Cyfoeth Naturiol Cymru
Natural Resources Wales

Wales Coastal Flooding Review – Project 4 Report – Recommendation 19

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Context

Following the coastal flooding of late December 2013 and early January 2014, the Minister for Natural Resources, asked Natural Resources Wales (NRW) to undertake a two stage Review into the coastal flooding events. The Minister requested that the Review be undertaken in collaboration with all Risk Management Authorities in Wales. Phase 2 of this Review identified 47 Recommendations for future progression and in January 2015 NRW published a Delivery Plan outlining a proposed way forward to address each Recommendation. The Minister directed NRW to collaboratively implement the Delivery Plan in 2015/16 with supporting funding made available.

Thirty of the Recommendations have been packaged into ten Projects to reflect common themes. The remaining seventeen Recommendations stand independently outside of these projects with individual leads for progression.

The 10 Projects and their broad technical themes are listed below:

Project 1 – Flood Forecasting and Coastal Design
Project 2 – Flood Warning and Forecasting
Project 3 – Community Resilience
Project 4 – Operational Response
Project 5 – Coastal Defences
Project 6 – National Coastal Defence Dataset and Inspection
Project 7 – Skills and Capacity Audit and Roles and Responsibilities
Project 8 – Review of Coastal Groups
Project 9 – Coastal Adaptation
Project 10 – Infrastructure Resilience

Recommendation 18, 19 and 20 together form Project 4 – **Operational Response.** This report summarises the work undertaken in regards to Recommendations 19 alone.

For practical ease of delivery, Recommendation 18 was moved into Project 10 due to its definition (see below) drawing clear links to infrastructure and resilience:

Rec.18	Review and identify how to improve involvement of infrastructure operators and managers in the coastal flood risk incident management process.

Recommendation 20 considers the local decision making process associated with the issue of Severe Flood Warnings. Its completion is described by relevant summary page text within the 2015/16 progress report. Recommendation 20 did not warrant a standalone report.

Rec.20	Review the local decision making process associated with the issue of Severe Flood Warnings and evacuation procedures in December 2013 and early January 2014. Identify improvements and share at an all Wales level.

Introduction to Recommendation 19

Within the Wales Coastal Flooding Review Delivery Plan -Recommendation 19 was outlined as follows:

Recommendation 19: Continue to develop potential 'impact scenario' assessments, maps and/or statements. This work must be developed in close discussion with Professional Partners to ensure it meets all parties' requirements.

The following statement has been taken from the Wales Coastal Flooding Review Phase 2 Report to give context behind the Recommendation:

'*There needs to be improved and accessible information on possible impacts in advance of incidents:*

During incident response there is a need for Professional Partners to have readily accessible information on potential impacts and 'what if scenarios'.

This work is best carried out in advance of the incident, in order that information is readily available and the incident response discussion can be more focussed on the likelihood, timing and confidence (level of uncertainty) in the forecast of the impact occurring.'

Creation of 'impact scenario' maps and/or statements will enable Risk Management Authorities (RMAs) and Local Resilience Forums (LRFs) to be aware of potential impacts in both the planning for, and response to, incidents.

This Recommendation considers two approaches to these maps. 1) Static impact scenario maps - maps created at one point in time based on a fixed dataset, which does not allow for the map to change once created. 2) Dynamic impact scenario maps - maps that can be edited to meet a user's requirements depending upon data inputs of their choosing and/or in response to a live forecast feed to spatially display different possible flood scenarios.

Methodology

To progress this Recommendation an internal NRW working group was created comprising a technical specialist from each of the three local Flood Incident Management teams (South West, South East and North Wales), representatives from the National Flood Forecasting team and NRW's Wales Coastal Flooding Review project team.

This report outlines work undertaken to date for Recommendation 19 and proposes next steps for implementation and future completion of Recommendation 19.
It contains:

- A short introduction to the Recommendation and why it was required.
- Summary of responses received from consultation and workshops.
- A description of preceding and current mapping methods applied in NRW, supported by a review of their pros and cons.
- A description of the proposed dynamic mapping method trialled within NRW and a review of the pros and cons.
- Conclusions and proposed next steps for taking impact scenario mapping forwards to completion.

Preceding work

Over recent years there have been gradual iterations and development of impact scenario mapping ideas by NRW and its legacy bodies. An early version created by Environment Agency Wales (see Figure 1 below) displayed the predicted flood extents with estimated flow routes. These maps took considerable time and resource to create. The end user requires more detailed information of the likely impacts to assets at risk (i.e. properties and infrastructure) and the associated hazards, not just extent outlines, in order to serve as an emergency planning tool for Professional Partners.

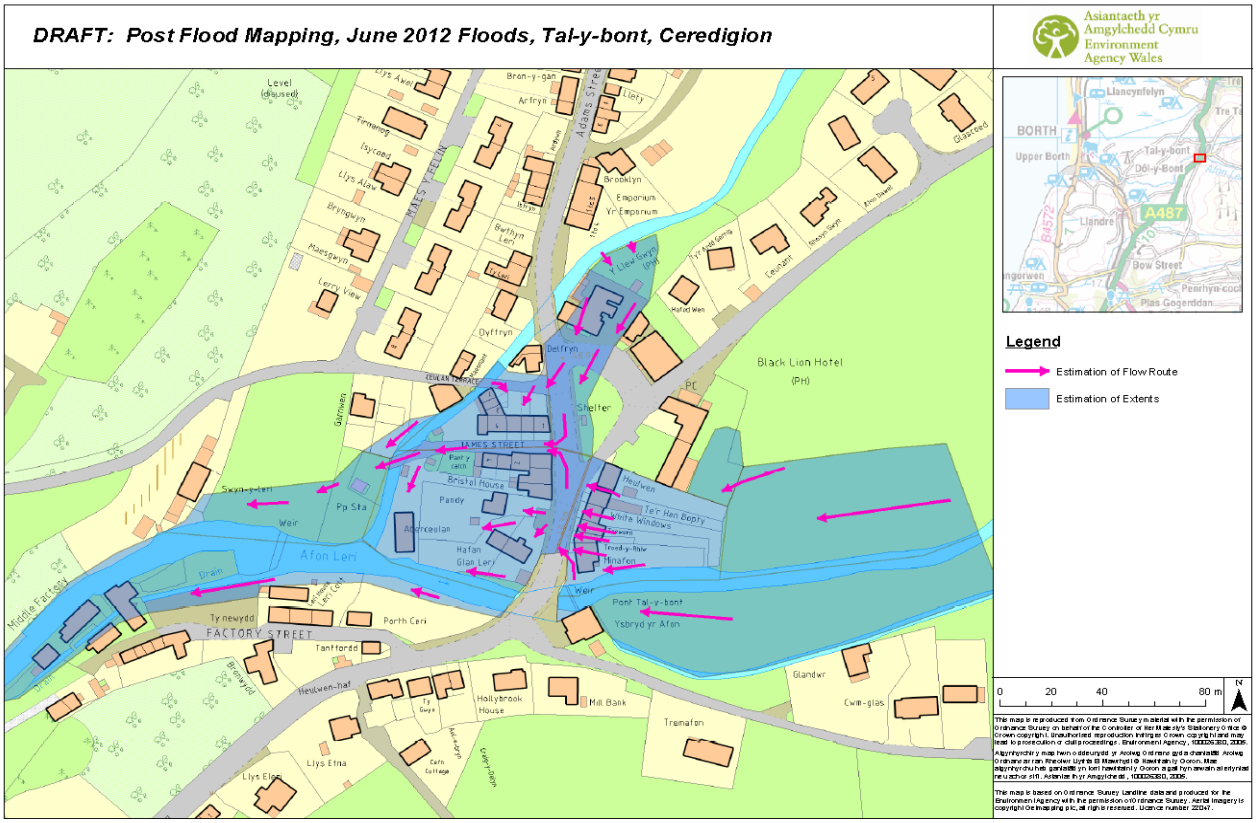


Figure 1 – Early version impact scenario map

Other versions were created (*Figure 2* is an example below for a 1 in 10 year event scenario) at considerable cost (£2k to produce a single map for a fluvial flood risk site). Consultation indicates these maps are much closer to what Professional Partners require. These maps show:

- Properties – Residential and commercial.
- Key infrastructure – Hospitals, care homes, power stations, water works, etc.
- Transport network – Rail and road.

This type of map works off the principle of selecting layers within the map to show specific flood event scenario and the assets at risk within the flood extent boundaries.

This type of map can also indicate the depth and velocity of predicted flooding for each individual scenario. All the features within these maps are shown at the scale of a flood warning area. Consultation held with partners (to inform this report) indicates this map is the closest version to what is needed as an impact map as it shows potential impacts to an area under different scenarios.

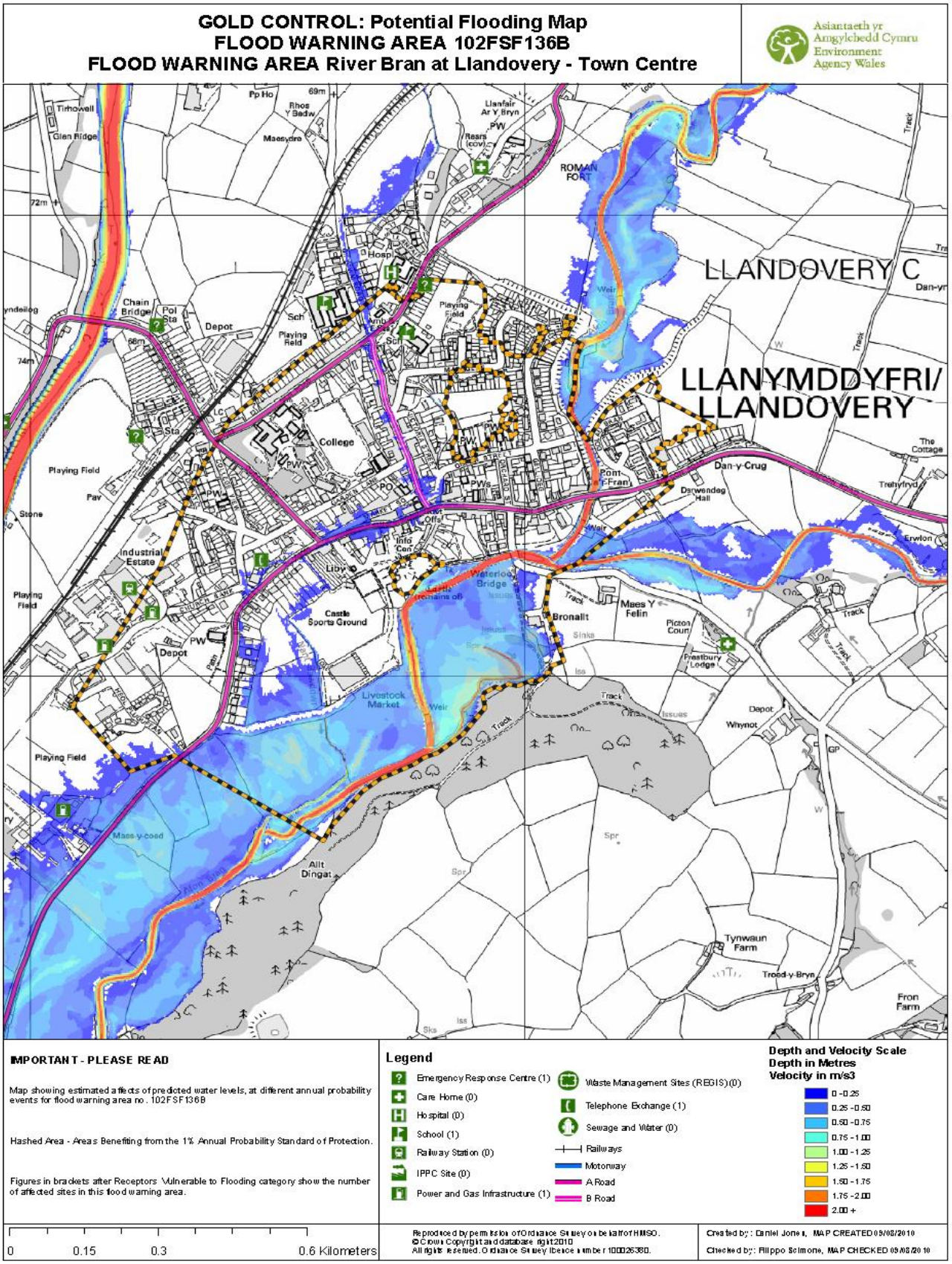


Figure 2 – Research & Development project - impact scenario map

Current impact scenario mapping method

At present in NRW, impact scenario mapping efforts have been static in nature and focused on South Wales only.

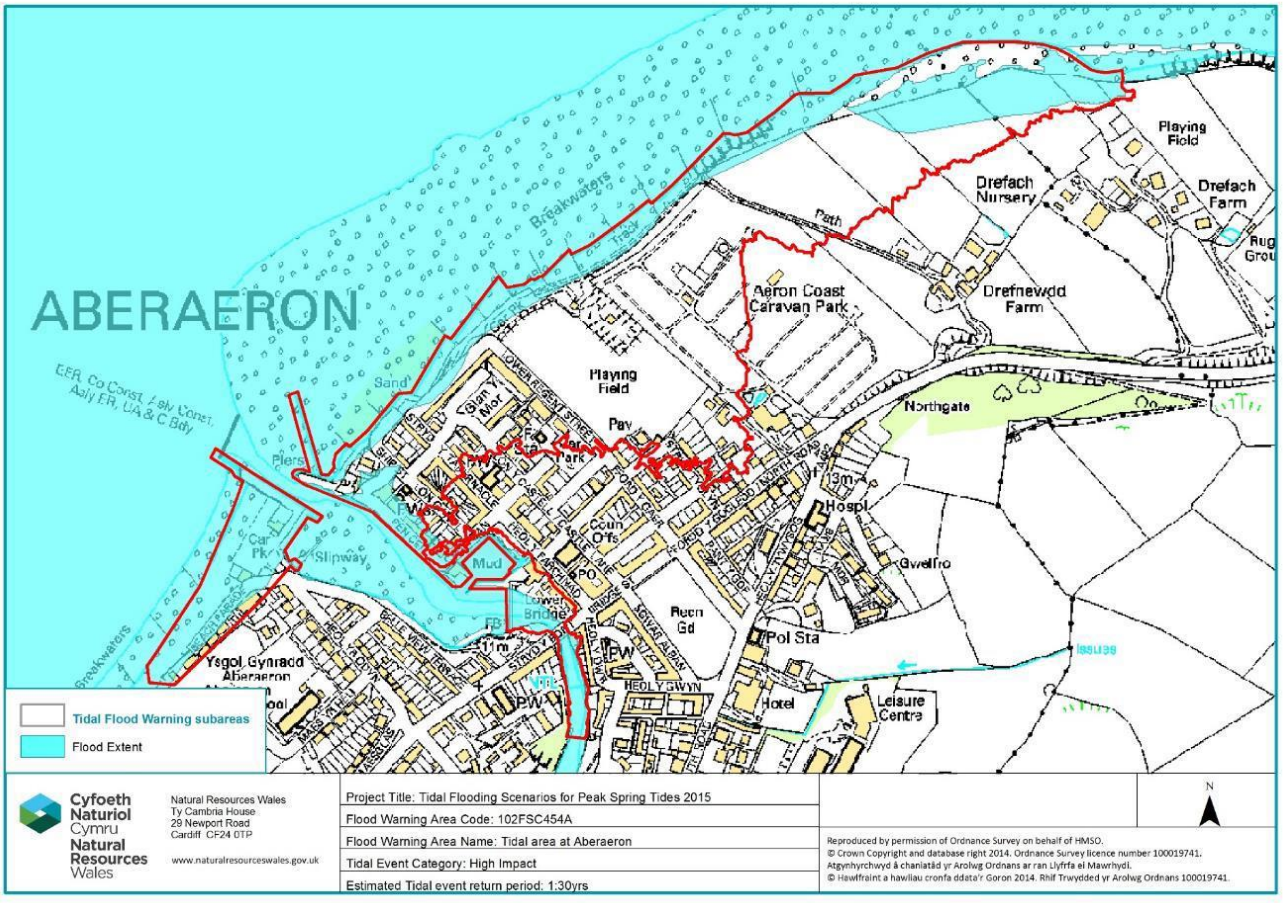
Background to South Wales impact maps – 2015 Tidal Scenario Mapping

In response to concerns in 2014 over the forthcoming high tides of 2015 by Dyfed Powys Local Resilience Forum (LRF), NRW invested resources in exploring options to source additional information to support LRF activities. The LRF preferred a mapping tool rather than having to explain and interpret potential impacts over the phone for each site, which can be a lengthy process. The preferred option was to create a selection of maps to aid Professional Partners in planning their operational response to predicted flood event impacts. NRW worked closely with the LRFs (including their Severe Weather Groups) and other Professional Partners and to create static impact maps for each high risk coastal site in South Wales.

These maps are based on:

- Astronomical tide, plus surge for that event.
- Typical conditions (wind strength and direction, wave height and direction).
- Forecast tools used to derive Still Water Level (SWL) and wave heights at each site.
- SWL flood extents mapped using Light Detection and Ranging (LiDAR).
- Extents adjusted based on historic data, flood defences and wave overtopping.

Below is an example of a ‘high impact scenario’ static map.



Consultations

To progress this Recommendation the NRW working group agreed to seek Professional Partners views on the following through a questionnaire:

- Gathering information on the current levels of awareness regarding impact maps.
- What information they think should displayed on the maps.
- How these maps should be used.
- How these maps should be accessed.
- Ideas on improvements for any future map development.

The questionnaire was sent to all 22 Local Authorities in Wales and the four Local Resilience Forums in Wales. Of the 26 requests issued, 18 responses were received. The questions and summary of responses received is outlined below:

Question 1: Current levels of awareness regarding impact maps

Out of the 18 responses, 56% indicated that they are aware of impact scenario maps. This figure was expected as NRW's static maps are currently only available for South Wales in view of their production having been undertaken to meet the request of Dyfed Powys LRF.

Question 2: What information should be displayed on the impact maps?

We asked what information should these impact maps contain and offered the following four suggestions:

1. Maps of flood predicted outlines.
2. Information of historic flood events.
3. Mapped information on flood warning areas likely to be affected.
4. Written Statements indicating likely impacts.

Collated responses showed that all sought equally balanced inclusion of the four suggestions, which is not surprising if considered a future 'wish list'. Any future map development will have to distinguish between the criteria that are desirable and those that are practically achievable both technically and financially at the time of design and development.

We also asked for any additional information that should be added. The following suggestions were made:

- Aerial photo layer to be overlaid.
- Additional detailed information containing depth and velocity.
- Additional information on all sources of flooding not just coastal sources of flooding.

Question 3: How should these maps be used & accessed?

We asked consultees *how* and *where* should these maps be used and stored. The responses received were:

How

- Flood warning areas should reflect historic information and allow for sub area of impacts.

- Impact maps should be issued before or with forecasts for high impact events.
- These maps should be used as a planning tool for incidents prior to events.
- These maps could be used as a dynamic tool linked to forecasting.
- There should be a choice of using a dynamic and static maps as both have benefits.

Where

- These maps should be stored on the Resilience Direct website (https://www.resilience.gov.uk/) on which LRF members can register for controlled, secured access.

Summary of questionnaire responses

The main themes from the consultee responses are:

1. The desire to be able to have access to both static and dynamic approaches due to the dual benefits in emergency planning and responding to live incidents.
2. A lack of knowledge and awareness of the existing impact scenario maps. Clarity is needed on where these maps are and will be stored, with guidance on how to get the best from these maps. This was identified in all parts of Wales, not just the North where the current static maps are not available.
3. The maps need to show potential quantified impacts to an area, such as numbers of assets at risk, the estimated flood flow routes and the estimated flood hazard (depth and velocity).

Proposed approach for impact scenario maps

A proposal to create a new dynamic impact scenario maps has been put forward. This proposal has been also generated from the results in the questionnaire. These maps will differ from the South approach, as it was felt that the South Wales maps did not offer enough detail on likely impacts to properties and infrastructure. The new maps need to show more information to aid in the emergency planning process.

The proposal is to produce a set of impact scenario maps for a single tide, based on a single forecast under two different scenarios:

1. Likely impact map.
2. Extreme impact map.

These maps would be created from:

- Taking information from the coastal forecast for any given day.
- Running this data through NRW's coastal model.
- Generating up to a five day location specific flood forecast.
- Producing daily outputs during periods of heightened flood risk.
- Linking the forecast to the relevant flood warning threshold.
- This will identify which flood warning areas are at risk and will be displayed in a map format, which can be shared with Professional Partners.

Further consultation

On the 3rd November 2015, a Wales Coastal Flooding Review: Delivery Plan workshop was held in Mid-Wales. The attendees ranged from coastal Local Authorities, infrastructure operators, LRF representatives and NRW staff.

As part of this workshop a break out session focused on Recommendation 19. It started with a short presentation which outlined the preceding / current methods, then outlined the two different approaches to the impact scenario maps that came from the questionnaire results. The two impact scenario mapping approaches: Approach 1 - current maps, Approach 2 – proposed method.

The workshop gathered the views for these different approaches and discussed the advantages and disadvantages of both approaches.

The discussion to both approaches is summarised below:

Current Version - Static Maps (being used in South Wales):

- Static maps are prone to going out of date. Also being a 500 page document is too large and bulky.
- Concerns were raised regarding awareness / access to these maps. Also with the sharing of this information within organisations.
- One of the concerns that links to both mapping approaches is making all parties aware of the maps and how to access them. An effective awareness raising programme needs to be implemented to support use of any future impact maps.

Proposal:

- The proposed approach is to create impact maps using a single forecast.
- These maps would be dynamic, meaning that they are created from the forecast data and would be created through using a five day forecast lead.
- Concerns were raised over the accuracy of the extents of the impacts i.e. only identifying flood warning areas as being impacted not the level of impacts in the areas.
- This method requires additional resource within NRWs - Flood Incident Management teams and Flood Forecasting teams to devote time and resource if these maps are produced.
- Concerns were raised as to how these maps will be used and issued prior to incidents.

Summary of comments from workshop

The workshop discussion again confirmed a desire for production of both static and dynamic maps for all of Wales. Dynamic maps could give real time impact extent mapping through the use of actual forecast information. Static maps can offer historic information of flood extents or flood extents of predicted return periods. This helps in emergency planning and for incident response by giving a greater indication of likely impacts scenarios to the surrounding environment. This would enable greater effectiveness and efficiency in deploying resources.

Conclusion

The NRW working group has evaluated all evidence generated from this Recommendation to inform this report. In going forward the desired approach by the majority of Professional Partners is to have both static and dynamic mapping approaches. Even though dynamic maps are preferred in an incident, the use of static maps bring great effectiveness when in the planning stages prior to an incident.

Our Professional Partners should be made aware of other tools that are available. For example NRW's external mapping tool that displays surface water, tidal and fluvial flooding. See link below:

https://naturalresources.wales/our-evidence-and-reports/maps/flood-risk-map/?lang=en

This may provide additional benefits to our Professional Partners.

Overall:
Benefits of having static maps are: Static maps are easier to produce. NRW have already created versions of these maps for part of Wales (South Wales impact scenario maps created from LRF request).
Consultation responses show that it would be desirable to have consistent static maps that cover all high priority (risk) areas in Wales. This would enable all emergency planners in Wales a consistent tool in aiding in the incident planning process.

Benefits of having dynamic maps are: Dynamic maps are generally more accurate and have more flexibility. These maps can be modified after creation, this may be to adjust the conditions from forecast information to enable a better picture in the incident planning process.
This could be pursued, but it will need resource additional to the static maps as dynamic maps requiring greater resource and information data in their creation.
More work is needed to define exactly the format required for impact scenario maps.

It is suggested that a working group is set up to assess the viability, cost versus benefits and the overall need / requirement of using these maps for incident planning and incident management.
A priority is to have a consistent approach across Wales.

The following stage of work is suggested to fulfil the intentions behind this Recommendation. Implementation depends on resources and prioritisation against other workload from all parties.

Next Stage

The first step should be to utilise NRWs working group and the relevant Professional Partners to assess the benefits and risks in creating static and dynamic impact scenario maps. This would be a significant project and require suitable resourcing. The key benefits in producing these maps will need to be explored. This will need to look at the multiple benefits that may come from the use of these impact scenario maps. This would enable a decision to be made if the investment / resource warranted and can be justified.

The working group / project team to lead on the maps needs to consist of local and national leads from various teams across Professional Partners and NRW (below is a list of suggested NRW teams to be involved):

Flood Incident Management (FIM); Flood Forecasting; Flood Mapping and modelling; Geographic Information Systems (GIS), and Flood warning and Informing. The project team would need to consider estimated timings, costings, resources and benefits of this project. Following this engagement with end users and Welsh Government will be necessary.

This stage will also need to include the following.

- The group should develop the business case for the creation of a consistent set of static or dynamic impacts maps for all high risk sites across Wales.(Priority should be given to areas that currently do not have any static maps available.)
- The group needs evaluate to see that the benefits from these static / dynamic maps are effective against the required resource and investment needed.
- The group will need to assess the need of these maps in the incident planning and management process.
- The group will need to assess further the viability, cost versus benefits.

The working group should completed a business case including the above points. This should be passed on to Welsh Government. Due to the scale of this work, the potential need for large investment and resources. The Welsh Government will decide on implementation how / if this is taken forward and to what degree.

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