# FCERM Infrastructure Management and Performance (iMaP)

## Scoping of a major new research initiative


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# Outline of iMAP

- To **scope** a significant **research programme** (over 5 years) to provide a new, richer, understanding of infrastructure performance and how to manage infrastructure systems efficiently and effectively.
- To **engage** leading **practitioners** within Local Authorities, Environment Agency, SEPA, NRW, Rivers Agency and consultancy together with the **best academics** to co-develop a programme of innovative with the and transformative research.
- To **develop co-funding** across EPSRC, NERC, ESRC and practitioner sources (Environment Agency, SEPA, DARNI and others)
- **Submit** the iMAP research proposal early 2015

***A new way of working*** - Seeding funding to develop iMAP has been provided by the Environment Agency, they have also committed to contributing to the main research

## What is FCERMi

The ontology of FCERMi (Sayers and Dawson, 2014, draft)

| Type of asset | | Example activities |
|---|---|---|
| **Local scale infrastructure** | | |
| **Private homes and businesses** | Avoidance | E.g. the use of planning to relocate new properties away from flood areas or above flood levels. |
| | Resistance | E.g. the use of flood products to prevent water entering a property. |
| | Resilience | E.g. the use of building materials and practice that aid the rapid return post internal flooding. |
| **Critical service nodes** | Avoidance | E.g. the use of planning to relocate individual sites away from flood areas or above flood levels; consider spatial coherence in the design of networks functions. |
| | Resistance | E.g. the deployment of property 'ring dykes'. |
| | Resilience | E.g. the use of function specific building designs and network redundancy to avoid loss of function if flooded (i.e. continued power or communication distribution). |
| **System scale infrastructure** | | |
| ***Hard path infrastructure – Planning, design and management of built infrastructure*** | | |
| **Linear and network assets** | Active | E.g. barriers that can be deployed as temporary and demountable defences. |
| | Passive - Above ground | E.g. raised defences and shore parallel structures (i.e. embankments, levee or dyke, breakwaters) through to storm water storage ponds. |
| | Passive - Below ground | E.g. individual pipes, CSO'sand the drainage network they compose. |
| **Point assets** | Active | E.g. pumps, floodsgates and sluices. |
| | Passive | E.g. fixed trash screen, groynes as well as interface assets (that link above and below ground linear systems) such as manholes and gullies. |
| ***Soft path infrastructure – Utilizing natural infrastructure systems*** | | |
| **Watercourse** | Channel | E.g. the management of vegetation (e.g. weed cutting) and sediment (e.g. shoal removal and dredging) |
| | Floodplain | E.g. the management of floodplain roughness and debris recruitment. |
| **Coast** | Foreshore and backshore | E.g. the management of dunes and beaches through active (e.g. recycling and profiling) and passive (e.g. sand fencing, marram grass planting) management as well as natural wetlands and soft cliffs. |
| **Urban landscape** | Urban land use | E.g. the engineering of urban green space, managing surface permeability and debris recruitment. |
| **Rural catchment** | Rural land use | E.g. the management of rural run-off, sediment yields as and debris recruitment. |

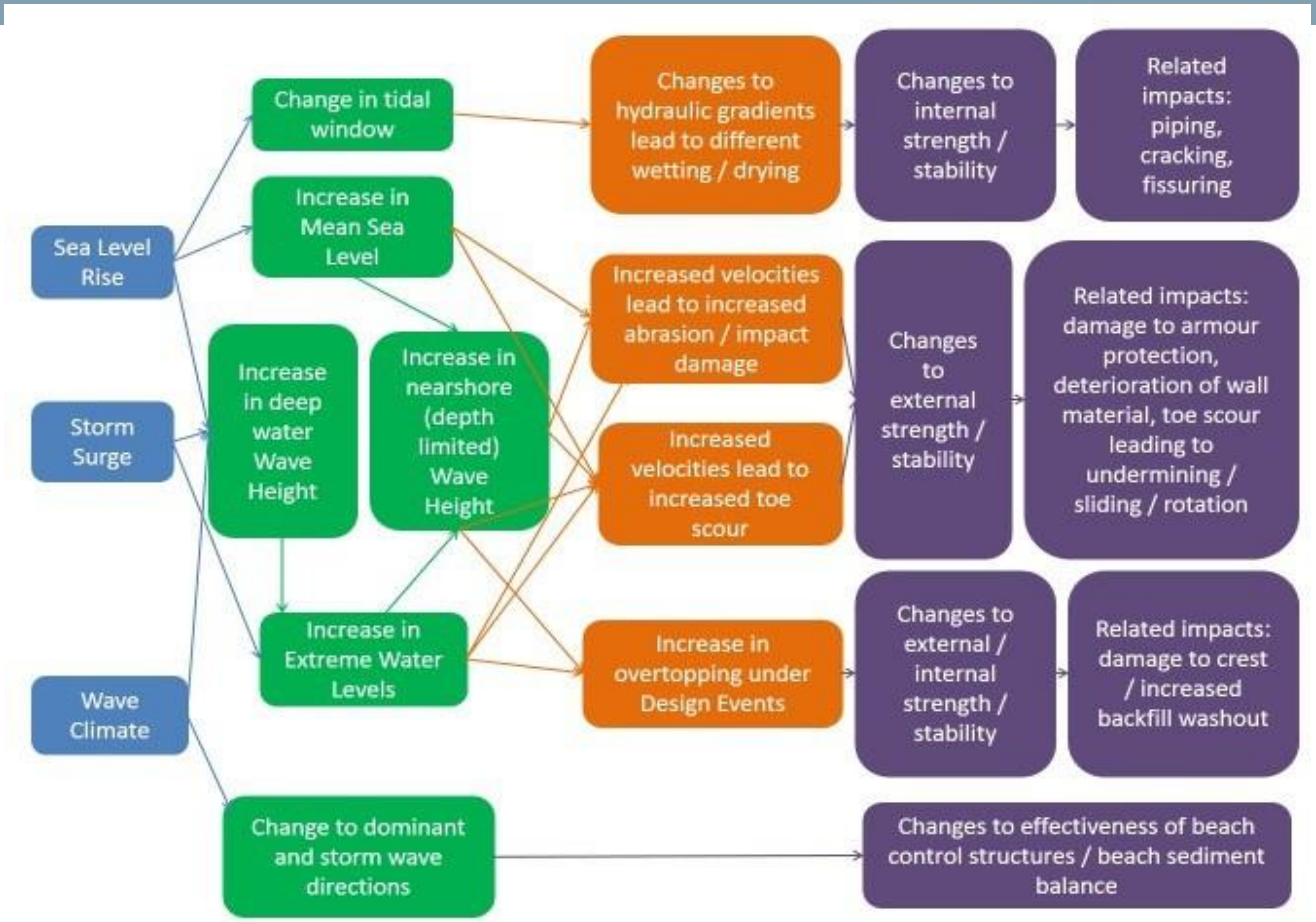
# How does climate change impact FCERMi?

A summary of the sensitivity to climate change and potential impacts

(Sayers and Dawson, 2014, draft)

| Primary load exposure | Example infrastructure that may be influenced | Primary climate change sensitivity | | Impact on FCERMi performance | |
|---|---|---|---|---|---|
| | | Change | Confidence | Scale of impact and examples | Confidence in impact |
| **Pluvial** | Urban drainage networks and above ground structures that may become saturated | Severity of individual storms | **Low** | **Moderate** Heightened run-off, increased flood flows | **High** |
| | | Spatial coherence | **Low** | | |
| | | Temporal sequence | **Low** | | |
| **Fluvial** | River embankments, culverts, barriers and pumps | Severity of individual storms (high flows and low flows) | **High** | **High** Crest overflow, by-passing, accelerated deterioration, reduced maintenance window, and an increase in the chance of failure. | **High** |
| | | Spatial coherence | **Low** | | |
| | | Temporal sequence | **Low** | | |
| **Ground-water** | Cliff slopes, foundations of raised structures, coastal wetlands | Mean and extreme values (higher and lower levels) | **Moderate** | **Low Moderate** Soil instabilities (slope failure) differential settlement (causing instability), greater/less saline intrusion. | **Moderate** |
| **Coastal and estuarine** | Hard and soft shoreline structures (seawalls, beaches to wetlands), tidal barriers | Higher mean sea levels (and associated increase in incident wave energy) | **High** | **Very High** Increased chance of failure due to, for example, increased overtopping, scour, beach lowering, coastal squeeze. | **High** |
| | | Severity of individual storm (surges and waves) | **Moderate** | | |
| | | Increased storminess (severity, frequency and sequence) | **Low** | | |
| | | Wave direction (mean) | **Low** | | |
| | | Salinity | **Low** | | |
| | | Acidity | **Low** | | |
| **Temp., solar radiation and drought** | Earth embankments and other 'soil' and 'vegetation' based infrastructure | Extremes of temperature – cold and hot – and extreme dry periods | **High** | **Moderate** Accelerated desiccation of soils, freeze-thaw induced spalling, loss of strength in surface cover, loss of vegetation for green infrastructure, Surface drying and increased cliff erosion | **High** |
| **Problematic invasions and bacterial attacks** | Potential to affect both hard and soft infrastructure in fluvial, coastal and estuarine settings | Changes in the prevalence and nature of microbes and invasive species | **Moderate** | **Moderate** Unwanted species (such as mosquitos around standing water and SUDs), Japanese knot-weed reducing channel conveyance, increased cases of accelerated low water corrosion in estuaries. | **Low** |

# Transforming our understanding of performance




Source: Environment Agency, 2014


The ‘design event is dead’ – **but how do we replace it ?**

Climate change is more than SLR or a change in flow – **but how do we reflect this?**

**Where are the real tipping points?**

# Transforming real-time infrastructure management and flood forecasts

Forecast models continue to advance: with better rainfall and coastal models, hydrological and nearshore responses – **but significant evidence gaps exist**

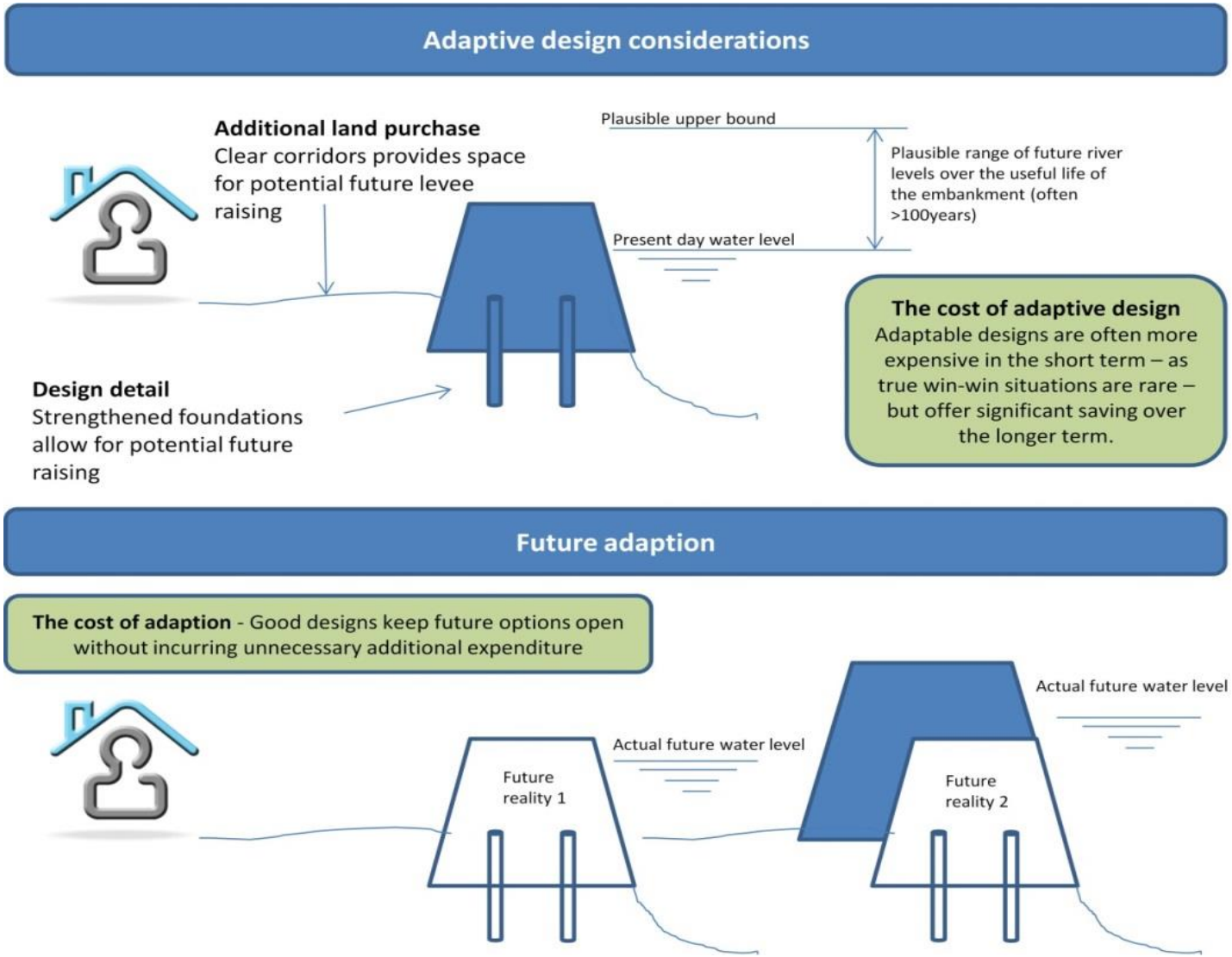
**Winter 2013/14 floods highlighted:**

- **Much richer nowcasting capability**. Taking account of infrastructure performance; identifying hotspots; attribution of flood water pathways (where is it coming from/going?)
- **Better week-to-month ahead forecasting** Including the changing performance and failure chance of defences. How bad could it get? When will it finish?
- **Real-time capacity for 'what-if' analysis**; testing of where the water would go in the event of a breach.

# Disrupting design practice - Adaptive and resilient

Traditional 'fixed designs' based on design loads has been exposed as not fit for purpose.

**But what does adaptive and resilient design look like (in detail)?**




Source: (Sayers et al, 2012b)

# Making better investment choices at multi-scales

Attractive investment choices have a number of well described attributes - **But transforming concepts to innovative and flexible (local, regional and national) strategies remains out of reach?**

1) **Reducing vulnerability**:
   - Consideration 1a: Have all reasonable opportunities to reduce vulnerability been taken?
   - Consideration 1b: Have steps been taken to limit future increases in vulnerability?
   - Consideration 1c: Has a full examination of the range of futures identified the potential for a significant increase in risk requiring a radical approach to managing the receptors?
2) **Making space for water and working with natural processes**:
   - Consideration 2a: Have opportunities to make space for water and function been maintained/ enhanced?
   - Consideration 2b: In making space for water, can the scale of the receptors at risk be reduced?
3) **Delivering co-benefits and co-funding:**
   - Consideration 3a: Have opportunities for present day co-benefits and co-funding been enhanced?
   - Consideration 3b: Have opportunities for future benefits been maintained/enhanced?
4) **Preparing for change:**
   - Consideration 4: Has future modification been considered?
5) **Deferring/removing or abandoning**:
   - Consideration 5a: Could it be removed/stopped with minimum impact on resources and the environment?
   - Consideration 5b: Can investment be delayed without an intolerable build-up of risk or foregoing of current opportunities?

Source: Brisley et al, 2014

# Next steps for iMAP

- Continue discussion with potential funders
- Invite leading researchers and practitioners to help develop the iMAP submission (including a research development workshop 9 Oct 2014).
- Issue an invitation to express interest in joining the workshop (to be issues in the coming weeks).

**Humber Southbank** (Courtesy, EA)


**Scarborough** (Courtesy, EA)