Department for Environment Food & Rural Affairs

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Environment Agency

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Asset performance tools: pre-calculated risk datasets guidance

SC140005/R4

Flood and Coastal Erosion Risk Management Research and Development Programme

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Professor Doug Wilson
Director, Research, Analysis and Evaluation

Executive summary

This guidance describes the type of risk information required by asset managers and the existing risk-based datasets that can support them in making rapid and cost-effective investment decisions. Detailed descriptions are provided for the following datasets:

- National Flood Risk Assessment (NaFRA)
- State of the Nation
- NaFRA2
- National Coastal Erosion Risk Mapping (NCERM)
- Long-Term Investment Scenarios (LTIS)
- Conveyance KPI dataset

The purpose of the guidance is to improve asset management decision-making by making use of existing information on risks. When combined with other information, the use of risk data will help better identify where, when and how to intervene to reduce flood risk for least cost and greatest benefit.

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1 Introduction

1.1 Purpose of this guidance

To reduce the number of people, properties, infrastructure and land at risk, it is essential that flood and coastal investment is directed toward those assets where the biggest risk reduction can be made for the money available.

This guidance outlines the perceived needs of asset managers for risk data and explains how existing risk-based datasets can support them in obtaining that understanding of risk. The guidance is intended for:

- local asset management teams involved in asset management investment decisions
- national teams involved in the generation and specification of risk data

Although the end users are primarily Environment Agency staff, the guidance will also be of interest to risk managers involved in flood risk asset management. However, some of datasets described here are currently not readily available outside the Environment Agency.

The purpose of this document is to improve understanding of asset management requirements for risk data and the availability of existing risk datasets. Using risk data, asset management decision-making can be improved, leading to better identification of where, when and how to intervene to reduce flood risk for least cost and greatest benefit.

This guidance is an output from the Phase 3 of the Asset Performance Tools project.

1.2 Report structure

Chapter 2 describes the use of risk information in asset management decision-making and the anticipated requirements of asset managers.

Chapter 3 presents different risk datasets in a structured form, including how they can be used in the context of asset management.

2 Risk information in asset management decision-making

2.1 General introduction

2.1.1 Definition of asset management

Asset management is defined in ISO 55000 as the 'coordinated activity of an organisation to realize value from assets' (BSI 2014).

On its website,[1] the Environment Agency defines asset management as:

> 'making the most of the resources we have and gaining best value from the work we do. In terms of flood and coastal risk management this means ensuring that we plan and deliver investment to gain the most effective reduction in flood risk to the public and infrastructure'.

2.1.2 The concept of risk

Risk (*R*) is defined as the likelihood or probability (*P*) of the consequence (*C*):

$$R = P \times C \tag{2.1}$$

The **consequence** refers to the undesirable outcome should an event be realised, which could extend beyond the local source of the hazard. The consequence can be expressed using different metrics such as damage costs or number of properties.

Risk-based analyses consider potential consequences for possible flood events of a wide range of sizes from small frequent storms to rare but very large events. This is distinct from more traditional methods that consider the consequences for a particular peak level of hazard without necessarily linking them with the likelihood of the hazard occurring.

In the context of flood-related asset management, there is merit in further refinement of the concept of risk into 2 subcategories:

- Residual Risk – the risk that remains when the influence of flood mitigation assets is accounted for
- Undefended Risk – the risk that arises when the influence of flood mitigation assets is removed

The avoided risk – or benefit afforded by the existing flood mitigation assets (Existing Benefit) – is therefore:

$$\text{Existing Benefit} = \text{Undefended Risk} - \text{Residual Risk} \tag{2.2}$$

If these metrics can be identified on an asset-specific basis, it enables asset managers to gain an understanding of which assets within the system are performing poorly and

[1] http://evidence.environment-agency.gov.uk/FCERM/en/Default/FCRM/Areas/AM.aspx

thereby contributing most to Residual Risk. This information can be used to help support cost-effective targeted investment decisions seeking to reduce Residual Risk.

In addition, Existing Benefit is useful in identifying the value of the prevailing flood management infrastructure on a per asset basis. This makes it easier to identify those assets within a system that are performing strongly and making a significant contribution to the reduction in Residual Risk. A decline in maintenance investment in these assets is therefore likely to significantly increase Residual Risk.

Risk information aims to support:

- decision-making on the type of investments required (for example, maintenance refurbishment or new capital investment), providing an understanding of the benefits of risk reduction, which must outweigh its cost, and other possible impacts. The main investment decisions are related to the improvement, replacement and maintenance of assets
- reporting of current and future performance of interventions (for example, based on Existing Benefit and key performance indicators, KPIs)
- influencing – by providing support to justify certain types of investments such as withdrawal of maintenance or where additional investment may be required from government
- the distribution of Existing Benefit to assets and receptors that can impartially provide the inventory of value used to accurately determine the relative costs that should be met by beneficiaries under partnership funding of capital schemes

2.1.3 Asset management modelling

Asset management modelling often consists of scenario simulation. These scenarios can relate to target condition grades and postulated maintenance activities that relate to deterioration rates. Such activities help generate asset-specific information relating to Residual Risk and Undefended Risk, and therefore support the development of efficient asset management plans.

2.1.4 Risk-based approaches

A risk-based approach to assess the impacts of asset interventions (either through investment or expenditure reduction) involves 2 main steps:

1. Understanding changes in asset performance due to an increase or decrease in investment
2. Understanding how these changes in asset performance translate into changes in Residual Risk and therefore Existing Benefit

Risk-based approaches help to comply with the principles of modern regulation. These principles are (Environment Agency 2005):

- transparency – rules and processes that are clear to those in businesses and local communities
- accountability – be able to explain performance
- consistency –the same approach should be applied within and between sectors and over time

- proportionality (or risk-based) – resources must be allocated according to the risks involved and the scale of outcomes which can be achieved
- targeted (or outcome-focused) – the environmental outcome must be central to planning and in assessing performance

The government set Outcome Measures for the Environment Agency and other operating authorities that manage flood risk such as local authorities and Internal Drainage Boards. Outcome Measures form the basis by which the priorities for capital investment decisions such as replacement and major refurbishes are set. For example, the Outcome Measure in relation to river and sea flooding is defined as the number of households moved out of any flood probability category to a lower probability category (Environment Agency 2014a).

In addition, the Environment Agency sets KPI targets in its corporate plans. KPIs support the monitoring and progress of maintenance activities which increase the resilience of people, property and business to the risks of flooding and coastal erosion. More details of current KPI indicators can be found in Environment Agency (2014b).

The main types of flood assets that the Environment Agency and other risk management authorities actively manage to reduce the chance of flooding are:

- linear assets (for example, raised defences such as embankments or walls)
- watercourses (for example, vegetation and sediment within a channel)
- point assets (for example, pumps, gates or culvert trash screens)
- flow control structures (for example, barriers, weirs, flood storage areas)
- coastlines (for example, groynes and beaches)

2.2 Risk information requirements

Flood risk management authorities have different levels of maturity in the way asset types are managed and thus may require different levels of information.

This section provides a review of the general and more specific requirements.

- Section 2.2.1 looks at aspirational requirements.
- Section 2.2.2 discusses general requirements, concepts such as system versus asset approaches, scales and metrics of risks, and future conditions.
- Section 2.2.3 examines specific requirements and explores the concepts related to maintenance of assets in terms of their standard of protection (SoP), structural integrity and conveyance capacity.

2.2.1 Aspirational requirements

The information requirements described in this section have been drawn up based on specific needs in the Environment Agency assimilated over many years. They have been developed as a complete set of metrics which includes some idealised aspirational requirements (not currently available) to enable existing information, and future developments, to be measured.

In relation to maintenance activities, asset managers require an understanding of:

- Residual Risk in the floodplain and asset-specific contribution to this
- Existing Benefit from assets and asset-specific contribution to this (it is necessary to determine Potential Risk in order to determine Existing Benefit)
- the influence on Residual Risk and Existing Benefit from increases/decreases in investment at a system and asset-specific level (that is, how can expenditure be optimised in terms of risk reduction)

When considering decisions related to the improvement of assets, information is required on future changes in risk conditions due to factors such as climate change, deterioration and their relationship with maintenance expenditure.

In general it is desirable for modelling systems that generate information to support asset management decisions to:

- determine all the metrics described above
- offer flexibility and be readily updated and modified to account for:
  - new data that comes online (for example, crest levels, geometry, condition, new receptors, new flood defence schemes)
  - explore different postulated asset management scenarios (for example, reduced or increased maintenance)

Asset managers provided feedback on the type of information required during the initial workshops held as part of the Asset Performance Tool project (Environment Agency 2015a). This feedback is summarised below.

- Risk-based information is needed for at least the most important asset types.
- Available risk-based information must be consistent for all relevant risk management authorities.
- It is necessary to ensure that access to risk-based information fits in with the overall management systems within end user organisations.
- The effort to gather risk-based information has to be proportionate to the decision being made.
- Resource requirements (skills and availability) to access risk datasets need to be considered reasonable by end users. This may require consideration of the computer hardware and software environment expected to be available to the end users.
- The accuracy of risk-based information needs to be appropriate for the context of the decision; hence lower accuracy will be acceptable for early stage planning.
- The decisions that can be supported by risk-based information need to be clearly stated.
- The information from the risk dataset should help to articulate quantitatively and transparently the benefits of investment.

The specific risk metrics required are summarised in Table 2.1.

Table 2.1 Risk metrics

Risk metric	Asset or floodplain (properties/infrastructure)?	Description
Residual Risk This can be further disaggregated into, for example, fluvial, coastal, per asset, saline, freshwater.	Floodplain	Flood risk remaining on the floodplain after the presence of flood mitigation assets is accounted for
Undefended Risk This can be further disaggregated into, for example, fluvial, coastal, per asset, saline, freshwater.	Floodplain	Flood risk on the floodplain that arises when flood mitigation assets are not accounted for
Existing Benefit This can be further disaggregated into, for example, fluvial, coastal, per asset, saline, freshwater.	Floodplain	Potential Risk – Residual Risk
Asset Contribution to Residual Risk (breaching/overtopping)	Asset	Residual Risk attributed to specific assets
Asset Contribution to Existing Benefit	Asset	Existing Benefit attributed to specific assets

2.2.2 Existing risk information

This section reviews existing risk-based approaches in relation to the requirements of asset managers defined above.

Existing system and asset-based risk approaches

Current practice provides risk-based information that considers the performance of flood mitigation assets using 2 approaches:

- Systems-based risk approach – risk information derived from the consideration of systems of flood defence assets, where each individual asset is assessed within the wider context of the system in which it operates
- Asset-specific approach – risk information derived from consideration of an asset in isolation to the other assets within its system

The primary information obtained from systems-based flood risk approaches such as the National Flood Risk Assessment (NaFRA) and implemented within the Modelling and Decision Support Framework 2 (MDSF2) consists of:

- floodplain risk maps that show the spatial distribution of Residual Risks (Figure 2.1)
- Asset Contribution to Residual Risk maps that show the influence of each asset in terms of the Residual Risk (Figure 2.2)

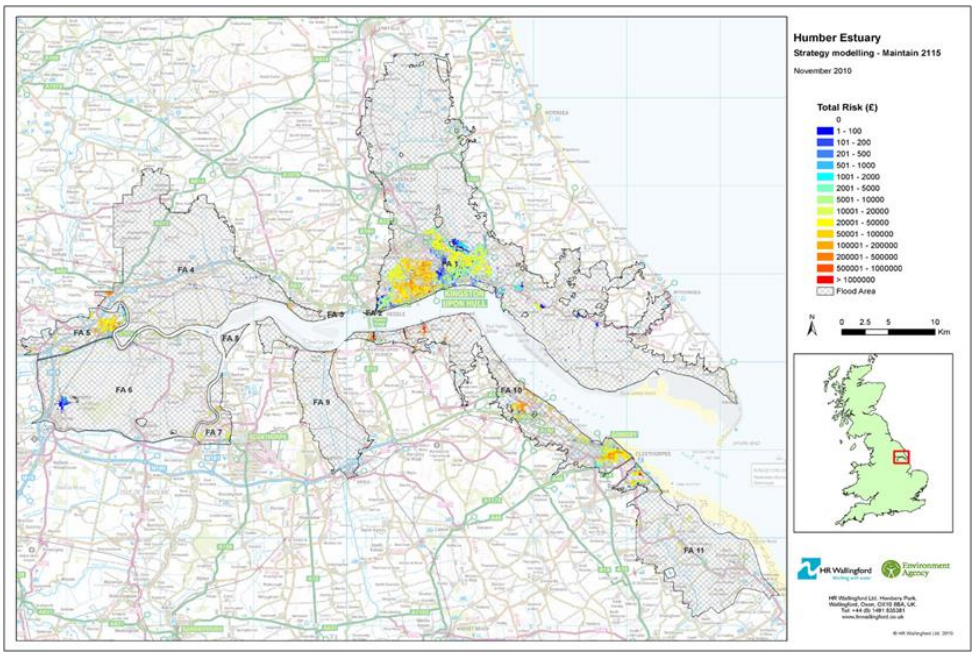

Figure 2.1 Example of a flood risk map showing the spatial distribution of Residual Risk across the floodplain obtained from a system risk model

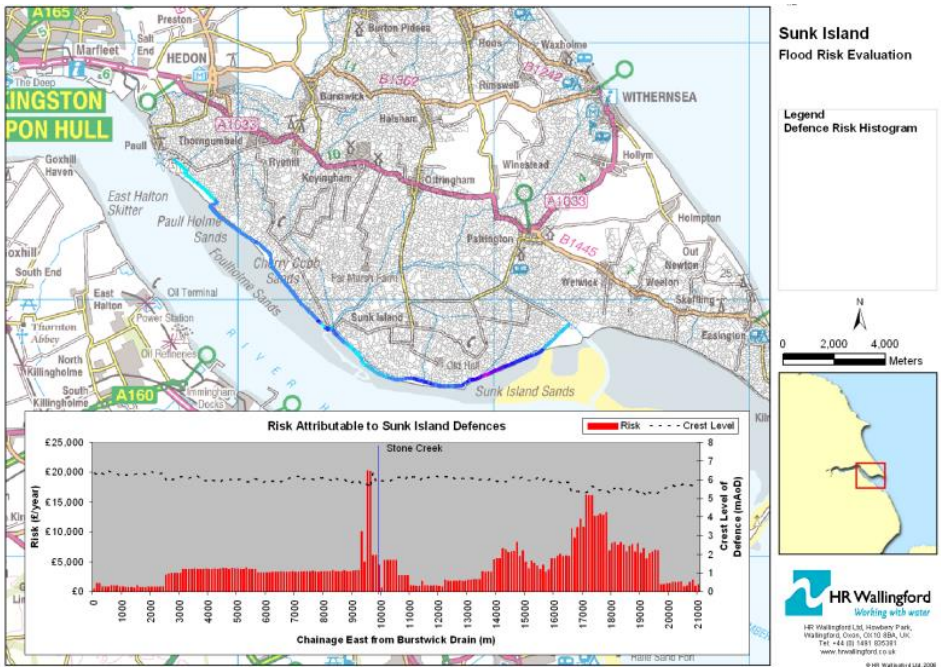

Figure 2.2 Example of Residual Risk, calculated using a system risk model, attributed to specific assets in the system

Assets with a high contribution to Residual Risk would be identified as a target for maintenance/refurbishment. All defences within the system can be ranked according to their asset contribution and this can help support the basis for prioritisation. However, the Asset Contribution to Residual Risk does not capture all of the relevant information associated with risk. More specifically, it does not include the Asset Contribution to

Existing Benefit. This gap is being address within the ongoing State of the Nation project whereby Undefended Risk is being evaluated and the related Asset Contribution to Existing Benefit is being evaluated using the systems modelling approach.

It is desirable to evaluate the Asset Contribution to Residual Risk and Existing Benefit metrics using systems-based approaches. However, there may be occasions when simplistic approaches that consider assets in isolation, rather than in a system, are required. More specifically this can relate to field-based methods such as the Risk Attribution Field Tool (RAFT) (HR Wallingford 2010) (Figure 2.3).

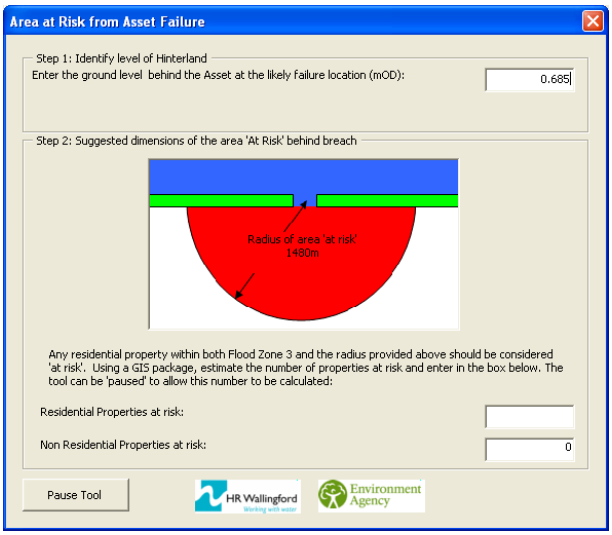

Figure 2.3 Example of how to input data about consequences into RAFT

When considering the risks of assets in isolation, it is important to be aware of the limitations. For example, the overall influence on risk of other assets in the system is not considered.

In the example shown in Figure 2.4, Asset 1 could be considered as crucial in protecting the properties in the system. However, when analysing it as part of a system and taking into account the influence of neighbouring assets, it is obvious that to reduce the risk of flooding of these properties, other assets in the system (in this case Asset 2) also need to be considered. If quantifying the benefits of any interventions in Assets 1 and 2 as number of properties protected, the asset in isolation approach could lead to double counting, where the benefits provided by Asset 1 (that is, 4 properties) are added to the benefits provided by Asset 2, which are the same 4 properties.

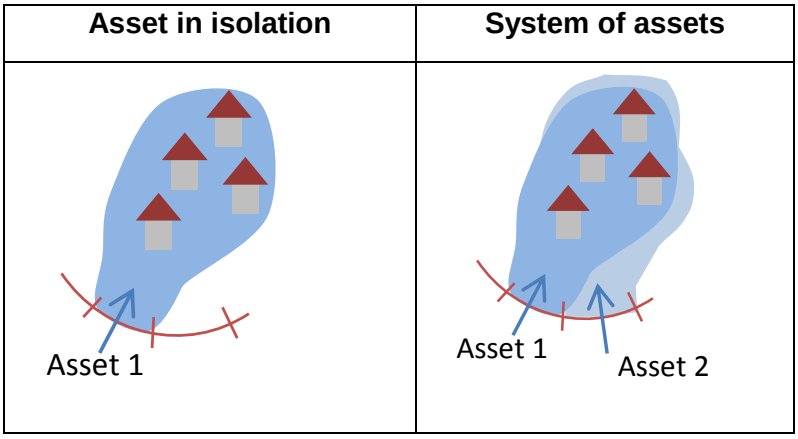

Figure 2.4 Comparison of asset in isolation and system approaches

Conversely, there may be situations where the asset in isolation approach underrepresents the risk, for example, in situations where there is insufficient volume associated with individual assets to inundate properties but the greater volume associated with the system is sufficient.

Scale of risk results

Asset management occurs at a number of levels ranging from national to local.

At the local level, for example, it is necessary to understand the contribution to risk of particular assets in order to take decisions on the level of maintenance required.

At national level, it may be necessary to understand the general level of risk associated with different investment strategies. Optimisation of maintenance strategies – and the trading off of the reduction in Residual Risk with costs associated with the intervention measures – can support the development of maintenance programmes that provide best value.

Existing Risk metrics

Past and current national risk assessments use a range of risk metrics, including:

- expected annual damages (EAD) – Residual Risk using a flood system risk analysis model
- weighted average annual damage – Residual Risk derived using national average flood depths and related damages
- expected number of properties flooded, differentiating between residential and non-residential
- expected number of people exposed to flooding

Another metric to be considered is the risk of death or serious harm to people, which can be estimated by taking into account the impacts of water depths and/or flow velocities on people (Defra and Environment Agency 2006). This metric could help to prioritise maintenance interventions in areas where, for example, a breach failure is likely to result in loss of life.

Future conditions

In addition to understanding the risks of the current situation, asset managers need to understand how changes of risk may be happening in the future associated with climate change and/or different development conditions, including different maintenance investment strategies.

Assessments such as Foresight (2004), the flood sector report for the Climate Change Risk Assessment (Defra 2012), Long-term investment scenario (Environment Agency 2014c) and the report by HR Wallingford for the Committee on Climate Change (HR Wallingford 2012) evaluated the risk of flooding under both present conditions and future projected climate conditions.

2.2.3 Specific requirements

This section reviews the requirements which asset managers face in relation to specific management activities such as maintaining:

- the SoP of an asset – related to its crest level
- its structural integrity – related to its condition grade
- its conveyance capacity

The SoP is linked to the probability of overtopping, while the loss of structural integrity is linked to the probability of breaching. Loss of conveyance capacity may have an influence in both – overtopping due to the increase in water levels, and breaching due to the increase in loading conditions – and thus on the probability of breaching (Figure 2.5).

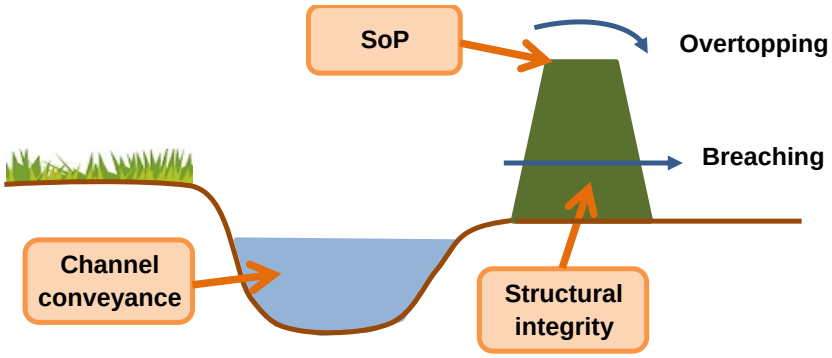

Figure 2.5 Asset characteristics and their relationship with flood risk

Standard of protection

The SoP in flood risk management is defined as the annual probability of the design flood level (crest level minus freeboard) being reached or exceeded. SoP is generally used in the context of linear and coastal defences, and the requirements described below have that type of assets in mind.

Asset managers need to understand how the SoP of an asset or a system of assets influences the risk in the following scenarios:

- the current situation in order to report present day risks – this is the Residual Risk associated with a particular SoP
- the situation where the risk increases if the SoP is not achieved (for example, due to reduction of crest level because of settlement or increase in loading conditions)
- the situation where the risk reduces if the SoP is increased by raising crest levels or lowering loading conditions

The risks associated with the above scenarios are represented in flood risk modelling by overtopping, which is the passage of water over an asset due to high water levels or wave action.

Structural asset maintenance regime

The maintenance regime influences the condition of the asset. For linear, coastal and point defences this is represented by the condition grade, which is associated with a fragility curve that provides an understanding of the probability of structural failure (Figure 2.6).

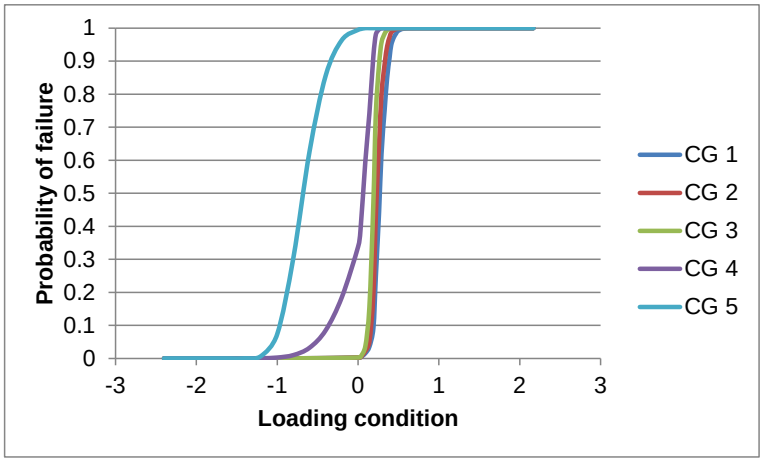

Figure 2.6 Example of fragility curves for different condition grades

The failure of linear assets is modelled in flood risk studies by considering a breach in the defence.

Asset managers need to understand how the maintenance regime influences risk in the following scenarios:

- In the current situation, to report present day risks. This is the residual risk associated with the current condition grade. It may be of specific interest to local asset managers to understand the current performance of their assets. At a national level, it is useful to get a general understanding of the risks in the country to support funding and monitoring.
- The situation where all assets are at their target condition grade. This condition grade could be different to the current grade. At both national and local level, it is useful to compare the current risk with the risk associated with the target condition grade.
- The situation where the risk increases if maintenance is withdrawn or reduced and, as a consequence, the condition grade of the defence drops.
- The situation where risk reduces if maintenance increases and therefore the condition grade of the asset improves.

The first scenario is assessed using the system risk model by considering all the defences at their current condition grade, while the second scenario considers them at their target condition grade. The understanding of the increase or decrease in risk is obtained by comparing the results from the 2 scenarios. In this case, the comparison of the risks at the target and current condition grades provides an understanding of the increase in risk due to not maintaining the assets at its target condition (since often the current condition grade is equal to or worse than target).

The last 2 scenarios above are of interest to both local and national asset managers in order to better understand the needs and impacts of maintenance programmes. The scenarios can be reproduced in modelling risk platforms by reducing or increasing the current condition grades of assets. For national managers, it can also be of interest to understand the increased risk if all maintenance is withdrawn and all assets are allowed to deteriorate to their worst condition. This is reproduced in the modelling by setting the condition grade of the existing defences to the lowest condition (condition grade 5).

Depending on the characteristics of the asset, standard fragility curves developed for a number of asset types may not properly describe the real condition of the asset. In

those cases, asset managers may be interested in using bespoke fragility curves to describe their assets in flood risk analysis.

Conveyance maintenance

Conveyance management can be seen as maintaining the channel to a particular condition with the aim of containing a certain water discharge below a given water level.

To demonstrate the effectiveness of channel activities such as vegetation cutting, desilting or dredging, asset managers need to understand the risks associated with current, target and no channel maintenance interventions. This comparison will provide an estimate of the benefits of interventions currently undertaken. These results can be used for strategic planning at national level and to justify interventions at more local level.

To explore the frequency or the need for certain types of channel interventions, local asset managers require risk estimations that take into account the detail of these type of interventions. National studies may not provide this information and so local studies may be required. These may involve the use of tools like the Vegetation and Roughness tool (also developed under the Asset Performance Tool project) to obtain an understanding of the likely impacts of channel maintenance options.

Channel conveyance activities are performed at a particular point in time and it is expected that the benefits (or risks) associated to them will change with time (for example, vegetation will grow or sediment will be deposited in the channel). Asset managers therefore require an understanding of the optimal frequency of conveyance management activities and how risks change over a range of temporal scales, from one year (to coincide with the seasonal life cycle of certain in-channel vegetation) to several years (for example, accretion of the river bed due to sediment deposition).

Channel conveyance assessment guidance is given in report SC140005/R2.

3 Risk datasets

3.1 Overview of the available datasets

Several datasets containing risk-based information have been produced to support asset management decision-making, helping to make the process quicker and more efficient.

National datasets have most often been created with national data.[2] Local knowledge and data should also be considered where necessary and appropriate.

The datasets reviewed in this guidance are summarised in Table 3.1 where a short description is provided. In addition, Table 3.2 provides details of the aspirational metrics and properties of modelling systems used to generate this information. Further information on each one is presented in the following sections.

Other pre-calculated risk datasets have been developed in some Environment Agency Areas that could prove useful data for asset management (for example, culvert blockage lookup tables). Environment Agency staff may wish to check with their Modelling and Forecasting, Modelling Mapping and Data, Asset Performance and Incident Management colleagues.

Table 3.1 Summary datasets (as of March 2018)

Dataset	Short description	Coverage	Availability
National Flood Risk Assessment (NaFRA)	System analysis to assess current risk associated with inundation from rivers and the sea	England and Wales	Public Latest national update 2008
State of the Nation (SoN)	Updated version of NaFRA including new modelling approaches and multiple asset management scenarios	England	Baseline available in Open Data Other results internal to Environment Agency To be released in 2018
NaFRA2	Single scalable assessment of flood risk	England	Due for release after 2018
National Coastal Erosion Risk Mapping (NCERM)	Coastal erosion risk mapping for the short, medium and long term	England	2012 version available, partial update 2017
Long-Term Investment Scenarios (LTIS)	Long-term flood and coastal erosion risk management investment scenarios reported at national scale	England	2014 version available, additional analysis due 2018
Conveyance KPI	Flood risk benefits of channel conveyance maintenance at national level	England	Internal Environment Agency, 2016

[2] Some of the national data consist of a central store of local data managed nationally.

Table 3.2 Risk modelling metrics provided by the different datasets

	NaFRA	SoN	NaFRA2	NCERM	LTIS	Conveyance KPI
Residual Risk	✓	✓	✓	✓	✓	✓
Undefended Risk		✓				
Existing Benefit		✓				
Asset Contribution to Residual Risk		✓				✓
Asset Contribution to Existing Benefit		✓				
Flexible and readily updateable						

3.2 National Flood Risk Assessment

National Flood Risk Assessment (NaFRA)	
Description	
The NaFRA database (also known as Risk of flooding from Rivers and Sea) provides the likelihood of flooding from rivers or the sea at national scale based on a maximum grid size of 50m by 50m. Several scenarios were considered in the assessment: • Current situation – standard NaFRA scenario providing Residual Risk for current conditions • No defence scenario – assumes no defences in place and its comparison with the Current situation provides an understanding of the risk reduction that defences are providing • No channel management scenario – assumes no conveyance maintenance activities are taken place in any watercourse, and its comparison with the Current situation provides an understanding of the benefits or performing channel maintenance activities The latest 2 scenarios were produced for the Environment Agency's System Asset Management Plans (SAMPs). NaFRA outputs support the development of the Environment Agency's Flood Map products, which show the risk of flooding from rivers and sea in England. This information supports the understanding of the areas likely to be flooded. The maps provide the likelihood of flooding to areas of land within floodplains defined by an extreme event (1 in 1,000 years or 0.1% chance in any given year). This outline is defined as Flood Zone 2. Flood Zone 3 shows the area that could be flooded by the sea with a probability of 0.5% (1 in 200)	**Coverage** England and Wales **Last update** Created in 2008, with several updates in particular areas since

or greater or from a river with a probability of 1% (1 in 100) or greater.	

How it can be used?

The public outputs provide an understanding of the areas that have a likelihood of flooding and therefore where the impacts of interventions are more likely to have a greater impact.

It is a standard dataset for determining categories of flood risk for the insurance industry.

Detailed outputs, only available internally to the Environment Agency through its asset management systems, provide more comprehensive information on several aspects such as risk impacts of channel maintenance and estimates of damage from flooding to property and agricultural land.

Advantages and limitations

NaFRA provides consistent flood risk information for the entire country. The flood likelihood category information is publicly available.

The maximum grid size of 50m by 50m may not be appropriate to study local flooding issues.

The accuracy of the dataset depends on the quality of the inputs at national scale.

The modelling is based on assessment of a significant number of return period (40) events and potential asset failure combinations.

The inundation model is not generally able to provide results at property level.

Where to get it from

Flood Map products can be checked online.

Long term flood risk assessment for locations in England: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map (select 'Flood risk from rivers or the sea')

Spatial data: https://data.gov.uk/dataset/risk-of-flooding-from-rivers-and-sea1

Detailed information is part of the Environment Agency asset management systems.

3.3 State of the Nation

State of the Nation (SoN)

Description

SoN is a national flood risk assessment that is using updated data and methods (MDSF2) to produce an update to NaFRA 2008. It provides a system-based approach to risk assessment. This type of approach aims to describe each element within the system and represent the links between them to provide a structured characterisation of the system behaviour. As in NaFRA, the floodplain area is discretised into a series of cells of maximum size 50m by 50m.

Coverage

England

Last update

Release of results expected 2018

The main scenarios considered in SoN are:

- Baseline – an overview of flooding risks based on present condition of flood assets; for this scenario it is considered that all asset are at their current condition
- Creating Asset Management Capacity (CAMC) – the benefits of flood protection assets and their condition at system level. It considers 2 scenarios:
  - CAMC target condition – all flood defences are considered to be at their target condition
  - CAMC CG5 – all assets are set to condition grade 5
- SAMPs – explores the benefits of maintaining assets and channel capacity. To do this, it explores 2 scenarios:
  - SAMPS without defences – all raised defences are considered to have a crest level elevation equal to the ground level
  - SAMPS–Conveyance Do Nothing – no maintenance is performed in any channel and thus vegetation and sediment load are at their maximum, reducing the conveyance capacity
- SoN–RAFT – explores the benefits of maintaining the condition of individual flood protection assets; it considers the risk associated with failing each individual asset with the rest of the assets not failing nor being overtopped (and therefore not contributing to the risk). Three scenarios are assessed under SoN–RAFT:
  - SoN–RAFT target condition – all flood defences are considered to be at their target condition
  - SoN–RAFT CG4 – all assets are set to condition grade 4
  - SoN–RAFT CG5 – all assets are set to condition grade 5

The risks estimated via SoN will be reported using the national spatial grid and at asset level for breach and non-breach situations, broken down into the coastal and fluvial risk associated with agriculture, residential and non-residential assets. The count of properties at different likelihood bands will also be assessed.

In addition to risk reported in floodplain grid cells and at asset level, it is also captured at a per property level. In addition, the depth probability data can be used to assess risk to other receptors such as critical infrastructure, vulnerable people and transport network. Other metrics include counts of properties in different likelihood categories

How it can be used?

The asset level results for SoN will be uploaded into the Asset and Information Management System (AIMS) planning tool used by the Environment Agency

The results of the CAMC programme contribute to a better understanding of the value

of the existing system of flood defences. The CAMC results could be used to:

- gain a better understanding of the benefits of maintaining the assets at their target condition by comparing the CAMC target condition results with the baseline SoN results
- quantify the benefits of maintaining the condition grade of the system of defences by comparing the results of the CAMC condition grade 5 results with the baseline or CAMC target condition results

The SoN–RAFT results can be used to:

- explore the increase in risk (expressed as EAD) due to deterioration of condition grade of a particular asset
- explore the flooded area, the number of properties and area of agricultural land affected by the failure of an asset during a 100-year flood event
- report the benefits of asset maintenance through KPIs
- compare the relative importance of assets to identify the ones with higher risks to provide evidence to support the funding allocation process

The SAMPS results show:

- the increased risk if channel conveyance maintenance is withdrawn – the results can be used to justify the need of such activities and to compare the relative importance of channels in their contribution to risk
- the benefits of the current system of raised defences in the country by comparing the results of the SAMPS no defences scenario with the Baseline results

Advantages and limitations

SoN provides a fully system-based approach to risk assessment. It provides a large number of outputs related to the risks associated with flood defence assets and their maintenance (from a system and individual point of view) and to channel conveyance capacity. It provides a consistent national approach to:

- the assessment of flood likelihood and risk in the floodplain
- the contribution of risk associated with breach and overflow of the assets in AIMS Planning

A wide range of extreme events are assessed, ensuring that a broad range of possible storm condition severities are considered. A comprehensive sampling approach is used to assess asset failure, resulting in robust evaluation of the possible breach conditions and culvert blockage scenarios that may occur.

The main limitations are related to the quality of input data (at national level) and the inability of the inundation model to provide results at property level.

The quantification of SoN–RAFT risks is not a proper system risk based approach because it considers the inundation associated with inflow volume from individual assets in isolation to all others in the defence system. In addition, the interaction of floodwaters discharged from across multiple defences simultaneously is not considered. This is in contrast to the other SoN EAD results, which are based on a system risk approach, where each element within the system and the links between them are represented.

The results provided by SAMPS conveyance management scenario considers activities

related to vegetation management from a flood risk perspective.
Where to get it from
The results are expected to be embedded within Environment Agency systems such as AIMS Planning and made available as Open Data.

3.4 National Flood Risk Assessment 2

National Flood Risk Assessment (NaFRA2)

Description

The proposed NaFRA2 dataset will be a new single, scalable assessment of flood risk for England meeting a wide range of business needs. It will:

- cover multiple sources of flooding including river, coastal and surface water
- maximise the use of local modelling
- be applicable at a range of scales from the Environment Agency's Flood Risk Management System (FRMS) to individual assets and properties
- include a wide range of output variables such as flood depth, level, probability, velocity, duration, property damage (property counts and direct economic damage) and infrastructure impact
- be Open Data
- include a range of scenarios including different asset management scenarios and climate change scenarios

The scenarios and output variables of specific relevance to asset management are:

- risk information (annual probability and damage in EAD) calculated for passive (in-line) assets for current condition grade, target condition grade and reduced condition grade (CG5), breaching and overtopping. Reported at the system level, apportioned to assets and aggregated at a range of scales
- impact calculated for a set of blockage scenarios for culverts
- channel maintenance scenarios

Coverage

Whole of England

Last update

The first NaFRA2 dataset is planned for 2018+.

How it can be used?

The NaFRA2 data can be used for a range of business needs, the most relevant for asset management being:

- RAFT-type process within Atrium to support investment decisions on flood defence walls and embankments

- supporting decisions on clearance or maintenance of culverts
- channel maintenance decision support
- general use within asset management decision-making

Advantages and limitations

The development of NaFRA2 will provide a consistent and 'rich' dataset to support asset management. It will directly include local modelling, thus enabling local detail to be brought into the national dataset and encouraging wider buy-in. The comprehensive range of output variables and modelled scenarios will save money and time, as it is developed once and used across multiple functions.

Development of NaFRA2 was due to start in 2017 and the date for the delivery of the first release had not, at the time of writing, been set. Although NaFRA2 will build on existing datasets and methods, there will be new methods and data and these bring risks with delivery of the proposed specification.

Where to get it from

NaFRA2 is expected to be embedded within Environment Agency systems and made available as Open Data for use by other organisations involved in asset management related to flood defence.

3.5 National Coastal Erosion Risk Mapping

National Coastal Erosion Risk Mapping (NCERM)

Description

The National Coastal Erosion Risk Map shows the coastal baseline position and provides modelled potential erosion distances for the short, medium and long term. There is a separate dataset for each Shoreline Management Plan (SMP).

The coastal baseline is split to frontages. These are defined as lengths of coast with consistent characteristics based on cliff behaviour characteristics and the defence characteristics.

For erodible frontages, information is provided about erosion projections aligned with each SMP management policy, under 2 scenarios:

- Scenario 1 – SMP management policies are implemented as they currently stand
- Scenario 2 – a hypothetical scenario of no active intervention along the entire coast

The following information is provided for each frontage:

- erosion extents for each epoch:
  - short term (0–20 years)
  - medium term (20–50 years)
  - long term (50–100 years)

Coverage

England and Wales

Last update

2012 version available

Partial update 2017

• 5th, 50th and 95th percentile confidence levels for:
  − no active intervention policy scenario
  − with SMP2 policy scenario
• defence type
• SMP2 polices for each of the 3 epochs described above
• co-ordinates of the frontage mid-point	

How it can be used?
For an assessment of numbers of properties at potential risk from coastal erosion
Advantages and limitations
The accuracy of the dataset depends on the quality of the inputs at authority scale and on assumptions made within the erosion model method. It is not suitable for complex geological areas.
Where to get it from
NCERM for SMP5 (it is available for all SMPs): https://data.gov.uk/dataset/national-coastal-erosion-risk-mapping-ncerm-smp5-hunstanton-to-kelling-hard The data package contains 2 guidance notes. One provides a comparison of the NCERM model results with the SMP plan (SMP2). The other provides workflows for generating potential erosion zones using the data provided. SMP mapping: https://data.gov.uk/dataset/shoreline-management-plan-mapping1

3.6 Long-Term Investment Scenarios

Long Term Investment Scenarios (LTIS) – future risk models	
Description	
Three general sources of flood risk are included in LTIS: • from rivers and sea • from coastal erosion (see Section 3.2 on NCERM) • from surface water The flood risk from rivers and sea component of LTIS is based on the NaFRA model data and method. As shown in Figure 3.1, NaFRA provides the 'present day', the LTIS modelled snapshots for 4 future epochs (10, 25, 50 and 100 years), which equates to the 2020s, 2030s, 2060s and 2100s. A range of FCERM policy options and climate change futures are modelled, ranging from Do Nothing through to Improve++ under the 'central', 'upper end' and 'without' climate change scenarios from Adapting to Climate Change: Guidance for Risk Management Authorities (Environment Agency 2011, updated 2016). The modelled Residual Risk (£) and number of properties by risk category are grouped to the Environment Agency's FRMS.	**Coverage** England **Last update** Published December 2014 Additional analysis due in 2018

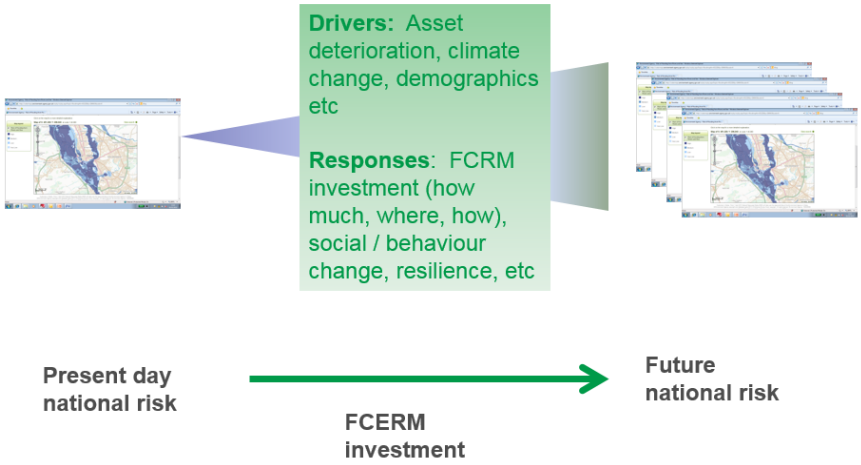

Figure 3.1 LTIS outputs

Climate change modelling

- 'Central estimate of CC'
- 'Upper end estimate of CC'
- 'No Climate Change'

For sensitivity testing on the flood likelihood category a 'Lower probability' scenario using the 'central' CC.

For each FRMS, epoch and climate change scenario, LTIS assesses the risk under the flood and coastal risk management (FCRM) policy options listed in Table 3.3. Each policy option is assessed. These are based on the definition from the Catchment Flood Management Plans.

Table 3.3 FCRM policy options assessed in LTIS

Option	Description
1. Do Nothing	Passive assets degrade and fail over a short period of time. The level of flood risk will increase quickly over time as assets fail. Non-operation of active assets increases risk on the very short term.
2. Do Minimum	The level of flood risk will increase slowly in the short term and then accelerate as assets begin to fail.
3. Maintain crest level	The level of flood risk will increase over time due to climate change
4. Maintain current flood risk	The level of flood risk will remain static as the size of defences keeps pace with climate change
5. Improve	The level of flood risk reduces as assets are replaced with ones that offer a better SoP
6. Improve+	The level of flood risk reduces as assets are replaced with ones that offer a better SoP

LTIS models also contain projected future asset-based expenditure for each FRMS, under each FCRM policy option.

The flood risk from other sources component of the LTIS is based on

national statistics from Environment Agency based on the updated Flood Map of risk from Surface Water. Note that these are not disaggregated to the FRMS level.	

How it can be used?

Risk metrics are by the FRMS. However, the granularity of analysis is national. Confidence decreases/uncertainty increases at regional level. It is not suitable for local level.

The data can be used for an initial assessment of potential future policy option(s), or the impact on risk (increase/decrease) of a particular given policy option and/or climate change in the future.

Advantages and limitations

The information is currently not publicly available.

The non-spatial databases with FRMS level risk metrics may be appropriate to study national or regional flooding issues.

The accuracy of the dataset depends on the quality of the inputs at national scale.

Where to get it from

FCERM long-term investment scenarios report (2014) (Environment Agency 2014c)

Or contact Environment Agency, Investment and Funding national team.

FRMS mapping is not published and not held in AIMS: contact Environment Agency

Risk of Flooding from Surface Water Extent: 3.3% annual chance: https://data.gov.uk/dataset/risk-of-flooding-from-surface-water-extent-3-3-percent-annual-chance

Risk of Flooding from Surface Water Extent: 0.1% annual chance: https://data.gov.uk/dataset/risk-of-flooding-from-surface-water-extent-0-1-percent-annual-chance

NCERM: see Section 3.5

3.7 Conveyance KPI dataset

Conveyance KPI dataset

Description

The Conveyance KPI is a national dataset developed for the Environment Agency reporting the flood risk benefits (at national level) of channel conveyance maintenance. It reports changes in channel conveyance (in-channel discharges and water levels) and associated risks for different assumed maintenance options. The risks are expressed as the number of houses at increased risk of flooding due to different management strategies. The results provide a quantified comparison of change in risk for the different maintenance scenarios considered.

Coverage

England

Last update

Released in 2016

How it can be used?
The dataset information can be used to identify strategically important watercourses where conveyance-related works produce the greatest benefit. This is done by identifying watercourses where maintenance works may have the potential to keep or increase conveyance capacity (potential important maintained watercourses) and watercourses where the attribution of benefits is important (potential important benefitting watercourses). The information in the dataset aims to support the definition of KPIs related to conveyance maintenance.
Advantages and limitations
The dataset provides a consistent approach to the benefits of channel maintenance across England. It does not take into account local conditions or maintenance works that are not flood risk related.
Where to get it from
The results are expected to be embedded within the Environment Agency's AIMS Planning and CAMC2 asset management programmes.

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List of abbreviations

AIMS	Asset Information Management System [Environment Agency]
CAMC	Creating Asset Management Capacity [Environment Agency]
EAD	estimated annual damages
FCRM	flood and coastal risk management [Environment Agency]
FRMS	Flood Risk Management System [Environment Agency]
KPI	key performance indicator
LTIS	Long-Term Investment Scenarios
MDSF2	Modelling and Decision Support Framework 2
NaFRA	National Flood Risk Assessment
NCERM	National Coastal Erosion Risk Mapping
SAMP	System Asset Management Plan
SMP	Shoreline Management Plan
SoN	State of the Nation [project]
RAFT	Risk Attribution Field Tool
SoP	standard of protection

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