measurement

These impacts are very location-specific and can be considered quantitatively and qualitatively (with stakeholder evidence)

The Figure on page 10 shows how impacts of FCERM on the local economy are likely to occur.

How FCERM can impact on local economic activity: the 'transmission mechanism'

The 'transmission mechanism' shows how lowering the risk of flooding can feed through into impacts on the local economy. The benefits of FCERM are assessed by comparing the case with the intervention (the 'do something') with the case without the intervention (the 'do nothing').



Non-technical summary – how do I use the toolkit?

What does this toolkit add to the existing FCERM appraisal guidance?

The Environment Agency currently has detailed guidance for assessing the benefits and costs of FCERM interventions. That guidance develops the evidence to inform decisions about where and how much resource is worthwhile investing in FCERM activities.

The advice in this document does not replace any of the FCERM appraisal guidance. It adds to it. It provides a richer understanding of the impacts of flood risk on the local economy that can arise over time.

This toolkit is the first of its kind. It offers new approaches to assessing a different range of benefits and costs of FCERM to the local economy. These approaches are expected to evolve as information and experience in these assessments build over time. This toolkit should therefore be developed over time as the evidence base on businesses and their responses to flood risk increases.

Some of the information needed to implement the approaches suggested in this toolkit will be generated as part of the standard FCERM appraisal. Where additional data or information is needed, this is highlighted in green boxes such as the following.

Data needed

Boxes like this offer suggestions for appropriate sources of published data

How to get started: some basics about this toolkit

This toolkit is intended to be user-friendly, yet rigorous and robust. Some important points to note when using this toolkit are now discussed.

(i) Proportionality

As with all appraisals, it is important to make the assessment proportionate. To help with this, alternative approaches are suggested to estimate the size and nature of particular impacts. These are:

- **A detailed approach:** this sets out how primary data collection could be undertaken to estimate impacts specific to the local area under consideration. This may be appropriate for larger-scale schemes for which more in-depth analysis would be justified; and,
- **A lighter touch approach:** this recognises that primary data collection is resource-intensive and may not be justified for some smaller-scale FCERM appraisals. Where this is the case, a lighter touch approach may be more appropriate. Credible secondary data sources are therefore suggested, along with more simple approaches to undertaking the assessment.

Non-technical summary – how do I use the toolkit?

(ii) User tips

Throughout this document, you will therefore see suggested user tips.

User Tip

Boxes like this provide helpful suggestions to save you time or to help you with a particular calculation or its interpretation.

(iii) Unit of measurement

Appraisals should ideally account for all costs and benefits of an intervention. The unit of measurement is money where possible, though this is often complemented with qualitative assessments. These monetary measures typically reflect the value (based on evidence) that society is willing to pay to see a particular outcome achieved (whether an increase in something seen as ‘good’, such as a new product, or a reduction in something seen as ‘adverse’, such as flood damage to property). Economists often refer to the aspects society values as components of society’s ‘welfare’.

As noted earlier, analysis in this toolkit uses an alternative monetary measure to capture impacts on the local economy. The unit is **Gross Value Added (or GVA)**. It measures the value added to the economy of each additional hour worked by a worker (measured by the projected earnings for that hour), or the value-added by a business when it puts together different inputs to create a product or service that is worth more than the inputs used (i.e. the profit).

This toolkit is focused on impacts on the local economy and

it uses an **input** based measure (earnings per employee), rather than an output metric. This is because there is good local data on earnings and GVA.

(iv) Focusing only on the benefits or costs generated by the particular intervention

This toolkit uses a standard approach for identifying the impacts of an FCERM intervention. The benefits and costs of the intervention are assessed by outlining what is expected to be achieved with the intervention in place, and comparing this with a credible (stakeholder-tested) view of what would have been likely to happen without the intervention (called ‘the counterfactual’). The difference between the two cases provides an estimate of the impact only of the intervention. This is not always easy, given uncertainties. Therefore, sensitivity tests using different assumptions, or scenarios reflecting a range of flood return periods, are recommended.

(iv) Appropriate interpretation of results

It is important to bear in mind that there is always a level of uncertainty about the impacts of flooding on businesses. This is particularly true when exploring the potential impacts on business decisions and responses over time. Results must therefore be read in that context, and all key results should be subject to ‘stress tests’ using alternative assumptions, and results presented as possible ranges.

We hope this provides you with a basic understanding of this document. We now present the framework and technical step-by-step advice.

TECHNICAL METHODS

1. Introduction to the technical section

What you can expect from this toolkit

This toolkit is intended to add to the current Environment Agency flood and coastal erosion risk management appraisal guidance (FCERM-AG), not to replace any part. It is consistent with the FCERM-AG but focuses on additional impacts of flood risk on the **local** economy. It relies on much of the same underlying data as the FCERM-AG.

This toolkit is the first of its kind. It should therefore be kept under review and updated over time as new data and information come to light. It will provide you with:

- i. The framework for considering the channels through which impacts on the local economy occur.
- ii. Step-by-step advice on how to assess the range of relevant impacts, with worked examples. It also suggests a format for presenting results in the form of a 'GVA summary table'.

A few pointers before you start

It is essential that uncertainty is recognised within all calculations and approaches used. The ways in which impacts on the economy are realised over time are uncertain so to account for this, the analysis must:

- Make use of scenario-based analysis reflecting various probabilities of flooding associated with the return periods consistent with those considered in the standard FCERM appraisal. These inform the estimate of 'expected' annual cost or benefit. The toolkit tells you how.
- Present results using ranges where at all possible to

reflect the extent to which results differ under alternative assumptions. The toolkit offers suggestions to generate ranges.

- Be transparent about key assumptions and the evidence used. In particular, be sure to highlight limitations in the analysis so that your results can be interpreted appropriately. The toolkit explains how this can be done.

It is also important to consider proportionality. This is referred to on page 11.

Each section begins with a brief overview of the headline points about that section. For example, it provides clear definitions of key terms so that you know what is being referred to and why. It also makes clear the key points underpinning the calculations that you need to know.

The next section sets out the framework for the analysis. It articulates the channels through which FCERM can feed through into impacts on the local economy. The framework consists of:

- The channels through which impacts on the local economy are likely to occur – known as the 'transmission mechanism'
- The potential business responses to flood risk and FCERM.
- Definitions of the two main types of impacts to be assessed: those on current businesses and assets ('first-round' impacts) and those that are likely over time as businesses make different decisions ('dynamic' impacts).

(i) The framework

2. The Framework

Headline points

- This toolkit focuses on the costs and benefits of FCERM for the local economy i.e. businesses and their employees.
- It builds on, and complements, existing FCERM appraisal guidance by looking in more detail at local economic impacts

This toolkit and the standard Environment Agency FCERM appraisal guidance

The Environment Agency currently has detailed guidance for appraising the economic, environmental and social impacts of FCERM interventions. Some economic impacts are assessed within that framework such as the expected annual damage to commercial properties or loss to agricultural production. Those assessments are ‘first-round’ in that they occur directly as a result of the flood itself and affect only those businesses, infrastructure and communities in that area at that time.

This toolkit is voluntary but adds to standard FCERM appraisal. It expands current methods by accounting for the ‘dynamic’ impacts on local economic activity i.e. explicitly considering businesses’ likely responses to the FCERM intervention. These are explained in detail in the next section.

As with FCERM-AG, the assessment compares outcomes with the intervention in place with the “do nothing” or “no active intervention” (also referred to as the ‘counterfactual’ i.e. what would have happened without the intervention).

Page 17 outlines the overlaps between the current FCERM

welfare appraisal guidance and the new GVA approach.

Before presenting the main material, some initial assumptions are useful to outline first.

Unit of measurement

As explained on page 12, this toolkit measures local economic impacts in terms of Gross Value Added (GVA). It does this by focusing on a measure of **inputs** (pre-tax earnings*) rather than an output measure (value of goods sold). To consider both would be double counting.

Time period for the assessment

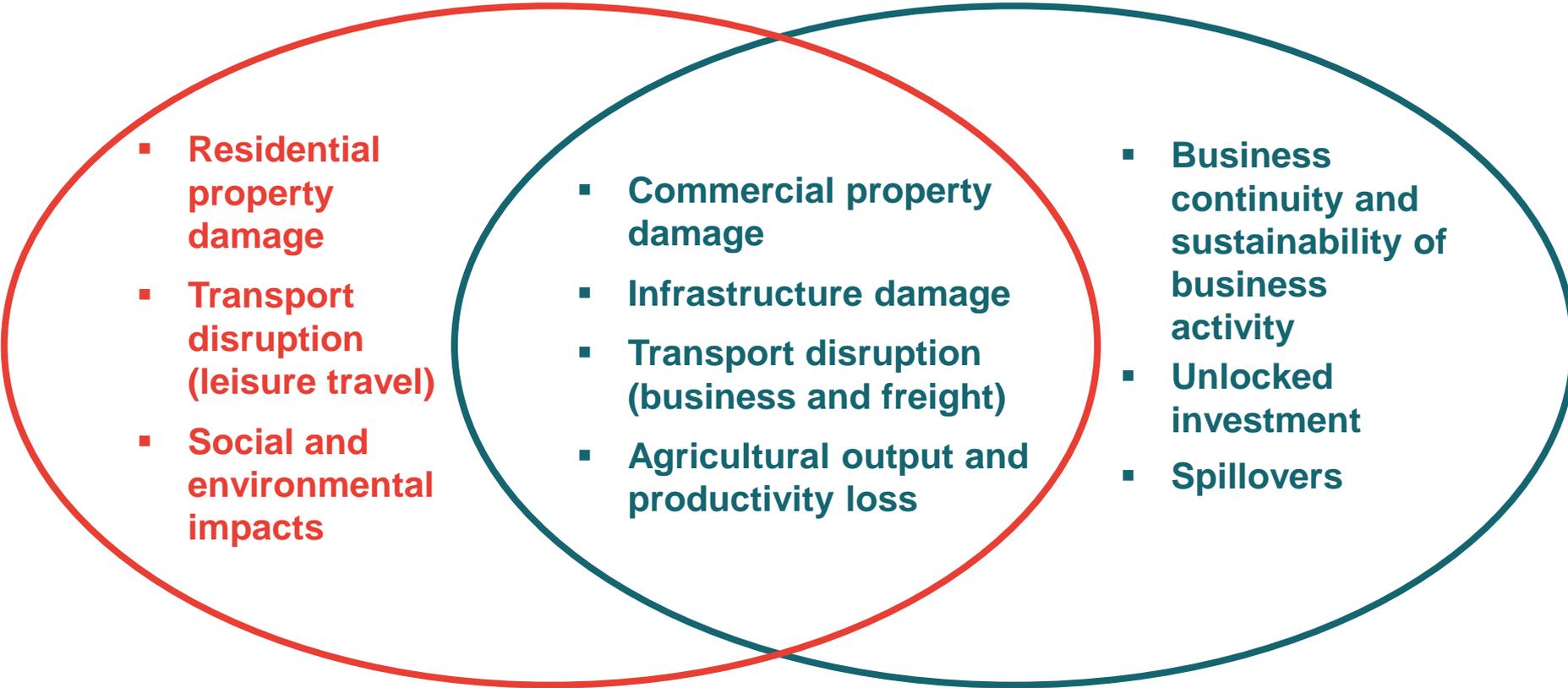
Although the standard FCERM appraisal can often consider periods up to 100 years or even beyond (reflecting the lifetime of the FCERM asset, where applicable), this toolkit suggests a much shorter time-period for considering GVA impacts: **10-years**. This is because the assessment focuses only on the impacts of the FCERM intervention, not other factors that can influence behaviour of businesses. Therefore, 10 years is considered adequate for businesses to respond to the intervention. If impacts attributable to the intervention are likely to occur beyond that timeframe, these should be acknowledged within the assessment.

17 * Note: The analysis would ideally consider post-tax data as this would be a more accurate measure of GVA of worker output to a local economy given that tax is a transfer payment to national government. However, pre-tax earnings are a recognised metric for considering GVA impacts.

Overlap of current FCERM-AG economic impacts and additional impacts on the local economy identified in this toolkit

Current FCERM-AG

GVA impacts



2.1 The Transmission Mechanism

Headline points

- The transmission mechanism articulates the channels through which FCERM affects business decisions and in turn results in impacts on the local economy.

What is a 'transmission mechanism'?

A transmission mechanism illustrates the channels through which changes in flood risk affect the local economy. The FCERM transmission mechanism is shown on page 19.

What impacts on the local economy are considered?

The two categories of impacts reflected in the transmission mechanism are:

(i) First-round impacts

First-round impacts reflect the costs and benefits of FCERM to existing businesses, assuming no change in the nature of business activity, types or numbers over time. They are assessed within standard FCERM-AG as reductions in:

- Expected damage to commercial properties (premises, inventories, machinery etc.);
- Damage to public infrastructure (utilities, for example);
- Business travel disruption;
- Loss of agricultural output and yield

First-round impacts can affect the efficiency of a business in terms of:

- Productive efficiency: the ability of a business to produce goods and services to a high quality and at least cost.
- Allocative efficiency: the ability of a business to allocate

resources to where they are most productive

- Dynamic efficiency (efficiency over time): embracing innovation to improve what is offered over time and how, along with offering new products or services.

These first-round impacts would be likely to trigger dynamic impacts.

(ii) Dynamic impacts

Dynamic impacts reflect the outcomes for a local economy over time as businesses respond to changes in flood risk. FCERM would be likely to:

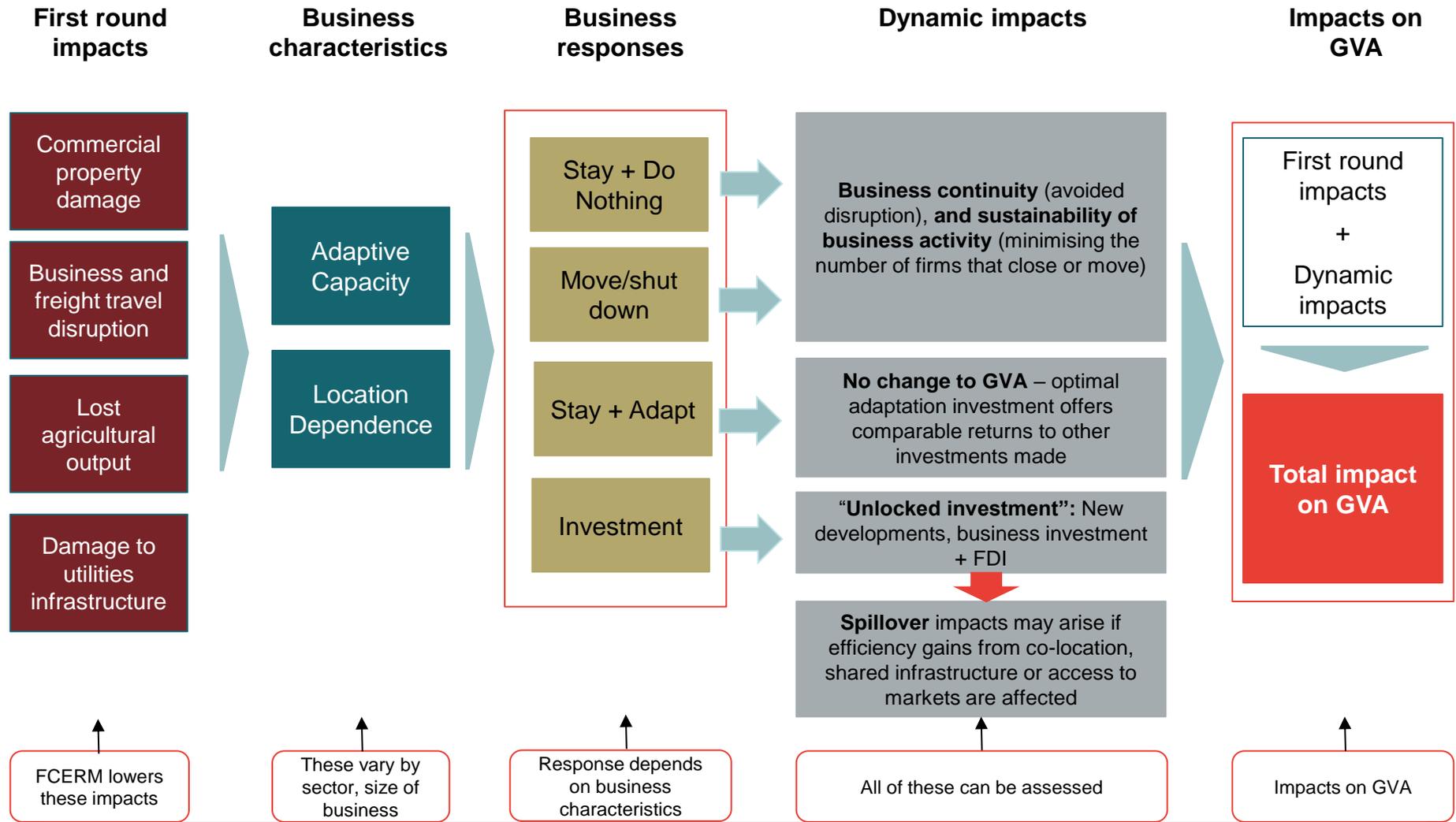
- Support business continuity and sustainability of businesses in an area;
- 'Unlock' investments that might otherwise have been constrained or unattractive given the flood risk; and,
- Lead to 'spillover' impacts which reflect interdependencies or other intangible impacts on economic activity.

Overall impact

The overall impact on the local economy is the sum of the first-round impacts and the dynamic impacts. This toolkit explains these impacts, and how to assess them in further detail.

How FCERM can impact on local economic activity: the 'transmission mechanism'

The 'transmission mechanism' shows how lowering the risk of flooding can feed through into impacts on the local economy. The benefits of FCERM are assessed by comparing the case with the intervention (the 'do something') with the case without the intervention (the 'do nothing').



2.2 First-round impacts

Headline points

- First-round impacts reflect the costs and benefits of FCERM for current businesses and their employees assuming no change in the nature of business activity over time.
- These impacts are assessed (as part of a wider set of impacts) in the current FCERM appraisal guidance, and shape how a business responds to the risk of flooding.

What impacts are included as 'first round' impacts?

First-round impacts reflect the costs and benefits of FCERM for current business and their employees assuming no change in the nature of business activity, types or numbers over time. The current FCERM-AG captures most of these under the 'economic impacts' category.

Economic impacts are outlined in the current FCERM-AG. Those relevant to methods in this toolkit are:

- **Avoided commercial property damages:** including premises, inventories, machinery etc. (disruptions to business activity are not accounted for in FCERM-AG because activity is assumed to be displaced to another area).
- **Infrastructure:** avoided damages to infrastructure including utilities (such as energy, water, sewage, and communications).
- **Transport infrastructure:** avoided impacts on airports, ports, road and rail services and disruption to business and freight travel.
- **Agriculture and relevant ecosystem services:** avoided impacts on agricultural land, forestry (timber).

How are they assessed?

The value of economic impacts is reported in the standard FCERM appraisal as expected annual averages and present values over a 100-year lifetime. These figures capture the difference between the "do nothing" scenario (without FCERM, often referred to as the 'counterfactual') and the "do something" scenario (with the FCERM). The expected annual impacts should be used as part of the methods in this toolkit.

Which estimates are needed from the FCERM appraisal?

Two formats of the results are needed. First, the expected annual average damage cost to commercial property, infrastructure, agricultural output etc. This is equivalent to the annual GVA impact. Second, the GVA assessment uses a 10-year appraisal period (see page 16), so future annual impacts should be discounted and summed to provide a 10-year present value using a discount rate of 3.5% (as in the *Green Book* Section 5.49).

User tips

Use information on relevant economic impacts that are assessed as part of the current FCERM-AG. E.g. avoided damage to commercial properties, agricultural production, business/freight travel and infrastructure.

2.2 Dynamic impacts

Headline points

- Dynamic impacts of FCERM on the local economy are those that arise from businesses' responses to changes in flood risk over time. They are measured quantitatively and qualitatively.
- They are in addition to the first-round impacts assessed in the FCERM appraisal process

What are dynamic impacts?

Dynamic impacts reflect the outcomes for a local economy over time as businesses respond to changes in flood risk (outlined in Section 3). They are generally triggered by the changes in first-round impact costs and can be assessed in three categories.

1) Business continuity and sustainable business activity

FCERM lowers flood risk and therefore lowers the scale of expected disruption associated with flooding events. This would increase GVA relative to the case without FCERM. Also, the composition of the local economic activity over time could be different with FCERM if a number of businesses who would otherwise have moved out of the local economy or shut down because of the flood risk (movement for other reasons should not be counted) no longer do so. These impacts can be measured quantitatively (see section 4.7).

2) Unlocked investment

FCERM effectively reduces the risk of flooding in the potential development sites it protects. This can help to encourage new investment in two main ways:

- **Potential developments are more likely to gain planning permission.** In the absence of the scheme, the level of flood risk in the area could negatively impact on any application for planning permission.

- **Helps to make new developments more viable.** As part of the planning process, developers have to build a minimum Standard of Protection into all new developments in areas at risk of flooding. By reducing the level of flood risk, less investment is required to provide the required level of protection. It can also have the effect of increasing the commercial value of new developments, which can help to increase revenues from the sites when these are sold or rented out.

New developments could be considered as an economic stimulus to the local economy. They can generate local GVA through *two* main channels:

- **Initial investment in development.** The development may use local materials and draw on local workers, creating temporary employment in the local area.
- **On-going employment and economic activity on the commercial developments.** Businesses located in commercial developments increase the number of working hours in the local area.

In our analysis, we quantify the second of these impacts explicitly. The first is considered on the next page.

2.2 Dynamic impacts

Assessing the benefits of new developments

GVA impacts from initial FCERM investments can be generated by residential and commercial developments, as well as through the construction of the flood defences themselves. However, the likely addition to *local* GVA is unclear. This is because contractors and raw materials from outside the area may be used, and the temporary increase in employment may displace economic activity elsewhere in the local area. Given the limited evidence that is available, it is not possible to determine this accurately.

As with commercial developments, residential developments may also result in on-going impacts on GVA. Specifically, individuals who move into these developments will spend money, effectively increasing demand in the local area. The impact of this demand increase would be measured through either increased working hours in the local area to service that demand, or an increase in productivity of existing workers. However again, there is not sufficient data available to quantify this impact accurately.

Given the current limitations on the evidence base, this toolkit recommends assessing the magnitude of contribution to the local economy of the new economic activity on the commercial developments i.e. the value-added by the new jobs. Other impacts can be considered qualitatively. This assumes that those jobs are new to the local economy and not displaced from elsewhere locally.

More details on how to assess the GVA impact of new developments is provided in section 4.7.

3) Spillovers

Investment in FCERM can lead to spillover impacts, which may be assessed qualitatively. These refer to:

- **Agglomeration impacts:** FCERM could incentivise businesses to remain in their current preferred location and benefit from the productivity gains associated with proximity to other similar businesses (sharing ideas, knowledge, supply chains etc).
- **Interdependencies:** FCERM can protect the public infrastructure on which businesses rely. This helps avoid disruptions associated with power outages, transport (affecting workers, customers or deliveries), communications or water supply.
- **A change in flood risk could affect incentives to invest in the business and productivity.** Lowering flood or coastal erosion risk through FCERM could increase business confidence to invest for the future.
- **Cost of insurance and credit:** a reduction in flood risk could affect the cost of insurance. This can in turn affect access to credit because flooding insurance (in certain locations) is often required by lenders.
- **Land values** may increase over the longer-term because of the reduction in flood risk (relative to what would be expected without the FCERM). Care must be taken not to double count because land values could just be an alternative way to value impacts that have already been quantified.

3. Business responses to a change in flood risk

Headline points

- Understanding likely businesses responses is important for estimating the potential dynamic impacts on the local economy.
- This requires us to understand the nature of businesses, constraints they face and how they may respond to changes in flood risk

Importance of business decisions in assessing dynamic impacts

Understanding likely businesses responses is important for estimating the potential dynamic impacts on the local economy.¹ Different responses will result in different economic impacts.

In some cases, some businesses may not even realise they are at risk of flooding. Of those that are aware, they need to decide how best to manage the risk. Potential options include:

- **Staying and doing nothing** - A business may choose to remain in its current location and not adapt, and face the expected damage that would be caused by flooding.
- **Staying and adapting** (including building capacity to take action in the future). Adaptation actions could include developing business continuity plans, building the resilience of the supply chain, introducing changes to corporate/business strategy, and implementing physical protection to business assets (Frontier et al, 2012). More details on possible adaptation actions are provided in **Annex 1**.
- **Moving** to a different area with a lower risk of flooding. This could also involve temporarily relocating the production/provision of goods or services to a different location in the event of a flood.

- **Shutting down** - a business may decide that the risk of flooding is so great that it chooses, or is forced, to close completely, or to close one of its sites of operation.

The business response is likely to be driven by the particular characteristics of the business.

Likely drivers of business responses to flood risk

Understanding how businesses could potentially respond requires us to consider the nature of those businesses and the various constraints they may face. At a basic level, we assume that business responses to flood risk are primarily driven by **two factors**:

- Adaptive capacity (AC):** The ability of a system/organisation to design or implement effective adaptation strategies to adjust to information about potential climate change (including climate variability and extremes), moderate potential damages, and take advantage of opportunities, or cope with the consequences (IPCC, 2007); and,
- Location dependence (LD):** operational factors (e.g. premises, assets and costs of moving); reliance on local markets (customer, labour or supplier markets); assets and infrastructure.

3.1 Understanding adaptive capacity

Headline points

- Adaptive capacity is a pre-condition for businesses to be able to adapt appropriately to flood risk
- For the purposes of the analysis, suggested categories of a business's adaptive capacity are (in relative terms) Low, Medium or High (in practice, there is a continuum, and it will change over time as businesses learn)

Building adaptive capacity

The presence of adaptive capacity in a business is a **necessary condition** for the design and implementation of effective adaptation strategies, so as to reduce the likelihood and the magnitude of harmful outcomes resulting from climate change (Brooks and Adger, 2005).

Actions are required to build and strengthen adaptive capacity in order to respond effectively to flood risk. Some actions will be generic, e.g. education, training, strengthening coordination, while others are specific to the climate change risk e.g. increasing access to flood resistant building design advisers or raising awareness of a flood risk.

Adaptive capacity would be expected to change over time, especially as a result of measures introduced to build it, so it needs to be monitored and assessments updated over time (Frontier et al., 2012).

Where is adaptive capacity likely to be higher?

Adaptive capacity is likely to be higher when there are:

- **Well understood risks** and organisations with in-house capability to respond
- **Flexible planning and processes embedded into**

decision-making – e.g. manufacturing activity can be (temporarily) shifted to alternative sites; or, supply chains can be diversified (generally in larger, multinational companies)

- **Partnerships and collaboration** – such as local authorities raising small businesses' awareness of flooding
- **Operational planning that already accounts for similar risks to flood risk** – e.g. process risk management in the chemicals sector
- **Access to risk spreading mechanisms** – e.g. insurance
- **Agents of change or champions** within the organisation
- **Strong leadership and culture** – e.g. corporations in the automotive sector are able to influence certain suppliers
- **Support networks** – particularly important for smaller organisations, and where long-term planning is limited

(Source: Frontier et al, 2012).

In the presence of adaptive capacity, the appropriate business response can be chosen and implemented. The selected actions should be reviewed and updated over time as the business learns more about the nature of risk and the most appropriate response (adaptive management).

3.1 Understanding adaptive capacity

Where might adaptive capacity be lower?

Adaptive capacity is likely to be lower where there is

- **Lack of awareness** of climate change and its relevance and lack of willingness to accept the nature of a risk, e.g., some vulnerable organisations do not wish to accept that they may be ‘vulnerable’.
- **Lack of financial support and skills to adapt** – e.g. small/medium-sized organisations may struggle to invest resources.
- **Lack of specialised skills and training** to understand and respond to climate change impacts, e.g. there may be difficulties in accessing the required advice to bolster resilience to flooding.
- **Poorly targeted information** – information can be overwhelming e.g., generic information for businesses may not be practical and may come from a range of sources.
- **Limited ability to influence decision making** – e.g. business tenants are dependent on landlords to take action to respond to certain risks.
- **Lack of engagement with vulnerable businesses** – e.g. some isolated businesses or those in remote areas may not have access to the required information.
- **Diversity of responsibility across parties with different objectives** – e.g. where businesses are dependent on other service or infrastructure providers taking action to prepare and respond to flooding.

- **Competing demands arise from different users** – e.g. different requirements for resilience may arise for farmers, industry or other businesses.

Measuring adaptive capacity

There is no quantitative scale to assess adaptive capacity. Instead, a qualitative assessment is recommended, based on the conditions for high and low adaptive capacity. In some cases, an assessment of ‘medium’ will be appropriate. Section 4.6 suggests how adaptive capacity can be assessed. Preliminary ‘look-up’ tables are provided in Annex 3 to aid practitioners.

Expert advice should be sought if the preliminary look-up tables provided (Annex 3) are not used and bespoke assessments are to be undertaken.

3.2 Location Dependence

Headline points

- The degree of location dependence reflects the ability of a business to operate sustainably in an alternative location. It is likely to be influenced by operational factors (e.g. investment in capital assets and premises), reliance on resources (such as water) or reliance on local markets (customer, labour or supplier markets). An assessment of businesses location dependence as Low or High is recommended

The following three factors can be identified as key drivers of location dependence:

1 Operational factors

- **Investment in capital assets (such as business premises or large-scale machinery).** If a business has made significant investments in these assets, the cost of moving is likely to be large. This could prohibit a business from relocating, especially if they have limited access to borrowing.
- **Dependence on proximity to similar businesses.** Some businesses prefer to locate in areas where similar businesses are also located. This is because some firms may find it easier to innovate (and potentially reduce their costs) if this is the case, as they are better able to share ideas (and potentially assets), and learn from each other. Silicon valley and TechCity are examples of this.

2 Dependence on local resources

- **Dependence on local infrastructure.** For example, dependence on local road links (for logistics), sea ports or airports (international connectivity), online connectivity (trading and internet-based companies).
- **Dependence on local natural resources.** For example, local gas reserves (energy production companies) or water supply (chemical companies, water treatment companies).
- **Dependence on local stock of labour.** For example, biotechnology firms may wish to locate close to a biotech hub or relevant universities.
- **Dependence on 'local identity'.** For example, local brands for which businesses make products named after their place of production

3 Dependence on local markets

- **Dependence on local customer base,** or specifically, the demand/taste preferences of the local population.
- **Dependence on local suppliers** for key inputs.
- **Obligation to serve the local area.** This is true for most public sector organisations. For example, local county council buildings have to be located in a particular local area, as they are obliged to serve the local population.

3.3 Likely adaptation action

Headline points

- Although subject to uncertainty, we can use the assessment of adaptive capacity and location dependence to identify the likely business responses to a change in flood risk.

The response of a business to a change in flood risk is highly uncertain. The level of adaptive capacity and location dependence of a particular business are used here to indicate the likely responses (see the figure on the right hand side). Some guiding principles are:

- Businesses are only able to adapt if they have high or (for some) medium adaptive capacity.** We assume that businesses would adapt whether the FCERM intervention is implemented or not, It is just the level of justified adaptation that would differ across the two cases.

It is assumed that businesses do not *maladapt* i.e. adapt in a way that does not decrease their vulnerability to flooding.

Businesses are assumed to invest in adaptation up to the point where the incremental investment cost is equal to the incremental benefit (e.g. avoided damage) from that investment. FCERM, which lowers flood risk, would therefore imply that a lower level of adaptation investment by a business is justified. This frees resources for other productive uses with a comparable return on the investment.

- Businesses may move their premises or re-locate economic activity.** A business is only likely to move if it has high or medium adaptive capacity (it knows when moving is the most effective response, given its flood risk) and low location dependence (it can feasibly operate in an alternative location at a reasonable re-location cost). This is consistent with existing evidence, which suggests that a very small proportion

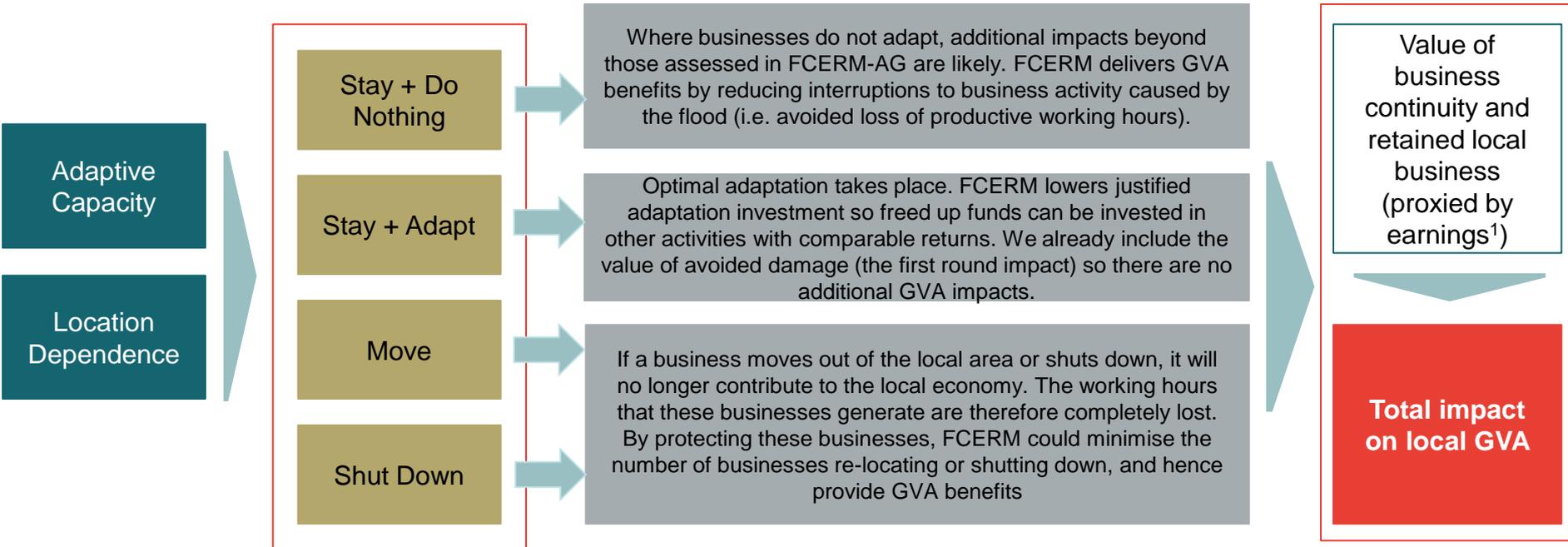
of businesses consider moving in the light of flood events (Devonomics, 2013; CSE, 2008). For large multi-sited businesses, shifting activity from one site to another may be more feasible.

- Businesses with medium and high adaptive capacity will be least likely to shut down.** If a business has the ability to protect itself and avoid closure, it is likely to do so.

		Location Dependence	
		Low	High
Adaptive Capacity	High	Stay + Adapt OR Move	Stay + Adapt
	Medium	Stay + Adapt OR Stay + Do Nothing OR Move	Stay + Adapt OR Stay + Do Nothing
	Low	Stay + Do Nothing OR Shut Down	Stay + Do Nothing OR Shut Down

3.4 How business responses impact on local GVA

The decisions that each business makes in response to a change in flood risk feeds directly into the dynamic impacts on local GVA. The diagram below shows business characteristics, business responses and the associated likely impact on GVA¹.



¹Specifically, we use annual earnings to value the annual value of lost working hours for a given employee. This is because earnings are assumed to reflect the productivity or value-added of employees.

Application of the framework

Applying the framework

The previous sections have outlined the underlying framework for the assessment of the first-round and dynamic impacts of FCERM on the local economy. The next sections provide detailed step-by-step advice for undertaking the calculations and qualitative assessments.

The ten-step approach is:

- 1 Define the area and flood risk
- 2 Characterise the intervention and standard of protection
- 3 Collate data and evidence on the local economy
- 4 Characterise economic activity in the area
- 5 Assess the first-round impacts on the economy

6 Map out likely business responses

7 Assess the dynamic effects

8 Summarise results in GVA Appraisal Summary Table

9 Highlight key observations

10 Review and evaluate

The ten steps are explained in the next section.

(ii) Step-by-step approach

4. Step by step advice on estimating the scale of impacts on the local economy

Headline points

- A 10-step approach is outlined in this section. It provides advice on how the impacts on the local economy of FCERM interventions can be assessed. The steps are fully consistent with the framework described in the previous section.
- Given the uncertainty in any flood risk assessment, the analysis should be undertaken for the flood probability scenarios (corresponding to different return periods) presented in the standard FCERM appraisal guidance.

Introduction to the step-by-step material

The following sections provide detailed step-by-step advice on how to assess the impacts on the local economy of FCERM interventions.

The steps presented have been tested through case study analysis (available shortly). However, it is important that the steps, data and evidence used are reviewed and updated over time by Defra and the Environment Agency as greater knowledge is generated about the first-round and dynamic impacts of FCERM on local economies.

As noted earlier, the steps are consistent with current FCERM appraisal guidance. In particular:

- The 'local' area is defined by the practitioner. It could be the Local Authority boundary for example, or the area defined in the FCERM standard appraisal (this may be the flood plain, or relevant flood risk zones).
- The businesses considered in the local economy are those identified as located within the defined area. If using the area as defined in the FCERM appraisal, then the first-round impacts can be taken directly from those appraisal results.
- Costs of the FCERM intervention are those assessed in

the FCERM standard appraisal

- To undertake this assessment of impacts on the local economy, it is recommended that stakeholders are identified and engaged. Undertaking this engagement alongside wider stakeholder engagement for the standard FCERM appraisal will help to minimise burdens on respondents.

The methods used to assess changes in flood risk can also be used, with some modification, to consider alternative approaches to **land drainage**, including cessation of drainage operations and different water level regimes. The key differences will be in the area of probability assessment, which may depend on probabilities of failure of pumping equipment etc, and/or in the need to assess impact on business productivity of different permanent water level regimes. FCERM-AG has more detail on these issues.

It is fully recognised that **coastal erosion** raises fundamentally different implications for businesses than flood risk or drainage regime. Therefore, **dedicated material on the assessment of the GVA impacts of FCERM where it addresses coastal erosion is provided in Annex 6.**

4.1 Step 1: Define the area and flood risk

Headline points

- The relevant area for the GVA assessment (i.e. the 'local economy') is the area defined by the practitioner. This is recommended to be the area identified for the purposes of the standard FCERM appraisal.
- The level of flood risk (and associated probability scenarios) are to be taken from the FCERM project appraisal and should be used for the GVA assessment.

Area under consideration

The relevant area – the 'local economy' – is defined by the practitioner. It is recommended that this should be the geographical area defined in the FCERM-AG. This means that businesses and commercial properties located within that area will already be identified. This is important for the later step of characterising the local economic activity (outlined further in Section 4.4).

In some cases, practitioners may wish to consider a larger area consistent with the level of decision-making (e.g. local authority). In this case, care must be taken because local economy impacts are likely to differ over a larger area than described here because of the likely displacement over such a larger scale. Also **note that the results of the FCERM appraisal for first-round impacts in this case would no longer be directly applicable** without further analysis.

Flood Risk

Flood risk is assessed as part of the current FCERM appraisal guidance. The associated probabilities of flooding under different return periods and scenarios ('do nothing', and the 'do something') should be used as the basis for this assessment.

The nature of the flood risk, and change to that risk with the intervention, feeds into the assessment of GVA.

User tips: use the information from the standard FCERM appraisal to define:

- the flood risk area under consideration
- the businesses and commercial properties located in that area
- the flood risk and change in that risk when the intervention is implemented

4.2 Step 2: characterise the intervention and standard of protection

Headline points

- The intervention is defined by the standard FCERM appraisal
- The standard of protection delivered by the FCERM intervention is assessed as part of the standard FCERM appraisal

The intervention

The intervention is the FCERM investment proposed in the project appraisal compiled by the Risk Management Authority (generally the Environment Agency, Local Authority or Internal Drainage Board). This will be specific to the area and flood plain under consideration. It may be proportionate to only undertake the GVA assessment for the “preferred option”, though this is a decision for the user of this toolkit, and is subject to proportionality principles, as it may be useful to assess all options so that they can be compared.

Standard of Protection

The standard of protection awarded is the level of flood risk after the FCERM intervention has been put in place. The standard FCERM appraisal outlines the level of protection offered by the FCERM option.

User tips: use the information from the standard FCERM appraisal to define:

- the intervention
- the standard of protection of the FCERM intervention

Worked examples are in the box below.

Worked Example Steps 1 and 2: Redcar Project Appraisal Report, 2009

Relevant area: 2.7km stretch of coastline which fronts Redcar town centre, with the Esplanade and the Stray the main areas of focus. The flood plain is an intensively developed urban area.

Flood risk: flood risk in the Redcar flood plain area before the intervention was 1 in 10.

The intervention: The intervention includes replacement of the seawall and works at the seafront which reduce the flood risk and prevent loss of property and infrastructure due to coastal erosion.

Standard of Protection: FCERM for the Redcar Coastal Defence has been to provide a 1 in 300 standard of protection. This level of protection will be maintained for 50 years.

4.3 Step 3: collate data and evidence on the local economy

Headline points

- A lighter touch approach would draw mainly on published evidence, and analysis provided as part of this toolkit.
- Additional local evidence (through stakeholder engagement, surveys or interviews) will need to be collected if a more detailed approach is to be used.

Data needed

Data/evidence will be needed to characterise the local business environment, and to estimate the first-round and dynamic effects of the FCERM investment. This may come through published sources and/or through engagement with stakeholders, as shown in the table below. Whether a lighter touch or more detailed approach is to be taken will determine the amount of primary data to be collected. A lighter touch approach will rely on secondary and published data sources.

Data/Evidence	Purpose	Source/Details – Detailed Approach	Source/Details – Lighter Touch Approach
Number of Businesses (by business size and sector)	Used to categorise the economic activity in the protected area. Feeds into the calculation of first-round and dynamic impacts	Should be gathered through business surveys or other forms of stakeholder engagement and local research	Local Authority data (ONS Neighbourhood Statistics), Regional data (BIS Business Population Estimates)
Number of employees per business	Used to calculate the value of lost working hours when business activity is interrupted by a flood	Should be gathered through business surveys or other forms of stakeholder engagement and local research	Use assumptions based on business sizes used in ONS ranges
Average projected earnings (by region & industry)	Used as a proxy of the annual value of working hours	Published as part of the Annual Survey of Hours and Earnings (available at the ONS)	Same as Detailed Approach
Adaptive capacity and location dependence of different business types	Key input in determining the likely responses of businesses	Use 'look-up table' (see Annex 3). Use stakeholder interviews and new published evidence to refine the table	Use 'look-up table' (in Annex 3). Cross check with new published evidence if possible.
Likely business responses of different business types.	Feeds into the calculation of (direct) dynamic impacts.	Use assumptions set out in this toolkit. Use stakeholder interviews to cross-check the percentage of businesses that adapt.	Use assumptions set out in this toolkit. Cross check with new published evidence.
Evidence on 'unlocked' investment	Helps to estimate the likely additional economic activity facilitated by the FCERM	Gather information through interviews with stakeholders and local planning applications or other administrative documents	Gather administrative documents through online research where possible.

4.4 Step 4: characterise economic activity in the area

Headline points

- Businesses should be categorised based on business size and sector
- Identifying the prevalent and high-value business types will help in understanding what is driving dynamic impacts

The first step in assessing economic impacts is to characterise the set of businesses protected by the scheme. This can be done in **two stages**:

1. Identify the number of businesses protected by the scheme
2. Allocate each business to a particular business-type based on Standard Industrial Classification (SIC) codes.

Identifying the number of protected businesses

The number of commercial properties protected is already estimated as part of the existing FCERM appraisal process.

Allocating businesses to business type categories

Businesses should be categorised based on **size** and **sector** (SIC code). Considering each size-sector combination, this creates **63** distinct business types:

- **Size** – To be consistent with commonly-used metrics (e.g. ONS data), business size should be defined based on the number of employees. From this, businesses should be split based on three business size types (see table opposite).
- **Sector** – Businesses should be categorised based on the 21 one-digit SIC codes, which are available at this [link](#). This is granular enough to ensure that the heterogeneity between businesses is captured, whilst ensuring that the number of sectors that are used is still manageable.

How particular businesses are allocated to each business type will depend on the approach (detailed or 'light-touch') that is used.

Size	Number of Employees
Micro	0-9
Small/Medium	10-249
Large	250+

Detailed Approach

Under this approach, the size and sector of *each* individual business should be determined using a business survey. For this, example survey questions are suggested in **Annex 2**.

'Lighter Touch' Approach

Under this approach, the *proportion* of businesses in each business type category is estimated using more aggregated data. The proportions can then be applied to the total number of protected businesses. The proportions can be estimated using the following **two-stage approach**:

1. **Calculate the % sector split based on local authority data.** The number of businesses by sector in each local authority area is available via the [ONS Neighbourhood statistics database](#). If the protected area spans more than one local authority area, the average sectoral split across these areas should be used.
2. **Calculate the business size split within each sector using regional data.** BIS provides business population estimates by business size and SIC, for each region of the UK ([link here](#)).

User Tip:

At this stage, it is useful to identify the prevalent and high-value businesses in the local area. This will help in understanding what is driving the dynamic impacts to be calculated.

4.5 Step 5: assess the first-round impacts

Headline points

- The standard FCERM-AG assesses various economic impacts relevant to this assessment. Those to be used in the GVA assessment are: expected avoided damage to commercial property, transport and utility infrastructure, transport disruption and lost agricultural output and yield.
- The GVA assessment should include these particular impacts because they affect the local economy by requiring resources to be diverted for repair and replacement.

Identify the data in the current appraisal

The first-round impacts of FCERM are assessed under the current appraisal guidance as economic impacts. It is important to include only those that are relevant for the GVA assessment (i.e. exclude avoided damage to residential property and social infrastructure for example). See the diagram on page 10 for reference. They are listed explicitly in the “Costs, Benefits and Scoring Data” table of the Project Appraisal Report. The figure may be reported as a benefit, or as value protected or avoided.

How do we assess first-round impacts?

Under the current FCERM appraisal guidance, figures may be reported in present values across the 100-year life time of the asset using the Green Book discount rate. Under the GVA assessment, the annual expected value is required and should be derived from the FCERM appraisal.

The annual average of economic impacts

This is the annual figure of the relevant economic impacts assessed for the standard FCERM appraisal guidance (not including the impacts on residential properties for example, as above). This is likely to include avoided commercial property damages and may also include impacts on transport (only avoided travel disruption to business and freight travel is relevant), infrastructure or agricultural impacts if they are likely to be material. In some cases, these may be reported as annual expected damage avoided – where this is the case, estimating the 10 year present value is more straightforward as this is the required value.

2) The ten-year present value

To calculate the ten-year present value of the first-round impact, a discount rate of 3.5% should be used (as recommended in the Green Book). This can be applied using the “PV” formula in Excel modelling, correcting for the negative number reported

$$-PV(\text{Discount_Rate}, 10, \text{'annual average'})$$

Alternatively, the ten-year present value of the GVA impact can be calculated using the multiplier of **8.607687**, which converts annual impacts to discounted 10-year impacts.

Note: If the figure for the annual average of economic impacts is calculated retrospectively using the total 100 year value of economic impacts from a submitted PAR, the calculation must account for the declining discount rate applied under the Green Book. Please refer to The Green Book (2003), Annex 6 for the schedule of long term discount rates.

Worked Example Step 5: Sandwich Project Appraisal Report, 2011

In the Sandwich Project Appraisal Report, economic impacts outlined consisted of residential benefits and commercial/industrial benefits. For the purpose of the GVA analysis, only commercial/industrial benefits are relevant.

The Annual Average was calculated by un-discounting 100 year present value reported in the Project Appraisal Report to derive the annual average, then converting to a 10-year present value.

$$\Rightarrow \text{Annual Average of Avoided Damage Cost} = \text{£}5,855,173$$

$$\Rightarrow \text{Ten-year present value} = \text{£}5,855,173 * 8.607687 = \text{£}50,399,496 \text{ (rounded to £}50.4 \text{ million).}$$

4.6 Step 6: map out likely business responses – assessing adaptive capacity and location dependence

Headline points

- Preliminary 'look-up tables' (Annex 3) can be used to assess the adaptive capacity and location dependence of each business type.
- These tables should be validated with local stakeholders

Adaptive capacity and location dependence

The adaptive capacity (AC) and location dependence (LD) of a particular business are assumed to be the key drivers of how it is likely to respond to flood risk. These therefore have to be determined before likely responses can be assessed.

For this, a preliminary 'look up table' has been provided as part of this toolkit (see **Annex 3**, and the **supplementary spreadsheet accompanying this document**). This sets out the likely level of adaptive capacity (High, Medium or Low) and location dependence (either High or Low) for each type of industry and size of business. This has been developed using published evidence on these factors, such as Frontier et al., 2012, and through discussions with stakeholders in various at-risk areas across England.¹

This provides practitioners with a useable tool, which circumvents the need to make individual assessments for each business type during the appraisal process (in some cases, this may not be feasible, or proportionate to the proposed FCERM investment).

However for some business types, area-specific characteristics of businesses may drive differences in these factors across local areas. It is recommended that the preliminary look-up table is 'fine-tuned' to ensure that it accurately reflects the specifics of the local business environment.

The extent to which the look-up table is fine tuned, and the evidence used to do this, will depend on whether the more detailed or the lighter touch approach is used.

Detailed Approach

Under this approach, the preliminary look-up table is fine-tuned using local evidence from stakeholder engagement. This information can be gathered through surveys of the businesses in the protected area. A list of example survey questions are suggested in **Annex 2**, which will help to ensure that the most relevant evidence is collected.

Specifically, practitioners should assess whether the judgements made on AC and LD in the look-up table are consistent with the local evidence. The information in **Annex 5**, which highlights the conditions under which AC and LD are likely to be strong/weak, should be used to conduct this assessment.

This should also be supplemented with a review of the published evidence on these issues, with the look up table also being cross-checked against this. Evidence on adaptive capacity is growing, and this is likely to continue over time.

'Lighter Touch' Approach

Under this approach, a consistency check is recommended to cross-check against new published literature.

If this is not feasible or proportionate to the proposed FCERM investment, then the preliminary look up table provided in **Annex 3** can be used as it stands.

4.6 Step 6: map out likely business responses

Headline points

- To capture the uncertainty around business responses, a range of likely responses should be generated
- Businesses moving/shutting down is less likely than other responses – the impact of this should be measured as a sensitivity test

Business responses

The assessment of adaptive capacity and location dependence can be used to determine the likely responses of businesses in each business type.

The matrix below outlines the likely responses that are suggested for a particular business type, given its level of adaptive capacity and location dependence. This has been developed based on published evidence, and on evidence gathered from stakeholders across various parts of the England. This evidence is again summarised in **Annex 4** of this toolkit.

In practice, exactly how businesses may respond to changes in flood risk is uncertain. To capture this uncertainty, the matrix opposite allows practitioners to generate a range of likely business responses. This will in turn allow a range of likely dynamic impacts to be estimated.

- Those with low adaptive capacity are not likely to respond to flood risk.** Evidence suggests that businesses with low adaptive capacity (often including small businesses) will not have the information or financial resources to protect themselves.
- High adaptive capacity businesses are likely to adapt.** Evidence suggests that if businesses are aware of the risks and have the means to mitigate them, they will.
- Those with medium adaptive capacity are likely to either adapt or 'do nothing'.** There is the greatest uncertainty around the responses of these businesses. To capture this in the assessment, a range of 25-75% is recommended as the proportion of businesses that adapt, with the remaining not responding at all.

		Location Dependence	
		High	Low
Adaptive Capacity	High	Stay + Adapt	Stay + Adapt
	Medium	25 – 75% Stay + Adapt	25 – 75% Stay + Adapt
	Low	Stay + Do Nothing	Stay + Do Nothing

Some businesses in these categories may move. We assess the impact of this as a sensitivity test

Some businesses may shut down or re-locate, either their premises or their economic activity, because of the risk of flooding; others may be forced to shut down given flood damage experienced. Published evidence suggests only a minor proportion of businesses would *consider* re-locating their premises as a result of experiencing a flood. A much smaller proportion would be likely to actually re-locate as a result of *flood risk* (i.e. the expectation of a flood). This is consistent with evidence from a range stakeholders in flood-risk areas across England.

4.7 Step 7: assess the dynamic GVA impacts – stay + do nothing

Headline points

- The intervention can act to bolster business continuity (avoid business disruption) for those that do not adapt.
- The intervention could reduce the annual probability of flooding, and the average length of business disruption.

What happens to these businesses in the event of a flood?

Businesses that do not adapt will not be protected against flooding in the “do nothing” case. As a result, in the event of a flood, these businesses are very likely to experience disruption and could be unable to operate for a period of time. By reducing the risk of flooding, FCERM can increase business continuity.

How is the Impact on GVA assessed?

The *expected* reduction in the value of lost working hours during business disruption.

How to quantify it?

As with the first-round impacts, both an annual average estimate of the dynamic impacts is calculated, as well as a 10-year present value.

An approach for calculating the annual average figure is below (the formula for the calculation of the 10-year PV is synonymous to that set out on **page 36**). The approach is set out separately for the detailed and lighter touch approaches, as there are slight differences between the two.

The appropriate measure of the dynamic impact is the ‘incremental’ impact i.e. the difference between the expected value of lost working hours with the intervention (“Do Something”), and the expected value without the intervention (“Do Nothing” or counterfactual). As a result, the calculations set out below will need to be performed both with and without the intervention. It is assumed that the FCERM intervention will reduce the probability that a flood will occur, as well as the length of time a business is disrupted for if a flood does occur.

For clarity, a simplified worked example is provided on page 41.

Detailed Approach

Under this approach, the calculations are undertaken at the individual business level. The calculation steps are set out below.

Calculation Steps

- 1) **Calculate the value of working hours lost through business disruption, for each business which stays and does nothing under both the do nothing and the do something.** This can be calculated using the formula below:

*[Average projected annual earnings per employee*Number of employees]*[Average length of disruption (weeks)/52].*

Practitioners should use the average projected earnings related to the sector and region the business is in. The number of employees for each business is collected as part of the business surveys.

Given the uncertainty around the exact period of disruption a business will experience, a range of business disruption lengths is suggested (split between with and without FCERM) are used. These ranges are set out on page 40.

- 2) **Calculate the expected annual value of lost working hours for each business.** This can be calculated by multiplying the value in 1) by the annual probability of flooding identified through the standard appraisal guidance (as defined in Steps 1 and 2).

*Value of lost working hours *Annual probability of flooding*

- 3) **Calculate the total expected value of lost working hours across all businesses.** This is done by summing the total expected value over all businesses (see formula below):

Sum[expected annual value (business i)] over all i

4.7 Step 7: assess the dynamic effects – stay + do nothing

'Lighter Touch' Approach

The main difference with this approach is that the calculations are by business type category rather than for individual businesses. Under this approach, additional assumptions on the number of employees per business have to be made (because without business surveys, this information is not collected).

Calculation Steps

- 1) **Identify the number of businesses by type which will stay and do nothing.** This is done by combining the business characterisation with the assumptions on likely responses.
- 2) **Calculate the value of working hours lost through business disruption, per business for each business type under the do nothing and do something.** This can be calculated using the formula below:

*[Average projected earnings per employee (business type i)*Average Number of employees per business (business type i)]*[Average length of disruption (weeks)/52].*

- 3) **Calculate the expected annual value of lost working hours per business, for each business type.** As in the detailed approach, this can be calculated by multiplying the value in 2) by the annual probability of flooding from the standard FCERM appraisal (see formula below).

*Value of lost working hours per business (business type i)*Annual probability of flooding*

- 4) **Calculate the total expected value of working hours lost across all businesses in each business type.** This is calculated by multiplying the value in 3) by the number of businesses in each particular business type that stay and do nothing (see formula below).

*Expected annual value per business (business type i)*Number of businesses who stay + do nothing (business type i)*

- 5) **Calculate the total expected value of working hours lost across all businesses.** This is done by summing up the total expected value across all business types (see formula below):

Sum[total expected annual value (business type i)] over all i

Key Additional Inputs and Assumptions

On top of the data highlighted in Step 3, the following inputs will be needed for the calculations.

- **Average length of business disruption.** The table below sets out the suggested disruption periods. These are based on the assessment of published evidence and engagement with various stakeholders across England¹. Given the uncertainty surrounding how long it takes for a business to recover after a flood, ranges are suggested both with and without FCERM. A shorter period of disruption is assumed with the intervention than without. We suggest that stakeholders are consulted on these ranges, to ensure that they are consistent with any local evidence on business disruption.

Scenario	Length of Business Disruption
With FCERM	2 – 4
Without FCERM	16 – 24

- **Average number of employees per business (Lighter Touch approach only).** For this, we suggest that the mid-points of the ranges used to define business sizes are used (see table below)

Size	Average number of Employees per business
Micro	5
Small/Medium	130
Large	500

41 ¹A summary of the published literature regarding the length of business disruption is provided in Annex 4.

4.7 Step 7: assess the dynamic effects – stay + do nothing – worked example

Headline points

- The calculations can be undertaken using Microsoft Excel.

Worked example

Below is a simplified example of how the estimated dynamic impact relating to those businesses choosing to stay and do nothing can be calculated. This considers a hypothetical scheme providing a 1 in 200 year standard of protection to 21 businesses in the South East of England, which had previously faced a 1 in 40 year level of flood risk. The example works through the calculations in both the “Do Nothing” and “Do Something” scenarios, using the light touch approach. The calculations are based on particular assumptions on the number of businesses that stay and do nothing, and particular duration of business disruption. Ideally, the calculations should be repeated using the range of possible business recovery times, plus over each year of the ten year period. This will ensure a range of likely GVA impacts is generated, reflecting uncertainty.

Calculate by multiplying employee numbers by average projected earnings, and then by the proportion of the year the business would be disrupted (16/52)

Multiply the lost value by the annual probability to derive an expected annual value per business

Multiply by the number of businesses to derive an expected annual value for each business type

“Do Nothing”

Size	Sector	Average Number of Employees per business	Earnings per Employee (£)	Length of Disruption as a result of flooding (weeks)	Value of lost working hours per business during disruption	Annual Probability of Flooding	Expected Annual Value of lost working hours per business during disruption	Number of Businesses Staying + Doing Nothing	Total Annual Value (£)
Micro	Agriculture	5	19,403	16	29,851	2.5%	746	5	3,731
Small	Manufacturing	130	34,335	16	1,373,400	2.5%	34,335	15	515,025
Large	Mining & Quarrying	500	60,795	16	9,353,077	2.5%	233,827	1	233,827
									752,583

Earnings related to the sector, and the region (South East)

The annual probability pre-intervention, identified in the standard appraisal

Calculated when characterising businesses in the local area (Step 4)

Sum over all business types

“Do Something”

Size	Sector	Average Number of Employees per business	Earnings per Employee (£)	Length of Disruption as a result of flooding (weeks)	Value of lost working hours per business during disruption	Annual Probability of Flooding	Expected Annual Value of lost working hours per business during disruption	Number of Businesses Staying + Doing Nothing	Total Annual Value (£)
Micro	Agriculture	5	19,403	4	7,463	0.5%	37	5	187
Small	Manufacturing	130	34,335	4	343,350	0.5%	1,717	15	25,751
Large	Mining & Quarrying	500	60,795	4	2,338,269	0.5%	11,691	1	11,691
									37,629

The intervention lowers the length of business disruption...

... and the annual probability of flooding

Incremental Impact (Annual Average) **714,954**

4.7 Step 7: assess the dynamic effects – stay + adapt

Headline points

- Businesses choosing to stay and adapt are assumed to have no incremental impact on GVA. This is a cautious assumption that is made in the absence of evidence on how businesses would invest the money that no longer needs to be invested in adaptation, in the presence of the FCERM intervention. It is therefore likely to under-estimate the benefit to the local economy.
- Under the proposed methodology, it is assumed that if a business has adequate adaptive capacity, it will adapt in a way that is 'optimal' given the level of flood risk it faces, both with and without the FCERM intervention. This means that a business will invest in adaptation up to the point where the adaptation investment (marginal cost of adaptation) is equal to the avoided flood damage and disruption (the associated marginal benefits).
- The investment in adaptation is itself a cost to businesses. The FCERM changes the level of adaptation investment that is justified. This is because FCERM lowers the flood risk and so lowers expected damage and disruption. Hence, a lower level of adaptation investment is likely to be required by the adapted business. This frees up resources within the business that can be used for productive uses.
- The impact on GVA of FCERM for those businesses that adapt is that they can therefore re-direct investment away from adaptation (that is no longer justified) to other productive uses. Given those alternative uses are not known, the return from doing so for the business, and hence the extent to which that adds to GVA, is not known.
- It is however known that the alternative investments will offer a return that is **at least as great as the adaptation investment** would have been (otherwise it would invest more in adaptation). Therefore, a conservative assumption is that the GVA from this investment is comparable to that which is already measured through the damage prevented by the FCERM (i.e. it is already measured as part of the first-round impact calculation so no additional dynamic GVA impact needs to be added). In practice, in some cases the alternative investment for which resources are now freed up for would offer a higher return, and therefore add to GVA.

4.7 Step 7: assess the dynamic effects – stay + adapt: business funding contributions

Headline points

If a flood alleviation scheme is funded wholly or partially through business contributions, there is no difference in GVA impacts relative to the case in which the scheme is funded through other means, such as Flood Defence Grant in Aid. That is, the GVA impact on the local economy is the same whether the FCERM intervention is funded by public or private fund (or some combination).

In some cases, businesses may contribute funds towards the delivery of FCERM, for example, via a local levy. Although, strictly speaking this is not adaptation by the business itself, the business is facilitating the delivery of action to lower the flood risk.

This is an increasingly important issue however, particularly in the context of Partnership Funding, where Business Improvement Districts, for example, are emerging. The GVA implications of such funding contributions are below.

- Under the proposed methodology, it is assumed that in a situation where businesses contribute to the funding of a flood alleviation scheme, these contributions are a necessary condition for the implementation of the scheme. In other words, **without such contributions, the scheme would not go ahead**. This means that the benefits of the intervention can only be realised if those contributions are made.
- It is assumed that businesses are consulted about whether they support the levy or not. It is therefore to be considered **a voluntary measure** and not a 'tax'. To make the decision whether to support the levy or not, we assume that the business behaves rationally. That is, a business weighs up the extent to which the benefits exceed the costs under two cases (i) the contribution is made and the business realises the benefits from the FCERM intervention; and (ii) the business does not contribute and incurs the costs associated with the flood risk. Where the levy is supported, we can therefore assume that a rational decision has been made, so that the benefits to the businesses (as a whole) are at least as great as the opportunity costs to those businesses from paying the levy (otherwise they wouldn't support the levy).
- In light of these conditions, we can therefore assume that there is no loss in GVA if a levy is used to raise funding for the FCERM intervention, relative to the situation in which the FCERM intervention is funded via FDGiA (or other central sources). This is because (i) the scheme can only go ahead if the business levy is used; and (ii) businesses will only support the levy if they expect a return from the FCERM intervention at least as great as the levy they pay.

4.7 Step 7: assess the dynamic effects – move or shut down

Headline points

- There are likely to be few businesses that move or shut down in response to the flood risk (others may be forced to close after experiencing a flood) but it is important to calculate the GVA impact of FCERM averting those losses to the local economy using sensitivity analysis.

Why would businesses move or shut down?

As outlined in Section 4.6, businesses may choose to re-locate their premises or some of their economic activity as a result of flood risk. Some may choose to shut down, or be forced to shut down having experienced a flood. These businesses that move or shut down in response to flood risk are in addition to the standard “business churn” in a local economy – the usual opening and closing of businesses.

To reflect these potential impacts, and recognising the uncertainty around the scale of such impacts, the impact of these responses can be illustrated as a sensitivity test. The suggested ranges for this sensitivity analysis in the case **without the intervention** are:

- 1-5% of businesses with medium/high adaptive capacity and low location dependence relocate** in the absence of FCERM. This assumes that only those businesses who can operate sustainably elsewhere and with the means and knowledge to re-locate would move, without FCERM.
- 1-5% of those with low adaptive capacity shut down** without FCERM.

It is assumed those businesses are not replaced. For a more detailed approach, a survey could be undertaken of the local business. In which case, these numbers could be replaced with local data.

Calculate the impacts of businesses moving and shutting down

Detailed Approach

If detailed business surveys have been undertaken for the purpose of understanding business response to flood risk, these may provide useful data on (i) the number of businesses who could move or shut down (ii) the types of these businesses and (iii) the number of employees affected. In this case, **calculate the total loss to GVA of businesses moving or shutting down for each business type – assuming they are not replaced - using the formula below**

*Average projected earnings per employee*Number of jobs in businesses which move or shut down* number of businesses*

Lighter Touch Approach

Under the lighter touch approach, the preliminary look up tables (Annex 3) can be used to identify the population of businesses from which those who are likely to re-locate or shut down can be taken. The following sub-steps are recommended:

(i) Businesses moving

To illustrate the potential impact of businesses moving, assume that 1% of businesses with medium to high adaptive capacity and low location dependence will move in the absence of FCERM, and calculate this number. Separately, assume that 5% move, and calculate this number. Using the number of employees and average earnings of those businesses, this illustrates a range for the potential benefit of FCERM if the intervention were to prevent these businesses moving.

(ii) Businesses shutting down

Using the look up tables, determine the number and type of businesses with low adaptive capacity and high location dependence. Assume that 1% and 5% of these businesses shut down in the absence of FCERM, and calculate this number. Using the number of employees and average earnings of those businesses, this illustrates a range for the potential benefit of FCERM if the intervention were to prevent these businesses closing down.

Summary of GVA impact

The GVA impact is the sum of :

*Average projected earnings per employee*Number of jobs in businesses which move or shut down.*

Results report the annual GVA impact without FCERM, and the 10 year PV (calculated using the formula on **Page 36**).

4.7 Step 7: assess the dynamic effects – move or shut down – worked example

Headline points

- There are likely to be few businesses that move or shut down in response to flood risk but it is important to illustrate the potential GVA impact of FCERM averting those losses to the local economy through sensitivity analysis.

Worked example

This considers a hypothetical scheme providing a 1 in 200 year SOP to 94 businesses in the South West of England, which had previously faced a 1 in 40 year level of flood risk. The calculations are based on particular assumptions on the number of businesses that move or shut down.

Without Intervention

Size	Industry	Average Number of Employees per business	Salary per Employee (£)	Annual value of lost working hours per business	Number of Businesses that move	Total Annual Value
Micro	Construction	5	£28,698	143490	1	£143,490
Small	Construction	130	£28,698	3730740	2	£7,461,480
Large	Information and Communication	500	£33,995	16997500	1	£16,997,500
Small	Real Estate Activities	130	£24,809	3225170	1	£3,225,170

Business size and sector indicate the adaptive capacity and location dependence assumptions

Calculate by multiplying employee numbers by average projected earnings

Multiply by the number of businesses to derive an expected annual value for each business type

Earnings related to the sector for the relevant region (South West). Figures for earnings are per employee average annual earnings, and take account of hours worked differing by sector.

Sum over all business types to get the total impact. The GVA impact without the intervention is the same as incremental benefit from FCERM

Total Value without intervention £27,827,640

Present Value discounted over the 10 year appraisal period

Present Value £239,531,615

4.7 Step 7: assess the dynamic effects – unlocked investment

Headline points

- It is possible that FCERM interventions that lower flood risk are able to contribute towards unlocking investment or development that might not otherwise have occurred.

How might new businesses be affected by FCERM?

FCERM investment may mean new investment, such as site development, is attracted to a local area that would otherwise not have been undertaken. Strictly speaking, the assessment should only include the value of new business development where FCERM was both a necessary and a sufficient condition for the development. That is, where the full value of the new development is entirely attributable to FCERM. However, in practice, it is likely that FCERM facilitates new developments, rather than being their only driver. For example, planning approval for a development may only be granted with FCERM in place but other factors are also needed to make the development happen.

How to assess it?

The scale of unlocked investment is very location-specific so stakeholder engagement is essential. If data allows, it is possible to provide a quantitative assessment of on-going GVA impact of new commercial developments. The calculation is focused on i) the additional commercial floor space created or number of new businesses supported (ii) the types of new businesses that would be located in the new development, and (iii) the number of additional jobs (and thus working hours) that are supported by these businesses. The detailed calculation steps are outlined below.

The impact on the local economy of the initial investment in new developments, and the on-going impact of residential developments, should be assessed qualitatively, based on the proposed size of the planned developments. This is because of a current lack of evidence on the likelihood of these local impacts.

Calculation Steps

The impact of new developments – assuming that they would not occur in the do nothing – can be assessed by following three steps. We again provide details of how a ‘Detailed’ or ‘Lighter Touch’ approach can be used.

1) Identify new commercial developments that are facilitated in the area protected by the FCERM intervention

For each development, the following information needs to be collected.

- Amount of additional commercial floorspace that is created (m²). This is either in Gross Internal Area (GIA), or Net Internal Area (NIA).
- The number of businesses that will be supported on the new development.

Detailed Approach

A detailed approach would include a full audit of local plans for investment and the extent to which they are hindered by flood risk. This would include interviews with individuals and representative bodies such as the local Chamber of Commerce, the local Council, town planners and in some cases, relevant businesses. The local council planning website, which highlights all new development that have applied for planning approval, may be a useful source. A detailed site-by-site valuation could be carried out.

Lighter Touch Approach

A lighter touch approach would be to gather information from a number of local representatives and local council planning officers, and use publically available data for the calculations.

4.7 Step 7: assess the dynamic effects – unlocked investment

Headline points

- The on-going GVA impact of new commercial developments can be quantified if the relevant data is available.
- Only a proportion of the GVA may be attributable to the FCERM intervention. FCERM is likely to facilitate new investment, rather than being the sole reason for it.

2) Estimate the GVA impact of new developments

The GVA impact can be measured by calculating the value of additional working hours supported on the new development. The calculation steps for each individual development are set out below. These will differ depending on whether the commercial floorspace or number of new businesses is known:

If commercial floorspace is known:

- **Derive the number of jobs supported by the additional commercial space.** To do this, divide the floor space by an Area per employee figure. These are provided in the Employment Densities Guide.¹ This provides the Area per Full Time Employee (FTE) for a number of business classifications, for both NIA and GIA. To capture the uncertainty around the number of jobs created, we suggest a range of ‘Area per FTE’ figures around the figure in the Guide is used to create a range of job estimates.
- **Estimate the total annual value of additional working hours.** Multiply the estimated number of FTEs by average annual earnings per employee. Consistent with our estimation of dynamic impacts, earnings data from ASHE should be used, which provides average earnings by region for different SIC sectors.

If number of businesses is known:

The calculation steps are analogous. However, the number of jobs supported is calculated by multiplying the number of businesses by average number of employees per business figures. These can be calculated using data from the Annual Business survey

(available [here](#)), which provides the number of employees and active enterprises by region and SIC sector.

3) Discuss what proportion of the GVA could be attributable to FCERM

As has been mentioned, the proportion of the GVA impact that can be attributed to FCERM is highly uncertain. This is because in practice, it is likely that FCERM facilitates new development, rather than being the sole reason for it.

Lighter Touch Approach

Under a Lighter Touch approach, information should be available from local authorities on the new sites and their size. This can be used as the basis for the calculations, alongside published information on earnings by sector and region.

Detailed Approach

Under a Detailed approach, a more detailed review of the site developments could be undertaken. This would explore in-depth the businesses to be located on the site along with their expected size and sector.

The calculations could then be undertaken on a business-by-business basis for each site.

The extent to which the GVA benefits can be attributed to the FCERM intervention could be explored with stakeholders to develop the necessary evidence. This would allow a qualitative assessment of attribution to be presented alongside the quantified results.

¹Employment Densities Guide, 2nd Edition (2010), Homes and Communities Agency. <http://www.homesandcommunities.co.uk/employment-densities-guide-2nd-ed> .

4.7 Step 7: assess the dynamic effects – unlocked investment – worked example

Headline points

- The GVA impact of commercial developments can be calculated using Microsoft Excel

Worked example

This considers a hypothetical development in Yorkshire and the Humber, which generates 10,000m² of manufacturing space, and a 1,000m² restaurant.

In practice, the specific use of the floorspace may not be known. If this is the case, an appropriate average Area per FTE should be derived based on the available information. The average annual earnings across all sectors in the relevant region should then be used to estimate the value of additional working hours.

The relevant Area per FTE should be chosen based on the proposed use of the floorspace. Here used the figure for the 'General Industrial' class.
In practice, ranges around this figure should be used to generate a range of job estimates

Calculated by dividing the additional floorspace by the Area per FTE

Earnings from the Manufacturing sector for the relevant region (Yorkshire and the Humber).

Multiply the number of jobs by the average annual earnings to estimate the **annual** value of working hours created by the development

Additional Floor Space Created (sq m)	Use of floorspace	Area per FTE	Number of Jobs created (FTE)	Average annual earnings	Annual value of working hours generated
10,000	Manufacturing	36	278	£28,531	£7,925,278
1,000	Restaurant	18	56	£12,185	£676,944

Total value of working hours generated	£8,602,222
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4.7 Step 7: assessment of spillover impacts

Qualitative assessment of additional spillovers

This toolkit has identified that additional spillover impacts may also be significant for the local economy. Specifically, flood risk and flooding itself can have additional (negative) impacts on the local economy, which could be reduced as a result of FCERM. These qualitative impacts should be assessed and outlined. Care should be taken not to double count impacts. These include:

- i. **Agglomeration:** clusters of businesses can be more productive because of the ability to share ideas, knowledge, skills etc across businesses. Where FCERM facilitates businesses to remain in those clusters, productivity gains are likely (relatively to what otherwise would have happened without FCERM).
- ii. **Infrastructure interdependencies:** businesses rely on infrastructure to enhance their efficiency. FCERM which better protects that infrastructure also benefits the businesses.
- iii. **Costs of insurance:** FCERM could lower insurance premia which means more businesses can afford to purchase insurance. This can in turn provide the business with greater access to finance (flooding insurance is often a pre-condition of loans).
- iii. **Incentives to invest in the growth of the business:** lowering the risk of flooding could enhance business confidence and lower operational uncertainty. This could lead to greater investment.
- iv. **Land values:** land values may rise in areas better protected by flooding relative to the values without FCERM (care is needed to avoid double counting this impact).

Evidence on the scale of these potential impacts is currently very limited. However, it does not mean that they are not important. Therefore, these impacts should be assessed qualitatively, working with local stakeholders as appropriate.

In some cases, depending on the proportionality principles, it may be necessary to engage experts. For example, the impact of FCERM on land values may be material because of the increased attractiveness of the land with FCERM in place. Expert advice should be sought on a case by case basis from professional land valuers. Note that it is likely that accounting for changes in land values will double count for impacts already quantified – care must be taken to avoid such double counting, and to only consider the increment to land values associated with impacts not measured elsewhere. Land value impacts would rarely be justified as part of this assessment.

It is likely that stakeholder interviews or surveys would provide valuable information on spillovers to aid decision-makers.

4.8 Step 8: Summary table

For the purpose of reporting the results from the GVA framework, a GVA summary table can be useful. This table will capture the results of the analysis in both quantitative and qualitative terms, including sensitivity ranges to reflect uncertainty. It should also outline limitations of the analysis in the local context and the headline interpretation of results.

Key impacts on the local economy

- A
- B
- C

Outline here the key impacts of FCERM intervention on the local economy

	Estimated undiscounted annual average (£)	Estimated 10-year GVA impact (£ discounted to PV)	Qualitative assessment
First-round impacts	£ <i>Result from Step 5</i>	£ <i>Result from Step 5</i>	<i>Information from survey and stakeholders</i>
Dynamic impacts	£ <i>Result from Step 7</i>	£ <i>Result from Step 7</i>	<i>Information from survey and stakeholders</i>

Limitations *Outline any limitations that were encountered under the local analysis*

4.9 Step 9: identify observations from the assessment

Headline points

- Key observations from the results should be carefully thought through and highlighted as part of the analysis. This will help when making key points with potential funders, Ministers, local stakeholders or as part of the learning process for such assessments

The importance of observations

Influential analysis requires findings to be:

- Clear
- Transparent
- Easily understood with the drivers of outcomes clearly articulated

The analysis in the 10-step approach provides decision-makers or potential funders with a wide range of information. To ensure that it has maximum impact it should be clearly presented so that the key messages can be understood at a glance.

The GVA summary table goes some way to making the results clear but it is recommended that the summary table is complemented with observations. In particular, this can relate to:

- Particular aspects of research that would be useful to undertake if the analysis was to be made in more

depth;

- How the results in the assessment compare with results for other FCERM interventions;
- The degree of confidence in the results, given the resources available for the analysis
- How the GVA results relate to the wider welfare analysis of the standard FCERM appraisal.

Other observations may of course be worth highlighting.

4.10 Step 10: identifying monitoring and evaluation data

Headline points

- The toolkit presented in this document is the first of its kind. It should be kept under review and updated over time as more research, evidence and experience are developed.
- We recommend lessons learned from the analysis are logged so that a body of evidence builds over what works, how the analysis can be undertaken more efficiently or effectively, and what improvements could be made.

Importance of monitoring and learning

As this toolkit is new, it is important to test its practical application in a number of different circumstances and to learn from doing so.

Just as adaptive management advocates taking iterative steps towards enhancing resilience to flooding, this toolkit should also be kept under review by Defra, the Environment Agency and practitioners and adjusted and improved over time.

Learning from the process of undertaking assessments is key. Therefore, suggested actions are :

- Logging lessons learned as the analysis is undertaken so that future assessments can benefit from enhanced knowledge;
- Holding a workshop to review the process of each appraisal undertaken (covering both the standard FCERM appraisal and this GVA appraisal) so that views can be aired and joint learning can take place.
- Sharing lessons learned with other practitioners so that

a process of continual improvement is embedded.

5. Limitations

Lack of evidence

In preparing this toolkit, some important evidence gaps are:

- Duration of business disruption will vary significantly. Data on this is scarce and is likely to be case specific.
- There is little evidence on the extent to which businesses have adapted, and how, in particular, the degree to which businesses are likely to move or shut down is uncertain.
- Interdependency of businesses, and the extent to which this affects flood resilience, is not well-understood.
- Whether business activity in the event of a flood is delayed or shifts to other businesses (and if so, to where) or is lost is not well-understood.
- The impact of flood risk on the perceptions of potential investors, or those wishing to start up businesses, is not well-understood.
- The impact of flood risk and associated uncertainty on productivity is not well-understood.
- The adaptive capacity of businesses is not straightforward to assess – this toolkit has suggested categorisations but further research would be required for greater accuracy.

Further research on these issues would be valuable.

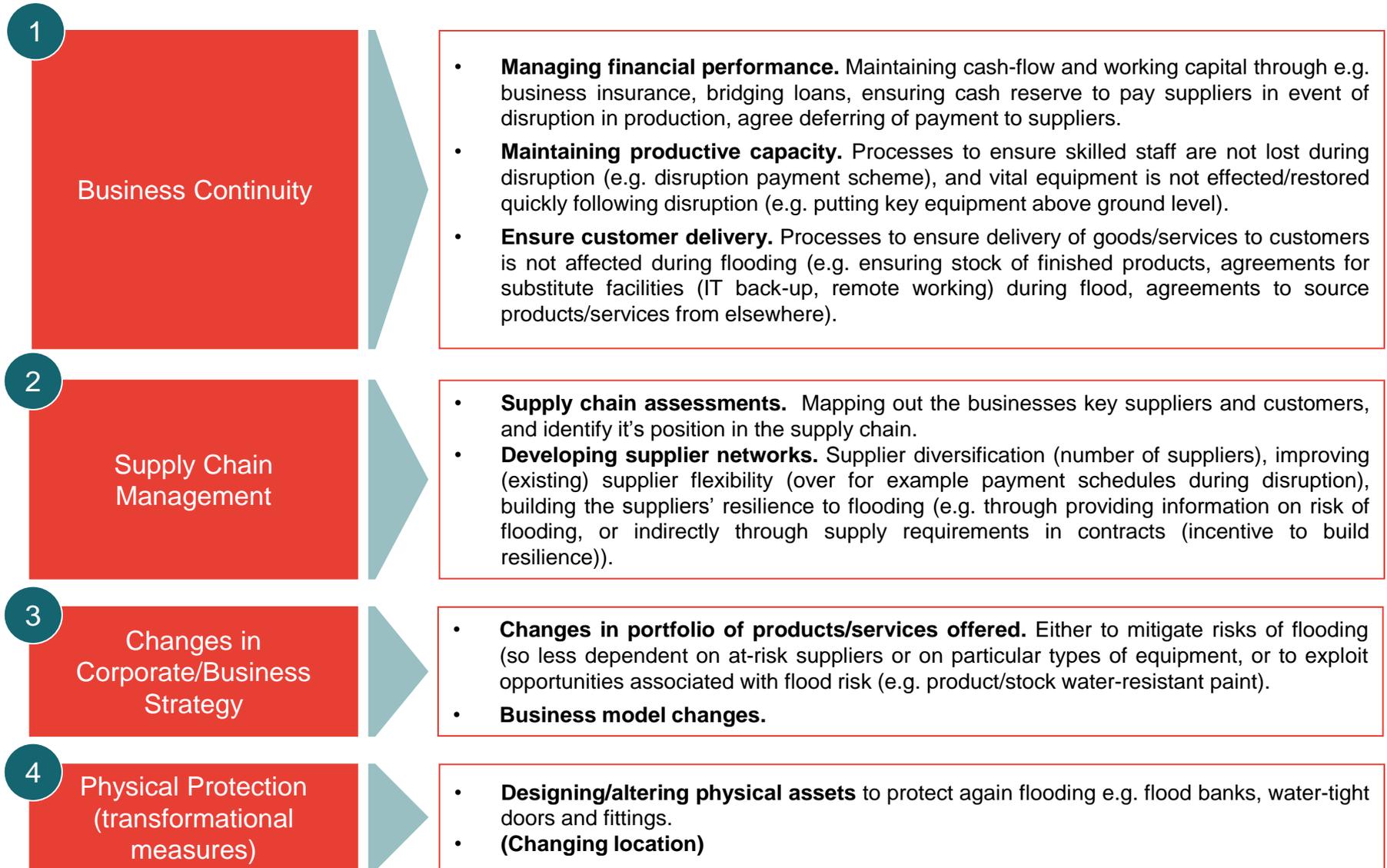
Data used

The GVA assessment is based on the information that is available at the time of the GVA assessment. Given natural business churn, the business categorisation of the area may not be fully reflective of the actual future business composition. Also:

- Data available on current businesses may not be fully reflective of actual business composition. In the absence of location-specific data, regional business composition may need to be applied to proxy the number of businesses in a flood plain.
- Information obtained through survey evidence is appropriate for the immediate time period under consideration so it may need to be updated before use in another time period.

ANNEXES

Annex 1: Potential adaptation actions



Source: Frontier et al., 2013

Annex 2: Example Survey Questions

In this annex, we provide a set of **example** survey questions that can be used to inform particular steps of the proposed approach.

Ideally, in order to get the deepest understanding of the characteristics of local businesses, each business in the local area would be surveyed. However, in areas where a large number of businesses are located, this is unlikely to be practical and cost-effective. Therefore, we suggest that representatives of each type of business are surveyed – these could be a selection of businesses of each type, or businesses associations which represent particular business sectors e.g. the Federation of Small Businesses or the local Chambers of Commerce. This will keep the survey process manageable, and ensure that the cost of the appraisal is proportionate to the value of the FCERM initiative/s that are being considered.

It is also important that the number of questions is kept small, and the questions are concise. This will maximise the number of survey respondents.

The questions provided here relate to the following steps of the analysis:

- Characterising economic activity
- Assessing adaptive capacity
- Assessing location dependence
- Identifying likely business responses

Characterising Businesses

Businesses

Q1: How many individuals does your business employ? (Choose one):

- 0-9
- 10-249
- 250+

Q2: Which sector does your business operate in? (Choose one sector from the list below)

- [List of Sectors, based on 1-digit SIC codes]

Business Associations / Representatives

Q1: Of the businesses in your sector in [the geographical area of interest], how many can be categorised as:

- Micro (0-9 employees)
- Small/Medium (10-249 employees)
- Large (250+ employees)

Q2: Of the businesses in your sector in [the area of interest], how many are in each of the following sectors:

- [List of Sectors, based on SIC codes]

Q3: How many business entities are operating in [the geographical area of interest]?

Annex 2: Survey Questions – Assessing Adaptive Capacity

Assessing Adaptive Capacity

Q1: Do you know whether your business is located in a floodplain? / Do businesses you represent generally know they are located in a floodplain?

Q2: How would you assess your businesses / businesses in your sector's vulnerability to flooding?

- Major
- Significant
- Moderate
- Low
- Don't know

Q3: Do you / businesses in your sector have in-house expertise to conduct the following operations?

- Risk Assessments
- Supply Chain Assessments
- Scope out potential actions to reduce risks to flooding

Q4: Do you / businesses in your sector have a process in place to assess the key risks to your business?

- Yes
- No

Q5: If Yes, how often do you / businesses in your sector assess these risks?

- On an on-going basis
- Month/ Quarterly/ bi-annually
- Annually
- Infrequently

Q6: Are senior decision makers aware of the risk to flooding?

- Yes
- No

Q7: Has your business been affected by flooding in the past? / What proportion of businesses in your sector have been effected by flooding in the past?

- Yes
- No

Q8: What is the status of ownership on your business property? Or What is the status of ownership on business property for the majority of businesses in your sector?

- Owned
- Leased
- Rented

Q9: Is your business subject to economic regulation? / Are businesses in your sector subject to economic regulation?

- Yes
- No

Q10: How would you describe the strength of your relationship (or the relationship of the businesses in your sector) with suppliers?

- Strong
- Moderate
- Weak

Q11: Does your business span across multiple sites? Do businesses in your sector tend to span across multiple sites?

- Yes
- No

Annex 2: Survey Questions – Assessing Adaptive Capacity

Assessing Adaptive Capacity - Continued

Q12: In your view, what would be the most important barriers to adapting your business (or businesses in your sector) to mitigating the effects of flooding (Can choose one or multiple):

- I'm not at risk from flooding
- Too costly
- Don't have the information or expertise to choose the right way to protect my business
- There is no point in me adapting if my suppliers or neighbouring businesses do not
- Physical protection would put off customers
- I don't want to be reminded of the risk of flooding

Adapted Question from EA (2008) Survey.

Annex 2: Survey Questions – Assessing Location Dependence

Assessing Location Dependence

Q1: In your view, would you be able to operate sustainably in any location apart from your current business location? / Are businesses in your sector able to operate sustainably in any location apart from their current business location?

- Yes
- No

Q2: Are any of the following characteristics of the local area key drivers of where your business is located? / Are any of the following characteristics of the local area key drivers of where the businesses in your sector are located?

- Local customers
- Local suppliers
- Obligation to serve the people of the local area
- Good transport links
- Local natural resources [could be river, sea, coal reserves, gas reserves etc. depending on the local area]
- Access to local workers
- Your business has a 'local identity'
- Being close to other similar businesses

Annex 2: Survey Questions – Likely Business Responses

Identifying businesses likely responses to flooding

Q1: Have you / businesses in your sector taken any precautionary measures to protect your business from potential future flooding?

- Yes
- No

Q2: If Yes, what adaptation actions have you / they taken (choose one or multiple options from the list below)

- Holding cash reserves in the event of disruption from flooding
- Holding additional inventory, in terms of inputs or finished products
- Identified alternative business premise in the event of flooding.
- Developed a business continuity plan
- Identified alternative suppliers of key inputs
- Negotiated flexible payment schedules with existing suppliers in the event of flooding,
- Built in certainty of supply into supplier contracts
- Ensured key suppliers have committed resources to building their resilience to flooding.
- Installed physical protection in business premises, such as flood-resilient fittings.

Q3: If No, have you / businesses in your sector considered taking adaptive action to avoid potential future flooding?

- Yes
- No

Q4: If No, what is the main reason for not considering protection?

Q5: Have you / businesses in your sector considered moving to avoid potential future flooding?

- Yes
- No

Q6: If No, what is the main reason for not considering relocation?

Q7: Have you / businesses in your sector considered shutting down to avoid potential future flooding?

- Yes
- No

Q8: If No, what is the main reason for not considering foreclosure?

Q9: If no, what would be your most likely action to avoid potential future flooding?

- Taking adaptation action
- Re-locating to a less at-risk area
- Shutting down/foreclosing
- No response

Q10: What are the reasons for taking this action over others? [List multiple reasons if applicable]

Annex 3: 'Look-Up Tables' for Adaptive Capacity, Location Dependence, and Likely Business Responses

This annex provides the look-up tables for Micro, Small/Medium, and Large businesses. These outline the likely level of adaptive capacity (Low, Medium or High), location dependence (Low or High), and likely response of each of the 62 business types. [The supplementary spreadsheet accompanying this document provides useable versions of these look-up tables.](#)

Look-up table for 'Micro' businesses

Business Type	Adaptive Capacity (High, Medium or Low)	Location Dependence (High or Low)	Likely Business Response
Agriculture, Forestry and Fishing - Micro	L	H	Stay + Do Nothing
Mining and Quarrying - Micro	H	H	Stay + Adapt
Manufacturing - Micro	L	L	Stay + Do Nothing
Electricity, Gas, Steam and Air Conditioning Supply - Micro	M	H	Stay + Do Nothing OR Stay + Adapt
Water Supply; Sewerage, Waste Management and Remediation Activities - Micro	M	H	Stay + Do Nothing OR Stay + Adapt
Construction - Micro	M	L	Stay + Do Nothing OR Stay + Adapt
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles - Micro	L	H	Stay + Do Nothing
Transportation and Storage - Micro	L	H	Stay + Do Nothing
Accommodation and Food Service Activities - Micro	L	H	Stay + Do Nothing
Information and Communication - Micro	L	L	Stay + Do Nothing
Financial and Insurance Activities - Micro	L	H	Stay + Do Nothing
Real Estate Activities - Micro	L	L	Stay + Do Nothing
Professional, Scientific and Technical Activities - Micro	L	H	Stay + Do Nothing
Administrative and Support Service Activities - Micro	L	L	Stay + Do Nothing
Public Administration and Defence; Compulsory Social Security - Micro	L	H	Stay + Do Nothing
Education - Micro	L	H	Stay + Do Nothing
Human Health and Social Work Activities - Micro	L	H	Stay + Do Nothing
Arts, Entertainment and Recreation - Micro	L	L	Stay + Do Nothing
Other Service Activities - Micro	L	L	Stay + Do Nothing
Activities of Households as Employers; Undifferentiated Goods-and Services-Producing Activities Of Households for Own Use - Micro	L	H	Stay + Do Nothing
Activities of Extraterritorial Organisations and Bodies - Micro	L	L	Stay + Do Nothing

Source: based on information in Frontier et al, 2012

Annex 3: 'Look-Up Tables' for Adaptive Capacity, Location Dependence, and Likely Business Responses

Look-up table for 'Small/Medium' businesses

Business Type	Adaptive Capacity (High, Medium or Low)	Location Dependence (High or Low)	Likely Business Response
Agriculture, Forestry and Fishing - Small/Medium	M	H	Stay + Do Nothing OR Stay + Adapt
Mining and Quarrying - Small/Medium	H	H	Stay + Adapt
Manufacturing - Small/Medium	M	H	Stay + Do Nothing OR Stay + Adapt
Electricity, Gas, Steam and Air Conditioning Supply - Small/Medium	M	H	Stay + Do Nothing OR Stay + Adapt
Water Supply; Sewerage, Waste Management and Remediation Activities - Small/Medium	M	H	Stay + Do Nothing OR Stay + Adapt
Construction - Small/Medium	M	L	Stay + Do Nothing OR Stay + Adapt
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles - Small/Medium	M	H	Stay + Do Nothing OR Stay + Adapt
Transportation and Storage - Small/Medium	M	H	Stay + Do Nothing OR Stay + Adapt
Accommodation and Food Service Activities - Small/Medium	M	H	Stay + Do Nothing OR Stay + Adapt
Information and Communication - Small/Medium	M	L	Stay + Do Nothing OR Stay + Adapt
Financial and Insurance Activities - Small/Medium	M	H	Stay + Do Nothing OR Stay + Adapt
Real Estate Activities - Small/Medium	M	L	Stay + Do Nothing OR Stay + Adapt
Professional, Scientific and Technical Activities - Small/Medium	M	H	Stay + Do Nothing OR Stay + Adapt
Administrative and Support Service Activities - Small/Medium	L	L	Stay + Do Nothing
Public Administration and Defence; Compulsory Social Security - Small/Medium	H	H	Stay + Adapt
Education - Small/Medium	M	H	Stay + Do Nothing OR Stay + Adapt
Human Health and Social Work Activities - Small/Medium	M	H	Stay + Do Nothing OR Stay + Adapt
Arts, Entertainment and Recreation - Small/Medium	L	H	Stay + Do Nothing
Other Service Activities - Small/Medium	L	L	Stay + Do Nothing
Activities of Households as Employers; Undifferentiated Goods-and Services-Producing Activities Of Households for Own Use - Small/Medium	L	H	Stay + Do Nothing
Activities of Extraterritorial Organisations and Bodies - Small/Medium	H	L	Stay + Adapt

Source: based on information in Frontier et al, 2013

Annex 3: 'Look-Up Tables' for Adaptive Capacity, Location Dependence, and Likely Business Responses

Look-up table for 'Large' businesses

Business Type	Adaptive Capacity (High, Medium or Low)	Location Dependence (High or Low)	Likely Business Response
Agriculture, Forestry and Fishing - Large	L	H	Stay + Do Nothing
Mining and Quarrying - Large	H	H	Stay + Adapt
Manufacturing - Large	L	L	Stay + Do Nothing
Electricity, Gas, Steam and Air Conditioning Supply - Large	M	H	Stay + Do Nothing OR Stay + Adapt
Water Supply; Sewerage, Waste Management and Remediation Activities - Large	M	H	Stay + Do Nothing OR Stay + Adapt
Construction - Large	M	L	Stay + Do Nothing OR Stay + Adapt
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles - Large	L	H	Stay + Do Nothing
Transportation and Storage - Large	L	H	Stay + Do Nothing
Accommodation and Food Service Activities - Large	L	H	Stay + Do Nothing
Information and Communication - Large	L	L	Stay + Do Nothing
Financial and Insurance Activities - Large	L	H	Stay + Do Nothing
Real Estate Activities - Large	L	L	Stay + Do Nothing
Professional, Scientific and Technical Activities - Large	L	H	Stay + Do Nothing
Administrative and Support Service Activities - Large	L	L	Stay + Do Nothing
Public Administration and Defence; Compulsory Social Security - Large	L	H	Stay + Do Nothing
Education - Large	L	H	Stay + Do Nothing
Human Health and Social Work Activities - Large	L	H	Stay + Do Nothing
Arts, Entertainment and Recreation - Large	L	L	Stay + Do Nothing
Other Service Activities - Large	L	L	Stay + Do Nothing
Activities of Households as Employers; Undifferentiated Goods-and Services-Producing Activities Of Households for Own Use - Large	L	H	Stay + Do Nothing
Activities of Extraterritorial Organisations and Bodies - Large	L	L	Stay + Do Nothing

Source: based on information in Frontier et al, 2013

Annex 4: Supporting Evidence – Published Literature

This annex summarises the published literature that was used to develop the look up tables, and the likely responses of different business types. This literature relates to:

- Adaptive Capacity
- Location Dependence
- Actual business responses to flooding
- Length of Business Disruption following a flood

As we have outlined in the main toolkit, the base of published evidence is likely to grow quite significantly over time. We therefore suggest that, if proportionate to the FCERM investment, practitioners conduct a similar review of evidence as part of the appraisal process, and ‘fine-tune’ the assumptions on adaptive capacity, location dependence, likely business responses and business disruption accordingly.

Adaptive Capacity

The base of empirical evidence on adaptive capacity is large, but focusses quite heavily on SMEs and does not cover all drivers of adaptive capacity. Specifically, many sources focus particularly on awareness of flood risk/information, and financial/managerial barriers.

- **UKCIP (2008)** provides a useful summary of the literature on the ability of SMEs to respond after flood events.
- **AXA (2008)** explores how managerial flaws can create barriers to adaptation.
- **BIEDO (2013)** highlights the extent which businesses have access to information pre-flood in a survey of businesses across sectors and size.
- **Climate South East (2008)** provides empirical evidence on the barriers SMEs face in adapting to climate change, particularly in terms of their technical capacity.
- **Crichton (2006)** analyses the results of a business survey of 2,420 small businesses which highlights the awareness of small businesses to the risk of flooding.
- **EA (2008)** – A survey of >1000 businesses of various sizes, highlighting a number of financial and technical barriers (expertise, investment horizon, personal) to adaptation.
- **Kreibich (2007)** looks at what drives private and public sector businesses to take precautionary measures to mitigate flood risk.
- **GfK (2007)** provides evidence on a range of businesses highlighting the effect that prior flood experiences and awareness of flood risk has on the decision to adapt.
- **Oxfordshire Economic Observatory (2007)** provides results of 11 interviews with SMEs, highlighting tenancy and interdependency with other businesses as key barriers to adaptation.
- **RICS (2012)** highlights the extent to which SMEs face technical and financial barriers to adaptation in response to the risk of flooding.
- **Woodman & Kumar (2009)** looks at how the lack of awareness of flood risk affects the take-up of business continuity plans amongst SMEs.

Annex 4: Supporting Evidence – Published Literature

Location Dependence

These sources focus primarily on literature looking at the drivers of business location decisions for businesses across different industries.

- **McQuaid et al. (2004)** provides a review of empirical and theoretical literature on the drivers of business location decisions for a variety of business types, with particular focus on the importance of transport.
- **Ipsos Mori (2011)** highlights how intellectual capital, access to markets, and proximity to local businesses are key drivers of location decisions for financial services companies
- **O'Mara (1999)** highlights how proximity to high quality infrastructure and skilled labour are key drivers of location decision-making for high quality 'information-age' companies.
- **Other useful sources** include Cushman and Wakefield (2002), Invest UK (2000), Cornwall County Council¹(1999), OECD (2002), Trinder (2002).

Actual Business Responses to Flooding

- **Devonomics (2013)** provides empirical evidence on the extent to which businesses of different sizes and across different sectors adapted, and considered moving, in the face of flood risk.
- **BIEDO (2013)** provides evidence from a survey of 29 businesses in North Burnet following the 2013 floods, looking specifically at whether businesses have insurance that included cover against flood damage.
- **RICS (2012)** provides evidence from Cockermonth, Cumbria on the extent to which SMEs had adapted to mitigate flood risk through planned and reactionary physical measures.

- **Woodman & Kumar (2009)** and **Critchon (2006)** provide evidence on the proportion of a range of businesses (varying by size, sector and region) implementing business continuity plans, and alternative adaptation measures such as provisions for flexible working.
- **EA (2008)** provides extensive evidence on the responses of businesses in high flood risk areas, and the cost effectiveness of various adaptation actions under different levels of flood risk.
- **CSE (2008)** provides evidence on the responses of SMEs to flooding in the Solent, East Kent and Thames Valley areas, including re-location.
- **GfK (2007)**, in a survey of a range of businesses across Yorkshire and Gloucester, provides empirical evidence on the extent to which businesses of different sizes adapt, do nothing, and potentially shut down in response to the risk of flooding.
- **Kreibich (2007)** and **Kreibich (2006)** assess the extent to which businesses in the manufacturing, commercial, financial, service, and agricultural sectors in Saxony, Germany had taken building, financial, and behavioural precautions to mitigate the risk of flooding they face.
- **Oxfordshire Economic Observatory (2007)** provides results of 11 interviews with SMEs, highlighting the actions they had taken in response to flood risk.

Annex 4: Supporting Evidence – Published Literature

Length of Business Disruption

- **Devonomics (2013)** found that of the 600 businesses they surveyed across Devon and Somerset, 18 temporarily closed following the floods of 2012/2013. These closed for a total of 342 days collectively, suggesting an average length of closure of 19 days. It also found that on average 10 working days were lost per business as a result of the floods. This suggests a range of 10 – 20 days (2-4 working weeks)
- **Critchon (2006)** found that in a survey of 2,420 businesses on average, businesses took over two months to re-open following flood events (P18). Critchon also found that among small businesses, the average length of business interruption as a result of flooding was 15 months in 2005, up from 8 months in 1996. This suggests an indicative range of 8 – 65 weeks
- **BIEDO (2013)** in a survey of flooded business in North Burnett, found that the time needed for businesses to recover and be up and running again ranged from 1 month to 12-24 months following the 2013 floods.
- **GfK (2007)**, in a study of a 2006 AXA survey of small businesses, found that flooded businesses lost over 50 working days as a result of flooding. The average cost of lost working hours, damage to stock and premises and loss of custom was reported as:
 - 1 to 3 employees: £7,900
 - 4 to 10 employees: £18,070
 - 11 to 50 employees: £27,480
- Also, those who had not been flooded thought it would take them less than a month to recover from such an event, those who had been flooded found it took more than two or three months. (UKCIP, 2009, P10 – See GfK 2007 for more details. This suggests a range of 5 days – 3 months

Annex 4: Supporting Evidence – Stakeholder Responses

This annex summarises the evidence that was gathered through engagements with various stakeholders across England. The sample size was small – around 20 – so the responses should be read in that context. This evidence was used alongside the published evidence to inform the development of the look up tables for adaptive capacity and location dependence, and the likely responses of different business types. This evidence relates specifically to:

- Adaptive Capacity
- Location Dependence
- Actual business responses to flooding

As outlined in the main toolkit, if a more detail approach is to be followed, this evidence should be supplemented with additional local evidence. This would be gathered through business surveys and stakeholder interviews.

Adaptive Capacity and Location Dependence

Stakeholders cited a number of barriers which limit businesses' ability to adapt and to relocate. These relate particularly to small and micro-sized businesses.

- **Lack of awareness of flood risk.** Businesses concentrate more on short term rather than longer term risks. Stakeholder mentioned that businesses care more about the issues that affect the day-to-day running of their business, rather than perceived longer-term risks such as flooding. The likely risk of flooding is therefore of low priority when making their key businesses decisions, unless it has been experienced before. Many stakeholders also cited businesses are generally unaware of their risk of flooding, unless they have had prior experience.
- **Lack of knowledge on how to adapt.** Stakeholders believed that even if businesses were aware of the risks, many would not have the knowledge or information on how to protect themselves effectively. Only a few stakeholders were aware of advice services that would provide information to businesses on possible ways to adapt.
- **Physical barriers.** Stakeholders mentioned that businesses in old listed buildings would find it particularly difficult to physically adapt because of planning permission constraints.
- **Financial constraints.** Many small businesses are likely to be restricted by lack of funds. This restricts their ability to re-locate, and invest in adaptation.

- **Barriers to collective adaptation.** Some businesses would be willing to invest in adaptation if other businesses benefitting from the protection were also willing to contribute. However, many mentioned that there were not the systems in place to connect these businesses.
- **Lack of property ownership.** Many small businesses are likely to lease or rent their commercial properties. This means businesses may not realise the full benefits of self-protection. Stakeholders also mentioned that most landlords are unwilling to fund self-adaptation projects.
- **Emotional barriers.** Stakeholders cited examples of business owners trying to 'forget' past flood events, rather than protect themselves against floods in the future

However overall, stakeholders cited that larger businesses, and also a number of medium-sized businesses would have the ability to adapt.

- Stakeholders cited that large businesses are more likely to have both the finances and the awareness/knowledge to adapt. Medium-sized businesses in sectors where risks are dealt with on a day-to-day basis (for example in regulated industries) will also be aware of the flood risks they face.

Annex 4: Supporting Evidence – Stakeholder Responses

- **Businesses owning their own property face particular barriers to re-locating.** These businesses may find it particularly difficult to re-locate, given the potential difficulty in (i) finding potential buyers (given the cost of the insurance needed to secure business mortgages in at risk areas), and (ii) finding likewise properties elsewhere (as property prices elsewhere will be higher all else equal, given the risk of flooding).
- **However, small businesses at high risk of flooding are likely to invest in adaptation, as long as it is cost-effective to do so.** Stakeholders cited a number of small businesses who flood on a regular basis that had installed flood-resilient doors, window boards and bought ‘aqua bags’ which soak up incoming flood water.

Likely Business Responses

- **Both small and large businesses may be likely to move or shut down in response to flood risk.** Stakeholders noted that large businesses would be unlikely to re-locate, given the majority have a large fixed asset base that would make moving particularly costly. No stakeholder was aware of any business, small or large, that had moved as a direct result of flooding.
- **Large and medium-sized businesses are likely to adapt to high levels of flood risk.** Stakeholders cited that such businesses are likely have both the finances and the awareness/knowledge to adapt, and are also likely have ‘the most to lose’ in the event of flooding.
- **Small businesses that are aware of flooding would be more likely to choose to adapt rather than re-locate.** According to stakeholders, small businesses would be unlikely to have the funds to re-locate, and would be particularly reliant on local connections for business. Small businesses owning their own property would find it particularly difficult to re-locate. Nevertheless, small businesses would also find it particularly difficult to adapt, given the financial and informational barriers they face. Also, where several firms are at risk, businesses find it very difficult to form a partnership/club and invest jointly. These businesses are therefore most likely to suffer significant damage to commercial and productive capabilities in the event of a flood

Annex 5: Adaptive capacity

This annex sets out the conditions under which adaptive capacity and location dependence are likely to be stronger and weaker. This can be used to help cross check the look-up tables and assumptions on likely responses against any new published or stakeholder evidence.

Adaptive Capacity is likely to be **strengthened** when ...

- The **risks of flooding are well understood**. Particularly in companies with in-house experts who can perform risk assessments or scope out potential adaptation actions.
- **Strong leadership and operational planning processes** are in place which incorporate flood risk into business decision-making.
- There has been **previous experience of flooding**, as this can help to increase awareness of flood risk and highlight the potential costs from not adapting.
- Businesses **work in Partnerships**, either with other businesses, suppliers or industry bodies.
- There is **low interdependency of adaptive capacity with others**, for example with suppliers and other sectors, or property and land owners who are not reliant on decisions made by their landlords.
- **Good quality information** on flood risk and possible actions is accessible.
- **Business complexity is low**. For example, when there is a simple organisational hierarchy, or businesses are located on single rather than multiple sites.
- **Decision lifetimes are short**. Frequently made decisions are more flexible, allowing for regular review and evolution of business strategies with increased knowledge of flooding risks.
- Businesses are operating in **Public and Regulated sectors** in which the regulatory requirements take due account of the current and projected risk of flooding.
- **There is a stable, supportive and transparent policy environment** so organisations may plan and take effective action.

Adaptive Capacity will be **weakened** when there is ...

- **Lack of awareness** of flood risk and its relevance to the business, the tools available to assess their risk of flooding and choose appropriate adaptation actions, and lack of willingness to accept vulnerability to flooding.
- **Lack of financial resources and specialised skills and training** to identify risks of flooding and adapt accordingly.
- **High interdependency of adaptive capacity with others** such as suppliers and neighbouring businesses.
- **Limited ability to influence decision making**, for example tenants who are dependent on landlords to take action to respond to flood risks
- **High business complexity**. Designing appropriate adaptation strategies and highlighting the risk of flooding to the relevant people will be difficult when there is a complex business hierarchy, and/or business operations are spread across multiple sites
- **Decision lifetimes are long**. May lock businesses into long term strategies without the ability to incorporate new knowledge regarding flood risk.

Annex 5: Location Dependence

High Location Dependence

A particular business is likely to have **high location dependence** if:

Their current location is either (i) the only possible location in which they can feasibly operate, or (ii) moving would entail excessive costs.

This is likely to be the case when a business is dependent on **two or more local characteristics** (e.g. local skills and local customer base).

Under these conditions, the local area is likely to provide a business environment that is particularly well-suited to that business. This business would therefore find it very difficult to find the same mix of characteristics that the local area provides, anywhere else.

Low Location Dependence

A particular business is likely to have **low location dependence** if:

There is a wide range of possible locations in which the business can feasibly operate and moving location does not incur prohibitive costs.

This is likely to be the case when either:

- A business's activities **do not materially depend on more than one** characteristic of the local area.

and

- The costs of moving are manageable.

Annex 6: Measuring the benefits to the local economy of managing coastal erosion risk

Measuring Coastal Erosion – Current Appraisal Guidance

A given property is assumed to be exposed to the risk of coastal erosion once the properties between it and the sea have either been lost, or are on the point of loss, because of coastal erosion. The current appraisal guidance outlines the year in which this is likely to occur. This is determined on the basis of “erosion lines”. The approach also accounts for the risk of “catastrophic slides”.

- Erosion lines are predictions of where the coastline will be in a given period of time. This measurement is suitable for “slow erosion” where the likelihood of erosion in a given year can be interpolated by the distance of a property from the coastline.
 - Short-term risk: erosion in year 0-20
 - Medium-term risk: erosion in year 21-50
 - Long-term risk: erosion in year 51-100
- Catastrophic slides have different probabilities of slides of different magnitudes. This means, for example, that there is a small probability that an event will occur in year 0 (or soon) that was originally assessed as a long-term risk (51-100 years).

How does this compare to assessing flood risk?

In the case of coastal erosion interventions, the “do something” options delay the point at which properties are considered at risk. The consequences of erosion are not eliminated, they are merely delayed. The benefits arise by delaying the point at which losses (property, land etc.) occur and allowing economic activity to continue in the meantime.

A key point about estimating the GVA impact of coastal erosion is that once a property has been lost due to coastal erosion, it is lost forever. There is no possibility to retrieve or adapt after coastal erosion has taken place. This is in contrast to flood risk where although businesses are disrupted by flooding (and can be severely so), many are able to survive (albeit after having incurred significant costs).

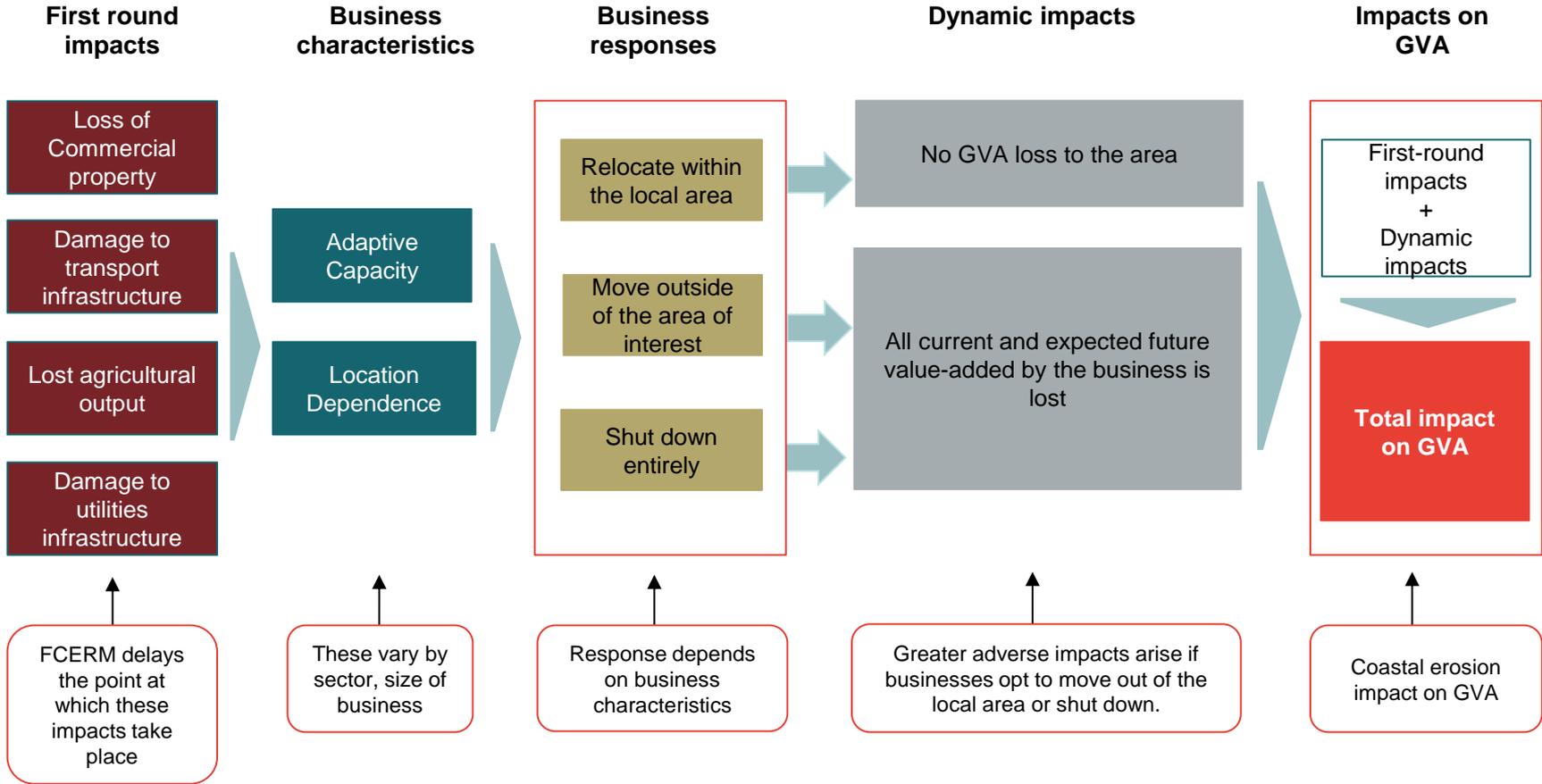
Methods to estimate the GVA impacts of coastal erosion interventions differ from those used in the context of flood risk in two ways.

- First, the probability calculations for coastal erosion are different to flood risk. The probability that a given property is at risk of coastal erosion in any given year is based on both erosion lines, but also must take into consideration the fact that that a given property may have been lost in any of the previous years, due to the risk of catastrophic slides. Each property therefore has a cumulative probability function depending on its proximity to the cliff edge. In the context of flood risk, although a probability of a given severity of flood is assessed in any given year, that probability does not explicitly take likelihood of previous flooding into account. Flood risk is considered in terms of return periods.
- Second, the GVA impact on the local economy in the context of coastal erosion is a one-off event. The magnitude of this depends on the nature of economic activity of the businesses at risk, and the extent to which they respond to the risk they face. Given that a property lost due to coastal erosion is not retrievable, once gone, all future value that could have been added by that property (i.e. the business) is lost, unless it moves. The intervention would delay this loss and therefore allow the business to deliver added-value for longer in its original location.

The interventions themselves are obviously also different to the case of flood risk. A probability of failure must be assigned to the protective structure, and this is likely to increase over time given wear and tear. However, it is important to bear in mind that even the destruction of a protective structure will continue to offer some level of protection given the debris left behind.

Annex 6: Assessing the impacts on the local economy of coastal erosion – The Transmission Mechanism

The same methodology used for considering the impacts on the local economy of managing flood risk can be applied to managing coastal erosion. Impacts on the local economy can be understood by considering the channels through which risk of coastal erosion, and changes to it, affect (i) current economic activity in the event of erosion (referred to here as ‘first round’ impacts; and (ii) how the workers and businesses in the local economy respond over time (referred to here as ‘dynamic’ impacts).



Annex 6: Measuring Coastal Erosion – GVA impacts (1)

First round Impacts

As in the case of flood risk, first-round impacts reflect the costs and benefits for current businesses assuming no change in the number, type or nature of those businesses over time. The difference between the value if loss occurs without the intervention (i.e. early) compared to losses with the intervention (some years later) is presented as an annual GVA figure and then converted to the ten-year GVA present value. These impacts are calculated in the same manner as outlined in Section 4.5 of the toolkit.

Dynamic Impacts

As in the case of flood risk, dynamic impacts reflect the outcomes for a local economy over time as businesses respond to changes in the risk of coastal erosion. Investment in FCERM could increase the ability of the business to continue its activity, it could ‘unlock’ investments that might otherwise have been constrained or unattractive given the coastal erosion risk; and deliver ‘spillover’ impacts which reflect interdependencies and how an impact on one business can affect another. Dynamic impacts are assumed to be driven by business responses which are determined by the adaptive capacity and location dependence of local businesses.

Business characteristics

Adaptive capacity

Adaptive capacity is assessed as in the main part of the toolkit. Stakeholder evidence indicates that businesses are often likely to be unaware of the risk of coastal erosion. This is due to the nature of the problem – it is a slow long-term process that may not be evident. Given the slow-process, businesses are reported as generally over-estimating the protection awarded by present visible walls and structures and under-estimating the risks of under-cutting to the infrastructure. Also, because businesses that are at risk tend to be small (they are located on the sea-front), it is likely that they will have limited adaptive capacity given constraints on resources and information available to them.

Location dependence

Location dependence of businesses is assessed as outlined in the same way as in main part of the toolkit. As in the case of flood risk assessments, location dependence determines the degree to which a business with sufficient adaptive capacity will prefer to remain in its current location, or to move to another area.

Business Responses

Given businesses’ adaptive capacity and location dependence business responses to the risk of coastal erosion will be different to their responses to flood risk. There are likely to be three general business:

- **Businesses can shut down entirely:** businesses that have low adaptive capacity and high location dependence may be likely to cease business entirely when faced with increasing risk of coastal erosion.
- **Businesses can move out of the local area:** businesses that have high adaptive capacity and low location dependence may opt to move outside of the local area to an area where they do not face the risk of coastal erosion.
- **Businesses can move but stay within the local area:** businesses that have high adaptive capacity and high location dependence may opt to move to a part of the local area where they are not at risk of coastal erosion, but still maintain strong links with the local area.

Assessment of dynamic impacts

In line with the assessment of flood risk, this toolkit suggests a 10-year time frame for the assessment of coastal erosion on GVA (although coastal erosion is a slow process, considerations of GVA beyond 10 years are less meaningful). Businesses are therefore assumed to respond to the impacts of a coastal erosion structure within a 10 year period. The dynamic impact on GVA depends on the point at which commercial properties are lost due to coastal erosion over the ten-year period.

Annex 6: Measuring Coastal Erosion – GVA impacts (2)

Assessment of GVA impacts

Understanding how businesses respond to the risk of coastal erosion will inform the assessment of the GVA benefits of FCERM. FCERM delays the loss of land. The three forms of dynamic impacts we assess are:

1) Business continuity

Without FCERM (i.e. in the ‘do nothing’ case):

- If businesses shut down entirely, then the GVA loss to the local (and national) economy, is the loss of the future stream of value added by that business.
- If businesses move out of the local area, then the GVA loss to the local economy is the future stream of value added by that business.
- If businesses, move but stays within the local area, then there is no GVA loss to the economy.

FCERM delays these impacts occurring for several decades. There is therefore a benefit from maintaining business continuity (i.e. avoiding these losses in economic activity).

2) Unlocked investment

As with investment in flood defences, there may be unlocked investment associated with the FCERM. It is possible that investment in coastal protection (and therefore a substantive delay in the expected loss of property and assets) could support the regeneration of the local economy and in some cases, potentially support new businesses.

Under the “do nothing” scenario, a loss of land further constrains supply of this natural resource in the local economy. It is possible that in this case, some businesses would move away from the coast but remain operational in close proximity (away from the coast). Under the “do something” scenario, more land remains available than would otherwise have been the case. Businesses could therefore remain in

their original locations for several more decades. It may therefore be the case that land is now freed up for new developments away from the coast that would have otherwise been occupied by displaced businesses.

Estimates of these impacts should be informed by stakeholder evidence. The gains to increased land for development is likely to be more evident when land and properties are in high demand.

3) Spillovers

It is possible that investment in coastal protection will have spillover effects for a local area. These effects will be similar to those outlined in Section 2.2 of the main part of the toolkit:

- interdependences;
- Impacts on business investment confidence given the need to operate under uncertainty about coastal erosion
- access to insurance and credit;
- agglomeration impacts; and
- land values (only to the extent that they reflect externalities not already accounted for).

These should be assessed qualitatively based on local stakeholder engagement.

Annex 6: Measuring Coastal Erosion – Estimation (1)

Depending on the data and resources available, it is possible to undertake either a lighter touch approach, or a more detailed approach, bearing in mind that need for proportionality

Lighter Touch Approach

Using evidence on the number of commercial properties that are at risk of coastal erosion in the local area of interest, the “lighter touch” approach outlines an illustrative range of the potential impact on local GVA of coastal erosion.

Calculation Steps

1) Identify the number of businesses by type which are at risk of coastal erosion. It is likely that businesses located on a coastal frontage will be mainly of three types: arts and entertainment, retail and wholesale, accommodation and food. However, this will be specific to a local area and should be validated with stakeholder evidence.

2) Using the preliminary look up tables for coastal erosion (see pages 78-80), identify the number of businesses that are likely to shut down, or move out of the local area. These depend on the assessments of adaptive capacity and location dependence.

3) Calculate the value of working hours of these businesses per annum, in discounted present value terms. Information required is the number, size and type of businesses in the area and associated annual earnings.

Lost working hours can be estimated as:

*Average number of employees per business * earnings per employee * number of businesses likely to move out of the area or shut down*

To calculate the aggregate lost economic activity in a given year, sum the values of lost working hours per business type across all businesses.

This gives the aggregate undiscounted value of lost GVA per year.

To calculate the present value of the dynamic impacts, apply the discount factor (based on a discount rate of 3.5% as recommended by the Green Book*) – the process of discounting is as described in the main part of this toolkit.

4) Illustrate the potential impact of coastal erosion on the local economy by considering three “what if?” scenarios:

• **What if all businesses at risk cease activity in Year 0?**

• If a business is lost in Year 0, then the local economy will have lost out on 10 years of GVA. The value of the loss from coastal erosion is the present value of the total loss of all businesses over the ten year GVA appraisal period.

• **What if all businesses at risk cease activity in Year 5?**

• If a business is lost in Year 5 of the appraisal period, then the local economy will have lost out on Years 5 to 10 (inclusive) of GVA. The value of the loss from coastal erosion will be the present value of the loss of these businesses from Year 5 to Year 10.

• **What if all businesses at risk cease activity in Year 10?**

• If a business is lost in year 10 of the appraisal period, then the local economy will have lost out on just 1 year of GVA. The value of the loss from coastal erosion will be the present value of the loss of these businesses in Year 10.

The benefits of FCERM arise because the intervention delays the losses until after year 100 so all of these calculated losses are avoided.

Annex 6: Measuring Coastal Erosion – Estimation (2)

Detailed Approach

Under the current appraisal guidance, where detailed modelling is undertaken, each business is assigned:

- a year of expected loss;
- probability of loss in that year

If this information is available, it is possible to undertake a more detailed approach to estimating the impact of coastal erosion on the local economy. The expected loss of GVA due to risk of coastal erosion is the probability of a given commercial property being lost in a particular year, multiplied by the present value of the stream of GVA that would have been delivered by that business over the remainder of the appraisal period. Then sum across businesses.

Calculation Steps

- 1) **Identify the number of businesses by type which are at risk of coastal erosion.** On the basis of stakeholder engagement, we suggest businesses located on a coastal frontage will be mainly of three types: arts and entertainment, retail and wholesale, accommodation and food. However, this will be specific to a local area and should be validated with stakeholder evidence.
- 2) **Using the preliminary look up tables for coastal erosion (see pages 78-80), identify the number of businesses that are likely to shut down, or move out of the local area.** This is based on the assessment of adaptive capacity and location dependence.
- 3) **Calculate the value of working hours of these businesses per annum, in present value discounted terms.** Using earnings data by business type, calculate the value of lost working hours per business type =

*Average number of employees per business * earnings per employee * number of businesses likely to move out of the area or shut down*

To calculate the present value of the dynamic impacts, apply the discount factor (based on a discount rate of 3.5% as recommended by the Green Book*) – the process of discounting is as described in the main part of the toolkit. This provides a present value for each year of activity.

4) Using the probability distribution for each property, **calculate the expected value of loss for properties at risk within the 10-year appraisal period.** The relevant formula is:

$$E[X] = \sum_{i=1}^{\infty} x_i p_i$$

Expected GVA loss for a given business over 10yr appraisal period (points to x_i)

Discounted GVA for business in year i (points to x_i)

Probability of business being lost in year i (points to p_i)

Benefits from FCERM arise because these losses are delayed.

Probability Distribution

Detailed modelling will, for some appraisals, have assigned a probability of loss in any given year to each property. Given the uncertainty, there is also likely to be a probability that the property is lost in adjacent periods. These probabilities can be used to estimate the expected value of lost economic activity for each property. When summed across all properties, this provides an estimate of the total GVA impact of coastal erosion in the “do nothing” scenario. FCERM would be assumed to delay the expected loss.

Annex 6: Measuring Coastal Erosion – worked example

Headline points

- The calculations can be undertaken using Microsoft Excel.

Worked example

Below is a simplified example of how the coastal erosion impact relating to those businesses that shut down, or move out of the local area can be calculated. This considers a hypothetical scheme providing protection to 9 businesses in the East of England. For each business, a ‘best view’ of the year in which it is likely to be lost is determined – this is assigned a probability of 70%. To reflect uncertainty, there is a smaller, 15% chance., that the property is lost in the 5-year preceding period, and a 15% chance it is lost in the 5-year subsequent period. In this example, the probability distribution analysis focuses on years 0, 5 and 10 rather than for each individual year across the 10-year appraisal period (in some cases, annual probability data may be available). The table can be read as follows. For year 5, for example, we need to account for:

- i. The potential loss for those businesses for whom the best view is that they are lost in that year (i.e. have a 70% chance of loss). This is £10,446,826
- ii. The potential loss from businesses for whom the best view (70% chance) is that they are lost in year 0 or year 10, i.e. they have a 15% chance they are lost in year 5. Respective values are £18,710,361 and £1,594,87.

The coastal erosion protection scheme is assumed to delay the risk of erosion until after year 100 so all potential losses are avoided.

Year Expected to Fall	Present Value of Lost Economic Activity over 10-year period	Probability of falling in that year	Expected Lost Economic Activity
0	£ 9,355,180	0.7	£ 6,548,626
0	£ 5,223,408	0.15	£ 783,511
5	£ 18,710,361	0.15	£ 2,806,554
5	£ 10,446,816	0.7	£ 7,312,771
5	£ 1,594,897	0.15	£ 239,235
10	£ 5,223,408	0.15	£ 783,511
10	£ 797,448	0.7	£ 558,214

Multiply the PV of lost GVA by probability of loss due to coastal erosion

This represents the present value of the stream of economic activity that is lost for the remainder of the 10-year GVA appraisal period.

Total loss from coastal erosion over the 10 year period =	£ 19,032,423
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Sum over all expected losses

Annex 6: ‘Look-Up Tables’ for Adaptive Capacity and Location Dependence and likely response for businesses to risk of coastal erosion

The following pages provide the preliminary look-up tables for Micro, Small/Medium, and Large businesses. These outline the likely level of adaptive capacity (Low, Medium or High), location dependence (Low or High), and likely response of each of the 62 business types. The supplementary spreadsheet accompanying this document provides useable versions of these look-up tables.

Look-up table for ‘Micro’ businesses

Business Type	Adaptive Capacity (High or Low)	Location Dependence (High or Low)	Likely Business Response
Agriculture, Forestry and Fishing - Micro	L	H	Shut down entirely
Mining and Quarrying - Micro	H	H	Stay within local area
Manufacturing - Micro	L	L	Shut down entirely
Electricity, Gas, Steam and Air Conditioning Supply - Micro	L	H	Shut down entirely
Water Supply; Sewerage, Waste Management and Remediation Activities - Micro	L	H	Shut down entirely
Construction - Micro	L	L	Shut down entirely
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles - Micro	L	H	Shut down entirely
Transportation and Storage - Micro	L	H	Shut down entirely
Accommodation and Food Service Activities - Micro	L	H	Shut down entirely
Information and Communication - Micro	L	L	Shut down entirely
Financial and Insurance Activities - Micro	L	H	Shut down entirely
Real Estate Activities - Micro	L	L	Shut down entirely
Professional, Scientific and Technical Activities - Micro	L	H	Shut down entirely
Administrative and Support Service Activities - Micro	L	L	Shut down entirely
Public Administration and Defence; Compulsory Social Security - Micro	L	H	Shut down entirely
Education - Micro	L	H	Shut down entirely
Human Health and Social Work Activities - Micro	L	H	Shut down entirely
Arts, Entertainment and Recreation - Micro	L	L	Shut down entirely
Other Service Activities - Micro	L	L	Shut down entirely
Activities of Households as Employers; Undifferentiated Goods-and Services-Producing Activities Of Households for Own Use - Micro	L	H	Shut down entirely
Activities of Extraterritorial Organisations and Bodies - Micro	L	L	Shut down entirely

Source: based on information in Frontier et al, 2013

Annex 6: 'Look-Up Tables' for Adaptive Capacity and Location Dependence and likely response for businesses to risk of coastal erosion

Look-up table for 'Small/Medium' businesses

Business Type	Adaptive Capacity (High, Medium or Low)	Location Dependence (High or Low)	Likely Business Response
Agriculture, Forestry and Fishing - Small/Medium	L	H	Shut down entirely
Mining and Quarrying - Small/Medium	H	H	Stay within local area
Manufacturing - Small/Medium	L	H	Shut down entirely
Electricity, Gas, Steam and Air Conditioning Supply - Small/Medium	L	H	Shut down entirely
Water Supply; Sewerage, Waste Management and Remediation Activities - Small/Medium	L	H	Shut down entirely
Construction - Small/Medium	L	L	Shut down entirely
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles - Small/Medium	L	H	Shut down entirely
Transportation and Storage - Small/Medium	L	H	Shut down entirely
Accommodation and Food Service Activities - Small/Medium	L	H	Shut down entirely
Information and Communication - Small/Medium	L	L	Shut down entirely
Financial and Insurance Activities - Small/Medium	L	H	Shut down entirely
Real Estate Activities - Small/Medium	L	L	Shut down entirely
Professional, Scientific and Technical Activities - Small/Medium	L	H	Shut down entirely
Administrative and Support Service Activities - Small/Medium	L	L	Shut down entirely
Public Administration and Defence; Compulsory Social Security - Small/Medium	H	H	Stay within local area
Education - Small/Medium	L	H	Shut down entirely
Human Health and Social Work Activities - Small/Medium	L	H	Shut down entirely
Arts, Entertainment and Recreation - Small/Medium	L	H	Shut down entirely
Other Service Activities - Small/Medium	L	L	Shut down entirely
Activities of Households as Employers; Undifferentiated Goods-and Services-Producing Activities Of Households for Own Use - Small/Medium	L	H	Shut down entirely
Activities of Extraterritorial Organisations and Bodies - Small/Medium	H	L	Move out of the local area

Source: based on information in Frontier et al, 2013

Annex 6: 'Look-Up Tables' for Adaptive Capacity and Location Dependence and likely response for businesses to risk of coastal erosion

Look-up table for 'Large' businesses

Business Type	Adaptive Capacity (High, Medium or Low)	Location Dependence (High or Low)	Likely Business Response
Agriculture, Forestry and Fishing - Large	H	H	Stay within local area
Mining and Quarrying - Large	H	H	Stay within local area
Manufacturing - Large	H	H	Stay within local area
Electricity, Gas, Steam and Air Conditioning Supply - Large	H	H	Stay within local area
Water Supply; Sewerage, Waste Management and Remediation Activities - Large	H	H	Stay within local area
Construction - Large	H	L	Move out of the local area
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles - Large	H	H	Stay within local area
Transportation and Storage - Large	H	H	Stay within local area
Accommodation and Food Service Activities - Large	H	H	Stay within local area
Information and Communication - Large	H	L	Move out of the local area
Financial and Insurance Activities - Large	H	H	Stay within local area
Real Estate Activities - Large	H	L	Move out of the local area
Professional, Scientific and Technical Activities - Large	H	H	Stay within local area
Administrative and Support Service Activities - Large	L	L	Shut down entirely
Public Administration and Defence; Compulsory Social Security - Large	H	H	Stay within local area
Education - Large	H	H	Stay within local area
Human Health and Social Work Activities - Large	H	H	Stay within local area
Arts, Entertainment and Recreation - Large	H	H	Stay within local area
Other Service Activities - Large	H	L	Move out of the local area
Activities of Households as Employers; Undifferentiated Goods-and Services-Producing Activities Of Households for Own Use - Large	L	H	Shut down entirely
Activities of Extraterritorial Organisations and Bodies - Large	H	L	Move out of the local area

Source: based on information in Frontier et al, 2013

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