Natural flood management within the Flood Risk Management (Scotland) Act
The role of GIS

Neil Nutt – Halcrow CH2M Hill (SEPA secondment project)
Neil.nutt@ch2.com

Acknowledgements

Project Technical Advisory Group

- Andrea Johnstonova (Chair) – SEPA
- Heather Forbes – SEPA
- Kirsty Jack – SEPA
- Richard Jefferies – SEPA
- Mark McLaughlin - SEPA
- Nadeem Shah – Forest Research
- Mark Williams – SEPA

External reviewers

- Prof Alan Werritty (Dundee University)
- Dr Scott Arthur (Heriot-Watt University)
- Dr Tom Ball (Dundee University)

Introduction

- Key legislation relating to NFM
- NFM study catchments
- What is NFM
- NFM screening methodologies

NFM – Natural Flood Management

Natural Flood Management

Legislation

The Flood Risk Management (Scotland) Act 2009

Section 20 Identification of potential
Identify where NFM could help manage flood risk

↓

Section 28 – Appraisals & Strategies
Consideration must be given to the Section 20 assessment when setting Flood Risk Management objectives and measures

↓

Section 34 - Local FRM Plans
Requirement to detail how implementing the plan may alter (including enhance) or restore natural features and characteristics

The Flood Risk Management (Scotland) Act 2009

Section 20 Identification of potential
Running of Screening Tools (GIS)

Output: Section 20 maps

2012
SEPA

↓

Section 28 Appraisals & Strategies
Develop and refine options (GIS)

Output: FRM Strategies – shortlist of preferred FRM measures

2013 - 2014
SEPA /
'Responsible Authorities'

↓

Section 34 Local FRM Plans
Refinement of preferred option (GIS)

Output: Local FRM Plans

2015 – 16
The relevant 'Responsible Authority'

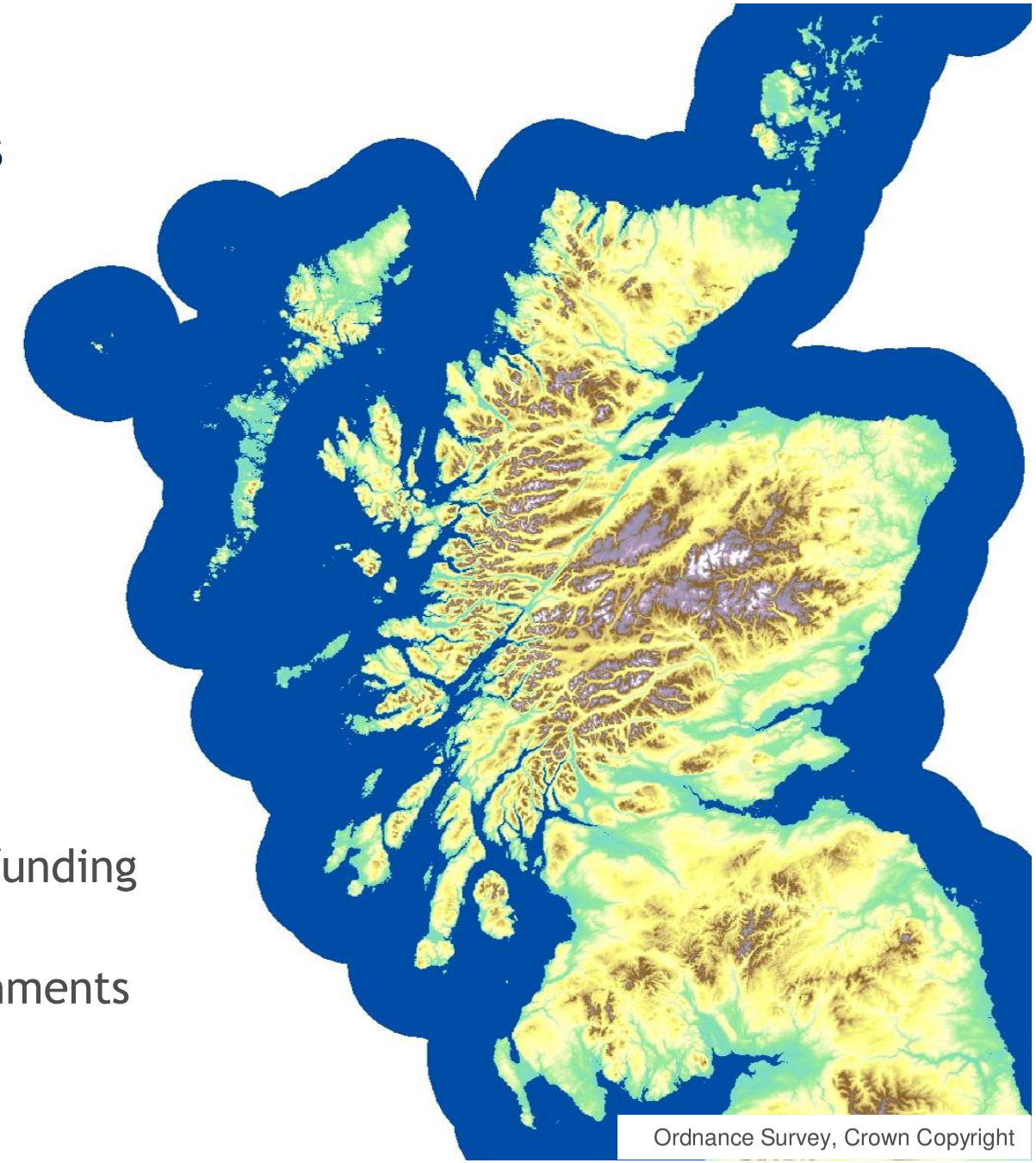
Natural Flood Management

Pilot projects

Pilot NFM projects

- Eddleston Water
- Allan Water
- Upper Clyde
- River Devon
- Borthwick Water
- Forth FutureScape

- Scottish Government funding additional pilot NFM/restoration catchments



General synopsis of pilot findings

- Technical challenges (hydrology, hydromorphology, ecology)
  - Does NFM work?
  - What can be achieved?
  - Where is NFM most effective?
- Land ownership/land manager issues
- Leadership/responsibility
- Funding
  - Is it economic?
  - Who should pay?
- Long timescales
- Maintenance
- Ambiguity over what NFM entails

… what is NFM?

*"techniques that aim to **work with natural hydrological** and **morphological processes**, features and characteristics to manage the sources and pathways of flood waters. These techniques include the **restoration**, **enhancement** and alteration of **natural features** and characteristics, but exclude traditional flood defence engineering that works against or disrupts these natural processes."*

(SAIFF -The Scottish Advisory and Implementation Forum for Flooding, 2011)

…and what does that entail?

Natural flood management techniques

A set of techniques that aim to work with natural processes, features and characteristics to manage the sources and pathways of flood waters.

The techniques include alteration, enhancement and restoration of natural features and characteristics that could contribute to the management of flood risk

Restoration

Return of natural processes to a more natural state, e.g. re-meandering, restoration of disconnected floodplains, upland grip blocking, restoration of native catchment woodlands, reinstatement of riparian woodlands and coastal realignment.

Alteration (including enhancement)

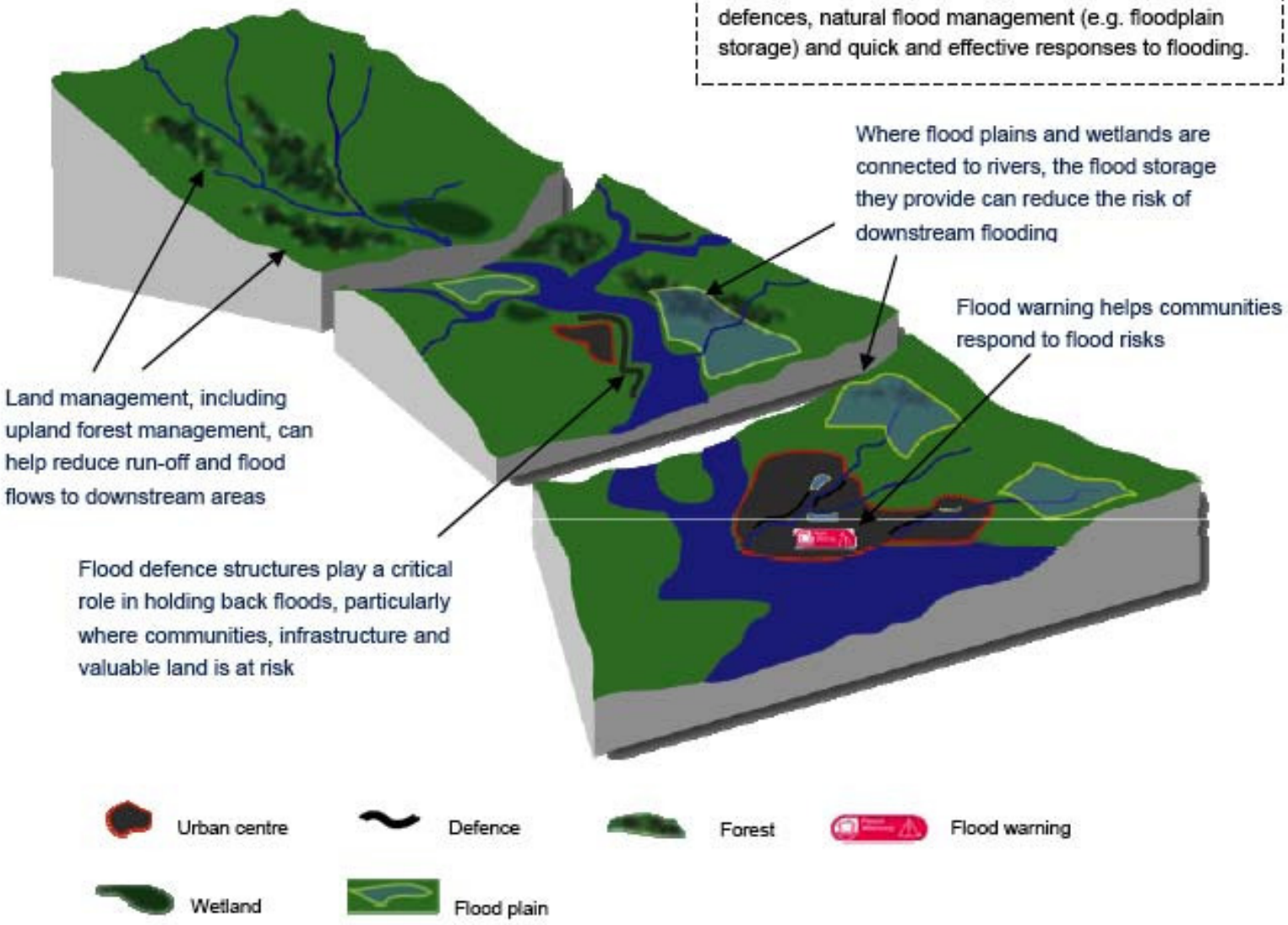
Improvement to, or enhancement of an existing function for the purpose of flood risk management, including partial restoration of natural processes and soft engineering e.g. enhancing the capacity for floodplains to store water (washlands), increasing channel roughness, SUDS and regulated tidal exchange.

(SAIFF, 2011)

Sustainable Flood Management

Sustainable flood management is an approach to planning and delivering measures to reduce flood risk.

Increasing resilience to flood risk is an important component of sustainable flood management. Resilience to flooding can be increased through a variety of measures, including flood warning, flood defences, natural flood management (e.g. floodplain storage) and quick and effective responses to flooding.



Natural Flood Management

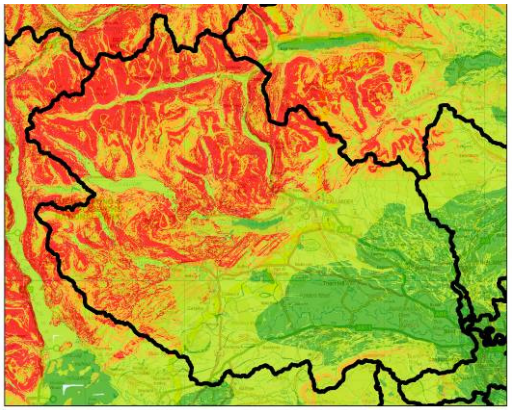
Screening for opportunities

Early identification of potential NFM locations

GIS screening methods

- Production of maps showing NFM potential for Section 20
- GIS toolboxes
- Nationally available data
- Nationally applicable
- Screenings looked at:
    1. Runoff generation
    2. Floodplain restoration
    3. Sub-catchment desynchronisation
    4. Hydraulic constrictions
    5. Hydromorphology
    6. Estuarine surge attenuation
    7. Wave energy attenuation

Screening: Runoff generation

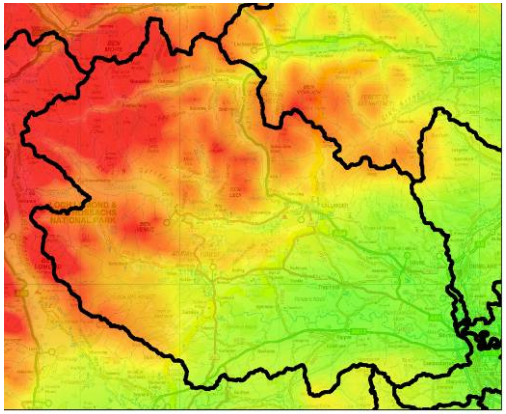


Subjective scoring method (Environment Agency)

Entirely subjective scores (1-4) given to land cover, soil, slope and rainfall

Score =

$$\text{Combined sensitivity} = \frac{\text{land cover class} + \text{soil class} + \text{slope class} + \text{rainfall class}}{4}$$

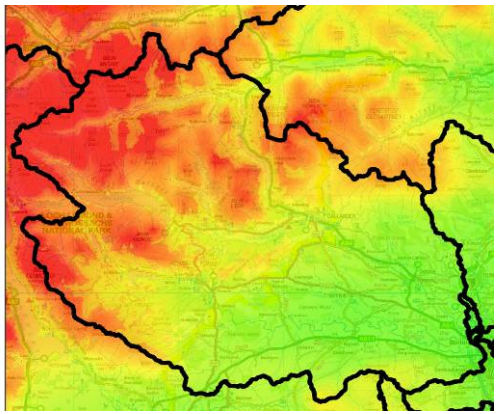


Restatement of the QMed by catchment descriptors

Dropping FARL & AREA

Score (runoff per unit area) =

$$q = 8.3062 \times 0.1536^{\frac{1000}{SAAR}} 0.0460^{BFIHOST^2}$$

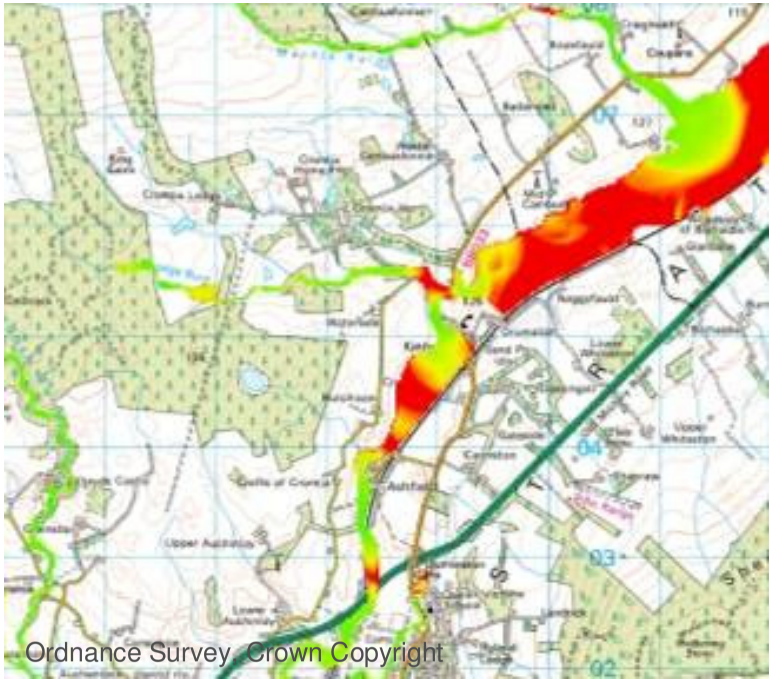


Hybrid method

Weight QMed based runoff per unit area with scores for slope and

Score (weighed runoff per unit area) =

$$q = 8.3062 \times 0.1536^{\frac{1000}{SAAR}} 0.0460^{BFIHOST^2} \times slope\_weight \times landuse\_weight$$



Screening: Floodplain restoration

$$ISP = \frac{v^{\frac{3}{2}}}{S^{\frac{3}{4}}}\left(n_{\max}^{\frac{3}{2}} - n_{existing}^{\frac{3}{2}}\right)$$

v = flow velocity

s = hydraulic gradient

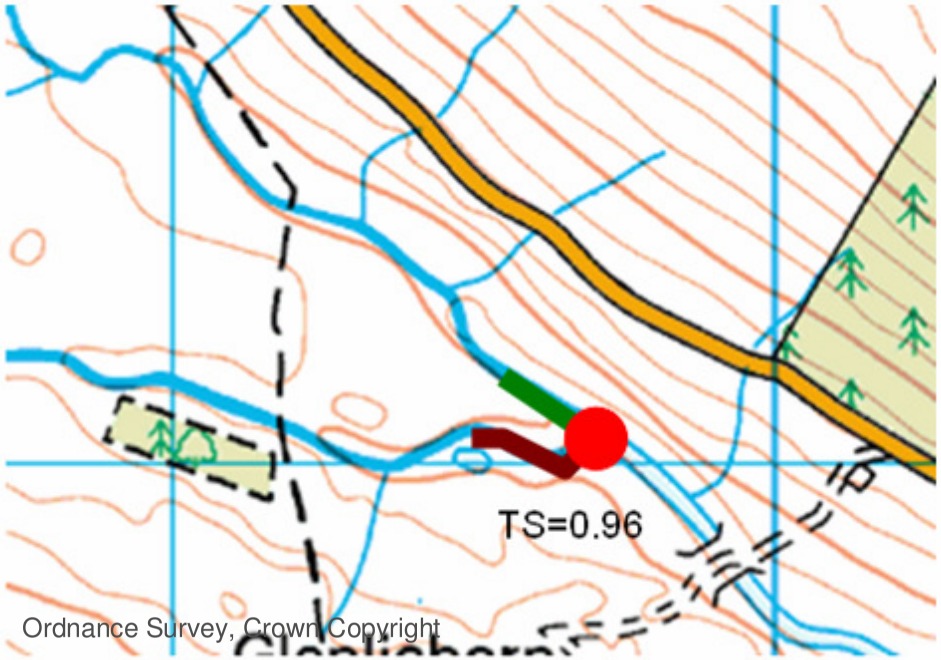
n = Manning's roughness

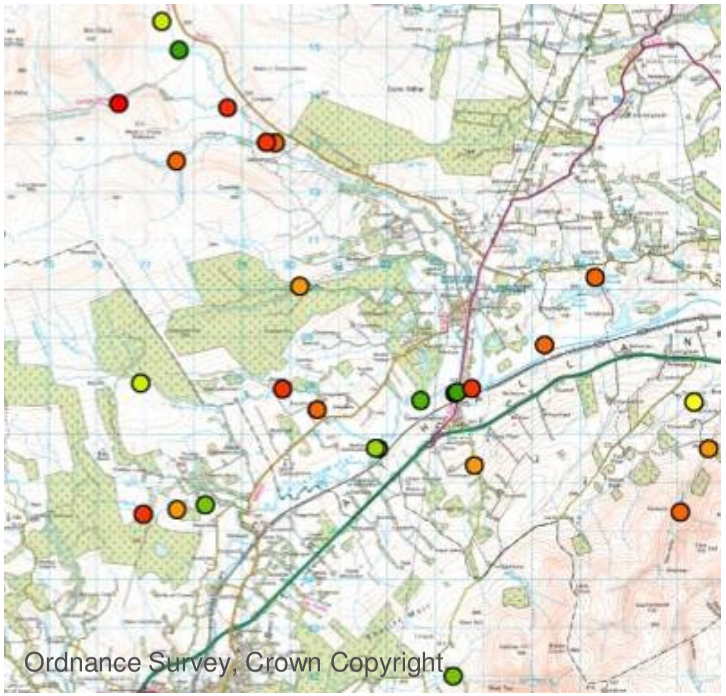
- Calculation based on Manning's equation
- Gives an indication of the increase in water level due to floodplain roughening (*Increased Storage Potential)*
- High scores (red above) indicate greater potential
- Morphological Pressures Database and Wetland Inventory used to give an indication of floodplain connectivity
- Need to consider backwater extents

Screening: Sub-catchment desynchronisation

$$TS = \left(\frac{T_{p,\min}}{T_{p,\max}} \right)^5$$

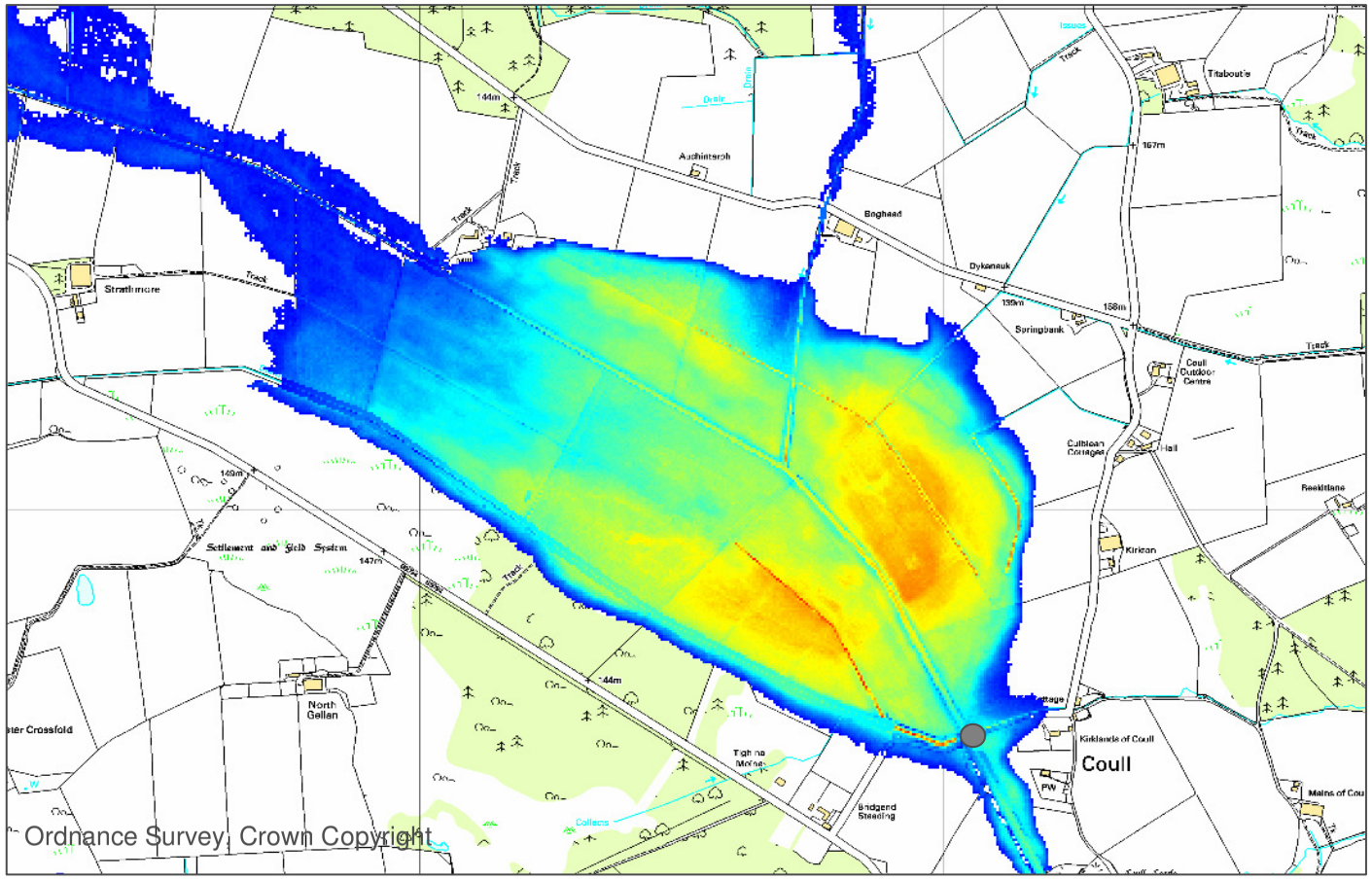
- Potential to desynchronise sub-catchment hydrographs
- Based on similarity of FEH Time to Peak for the two sub-catchments (*Time to Peak Similarity)*
- Controversial due to uncertainty (storm movement and quality of Tp estimate)
- Requires difficult to access data





Screening: Hydraulic constrictions

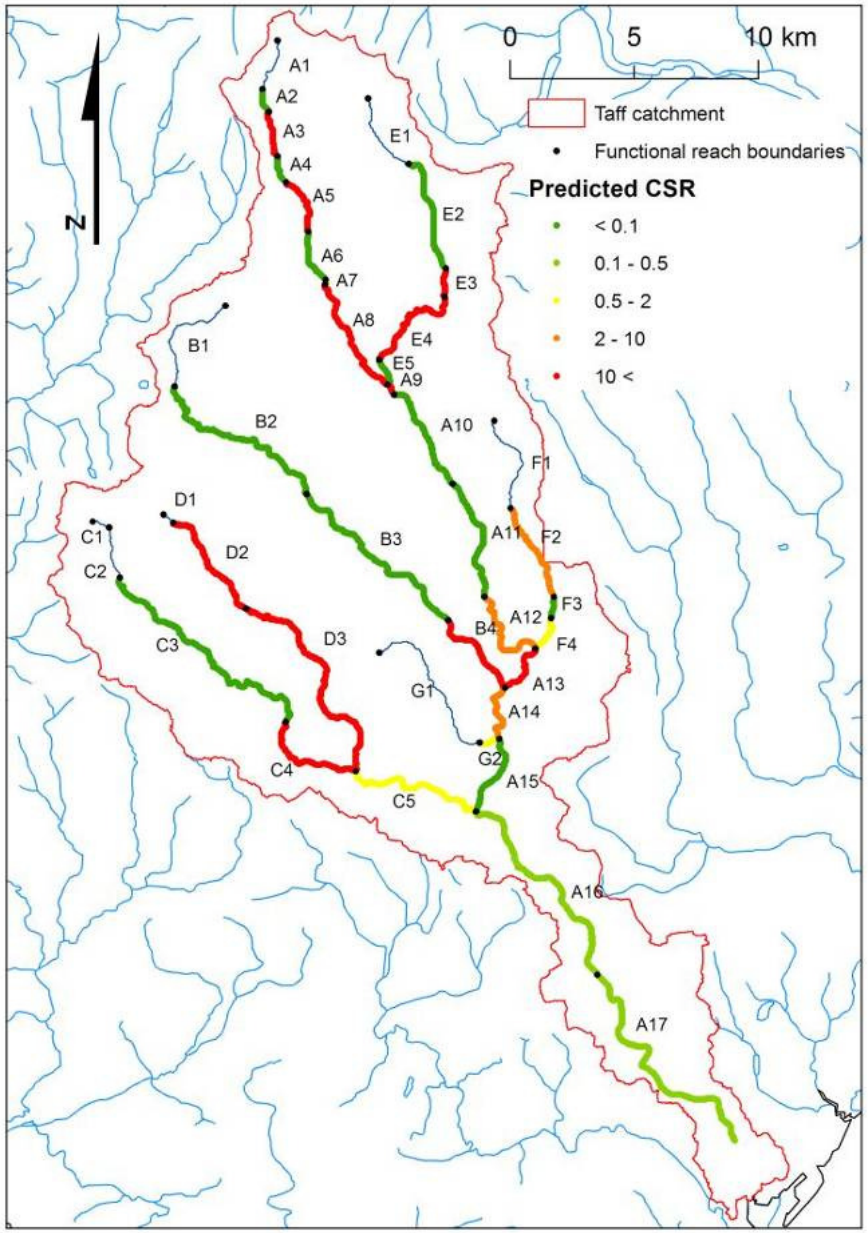
- Identification of artificially constricted flow paths
- National fluvial flood hazard mapping



(Early draft of national fluvial hazard mapping, SEPA/Halcrow - ongoing)

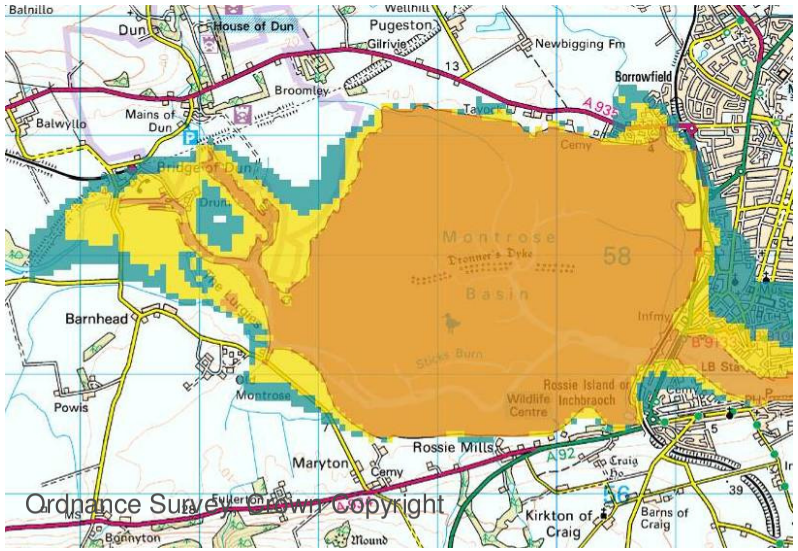
Screening: Areas of heightened morphological activity

- Sediment budget modelling using ST:REAM (Parker in press)
- Overview of probable areas of:
  - Source
  - Transport
  - Deposition



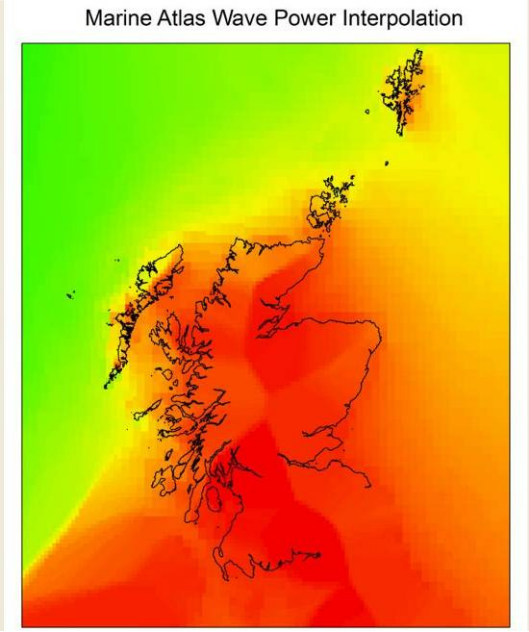
Screening: Estuarine surge attenuation potential

- Latest national coastal maps
  - Projection of estimated extreme water levels
- Simple process of overlaying flood maps with known defence locations
  - SFDAD & coastal hydromorphology database
- Direction on where to consider in more detail



(For illustration only, not produced as part of national coastal mapping project)

Screening: Wave attenuation potential



- Identifying high energy coastlines that potentially have adequate space to permit (semi) natural wave energy dissipation measures
- Poor data
  - Incident wave power
  - Shore width/slope
  - Shore substrate

Summary

- Overview of Flood Risk Management (Scotland) Act 2009
- Overview of pilot projects

- GIS screening tools have been presented that allow the rapid national identification of NFM opportunities Assessment
  1. Runoff generation
  2. Floodplain restoration
  3. Sub-catchment desynchronisation
  4. Hydraulic constrictions
  5. Hydromorphology
  6. Estuarine surge attenuation
  7. Wave energy attenuation

Thank you

Any questions?

Neil.nutt@ch2m.com