



## **Collaboration for Environmental Evidence**

### **Systematic Review No. 89**

#### **WORKING TITLE: THE IMPACT OF CLIMATE CHANGE ON LOCAL SCALE FLOOD RISK FOR INDIVIDUAL DEVELOPMENTS**

#### **Draft Review Protocol**

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## Cover Sheet

Title	<b>Working title: THE IMPACT OF CLIMATE CHANGE ON LOCAL SCALE FLOOD RISK</b>
Systematic review	N <sup>o</sup> 89
Reviewer(s)	Professor David Proverbs, Dr Jessica Lamond
Date draft protocol published on website	23 <sup>rd</sup> February 2010
Date final protocol published on website	-
Date of most recent amendment	-
Date of most recent SUBSTANTIVE amendment	-
Details of most recent changes	-
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Sources of support	NERC
Conflicts of interest	-

## 1. Background

Climate models have converged on a consensus which predicts that future UK weather patterns will involve more flooding (Evans *et al.* 2008). Flooding will occur from many sources, wetter winters leading to more fluvial flooding, sea level rise leading to greater coastal flooding and erosion, more intense rainfall events leading to more pluvial and surface water flooding. However, the level of detail necessary for decisions about local scale flood risk has often been lacking (Steemers 2003, Nielsen 2006). For example DEFRA guidance to consider 20% increase in flood magnitudes by 2050 (Wheater 2006) may only suffice for planning purposes on sites with known and well understood fluvial flood risk.

Risk from flooding is a combination of the flood hazard coupled with exposure and vulnerability to flooding (Clark *et al.* 2002) and while climate projections may provide estimates of hazard they do not address exposure or vulnerability. The results of the scoping study have highlighted the circular nature of the enquiry into the impact of climate change on development. The projection of the impact of climate change scenarios contain implied patterns of development which themselves affect the flood vulnerability and exposure of future developments (Hall 2003, Milligan 2005). Questions about the proportion of future development at risk from climate change are crucially dependent on assumptions about planning policy and its implementation (BRE 2009, Potter 2008, Building futures 2007).

The construction industry may be more vulnerable to climate risk than other sectors due to short term reactions of other stakeholders to perceived risks (Hertin *et al.* 2003). Recent projects within the LWEC programme, the Tyndall centre, SNIFFER, Flood Risk Management Research Consortium and the EPSRC Community Resilience to Extreme Weather (CREW) network have or are considering the necessary scaling issues which will allow climate models to inform local risk planning. What should be emerging from these initiatives is a better appreciation of the type and level of flood risk information required by the construction industry and the feasibility of providing such information from climate models with sufficient precision and reliability. At the same time construction projects continue, with the developers and their consultants making use of the best available information at the various stages of the construction process.

In the pre-planning stage flood risk affects the suitability of locations for development and the conditions under which development is permitted.

Commercial viability rests upon considerations such as: possible reduced land price; increased investment in planning consent; increased construction costs; reduced saleability, mortgageability and insurability; and long term viability of the built facility.

In the planning and design stages flood risk affects the design of the built facility. Under planning conditions specific drainage, building elevation, structural designs and specialised materials may be necessitated. Developers may need to build or adopt flood defences under section 106 agreements or under the proposals in the draft water management bill. This may represent long term commitments for design and construction companies and importantly their clients. During construction of the built facility extreme weather events and flood risk may hamper construction processes causing delay and extra expense (Hertin et al. 2003). During the operation of built facilities, flood and extreme weather events cause damage to buildings and contents necessitating remedial work. Alternatively retrofitting of flood protection or mitigation measures may be necessary. Insurance premiums and contingency costs for construction firms may rise (Hertin et al. 2003). The proposed review will encompass both the prediction mechanisms and the information needs of the construction industry.

## **2. Objective of the Review**

The proposed scoping study and subsequent review would ideally encompass both the prediction mechanisms and the information needs of the construction industry.

### **2.1 Primary question**

What is the impact of climate and extreme events on local-scale flood risk for individual developments.

### **2.2 Secondary question (if applicable)**

Secondary questions addressing the primary survey question could be:

1. Is the scale of the increased flood hazard due to climate change the same in potential development sites as in regions as a whole?
2. How can the national and regional forecasts of increasing flood hazard be scaled down to the appropriate scale for development planning?
3. Will increased flood risk increase the cost of future developments or damage the profitability of construction companies?
4. Are the increased levels of flood risk due to climate change changing the way in which developments are planned?

5. What proportion of development sites will become unviable due to future increased flood hazard?
6. What sort of forecasts do construction professionals need to design developments robust to future flooding?

The scoping study identified that the literature covering all of these issues is wide and diverse. There are gaps in the evidence base regarding downscaling to local scale, the translation of climate models into impact scenarios, the impacts of uncertainty and the cost/benefit of adaptation strategies. National level consistent statistics regarding future flood risk in possible development sites is also lacking. The current initiatives by the Environment Agency and others have not yet progressed to this stage. The full review may want to concentrate on a subset of these questions.

### **3. Methods**

One of the objectives of a systematic review is to ensure that the conclusions are based on the best available evidence no matter what subject area the research derives from. In a multidisciplinary field such as flood risk management a challenge for reviewers is to ensure adequate coverage of all the potential sources of evidence. The scoping study identified that the previous search strategy had great merit but also highlighted some modifications which will ensure the full review encompasses more of the literature.

#### **3.1 Search strategy**

Databases of academic and industry sources will be scoped during this study. Generic search engines will also be used. As this review concerns impacts on the construction industry there may be a large contribution from grey literature sources. The websites of specialised organisations which may contain relevant information will also be accessed. During the full review study the a maximum of 50 references will be extracted from each database up to a combined maximum of 400. More specialised databases will be sampled first and duplication will be avoided.

##### **3.1.1**

Database sources:

- Compendex
- ISI web of knowledge
- Directory of Open Access Journals
- Sciencedirect
- Infotrac
- EBSCO host research databases
- ICE virtual library

- Geobase
- Knovel Interactive
- Construction Information Service
- Ethos
- IngentaConnect

Search websites:

- Google scholar
- Google

Websites of Specialised organisations UK:

- Construction Industry Research and Information Association
- Building Research Establishment
- Commission for Architecture and the Built Environment
- House Builders Federation
- Royal Institution of Chartered Surveyors
- Royal Institute of British Architects
- Royal Town Planning Institute
- National Flood Forum
- Environment Agency
- Centre for Ecology and Hydrology
- British Hydrological Society
- Scotland and Northern Ireland Forum For Environmental Research
- Tyndall Centre for climate change research
- UK Climate Impacts Programme
- Flood risk management research consortium
- Scottish Environment Protection Agency
- Office of Public Works
- Royal Geographical Society
- British Geological Survey
- Department of the Environment Food and Rural Affairs
- Community Resilience to Extreme Weather
- Planning portal
- Chartered Institute of Building
- Flood risk management research consortium
- Association of British Insurers
- Local Authorities

International:

- International Association of Hydrological Sciences

- Flood Awareness and Prevention Policy Border Areas
- FLOODsite
- Flows
- Conseil International de Batiment
- European Environment Agency
- International Panel on Climate Change
- United Nations Environment Programme
- Atlantis
- Espace

### 3.1.2 Search terms

Subject terms	Intervention terms	Outcome terms
Property level	Environmental Change	Flood
Housing development	Climate change	Inundation
Development site	Changing climate	Drainage exceedance
Building development	UKCIP	Runoff
Construction site	Increasing risk	Surface water
Construction project	Future risk	Groundwater
Local scale	Global warming	
Building site	Increased frequency	
Building plot	Changing risk	
Site level	Growth in	
Individual development	Greenhouse effect	
Development scale	Climate threat	
Property development	Increasing hazard	
Urban development	Increasing probability	
High resolution	Increasing vulnerability	
Fine grain		
Local adaptation		
Small scale		
Flood risk assessment (FRA)		
PPS25		
Downscaling		

### 3.2 Study inclusion criteria

All studies retrieved will be assessed for relevance at title and then abstract level. Those passing through the title and abstract filters will then be viewed at full text level. Articles without abstracts will be viewed at full text.

- **Relevant subject(s):** Studies which concentrate on small or local scale and property level present disaggregated or high resolution data.
- **Types of intervention:** Studies relating to future hazards and risk in the presence of changing climate or risk scenarios

- **Types of outcome:** must include flooding
- **Types of study:** methodological studies, empirical studies and statistical analyses of risk. Guidelines and policy documents. Flood risk assessments and flood management plans
- **Geographical scope of empirical and statistical studies:** UK
- **Geographical scope of methodological studies:** developed world
- **Language scope:** English language only

### 3.3 Potential effect modifiers and reasons for heterogeneity:

There will be considerable heterogeneity in estimates of future flood risk depending on the climate change scenario assumed. There will also be heterogeneity in the presentation of future risk scenarios from detailed maps to overview statistics.

### 3.4 Study quality assessment:

In arriving at empirical estimates of future flood risk a wide variety of models may be used and there is no available discriminator which can determine which models are to be preferred. Studies will therefore be assessed against the existing guidelines for generating flood risk assessments and whether they use recognised data sources and recognised climate change scenarios.

### 3.5 Data extraction strategy:

It is anticipated that empirical data presented will vary immensely from potentially high resolution maps of specific areas to statistical overviews of potential local or regional changes in average flood risk to specific guidelines regarding potential flood depths. It is beyond the scope of this review to collect and reformat detailed flood maps so the data extraction will be twofold, to record the available detailed datasets and to extract any summary information available regarding average changes in flood risk.

### 3.6 Data synthesis and presentation:

The appropriate level of synthesis will depend on the ability to extract averages from detailed risk assessments. As a minimum the data will be tabulated by region, type of study, climate change scenario and key statistic type. If possible the distribution and expected values of estimates under similar climate scenarios will be examined using robust statistics such as median and boxplots. Estimates of different scenarios in the same region will also be compared where available.

## 4. Potential Conflicts of Interest and Sources of Support

This study is being carried out as part of a NERC funded systematic review into the impact of climate change on the construction industry.

## 5. References

- Bre (2009) *Life handbook. Long-term initiatives for flood-risk environments.* (Bracknell: BRE).
- Building Futures (2007) *Living with water: visions of a flooded future.* (London: RIBA).
- Clark, M. J., Priest, S. J., Treby, E. J. and Crichton, D. (2002) *Insurance and UK floods a strategic reassessment.* Report of the Tsunami Project, (Universities of Southampton, Bournemouth and Middlesex).

- Evans, E. P., Simm, J. D. and Thorne, C. R. (2008) *An update of the foresight future flooding 2004 qualitative risk analysis*. (London: Cabinet Office).
- Hall, J., E. P. Evans, E. Penning-Rowsell, P. Sayers, Cr Thorne, and Aj Saul (2003) Quantified scenarios analysis of drivers and impacts of changing flood risk in England and Wales: 2030-2100. *Environmental Hazards*, **5**(3-4), pp. 51-65.
- Hertin, J., Berkhout, F., Gann, D. M. and Barlow, J. (2003) Climate change and the UK house building sector: perceptions, impacts and adaptive capacity. *Building Research and Information*, **31**(3-4), pp. 278-290.
- Milligan, J., a Jordan, J. Hall, M. E. Dickson, R. J. Nicholls, M. Walkden, J. Richards, P. Bates, and R. J. Dawson (2005) *Assessing coastal flood risk at specific sites and regional scales: Regional assessment of coastal flood risk*. Tyndall Centre Technical Report 45, (Tyndall Centre).
- Nielsen, J. (2006) On the design of buildings in relation to climate change. *World Conference for Accelerating Excellence in the Built Environment*, October 2006, Birmingham.
- Potter, K. (2008) Planning space for water. *10th National Hydrology Symposium*, Exeter, (British Hydrological Society).
- Stemmers, K. (2003) Towards a research agenda for adapting to climate change. *Building Research and Information*, **31**(3-4), pp. 291-301.
- Wheater, H. S. (2006) Flood hazard and management : A UK perspective. *Philosophical transactions of the Royal Society of London (A)*, **364**, pp. 2135-2145.