STANDARDS FOR MODELLING OF FLOODING IN OPEN COASTS AND LARGE ESTUARIES

Keynote Presentation by:

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Cumbrian coast

Source

Dawlish 2004

Project Team:

The following members participated at various stages in producing this work

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- Karim Rakha,
- John Scrase and
- Laura Baird.

We acknowledge the contributions of various Environment Agency Area Teams that provided data and attended workshops for the National baseline study;

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Outline of presentation

- Why Standards?
  - Motivation
  - Objectives
- What Standards?
  - Model Standards
  - Assessment of model quality
- How to use Standards?
  - Treating models as assets
- National baseline of coastal/estuary flood model standards
- Conclusions

Why standards?

- Motivation
- Objectives

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Motivation

- £150 billion assets & 2.5 million people at risk from coastal flooding in the UK.
- Coastal flood models are used to:
  - **Underpin key investment decisions** to manage coastal flood risk.
  - **provide flood information for emergency response**.
  - **provide the evidence to prevent inappropriate development** in the flood plain.
- **Existing models are not designed to nationally consistent standards.**
  Consequences:
  - Lack of clarity of **what is good enough**
  - Model **quality can vary widely**
  - **No systematic approach to model maintenance**.

The Dialogue

Standards clarifies what is good enough for both parties!

Objectives

- Develop nationally consistent standards for coastal flood modelling.

Target standard

Develop & maintain to target standards

Confidence in evidence used in decisions

- National baseline of model standards for existing coastal flood models.

Understand existing evidence

ID improvements to target standard

Plan for the future

What standards

- Model standards
- Assessment of model quality

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Model standards

- **Target quality standard**
  - based on intended use/s. It defines *what is good enough*.
- **Model quality standard**
  - measures *how well key flooding processes are represented* in the model (key processes: Sources, Pathways and flood spreading to Receptors).
- **Model condition standard**
  - measures *how up-to-date* a model is, in terms of *key data, technology, flood events and changes to capital schemes*.
- **Overall model score –** based on model quality and condition.

Target quality standard

Model quality scores

A – Design
Best possible quality at current state of knowledge & technology. It is aimed at minimising potential errors in the modelling process.

B – Appraisal
This grade lies between the minimum acceptable quality & the best available quality. In practice, it may contain elements of both.

C – Strategic
The minimum acceptable quality at the current state of knowledge & technology. This ensures a good balance between project cost and effort.

U – Below standard
At the current state of knowledge & technology, this grade is not considered suitable for flood modelling work

Intended use/s

- **Detailed Scheme design** (eg crest levels, flows, volume)
- Individual Property level protection
- Real-time inundation & real-time threshold crossing (could include pre-prepared maps), and Flood Warning areas for Higher Risk communities

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- **Appraisal** of flood risk management solutions
- Damage estimation based on depth (AAD/EAD)
- Real-time threshold crossing (could include pre-prepared maps), and Flood Warning areas for Lower Risk communities
- National Flood Risk Assessment (NaFRA) [input to quality levels A or B]

- Coastal cell - **Broad scale** investment information [Strategy Report]
- Broad scale information for Flood Guidance Statement
- Weighted annual average damage (WAAD) estimation
- Flood Alert area & Forecast scenarios in the day T + 2-6 day period (exclude real-time inundation maps).

- ~~Unsuitable for flood modelling at the current state of knowledge and technology.~~

Model standards

Model technical quality

(how well key flooding processes are represented in the model).

- **Conceptual understanding** – how current?
- **Source data quality** – tides, surges, waves, river discharge etc.
- **Pathway data quality** - topo, bathy, defences, breaching etc.
- **Model build quality** - type, resolution, validation etc.

Scoring is based on evidence obtained from literature and current practice.

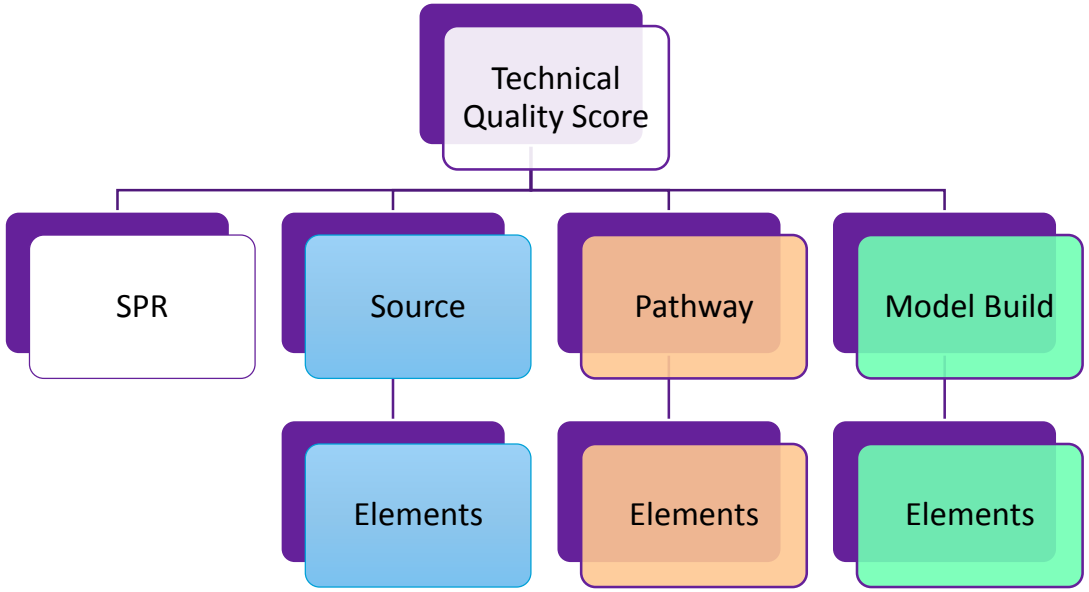
Model condition

(how up-to-date a model is).

- **Conceptual understanding** – how current?
- **Changes to Data:** Topo surveys, hydrographic surveys, Capital schemes
- **Changes to Methods –** hydrology / hydraulic methods
- **Occurrence of major flood event**.

Scoring is based on evidence from publically available GIS databases.

Assessment of model technical quality



Element score

Component score

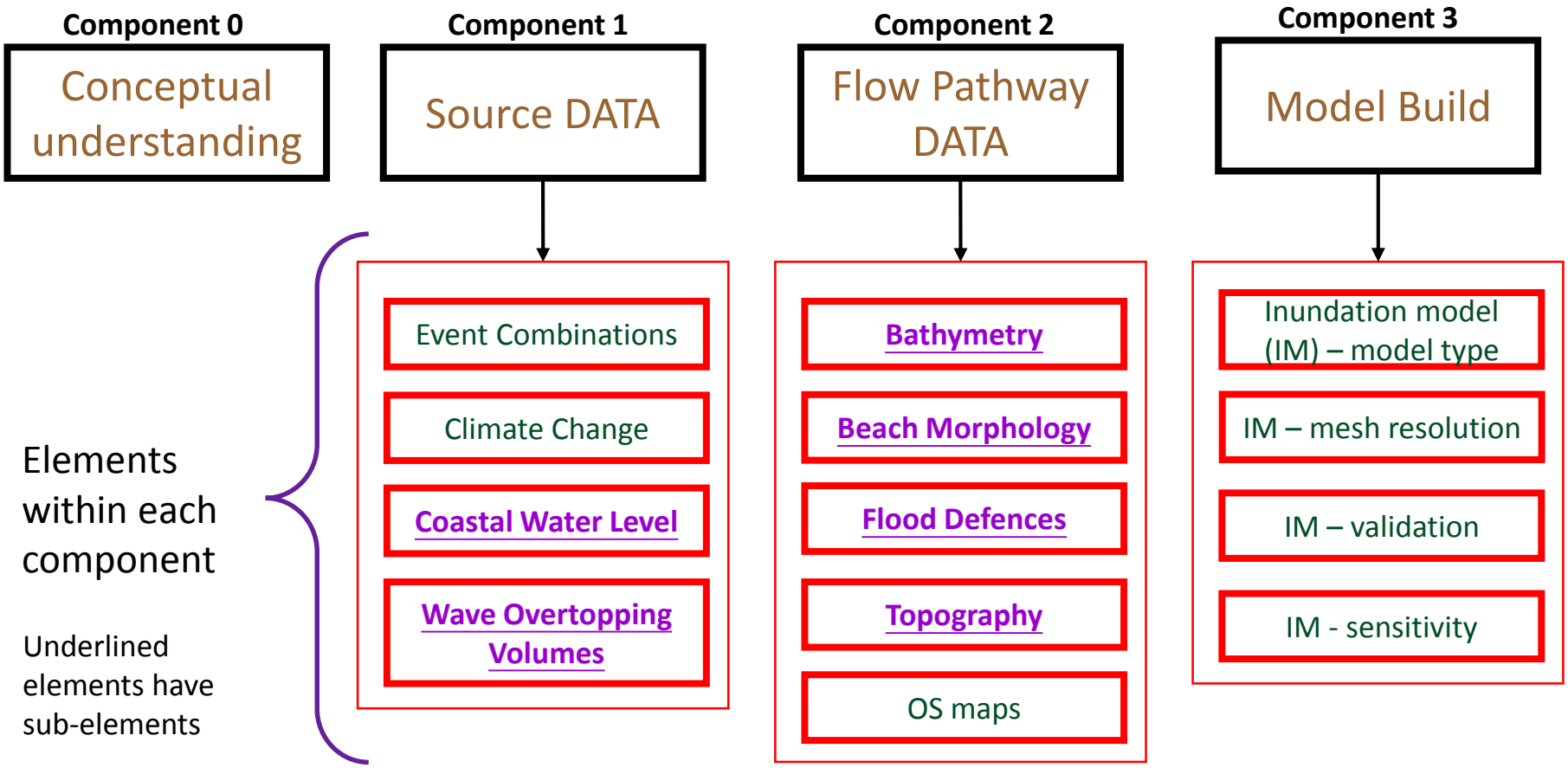
Technical Quality score

Element score is **based on evidence** from literature or practice.

Component score = **weighted scores for all elements.** If any critical element score is “U”, score = “U”.

Quality score = **average of component scores.** If any component score is “U”, score = “U”.

Assessment of model technical quality



Assessment of model technical quality – Element scoring examples

Surge Profile

A: Average profile from ≥15 storms

Data from Class A gauge OR CFB method

B: Average profile from 10 or more storm surge events

C: Average profile from 5 or more storm surge events.

U: Effect of storm surge not considered or considered incorrectly

The effect of the storm surge profile may be quite critical in some cases, but this is difficult to quantify without site specific sensitivity testing.

Evidence :

- Environment Agency (2011) Coastal Flood Boundary Conditions for UK mainland and islands - Project: SC060064/TR2: Design sea levels, Flood and Coastal Erosion Risk Management Research and Development Programme, February 2011.
- Experience from practice - Project Team

Assessment of model technical quality – Element scoring example

Flood inundation model - type

- **A:** 2D depth averaged models. Examples: TUFLOW, MIKE 21
- **B:** As in (A)
- **C:** Simplified 2D model (2D-) OR GIS level or volume contour or 1D bucket model subject to caveats.
- **U:** None of the above OR caveats for "C" not met.

Caveats:
Flood plain < 350m, <100 receptors & no essential infrastructure.

GIS level - no defences.

Evidence:

- Defra/EA, 2013. Benchmarking the latest generation of 2D hydraulic modelling packages.
- FLOODsite Consortium, 2007. Evaluation of Inundation Models, Report T08-07-01, Revision Number 1_7_P15, April 2007

Assessment of model technical quality

Element score

Element score is **based on evidence** from literature or practice.

Component score

Component score = **weighted scores for all elements**. If any critical element score is “U”, score = “U”.

Model Quality score

Quality score = **average of component scores.** If any component score is “U”, score = “U”.

Model technical quality

Coastal/Estuary Flood
Model Quality Standard

Quality control and modelling processes

Conceptual Understanding using S-P-R framework

Data on **SOURCES** of flooding

Data on Flow **PATHWAYS**

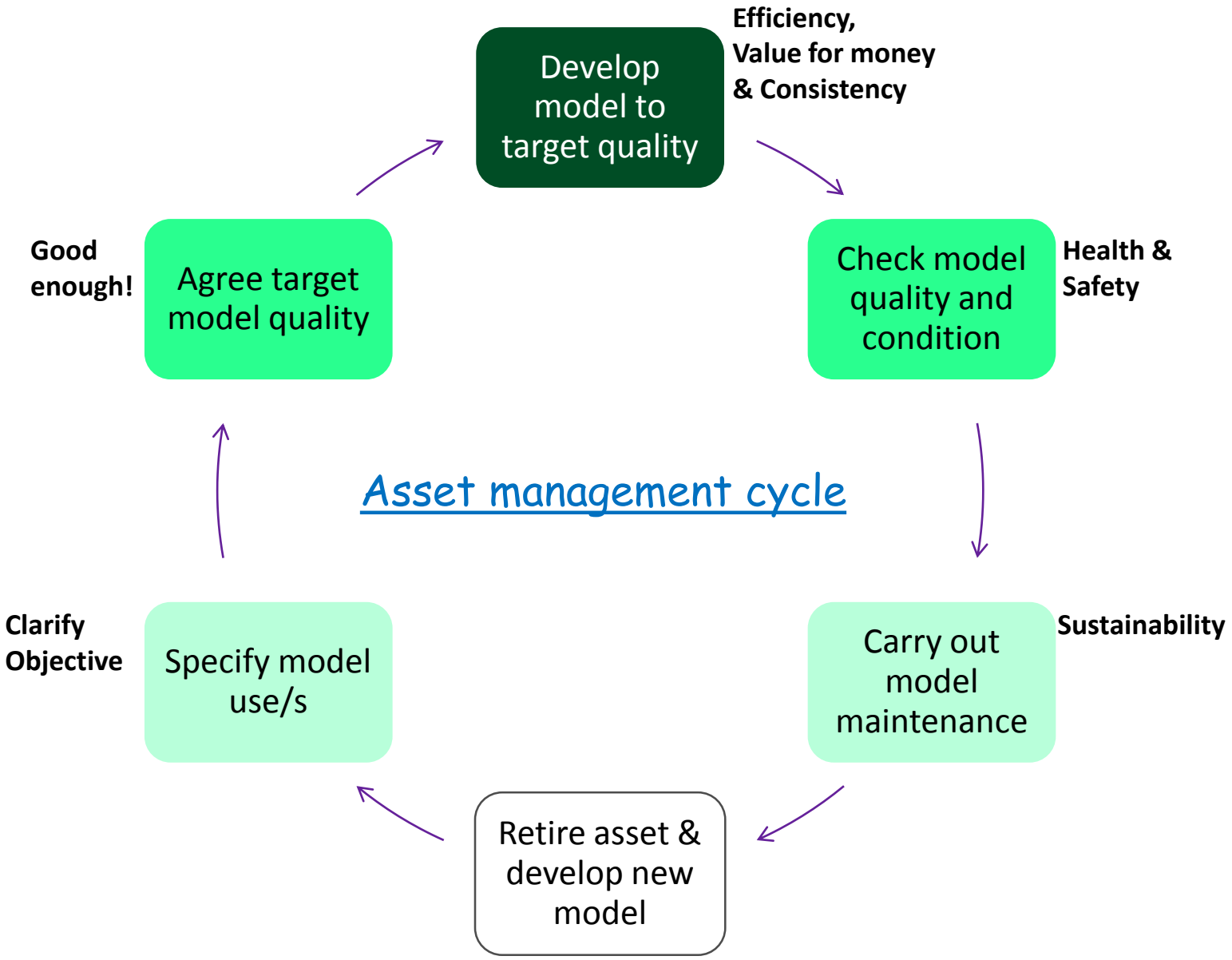
Model build properties & reliability for predicting flooding at **RECEPTORS**

Modeller skill and experience

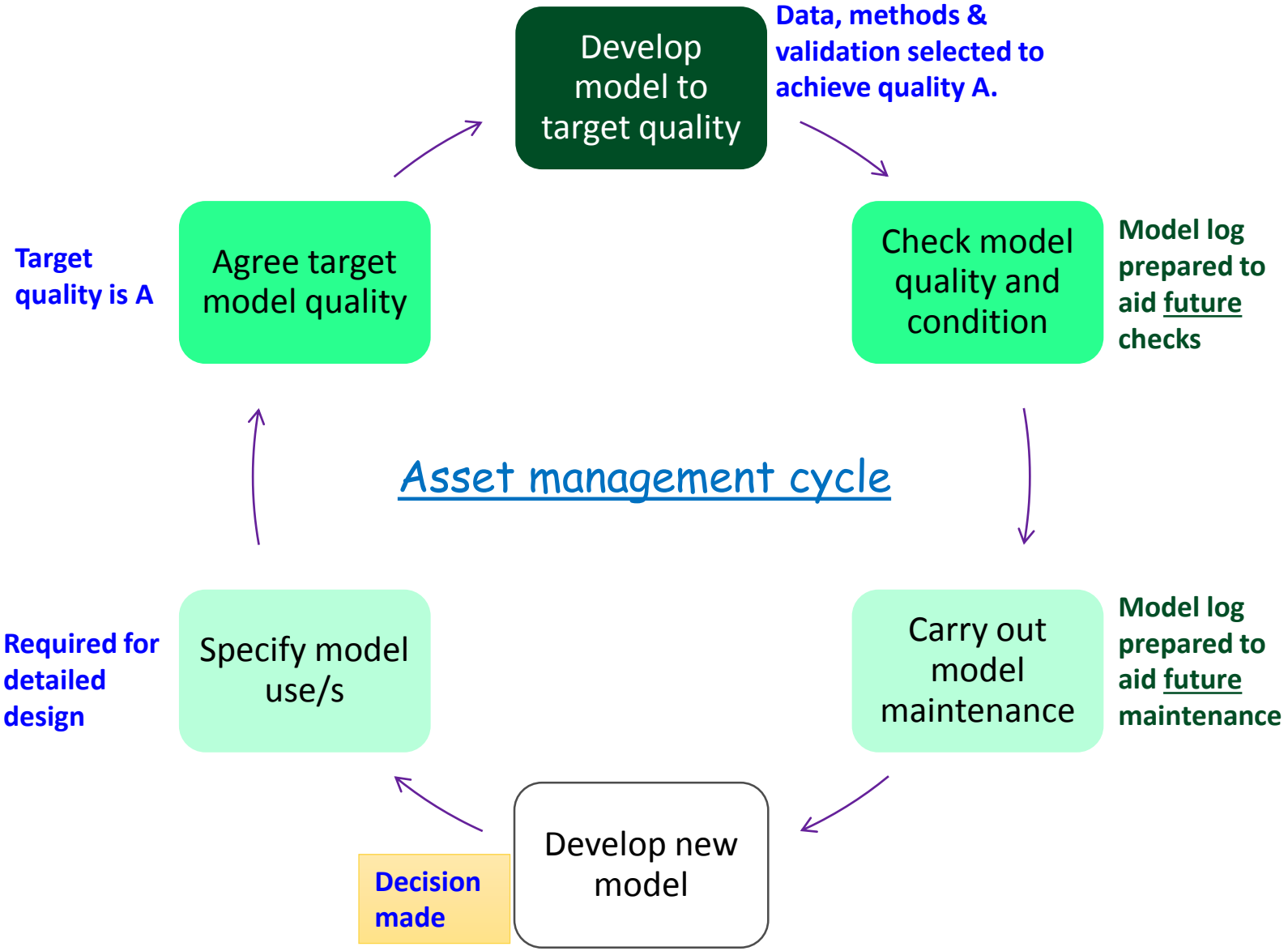
How to use Standards

- Treating models as assets
  Example: Outer Thames Estuary Wave model

Models as Assets



Example: Outer Thames wave model



Selection of data & methods to target quality “A”

Comp-onent	Element (or Sub-element)	Requirement for "A" grade	Quality achieved / Remarks
Source	**Event combinations**	Joint probability analysis should be carried out using a) Heffernan and Tawn method; b) JOINSEA; or equivalent.	**A** / Hefernan and Tawn method used for JPA between waves and water levels
	Climate change (CC)	CC sensitivity tests to: SLR, wind and waves & impact of SLR on beach profile. Latest EA guidance on climate change applied.	**A** / CC tests planned to include SLR, wind and waves + test on effect of bathymetry.
	Wave Overtopping Volumes – Coastal Wave Parameters - **Offshore Wave Data**	Measured data or UK Met Office hindcast data, validated with RMSE a) ≤ 0.5m or SI b) ≤ 0.20. The record length should ≥ 30 years.	**A** / Offshore data successfully validated (using WaveNet data) to required targets.
	Wave Overtopping Volumes – Coastal Wave Parameters - **Wind forcing**	Data from UK Met Office or similar. Resolution of meteorological model ≤ 12 km and hourly temporal resolution	**A** / UK Met office data used met requirements.
	Wave overtopping volumes – Coastal Wave Parameters – **Type of Nearshore Wave Model**	Calibrated 2D fully spectral wind-wave model.	**A** / Calibrated 2D fully spectral model (MIKE 21 SW) used.
	Wave overtopping volumes – Coastal Wave Parameters – **Validation of Nearshore Wave Model**	RMSE ≤ 0.3 m or SI < 20% on peak Hm0. RMSE is calculated using storm peak Hm0 data or data above storm threshold.	**A** / Model calibrated to required targets.
	Wave overtopping volumes – Coastal Wave Parameters – **Type of Surf Zone Model**	Transformed from nearshore location to toe of structure using 1-D spectral wave model, e.g. SWAN1D	**A** / 1-D spectral wave model (SWAN1D) used.
	Wave overtopping volumes – Coastal Wave Parameters – **Resolution of Surf Zone Model**	10 to 12 grid points across the surf zone	**A** / Grid-spacing on beach profile meets requirements.

Selection of data & methods to target quality “A”

Comp-onent	Element (or Sub-element)	Requirement for "A" grade	Quality achieved / Remarks
Pathway	Bathymetry – **Source of Bathymetry Data**	Approved bathymetric surveys for study (including sub-tidal LIDAR surveys)	**A** / Bathymetry data extracted from various bathymetry surveys.
	Bathymetry – **Survey resolution (or spacing between estuary cross-sections)**	Average distance between surveyed depths along the estuary channel ≤ 200m	**A** / Typical distance between survey points meets requirement.
	Bathymetry – **Age of Bathymetry Data**	Age of data for 80% or more of the study area in the estuary ≤ 5 years	**B /** Bathymetry survey did not meet "A, B or C" everywhere. Sensitivity tests (+/- 1m dz) for areas with "U" showed that impact on waves in outer estuary is small (< 0.03m).
	Beach Morphology - **Impact of morphological change**	Consider morphological change using the FLOODsite framework (T05_07_02), including use of historical data of winter beach profiles over at least 10 years and expert judgment to derive a minimum of 6 'what if' beach profiles scenario.	/ Not included in scope.

Model Log template

National Baseline Study

Baseline study on:

Existing Environment Agency coastal/estuary models

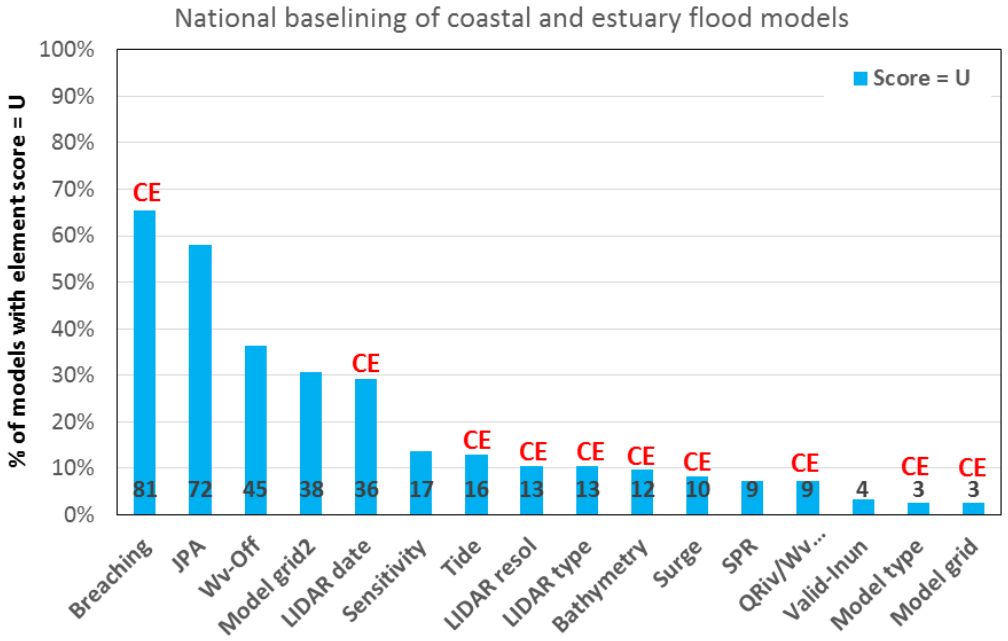
Model Score

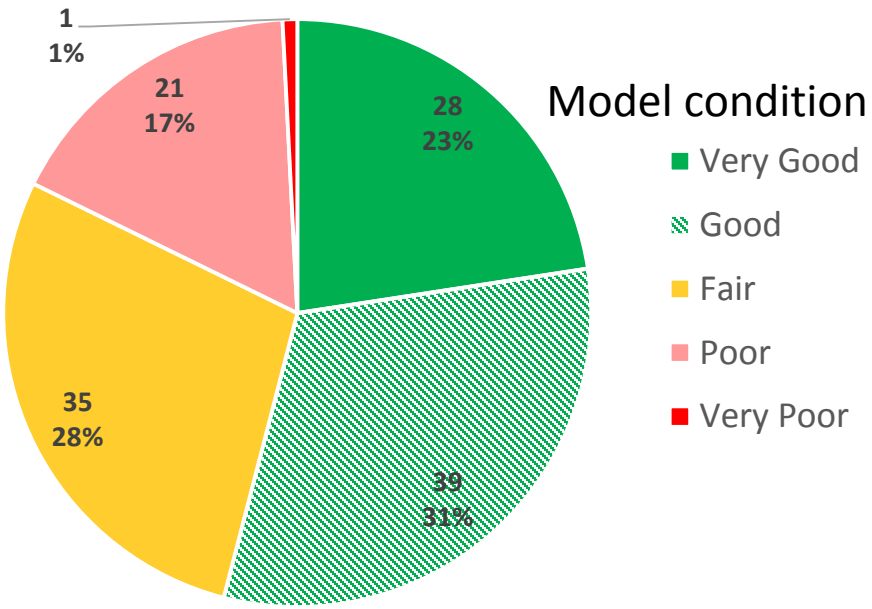
Code	RA Technical Quality (RATQ)		Model Condition (MC)	
	Score	**Description**	Score	Description
0	A/B	Model score meets or exceeds **target quality score of B**	Good / Very Good	Model meets or exceeds **target condition of Good**
1	A- / B-	Meets or exceeds target quality score (breach analysis not considered).	Fair	1 step below target condition
2	C / C-	Model score below target quality score	Poor	2 steps below target condition
3	U	Below standard. Model needs major improvements to bring it up to date.	Very Poor	3 steps below target condition. Brighton beach

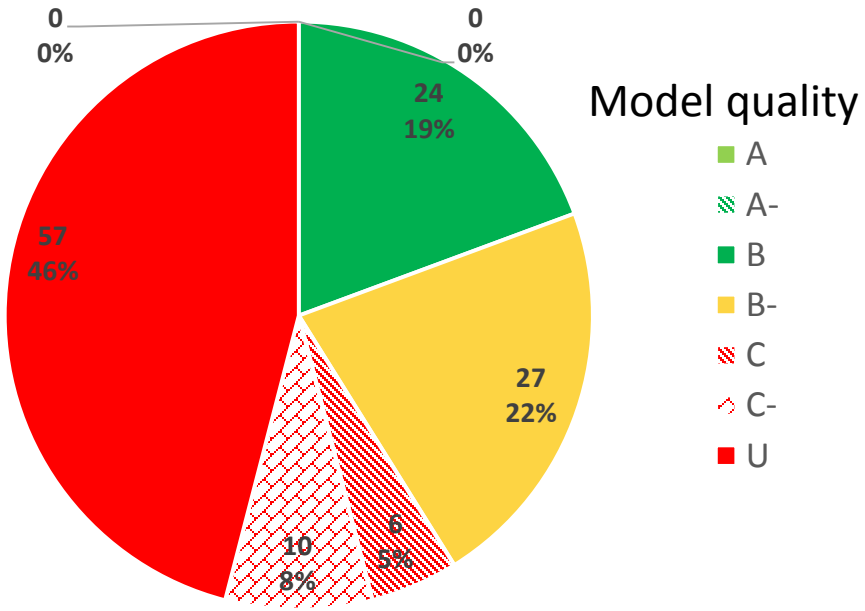
Model Overall Score = Max (MC Score code, RATQ score code)

NATIONAL BASELINE STUDY

Key numbers	
124	Existing coastal & estuary flood **models audited** with new standards
41% (51 No)	Percentage of models that met **target quality** (B/B-)
54% (67 No)	Percentage of models that met **target condition** (Good)



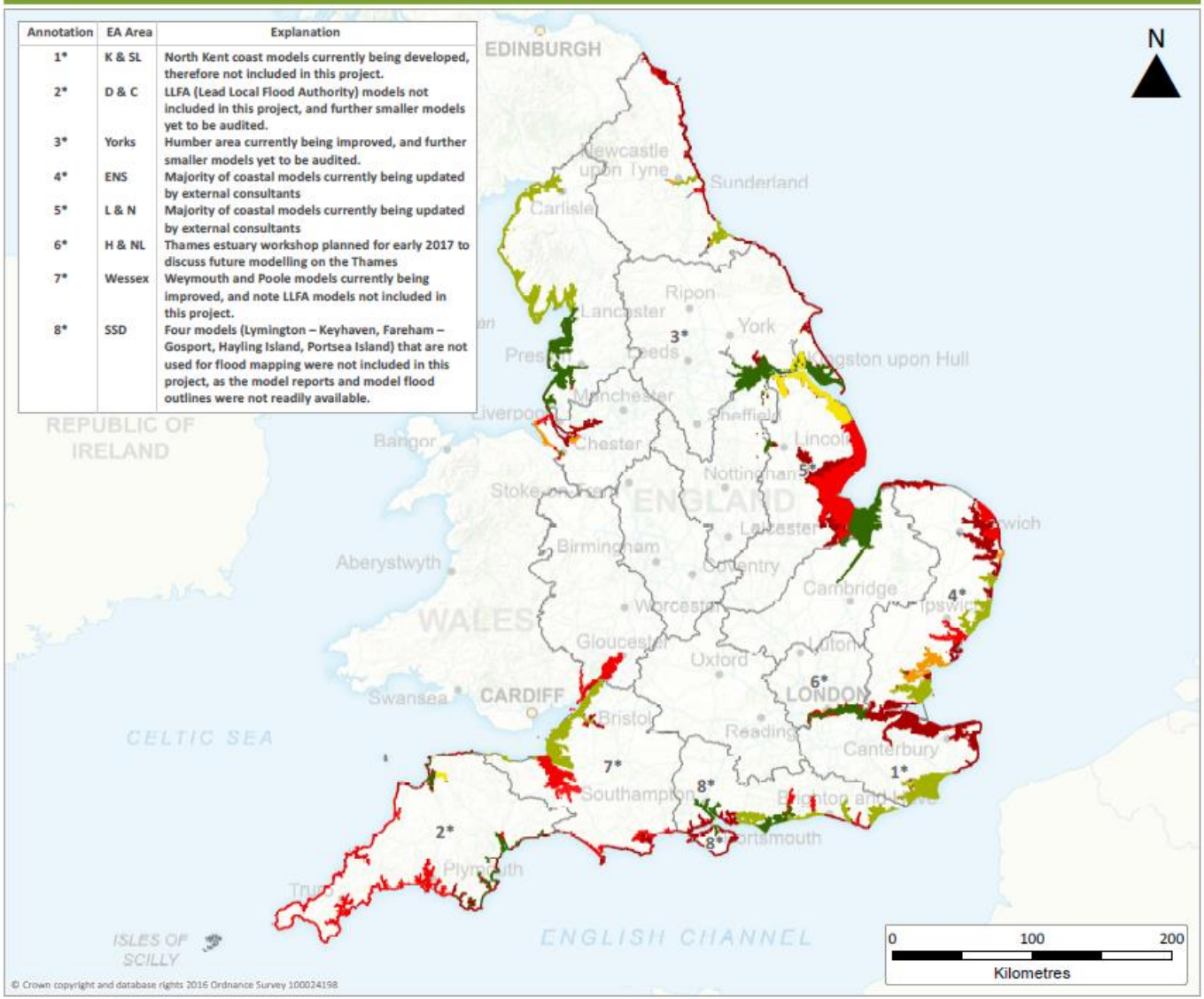




Model quality (RATQ) score: National

Coastal Hazard Mapping - National

Annotation	EA Area	Explanation
1*	K & SL	North Kent coast models currently being developed, therefore not included in this project.
2*	D & C	LLFA (Lead Local Flood Authority) models not included in this project, and further smaller models yet to be audited.
3*	Yorks	Humber area currently being improved, and further smaller models yet to be audited.
4*	ENS	Majority of coastal models currently being updated by external consultants
5*	L & N	Majority of coastal models currently being updated by external consultants
6*	H & NL	Thames estuary workshop planned for early 2017 to discuss future modelling on the Thames
7*	Wessex	Weymouth and Poole models currently being improved, and note LLFA models not included in this project.
8*	SSD	Four models (Lymington – Keyhaven, Fareham – Gosport, Hayling Island, Portsea Island) that are not used for flood mapping were not included in this project, as the model reports and model flood outlines were not readily available.



Legend

- B
- B-
- C
- C-
- U
- Models not available for this study
- Water Management Areas

Flood Model RATQ Score

The models have been assessed against 2016 modelling standards. Older models may have used different methods as applicable at the time of creation. A common baseline is essential for all future modelling. Please refer to the main report for further information.

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Model condition score: National

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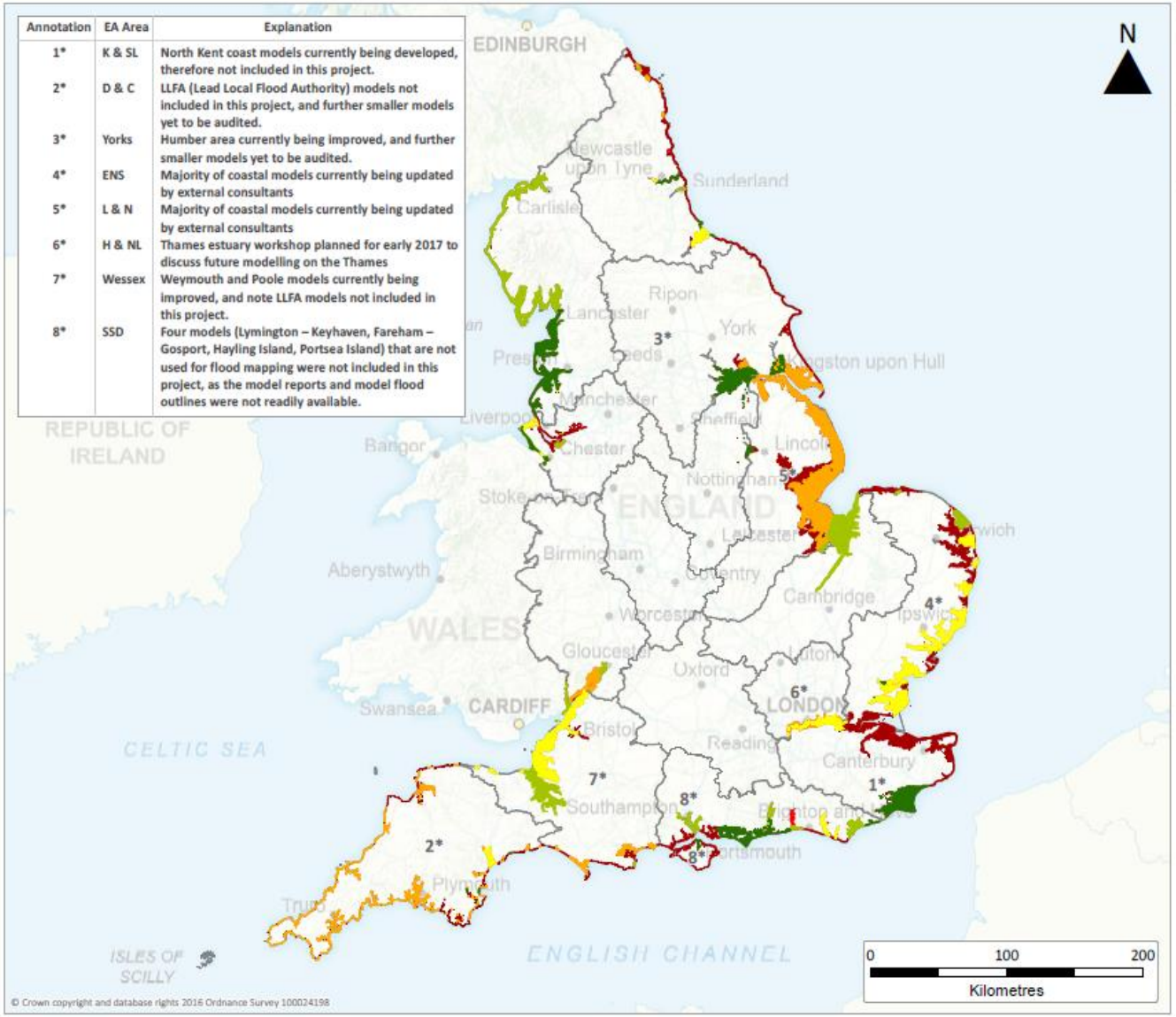

Legend

- Very good
- Good
- Fair
- Poor
- Very poor
- Models not available for this study
- Water Management Areas

Flood Model Condition Score

The models have been assessed against 2016 modelling standards. Older models may have used different methods as applicable at the time of creation. A common baseline is essential for all future modelling. Please refer to the main report for further information.

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Summary & Conclusions

- Model standards have been developed to guide management of coastal flood models.
  - Target standard,
  - Model quality & model condition
- Benefits:
  - Clarity on what is good enough
  - Efficiency and national consistency
  - Greater confidence in evidence
  - Treats models as assets & maintenance culture
- National baseline of coastal/estuary flood model standards has been carried out.
  - 41% of the 124 models met target quality of B/B-
  - 54% met the target condition of “Good”

Needs analysis ➔ Priority scores for model improvements

Thank You

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