Flood Protection Infrastructure

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Workshop on:

Critical Infrastructure - Adaptation for Climate Change

Dublin Castle 28th April 2009

Introduction

Definition of critical infrastructure in flood defence context

Typically **Critical infrastructure** is a term used by governments to describe assets that are essential for the functioning of a society and economy. Most commonly associated with the term are facilities for electricity generation and transmission, telecommunications, transportation, water supply and public health services.

For the purposes of this paper, I am taking the definition to extend to those assets that provide protection to these facilities from flood damage. They are referred to as flood defence assets, i.e. infrastructure that provides protection from flooding to homes, businesses, infrastructure and the environment and includes embankments and walls, which have been constructed by a public authority or by a private concern. It includes river or coastal defences, natural or constructed, whether or not they are subject to a maintenance programme.

A brief outline of the critical infrastructure – existing & planned.

Do we know the defence assets?

In many cases we do know that flood defence structures exists because they have been constructed by a public authority in relatively recent times for the specific purpose of providing flood protection. Such defence assets include:

Flood defence schemes

The OPW has a significant programme of flood defence schemes as part of our wider flood risk management responsibilities. Such schemes are designed to provide the internationally accepted standard of protection and are climate checked by examining two scenarios of Climate Change.

They include also those assets constructed by the OPW as part of the Arterial Drainage Programme under 1945 Act, or as part of a coastal protection scheme. They include flood relief and drainage works constructed under statutes that pre-date the 1945/'96 Acts.

All of these schemes and assets are, in general, subject to a statutory duty of maintenance.

Old Land Commission Embankments:

In some cases, however, defence assets were constructed in the distant past and while they provide a level of flood protection, they may not always be identified as such. The design standard of protection is probably not known and the structural condition may be uncertain. It may not be the subject of regular inspection and maintenance regime. While in some cases old trust funds exist to provide for the maintenance, in reality they are now inadequate to fund a proper maintenance programme.

Urban drainage network,

The urban drainage network particularly in the older areas of cities & towns may have been designed & constructed during the Victorian era. That they are still serviceable is a tribute to their original designers/constructors and to the inspection and maintenance regimes in place in the Local Authorities.

Design and planning parameters affected by climate change and current assumptions for change.

Design of flood defences and flood relief schemes is based on historic record or on methods derived from such records and make the assumption that the period of record is statistically stationary. We normally define the level of flood defence for rivers as the 1% event and for coastal flooding as the 0.5% event, subject to the proposed scheme being cost beneficial and environmentally sustainable.

However, climate science is saying that for the future the rainfall, and hence river flows, and sea levels are likely to increase significantly. For example the recently completed Kilkenny flood relief scheme was designed to provide protection against the 1% flood. We don't know however, what level of protection the scheme will provide in say 50 years time, and hence what works need to be planned and financed to maintain the design standard, and indeed whether it is economically viable to maintain this standard.

Similarly, for coastal defences, the prediction is that sea level will rise and that surges will become more frequent. This would expose coastal defences to a greater risk of erosion, to more frequent storm events, increasing the risk of damage or collapse, and increasing the need for maintenance.

Allowances for Future Scenarios

At present the allowances that the OPW makes, in terms of numerical values for future changes in relevant phenomena or characteristics, which should typically be used for each of these scenarios, are set out in Table 1 below.

	Mid-Range Future Scenario	High-End Future Scenario
Extreme Rainfall Depths	+ 20%	+ 30%
Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 500 mm	+ 1000 mm
Land Movement	- 0.5 mm / year[1]	- 0.5 mm / year[1]

Note 1: Applicable to the southern part of the country only (Dublin – Galway and south of this)

Table 1: Allowances for Future Scenarios

It is important to note that:

– The allowances are based on current knowledge and science, and will be frequently reviewed and may be updated, as further research is undertaken

– The allowances are national, and some regionalisation or provision for the nature of the relevant catchment may be suitable where adequate knowledge or analysis would support this (although this would need to be robustly justified where the allowances are less than the assumed national allowances)

Similarly, the Greater Dublin Strategic Drainage Study sets out these values to be applied to drainage design.

Climate Change Category	Characteristics
River flows	20% increase in flows for all return periods up to 100 years
Sea level	400+mm rise (see Climate Change policy document for sea levels as a function of return period)
Rainfall	10% increase in depth (factor all intensities by1.1) Modify time series rainfall in accordance with the GDSDS climate change policy document

Table 2 Climate Change Factors to be Applied to Drainage Design

We can, therefore, have a reasonable degree of confidence that the standards for newly designed flood defences and drainage infrastructure do take the anticipated impacts of climate change into consideration. These allowances will be need to be kept under review and amended as the climate science identifies emerging scenarios and is in a position to provide further evidence on the impacts on river flows and sea levels.

Vulnerabilities of this critical infrastructure to climate change.

Two aspects of vulnerability need to be considered:

i. Failure of the asset itself through damage during flood event, inadequate maintenance programme or the design capacity being exceeded.
ii. Consequential damage to other infrastructure or assets protected by the flood defences.

The first of these has to do with the intrinsic condition and performance of the flood defence asset. The second with the infrastructure it protects from the flood event.

What is at risk? – Identify the assets

As a first step it is important to identify those significant flood defence assets that provide flood protection. These are the embankments, walls that provide protection from the flood event. As stated above these are not always known or identified and in such circumstances may be vulnerable to being removed as part of a development or other works at their location.

Vulnerabilities due to climate change-

Conor has set out in his paper the climate change impacts related to flooding. For convenience and ease of reference I've summarised them here:

- Stream flow is expected to increase in winter and spring. It is expected that an increase in the order of 20% in winter are likely by mid to late century. Reductions in summer and autumn months of over 40% are likely in many catchments. There are, however differences between catchments.

- Flood events are likely to become more frequent with the current 50 year event likely to be associated with a ~10 year return period by mid to late century. While uncertainty remains low flow events are also likely to become more frequent.

- IPCC scenarios suggest a likely sea level rise of between 0.28 and 0.43m by the end of the century, relative to 1980-1999. However, recent thinking suggests that this may be too conservative.

- The likelihood of increased storminess, higher sea levels and wind speeds will result in a subsequent enhancement of wave heights and storm surges, when combined with riverine flooding will pose serious flood risks in many of our coastal cities and for key infrastructure

Flood defence assets – designs become inadequate

Rivers,

The implications therefore are that many flood defences will not continue to provide the level of protection that was anticipated when they were built. The flood design event will be exceeded more frequently than was assumed at the design stage.

Coastal

The expected rise in sea level will impact on the coastal flood risk due to the higher water levels and to the greater and more frequent surges. It will impact also on the rate of erosion of vulnerable coastline, as it will expose areas of natural shoreline, which are not at present subject to frequent storm action

What is being done in this sector, here and internationally, to adapt to climate change.

Specifically in the area of flood risk management:

The OPW has commenced the Catchment Flood Risk Assessment and Management (CFRAM) programme. It's useful to set out here a very brief description of the CFRAM programme, as it is anticipated that the programme will address most of the shortcomings and vulnerabilities identified above.

Catchment Flood Risk Management

Underlying the policy is a fundamental shift in the way we deal with flood risk and is reflected in our Catchment Flood Risk Assessment and Management (CRFAM) Programme. The objective of the programme is to develop and implement an integrated, pro-active and catchment-based approach in line with international best practice to ensure effective management of existing and potential future flood risks

Under the Programme, it is intended to carry out Catchment Flood Risk Assessment and Management Studies Plan (CFRAMS) for each river Catchment. The output from these studies will be a Flood Risk Management Plan (CFRMP) that defines existing and foreseeable flood hazards and risks within a catchment and the methods, mechanisms, policies and proposals for managing the hazards and risks.

The CFRMP includes examination of 'most likely future scenario' and a high-end future scenario, in terms of risk, and management options for dealing with the risk identified. It is important to note that climate change is considered at every stage of the CFRAM process.

We have begun this process with pilot studies on the River Lee, the River Dodder, the River Suir, and the Fingal-East Meath area. There is an informative website for the Lee project for anyone seeking further information. (www.leecframs.ie)

The OPW intends to roll out a national programme of CFRAMS to cover all river catchments and coastal areas. The completion date, subject to continued funding by Government for the Flood Risk Management Programme, will meet the dates set out in the EU Floods Directive for the preparation of flood hazard and risk maps, and flood risk management plans.

OPW database as part of CFRAMS process

As part of the CFRAMS programme underway, the OPW plans to identify systematically the major flood defence assets and record them in a Flood Asset Database. In this way it is planned to record on a database, their position, and to inform the owners or other authorities of their importance for flood protection. The data gathered during the survey has been incorporated into our flood risk assessment. And will be used to develop a programme of flood defence asset management and maintenance.

Flood extent maps – example from Lee

Another output from each CFRAM will be a set of flood extent maps, showing the areas at risk from flood inundation for three levels of probability, 10%, 1%, and 0.1%. I've included a sample, which is in draft at present, at the end of the paper for illustration. (See figure 1)

Flood Risk Management Plan

The CFRAM process described briefly above, will develop for each catchment, a set of predictive flood maps which will include an allowance for the impacts of climate change in the delineation of the flood extent maps.

The Flood Risk Management Plan will consider various future pressures including climate change when identifying the measures and actions to manage floods in the catchment.

Design specification

The design specification for flood relief schemes (fluvial and coastal) and for urban drainage schemes as seen above will make allowances for the impacts of climate change.

Planning & Development Guidelines

During 2008, the OPW, and the DoEHLG published draft guidelines "The Planning System and Flood Risk Management". Taken together with emerging information on flood extents, these guidelines will lead to improved development decision-making by Planning Authorities and by developers.

EU floods directive

The purpose of the directive is "*to establish a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community*".

The principal requirements of the Directive are that Member States shall:

- Undertake a preliminary flood risk assessment (PFRA) to determine areas of existing or potential future 'significant' risk, and for those areas;
- Prepare flood hazard and risk maps; and
- Prepare flood risk management plans.

In Ireland, these latter two requirements of the Directive will be delivered through the Catchment Flood Risk Assessment and Management (CFRAM) Studies.

Northern Ireland

The approach in Northern Ireland is similar to that adapted here, and indeed is somewhat further advanced. I know from our regular meetings and from information on their website that the Rivers Agency has already developed Asset Management Plans for their flood defences. They have produced a Strategic Flood Map, which illustrates the areas

throughout Northern Ireland that have flooded from rivers and the sea in the past and those which are estimated to be prone to flooding now and in the future.

The map developed in co-operation with the Department of Environment to meet the requirements of its Planning Policy Statement 15 (PPS 15) - Planning and Flood Risk.

What climate change / research information is required and in what form

Uncertainty

The biggest challenge is the uncertainty associated with the climate change scenarios being developed by climate scientists. If we knew with confidence what was going to happen, it would be far easier to make the economic and other decisions related to investment in flood protection and risk management works, development planning, etc. The uncertainty requires policies to be implemented that are based on emerging scientific data and general assumptions about its impacts. The research efforts need to be concentrated on reducing these sources of uncertainty, to enable more cost effective flood risk management solutions to be devised that are 'climate change proofed'.

The OPW has been aware of the gaps in our knowledge & information in relation to the effects that climate change scenarios will have on the flood risk management programme. To address these short -comings we have identified the following areas that require research programmes.

- Rainfall and Climate Analysis
- Catchment Response Analysis
- Sea Level and Storm Surge Analysis.

Conclusions

There is uncertainty about the level of impacts climate change will have on river and coastal flooding. In the light of the costs of providing protection to our towns and cities, it is most important that this research is directed to reducing these uncertainties to allow engineers to design, construct and maintain the most cost effective defences.

Disclaimer

This paper was prepared by Tony Smyth, for presentation at an Irish Academy of Engineering workshop on "Critical Infrastructure – Adapting for Climate Change", to stimulate discussion on the potential issues relating to flooding. The views expressed are those of the author.

Acknowledgements

I would like to thank my colleagues in Engineering Services of the OPW for their contributions and help in compiling this paper, particularly Mark Adamson, and Jim Casey.

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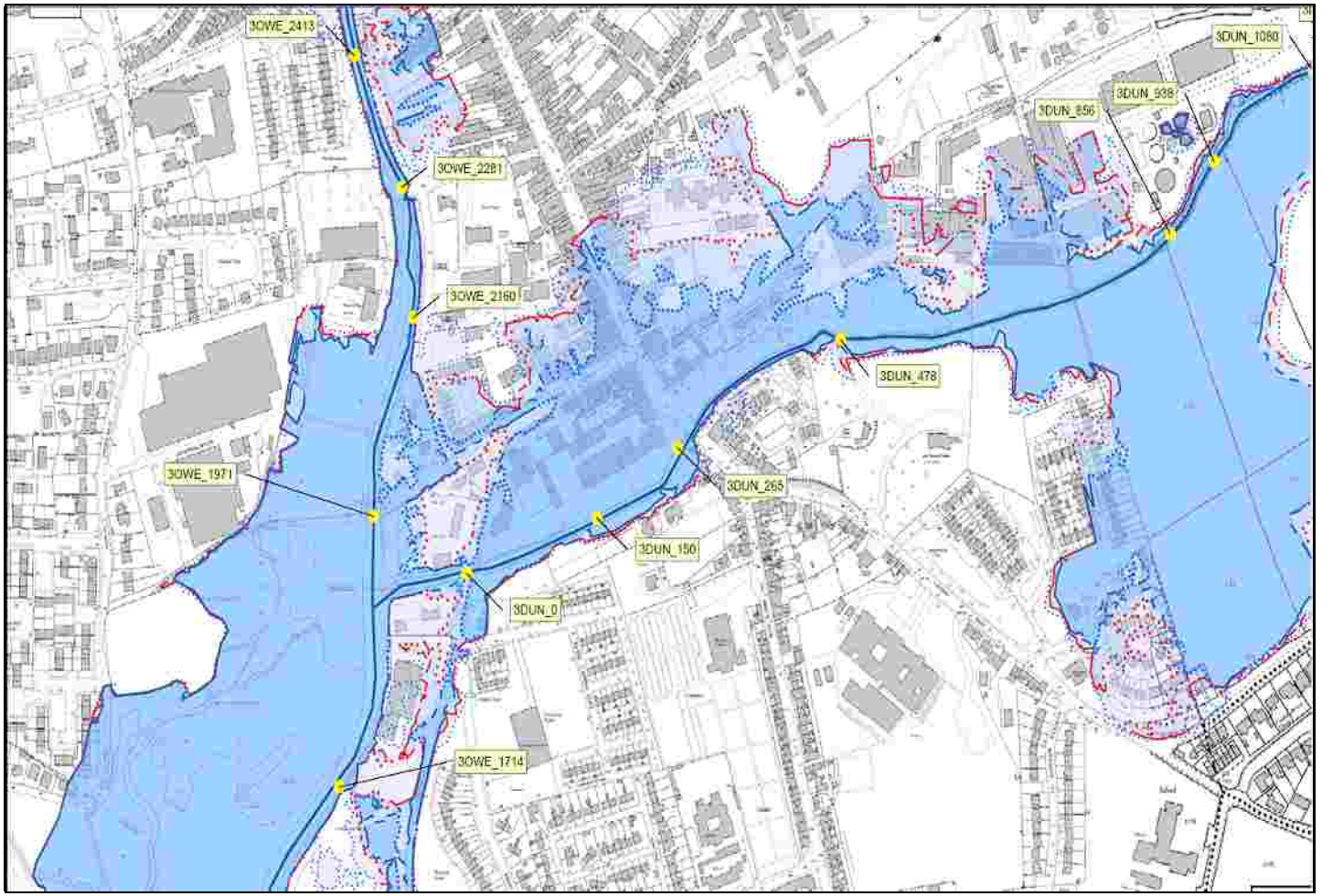

Figure 1: Sample Flood Extent Map from River Lee CFRAMS. For 10%, 1% and 0.1% predicted flood